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Fertilizer by Weed Management Study:

1998
Annual Report

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Forward

The Fertilizer by Weed Management Study was initiated to determine the effect of fertilizer timing and placement in conservation tillage with weed management.

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- Monsanto Canada Inc.
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Note: The data presented within this report are preliminary in nature and should not be taken out of context from other research. Basic agronomic and weed management data are presented in this report. Additional information will become available from further laboratory analysis of 1998 samples. The data from other years and further statistical analysis are required before the data can be generalized. The data should not be used without the permission of the authors.

Executive Summary

1998 saw the completion of the third year of the nitrogen management study at Brandon, Melfort, and Beaverlodge, and the second and final year of the mono-ammonium phosphorus and potassium chloride MSc project by K. Callow. In all instances, plot work and data analysis was successfully completed. For the first time, extensive technology transfer occurred using project information at field days, presentations at winter meetings, and published papers in proceedings of technical and producer conferences (included in report). Data from the final two years, 1999 and 2000, will address questions that are still unanswered and allow for a complete analysis of the response of weeds species to the five fertilizer/direct-seeding systems tested in this project.

Results from 1998 again indicated that no single nitrogen fertilizer/direct-seeding system consistently provided the highest yields nor the lowest weed density; however, several trends have emerged. Firstly, the sweep seeded treatment tends to have lower yields and higher weed densities, especially at Melfort and Brandon, but results were highly variable. Secondly, the narrow-row- spacing low-disturbance one-pass treatment (9") is the most consistent, particularly at Melfort and Brandon while lower yields and increased weediness have become apparent for the wide-row- spacing low disturbance treatment (12"). These reduced yields are likely due to inadequate separation between the nitrogen fertilizer (2.5 cm beside and 2.5 cm below the seed) and the seed row and is therefore as much a side banding issue as a row-spacing issue. The problem could be solved using slow release urea fertilizer treatments, safer forms of nitrogen, or greater physical separation between fertilizer and seed. Interestingly, the yield reduction problem at wide row spacing occurred more frequently in wheat although it was more dramatic when it occurred in canola. This is a new finding. Furthermore, fall banding was found to increase weediness at seeding compared to other treatments, but before implications for yield can be ascertained, several years more data are required.

1998 marks the end of research comparing wheat development among the treatments by G. Lafond. A paper comparing results from 1996-1999 will be prepared. Main stem Haun stage can be used as an accurate estimator of speed of plant emergence. In 1998, there were no nitrogen treatment effects at Beaverlodge on main stem Haun stage. At Melfort, there was a significant effect where the pre-seeding nitrogen banding treatments were slightly more advanced than treatments where the nitrogen was side-banded during the seeding operation. The sweep treatment was similar to the pre-seed banding treatments. At Brandon, there was more significant effects, probably a reflection of the lower standard error recorded. The treatment where the full rate of herbicide was used was slightly more advanced than where only 66% of the full rate was used. The pre-seeding bands and the sweep treatments were slightly more advanced than the the 9" and 12" spacing where the nitrogen was side-banded during the seeding operation. The 9" with fertilizer side-banded at seeding time was also slightly more advanced than with the similar treatment on 12". Overall, where treatment effects were present, the absolute differences tended to be small.

Information on differences in wheat and canola disease in the five fertilizer/seeding systems was gathered for the first time in these trials in 1998. Initial data from Brandon by D. McLaren found that blackleg incidence on canola was slightly greater in the fall banded treatment and confirmed previous laboratory work showing that glyphosate application to stubble can reduce blackleg. In the study, blackleg was worse in plots receiving the lower rate of glyphosate, especially in the low-disturbance single pass treatments. Initial data collected by K. Turkington at Beaverlodge found that root diseases in wheat were least in the side-banded low-disturbance treatments and greatest in the sweep treatments. The next two years of the trial will provide an opportunity to gather further data on the plant diseases within the trials if additional funds can be found.

New information was found in the results from the two years research on the impact of P&K on weed-crop interactions in wheat and flax. Firstly, a competitive advantage against wild oats from the "pop up effect" of these nutrients applied at low to moderate rates was not observed. Secondly, toxicity leading to yield loss at high rates of P&K did not occur or were less than anticipated; however, side banding provided higher crop yields and lower wild oat growth and dockage compared to seed placed fertilizer indicating that some toxicity did occur. 1997 and 1998

were two very different growing seasons, but overall fertilzer rate responses were the same both years; however, in the dry year of 1997 losses due to the presence of wild oat occurred, while in 1998, a wet year, the difference between side band and seed place fertilizer was particularly evident. Greenhouse and field data indicated that wild oat had a much greater ability to uptake both phosphorus and potassium than spring wheat and flax. In general, flax was relatively unresponsive to P and K in the field, while wheat showed significant increases in yield to high rates of P, but a yield decline at all K rates on soils with high background K levels. The yield decline corresponded with an increase in wild oat dockage, therefore, the effect may have been due to increased wild oat competition from the addition of KCl on high K soils. Wheat yield increases at low K rates on soils with average background K levels did occur. Further research to explore the implications of these results on the effect of P&K on crop-weed competition in direct-seeding systems would lead to improved fertilizer recommendations for this new approach to crop production.

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Introduction

Objectives:

1) To determine the impact of fertilizer placement and timing in direct-seeding systems on N fertilizer-use efficiency, herbicide usage, and weed communities. This objective is being met through the establishment of a short-term management study in three agroecological zones of the Black soil zone.

2)To determine the impact of P and K fertilizer on weed-crop competition. This objective is being met through a graduate student MSC. thesis project.

Background:

Direct-seeding systems are the most rapidly evolving agricultural technology in western Canada. Direct economic and soil conservation benefits have been documented at the farm and research level and have become the driving forces behind producer adoption of these conservation-tillage systems. Because the term direct seeding encompasses a broad range of one- and two-pass fertilization and seeding systems, questions have arisen regarding the relative efficiency of these different approaches. The most commonly asked questions relate to the effects of soil disturbance and fertilizer placement on crop yields, weed management, and production economics.

Potential Impact and Benefits:

The project will provide a knowledge base for efficient fuel, fertilizer, and herbicide usage thereby optimizing net-returns at a cropping-systems level for the Black Soil Zone. The data generated from this research will be the largest data base dealing in an integrated manner with the impact of fertilizer placement on weeds in direct-seeding systems and will be of interest to producers and the agro-industry. The principles elucidated will have regional and national application. The commercialization of this knowledge will occur through field days, presentation at grower meetings, and through the publication of results in the farm press, industry and extension publications and scientific journals. As decision support systems are developed, this data will be useful for predicting the response of crops, weed communities, and soils to direct-seeding systems and recommending appropriate management options.

Project Description:

I) Protocol for Management Studies:

a) General description:

The management studies were set up in a split-split plot design with 4 replicates. Plots were 7.3m X 15.0m in size. Crops (wheat and canola) were the main plot, fertilizer placement was the sub-plot, and herbicide rate was the sub-sub plot. For the sake of statistical analysis, all agronomic data was analysed by crop separately. Once several years of data are collected, weed community analysis by multivariate ordination will be done with using all plots in the analysis (wheat and canola plots used together).

In order to reduce site to site variability, seeding was done at all sites using identical seeders. Conservapak zero-tillage air seeders setup to seed on 9 inch and 12 inch row spacings were used (one pair of seeders at each site). For the sweep seeding, sweeps were purchased from a common sourse and used at all locations.

b) Core Treatments at each site:

-each of the following fertilizer treatment will be conducted in wheat and canola at 100% and 66% of in-crop herbicide rates with treatments being continuous (in same plot with crop rotating annually) for 5 years (1 startup year plus 2 cycles of crop rotation).

Treatment	Spacing of fertilizer (in)	Row spacing of seed (in)
fall band	12	9
spring band	12	9
side band at seeding	9	9
side band at seeding	12	12
one pass sweeps	9	9

Note; additional fertilizer treatments have been added at Melfort and Beaverlodge but are not summarized in this years report.

c) Agronomic Information:

I)Fertility: 66% of soil test recommendations for N

-approximately 85lb/ac at Melfort, 70 lb/ac at Beaverlodge, 65 lb/ac at Brandon

-$P_2 0_5$: recommended rate (adjust N)

-S: elemental as required

ii)Crops: Teal wheat-common source from Melfort

Seed at 2 bu/ac (160 kg/ha)

Quest RR canola- common source from Monsanto

Seed at 7 kg/ha plus Furadan or Counter

iii)Herbicides: Pre-seeding, pre-harvest, and post-harvest as required at each site

In-crop use common treatments

Roundup in canola (1.24L/ha (0.5 l/ac) = 1X, 0.82L/ha=66%)

Horizon plus target in wheat

(Horizon rate wild oat rate 230ml/ha(56gai/ha)=1X and reduced rate of 172.5ml/ha=75%X and 60% of wild oat and green foxtial rate). Reduced rate for Horizon changed based on dose response information from Ciba's data base. Target is to be used as a tank mix (it should control most weeds at all sites). 1X rate = 1.0 L/ha and 66% =0.66L/ha (Note that 1.0l/ha is at the low end of the recommended range, but should still suppress cleavers and other difficult to control weeds).

iv)Fungicides: As needed at each site

d)Data Collection:

I)Crop data: -crop stand prior to tillering (4-1m row counts per plot for wheat & canola using 4-0.25 m2 quadrats per plot for sweeps)

-head count 4 1m row per plot in wheat

-crop height in canola and wheat

ii)Haun Stage (wheat only):

-Haun stage and depth of seeding at 5-6 lf stage (GS 32 start of elongation) in full and reduced rate herbicide plots. Collect 20 plants/plot at 5-6 leaf stage in wheat.

iii)Nutrient dynamics:

-biomass at heading of weeds and crop

-1 of $1m^2$ quadrat per plot (separate weeds and crop) dry weight (also give biomass data to Derksen for weeds) and send ground samples to Grant (need about 25 grams, but for weeds send what there is).

iv)Yield: -per plot

-seed quality (1000k count, protein, green seed in canola, etc?)

-oil content for canola at Beaverlodge ??

e)Soil Sampling:

-soil moisture: 0-6, 6-12, 12-24, 24-36 spring and fall

-archive samples each year

-soil fertility: fall for N and P

0-6 and 6-24

f)Weeds:

-for counts use 20 0.5 X 0.5 m^2 ($0.25m^2$) quadrats per plot (always take the same # crop rows per quadrat). For very dense weed species devide quadrat into 4, count in one quarter of the quadrat, and multiply by 4 for density per quadrat on input sheets.

-count all weeds by species (density/quadrat)

Pre-seeding, pre-spray (in-crop), and residual weed community (July)

-send electronic files to Derksen for analysis (format to be sent out)

-emergence: estimate number of days difference in emergence between each dominate weed and the crop (Derksen will do detailed emergence sampling)

-need a weedy check in each plot (make tarp to cover about $2m^2$ so that a $1m^2$ weedy quadrat remains after spraying. Need a weed count at spraying and in July in this quadrat that is separate from "20 quadrat" count. Harvest and thrash separately from main plot to obtain an estimate of crop yield loss due to weeds (i.e., sample of crop yield, weed yield)

-crop tolerance 7 DAT on 0-100 ECW scale for wheat and canola

Summary Papers Published in MANDAK Proceedings in 1999

Weed Management and Fertilizer Interactions for Nitrogen Timing and Placement in Zero Tillage

D.A. Derksen[1], A. Johnston[2], G. Clayton[3], C.A. Grant[1], G.P Lafond[4], and K.N. Harker[3]. Agriculture and Agri-Food Canada: [1] Box 1000A RR#3 Brandon, MB. R7A 5Y3; [2] Box 1240 Melfort, SK S0E 1A0; [3] Bag Service 5000, Lacombe, AB T4L 1W1; [4]Box 760, Indian Head, SK S0G 2K0.

Direct-seeding systems are the most rapidly evolving agricultural technology in western Canada. Economic and soil conservation benefits have been documented at the farm and research level and have become the driving forces behind producer adoption of these conservation-tillage systems. Because the term direct seeding encompasses a broad range of one- and two-pass fertilization and seeding systems, questions have arisen regarding the relative efficiency of different approaches. The most commonly asked questions relate to the effects of soil disturbance and fertilizer placement on crop yields, weed management, and production economics.

Field research was initiated at Brandon MB, Melfort SK, and Beaverlodge AB to determine the impact of the different timings and placements of nitrogen (N) on wheat and canola agronomy and weed dynamics.

Materials and Methods

Studies were established in 1996 on AAFC research stations at the respective locations. The experiments were set up in a split-split plot design with 4 replications. Plots were 7.3m (24') X 15.0m (50') in size. Crops (wheat and canola) grown in rotation were the main plot, fertilizer treatments (placement and timing) were the sub-plots, and herbicide rate used was the sub-sub plot. For the sake of statistical analysis, all agronomic data were analysed separately by crop. In order to reduce site to site variability, seeding was done at all sites using identical air-seeders setup to seed on 22.5 cm (9") and 30 cm (12") row spacings (one pair of seeders at each site). With these seeders MAP fertilizer (11-51-0) was seed placed and for side banding treatments urea nitrogen fertilizer (46-0-0) was side banded 2.5cm (1") to the side and 2.5cm (1") below the crop row. The high disturbance seeding treatments (sweep seeding) were seeded with 30 cm (12" inch) shovels on 22.5 cm (9") spacing (using the 22.5 cm row spacing seeder). To ensure uniformity, sweeps were purchased from a common source and used at all locations.

Table 1. Treatments used to compare one and two pass, and high and low disturbance seeding systems at each site.

Treatment	Spacing of fertilizer	Row spacing of seed
fall band	30.0cm/12"	22.5cm/9"
spring band	30.0cm/12"	22.5cm/9"
side band at seeding	22.5cm/9"	22.5cm/9"
side band at seeding	30.0cm/12"	30.0cm/12"
sweep seeding/harrow packing	22.5cm/9"shanks spacing + sweeps	22.5cm/9"shank spacing + sweeps

Each of these fertilizer treatments was present in wheat and canola with the two crops rotating on an annual basis. To determine the long-term impact of adopting one of these approaches, the fertilizer treatments remained constant from year to year (eg: fall banding treatments always occurred on previous fall banding plots). The experiments were established to run for five years. To determine if efficient fertilizer usage by the crops would reduce weed competition, each of the fertilizer treatments was duplicated at 100% and 66% of recommended rates of Horizon plus Target and Roundup in wheat and canola, respectively (herbicide plots remained constant from year to year eg. the 100% rate was used every year in the same plot regardless of crop). This resulted in 10 fertilizer/herbicide treatments in each crop per replicate for a total of 80 plots per site.

Agronomic details: To best determine the efficiency of nitrogen fertilizer, it was applied at 66% of typical recommended rates. This was 85kg/ha at Melfort, 70 kg/ha at Beaverlodge, 65 kg/ha at Brandon with N rates adjusted for nitrogen in MAP which was seed placed at soil test recommendation levels. Sulphur fertilizer was applied as needed at each site for canola production. Teal wheat was seeded at 160 kg/ha. Quest canola (Round-Up/glyphosate tolerant) was seed at 7 kg/ha plus granular insecticide for flea beetle control. Pre-seeding, pre-harvest, and post-harvest herbicide treatments were applied as required at each site. In-crop use was kept common at all sites with Roundup (glyphosate) applied to canola at a rate of 1.24L/ha for the 100% rate treatment and Horizon (clodinafop propargyl) plus target in wheat at 230ml/ha for the 100% rate. Target (MCPA + mecoprop+ dicamba) was applied as a tank mix with Horizon to control most broadleaf weeds at all sites with the 100% rate being 1.0 L/ha. Fungicides were applied as needed for plant diseases at each site.

Crop stand counts, head counts, height, Haun stage (wheat only) were evaluated to compare the impact of the treatments on crop growth. Whole plots were harvested and canola was swathed prior to machine harvesting. Grain samples were cleaned to grain commission standards and corrected for differences in moisture prior to data analysis. To compare nutrient dynamics, weed and crop biomass samples were collected at crop heading and analysed for nutrient content. Protein levels were determined for the grain samples. Soil samples were taken in the spring and fall of each year from each plot to determine moisture usage and in the fall for nutrient analysis. Weeds were identified by species and counted in 20 0.5 X 0.5 m^2 ($0.25m^2$) quadrats per plot prior to seeding, before in-crop spraying and in late July each year. Since this the purpose of this paper was to summarize the trends during the first 3 years of the trials, only yield data and weed counts will be presented.

All data were subjected to an analysis of variance with means separated by determining the Least Significant Difference ($p<0.05$) or orthogonal contrasts ($p<0.05$). For the sake of data summarisation the number of site years where statistical differences occurred, and the rank of least weedy and rank of highest yields for each treatment were presented. Sixty seven weed species were present within the study including typical annual species, perennial species, and volunteer crops as weeds with about 30 species present in a site year. Total weed density information was used to summarize the weed data for this paper.

Results and Discussion

When statistical differences in crop yields were compared for the 9 site years of data (1996, 1997, 1998 at each of the three sites), no one fertilizer treatment was superior in the majority of cases and in all but one case reducing the rate of herbicide in wheat or canola did not reduce yield (Table 2). Fall banding N was better than spring banding at Melfort for wheat in 2 of 3 years while spring banding was better in 1 of 3 years at each site. Seeding wheat on the narrow row spacing was superior to the wide row spacing for 2 of 3 years at Brandon and Melfort and 1 of 3 years at Beaverlodge. Seeding canola on the narrow row spacing was superior at Brandon in 2 of 3 years, but did not have the same effect at Melfort or Beaverlodge. In no case was the wide row spacing superior to the narrow for wheat or canola yield. Seeding with sweeps had a positive impact on wheat yield in some cases and a negative impact on others while seeding canola with sweeps had a negative impact in 2 of the 9 site years.

To further compare differences between treatments data were ranked from highest to lowest yields (Table 3). Since herbicide rates were not significantly different, only the 5 fertilizer treatments were ranked. Again the data indicated that no one treatment was the best over all, but that the most consistent treatment was the 20 cm (9") side banded treatment for both crops, especially at Brandon and Melfort. However, considerable variability existed with any one treatment being ranked from highest to lowest yield depending on site and year and crop. For example, at Brandon the sweeps were generally ranked 4th or 5th while the reverse was true at Melfort. Furthermore, while sweeps were ranked 1st for wheat in 1996 and 1997 they ranked 4th and 5th for canola grown during the same years at Beaverlodge. Therefore, the pursuit of the ultimate seeding system may be less important than other aspects of crop agronomy in direct-seeding systems.

When the impact of fertilizer and herbicide management on weeds was compared for statistical differences over the 8 site years of data (data not available for Melfort in 1996) no one treatment was consistently the most or least weedy (Table 4). Prior to seeding, fall banding treatments in wheat (canola stubble) were weedier than other treatments. For canola, fall banding was weedier in 2 of 8 site years, but spring banding was weedier in 3 of 8 site years. Particular attention should be paid to the pre-spray weed counts since this is when most of crop yield losses due to weeds occurs. At this time spring banding fertilizer was weedier than fall banding in 4 of 8 site years in wheat (canola stubble), but fall and spring banding each were weedier than the other in 2 of 8 situation for canola (wheat stubble). When differences occurred, random banding (fall or spring) was weedier than side banding. Sweeps were more often weedier at the in-crop stage. These data suggest that side banding has the greatest potential to reduce crop losses due to weeds. When statistical differences occurred at the July time frame the residual weeds were generally greater in fall versus spring banded treatments, wide versus narrow row spacings, and in sweep treatments. In only 1 of 8 site years was the reduced herbicide rate plots weedier than high rate plots at the in-crop time frame. This indicates that potential crop yield losses due to increased weediness in reduce rate treatments may not be as great as has been thought; however, in 7 of 8 cases reduced rate plots were weedier in late July indicating the potential for increased losses due to weed pressure does exist.

When treatments were compared by ranking weediness, the fall banded and sweep seeded treatments tended to be the weediest while the side banded treatments tended to be the least weedy prior to seeding the crop (Table 5). At the time of in-crop spraying, when crop losses due to weed competition occurs, fall banded wheat plots were the least weedy followed by side banded treatments with sweeps and spring banding tending to be the most weedy (Table 6). A consistent pattern of increased or decreased weediness due to low rates of herbicide being used was not evident at either the pre-seeding or the in-crop time of assessment. Conversely, in July weediness ranked higher for plots receiving the low rate of herbicide (Table 7). At this time the wide row spacing treatments ranked as weedier compared to those with narrow row spacings. Due to variability between sites, years, and crops it was difficult to find consistent differences among the five fertilizer management systems based on ranking weediness in July.

Conclusions

The row spacing comparisons require further discussion. The lack of increased weediness of the wide row spacing treatments and the increased weediness of the narrow row spacing treatment (1 of 8 site years only) at the time of in-crop spraying indicates that the potential for crop yield loss due to weed competition may not neccesarily be greater at the wide row spacing. However, there was an increased weediness of the wide row spacing in July and lower crop yields in this treatment. Past research showing wide row spacings do not have lower yields was conducted without side banding N. The urea fertilizer being placed 2.5 by 2.5 cm (1" by 1") to the side and below the seed may have caused the yield reduction and subsequent increased weediness of the wide row spacing treatment due to the higher concentration of N in the band (same rate per unit area in narrow and wide row spacings). Furthermore, this problem for side banding may be alleviated for any row spacing by changing the form of N to a potentially less toxic source, using urease inhibitors to delay the release of N from urea, and physically increasing the separation between seed and fertilizer. The main point of these results is that there is greater potential for crop injury from side banding urea than was previously thought, but that side banding over all performed well from a weed point of view compared to random banding or high disturbance sweep seeding and therefore requires further research to get the full potential benefits from one pass seeding.

Caution should be used when interpreting the data presented in this paper because using ranked rather than absolute values may give the impression that larger or smaller differences occurred. For example, yields among the fall, spring, narrow row spacing, and sweep treatments in wheat were often very close despite differences in rank. Conversely, although the narrow and wide row spacing canola treatments were often ranked close together, large differences in yield occurred in some instances.

Several generalizations can be made from the data after three years of research, but the full story will become evident after 5 years. In general, the low rate herbicide treatments have not led to lower yields despite weedier conditions in July of each year. This may be due to lack of differences in weed pressure at the time of in-crop spraying suggesting that the occasional use of lower than registered herbicide rates will not necessarily lead to production problems. The fertilizer/disturbance treatment that has been most consistent for yield and weediness to date for wheat and canola has been the narrow row spacing side banded treatment. However, it is worth noting that no one treatment performed the best every year or at every location. Future data will help to elucidate interactions between herbicide rates and fertilizer/disturbance treatments.

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Table 2: The number of site years where differences in crop yield were significantly different

	Wheat				Canola		
	Brandon	Melfort	Beaverlodge	total	Brandon	Melfort	Beaverlo
Fall band >Spring band	0	2	0	2	0	0	0
Spring band >fall band	1	1	1	3	0	1	0
12"row spacing >9" row spacing	0	0	0	0	0	0	0
9">12"	2	2	1	5	2	0	0
Sweep> other treatments	0	1	1	2	0	0	0
Sweep< other treatments	1	2	0	3	2	0	0
over all fertilizer treatments ns	1	0	2	3	1	2	3
66% herbicide <100% herbicide	0	0	1	1	0	0	0
herbicide rate ns	3	3	2	8	3	3	3

< = yield is less than, >= yield is greater than, ns= not significant

Table 3: Rank of crop yield from highest to lowest.

Crop	Fertilizer treatment	Brandon 1996	Brandon 1997	Brandon 1998	Brandon mean rank	Brandon rank of mean	Melfort 1996	Melfort 1997	Melfort 1998	Melfort mean rank	Melfort rank of mean	Beaverlodge 1996	Beaverlodge 1997	Beaverlodge 1998	Beaverlodge mean rank	Beaverlodge rank of mean
Wheat	Fall Band	2	4	1	2.3	1	2	5	2	3.0	3	5	3	1	3.0	3
Wheat	Spring Band	4	2	2	2.7	3	3	1	5	3.0	3	2	2	2	2.0	1
Wheat	Side Band 9"	3	1	3	2.3	1	4	3	1	2.7	2	4	4	4	4.0	5
Wheat	Side Band 12"	1	5	5	3.7	4	5	4	3	4.0	5	3	5	3	3.7	4
Wheat	Sweeps	5	3	4	4.0	5	1	2	4	2.3	1	1	1	5	2.3	2
Canola	Fall Band	4	1	2	2.3	2	3	5	5	4.3	5	2	1	3	2.0	1
Canola	Spring Band	2	3	3	2.7	3	5	3	2	3.3	4	1	3	4	2.7	2
Canola	Side Band 9"	3	2	1	2.0	1	4	1	1	2.0	1	3	2	5	3.3	3
Canola	Side Band 12"	1	4	5	3.3	4	1	4	3	2.7	3	5	4	2	3.7	5
Canola	Sweeps	5	5	4	4.7	5	2	2	3	2.3	2	4	5	1	3.3	3

Table 4: Number of site years where differences in total weed density were significantly different (8 site years total- no data for Melfort in 96).

	Wheat				Canola			
	pre-seeding	pre in-crop spraying	residual (late July)	total	pre-seeding	pre in-crop spraying	residual (late July)	total
Fall band >Spring band	5	0	3	8	2	2	0	4
Spring band >Fall band	0	4	0	4	3	2	1	6
Random band > Side banding	1	3	1	5	2	2	0	4
Side band >Random banding	1	0	0	1	0	1	2	3
12" row spacing >9" row spacing	0	0	2	2	0	0	2	2
9">12"	0	1	0	1	0	1	0	1
Sweep> other treatments	0	1	1	2	1	2	2	5
Sweep< other treatments	1	0	0	1	0	0	0	0
66% > 100%	0	0	4	4	1	1	3	5
100% > 66%	1	0	0	1	0	0	0	0

<= less weedy than, >= more weedy than

Table 5: Pre - seeding rank of total weed density from least weedy (1) to most weedy (10).

Crop	Fertilizer application	Herbicide Rate	BRANDON 96	97	98	mean rank	rank of mean	MELFORT 97	98	mean rank	rank of mean	BEAVERLODGE 96	97	98	mean rank	rank of mean
Wheat	Fall Band	100%	4	5	9	6.0	6	9	10	9.5	9	2	7	10	6.3	8
Wheat	Fall Band	66%	5	7	10	7.3	10	10	9	9.5	9	1	10	4	5.0	4
Wheat	Spring Band	100%	7	3	3	4.3	3	1	4	2.5	2	5	6	1	4.0	2
Wheat	Spring Band	66%	10	2	7	6.3	7	2	6	4	3	4	3	7	4.7	3
Wheat	Side Band 9"	100%	3	1	8	4.0	2	8	2	5	6	8	1	8	5.7	7
Wheat	Side Band 9"	66%	2	8	6	5.3	4	6	7	6.5	7	7	5	3	5.0	4
Wheat	Side Band 12"	100%	6	6	4	5.3	4	7	1	4	3	3	2	5	3.3	1
Wheat	Side Band 12"	66%	1	4	1	2.0	1	5	8	6.5	7	9	4	2	5.0	4
Wheat	Sweeps	100%	9	9	2	6.7	8	3	3	3	1	6	9	9	8.0	9
Wheat	Sweeps	66%	8	10	5	7.7	9	4	5	4.5	5	10	8	6	8.0	9
Canola	Fall Band	100%	3	9	9	7.0	7	5	3	4	3	1	5	10	5.3	4
Canola	Fall Band	66%	1	10	10	7.0	7	8	10	9	9	2	7	9	6.0	7
Canola	Spring Band	100%	7	8	4	6.3	6	1	1	1	1	4	8	8	6.7	10
Canola	Spring Band	66%	10	6	8	8.0	10	2	6	4	3	3	10	3	5.3	4
Canola	Side Band 9"	100%	2	5	1	2.7	2	6	2	4	3	8	2	5	5.0	3
Canola	Side Band 9"	66%	6	2	7	5.0	4	10	5	7.5	8	10	1	2	4.3	1
Canola	Side Band 12"	100%	5	1	5	3.7	3	3	4	3.5	2	7	9	1	5.7	6
Canola	Side Band 12"	66%	4	3	2	3.0	1	9	9	9	9	5	4	4	4.3	1
Canola	Sweeps	100%	9	4	3	5.3	5	4	8	6	6	6	6	7	6.3	9
Canola	Sweeps	66%	8	7	6	7.0	7	7	7	7	7	9	3	6	6.0	7

Table 6: Pre in-crop spraying rank of total weed density from least weedy (1) to most weedy (10).

Crop	Fertilizer application	Herbicide Rate	BRANDON 96	97	98	mean rank	rank of mean	MELFORT 97	98	mean rank	rank of mean	BEAVERLODGE 96	97	98	mean rank	rank of mean
Wheat	Fall Band	100%	6	1	1	2.7	1	1	2	1.5	1	10	2	1	4.3	1
Wheat	Fall Band	66%	4	3	2	3.0	2	2	1	1.5	1	8	6	2	5.3	5
Wheat	Spring Band	100%	7	4	6	5.7	6	7	7	7	6	7	5	5	5.7	6
Wheat	Spring Band	66%	8	3	10	7.0	8	6	10	8	8	9	3	3	5.0	4
Wheat	Side Band 9"	100%	2	5	3	3.3	3	5	4	4.5	5	6	7	8	7.0	10
Wheat	Side Band 9"	66%	5	6	4	5.0	4	4	3	3.5	3	1	10	9	6.7	8
Wheat	Side Band 12"	100%	3	7	7	5.7	6	3	5	4	4	5	8	4	5.7	6
Wheat	Side Band 12"	66%	1	9	5	5.0	4	8	6	7	6	2	1	10	4.3	1
Wheat	Sweeps	100%	9	8	8	8.3	9	10	8	9	9	3	4	6	4.3	1
Wheat	Sweeps	66%	10	10	9	9.7	10	9	9	9	9	4	9	7	6.7	8
Canola	Fall Band	100%	8	5	4	5.7	6	5	10	7.5	9	8	8	4	6.7	7
Canola	Fall Band	66%	4	7	2	4.3	4	3	6	4.5	3	9	4	1	4.7	3
Canola	Spring Band	100%	6	6	7	6.3	7	10	9	9.5	10	10	1	6	5.7	6
Canola	Spring Band	66%	5	10	5	6.7	8	8	2	5	6	7	6	10	7.7	9
Canola	Side Band 9"	100%	1	8	1	3.3	1	1	7	4	1	4	5	7	5.3	5
Canola	Side Band 9"	66%	2	2	9	4.3	4	6	3	4.5	3	5	7	8	6.7	7
Canola	Side Band 12"	100%	7	1	3	3.7	2	2	8	5	6	1	2	5	2.7	2
Canola	Side Band 12"	66%	3	3	6	4.0	3	4	5	4.5	3	2	3	2	2.3	1
Canola	Sweeps	100%	10	4	10	8.0	9	9	4	6.5	8	6	10	9	8.3	10
Canola	Sweeps	66%	9	9	8	8.7	10	7	1	4	1	3	9	3	5	4

Table 7: Residual (late July) rank of total weed density from least weedy (1) to most weedy (10).

Crop	Fertilizer application	Herbicide Rate	BRANDON 96	97	98	mean rank	rank of mean	MELFORT 97	98	mean rank	rank of mean	BEAVERLODGE 96	97	98	mean rank	rank of mean
Wheat	Fall Band	100%	8	2	1	3.7	2	2	4	3	2	5	4	7	5.3	5
Wheat	Fall Band	66%	5	6	5	5.3	5	10	8	9	9	9	3	6	6.0	6
Wheat	Spring Band	100%	7	1	2	3.3	1	6	3	4.5	4	2	2	1	1.7	1
Wheat	Spring Band	66%	10	5	9	8.0	10	8	9	8.5	8	8	10	3	7.0	8
Wheat	Side Band 9"	100%	4	7	3	4.7	4	5	2	3.5	3	4	1	2	2.3	2
Wheat	Side Band 9"	66%	9	8	4	7.0	8	3	7	5	5	3	5	4	4.0	3
Wheat	Side Band 12"	100%	2	9	8	6.3	7	7	5	6	7	1	8	5	4.7	4
Wheat	Side Band 12"	66%	6	10	6	7.3	9	9	10	9.5	10	7	9	10	8.7	9
Wheat	Sweeps	100%	1	3	7	3.7	2	1	1	1	1	6	6	8	6.7	7
Wheat	Sweeps	66%	3	4	10	5.7	6	4	6	5	5	10	7	9	8.7	9
Canola	Fall Band	100%	2	1	1	1.3	1	4	2	3	3	1	1	3	1.7	1
Canola	Fall Band	66%	4	3	4	3.7	2	10	8	9	10	2	10	1	4.3	3
Canola	Spring Band	100%	6	6	2	4.7	5	1	4	2.5	2	4	2	2	2.7	2
Canola	Spring Band	66%	5	8	7	6.7	7	9	6	7.5	8	5	7	8	6.7	7
Canola	Side Band 9"	100%	1	5	5	3.7	2	3	1	2	1	7	3	10	6.7	7
Canola	Side Band 9"	66%	7	2	3	4.0	4	7	7	7	7	6	4	5	5.0	4
Canola	Side Band 12"	100%	10	7	10	9.0	10	2	9	5.5	5	3	6	7	5.3	5
Canola	Side Band 12"	66%	3	4	9	5.3	6	5	10	7.5	8	10	8	6	8.0	9
Canola	Sweeps	100%	9	9	8	8.7	9	6	3	4.5	4	8	5	4	5.7	6
Canola	Sweeps	66%	8	10	6	8.0	8	8	5	6.5	6	9	9	9	9.0	10

The Impact of Monoammonium Phosphate and Potassium Chloride on Wild Oat (*Avena fatua* L.) Competition in Zero-Till Spring Wheat and Flax

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Abstract

Fertilizer placement can directly affects a crop's ability to compete with weeds.
To determine the rate and placement of monoammonium phosphate (MAP) and potassium chloride (KCl) that increase spring wheat and flax competitiveness against wild oats, four field experiments on two soil types were conducted over two years. Growth chamber experiments comparing growth response to, and uptake of phosphorus and potassium of each species showed analogous results to field experiments. Data were subjected to ANOVA and orthogonal contrasts. Regression analysis did not indicate consistent linear, quadratic or cubic responses and therefore was not utilized.

There was not one particular rate and placement that provided a competitive advantage to the crop. Environment plays an extremely important role when dealing with immobile nutrients. 1997 and 1998 were two very different growing seasons, however, overall rate responses were the same both years, although, the significance of placement and presence of wild oats did vary. Differences in fertilizer placement were evident in both P and K trials in 1998, whereas, the impact of wild oats on yield was greatest in both P and K trials in 1997. Wild oats had a much greater ability to uptake both phosphorus and potassium regardless of growing conditions compared to spring wheat and flax. Flax was relatively unresponsive to P and K addition. Wheat showed significant increases in yield to high rates of P. Wheat yield declined at high K rates on soils with high background K levels, but yield increased at low K rates on soils with average background K levels. Side banded fertilizer provided greater crop competitiveness against wild oats than seed placed fertilizer.

This research has shown a need for the re-evaluation of fertilizer recommendations in direct seeding systems, and the implications that arise from wild oat competition for fertilizer.

Introduction

For decades wild oats (*Avena fatua* L.) have been recognized as one of the most widespread and troublesome weed species on the Canadian prairies. It has dominated the weed community for the last twenty years (Thomas et al., 1998), and will continue to be one of the most aggressive and difficult to control weed species, as it has developed multiple resistance to herbicide groups 1, 2, 8 and 25. With resistance spreading, producers are left with fewer and fewer herbicide options. Therefore, it is necessary to develop integrated weed management (IWM) strategies.

IWM has been defined as the application of numerous weed control measures, which include cultural, genetic, mechanical, biological and chemical (Swanton and Weise, 1991). An IWM system should enhance the competitive ability of the crop to suppress weed growth (Swanton and Weise, 1991). Fertilizer placement affects the crop's ability to compete with weeds. Placing fertilizer where the crop has access to it but the weeds do not, allows the crop to be more competitive (Kelner et al, 1996). There has been little information obtained concerning fertility interactions on weed - crop competition. This study provides information on how wild oats compete for side banded and seed placed monoammonium phosphate and potassium chloride fertilizer in spring wheat and flax.

Materials and Methods

Growth Chamber: Two growth chamber experiments (which were repeated) were conducted to assess the growth response and uptake of P and K of each species (spring wheat, flax and wild oats) separately. The experiments were organized as completely randomized designs:
1) 0, 4.37, 8.74, and 17.48 kg of actual P ha^{-1}.
2) 0, 8.3,16.6, and 33.2 kg of actual K ha^{-1}.
Destructive harvests began at 14 days after emergence (DAE) and continued on a weekly basis until 42 DAE, to determine growth responses and nutrient uptake. At each harvest date growth staging, dry matter production and tissue nutrient analysis were assessed.

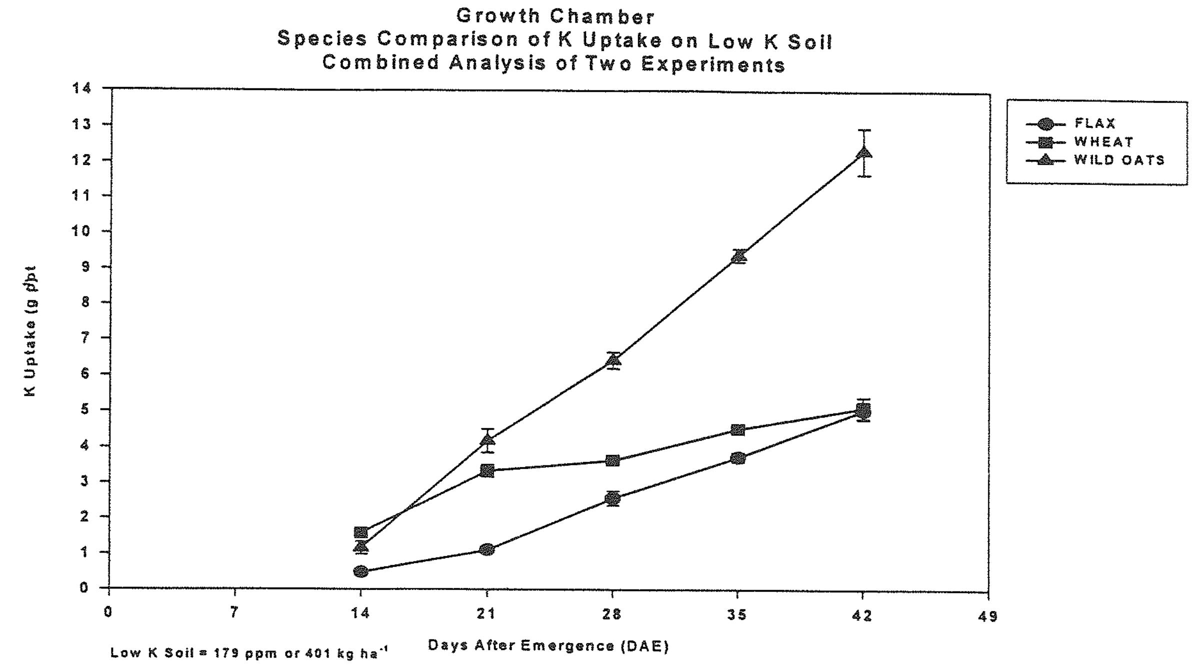
Field: Four field experiments on two soil types were conducted during two years, in the Aspen Parkland Ecoregion of Manitoba. Soil types were a sandy loam soil south of Brandon and a clay loam soil north of Brandon. The experiments were conducted in a split plot factorial design. Rate and placement of fertilizer comprised the main plot effects and +/- wild oats comprised the subplots. A RCBD was used with the main plots randomized within blocks. Treatments were as follows:
1) Wheat +/- wild oats, phosphorus banded and seed placed at rates of 0, 4.37, 8.74, 17.48, 34.96 and 52.44 kg of actual P ha^{-1}.
2) Wheat +/- wild oats, potassium banded and seed placed at rates of 0, 8.3, 16.6, 33.2, 66.4, and 99.6 kg of actual K ha^{-1}.
3) Flax +/- wild oats, phosphorus banded and seed placed at rates of 0, 3.5, 4.37, 6.56, 8.74 and 17.48 kg of actual P ha^{-1}.
4) Flax +/- wild oats, potassium banded and seed placed at rates of 0, 8.3, 12.45, 16.6, 24.9 and 33.2 kg of actual K ha^{-1}.
Nitrogen (as 46-0-0) was banded, prior to seeding, across each replication perpendicular to the direction of seeding at a blanket rate of 78.4 kg ha^{-1}. Fertilization with P and K and seeding occurred at the same time with an air seeder on nine inch row spacing. Each plot was planted consecutively with gear settings and ratios changed by hand (ie. rate and placement of fertilizer), in a serpentine pattern. The side banded treatments were 2.5 cm to the side of the seed row and 2.5 cm down.
Data collected included: crop counts, wild oat density, biomass four weeks after emergence, biomass at heading of wheat and full boll formation of flax, crop yield, weed yield, dockage (other weed species that were not controlled), 1000 kernel weights, tissue nutrient analysis of early biomass (only 1997) and late biomass samples, grain analysis of wheat and wild oats and oil analysis of flax.

Statistics: All data was subjected to ANOVA and orthogonal contrasts with significant differences discussed in the text. In the field there was a lack of consistent fertilizer rate response (ie. linear, quadratic or cubic), therefore, regression analysis was not utilized. Similarly, in the growth chamber there was no rate response. Growth chamber experiments were combined (P and K experiments separately), after passing Bartlett's test. Field experiments were not combined due to environmental variability across years and because different locations were selected each year.

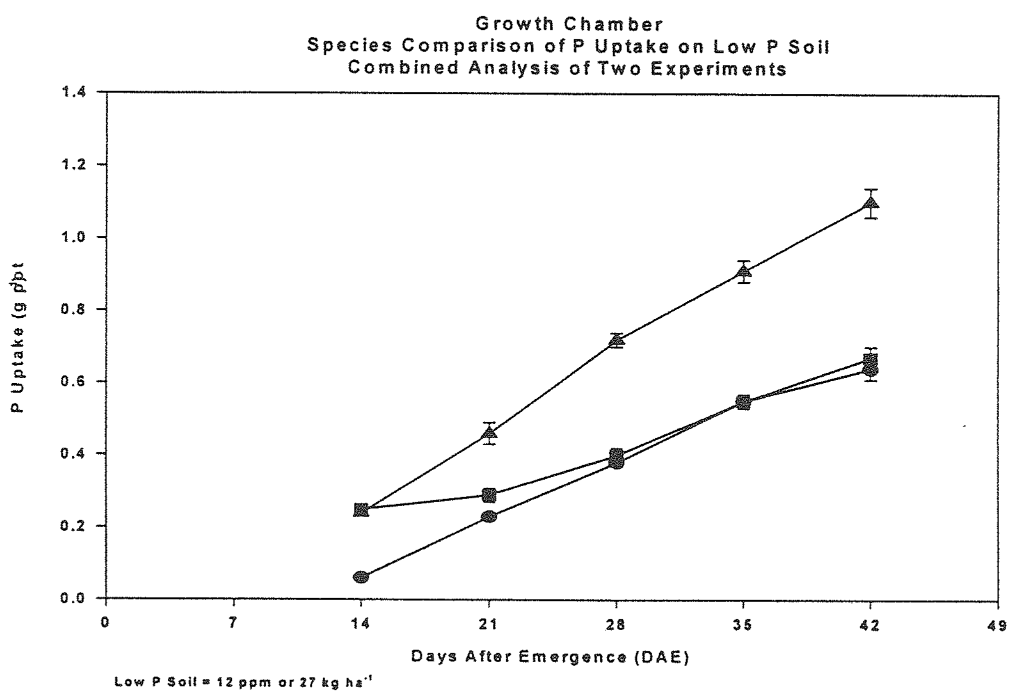
Results and Discussion

Flax: Flax did not show a positive or negative response to P or K addition, on either soil type or in either year. It has been shown that flax is notorious for poor response to phosphorus fertilizer in a broad range of experiments (Lafond et al., 1996). General recommendations are for very low rates of phosphorus fertilizer for flax, with the consensus that flax does not efficiently use phosphorus from fertilizer sources (Bailey et al., 1980). Flax did not show toxicity or damage at the high fertilizer rates.

Wheat: Wheat showed a response to both P and K addition, on both soil types and in both years. There was a significant yield increase to P addition even at the highest fertilizer rate (soils were marginal and average in background P, ie. 12 - 19 ppm). However, addition of K provided a yield decline on soils with high background levels of K (>600 ppm), but slight yield increases to K addition at low application rates on soils with average background K levels (300 - 600 ppm). Lack of a significant increase in yield to KCl addition may be due to a varietal response, increased toxicity due to less water holding capacity on light textured soils, and the presence of wild oats. Teal wheat, the variety used in this study, may show yield declines with KCl application (Grant, 1997).

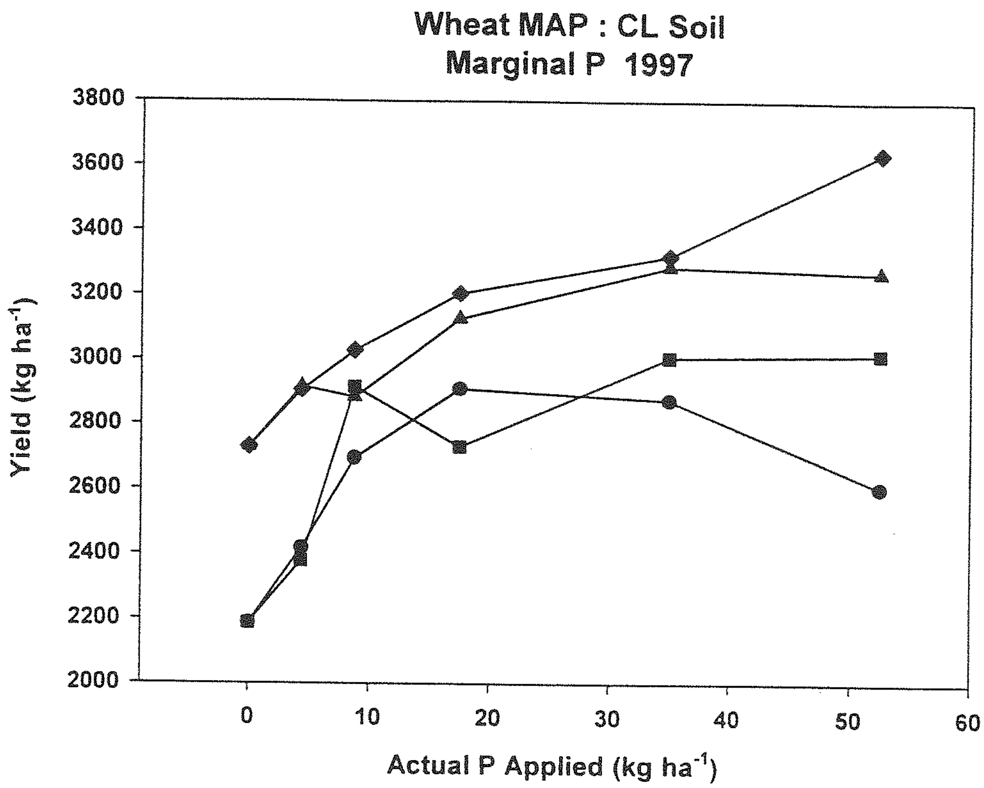


Growth Chamber
Species Comparison of K Uptake on Low K Soil
Combined Analysis of Two Experiments
K Uptake (g p/pt
FLAX
WHEAT
WILD OATS
Days After Emergence (DAE)
Low K Soil = 179 ppm or 401 kg ha⁻¹

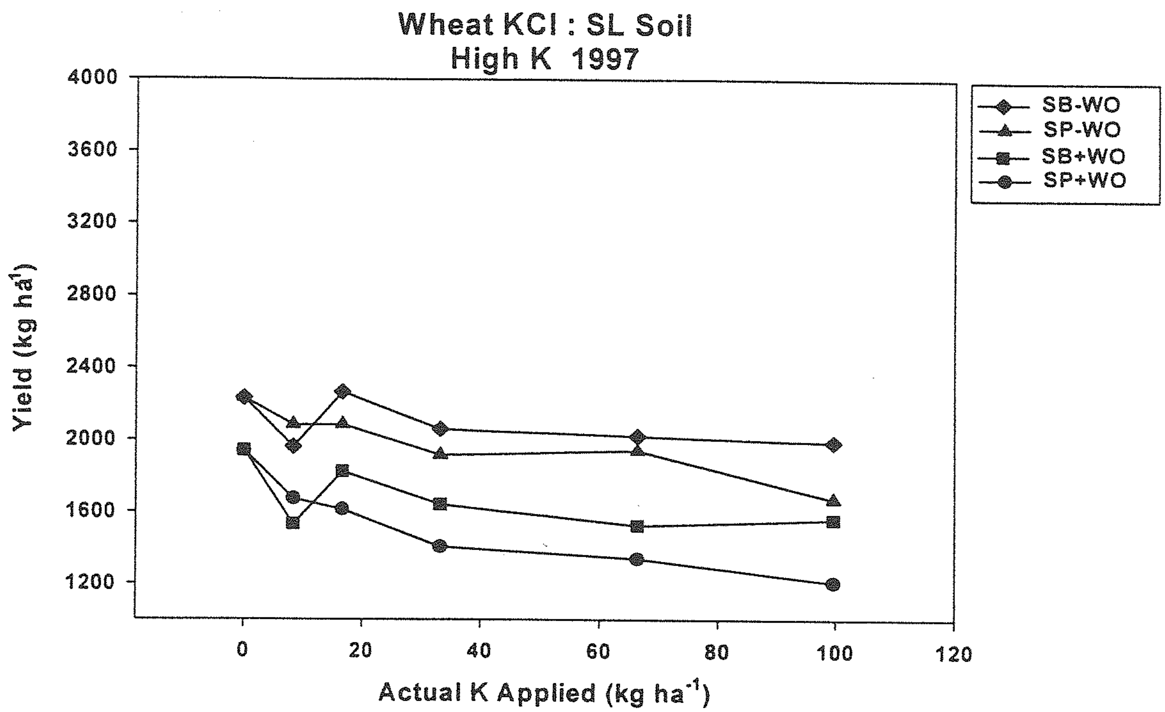


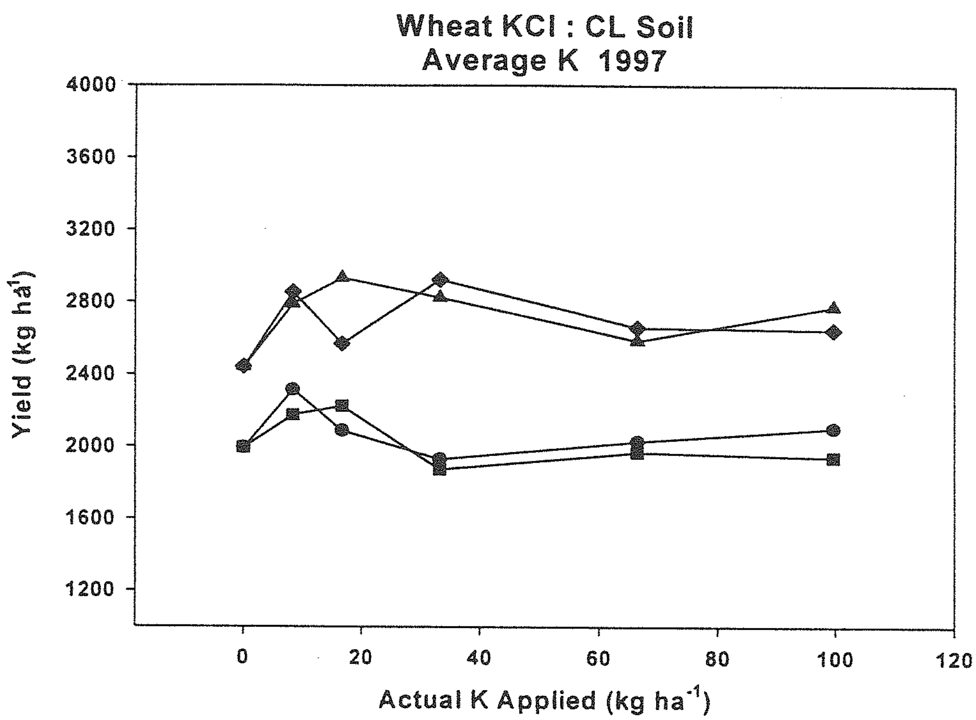
Growth Chamber
Species Comparison of P Uptake on Low P Soil
Combined Analysis of Two Experiments
P Uptake (g p/pt
Days After Emergence (DAE)
Low P Soil = 12 ppm or 27 kg ha⁻¹

Wild Oat Fertility Interaction: Side banding provided the highest crop yields in all trials, and therefore, was better than seed placed fertilizer application in giving the crop a competitive advantage. It was thought that seed placed fertilizer would give the crop a head start ("pop up" effect) at the lower rates. This may have occurred at low rates, but was not found consistently.



Marginal P Soil = 13 ppm or 29 kg ha^{-1}





High K > or = 600 ppm or 1344 kg ha^{-1}
Average K = 355 ppm or 795 kg ha^{-1}

Growth Chamber Experiments

Wild oats' uptake of both P and K was significantly higher than spring wheat and flax, even though the wild oats produced approximately the same dry matter as the spring wheat. Therefore, many questions arise when we look at fertilizer management practices: When we apply P and K fertilizer in field situations are we giving wild oats a competitive advantage? Is the higher uptake ability due to wild oats' phenotypic plasticity and/or genetic variability?

Summary and Conclusions

Environment, both climatic and edaphic, play extremely important roles when dealing with immobile nutrients. 1997 was dry, whereas, 1998 was excessively wet, but, there was not a significant difference between the wet and dry years when looking at rate responses and overall trends in yield. However, there was more competition from wild oats in the dry years. The greatest difference between seed placed and side banded fertilizer placement occurred in 1998, likely due to excess moisture increasing the mobility of the P and K applied.

This research has led to the re-evaluation of IWM and fertilization rates in direct-seeding systems. It has shown the need for further KCl research in wheat, particularly in the Aspen Parkland Ecoregion, and the need to incorporate different wheat varieties and weed species with these studies. Fertilizer recommendations may no longer be accurate because soils have changed due to changing management systems. New information regarding the uptake potential of P and K by wild oats was provided. Mechanisms of nutrient uptake, as well as, the probability of mycorrhizal associations need to be investigated. Could the wild oat problem on the Canadian prairies be directly associated with a genotypic need for K and the inherently high levels of K in the soil?

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Agronomy
prepared by A. Johnston and G. Clayton.

A general discussion of the agronomy results is given in the MANDAK paper printed earlier in this report. Following are tables detailing 1998 results.

Table 1. Canola (*B. napus* cv. Quest) agronomic response to fertilizer N placement and herbicide application rate at Melfort, Brandon and Beaverlodge in 1998.

	Melfort			Brandon			Beaverlodge		
	Crop Stand	Grain Yield	Grain Protein	Crop Stand	Grain Yield	Grain Protein	Crop Stand	Grain Yield	Grain Protein
	Plants/m2	Kg/ha	%	Plants/m2	Kg/ha	%	Plants/m2	Kg/ha	%
Fertilizer Placement									
1. Fall Band – FBd	156 a	1642	23.2 b	84 a	911 a		114	727	
2. Spring Band – SBd	141 b	1834	23.8 ab	81 a	806 a		100	693	
3. Sideband 9" – SB9	146 ab	1920	24.2 a	78 a	1029 a		190	601	
4. Sideband 12"–SB12	109 c	1763	24.1 a	43 b	488 b		108	787	
5. Sweep - SW	108 c	1763	23.8 ab	44 b	544 b		85	855	
Herbicide Rate									
1. Full Rate – F	134	1825	23.8	66	703		119	685	
2. 2/3 Rate - R	130	1744	23.8	66	809		120	781	
Pr>f									
Placement	0.0001	0.3966	0.0463	0.0001	0.0006		.0002	.0642	
Herbicide	0.2070	0.3739	0.8403	0.9598	0.1643		.8981	.0765	
Plmt x Herb	0.0605	0.9574	0.9473	0.5279	0.9611		.6352	.1676	
CV	9	16	3	14	26		33	22	
Interaction									
FBd – F	164	1686	23.2	80	906		130	656	
FBd – R	148	1597	23.3	88	916		98	798	
SBd – F	143	1839	23.9	86	739		99	701	
SBd – R	139	1830	23.7	76	874		101	686	
SB9 – F	142	1991	24.2	76	951		175	595	
SB9 – R	150	1848	24.1	80	1108		205	608	
SB12 – F	119	1758	23.9	45	411		105	790	
SB12 – R	99	1767	24.2	41	565		115	785	
SW – F	104	1848	23.8	43	506		87	681	
SW – R	112	1677	23.8	45	581		83	1029	

Table 2. Wheat (CWRS cv. CDC Teal) agronomic response to fertilizer N placement and herbicide application rate at Melfort, Brandon and Beaverlodge, 1998.

	Melfort			Brandon			Beaverlodge		
	Crop Stand	Grain Yield	Grain Protein	Crop Stand	Grain Yield	Grain Protein	Crop Stand	Grain Yield	Grain Protein
	Plants/m2	Kg/ha	%	Plants/m2	Kg/ha	%	Plants/m2	Kg/ha	%
Fertilizer Placement									
1. Fall Band – FBd	237 a	3292 ab	13.0 b	214 a	3649 a		153 b	2410	
2. Spring Band – SBd	234 ab	3135 b	13.1 b	215 a	3608 a		170 ab	2316	
3. Sideband 9" – SB9	227 ab	3418 a	13.6 a	214 a	3570 a		191 a	2163	
4. Sideband 12"–SB12	212 bc	3265 ab	13.3 ab	149 c	3170 b		169 ab	2262	
5. Sweep - SW	190 c	3243 ab	13.0 b	176 b	3473 a		118 c	2028	
Herbicide Rate									
1. Full Rate – F	221	3382 a	13.3	195	3572		164	2217	
2. 2/3 Rate - R	220	3159 b	13.1	192	3416		157	2253	
Pr>f									
Placement	0.0014	0.0548	0.0101	0.0001	0.0204		.0061	.2150	
Herbicide	0.8939	0.0005	0.0676	0.4971	0.1036		.5444	.7316	
Plmt x Herb	0.3234	0.1285	0.7495	0.7241	0.7507		.2818	.3037	
CV	10	5	3	9	8		20	15	
Interaction									
FBd – F	230	3355	13.0	214	3714		164	2545	
FBd – R	245	3229	12.9	214	3585		141	2275	
SBd – F	243	3157	13.2	217	3656		167	2177	
SBd – R	224	3113	13.1	213	3560		174	2455	
SB9 – F	234	3588	13.8	214	3622		216	2262	
SB9 – R	221	3247	13.3	213	3519		166	2064	
SB12 – F	216	3498	13.4	147	3192		163	2106	
SB12 – R	208	3032	13.2	152	3147		175	2417	
SW – F	180	3310	13.1	185	3675		109	1998	
SW – R	200	3175	12.9	168	3270		128	2058	

Impact of row spacing, fertilizer management and herbicide rate on plant development in spring wheat in 1998.
Prepared by Guy Lafond

Objective:
To determine the effects of nitrogen management, row spacing and herbicide rate on seeding depth, main stem Haun stage and plant development in spring wheat at three locations, Brandon, Melfort and Beaverlodge.

Materials and Methods:

Twenty wheat plants per plot were collected from the five core nitrogen management treatments of the CFI project. Each plant was scored for actual depth of seeding, main stem Haun stage and each tiller on each plant was identified and scored for plant development according to the method developed by Klepper et al. (1983). The plants were collected on June 25th in Brandon, on June 23rd in Melfort and on June 11th in Beaverlodge.

The analysis of the data for seeding depth and main stem Haun stage was done using an analysis of variance and all the interactions with rep were pooled and used as the error term. The main stem Haun stage is also a very good indicator of rate of emergence as shown by Lafond and Baker (1986).

The analysis of the data for the tillers present was done in three steps. The first step consisted in determining the number of plants from each plot which had a specific tiller and converting this value into a proportion. The second step consisted in doing an $\arcsin((x)^{.5})$ transformation of the proportion for each tiller as developed by Snedecor and Cochran (1976). With $n<50$, in this case 20, values of 0% were given a value of 1/4n or 0.0125 and values of 100% values (n-1/4)/n or 0.9875 (Snedecor and Cochran, 1976). The analysis of variance was done on the transformed values and the reported values in the tables are untransformed. The probability values indicated for the contrasts associated with nitrogen management and herbicide rate are based on the analysis of the transformed values. The approach for presenting the data is similar to the one used by Wilkins et al. (1988).

Results and Discussion:

Seeding Depth

Seeding depth was similar for Brandon and Melfort with the deepest planting occurring with the sweep treatments (Table 1). The shallowest planting occurred at Beaverlodge and similar depths were obtained with the sweeps as with the points. The standard error was greatest at Melfort and least at Brandon and Beaverlodge. The standard error is high enough in all cases to show that there is still much variability in seeding depth, even over very short distances (Table 1).

Table 1. The effects of nitrogen management on seeding depth (mm) of spring wheat at three locations in 1998.

Nitrogen Management	Brandon	Melfort	Beaverlodge
Fall banding	41	45	34
Spring banding	48	49	36
Side-banding at seeding on 12" spacing	45	43	34
Side-banding at seeding on 9" spacing	43	48	37
Sweep	52	57	34
Mean	46	48	35
s.e.	13	20	14

Main Stem Haun Stage

Main stem Haun stage can be used as an accurate estimator of speed of emergence. In 1998, there were no nitrogen treatment effects at Beaverlodge on main stem Haun stage. At Melfort, there was a significant effect where the pre-seeding nitrogen banding treatments were slightly more advanced than treatments where the nitrogen was side-banded during the seeding operation. The sweep treatment was similar to the pre-seed banding treatments. At Brandon, there was more significant effects, probably a reflection of the lower standard error recorded. The treatment where the full rate of herbicide was used was slightly more advanced than where only 66% of the full rate was used. The pre-seeding bands and the sweep treatments were slightly more advanced than the the 9" and 12" spacing where the nitrogen was side-banded during the seeding operation. The 9" with fertilizer side-banded at seeding time was also slighlty more advanced than with the similar treatment on 12". Overall, where treatment effects were present, the absolute differences tended to be small.

Table 2. The effects of nitrogen management and herbicide rate on main stem Haun stage of spring wheat at three locations in 1998.

Nitrogen Management	Brandon		Melfort		Beaverlodge	
	100%	66%	100%	66%	100%	66%
Fall banding	5.9	6	5.8	5.8	5.5	5.2
Spring banding	5.9	5.8	5.8	5.6	5.5	5.4
Side-banding at seeding on 12" spacing	5.8	5.7	5.6	5.7	5.4	5.5
Side-banding at seeding on 9" spacing	6	5.8	5.5	5.6	5.4	5.5
Sweep	6	6	5.6	5.7	5.4	5.2
Mean	5.9	5.8	5.7	5.7	5.4	5.3
s.e.	0.2		0.5		0.6	
Contrast[1]						
Herbicide 100% vs 66%	'*'		ns		ns	
Fall Banding vs Spring Banding	'*'		ns		ns	
Sweep vs Pre-Seed banding	**		ns		ns	
Pre-seed banding vs Side-banding	ns		'*'		ns	
9" vs 12"	**		ns		ns	
9" vs Sweep	'*'		ns		ns	
12" vs Sweep	'*'		ns		ns	

[1] Values followed by **, * and ns are significant at the 1% level, 5% level or not significant.

Plant Development:

Brandon: The rates of herbicides used had an effect on only the frequencies of T3's and T11's. In both cases, the high rate of herbicide produced the highest frequencies. The nitrogen treatments had no effect on the frequency of T0, T1 and T2's. However, the sweep treatments produced a higher frequency of T3, T11 and T21 (Table 3). From a practical perspective, the main tillers T1 and T2 have the largest contribution towards yield.

Melfort: At Melfort in 1998, only two nitrogen treatments had an effect on the frequency of tillers. The 9" spacing had more T2's than the 12" spacing when the fertilizer was side-banded and the sweep treatment had more T3's than when the fertilizer was applied prior to seeding either in the fall or the spring (Table 4).

Beaverlodge: At Beaverlodge, the frequency of T0's was greatest for the treatments where the nitrogen was side-banded at seeding time versus banded prior to seeding. The frequency of T3's was greatest for the fall banding than the spring banding treatments. With respect to T11's, the sweep treatment had a greater percentage than the pre-seed banding treatment. On the other hand, the 9" with fertilizer banded at seeding time had a higher frequency of T11's than the sweep treatment.

Table 3. The effects of nitrogen management and herbicide rate on plant development in spring wheat at Brandon in 1998. The values represents the percentage of plant having a particular tiller.

Nitrogen Management	T0		T1		T2		T3		T01		T11		T21	
	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%
Fall banding	24	40	91	98	70	83	5	3	0	0	4	0	0	0
Spring banding	34	24	96	80	75	68	15	0.3	0	0	7	1	1	0
Side-banding at seeding on 12" spacing	39	48	99	95	89	78	4	5	0	1	0	1	0	0
Side-banding at seeding on 9" spacing	39	34	99	100	88	74	8	4	0	0	6	1	0	0
Sweep	29	35	98	96	88	80	29	19	0	0	19	9	3	1
Mean	**33**	**36**	**97**	**94**	**82**	**76**	**12**	**6**	**0**	**0.3**	**7**	**3**	**1**	**0.3**
Contrast[1]														
Herbicide 100% vs 66%	ns		ns		ns		'*'		ns		**		ns	
Fall Banding vs Spring Banding	ns		ns		ns		ns		ns		ns		'*'	
Sweep vs Pre-Seed banding	ns		ns		ns		***		ns		***		'*'	
Pre-seed banding vs Side-banding	ns		ns		ns		ns		ns		ns		ns	
9" vs 12"	ns		ns		ns		ns		ns		ns		ns	
9" vs Sweep	ns		ns		ns		***		ns		***		**	
12" vs Sweep	ns		ns		ns		***		ns		***		**	

[1] Values followed by ***, **, * or ns are significant at the p<1%, p<5%, p<10% or not significant.

Table 4. The effects of nitrogen management and herbicide rate on plant development in spring wheat at Melfort in 1998. The values represents the percentage of plant having a particular tiller.

Nitrogen Management	T0		T1		T2		T3		T01		T11		T21	
	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%
Fall banding	29	24	88	91	64	56	0	0	0	0	0	0	0	0
Spring banding	33	11	79	75	59	35	0	0	0	0	0	0	0	0
Side-banding at seeding on 12" spacing	19	14	88	79	46	48	3	1	0	0	3	0	1	0
Side-banding at seeding on 9" spacing	34	21	88	86	74	60	5	1	0	0	1	0	0	0
Sweep	18	16	83	99	41	80	0	3	0	0	0	1	0	0
Mean	**26**	**17**	**85**	**86**	**57**	**56**	**2**	**1**	**0**	**0**	**1**	**1**	**0**	**0**
Contrast[1]														
Herbicide 100% vs 66%	ns		ns		ns		ns		-		ns		ns	
Fall Banding vs Spring Banding	ns		ns		ns		ns		-		ns		ns	
Sweep vs Pre-Seed banding	ns		ns		ns		ns		-		ns		ns	
Pre-seed banding vs Side-banding	ns		ns		ns		'*'		-		ns		ns	
9" vs 12"	ns		ns		'*'		ns		-		ns		ns	
9" vs Sweep	ns		ns		ns		ns		-		ns		ns	
12" vs Sweep	ns		ns		ns		ns		-		ns		ns	

[1] Values followed by ***, **, * and ns are significant at p<1%, p< 5%, p<10% or not significant.

Table 5. The effects of nitrogen management and herbicide rate on plant development in spring wheat at Beaverlodge in 1998. The values represents the percentage of plant having a particular tiller.

Nitrogen Management	T0		T1		T2		T3		T01		T11		T21		T31	
	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%	100%	66%
Fall banding	4	4	85	78	64	53	10	15	0	0	1	1	0	0	0	0
Spring banding	11	5	79	73	40	39	0	0	0	0	0	0	0	0	0	0
Side-banding at seeding on 12" spacing	14	13	90	88	60	64	4	10	0	0	4	4	0	0	0	0
Side-banding at seeding on 9" spacing	16	16	78	88	51	55	8	3	0	0	0	0	0	0	0	0
Sweep	13	14	83	84	66	53	17	8	0	0	5	4	0	0	0	0
Mean	**12**	**10**	**83**	**82**	**56**	**53**	**8**	**7**	**0**	**0**	**2**	**2**	**0**	**0**	**0**	**0**
Contrast[1]																
Herbicide 100% vs 66%	ns		ns		ns		ns		-		ns		-		-	
Fall Banding vs Spring Banding	ns		ns		ns		'*'		-		ns		-		-	
Sweep vs Pre-Seed banding	ns		ns		ns		ns		-		'*'		-		-	
Pre-seed banding vs Side-banding	'*'		ns		ns		ns		-		ns		-		-	
9" vs 12"	ns		ns		ns		ns		-		ns		-		-	
9" vs Sweep	ns		ns		ns		ns		-		**		-		-	
12" vs Sweep	ns		ns		ns		ns		-		ns		-		-	

[1] Values followed by ***, ** , * or ns are significant at the p<1%, p<5%, p<10% level or not significant.

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Weed Community Analysis
prepared by D. Derksen and K. McGillivray

Broadleaf and grass weeds species were present within the study. Species perennation included annual, biennial, and perennial. Both native and introduced species were present. The weed communities were reflective of the agroecological zone in which the research was conducted.

The number of individual weeds were counted by species prior to seeding, at the seedling stage, and at maturity. Counts were conducted in twenty quadrats randomly placed quadrats following a "W" pattern across each plot. Total weed densities were calculated as the average density of all individuals of all species per metre squared in each plot. In order to assess spacial as well as density aspects of the weed community, relative abundance values were calculated by species per plot and averaged by experimental factor, such as fertilizer treatment. Relative abundance was calculated as: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Summary of results

In general, the reduced rate of herbicide applied in 1996 did not result in greater weed recruitment prior to crop seeding or in-crop spraying in 1998; however, weed densities were greater in reduced rate plots after herbicide application in 1998 at Melfort and Beaverlodge. The lack of difference between reduced and full rate herbicide usage at Brandon may be due to the lower overall weed density at this site.

The impact of fertilizer timing, placement, and level of soil disturbance on weed densities varied by site. Weed densities were greater in sweep treatments in canola, but not necessarily in wheat. In some cases sweep seeding resulted in more weeds present at the time of in-crop spraying while in other cases densities were greater in the July counts. This may be due to the timing of seeding in relation to soil temperature and weed seedling recruitment (ie emergence patterns). Research at Brandon, indicated that weed seedling recruitment patterns were similar for fall and side banded treatments, but were different in the sweep treatments (Figures 1, 2, and 3). Seeding with sweeps resulted in a greater number of weeds emerging earlier.

At Melfort and Brandon, weed densities were greater prior to seeding or in-crop spraying in the two pass seeding systems where fertilizer was random banded in the fall or spring compared to the side banded treatments. At Melfort, weed densities were greater in the 12" side banded plots compared to the 9" side banded plots, while the reverse was true at Beaverlodge. Hopefully, future data will aid in the understanding of this anomaly.

Brandon

Prior to crop seeding, weed densities were similar in all treatments for wheat (Tables 1, 4-18). Weed densities were higher in the fall and spring band treatments for canola. Herbicide input level the previous year did not affect weed densities before seeding.

Prior to in-crop herbicide application weed densities were again similar in all treatments for wheat with the fall and spring band having greater weed densities than the side band or sweep treatments. Herbicide input level the previous year did not affect weed densities before seeding.

July weed counts revealed that weeds densities were greater in the side banding treatments for wheat compared to random banding in the fall or spring. In canola plots, weed densities were greater in the spring band compared to fall banding and were highest in the sweep treatments, due to high levels of soil disturbance and low crop stands. Reducing herbicide rates did not significantly increase weed densities.

Melfort

Prior to crop seeding, weed densities were greater for fall banded versus spring banded treatments in wheat, with the spring banding treatment having the lowest weed density of all treatments (Tables 2, 19-33). Side banding on nine or twelve inch row spacings had more weeds than the sweep treatment. Herbicide input level the previous year did not affect weed densities before seeding. Weed densities in canola were similar for all treatments.

Prior to in-crop herbicide application, the sweep treatments had the highest weed densities in the wheat plots. Spring banding treatments had higher weed densities than fall banding with side banding treatments being intermediate between fall banding and sweep treatments. Herbicide input level the previous year did not affect weed densities before seeding for wheat or canola. Spring banding treatments had greater weed densities than the other canola plots which were not different from one another.

July weed counts revealed that weed densities in the reduced herbicide rate plots in canola and wheat were higher than where the full rate was used. In wheat, weed densities were greater in fall banding and the 12" row spacing plots compared to other treatments (especially at reduced herbicide rates). In canola, the weed densities were lower in the side banded treatments with reduced herbicide rate compared to random banding in the fall or spring and to sweep treatments.

Beaverlodge

Prior to crop seeding, weed densities were greater for fall banding compared to spring banding in wheat with all other plots having similar densities. Weed densities were similar in all canola plots (Table 3, 34-48). Herbicide input level the previous year did not affect weed densities before seeding for either canola or wheat.

Prior to in-crop herbicide application, weed densities were similar in wheat except for the low-input 9" side band which had higher densities of weeds compared to the low-input 12" side band treatment. In canola, fall banded treatments had more weeds than spring banded treatments, 9" side banding had more weeds than 12" side banding, and the sweep treatments had the greatest number of weeds. Herbicide input level the previous year did not affect weed densities before seeding in wheat or canola.

July weed counts revealed that the low herbicide rate treatments had more weeds than the full rate treatments in canola, but not in wheat. Fertilizer treatments did not significantly impact weed densities at this stage in either wheat or canola.

Table 1.0 Average total density (+/- SE) of all weed species at Brandon in 1998.

Crop	Fertilizer application	Herbicide Rate	Pre-seeding Count	Pre-spray Count	July Count
Wheat	Fall Band	100 %	25.9 ± 2.0	34.4 ± 15.6	43.3 ± 6.6
Wheat	Fall Band	66 %	28.8 ± 7.1	39.2 ± 16.4	52.5 ± 5.9
Wheat	Spring Band	100 %	8.8 ± 4.1	61.6 ± 26.7	46.1 ± 7.7
Wheat	Spring Band	66 %	10.9 ± 3.9	85.1 ± 26.1	62.2 ± 8.8
Wheat	Side Band 9"	100 %	14.2 ± 5.7	46.5 ± 18.9	46.8 ± 10.8
Wheat	Side Band 9"	66 %	10.8 ± 3.5	50.8 ± 16.1	48.4 ± 8.0
Wheat	Side Band 12"	100 %	9.7 ± 2.3	66.1 ± 12.1	62.0 ± 5.9
Wheat	Side Band 12"	66 %	6.7 ± 1.1	55.8 ± 22.5	60.0 ± 7.9
Wheat	Sweeps	100 %	8.7 ± 4.9	66.4 ± 11.4	60.4 ± 6.7
Wheat	Sweeps	66 %	10.1 ± 2.9	79.9 ± 5.3	72.4 ± 4.4
Canola	Fall Band	100 %	90.6 ± 15.1	58.0 ± 7.1	78.9 ± 5.6
Canola	Fall Band	66 %	102.7 ± 10.1	51.1 ± 9.5	91.5 ± 9.2
Canola	Spring Band	100 %	38.9 ± 5.8	71.1 ± 23.0	86.7 ± 6.8
Canola	Spring Band	66 %	50.3 ± 14.5	62.6 ± 10.9	99.4 ± 9.5
Canola	Side Band 9"	100 %	32.3 ± 6.4	51.0 ± 10.9	92.2 ± 12.0
Canola	Side Band 9"	66 %	47.2 ± 5.7	79.5 ± 17.4	88.4 ± 11.4
Canola	Side Band 12"	100 %	40.3 ± 15.9	55.4 ± 12.1	115.4 ± 9.0
Canola	Side Band 12"	66 %	34.9 ± 9.9	69.3 ± 16.1	108.5 ± 10.9
Canola	Sweeps	100 %	36.5 ± 4.7	81.6 ± 10.5	107.2 ± 14.7
Canola	Sweeps	66 %	43.4 ± 4.9	73.0 ± 13.3	92.4 ± 7.9

Table 1b. Orthogonal contrasts comparing the average total density of all weeds at Brandon in 1998.

Orthogonal contrasts	**Pre-seed Counts**	**Pre-spray Counts**	**July Counts**
	p value	p value	p value
Wheat (Rec. vs low herbicide)	ns	ns	ns
Canola (Rec. vs low herbicide)	<0.078	ns	ns
Wheat (rec. herb) Fall vs Spring band	<0.091	ns	ns
Wheat (rec. herb) Fall + Spring vs Side band	ns	ns	ns
Wheat (rec. herb) Side band (9" vs 12")	ns	ns	ns
Wheat (rec. herb) Side band 9" vs Sweep	ns	ns	ns
Wheat (low herb) Fall vs Spring band	<0.078	<0.016	ns
Wheat (low herb) Fall + Spring vs Side band	ns	ns	ns
Wheat (low herb) Side band (9" vs 12")	ns	ns	ns
Wheat (low herb) Side band 9" vs Sweep	ns	ns	<0.035
Canola (rec. herb) Fall vs Spring band	<0.0001	ns	ns
Canola (rec. herb) Fall + Spring vs Side band	<0.0002	ns	<0.010
Canola (rec. herb) Side band (9" vs 12")	ns	ns	<0.042
Canola (rec. herb) Side band 9" vs Sweep	ns	ns	ns
Canola (low herb) Fall vs Spring band	<0.0001	ns	ns
Canola (low herb) Fall + Spring vs Side band	<0.0001	ns	ns
Canola (low herb) Side band (9" vs 12")	ns	ns	<0.078
Canola (low herb) Side band 9" vs Sweep	ns	ns	ns

Table 2.0 Average total density (+/- SE) of all weed species at Melfort in 1998.

Crop	Fertilizer application	Herbicide Rate	Pre-seeding Count	Pre-spray Count	July Count
Wheat	Fall Band	100 %	46.6 ± 20.6	62.3 ± 6.7	14.8 ± 3.4
Wheat	Fall Band	66 %	43.8 ± 7.6	57.4 ± 18.6	22.1 ± 2.7
Wheat	Spring Band	100 %	15.8 ± 2.7	93.1 ± 30.9	12.4 ± 1.5
Wheat	Spring Band	66 %	22.3 ± 4.3	131.6 ± 27.1	21.7 ± 3.9
Wheat	Side Band 9"	100 %	14.0 ± 4.1	73.5 ± 19.8	12.1 ± 1.5
Wheat	Side Band 9"	66 %	22.8 ± 4.6	73.2 ± 6.8	18.4 ± 2.0
Wheat	Side Band 12"	100 %	9.7 ± 2.4	82.9 ± 11.2	15.8 ± 1.7
Wheat	Side Band 12"	66 %	23.0 ± 6.9	90.4 ± 11.2	33.7 ± 5.1
Wheat	Sweeps	100 %	14.8 ± 6.3	108.5 ± 32.0	10.4 ± 1.6
Wheat	Sweeps	66 %	17.5 ± 2.7	112.3 ± 36.0	18.1 ± 3.3
Canola	Fall Band	100 %	16.7 ± 0.4	38.4 ± 6.9	5.1 ± 1.4
Canola	Fall Band	66 %	24.9 ± 5.1	32.8 ± 3.9	9.9 ± 2.4
Canola	Spring Band	100 %	13.3 ± 3.5	37.9 ± 5.2	5.8 ± 1.3
Canola	Spring Band	66 %	18.8 ± 6.5	31.0 ± 3.7	7.3 ± 1.6
Canola	Side Band 9"	100 %	16.4 ± 7.6	34.5 ± 7.5	4.5 ± 1.1
Canola	Side Band 9"	66 %	17.2 ± 1.4	31.1 ± 1.7	8.0 ± 1.5
Canola	Side Band 12"	100 %	16.8 ± 4.1	37.9 ± 2.9	10.2 ± 2.8
Canola	Side Band 12"	66 %	21.4 ± 2.0	31.9 ± 6.2	11.4 ± 4.0
Canola	Sweeps	100 %	20.3 ± 3.7	31.8 ± 1.8	5.6 ± 0.5
Canola	Sweeps	66 %	19.4 ± 5.8	30.6 ± 2.9	5.8 ± 2.3

Table 2b. Orthogonal contrasts comparing the average total density of all weeds at Melfort in 1998.

Orthogonal contrasts	Pre-seed Counts	Pre-spray Counts	July Counts
	p value	p value	p value
Wheat (Rec. vs low herbicide)	ns	ns	<0.0001
Canola (Rec. vs low herbicide)	ns	ns	ns
Wheat (rec. herb) Fall vs Spring band	<0.0003	ns	ns
Wheat (rec. herb) Fall + Spring vs Side band	<0.0011	ns	ns
Wheat (rec. herb) Side band (9" vs 12")	ns	ns	ns
Wheat (rec. herb) Side band 9" vs Sweep	ns	ns	ns
Wheat (low herb) Fall vs Spring band	<0.0092	<0.0024	ns
Wheat (low herb) Fall + Spring vs Side band	<0.0777	ns	<0.0739
Wheat (low herb) Side band (9" vs 12")	ns	ns	<0.0001
Wheat (low herb) Side band 9" vs Sweep	ns	<0.1001	ns
Canola (rec. herb) Fall vs Spring band	ns	ns	ns
Canola (rec. herb) Fall + Spring vs Side band	ns	ns	ns
Canola (rec. herb) Side band (9" vs 12")	ns	ns	<0.0806
Canola (rec. herb) Side band 9" vs Sweep	ns	ns	ns
Canola (low herb) Fall vs Spring band	ns	ns	ns
Canola (low herb) Fall + Spring vs Side band	ns	ns	ns
Canola (low herb) Side band (9" vs 12")	ns	ns	ns
Canola (low herb) Side band 9" vs Sweep	ns	ns	ns

Table 3.0 Average total density (+/- SE)of all weed species at Beaverlodge in 1998.

Crop	Fertilizer application	Herbicide Rate	Pre-seed Count	Pre-spray Count	July Count
Wheat	Fall Band	100 %	11.8 ± 2.1	198.1 ± 46.9	52.5 ± 27.5
Wheat	Fall Band	66 %	4.2 ± 0.7	215.6 ± 10.6	51.2 ± 13.5
Wheat	Spring Band	100 %	3.0 ± 0.4	297.5 ± 52.9	24.3 ± 5.6
Wheat	Spring Band	66 %	6.8 ± 0.9	256.5 ± 32.1	33.2 ± 8.5
Wheat	Side Band 9"	100 %	7.6 ± 6.3	339.4 ± 36.9	31.4 ± 8.2
Wheat	Side Band 9"	66 %	3.9 ± 1.8	342.7 ± 23.8	35.9 ± 15.3
Wheat	Side Band 12"	100 %	4.5 ± 1.1	272.6 ± 23.9	39.0 ± 5.7
Wheat	Side Band 12"	66 %	3.6 ± 1.2	377.3 ± 48.2	80.4 ± 20.4
Wheat	Sweeps	100 %	11.5 ± 4.3	305.2 ± 58.5	52.8 ± 6.6
Wheat	Sweeps	66 %	5.9 ± 1.8	334.1 ± 74.0	73.2 ± 13.8
Canola	Fall Band	100 %	5.3 ± 2.0	268.6 ± 41.5	21.6 ± 9.7
Canola	Fall Band	66 %	1.7 ± 0.6	206.8 ± 28.6	18.2 ± 4.0
Canola	Spring Band	100 %	1.0 ± 0.8	286.3 ± 27.2	21.5 ± 4.4
Canola	Spring Band	66 %	0.7 ± 0.4	354.8 ± 31.0	37.8 ± 14.1
Canola	Side Band 9"	100 %	0.9 ± 0.3	294.7 ± 48.4	45.1 ± 13.9
Canola	Side Band 9"	66 %	0.6 ± 0.3	295.6 ± 49.9	27.3 ± 4.8
Canola	Side Band 12"	100 %	0.5 ± 0.1	275.0 ± 30.1	37.4 ± 13.8
Canola	Side Band 12"	66 %	0.8 ± 0.4	225.2 ± 36.5	35.8 ± 10.1
Canola	Sweeps	100 %	1.0 ± 0.6	305.0 ± 80.7	26.0 ± 9.5
Canola	Sweeps	66 %	1.0 ± 0.4	240.9 ± 29.2	43.4 ± 7.3

Table 3b. Orthogonal contrasts comparing the average total density of all weeds at Beaverlodge in 1998.

Orthogonal contrasts	**Pre-seed Counts**	**Pre-spray Counts**	**July Counts**
	p value	p value	p value
Wheat (Rec. vs low herbicide)	<0.0314	ns	<0.0523
Canola (Rec. vs low herbicide)	ns	ns	ns
Wheat (rec. herb) Fall vs Spring band	<0.0029	ns	<0.0971
Wheat (rec. herb) Fall + Spring vs Side band	ns	ns	ns
Wheat (rec. herb) Side band (9" vs 12")	ns	ns	ns
Wheat (rec. herb) Side band 9" vs Sweep	ns	ns	ns
Wheat (low herb) Fall vs Spring band	ns	ns	ns
Wheat (low herb) Fall + Spring vs Side band	ns	<0.0072	ns
Wheat (low herb) Side band (9" vs 12")	ns	ns	<0.0100
Wheat (low herb) Side band 9" vs Sweep	ns	ns	<0.0293
Canola (rec. herb) Fall vs Spring band	ns	ns	ns
Canola (rec. herb) Fall + Spring vs Side band	ns	ns	<0.1005
Canola (rec. herb) Side band (9" vs 12")	ns	ns	ns
Canola (rec. herb) Side band 9" vs Sweep	ns	ns	ns
Canola (low herb) Fall vs Spring band	ns	<0.0220	ns
Canola (low herb) Fall + Spring vs Side band	ns	ns	ns
Canola (low herb) Side band (9" vs 12")	ns	ns	ns
Canola (low herb) Side band 9" vs Sweep	ns	ns	ns

Table 4.0 Weed relative abundance and density by crop prior to crop seeding at Brandon in 1998.

Weed Species	Wheat RelAb	Wheat $\#/m^2$	Canola RelAb	Canola $\#/m^2$
Mustard species	53.1	8.8	13.7	4.9
Volunteer wheat	15.0	1.4	46.6	31.3
Wild buckwheat	9.6	1.1	11.9	6.1
Perennial sowthistle	5.8	0.5	12.6	4.4
Stinkweed	5.7	0.9	2.9	0.9
Canada thistle	4.8	0.3	5.2	1.1
Common lambsquarters	2.3	0.2	3.4	1.8
Dandelion	1.4	0.1	0.2	0.0
Wild oat	0.6	0.1	0.3	0.2
Smartweed species	0.6	0.1	0.2	0.0
Green foxtail	0.4	0.1	2.0	0.6
Yellow whitlow grass	0.3	0.0	0.1	0.0
Cleavers	0.1	0.0	.	.
Round-leaved mallow	0.1	0.0	.	.
Common chickweed	0.1	0.0	0.0	0.0
Sweet clover species	0.0	0.0	0.0	0.0
Volunteer maple	.	.	0.0	0.0
Quackgrass	.	.	0.1	0.0
Biennial wormwood	.	.	0.1	0.0
Shepherds purse	.	.	0.4	0.1
Narrow leaved hawks beard	.	.	0.4	0.1
Flixweed	.	.	0.0	0.0
American dragonhead	.	.	0.1	0.0
Goatsbeard species	.	.	0.0	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 5.0 Weed relative abundance and density by crop prior to in-crop spraying at Brandon in 1998.

Weed Species	Wheat RelAb	Wheat $\#/m^2$	Canola RelAb	Canola $\#/m^2$
Mustard species	46.7	38.2	14.8	11.8
Wild oat	20.2	8.6	29.1	20.7
Wild buckwheat	9.3	3.8	11.7	6.8
Canada thistle	6.5	1.6	12.5	6.4
Perennial sowthistle	6.4	2.5	9.7	6.1
Stinkweed	4.1	1.8	2.6	1.2
Common lambsquarters	2.7	1.2	0.7	0.3
Green foxtail	1.3	0.4	3.2	2.5
Shepherds purse	0.7	0.1	1.8	1.0
Pigweed species	0.1	0.0	0.1	0.0
Nightflowering catchfly	0.1	0.0	0.1	0.1
Smartweed species	0.1	0.1	0.1	0.0
Dandelion	0.1	0.0	0.2	0.1
Round-leaved mallow	0.1	0.1	0.1	0.1
Vetch species	0.1	0.0	.	.
Prostrate knotweed	0.1	0.0	.	.
Thyme leaved spurge	0.0	0.0	.	.
Narrow leaved hawks beard	0.0	0.0	.	.
Quackgrass	.	.	0.0	0.0
American dragonhead	.	.	0.0	0.0
Foxtail barley	.	.	0.1	0.1
Volunteer wheat	.	.	13.2	8.1

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 6.0 Weed relative abundance and density by crop in July at Brandon in 1998.

Weed Species	Wheat RelAb	Wheat #/m^2	Canola RelAb	Canola #/m^2
Sowthistle species	31.0	20.4	22.0	24.2
Wild buckwheat	18.5	11.2	17.4	16.9
Canada thistle	15.9	8.2	14.0	11.9
Wild mustard	12.4	6.6	4.2	2.9
Shepherds purse	4.5	2.2	5.7	5.9
Common lambsquarters	3.1	1.7	0.9	0.6
Green foxtail	2.4	1.1	3.5	2.7
Smartweed species	1.6	0.5	0.6	0.3
Stinkweed	1.5	0.5	0.4	0.2
Volunteer canola	1.4	0.4	.	.
Wild oat	1.2	0.3	5.1	4.3
Field peppergrass	1.1	0.5	0.3	0.2
Nightflowering catchfly	0.7	0.3	0.9	0.8
Narrow leaved hawks beard	0.5	0.2	0.6	0.5
Redroot pigweed	0.5	0.2	0.4	0.2
Toadflax (yellow)	0.4	0.1	0.0	0.0
Cinquefoil	0.4	0.2	0.4	0.2
Dandelion	0.3	0.1	0.4	0.2
Flixweed	0.3	0.1	0.1	0.0
Purple leaf willowherb	0.3	0.1	0.1	0.0
Biennial wormwood	0.3	0.1	0.0	0.0
Worm seed mustard	0.3	0.1	0.2	0.1
Absinth	0.2	0.0	.	.
Black poplar	0.2	0.0	0.0	0.0
Broadleaved plantain	0.1	0.0	0.1	0.0
Henbit	0.1	0.0	0.0	0.0
Thyme leaved spurge	0.1	0.1	.	.
Round-leaved mallow	0.1	0.0	0.1	0.0
American dragonhead	0.1	0.0	0.0	0.0
Wild carrot	0.1	0.0	0.1	0.0
Common chickweed	0.1	0.0	.	.
Ricknell geranium	0.1	0.0	.	.
Storks bill	0.0	0.0	0.0	0.0
Vetch species	0.0	0.0	0.0	0.0
Horseweed	0.0	0.0	0.0	0.0
Quackgrass	0.0	0.0	0.0	0.0
Dog mustard	0.0	0.0	0.1	0.0
Mouse ear chickweed	0.0	0.0	.	.
Bluebur	0.0	0.0	0.1	0.0
Mustard species	0.0	0.0	.	.
Goosefoot	0.0	0.0	.	.
Barnyard grass	0.0	0.0	0.2	0.1
Kochia	.	.	0.0	0.0
Sweet clover	.	.	0.0	0.0
Golden dock	.	.	0.0	0.0
Common groundsel	.	.	0.0	0.0
Volunteer wheat	.	.	21.7	23.6

Relative Abundance values(RelAb)were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 7.0 Weed relative abundance and density by fertilizer treatment in wheat prior to crop seeding at Brandon in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2
Mustard species	57.4	19.6	51.5	6.7	63.5	9.7	54.6	5.1	38.6	3.1
Volunteer wheat	16.0	2.8	16.4	0.9	9.9	0.8	16.7	1.1	16.1	1.3
Wild buckwheat	15.0	3.3	7.1	0.4	5.8	0.7	7.1	0.4	13.0	0.8
Perennial sowthistle	2.7	0.4	9.5	0.8	7.0	0.5	2.6	0.2	7.2	0.5
Stinkweed	2.3	0.4	3.9	0.3	1.8	0.1	8.4	0.8	12.0	2.8
Canada thistle	2.1	0.3	6.2	0.5	5.8	0.4	3.5	0.2	6.5	0.4
Wild oat	1.5	0.2	0.2	0.0	.	.	1.4	0.1	.	.
Common lambsquarters	1.3	0.2	2.3	0.1	1.8	0.1	4.2	0.3	2.0	0.1
Green foxtail	0.7	0.1	.	.	1.0	0.1	.	.	0.5	0.1
Dandelion	0.7	0.1	2.1	0.1	2.3	0.1	1.4	0.1	0.4	0.0
Yellow whitlow grass	.	.	.	.	.	.	.	.	1.4	0.1
Cleavers	.	.	0.5	0.1	.	.	.	.	.	.
Round-leaved mallow	.	.	.	.	0.4	0.0	.	.	.	.
Sweet clover species	.	.	.	.	.	.	.	.	0.2	0.0
Smartweed species	.	.	.	.	0.7	0.1	.	.	2.0	0.4
Common chickweed	.	.	0.3	0.0	.	.	.	.	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 8.0 Weed relative abundance and density by fertilizer treatment in canola prior to crop seeding at Brandon in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Volunteer wheat	40.7	52.3	49.4	31.0	51.9	27.0	45.5	24.0	45.3	22.2
Wild buckwheat	23.1	21.4	12.6	3.8	5.6	1.1	10.0	2.1	8.1	2.3
Mustard species	17.3	11.8	12.9	3.3	12.8	3.1	13.9	3.4	11.5	3.1
Perennial sowthistle	6.8	4.0	9.7	2.6	14.4	4.1	16.2	4.9	15.7	6.3
Stinkweed	3.4	1.8	2.5	0.6	2.5	0.6	3.2	0.6	2.6	0.7
Common lambsquarters	2.7	2.3	4.3	1.5	3.6	2.0	2.6	1.0	3.8	2.0
Canada thistle	2.2	0.8	3.2	0.6	6.3	1.2	6.0	1.1	8.1	2.0
Green foxtail	2.1	1.3	2.9	0.7	1.7	0.3	0.8	0.1	2.5	0.7
Wild oat	1.1	0.9	0.3	0.1	.	.	.	.	.	.
Narrow leaved hawks beard	0.2	0.1	0.4	0.1	0.4	0.2	.	.	0.8	0.4
Dandelion	0.1	0.0	0.5	0.1	0.1	0.0	0.2	0.0	0.3	0.1
Common chickweed	0.1	0.0	.	.	.	.	.	.	.	.
American dragonhead	0.1	0.0	0.1	0.0	0.2	0.0	.	.	.	.
Flixweed	0.1	0.0	.	.	.	.	.	.	.	.
Volunteer maple	.	.	.	.	.	.	0.1	0.0	.	.
Quackgrass	.	.	0.2	0.1	0.1	0.0	.	.	.	.
Biennial wormwood	.	.	0.1	0.0	0.3	0.0	.	.	.	.
Shepherds purse	.	.	0.7	0.2	.	.	0.8	0.3	0.8	0.2
Yellow whitlow grass	.	.	.	.	.	.	0.4	0.1	.	.
Sweet clover species	.	.	.	.	.	.	.	.	0.2	0.0
Smartweed species	.	.	.	.	0.2	0.0	0.3	0.0	0.4	0.1
Goatsbeard species	.	.	0.2	0.0	.	.	.	.	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 9.0 Weed relative abundance and density by fertilizer treatment in wheat prior to in-crop spraying at Brandon in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Mustard species	41.3	22.1	49.4	51.1	46.9	31.4	49.0	41.5	47.1	44.7
Wild oat	19.2	6.1	20.8	8.9	22.1	8.2	23.0	10.5	16.1	9.4
Wild buckwheat	8.3	1.9	9.2	4.8	10.0	3.4	8.1	3.2	11.1	5.6
Canada thistle	7.8	1.6	6.2	1.7	7.6	1.9	6.0	1.5	4.9	1.5
Perennial sowthistle	5.0	0.8	5.9	2.6	6.8	1.6	5.4	1.6	9.1	5.8
Stinkweed	3.7	1.2	3.5	1.7	3.0	1.1	4.2	1.4	6.0	3.7
Common lambsquarters	3.4	1.2	2.8	1.8	1.5	0.6	2.7	0.9	3.1	1.4
Green foxtail	2.2	0.8	1.7	0.7	0.6	0.1	1.0	0.2	0.9	0.3
Shepherds purse	1.7	0.2	0.3	0.0	1.0	0.3	.	.	0.7	0.1
Nightflowering catchfly	0.4	0.1	0.1	0.0	0.1	0.0	.	.	.	.
Dandelion	0.4	0.1	.	.	.	.	0.1	0.0	.	.
Pigweed species	0.3	0.1	.	.	0.3	0.1	.	.	.	.
Thyme leaved spurge	0.2	0.1	.	.	.	.	.	.	.	.
Prostrate knotweed	0.1	0.0	.	.	.	.	.	.	0.2	0.1
Narrow leaved hawks beard	.	.	.	.	.	.	.	.	0.1	0.0
Round-leaved mallow	.	.	.	.	.	.	.	.	0.4	0.6
Smartweed species	.	.	0.2	0.1	.	.	0.2	0.0	0.2	0.2
Vetch species	.	.	.	.	.	.	0.2	0.2	0.1	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 10.0 Weed relative abundance and density by fertilizer treatment in canola prior to in-crop spraying at Brandon in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2
Wild oat	27.4	17.1	31.6	22.9	27.5	17.6	27.1	17.2	32.1	29.0
Mustard species	17.6	11.4	18.0	17.4	12.7	10.4	15.0	11.1	10.5	8.6
Wild buckwheat	11.8	4.9	12.9	7.1	10.5	6.4	10.1	4.5	13.0	11.0
Volunteer wheat	11.2	5.2	14.3	8.6	12.0	8.4	13.3	8.4	15.2	10.0
Canada thistle	11.2	4.9	8.2	3.8	16.7	8.5	13.5	7.6	12.8	7.4
Perennial sowthistle	10.8	5.6	8.7	4.7	9.1	5.1	10.2	7.8	9.6	7.4
Green foxtail	4.9	3.1	1.4	0.6	4.6	4.6	2.8	2.3	2.6	1.7
Stinkweed	2.5	1.5	2.0	0.7	3.0	1.6	3.0	1.0	2.3	1.4
Shepherds purse	1.4	0.4	1.1	0.4	2.6	2.3	3.0	1.4	0.8	0.5
Common lambsquarters	0.7	0.2	0.9	0.3	0.5	0.2	0.6	0.2	0.9	0.4
Round-leaved mallow	0.2	0.1	0.3	0.2	.	.	0.1	0.0	.	.
Pigweed species	0.1	0.1	0.2	0.1	.	.	.	.	.	.
Dandelion	0.1	0.1	0.1	0.0	0.2	0.1	0.4	0.1	0.1	0.0
Quackgrass	.	.	.	.	.	.	0.1	0.0	.	.
American dragonhead	.	.	.	.	0.1	0.0	.	.	.	.
Foxtail barley	.	.	.	.	0.1	0.1	0.5	0.6	.	.
Nightflowering catchfly	.	.	0.1	0.0	0.3	0.2	0.3	0.1	.	.
Smartweed species	.	.	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 11.0 Weed relative abundance and density by fertilizer treatment in wheat in July at Brandon in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Sowthistle species	29.5	15.7	28.8	17.5	31.2	15.5	28.4	19.9	37.0	33.7
Canada thistle	18.9	9.8	15.7	7.6	17.6	9.4	15.0	8.0	12.4	6.4
Wild buckwheat	17.3	9.1	19.9	12.5	20.3	10.6	17.9	12.2	17.0	11.7
Wild mustard	8.3	3.7	10.9	6.1	10.0	4.4	17.7	10.9	15.0	8.1
Shepherds purse	5.1	2.3	5.0	2.5	5.0	2.2	3.0	2.3	4.5	1.7
Common lambsquarters	3.6	1.8	3.7	2.3	2.3	1.8	3.3	1.7	2.7	1.1
Green foxtail	3.4	1.7	3.0	1.5	0.8	0.3	2.6	1.3	2.5	1.1
Smartweed species	1.7	0.5	2.2	0.6	1.4	0.4	1.5	0.4	1.1	0.4
Volunteer canola	1.6	0.4	1.6	0.5	1.8	0.6	1.0	0.3	1.1	0.3
Stinkweed	1.4	0.4	1.1	0.5	1.5	0.5	2.1	0.7	1.4	0.4
Nightflowering catchfly	1.3	0.5	0.8	0.3	0.7	0.3	0.6	0.3	0.2	0.1
Field peppergrass	1.3	0.3	1.7	0.5	1.0	0.3	1.5	1.4	0.2	0.1
Wild oat	1.0	0.3	0.4	0.1	1.9	0.4	1.5	0.5	1.1	0.3
Narrow leaved hawks beard	0.9	0.5	0.5	0.1	0.1	0.0	0.2	0.1	0.9	0.3
Cinquefoil	0.6	0.2	0.5	0.2	0.3	0.1	0.4	0.2	0.3	0.1
Redroot pigweed	0.6	0.1	0.6	0.2	0.7	0.2	0.1	0.0	0.5	0.4
Dandelion	0.4	0.1	0.6	0.2	0.4	0.1	.	.	0.1	0.0
Black poplar	0.4	0.1	.	.	0.1	0.0	0.3	0.1	.	.
Toadflax (yellow)	0.3	0.1	0.3	0.2	0.8	0.2	0.4	0.1	0.4	0.1
Biennial wormwood	0.3	0.1	0.5	0.2	0.1	0.1	0.2	0.1	0.1	0.0
Flixweed	0.3	0.1	0.7	0.3	0.1	0.0	0.2	0.1	0.2	0.1
Henbit	0.3	0.1	.	.	0.1	0.0	.	.	0.1	0.0
Broadleaved plantain	0.3	0.1	0.1	0.0	0.1	0.0	0.3	0.1	.	.
Absinth	0.3	0.1	0.1	0.0	0.4	0.1	0.1	0.0	0.1	0.0
Ricknell geranium	0.2	0.1	.	.	.	.	0.1	0.0	.	.
Horseweed	0.2	0.1	.	.	.	.	.	.	.	.
American dragonhead	0.1	0.0	0.1	0.0	.	.	0.1	0.0	0.1	0.0
Purple leaf willowherb	0.1	0.0	0.2	0.1	0.1	0.0	0.4	0.1	0.5	0.1
Quackgrass	0.1	0.0	.	.	.	.	.	.	.	.
Worm seed mustard	0.1	0.0	0.3	0.1	0.4	0.1	0.4	0.1	0.1	0.0
Wild carrot	0.1	0.0	.	.	.	.	0.3	0.1	.	.
Mouse ear chickweed	.	.	0.1	0.0	.	.	.	.	.	.
Goosefoot	.	.	0.1	0.0	.	.	.	.	.	.
Barnyard grass	.	.	0.1	0.0	.	.	.	.	.	.
Thyme leaved spurge	.	.	.	.	0.5	0.3	.	.	.	.
Dog mustard	.	.	0.1	0.1	.	.	.	.	.	.
Storks bill	.	.	.	.	.	.	.	0.2	0.1	.
Bluebur	.	.	.	.	0.1	0.0	.	.	.	.
Round-leaved mallow	.	.	0.1	0.0	.	.	0.1	0.0	0.3	0.1
Mustard species	.	.	.	.	0.1	0.0	.	.	.	.
Common chickweed	.	.	0.1	0.0	.	.	0.1	0.0	0.1	0.0
Vetch species	.	.	0.1	0.0	.	.	0.1	0.0	.	.

Table 12.0 Weed relative abundance & density by fertilizer treatment in canola in July at Brandon in1998

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Sowthistle species	23.5	24.1	22.9	24.1	23.7	26.5	18.7	22.4	21.2	24.0
Volunteer wheat	20.2	18.9	21.7	22.0	21.3	22.7	22.6	29.0	22.6	25.3
Wild buckwheat	17.9	15.5	20.4	19.9	15.2	13.1	16.4	18.1	17.2	17.8
Canada thistle	14.3	11.2	9.8	7.2	16.5	13.4	14.2	14.6	15.3	13.0
Green foxtail	5.6	4.0	2.4	1.4	4.4	3.4	2.5	2.6	2.8	2.3
Shepherds purse	5.1	4.1	6.3	7.8	5.8	4.2	6.0	8.2	5.2	5.5
Wild mustard	3.4	2.2	4.0	2.5	2.6	1.4	7.1	6.1	3.8	2.3
Wild oat	3.3	2.4	4.9	3.3	5.1	3.3	6.4	6.5	6.1	5.9
Common lambsquarters	1.2	0.6	0.9	0.5	0.7	0.5	0.7	0.6	1.1	0.9
Redroot pigweed	0.9	0.6	0.6	0.5	0.3	0.1	0.1	0.0	0.1	0.0
Cinquefoil	0.8	0.3	0.4	0.2	0.4	0.2	0.2	0.1	0.1	0.0
Nightflowering catchfly	0.7	0.4	1.8	1.8	0.4	0.2	1.2	1.3	0.5	0.3
Smartweed species	0.6	0.2	1.1	0.9	0.5	0.2	0.7	0.4	0.2	0.1
Field peppergrass	0.6	0.3	0.2	0.1	0.1	0.0	0.5	0.7	0.2	0.1
Dandelion	0.3	0.1	0.6	0.2	0.5	0.2	.	.	0.7	0.3
Stinkweed	0.3	0.1	0.6	0.2	0.4	0.2	0.6	0.3	0.2	0.1
Flixweed	0.2	0.1	0.1	0.0	.	.	0.3	0.1	.	.
Narrow leaved hawks beard	0.2	0.1	0.6	0.4	0.6	0.2	0.2	0.2	1.6	1.7
Round-leaved mallow	0.2	0.1	0.1	0.1	0.1	0.1	.	.	.	.
Barnyard grass	0.2	0.1	0.2	0.1	0.3	0.2	0.2	0.1	0.1	0.0
Quackgrass	0.1	0.1	.	.	.	.	.	.	.	.
Storks bill	0.1	0.0	.	.	0.1	0.0	.	.	.	.
Vetch species	0.1	0.0	.	.	.	.	.	.	0.1	0.0
Henbit	0.1	0.0	.	.	.	.	0.1	0.0	.	.
Biennial wormwood	0.1	0.0	0.1	0.0	0.1	0.0	.	.	.	.
American dragonhead	0.1	0.0	.	.	.	.	.	.	0.2	0.1
Horseweed	0.1	0.0	.	.	.	.	.	.	.	.
Toadflax (yellow)	0.1	0.0	.	.	0.1	0.0	.	.	.	.
Bluebur	0.1	0.0	.	.	0.1	0.1	0.1	0.0	.	.
Black poplar	0.1	0.0	0.2	0.1	.	.	.	.	.	.
Wild carrot	.	.	0.1	0.0	.	.	0.1	0.1	0.1	0.0
Purple leaf willowherb	.	.	0.2	0.1	0.1	0.1	.	.	.	.
Dog mustard	.	.	.	.	0.3	0.1	0.1	0.0	.	.
Worm seed mustard	.	.	.	.	0.1	0.1	0.7	0.5	0.4	0.2
Kochia	.	.	.	.	.	.	.	.	0.1	0.0
Sweet clover	.	.	0.1	0.0	.	.	.	.	.	.
Broadleaved plantain	.	.	0.1	0.0	0.2	0.1	0.1	0.1	0.1	0.0
Golden dock	.	.	.	.	.	.	0.1	0.0	.	.
Common groundsel	.	.	.	.	.	.	0.1	0.0	0.1	0.0

Table 13.0 Weed relative abundance and density by herbicide treatment in wheat prior to crop seeding at Brandon in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Mustard species	53.3	9.0	52.9	8.7
Volunteer wheat	17.1	1.4	13.0	1.3
Wild buckwheat	8.0	0.9	11.2	1.3
Stinkweed	6.4	1.1	5.0	0.6
Perennial sowthistle	4.7	0.3	7.0	0.6
Canada thistle	4.1	0.3	5.6	0.4
Common lambsquarters	3.0	0.2	1.6	0.1
Dandelion	1.4	0.1	1.4	0.1
Green foxtail	0.6	0.1	0.3	0.1
Wild oat	0.6	0.1	0.7	0.1
Yellow whitlow grass	0.6	0.0	.	.
Round-leaved mallow	0.2	0.0	.	.
Common chickweed	0.1	0.0	.	.
Cleavers	.	.	0.2	0.1
Sweet clover species	.	.	0.1	0.0
Smartweed species	.	.	1.1	0.2

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 14.0 Weed relative abundance and density by herbicide treatment in canola prior to crop seeding at Brandon in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Volunteer wheat	47.7	30.9	45.5	31.7
Mustard species	14.0	4.7	13.4	5.1
Wild buckwheat	12.0	4.7	11.7	7.5
Perennial sowthistle	11.4	3.3	13.7	5.5
Canada thistle	4.6	0.9	5.7	1.4
Stinkweed	3.3	1.0	2.4	0.7
Common lambsquarters	2.7	1.0	4.1	2.5
Green foxtail	2.0	0.5	2.0	0.7
Shepherds purse	0.7	0.2	0.2	0.1
Dandelion	0.3	0.1	0.2	0.0
Narrow leaved hawks beard	0.3	0.1	0.4	0.2
Wild oat	0.2	0.1	0.3	0.3
Smartweed species	0.2	0.0	0.1	0.0
American dragonhead	0.1	0.0	0.0	0.0
Biennial wormwood	0.1	0.0	0.0	0.0
Quackgrass	0.1	0.0	0.1	0.0
Sweet clover species	0.1	0.0	.	.
Goatsbeard species	0.1	0.0	.	.
Common chickweed	0.0	0.0	.	.
Volunteer maple	.	.	0.1	0.0
Flixweed	.	.	0.0	0.0
Yellow whitlow grass	.	.	0.2	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 15.0 Weed relative abundance and density by herbicide treatment in wheat prior to in-crop spraying at Brandon in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Mustard species	50.3	37.8	43.2	38.5
Wild oat	18.3	7.2	22.2	10.0
Wild buckwheat	8.1	2.7	10.6	4.9
Canada thistle	6.2	1.6	6.8	1.7
Perennial sowthistle	5.5	1.7	7.4	3.2
Stinkweed	4.5	2.1	3.7	1.5
Common lambsquarters	2.3	1.1	3.1	1.3
Green foxtail	1.2	0.4	1.3	0.5
Shepherds purse	0.8	0.1	0.7	0.2
Nightflowering catchfly	0.2	0.0	0.1	0.0
Pigweed species	0.1	0.0	0.1	0.0
Prostrate knotweed	0.1	0.0	.	.
Thyme leaved spurge	0.1	0.0	.	.
Narrow leaved hawks beard	.	.	0.0	0.0
Round-leaved mallow	.	.	0.2	0.3
Smartweed species	.	.	0.3	0.1
Dandelion	.	.	0.2	0.0
Vetch species	.	.	0.1	0.1

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 16.0 Weed relative abundance and density by herbicide treatment in canola prior to in-crop spraying at Brandon in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m²	RelAb	#/m²
Wild oat	29.7	20.7	28.5	20.8
Mustard species	15.3	12.7	14.2	10.8
Volunteer wheat	13.4	7.9	13.1	8.4
Canada thistle	12.0	5.8	13.0	7.1
Wild buckwheat	11.9	6.9	11.5	6.6
Perennial sowthistle	8.8	4.7	10.5	7.5
Stinkweed	3.1	1.5	2.0	0.9
Green foxtail	2.7	1.7	3.8	3.2
Shepherds purse	1.6	0.8	2.0	1.2
Common lambsquarters	0.6	0.2	0.9	0.3
Dandelion	0.3	0.1	0.1	0.0
Foxtail barley	0.2	0.2	0.0	0.0
Nightflowering catchfly	0.2	0.1	0.1	0.0
Pigweed species	0.1	0.0	.	.
Round-leaved mallow	0.1	0.0	0.1	0.1
American dragonhead	0.1	0.0	.	.
Smartweed species	0.0	0.0	0.1	0.1
Quackgrass	.	.	0.0	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 17.0 Weed relative abundance and density by herbicide treatment in wheat in July at Brandon in 1998.

Weed Species	Full rate RelAb	Full rate #/m^2	Reduced Rate RelAb	Reduced Rate #/m^2
Sowthistle species	31.1	19.4	30.8	21.5
Wild buckwheat	16.8	9.4	20.1	13.0
Canada thistle	15.0	7.1	16.8	9.4
Wild mustard	12.7	6.6	12.0	6.6
Shepherds purse	5.5	2.2	3.5	2.2
Common lambsquarters	3.2	1.7	3.1	1.7
Green foxtail	2.9	1.2	2.0	1.0
Stinkweed	1.7	0.5	1.3	0.4
Smartweed species	1.5	0.4	1.6	0.5
Volunteer canola	1.4	0.5	1.4	0.4
Field peppergrass	1.4	0.8	0.8	0.3
Wild oat	1.2	0.3	1.1	0.3
Nightflowering catchfly	0.9	0.3	0.5	0.2
Narrow leaved hawks beard	0.7	0.2	0.4	0.2
Cinquefoil	0.6	0.2	0.3	0.1
Toadflax (yellow)	0.6	0.2	0.3	0.1
Biennial wormwood	0.4	0.1	0.2	0.0
Redroot pigweed	0.4	0.1	0.6	0.2
Flixweed	0.4	0.1	0.3	0.1
Purple leaf willowherb	0.3	0.1	0.3	0.1
Black poplar	0.2	0.1	0.1	0.0
Dandelion	0.2	0.1	0.4	0.1
Broadleaved plantain	0.2	0.1	0.1	0.0
Worm seed mustard	0.2	0.1	0.4	0.1
Henbit	0.1	0.0	0.1	0.0
Wild carrot	0.1	0.0	0.1	0.0
Absinth	0.1	0.0	0.3	0.1
American dragonhead	0.1	0.0	0.1	0.0
Dog mustard	0.0	0.0	.	.
Ricknell geranium	0.0	0.0	0.1	0.0
Common chickweed	0.0	0.0	0.1	0.0
Mustard species	0.0	0.0	.	.
Goosefoot	0.0	0.0	.	.
Barnyard grass	0.0	0.0	.	.
Round-leaved mallow	0.0	0.0	0.2	0.1
Quackgrass	.	.	0.1	0.0
Mouse ear chickweed	.	.	0.0	0.0
Thyme leaved spurge	.	.	0.2	0.1
Horseweed	.	.	0.1	0.0
Storks bill	.	.	0.1	0.0
Bluebur	.	.	0.0	0.0
Vetch species	.	.	0.1	0.0

Table 18.0 Weed relative abundance and density by herbicide treatment in canola in July at Brandon in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Volunteer wheat	22.3	24.4	21.1	22.8
Sowthistle species	21.7	23.1	22.3	25.4
Wild buckwheat	18.0	17.5	16.8	16.2
Canada thistle	13.0	10.6	15.0	13.1
Shepherds purse	6.2	6.8	5.2	5.1
Wild oat	4.3	3.9	6.0	4.7
Wild mustard	4.3	3.0	4.2	2.8
Green foxtail	3.8	3.0	3.3	2.4
Nightflowering catchfly	1.1	1.0	0.7	0.5
Common lambsquarters	0.9	0.5	1.0	0.8
Dandelion	0.6	0.2	0.3	0.1
Cinquefoil	0.5	0.2	0.2	0.1
Narrow leaved hawks beard	0.5	0.4	0.8	0.6
Redroot pigweed	0.5	0.3	0.3	0.2
Smartweed species	0.4	0.3	0.7	0.4
Field peppergrass	0.4	0.3	0.2	0.1
Stinkweed	0.3	0.1	0.6	0.3
Barnyard grass	0.2	0.1	0.2	0.1
Flixweed	0.1	0.1	0.1	0.0
Dog mustard	0.1	0.1	.	.
Round-leaved mallow	0.1	0.0	0.1	0.1
Broadleaved plantain	0.1	0.0	0.1	0.0
Purple leaf willowherb	0.1	0.0	0.0	0.0
Storks bill	0.1	0.0	.	.
American dragonhead	0.1	0.0	0.0	0.0
Biennial wormwood	0.1	0.0	0.0	0.0
Wild carrot	0.1	0.0	0.1	0.0
Black poplar	0.1	0.0	0.0	0.0
Worm seed mustard	0.1	0.0	0.4	0.3
Vetch species	0.0	0.0	0.0	0.0
Kochia	0.0	0.0	.	.
Golden dock	0.0	0.0	.	.
Horseweed	0.0	0.0	.	.
Toadflax (yellow)	0.0	0.0	0.0	0.0
Bluebur	0.0	0.0	0.1	0.0
Quackgrass	.	.	0.1	0.0
Henbit	.	.	0.1	0.0
Sweet clover	.	.	0.0	0.0
Common groundsel	.	.	0.1	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 19.0 Weed relative abundance and density by crop prior to crop seeding at Melfort in 1998.

Weed Species	Wheat RelAb	Wheat #/m^2	Canola RelAb	Canola #/m^2
Dandelion	54.8	11.6	58.6	12.1
Mustard species	14.9	5.7	10.8	2.0
Cleavers	6.2	1.1	5.4	0.8
Stinkweed	4.9	1.4	2.4	0.3
Volunteer cereals	4.1	0.7	12.2	1.9
Wild oat	4.1	0.7	1.1	0.2
Wild buckwheat	2.7	0.6	2.2	0.3
Shepherds purse	2.3	0.3	0.3	0.0
Flixweed	1.4	0.2	4.0	0.5
Canada thistle	0.9	0.1	0.5	0.1
Cinquefoil	0.8	0.1	0.3	0.0
Prickly lettuce	0.8	0.4	0.3	0.0
Common lambsquarters	0.7	0.1	0.4	0.0
Pygmy flower	0.3	0.0	0.1	0.0
Quackgrass	0.3	0.0	1.2	0.2
Perennial sowthistle	0.2	0.0	0.1	0.0
American dragonhead	0.2	0.0	.	.
Bird vetch	0.1	0.0	.	.
Bluebur	0.1	0.0	0.1	0.0
Sweet clover species	0.1	0.0	.	.
Yellow whitlow grass	0.0	0.0	0.1	0.0
Prostrate knotweed	0.0	0.0	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 20.0 Weed relative abundance and density by crop prior to in-crop spraying at Melfort in 1998.

Weed Species	Wheat RelAb	Wheat #/m²	Canola RelAb	Canola #/m²
Mustard species	58.1	80.8	0.3	0.1
Dandelion	8.5	3.4	13.1	3.1
Cleavers	7.8	5.1	7.3	3.3
Wild buckwheat	4.9	1.8	5.3	1.2
Stinkweed	4.6	2.3	6.4	2.0
Wild oat	4.0	1.9	36.5	14.5
Green foxtail	3.4	1.4	6.1	1.8
Common lambsquarters	3.2	1.1	2.5	0.6
Perennial sowthistle	1.3	0.7	1.2	0.3
Canada thistle	1.2	0.4	0.8	0.2
Barnyard grass	0.9	0.4	0.9	0.2
Redroot pigweed	0.7	0.2	2.6	0.8
Shepherds purse	0.6	0.2	0.9	0.2
Narrow leaved hawks beard	0.4	0.1	0.1	0.0
Cinquefoil	0.2	0.1	0.0	0.0
Flixweed	0.1	0.0	0.2	0.0
Pygmy flower	0.0	0.0	.	.
Bird vetch	0.0	0.0	.	.
Sweet clover species	0.0	0.0	.	.
Hempnettle	.	.	0.0	0.0
Bluebur	.	.	0.0	0.0
Smartweed species	.	.	0.2	0.0
Common groundsel	.	.	0.1	0.0
Volunteer wheat	.	.	15.1	5.4

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 21.0 Weed relative abundance and density by crop in July at Melfort in 1998.

Weed Species	Wheat RelAb	Wheat #/m²	Canola RelAb	Canola #/m²
Mustard species	41.0	7.4	.	.
Cleavers	21.7	5.1	17.2	2.2
Wild buckwheat	10.5	1.3	9.7	0.5
Dandelion	9.4	1.3	7.4	0.3
Green foxtail	4.0	0.9	1.1	0.1
Stinkweed	3.1	0.4	0.6	0.0
Perennial sowthistle	2.7	0.5	2.5	0.1
Wild oat	2.0	0.3	56.1	3.8
Canada thistle	2.0	0.2	0.3	0.0
Redroot pigweed	1.5	0.2	0.8	0.0
Cinquefoil	0.5	0.1	.	.
Common lambsquarters	0.3	0.0	1.5	0.1
Shepherds purse	0.3	0.0	0.5	0.0
Narrow leaved hawks beard	0.3	0.0	.	.
Hempnettle	0.3	0.0	0.1	0.0
Barnyard grass	0.2	0.1	.	.
Smartweed species	0.2	0.0	1.1	0.0
Bluebur	0.0	0.0	.	.
Pygmy flower	.	.	0.1	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 22.0 Weed relative abundance and density by fertilizer treatment in wheat prior to crop seeding at Melfort in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Mustard species	35.0	23.1	11.6	2.0	9.8	1.6	8.1	0.8	10.0	1.3
Dandelion	28.1	9.0	55.7	11.9	57.4	12.7	67.5	12.5	65.4	11.9
Stinkweed	9.0	4.7	5.4	0.8	3.6	0.5	4.0	0.6	2.8	0.3
Wild oat	6.8	1.8	5.9	0.8	2.1	0.2	3.9	0.5	1.8	0.2
Cleavers	5.7	1.7	7.1	1.4	10.0	1.5	4.9	0.4	3.3	0.3
Volunteer cereals	4.9	1.6	3.7	0.5	5.9	0.6	1.3	0.2	4.9	0.7
Wild buckwheat	4.8	1.4	3.0	0.6	2.1	0.2	1.8	0.3	2.0	0.4
Prickly lettuce	1.6	1.2	0.8	0.3	0.7	0.1	.	.	0.8	0.2
Canada thistle	1.2	0.2	0.8	0.1	0.8	0.1	1.7	0.2	0.2	0.0
Shepherds purse	0.8	0.2	2.0	0.3	2.0	0.3	3.3	0.3	3.2	0.5
Common lambsquarters	0.7	0.2	1.0	0.2	0.4	0.0	0.3	0.0	1.1	0.1
Cinquefoil	0.6	0.1	0.3	0.1	1.5	0.1	0.8	0.1	0.9	0.1
American dragonhead	0.5	0.1	.	.	0.4	0.0	.	.	.	.
Perennial sowthistle	0.3	0.1	0.6	0.1	.	.	.	.	0.3	0.0
Quackgrass	.	.	0.9	0.1	.	.	0.4	0.1	.	.
Pygmy flower	.	.	.	.	0.7	0.1	.	.	0.8	0.1
Flixweed	.	.	1.2	0.2	2.2	0.3	1.1	0.1	2.5	0.2
Yellow whitlow grass	.	.	.	.	.	.	0.2	0.0	.	.
Bluebur	.	.	.	.	0.3	0.1	.	.	.	.
Sweet clover species	.	.	.	.	0.3	0.0	.	.	.	.
Prostrate knotweed	.	.	.	.	.	.	0.2	0.0	.	.
Bird vetch	.	.	.	.	.	.	0.4	0.1	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 23.0 Weed relative abundance and density by fertilizer treatment in canola prior to crop seeding at Melfort in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2
Dandelion	42.5	10.4	51.4	8.9	57.2	11.2	74.8	15.6	67.3	14.5
Volunteer cereals	26.0	5.1	10.7	1.2	11.5	1.5	5.0	0.9	8.0	1.2
Mustard species	11.5	2.1	16.5	3.7	13.3	2.1	4.0	0.5	8.6	1.5
Stinkweed	7.5	1.2	1.9	0.2	1.1	0.1	1.1	0.1	0.5	0.1
Wild buckwheat	4.9	0.8	2.7	0.4	1.2	0.1	1.1	0.1	1.0	0.1
Cleavers	3.6	0.7	7.8	0.7	4.3	0.4	6.2	1.0	5.0	1.1
Wild oat	1.5	0.2	0.8	0.2	1.2	0.2	0.7	0.1	1.3	0.2
Quackgrass	1.0	0.3	1.9	0.3	1.8	0.3	0.3	0.0	0.8	0.2
Canada thistle	0.4	0.1	0.4	0.1	.	.	1.5	0.2	.	.
Common lambsquarters	0.2	0.0	1.1	0.1	0.5	0.1	0.2	0.0	.	.
Prickly lettuce	0.2	0.0	.	.	0.8	0.1	0.3	0.0	.	.
Flixweed	0.2	0.0	3.5	0.4	6.6	0.8	3.8	0.6	5.7	1.0
Shepherds purse	0.2	0.0	.	.	0.2	0.0	0.6	0.1	0.7	0.1
Pygmy flower	.	.	0.4	0.0	.	.	0.3	0.0	.	.
Yellow whitlow grass	.	.	.	.	.	.	.	.	0.3	0.0
Bluebur	.	.	.	.	.	.	.	.	0.3	0.0
Cinquefoil	.	.	0.5	0.1	0.3	0.0	0.4	0.0	0.3	0.0
Perennial sowthistle	.	.	0.4	0.1	.	.	.	.	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 24.0 Weed relative abundance and density by fertilizer treatment in wheat prior to in-crop spraying at Melfort in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Mustard species	48.1	39.6	56.0	102.5	55.7	63.4	58.3	70.8	72.5	127.8
Cleavers	11.6	6.4	8.0	8.1	9.0	6.2	4.5	2.3	5.9	2.8
Dandelion	10.4	4.3	7.5	3.2	9.3	3.4	10.3	4.3	4.7	2.0
Wild oat	6.3	2.7	4.1	2.4	3.9	1.8	4.9	2.4	1.1	0.3
Green foxtail	5.4	2.5	3.7	1.8	2.2	0.7	3.4	1.0	2.3	0.8
Wild buckwheat	4.3	1.8	6.4	2.8	4.8	1.7	3.2	0.9	5.7	1.7
Stinkweed	3.7	2.0	4.8	4.0	5.4	2.3	5.7	2.1	3.2	1.1
Common lambsquarters	3.3	1.2	4.1	1.8	4.0	1.4	2.9	0.7	1.8	0.5
Perennial sowthistle	1.7	1.1	2.2	1.4	1.5	0.4	0.8	0.5	0.3	0.1
Barnyard grass	1.5	0.8	0.6	0.3	0.7	0.2	0.5	0.1	1.0	0.4
Canada thistle	1.4	0.5	0.6	0.3	1.4	0.4	1.9	0.6	0.5	0.1
Redroot pigweed	0.8	0.2	0.9	0.3	0.6	0.2	0.7	0.3	0.4	0.1
Narrow leaved hawks beard	0.6	0.1	0.3	0.1	0.2	0.1	0.9	0.2	0.1	0.0
Cinquefoil	0.3	0.2	.	.	0.1	0.0	0.5	0.1	.	.
Pygmy flower	0.2	0.1	.	.	.	.	.	.	.	.
Shepherds purse	0.2	0.1	0.2	0.1	1.1	0.3	1.3	0.4	0.3	0.1
Flixweed	.	.	0.5	0.1	.	.	0.1	0.0	.	.
Sweet clover species	.	.	.	.	0.1	0.0	.	.	.	.
Bird vetch	.	.	.	.	.	.	.	.	0.2	0.1

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 25.0 Weed relative abundance and density by fertilizer treatment in canola prior to in-crop spraying at Melfort in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2	RelAb	#/m^2
Wild oat	27.1	10.8	36.9	14.6	44.7	18.8	36.1	14.6	37.7	13.6
Volunteer wheat	15.6	5.1	15.4	6.0	10.3	3.0	10.7	4.6	23.5	8.2
Cleavers	10.6	6.3	5.8	2.2	6.8	2.7	8.0	3.6	5.4	1.9
Dandelion	9.2	2.4	9.9	2.4	17.9	3.5	18.6	5.2	10.1	2.1
Green foxtail	8.4	2.8	8.5	2.7	3.1	0.6	5.9	1.9	4.7	1.0
Stinkweed	7.8	2.0	6.7	2.5	6.5	2.2	4.7	1.4	6.2	1.9
Redroot pigweed	6.4	2.4	3.5	0.9	1.6	0.3	0.6	0.2	1.0	0.2
Wild buckwheat	3.8	0.9	6.7	1.5	3.7	0.8	5.8	1.3	6.5	1.3
Common lambsquarters	3.7	0.8	3.5	1.0	1.7	0.4	2.2	0.4	1.2	0.3
Shepherds purse	1.2	0.3	0.1	0.0	1.0	0.2	1.1	0.2	0.9	0.2
Perennial sowthistle	1.1	0.2	0.9	0.2	0.6	0.1	1.9	0.5	1.7	0.3
Canada thistle	0.9	0.2	0.3	0.1	0.8	0.1	1.9	0.4	.	.
Barnyard grass	0.8	0.2	1.2	0.3	0.7	0.1	1.0	0.5	0.8	0.2
Mustard species	0.6	0.1	0.2	0.1	0.3	0.1	0.5	0.1	.	.
Smartweed species	0.6	0.2	.	.	.	.	.	.	0.2	0.0
Bluebur	0.1	0.0	.	.	.	.	.	.	0.1	0.0
Narrow leaved hawks beard	.	.	0.3	0.1	.	.	.	.	.	.
Flixweed	.	.	.	.	0.2	0.1	0.7	0.2	.	.
Hempnettle	.	.	0.1	0.0	.	.	0.1	0.0	.	.
Cinquefoil	.	.	.	.	.	.	0.2	0.0	.	.
Common groundsel	.	.	.	.	0.2	0.0	0.2	0.0	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 26.0 Weed relative abundance and density by fertilizer treatment in wheat in July at Melfort in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Mustard species	28.5	5.1	40.5	6.1	42.9	6.5	46.4	12.8	46.6	6.8
Cleavers	24.1	6.3	23.4	5.6	22.7	4.5	18.4	5.9	19.7	3.3
Wild buckwheat	12.0	1.8	13.5	1.8	10.7	1.3	4.7	0.8	11.5	1.0
Dandelion	12.0	1.6	7.9	1.0	11.0	1.5	10.2	1.8	5.8	0.6
Stinkweed	6.8	1.1	0.7	0.1	0.8	0.1	3.4	0.6	3.6	0.3
Wild oat	3.7	0.6	.	.	2.9	0.3	2.2	0.3	1.3	0.1
Canada thistle	3.1	0.3	1.3	0.2	2.8	0.3	1.8	0.2	0.9	0.1
Green foxtail	2.9	0.6	5.0	1.0	1.3	0.2	5.1	1.3	5.5	1.6
Perennial sowthistle	2.7	0.5	5.6	1.2	1.6	0.3	3.2	0.5	0.6	0.1
Redroot pigweed	2.5	0.3	0.3	0.0	2.4	0.3	1.5	0.2	0.9	0.1
Cinquefoil	1.3	0.3	.	.	.	.	0.3	0.1	0.8	0.1
Hempnettle	0.2	0.0	.	.	.	.	.	.	1.1	0.1
Smartweed species	0.2	0.0	.	.	.	.	0.3	0.0	0.5	0.1
Shepherds purse	.	.	.	.	1.0	0.1	0.4	0.1	0.3	0.0
Common lambsquarters	.	.	0.8	0.1	.	.	0.3	0.1	0.7	0.1
Narrow leaved hawks beard	.	.	0.6	0.1	.	.	0.9	0.1	.	.
Barnyard grass	.	.	0.3	0.0	.	.	0.8	0.2	.	.
Bluebur	.	.	0.2	0.0	.	.	.	.	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 27.0 Weed relative abundance and density by fertilizer treatment in canola in July at Melfort in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Wild oat	47.3	3.4	58.3	3.5	63.0	3.7	57.0	5.4	54.7	3.3
Cleavers	23.9	3.1	19.3	2.1	16.7	1.7	16.1	3.5	10.2	1.0
Wild buckwheat	6.6	0.4	9.5	0.4	7.4	0.4	10.5	0.8	14.2	0.6
Smartweed species	5.0	0.1	.	.	.	.	.	.	0.7	0.0
Dandelion	3.9	0.2	6.8	0.3	6.9	0.3	7.6	0.5	11.6	0.5
Common lambsquarters	3.0	0.1	0.6	0.0	0.9	0.1	1.0	0.1	2.0	0.1
Perennial sowthistle	2.0	0.1	2.5	0.1	2.8	0.1	2.5	0.2	2.5	0.0
Green foxtail	1.6	0.2	1.4	0.1	.	.	1.5	0.2	1.2	0.1
Redroot pigweed	0.7	0.1	0.9	0.1	1.2	0.0	1.1	0.1	.	.
Shepherds purse	0.5	0.0	.	.	0.5	0.0	.	.	1.5	0.1
Stinkweed	0.4	0.0	.	.	0.5	0.0	1.0	0.1	0.9	0.1
Pygmy flower	.	.	0.6	0.0	.	.	.	.	.	.
Canada thistle	.	.	.	.	.	.	1.7	0.1	.	.
Hempnettle	.	.	.	.	.	.	.	.	0.7	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 28.0 Weed relative abundance and density by herbicide treatment in wheat prior to crop seeding at Melfort in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Dandelion	55.2	8.8	54.5	14.4
Mustard species	15.0	6.1	14.9	5.4
Wild oat	5.6	0.9	2.6	0.4
Cleavers	5.4	0.7	6.9	1.4
Stinkweed	5.2	1.7	4.6	1.1
Volunteer cereals	4.9	0.9	3.4	0.5
Flixweed	2.2	0.2	0.6	0.1
Shepherds purse	2.1	0.2	2.4	0.4
Wild buckwheat	2.0	0.4	3.5	0.8
Common lambsquarters	0.6	0.1	0.8	0.1
Canada thistle	0.6	0.1	1.3	0.2
Cinquefoil	0.4	0.1	1.2	0.2
Perennial sowthistle	0.3	0.0	0.2	0.0
Pygmy flower	0.2	0.0	0.4	0.0
American dragonhead	0.2	0.0	0.2	0.0
Quackgrass	0.1	0.0	0.4	0.1
Yellow whitlow grass	.	.	0.1	0.0
Prickly lettuce	.	.	1.6	0.7
Bluebur	.	.	0.1	0.0
Sweet clover species	.	.	0.1	0.0
Prostrate knotweed	.	.	0.1	0.0
Bird vetch	.	.	0.2	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 29.0 Weed relative abundance and density by herbicide treatment in canola prior to crop seeding at Melfort in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Dandelion	54.4	9.9	62.9	14.3
Volunteer cereals	12.4	1.8	12.1	2.1
Mustard species	12.3	2.1	9.3	1.9
Cleavers	5.8	0.8	5.0	0.7
Flixweed	5.6	0.8	2.3	0.3
Stinkweed	3.5	0.5	1.3	0.2
Wild buckwheat	3.2	0.4	1.2	0.2
Wild oat	1.1	0.2	1.1	0.1
Quackgrass	0.5	0.1	1.8	0.3
Common lambsquarters	0.4	0.0	0.4	0.0
Cinquefoil	0.3	0.0	0.3	0.0
Canada thistle	0.2	0.0	0.7	0.1
Pygmy flower	0.1	0.0	0.2	0.0
Shepherds purse	0.1	0.0	0.6	0.1
Prickly lettuce	0.1	0.0	0.5	0.0
Yellow whitlow grass	.	.	0.1	0.0
Bluebur	.	.	0.1	0.0
Perennial sowthistle	.	.	0.2	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 30.0 Weed relative abundance and density by herbicide treatment in wheat prior to in-crop spraying at Melfort in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Mustard species	59.2	81.7	57.1	79.9
Dandelion	6.1	2.1	10.8	4.8
Wild oat	5.9	2.9	2.2	0.9
Cleavers	5.6	3.8	10.0	6.5
Wild buckwheat	4.9	1.6	4.9	1.9
Stinkweed	4.8	3.1	4.3	1.5
Green foxtail	4.6	1.8	2.2	0.9
Common lambsquarters	3.6	1.3	2.8	0.9
Canada thistle	1.2	0.4	1.1	0.4
Barnyard grass	0.9	0.5	0.8	0.2
Perennial sowthistle	0.9	0.3	1.8	1.1
Redroot pigweed	0.9	0.3	0.5	0.2
Shepherds purse	0.5	0.2	0.8	0.2
Narrow leaved hawks beard	0.4	0.1	0.4	0.1
Flixweed	0.2	0.1	0.1	0.0
Pygmy flower	0.1	0.0	.	.
Bird vetch	0.1	0.0	.	.
Cinquefoil	0.1	0.0	0.3	0.1
Sweet clover species	0.1	0.0	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 31.0 Weed relative abundance and density by herbicide treatment in canola prior to in-crop spraying at Melfort in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Wild oat	34.9	14.9	38.1	14.0
Volunteer wheat	16.8	6.3	13.3	4.5
Dandelion	12.0	2.8	14.3	3.4
Stinkweed	7.6	2.6	5.1	1.4
Green foxtail	6.7	2.0	5.5	1.5
Cleavers	6.7	3.4	8.0	3.2
Wild buckwheat	5.3	1.2	5.3	1.1
Redroot pigweed	2.4	0.7	2.9	0.9
Common lambsquarters	2.0	0.6	2.9	0.6
Shepherds purse	1.1	0.3	0.6	0.1
Barnyard grass	1.1	0.3	0.7	0.1
Perennial sowthistle	1.0	0.2	1.5	0.3
Canada thistle	0.5	0.1	1.1	0.2
Flixweed	0.4	0.1	.	.
Mustard species	0.3	0.1	0.3	0.1
Smartweed species	0.2	0.1	0.1	0.0
Hempnettle	0.1	0.0	.	.
Narrow leaved hawks beard	0.1	0.0	0.1	0.0
Bluebur	0.0	0.0	0.1	0.0
Cinquefoil	.	.	0.1	0.0
Common groundsel	.	.	0.1	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 32.0 Weed relative abundance and density by herbicide treatment in wheat in July at Melfort in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m²	RelAb	#/m²
Mustard species	47.3	6.6	34.7	8.3
Cleavers	15.5	2.4	27.8	7.8
Wild buckwheat	10.6	1.0	10.4	1.6
Dandelion	8.1	0.8	10.7	1.8
Stinkweed	4.3	0.6	1.8	0.3
Green foxtail	2.6	0.4	5.3	1.4
Perennial sowthistle	2.5	0.4	3.0	0.7
Wild oat	2.4	0.3	1.7	0.2
Redroot pigweed	2.1	0.2	1.0	0.1
Canada thistle	1.8	0.2	2.2	0.3
Cinquefoil	0.7	0.2	0.2	0.1
Hempnettle	0.5	0.0	0.1	0.0
Common lambsquarters	0.4	0.0	0.2	0.0
Smartweed species	0.4	0.1	.	.
Narrow leaved hawks beard	0.4	0.0	0.3	0.0
Shepherds purse	0.3	0.0	0.4	0.0
Barnyard grass	0.1	0.0	0.3	0.1
Bluebur	.	.	0.1	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 33.0 Weed relative abundance and density by herbicide treatment in canola in July at Melfort in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Wild oat	60.4	3.7	51.7	4.0
Cleavers	13.4	1.4	21.1	3.1
Wild buckwheat	9.3	0.5	10.0	0.6
Dandelion	6.5	0.3	8.2	0.4
Smartweed species	2.3	0.0	.	.
Common lambsquarters	2.1	0.1	0.9	0.1
Green foxtail	1.8	0.1	0.4	0.0
Stinkweed	0.6	0.0	0.5	0.0
Redroot pigweed	0.6	0.0	1.0	0.1
Perennial sowthistle	0.4	0.0	4.5	0.2
Hempnettle	0.3	0.0	.	.
Shepherds purse	0.2	0.0	0.8	0.1
Pygmy flower	.	.	0.3	0.0
Canada thistle	.	.	0.7	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 34.0 Weed relative abundance and density by crop prior to crop seeding at Beaverlodge in 1998.

Weed Species	Wheat RelAb	Wheat #/m^2	Canola RelAb	Canola #/m^2
Red clover	32.3	1.6	3.4	0.0
Volunteer canola	21.6	2.2	2.5	0.0
Stinkweed	19.3	1.2	44.1	0.8
Dandelion	13.9	0.6	26.3	0.2
Bluebur	4.4	0.3	1.4	0.0
Quackgrass	3.5	0.1	11.6	0.1
Cleavers	1.3	0.1	.	.
Common chickweed	1.1	0.0	.	.
Wild buckwheat	0.7	0.0	8.6	0.1
Canada thistle	0.5	0.0	.	.
Ball mustard	0.4	0.0	0.6	0.0
Common groundsel	0.3	0.0	.	.
Cinquefoil	0.2	0.0	.	.
Storks bill	0.1	0.0	.	.
Common lambsquarters	.	.	0.4	0.0
Wild tomato	.	.	0.4	0.0
Purslane	.	.	0.7	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 35.0 Weed relative abundance and density by crop prior to in-crop spraying at Beaverlodge in 1998.

Weed Species	Wheat RelAb	Wheat #/m²	Canola RelAb	Canola #/m²
Volunteer canola	25.0	100.6	.	.
Stinkweed	18.7	63.6	19.2	52.4
Wild oat	15.7	50.6	30.8	117.6
Wild buckwheat	11.2	21.8	13.1	24.1
Common groundsel	8.9	28.6	12.7	50.2
Common lambsquarters	5.5	5.7	6.1	6.2
Bluebur	4.8	7.8	3.5	3.0
Dandelion	2.9	2.4	1.6	0.8
Red clover	2.4	3.9	2.5	2.1
Quackgrass	1.3	2.2	3.4	8.0
Ball mustard	1.0	1.1	2.4	2.9
Cleavers	1.0	1.9	0.6	0.9
Shepherds purse	0.8	1.0	0.2	0.1
Storks bill	0.5	2.3	.	.
Corn spurry	0.1	0.1	0.0	0.0
Hempnettle	0.0	0.1	0.0	0.1
Broadleaved plantain	0.0	0.0	.	.
Perennial sowthistle	0.0	0.0	0.1	0.0
Vetch species	0.0	0.0	0.0	0.1
Purslane	0.0	0.0	.	.
Prostrate knotweed	0.0	0.0	0.2	0.1
Narrow leaved hawks beard	.	.	0.1	0.1
Volunteer wheat	.	.	3.6	6.8

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 36.0 Weed relative abundance and density by crop in July at Beaverlodge in 1998.

Weed Species	Wheat RelAb	Wheat #/m²	Canola RelAb	Canola #/m²
Common groundsel	24.8	14.0	4.6	1.4
Quackgrass	15.8	13.0	6.0	3.5
Wild oat	12.9	6.3	58.3	19.4
Bluebur	10.7	4.6	0.7	0.1
Dandelion	8.4	2.0	4.0	0.5
Wild buckwheat	6.6	2.8	3.9	1.0
Stinkweed	6.2	2.5	3.4	1.1
Cleavers	5.0	2.2	0.1	0.0
Volunteer canola	3.6	0.9	.	.
Narrow leaved hawks beard	2.1	1.1	0.6	0.3
Common lambsquarters	1.0	0.1	1.6	0.2
Ball mustard	0.9	0.2	0.3	0.1
Red clover	0.8	0.3	15.4	4.0
Hempnettle	0.3	0.1	.	.
Shepherds purse	0.2	0.1	0.4	0.0
Storks bill	0.1	0.0	.	.
Perennial sowthistle	0.1	0.0	.	.
Vetch species	0.1	0.0	0.1	0.0
Corn spurry	0.1	0.0	0.5	0.0
Common chickweed	0.1	0.0	.	.
Broadleaved plantain	0.0	0.0	.	.
Canada thistle	.	.	0.1	0.0
Foxtail barley	.	.	0.0	0.0
Pineappleweed	.	.	0.0	0.0
Wild tomato	.	.	0.0	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 37.0 Weed relative abundance and density by fertilizer treatment in wheat prior to crop seeding at Beaverlodge in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Stinkweed	36.9	2.8	22.7	1.6	17.5	0.3	10.8	0.5	8.6	1.0
Volunteer canola	26.5	2.7	19.5	1.1	27.8	3.8	15.0	0.8	19.2	2.8
Red clover	14.6	1.1	27.8	1.1	19.1	0.7	39.5	1.1	60.3	4.3
Dandelion	12.1	0.7	6.5	0.3	23.6	0.6	18.0	0.9	9.3	0.4
Bluebur	5.9	0.6	3.8	0.2	7.8	0.3	3.1	0.1	1.2	0.2
Quackgrass	1.4	0.1	6.3	0.2	2.5	0.0	5.9	0.3	1.3	0.1
Wild buckwheat	0.6	0.0	1.8	0.1	.	.	1.3	0.0	.	.
Canada thistle	.	.	2.4	0.1	.	.	.	.	.	.
Storks bill	.	.	.	.	0.6	0.1	.	.	.	.
Cleavers	.	.	.	.	.	.	6.4	0.3	.	.
Ball mustard	.	.	1.0	0.0	1.0	0.1	.	.	.	.
Cinquefoil	.	.	1.2	0.0	.	.	.	.	.	.
Common groundsel	.	.	1.7	0.1	.	.	.	.	.	.
Common chickweed	.	.	5.3	0.2	.	.	.	.	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 38.0 Weed relative abundance and density by fertilizer treatment in canola prior to crop seeding at Beaverlodge in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Stinkweed	84.4	3.1	84.5	0.4	27.0	0.2	3.6	0.0	20.9	0.2
Bluebur	5.6	0.1	.	.	.	.	.	.	1.3	0.0
Dandelion	4.1	0.1	3.0	0.1	40.1	0.3	30.9	0.2	53.3	0.5
Wild buckwheat	3.4	0.1	9.5	0.2	14.2	0.2	6.6	0.1	9.2	0.1
Wild tomato	2.0	0.1	.	.	.	.	.	.	.	.
Quackgrass	0.4	0.0	.	.	16.6	0.1	35.4	0.2	5.5	0.1
Volunteer canola	.	.	.	.	.	.	12.5	0.1	.	.
Common lambsquarters	.	.	.	.	2.1	0.0	.	.	.	.
Ball mustard	.	.	3.0	0.1	.	.	.	.	.	.
Red clover	.	.	.	.	.	.	7.3	0.1	9.8	0.1
Purslane	.	.	.	.	.	.	3.6	0.0	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 39.0 Weed relative abundance and density by fertilizer treatment in wheat prior to in-crop spraying at Beaverlodge in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Volunteer canola	24.3	58.6	21.5	75.3	26.5	119.7	27.4	135.0	25.2	114.3
Stinkweed	20.4	54.5	21.8	67.4	14.3	53.7	16.2	62.5	20.7	80.1
Wild buckwheat	13.4	23.6	12.2	25.4	8.9	16.5	10.6	23.5	10.7	19.9
Wild oat	12.4	33.4	18.3	55.9	20.4	78.7	14.1	45.8	13.4	39.3
Common groundsel	8.5	16.6	5.9	20.2	11.4	45.4	8.5	24.2	10.1	36.8
Common lambsquarters	5.7	4.5	4.8	3.3	5.6	5.7	5.5	7.5	6.1	7.5
Bluebur	4.7	5.7	5.0	14.7	3.1	2.9	6.5	10.4	4.6	5.4
Dandelion	3.8	2.7	2.2	2.1	3.0	2.4	4.1	3.8	1.4	1.3
Red clover	1.8	1.7	2.0	2.8	2.2	2.4	2.9	4.6	3.1	8.1
Ball mustard	1.3	1.3	0.8	1.4	1.2	1.0	0.6	0.5	1.3	1.6
Shepherds purse	1.2	2.1	1.9	2.1	0.7	0.9	.	.	.	.
Quackgrass	1.0	1.0	2.4	5.0	0.2	0.3	1.3	2.3	1.6	2.5
Cleavers	0.7	0.8	0.9	1.3	.	.	1.9	4.8	1.5	2.9
Broadleaved plantain	0.1	0.1	.	.	0.1	0.1	.	.	.	.
Purslane	0.1	0.1	.	.	.	.	.	.	.	.
Storks bill	.	.	.	.	2.4	11.7	.	.	.	.
Hempnettle	.	.	.	.	.	.	0.2	0.3	.	.
Prostrate knotweed	.	.	0.1	0.1	.	.	.	.	.	.
Perennial sowthistle	.	.	.	.	.	.	0.1	0.1	0.1	0.1
Corn spurry	.	.	0.2	0.4	.	.	0.1	0.1	.	.
Vetch species	.	.	.	.	.	.	.	.	0.1	0.1

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 40.0 Weed relative abundance and density by fertilizer treatment in canola prior to in-crop spraying at Beaverlodge in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Wild oat	30.8	98.8	36.6	176.5	33.5	126.8	25.9	86.5	27.3	99.7
Stinkweed	18.8	45.6	17.0	48.9	19.3	62.6	18.1	43.5	22.6	61.6
Wild buckwheat	15.6	31.5	11.7	23.0	12.6	21.4	12.1	23.7	13.6	20.7
Common groundsel	9.2	32.3	10.1	38.2	13.0	56.3	18.7	65.6	12.6	58.5
Common lambsquarters	6.1	5.2	6.4	5.4	6.2	9.4	3.4	2.9	8.4	8.1
Quackgrass	4.9	11.4	3.0	9.0	2.5	6.6	3.7	7.5	2.6	5.7
Bluebur	4.0	2.7	3.8	3.1	3.5	2.8	2.7	2.4	3.5	3.9
Red clover	3.6	3.8	3.5	3.0	2.0	1.4	2.6	1.8	1.1	0.7
Dandelion	2.7	1.4	0.7	0.6	1.6	0.7	2.1	1.2	0.7	0.3
Volunteer wheat	2.0	2.0	4.4	9.9	0.9	0.7	5.4	9.5	5.0	11.8
Ball mustard	1.6	3.0	2.4	2.9	3.8	5.3	3.5	3.1	0.5	0.2
Cleavers	0.3	0.1	0.1	0.1	0.2	0.5	1.0	1.9	1.4	1.8
Perennial sowthistle	0.2	0.1	.	.	0.1	0.1	.	.	.	.
Prostrate knotweed	0.2	0.1	.	.	0.6	0.5	.	.	.	.
Shepherds purse	0.2	0.1	0.1	0.1	.	.	.	.	0.5	0.3
Narrow leaved hawks beard	.	.	.	.	.	.	0.5	0.4	.	.
Hempnettle	.	.	.	.	0.2	0.3	.	.	.	.
Corn spurry	.	.	0.1	0.1	.	.	.	.	0.1	0.1
Vetch species	.	.	.	.	.	.	0.1	0.3	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 41.0 Weed relative abundance and density by fertilizer treatment in wheat prior to in July at Beaverlodge in 1998.

Weed Species	Fall band		Spring band		Spring band 9"		Spring band 12"		Sweep	
	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²	RelAb	#/m²
Common groundsel	24.4	9.8	17.3	6.5	28.0	11.2	23.0	16.6	31.1	25.9
Quackgrass	24.1	25.8	24.0	21.1	10.5	5.2	15.5	9.9	4.8	3.0
Bluebur	11.2	3.3	8.0	2.4	10.6	3.5	11.0	7.4	12.7	6.5
Dandelion	8.1	2.1	8.6	1.5	12.2	2.3	8.5	2.7	4.4	1.7
Stinkweed	7.4	2.2	3.7	1.3	4.8	1.1	4.8	2.4	10.2	5.5
Wild buckwheat	6.8	3.1	6.5	2.6	6.5	2.0	8.1	3.3	4.9	2.9
Volunteer canola	5.3	1.2	2.2	0.3	2.9	0.5	2.6	0.9	5.1	1.8
Cleavers	3.6	1.5	6.5	1.6	2.6	0.5	4.4	2.0	7.7	5.3
Wild oat	2.7	0.9	16.0	5.4	14.5	5.3	17.4	11.4	14.0	8.5
Ball mustard	1.3	0.2	2.2	0.7	0.5	0.1	0.2	0.1	0.4	0.1
Narrow leaved hawks beard	1.1	0.3	2.4	0.6	2.4	1.2	2.2	2.3	2.6	1.3
Common lambsquarters	1.1	0.2	0.1	0.0	2.4	0.2	0.7	0.1	0.6	0.2
Hempnettle	0.6	0.2	.	.	0.2	0.1	0.2	0.0	0.7	0.2
Red clover	0.5	0.2	1.3	0.3	0.8	0.2	0.9	0.4	0.4	0.2
Shepherds purse	0.2	0.1	0.5	0.0	0.6	0.2	.	.	.	.
Storks bill	.	.	.	.	0.3	0.1	.	.	0.2	0.1
Broadleaved plantain	.	.	.	.	.	.	.	.	0.1	0.0
Perennial sowthistle	.	.	.	.	0.1	0.0	0.3	0.1	0.1	0.0
Corn spurry	.	.	0.1	0.0	0.1	0.0	0.2	0.0	.	.
Common chickweed	.	.	0.3	0.1	.	.	.	.	.	.
Vetch species	.	.	0.2	0.1	.	.	0.2	0.0	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 42.0 Weed relative abundance and density by fertilizer treatment in canola prior to in July at Beaverlodge in 1998.

Weed Species	Fall band RelAb	Fall band #/m²	Spring band RelAb	Spring band #/m²	Spring band 9" RelAb	Spring band 9" #/m²	Spring band 12" RelAb	Spring band 12" #/m²	Sweep RelAb	Sweep #/m²
Wild oat	68.3	15.1	56.0	20.6	65.8	28.1	45.5	15.3	56.1	17.8
Red clover	16.1	3.4	25.6	5.9	9.8	2.1	14.1	4.9	11.5	3.7
Dandelion	5.9	0.5	4.4	0.5	3.4	0.6	4.1	0.5	2.5	0.5
Quackgrass	3.8	0.4	4.4	1.5	3.1	1.4	12.2	8.9	6.3	5.3
Common groundsel	3.1	0.5	2.8	0.8	4.4	1.7	7.4	2.9	5.1	1.3
Wild buckwheat	1.3	0.2	1.6	0.3	3.8	0.6	5.1	1.1	7.5	2.8
Common lambsquarters	0.6	0.1	1.5	0.2	4.3	0.6	0.7	0.1	0.9	0.2
Shepherds purse	0.6	0.1	0.5	0.1	.	.	.	.	1.0	0.0
Canada thistle	0.3	0.0	.	.	.	.	.	.	.	.
Narrow leaved hawks beard	.	.	0.1	0.0	0.2	0.1	2.5	1.2	.	.
Cleavers	.	.	.	.	.	.	0.5	0.0	.	.
Foxtail barley	.	.	0.1	0.0	.	.	.	.	.	.
Bluebur	.	.	0.3	0.0	0.9	0.1	1.2	0.1	1.1	0.2
Pineappleweed	.	.	.	.	0.2	0.0	.	.	.	.
Ball mustard	.	.	0.8	0.3	.	.	0.1	0.0	0.9	0.2
Wild tomato	.	.	.	.	.	.	0.2	0.0	.	.
Corn spurry	.	.	.	.	.	.	2.4	0.1	.	.
Stinkweed	.	.	1.6	0.4	3.9	0.9	4.2	1.4	7.1	2.8
Vetch species	.	.	0.3	0.1	.	.	.	.	.	.

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 43.0 Weed relative abundance and density by herbicide treatment in wheat prior to crop seeding at Beaverlodge in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Red clover	29.1	1.6	35.4	1.7
Volunteer canola	24.6	3.4	18.6	1.1
Stinkweed	17.9	1.3	20.7	1.2
Dandelion	11.1	0.5	16.8	0.6
Bluebur	5.7	0.4	3.0	0.1
Quackgrass	3.5	0.2	3.4	0.1
Cleavers	2.6	0.1	.	.
Common chickweed	2.1	0.1	.	.
Canada thistle	0.9	0.0	.	.
Wild buckwheat	0.8	0.0	0.7	0.0
Common groundsel	0.7	0.0	.	.
Cinquefoil	0.5	0.0	.	.
Ball mustard	0.4	0.0	0.4	0.0
Storks bill	.	.	0.3	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 44.0 Weed relative abundance and density by herbicide treatment in canola prior to crop seeding at Beaverlodge in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Stinkweed	45.5	1.1	42.7	0.4
Dandelion	28.0	0.3	24.6	0.2
Wild buckwheat	10.2	0.2	6.9	0.1
Volunteer canola	5.0	0.0	.	.
Quackgrass	3.5	0.0	19.7	0.1
Red clover	2.9	0.0	3.9	0.1
Purslane	1.5	0.0	.	.
Bluebur	1.4	0.0	1.4	0.0
Ball mustard	1.2	0.0	.	.
Common lambsquarters	0.8	0.0	.	.
Wild tomato	.	.	0.8	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 45.0 Weed relative abundance and density by herbicide treatment in wheat prior to in-crop spraying at Beaverlodge in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Volunteer canola	27.7	104.8	22.3	96.3
Stinkweed	18.3	61.8	19.0	65.4
Wild oat	14.7	44.5	16.8	56.7
Wild buckwheat	10.8	18.1	11.5	25.5
Common groundsel	9.2	27.9	8.6	29.4
Common lambsquarters	5.4	5.1	5.7	6.3
Bluebur	4.4	9.2	5.1	6.5
Dandelion	2.7	2.2	3.1	2.7
Red clover	2.3	3.1	2.5	4.7
Quackgrass	1.4	1.8	1.2	2.6
Shepherds purse	1.2	1.2	0.3	0.8
Cleavers	0.9	1.7	1.0	2.2
Ball mustard	0.9	1.0	1.2	1.3
Corn spurry	0.1	0.2	0.0	0.0
Purslane	0.0	0.0	.	.
Storks bill	.	.	1.0	4.7
Hempnettle	.	.	0.1	0.1
Broadleaved plantain	.	.	0.1	0.0
Prostrate knotweed	.	.	0.0	0.0
Perennial sowthistle	.	.	0.1	0.0
Vetch species	.	.	0.1	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 46.0 Weed relative abundance and density by herbicide treatment in canola prior to in-crop spraying at Beaverlodge in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m²	RelAb	#/m²
Wild oat	32.0	120.9	29.7	114.4
Stinkweed	19.0	54.0	19.3	50.8
Wild buckwheat	13.2	26.4	13.0	21.7
Common groundsel	12.4	53.6	13.1	46.7
Common lambsquarters	6.0	7.5	6.2	4.9
Bluebur	4.0	3.8	3.0	2.1
Red clover	3.2	2.9	1.9	1.3
Volunteer wheat	2.9	4.8	4.2	8.7
Quackgrass	2.7	7.6	4.0	8.4
Ball mustard	2.5	2.9	2.2	2.9
Dandelion	1.0	0.4	2.1	1.2
Cleavers	0.7	0.8	0.6	0.9
Prostrate knotweed	0.2	0.1	0.1	0.1
Shepherds purse	0.2	0.1	0.1	0.1
Vetch species	0.1	0.1	.	.
Corn spurry	0.0	0.0	0.0	0.0
Narrow leaved hawks beard	.	.	0.2	0.2
Hempnettle	.	.	0.1	0.1
Perennial sowthistle	.	.	0.1	0.1

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 47.0 Weed relative abundance and density by herbicide treatment in wheat in July at Beaverlodge in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Common groundsel	24.4	10.3	25.1	17.7
Quackgrass	18.6	16.6	13.0	9.4
Wild oat	12.1	5.6	13.7	7.0
Bluebur	8.4	2.7	13.0	6.5
Dandelion	7.8	1.5	8.9	2.6
Wild buckwheat	7.0	2.5	6.1	3.0
Stinkweed	6.2	1.7	6.2	3.3
Cleavers	5.2	2.4	4.7	2.0
Volunteer canola	4.5	1.0	2.8	0.8
Narrow leaved hawks beard	2.4	1.0	1.9	1.2
Ball mustard	1.4	0.4	0.4	0.1
Common lambsquarters	0.9	0.1	1.0	0.1
Hempnettle	0.4	0.1	0.2	0.1
Shepherds purse	0.3	0.0	0.2	0.1
Red clover	0.3	0.1	1.3	0.4
Common chickweed	0.1	0.0	.	.
Vetch species	0.1	0.0	0.1	0.0
Corn spurry	0.1	0.0	0.1	0.0
Storks bill	.	.	0.2	0.1
Broadleaved plantain	.	.	0.0	0.0
Perennial sowthistle	.	.	0.2	0.1

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Table 48.0 Weed relative abundance and density by herbicide treatment in canola in July at Beaverlodge in 1998.

Weed Species	Full rate		Reduced Rate	
	RelAb	#/m^2	RelAb	#/m^2
Wild oat	61.2	18.4	55.4	20.3
Red clover	15.7	4.5	15.2	3.6
Quackgrass	7.1	4.2	4.8	2.8
Common groundsel	5.3	1.6	3.9	1.3
Wild buckwheat	2.7	0.4	5.0	1.5
Stinkweed	2.6	0.8	4.1	1.3
Dandelion	2.2	0.3	5.9	0.7
Common lambsquarters	1.2	0.2	2.0	0.3
Bluebur	0.6	0.1	0.8	0.1
Shepherds purse	0.6	0.1	0.3	0.0
Narrow leaved hawks beard	0.4	0.2	0.8	0.4
Corn spurry	0.3	0.0	0.6	0.0
Foxtail barley	0.1	0.0	.	.
Ball mustard	0.0	0.0	0.6	0.2
Canada thistle	.	.	0.1	0.0
Cleavers	.	.	0.2	0.0
Pineappleweed	.	.	0.1	0.0
Wild tomato	.	.	0.1	0.0
Vetch species	.	.	0.1	0.0

Relative Abundance values (RelAb) were calculated by plot for each weed species: (relative density + relative frequency)/2. Relative density was calculated as: number of individuals for a given species within the 20 quadrats for each plot divided by the total number of individuals within the plot. Relative frequency was calculated as the proportion of quadrats in which the species was present per plot divided by the total frequency of all species.

Plant Pathology

Fertilizer and Weed Management Study - 1998
Disease Assessment - D.L. McLaren

Blackleg of Canola

Petrie (1995) found that chemical treatment of blackleg-infected stubble inhibited or eliminated the production of ascospores of *Leptosphaeria maculans*. The herbicide glyphosate completely prevented ascospore formation when stubble was dipped in the test compound for 10 seconds. In the current study, Roundup was applied to canola field trials at the recommended rate (100%) and at a reduced rate (66%). The incidence of blackleg was lower in 4/5 fertilizer treatments where the higher or recommended rate of Roundup was applied (Figure 1). Although no spore counts were conducted in the plots, the reduced levels of disease can be related to ascospore production as the number of ascospores produced from the residue is directly related to severity of disease in the succeeding crop (McGee & Emmett, 1977). These results support the conclusion of Humpherson-Jones and Burchill (1982) that treatment of blackleg-infected stubble may be effective in breaking the life cycle of the blackleg pathogen.

The effect of different rates of a commonly used herbicide on ascospore production indicates a need for further studies. With the increased adoption of conservation of plant debris on the soil surface, further investigations of selected chemicals in the field and estimates of the economic returns are warranted.

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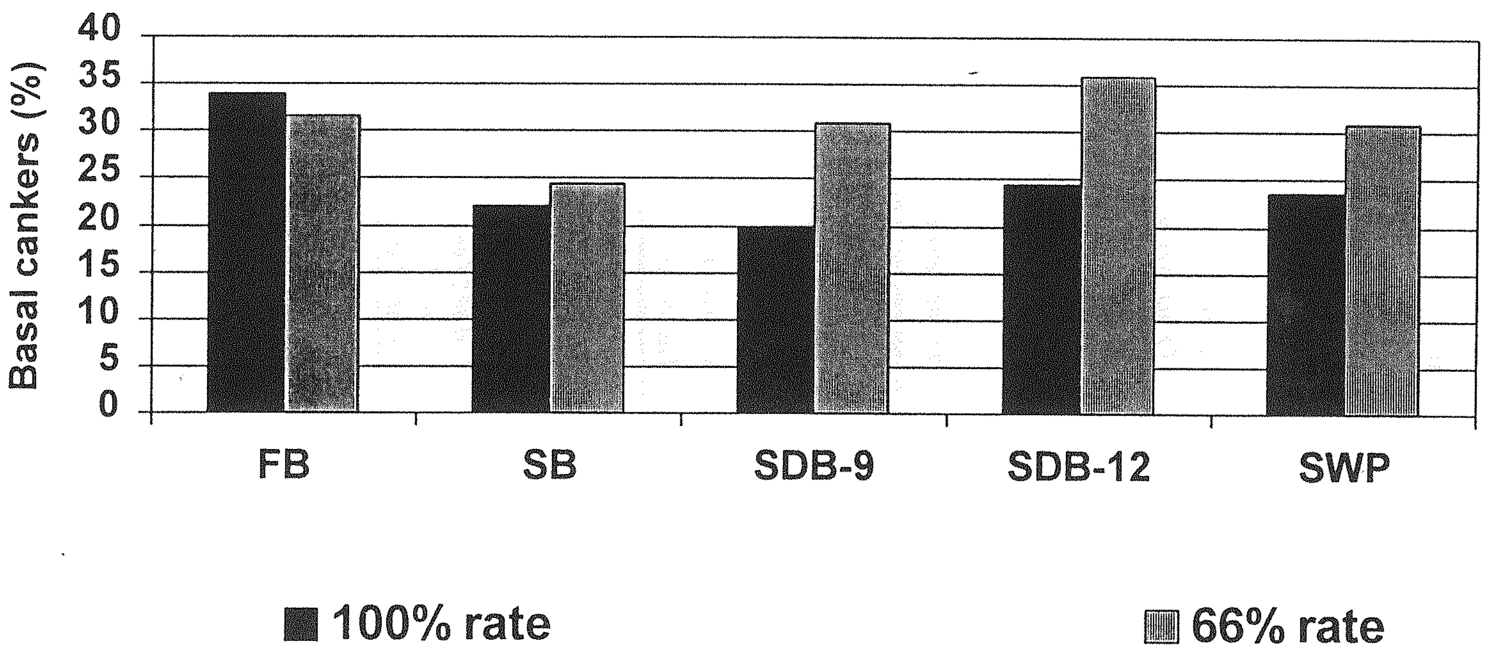
2. McGee, D.C. and Emmett, R.W. 1977. Black leg [Leptosphaeria maculans (Desm.) Ces. et de Not.] of rapeseed in Victoria: Crop losses and factors which affect disease severity. Aust. J. Agric. Res. 28: 47-51.

3. Petrie, G.A. Effects of chemicals on ascospore production by Leptosphaeria maculans on blackleg-infected canola stubble in Saskatchewan. Can. Plant Dis. Surv. 75:1, 45-50.

At Brandon in 1998 blackleg incidence was greater at in plots receiving the low rate of glyphosate and in plots with less soil disturbance (side banded treatments). These data are among the first to confirm work by Petrie in the field.

Rate of glyphosate, fertilizer management and blackleg incidence at Brandon in 1988.



Beaverlodge Pathology. Prepared by Kelly Turkington

The influence of fertilizer placement and row spacing on leaf spots and common root rot of wheat were studied at Beaverlodge, AB. Leaf disease collections were made when the plants were in late milk to early dough (Zadoks et al. 1974). Disease severity expressed as percentage leaf area diseased (PLAD) was assessed on 25 nonselectively chosen flag leaves from each plot. Common root rot (CRR) was assessed at harvest by nonselectively collecting subcrown internodes from each plot. Disease assessments were based on the extent of discolouration of the sub-crown internode of 25 plants using a 0 to 1 scale (0 = <50% of the sub-crown internode and 1 = >50% of the sub-crown internode discoloured). No isolations were made, but most symptoms were typical of common root rot. Data for each plot were expressed as the mean percentage of roots with >= 50% of subcrown internode discoloured.

Only the following treatments were assessed for leaf spots and CRR:

1. Fall band fertilizer (30cm); seed 23 cm; 1x WO herbicide (full rate of herbicide)
2. Spring band fertilizer (30cm); seed 23 cm; 1x WO herbicide
3. Side band fertilizer (30cm); seed 30 cm; 1x WO herbicide
4. Side band fertilizer (23cm); seed 23 cm; 1x WO herbicide
5. Fertilizer and seed (20 cm sweeps on 23 cm centres); 1x WO herbicide
10. Side band fertilizer (23cm); seed 23 cm; 0.75x WO herbicide (3/4 rate of herbicide)

Overall the severity of leaf spots was low with low to moderate levels of CRR. Leaf spot severity was similar for all treatments (Table 1). Percentage root rot severity did vary among the treatments, with the highest level for Treatment 10, intermediate levels for Treatments 1-3 and the lowest levels for Treatments 4 & 5. However, it is not clear that these differences are statistically significant. In addition, the trends observed in 1998 were not consistent with those observed in 1997.

Table 1. Average leaf spot and common root rot severities for various fertilizer placements, row spacings and two rates of herbicide, Beaverlodge 1998.

Trt	Fertilizer	Seeding	Herbicide	CRR	PLAD
1	fall band fertilizer [30cm]	seed 23 cm	1	23	1.9
2	spring band fertilizer [30cm]	seed 23 cm	1	25	1.3
3	side band fertilizer [30cm]	seed 30 cm	1	20	1.6
4	side band fertilizer [23cm]	seed 23 cm	1	15	1.6
5	fertilizer [20cm sweeps on 23 cm centres]	seed 23 cm	1	17	2.4
10	side band fertilizer [23cm]	seed 23 cm	0.75	31	2.3

Considerations for Side-Banded Nitrogen Fertilization

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Abstract
Side-band application of nitrogen fertilizer in a one-pass seeding and fertilizing system can improve operational efficiency and conserve soil moisture. However, under some circumstances, seedling damage can result from excessive concentrations of nitrogen coming in contact with the germinating seedling. Risk factors include high nitrogen application rates, use of urea-based fertilizers, wide row spacing leading to low seed-bed utilisation, high pH carbonated soils, soils with low cation exchange capacity and drying conditions after seeding. Loss of separation between seed and fertilizer can also increase potential for damage. Risk can be reduced by use of forms of nitrogen fertilizer other than urea, reducing the rate of nitrogen fertilizer applied, increasing the separation between seed and fertilizer and ensuring that the planned separation is maintained, increasing seed-bed utilization or selecting another method of nitrogen placement.

One-pass seeding systems using side-banded applications of fertilizer are becoming increasingly popular on the prairies. These systems can save the producer time, labour and fuel costs, by combining the application of seed and fertilizer in one operation. Avoiding a separate operation for fertilizer banding can lead to a firmer seed-bed and help to conserve critical spring moisture. Side-banding tends to reduce volatile losses of nitrogen, by placing the fertilizer beneath the soil surface and can result in increased fertilizer use efficiency of both nitrogen and phosphorus by reducing contact between the fertilizer and the soil (Follett et al. 1981). Under very deficient situations or in cool or compacted soils, side-banded applications of phosphorus may be superior to pre-seeding band applications where the fertilizer may be further from seed. Side-banding allows the plants to access the fertilizer earlier in the season, when phosphorus, and to some extent nitrogen, can have the greatest impact on plant growth. Some researchers suggest that placing the nitrogen close to the seed may give the crop a competitive advantage over weeds Kirkland and Beckie 1998).

Although side-band applications have many advantages, there may be some risks to this practice. Excess concentrations of nitrogen, particularly urea, in contact with germinating seedlings can lead to seedling damage. This is a frequently observed problem with seed-placed fertilizer. While it has been commonly assumed that separating the seed and fertilizer through side-banding with the 1" by 1" geometry would eliminate problems with seedling toxicity, it appears that this is not always the case.

In studies conducted by Loraine Bailey at Brandon Research Centre, side-banding urea ammonium nitrate an inch to the side and an inch below the seed generally produced good results in canola (Tables 1 and 2). However, in 1995, dry conditions increased the potential for seedling damage and side-banding the N and P led to significant reductions in canola stand. Yield was lower with the side-banded N and P, as compared to a pre-plant band application of N with seed-placed P, when high rates of nitrogen were used. This occurred both on a fine sandy loam and a silty clay soil, but the effects were greater on the dry, coarse-textured soil (Table 1 and 2). It is important to note that there was also a reduction in canola stand with seed-placed P and pre-plant banded N.

Table 1: Effect of rate of side-banded urea fertilizer on plant stand and seed yield of canola at 8-inch row spacing (Fine Sandy Loam, 1995-97).

Nitrogen Rate (kg/ha)	Stand (% of Control)			Seed Yield (kg/ha)		
	1995	1996	1997	1995	1996	1997
0	100	100	100	389	588	648
50	87	133	93	818	844	1005
100	49	106	95	1125	1361	1450
150	49	97	97	866	1202	1420
150-30 (sideband)	22	84	94	953	1775	1120
150-30 (N pre-plant band P seed-placed)	59	67	64	1318	1608	1102

Table 3: Effect of rate of side-banded urea fertilizer on plant stand and seed yield of canola at 8-inch row spacing (Clay Loam, 1995-97).

Nitrogen Rate (kg/ha)	Stand (% of Control)			Seed Yield (kg/ha)		
	1995	1996	1997	1995	1996	1997
0	100	100	100	1509	705	1098
50	94	88	86	1540	1162	1420
100	67	95	94	1704	1308	1650
150	41	68	71	1688	1806	1800
150-30 (sideband)	40	85	79	1385	1839	1903
150-30 (N pre-plant band P seed-placed)	69	85	96	1869	1741	1895

Potential for seedling damage depends on a number of factors including environmental conditions, crop grown, soil type, width of the seed/fertilizer band, row spacing and fertilizer source. Damage may increase with high pH, in the presence of salts or free lime, on light textured soils or soils low in organic matter, cool growing conditions, low soil moisture, or with the use of wide row spacing. Small seeded crops such as flax or canola are more sensitive to seedling damage than crops such as wheat or barley. Urea tends to be more damaging than ammonium nitrate, while urea ammonium nitrate (UAN) tends to be intermediate, since it is a blend of urea and ammonium nitrate. The amount of damage can vary greatly from year to year, depending on the specific conditions at seeding, so a rate which caused no problems one year may cause significant damage the next.

Since the concentration of fertilizer in contact with the seed has a great influence on seedling damage, extra caution must be taken when side-banding is combined with wide row spacing. By increasing row spacing, the concentration of fertilizer present beside the seed-row is increased. With small-seeded crops such as canola or flax, which are sensitive to seed-fertilizer contact, this may lead to seedling toxicity, even where the fertilizer is separated from the seedling by the common 1-inch by 1-inch side-banded pattern. Toxicity may be accentuated if the separation between seed and fertilizer is compromised due to "bounce" of the seed and fertilizer during the seeding operation.

Co-operative studies are being conducted across western Canada evaluating the impact of urea nitrogen timing, placement and row spacing on canola and wheat yield and weed competition. Sites are located at Brandon, Melfort and Beaverlodge. The most consistently effective treatment in this study has been the 9-inch row spacing with side-banded urea application (Table 4).

Table 4: Ranking of seeding and N fertilization systems at three locations (Data courtesy of CFI cooperative study)

Fertilizer Placement	Brandon		Melfort		Beaverlodge	
	Rank	Range	Rank	Range	Rank	Range
Fall Band	2	1-4	5	3-5	1	1-3
Spring Band	3	2-3	4	3-5	2	1-4
9" Side	1	1-3	1	1-4	3	3-5
12" Side	4	1-5	3	1-4	5	2-4
Sweep	5	4-5	2	2-3	3	1-5

In 4 of 7 site years of canola and 2 of 7 site-years of wheat, yield was lower with 12-inch row spacing and side-banded urea nitrogen as compared to the 9-inch row-spacing treatment. The problems with the 12-inch row spacing appear to be due to seedling damage from the side-banded urea. Problems with seedling toxicity are likely to be greater on carbonated, high pH soils, coarse-textured soils, or when dry conditions occur after seeding. High pH carbonated soils are more frequently encountered in the eastern prairies than in more westerly regions.

Table 5: Effect of rate side-banded urea fertilizer on plant stand and seed yield of canola at 9-inch and 12-inch row spacing (Brandon 1998).

Nitrogen Rate (kg/ha)	Stand (Plants/m2)		Seed Yield (kg/ha)	
	9 Inch	12 Inch	9 Inch	12 Inch
0	78.1	60.0	778	699
45	79.0	36.6	1086	922
60	95.5	43.3	1128	944
80	69.3	32.0	973	793
107	91.5	43.0	1149	841
143	82.6	25.0	1149	854

Based on initial results of the CFI studies, additional experiments were conducted in 1998 across western Canada at Brandon, Melfort, Lacombe and Swift Current to take a closer look at the effect of row spacing at different rates of urea N. While there was little difference between 9-inch and 12-inch spacing at most of the sites, the 9-inch spacing produced higher stand density and higher yields than the 12-inch spacing at the Brandon location (Table 4). The sensitivity of the Brandon site to seedling damage may relate to the high soil pH and carbonate content at the site, conditions common in the eastern prairies. In contrast, at the Melfort location, while stand density tended to be lower at the 12 inch row spacing, canola yield was not negatively affected (Table 5).

While side-banding nitrogen fertilizer will generally be an effective and safe method of application, it is important to recognize that there are risks associated with the practice. Damage may occur in situations that promote seedling toxicity. Risk factors include high pH carbonated soils, soils with low cation exchange capacity (i.e. coarse textured soils, soils with low organic matter content), drying conditions after seeding, and application on sensitive crops, such as canola or flax. Risk of damage increases at high fertilization rates or when using wide row spacing increases the effective concentration near the seed-row. If the seed-fertilizer separation is not maintained, risk of damage will also be higher. Where risk of damage is considerable, it may be advisable to increase the separation between seed and fertilizer band, to use a less-damaging fertilizer source or to consider an alternate method of fertilizer application.

Table 5: Effect of rate side-banded urea fertilizer on plant stand and seed yield of canola at 9-inch and 12-inch row spacing (Melfort 1998).

Nitrogen Rate (kg/ha)	Stand (Plants/m)		Seed Yield (kg/ha)	
	9 Inch	12 Inch	9 Inch	12 Inch
0	128	106	1843	1867
45	126	93	1955	1848
60	112	101	1726	1867
80	117	90	1931	1916
107	109	99	1921	1993
143	115	94	2062	2043

Studies are continuing across western Canada to more clearly evaluate the impact of row spacing and fertilizer placement on yield, quality and competitive ability of canola and wheat. This should help to clarify factors contributing to damage and develop management practices that will optimize economics of crop production in one-pass seeding systems.

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CFI – Fertilizer and Weed Management Study
Agronomic Component 1996-1998 Summary

SUMMARY

To date there are some definite trends in the data we have collected indicating that both crop establishment and grain yield are sensitive to fertilizer placement. Seeding canola with a cultivator sweep, spreading all fertilizer with the seed, generally resulted in lower plant establishment than when seeded in 9" rows. The side band application of N on 12" spacing reduced canola and wheat seedling establishment relative to 9" spacing at most locations and years in the study. However, the negative impact on stand resulted in reduced canola yield only at Brandon, while lower wheat yields were recorded at Brandon and Melfort. There were almost no differences for grain yield between fall and spring banding. In a few instances there were minor differences recorded due to using a reduced herbicide rate. No differences were recorded in either grain protein or crop water use with N treatment or herbicide rate.

WHEAT

1. Brandon

Crop Establishment:

- Different in each year, with the sweep best in 96, and 9" rows best in 97 and 98.
- There was a lower seedling stand with the 12" side band treatment in 1998, relative to 9".
- Over the three years combined, the 12" side band was inferior to the 9" or sweep seeded treatments.

Grain yield:

- While no differences were recorded in 1996, the 12" side band treatment was significantly lower than 9" in 1997 and 1998, and in the combined analysis for 1996-98.

Grain Protein:

- No differences were recorded in grain protein level in 1996 or 1997, however, there was a trend to lower protein with the sweep treatment in 1996. In 1998 the sweep treatment had the lowest protein, while fall banding showed the highest protein. With the lower grain yield for the 12" side band treatment we observed higher protein relative to the 9" side band.
- The trend observed in 1998 was reflected in the 1996-98 combined analysis of data, with the 12" side band protein higher than 9", and the sweep treatment having the lowest protein. Spring banding was lower than fall banding, which was observed in all years of the study.
- Grain protein at the Brandon location was never below 13.5%, indicating that yields were most likely optimized with the N rate being used.

Crop Water Use:

- Minor differences were recorded in crop water use between years in the study, with the fall banded treatment showing higher water use than the other treatments in 1996. When considered across the 3 years there were really no significant differences in crop water use.

Herbicide Rate – no effect was measured of reduced herbicide rate on the seedling stand, grain yield, grain protein and water use.

2. Melfort

Crop Establishment:

- Significant differences were recorded in wheat seedling establishment at Melfort in all years of this study. In 1997 and 1998 the sweep treatment had fewer seedlings than the row treatments. The exception was in 1997 when the lowest seedling number was recorded for the 12" side band treatment. However, in 1996 the opposite was true where the sweep treatment had the best seedling stand.
- In the combined analysis over years the trend of lower seedling stand with 12" side band observed a Brandon was also recorded.

Grain Yield:
- Unlike Brandon, the sweep treatments at Melfort were either highest yielding, or grouped with the highest yielding treatments in each of the study years. There was a trend to lower yields with the 12" side band versus the 9".
- In 1997, the fall banded treatment was inferior to spring banding. We speculate that this was due to an error in calibration for the fall treatment.
- In the combined analysis over years, the fall banding was inferior to spring banding and the 9" side band was superior to the 12" side band. On average the sweep treatment was the best.
- A herbicide effect was recorded in 1998, where the 2/3 rate was inferior to the full rate. Volunteer canola populations were high in the wheat and obviously had a negative effect on the final grain yield in that year.

Grain Protein:
- Grain protein content was usually highest with the 9" side band treatment in all years of the study, with the sweep showing lowest protein in 1996 and 1998.
- As recorded with grain yield in 1997, the lower yield with the fall banding was accompanied with lower protein, further supporting our assumption of an application error.
- The trends observed in individual years was reflected in the combined analysis, where fall banding was lower than spring banding, and 9" side banding was superior to seeding with sweeps.
- While not significant, in both 1996 and 1998 grain protein was lower with the 2/3 herbicide rate.

Crop Water Use:
- No differences were recorded in crop water use in any individual year, or across years, at the Melfort trial location.

3. Beaverlodge

Crop Establishment:
- Crop stand at Beaverlodge was similar to Melfort and Brandon in that the best crop stand was recorded with the sweep treatment in 1996, while it was grouped with the poorest treatments in 1998.
- The 9" side banded treatment was superior to 12" in 1996, however, similar in 1998.
- In the combined analysis for 1996 and 1998, the spring banded treatment was found to be superior to the sweep treatment.

Grain Yield:
- Fall and spring banding resulted in similar grain yield responses in all years of this study and when considered across years.

- In 1997 and 1998, and with the combined analysis, side band treatment on 12" resulted in lower grain yields than 9".
- Yields with the sweep treatment varied from year-to-year, being superior to the 9" side band in 1997, however, the reverse was true in 1998.
- Reduced herbicide rates resulted in lower wheat yield than full rate in 1997.

Grain Protein:
- No difference was recorded in wheat grain protein at this trail location either in individual years, or across years.
- Grain protein content was high at the Beaverlodge trial location, exceeding 13% in all years, and 15% in 1998.

Crop Water Use:
- No difference was recorded in wheat crop water use at this trail location either in individual years, or across years.

CANOLA

1. Brandon

Crop Establishment:
- The concentration of urea N in 12" side band rows at seeding resulted in a reduction in canola seedling stand relative to the fall band and 9" side band treatments. Sweep seeding also had fewer seedling on emergence.
- When considered across years, both 9" and 12" side band treatments showed lower canola seedling stands than the pre-seeding banded treatments.

Grain yield:
- While no difference was recorded in canola yields between fertilizer treatments in 1996, side banding at 12" and sweep treatments proved to be inferior to side band 9" and the pre-seeding banded treatments in both 1997 and 1998. These differences were also reflected in the combined analysis over years.

Grain Protein:
- The lower yields with 12" side band and sweep treatments were reflected in higher canola seed protein in most years, and in the combined analysis. An unusually low seed protein for spring pre-seed banding was recorded in 1997.

Crop Water Use:
- No differences in crop water use were recorded in individual years for canola, however, the 12" side band showed a slightly lower crop water use than the side band 9" in the combined analysis.

2. Melfort

Crop Establishment:
- As recorded at Brandon, lower seedling populations were recorded with the sweep and 12" side band treatments. The exception was in 1996 when the 12" side band had the highest plant population, which could have been a calibration error (rented equipment). This trend to lower canola seedling stands was also observed in the combined analysis, however, the differences were less dramatic.

Grain yield:

- While plant populations varied between N treatments, this was not reflected in final grain yield. The exception was the low yield with fall banding in 1997, a reflection on the improper calibration of the fall band treatment at this location.

Grain Protein:

- The canola grain protein was unaffected by fertilizer management or herbicide rate at Melfort.

Crop Water Use:

- There were minor differences in crop water use recorded between fall and spring banded treatments at Melfort, with fall being poorer than spring in its use of water. This was observed in all years of the test and was picked up in the combined analysis over years.

3. Beaverlodge

Crop Establishment:

- While the low canola seedling number with sweep treatments observed at Brandon and Melfort was also recorded at Beaverlodge, the 12" side band actually provided the best seedling stands in 1996, 1998 and in the combined analysis across years.

Grain yield:

- While canola grain yields were very low (less than 1 t/ha) in all years of this study, there were no differences between the N or herbicide treatments.

Grain Protein:

- The canola grain protein was unaffected by fertilizer management or herbicide rate at Beaverlodge.

Crop Water Use:

- There were no differences in crop water use recorded between fertilizer or herbicide treatments at Beaverlodge.

Table 1. Agronomic response of wheat to fertilizer placement and herbicide rate at Brandon 1996, 1997 and 1998.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
	------- 1996 -------				------- 1997 -------				------- 1998 -------			
Fertilizer Placement												
1. Fall Band - FBd	170 b	3623	14.3	34.1 a	175 a	2573	14.2	29.8	214 a	3650 a	15.4 a	41.7
2. Spring Band - SBd	168 b	3616	14.0	31.5 ab	168 a	2644	14.0	30.2	215 a	3610 a	14.6 bc	40.6
3. Sideband 9" - SB9	164 b	3622	13.8	31.0 ab	173 a	2662	14.1	29.5	214 a	3571 a	14.4 cd	43.0
4. Sideband 12" - SB12	158 b	3692	13.9	27.6 b	182 a	2479	14.2	29.1	149 c	3170 b	14.9 b	40.8
5. Sweep - SW	228 a	3592	13.6	29.1 b	138 b	2588	14.0	30.6	176 b	3474 a	14.2 d	40.0
Herbicide Rate												
1. Full Rate - F	179	3648	14.0	31.0	166	2603	14.0	31.0	195	3573	14.8	41.1
2. 2/3 Rate - R	176	3610	13.8	30.3	168	2576	14.2	28.6	192	3417	14.6	41.3
Placement x Herb Rate												
FBd x F	184	3699	14.2	34.8	173	2499	14.2	30.4	214	3715	15.4	40.8
FBd x R	155	3547	14.3	33.4	177	2647	14.3	29.1	214	3586	15.4	42.6
SBd x F	168	3605	14.3	32.5	167	2679	13.9	30.0	218	3657	14.9	41.1
SBd x R	167	3627	13.7	30.5	170	2610	14.0	30.4	213	3561	14.3	40.1
SB9 x F	161	3649	14.0	30.2	172	2660	14.0	28.8	214	3623	14.5	44.0
SB9 x R	167	3596	13.6	31.8	174	2664	14.1	30.3	213	3520	14.3	41.9
SB12 x F	160	3682	13.8	26.1	177	2531	14.1	32.1	147	3193	14.8	39.4
SB12 x R	155	3702	14.1	29.1	186	2427	14.4	26.2	152	3148	15.0	42.3
SW x F	223	3605	13.8	31.5	140	2644	14.0	33.9	185	3676	14.2	40.3
SW x R	234	3580	13.4	26.7	135	2532	14.1	27.2	168	3271	14.1	39.7
Study Mean	177	3629	13.9	30.7	167	2589	14.1	29.8	194	3495	14.7	41.2
Pr > F												
Placement	0.0001	0.8300	0.0655	0.0360	0.0001	0.1373	0.3345	0.9443	0.0001	0.0204	0.0001	0.1193
Herbicide	0.5370	0.5012	0.2171	0.5675	0.6408	0.5672	0.1902	0.0527	0.4971	0.1037	0.1701	0.8035
Plmt x Herb	0.2875	0.8535	0.1996	0.3516	0.9558	0.3928	0.9659	0.1283	0.7241	0.7508	0.2282	0.1938
C.V.	11	5	3	13	10	6	2	12	9	8	2	6
Treatment Comparisons												
FBd vs. SBd	0.8290	0.9325	0.2002	0.2093	0.4370	0.3413	0.0814	0.8285	0.8937	0.7800	0.0001	0.3458
SB9 vs. SB12	0.4908	0.4287	0.4991	0.1101	0.2828	0.0194	0.3154	0.8300	0.0001	0.0107	0.0074	0.0761
SBd vs. SW	0.0001	0.7905	0.0982	0.2408	0.0008	0.4538	0.5862	0.8342	0.0001	0.3626	0.0149	0.5969
SB9 vs SW	0.0001	0.7363	0.3993	0.3657	0.0002	0.3252	0.9379	0.5767	0.0001	0.5098	0.2174	0.0150

Table 2. Agronomic response of wheat to fertilizer placement and herbicide rate at Melfort 1996, 1997 and 1998.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
	------- 1996 -------				------- 1997 -------				------- 1998 -------			
Fertilizer Placement												
1. Fall Band - FBd	265	3819 ab	13.2 ab	24.9	240 b	2598 d	10.5 b	22.6	237 a	3292	13.0 b	20.8
2. Spring Band - SBd	266	3669 b	12.8 bc	22.7	229 b	3315 a	11.4 a	23.1	234 ab	3135	13.1 b	21.0
3. Sideband 9" - SB9	245	3607 b	13.2 ab	24.6	274 a	3032 bc	11.5 a	24.4	227 ab	3418	13.6 a	22.9
4. Sideband 12" - SB12	266	3599 b	13.6 a	24.8	158 d	2798 cd	11.2 a	24.2	212 bc	3265	13.3 ab	23.3
5. Sweep - SW	316	3938 a	12.5 c	23.1	199 c	3143 ab	11.5 a	23.9	190 c	3243	13.0 b	21.9
Herbicide Rate												
1. Full Rate - F	275	3764	13.2	24.1	221	2939	11.2	23.8	221	3382 a	13.3	22.1
2. 2/3 Rate - R	268	3689	12.9	24.0	219	3015	11.2	23.5	220	3159 b	13.1	21.8
Placement x Herb Rate												
FBd x F	261	3766	13.1	23.4	231	2573	10.6	21.7	230	3355	13.0	22.8
FBd x R	270	3873	13.3	26.4	249	2622	10.4	23.5	245	3229	12.9	18.8
SBd x F	281	3719	12.9	23.5	231	3275	11.3	24.3	243	3157	13.2	20.1
SBd x R	251	3620	12.7	21.9	227	3356	11.6	21.9	224	3113	13.1	21.9
SB9 x F	258	3692	13.8	25.5	276	2832	11.3	25.1	234	3588	13.8	23.3
SB9 x R	231	3522	12.7	23.6	272	3231	11.6	23.7	221	3247	13.3	22.5
SB12 x F	260	3711	13.9	26.0	154	2779	11.3	24.1	216	3498	13.4	22.8
SB12 x R	272	3486	13.4	23.7	162	2816	11.2	24.2	208	3032	13.2	23.9
SW x F	317	3934	12.6	21.9	214	3235	11.7	23.5	180	3310	13.1	21.7
SW x R	315	3943	12.5	24.3	184	3051	11.2	24.2	200	3175	12.9	22.0
Study Mean	272	3726	13.1	24	220	2977	11.2	23.6	220	3270	13.2	22.0
Pr > F												
Placement	0.0836	0.0166	0.0038	0.2704	0.0001	0.0001	0.0002	0.7642	0.0014	0.0548	0.0101	0.3538
Herbicide	0.6061	0.2837	0.0538	0.9294	0.7166	0.3679	0.6540	0.8063	0.8937	0.0005	0.0676	0.7491
Plmt x Herb	0.8029	0.5627	0.2107	0.1101	0.2943	0.3127	0.3219	0.6813	0.3234	0.1284	0.7495	0.3490
C.V.	11	6	4	10	10	9	4	13	10	5	3	14
Treatment Comparisons												
FBd vs. SBd	0.9752	0.1818	0.1694	0.0903	0.3222	0.0001	0.0001	0.7414	0.7456	0.0863	0.3246	0.9039
SB9 vs. SB12	0.3540	0.9435	0.1444	0.8336	0.0001	0.0872	0.2427	0.8843	0.1814	0.0951	0.1632	0.7621
SBd vs. SW	0.0487	0.0205	0.3473	0.7787	0.0125	0.2015	0.7675	0.6320	0.0006	0.2327	0.3973	0.5393
SB9 vs SW	0.0098	0.0053	0.0151	0.2502	0.0001	0.4066	0.9058	0.7444	0.0025	0.0575	0.0027	0.5130

Table 3. Agronomic response of wheat to fertilizer placement and herbicide rate at Beaverlodge 1996, 1997 and 1998.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
	------- 1996 -------				------- 1997 -------				------- 1998 -------			
Fertilizer Placement												
1. Fall Band - FBd	135 a	1003	13.5	36.8	N/A	1254 ab	13.2	29.5	167 bc	2351 a	15.1	25.5
2. Spring Band - SBd	155 a	1244	13.7	39.4	N/A	1422 a	13.5	29.2	186 ab	2260 ab	15.3	28.0
3. Sideband 9" - SB9	139 a	1237	14.1	39.3	N/A	1147 b	13.8	30.8	185 ab	2359 a	15.2	28.2
4. Sideband 12" - SB12	91 b	1077	13.7	37.8	N/A	755 c	13.7	31.7	211 a	1967 b	15.2	27.0
5. Sweep - SW	156 a	1308	13.7	37.2	N/A	1430 a	13.4	33.3	137 c	1977 b	14.9	25.5
Herbicide Rate												
1. Full Rate - F	144	1179	13.7	38.2	N/A	1289 a	13.6	30.2	179	2151	15.0	26.8
2. 2/3 Rate - R	126	1168	13.8	38.0	N/A	1114 b	13.5	31.6	175	2215	15.2	26.9
Placement x Herb Rate												
FBd x F	148	1026	13.7	38.7	N/A	1352	13.2	29.0	179	2481	14.9	25.2
FBd x R	123	979	13.3	34.8	N/A	1156	13.2	29.9	154	2220	15.3	25.9
SBd x F	164	1187	14.1	39.4	N/A	1536	13.4	28.7	182	2126	15.2	25.9
SBd x R	145	1301	13.4	39.3	N/A	1308	13.6	29.8	191	2394	15.5	30.1
SB9 x F	157	1217	13.9	39.1	N/A	1101	13.8	32.3	191	2298	15.3	29.6
SB9 x R	120	1258	14.3	39.6	N/A	1193	13.8	29.4	179	2420	15.1	26.9
SB12 x F	97	1155	13.4	39.2	N/A	874	14.0	28.3	223	1901	15.2	26.7
SB12 x R	84	1000	13.9	36.5	N/A	636	13.4	35.2	198	2032	15.2	27.3
SW x F	153	1310	13.3	34.5	N/A	1583	13.5	33.0	119	1946	14.7	26.4
SW x R	159	1305	14.0	39.8	N/A	1278	13.2	33.7	154	2008	15.0	24.5
Study Mean	135	1174	13.7	38.1	N/A	1202	13.5	30.9	177	2183	15.1	26.8
Pr > F												
Placement	0.0005	0.0796	0.5371	0.5430	N/A	0.0001	0.1836	0.3979	0.0108	0.0237	0.5518	0.1718
Herbicide	0.0559	0.8875	0.6622	0.8913	N/A	0.0351	0.5022	0.3656	0.7496	0.5073	0.3710	0.8716
Plnt x Herb	0.6353	0.8312	0.1953	0.1795	N/A	0.5548	0.4573	0.3634	0.4910	0.5109	0.7716	0.1492
C.V.	21	20	5	10	N/A	21	4	15	22	14	4	10
Treatment Comparisons												
FBd vs. SBd	0.1691	0.0508	0.5138	0.1881	N/A	0.1877	0.2917	0.9240	0.3213	0.5548	0.3766	0.0896
SB9 vs. SB12	0.0020	0.1863	0.2357	0.4366	N/A	0.0040	0.6127	0.7070	0.1908	0.0153	0.8239	0.3911
SBd vs. SW	0.9318	0.5941	0.7989	0.2638	N/A	0.9495	0.6485	0.0897	0.0159	0.0733	0.1079	0.0851
SB9 vs SW	0.2227	0.5574	0.2092	0.2718	N/A	0.0307	0.1025	0.2918	0.0193	0.0180	0.2190	0.0619

Table 4. Agronomic response of wheat to fertilizer placement and herbicide rate at Brandon, Melfort and Beaverlodge, 1996 to 1998.

	----- BRANDON, 1996 to 1998 -----				----- MELFORT, 1996 to 1998 -----				----- BEAVERLODGE, 1996 to 1998 -----			
	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
Fertilizer Placement												
1. Fall Band - FBd	186	3282	14.6 a	35.2	244	3236	12.2	22.8	151	1536	13.9 c	30.6
2. Spring Band - SBd	184	3290	14.2 bc	34.1	238	3373	12.4	22.3	171	1642	14.2 ab	32.2
3. Sideband 9" - SB9	183	3285	14.1 bc	34.5	249	3352	12.7	23.9	162	1581	14.4 a	32.8
4. Sideband 12" - SB12	163	3114	14.3 ab	32.5	201	3221	12.7	24.1	151	1266	14.2 abc	32.2
5. Sweep - SW	181	3218	13.9 c	33.2	219	3441	12.3	23.0	146	1572	14.0 bc	32.0
Herbicide Rate												
1. Full Rate - F	180	3275	14.3	34.4	232	3362	12.6	23.3	161	1540	14.1	31.7
2. 2/3 Rate - R	179	3201	14.2	33.4	229	3288	12.4	23.1	151	1499	14.1	32.2
Placement x Herb Rate												
FBd x F	190	3304	14.6	35.4	237	3231	12.2	22.6	164	1620	13.9	31.0
FBd x R	182	3260	14.7	35.0	252	3241	12.2	22.9	138	1452	13.9	30.2
SBd x F	184	3314	14.4	34.5	246	3384	12.4	22.6	173	1616	14.2	31.4
SBd x R	183	3266	14.0	33.7	231	3363	12.4	21.9	168	1668	14.2	33.1
SB9 x F	183	3311	14.1	34.3	255	3371	13.0	24.6	174	1539	14.3	33.7
SB9 x R	184	3260	14.0	34.6	243	3333	12.5	23.3	149	1624	14.4	31.9
SB12 x F	161	3136	14.2	32.5	200	3330	12.8	24.3	160	1310	14.2	31.4
SB12 x R	164	3092	14.5	32.5	203	3111	12.6	23.9	141	1223	14.2	33.0
SW x F	182	3309	14.0	35.2	221	3493	12.5	22.4	136	1613	13.8	31.3
SW x R	179	3128	13.9	31.2	217	3390	12.2	23.5	156	1530	14.1	32.7
Study Mean	179	3238	14.2	33.9	230	3325	12.5	23.2	156	1519	14.1	32.0
Pr > F												
Year	0.3934	0.0009	0.2289	0.0009	0.0914	0.0141	0.0001	0.3156	0.2060	0.0017	0.5122	0.4248
Placement	0.8655	0.3574	0.0248	0.2944	0.6363	0.6625	0.3301	0.0614	0.9505	0.2004	0.0209	0.4568
Herbicide	0.5079	0.2169	0.5893	0.3222	0.1489	0.4818	0.1323	0.0981	0.3606	0.6259	0.5947	0.4405
Plmt x Herb	0.7801	0.5453	0.0167	0.4475	0.2542	0.5950	0.6216	0.7546	0.0946	0.2453	0.9459	0.6712
Year x Placement	0.0001	0.0317	0.0139	0.5067	0.0006	0.0167	0.0411	0.9153	0.0032	0.0068	0.9609	0.7230
Year x Herbicide	0.6444	0.2056	0.0443	0.4314	0.8638	0.0897	0.5003	0.9877	0.1728	0.0695	0.7012	0.7760
Year x Plmt x Herb	0.5241	0.7970	0.8777	0.1599	0.5850	0.2249	0.2113	0.2003	0.8748	0.8037	0.1611	0.1190
C.V.	10	7	3	10	10	7	4	12	22	17	4	12
Treatment Comparisons												
FBd vs. SBd	0.6228	0.9025	0.0001	0.2714	0.5515	0.0358	0.0601	0.5461	0.1053	0.1678	0.1461	0.1494
SB9 vs. SB12	0.0001	0.0069	0.0140	0.0520	0.0001	0.0439	0.8216	0.8431	0.3622	0.0001	0.2360	0.5777
SBd vs. SW	0.5455	0.2502	0.0255	0.3770	0.3216	0.2923	0.3681	0.4165	0.0470	0.3591	0.1911	0.8544
SB9 vs SW	0.5707	0.2812	0.1990	0.2037	0.0914	0.1679	0.0016	0.2357	0.2052	0.9020	0.0193	0.4748

Table 5. Agronomic response of canola to fertilizer placement and herbicide rate at Brandon 1996, 1997 and 1998.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
	------- 1996 -------				------- 1997 -------				------- 1998 -------			
Fertilizer Placement												
1. Fall Band - FBd	145 b	1830	N/A	28.6	61 a	1320 a	22.6 ab	26.5	84 a	912 a	24.3	43.5
2. Spring Band - SBd	127 b	1893	N/A	29.8	65 a	1190 a	21.5 c	25.3	81 a	807 a	24.3	42.6
3. Sideband 9" - SB9	120 bc	1875	N/A	32.3	60 a	1281 a	22.0 bc	27.7	78 a	1030 a	23.2	43.9
4. Sideband 12" - SB12	97 c	1894	N/A	28.8	42 b	907 b	22.9 a	25.4	43 b	488 b	24.6	42.5
5. Sweep - SW	246 a	1802	N/A	29.9	19 c	408 c	22.8 a	24.2	44 b	544 b	24.0	46.9
Herbicide Rate												
1. Full Rate - F	146	1844	N/A	29.2	50	1027	22.4	26.1	66	703	24.1	44.8
2. 2/3 Rate - R	148	1873	N/A	30.6	49	1015	22.3	25.5	66	809	24.0	43.0
Placement x Herb Rate												
FBd x F	135	1822	N/A	29.3	66	1378	22.3	27.3	80	907	24.0	44.4
FBd x R	155	1838	N/A	27.8	54	1262	22.8	25.7	88	916	24.6	42.5
SBd x F	127	1886	N/A	30.3	59	1217	21.9	26.0	86	739	24.2	42.7
SBd x R	126	1900	N/A	29.2	70	1163	21.1	24.5	76	874	24.4	42.6
SB9 x F	128	1855	N/A	34.0	61	1278	21.9	26.1	76	951	23.2	46.6
SB9 x R	113	1895	N/A	30.6	59	1284	22.1	29.2	80	1108	23.1	41.2
SB12 x F	106	1861	N/A	24.1	43	810	23.0	25.2	45	411	24.9	44.2
SB12 x R	89	1927	N/A	33.4	41	1004	22.7	25.5	41	565	24.2	40.8
SW x F	233	1797	N/A	28.1	19	452	22.7	26.0	43	506	24.4	45.9
SW x R	259	1807	N/A	31.8	18	364	22.9	22.4	45	581	23.6	48.0
Study Mean	147	1859	N/A	29.9	49	1021	22.3	25.8	66	756	24.1	43.9
Pr > F												
Placement	0.0001	0.2594	N/A	0.2774	0.0001	0.0001	0.0011	0.3594	0.0001	0.0006	0.1002	0.4176
Herbicide	0.7773	0.3571	N/A	0.2355	0.6135	0.8452	0.9242	0.5433	0.9598	0.1642	0.6125	0.2838
Plmt x Herb	0.4181	0.9759	N/A	0.0116	0.0435	0.4792	0.2723	0.4244	0.5278	0.9610	0.5910	0.6230
C.V.	19	5	N/A	12	13	18	3	14	15	26	4	10
Treatment Comparisons												
FBd vs. SBd	0.2032	0.2091	N/A	0.5162	0.1597	0.1686	0.0030	0.4930	0.5609	0.3756	0.9744	0.7509
SB9 vs. SB12	0.1118	0.7003	N/A	0.0611	0.0001	0.0004	0.0131	0.2034	0.0001	0.0002	0.0126	0.5911
SBd vs. SW	0.0001	0.0748	N/A	0.9162	0.0001	0.0001	0.0006	0.5309	0.0001	0.0356	0.6083	0.1038
SB9 vs SW	0.0001	0.1474	N/A	0.2055	0.0001	0.0001	0.0240	0.0580	0.0001	0.0005	0.1073	0.2368

Table 6. Agronomic response of canola to fertilizer placement and herbicide rate at Melfort 1996, 1997 and 1998.

	Crop Stand (plants/m²)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m²)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m²)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
	------- 1996 -------				------- 1997 -------				------- 1998 -------			
Fertilizer Placement												
1. Fall Band - FBd	93 b	2259	25.9	23.5	60 ab	1184 b	23.6	19.2	156 a	1642	23.2 b	19.8
2. Spring Band - SBd	90 b	2221	25.8	24.3	67 a	1434 a	23.5	22.4	141 b	1834	23.8 ab	22.2
3. Sideband 9" - SB9	92 b	2224	25.7	25.3	69 a	1503 a	23.7	22.7	146 ab	1920	24.2 a	18.8
4. Sideband 12" - SB12	127 a	2394	26.0	25.0	51 bc	1408 a	23.4	21.4	109 c	1763	24.1 a	19.6
5. Sweep - SW	72 c	2369	25.6	23.9	43 c	1478 a	23.6	21.9	108 c	1763	23.8 ab	19.2
Herbicide Rate												
1. Full Rate - F	96	2304	25.8	23.9	61	1403	23.7	21.6	134	1824	23.8	19.3
2. 2/3 Rate - R	94	2283	25.7	24.9	55	1400	23.5	21.5	130	1744	23.8	20.5
Placement x Herb Rate												
FBd x F	96	2274	25.6	22.8	64	1040	23.6	19.0	164	1686	23.2	19.8
FBd x R	91	2244	26.1	24.1	55	1329	23.6	19.4	148	1597	23.3	19.9
SBd x F	88	2195	25.9	20.9	73	1494	23.6	22.8	143	1839	23.9	21.9
SBd x R	91	2248	25.6	27.7	61	1375	23.4	22.0	139	1830	23.7	22.5
SB9 x F	98	2243	25.8	26.2	68	1549	23.9	21.9	142	1991	24.2	19.8
SB9 x R	85	2205	25.6	24.3	69	1457	23.5	23.5	150	1848	24.1	17.9
SB12 x F	131	2470	26.3	26.0	56	1463	23.4	22.6	119	1758	23.9	17.9
SB12 x R	124	2317	25.6	24.0	47	1353	23.4	20.3	99	1767	24.2	21.3
SW x F	66	2337	25.3	23.6	44	1467	23.9	21.5	104	1848	23.8	17.3
SW x R	78	2401	25.9	24.1	42	1489	23.4	22.2	112	1677	23.8	21.1
Study Mean	95	2293	25.8	24.4	58	1402	23.6	21.5	132	1784	23.8	19.9
Pr > F												
Placement	0.0005	0.1503	0.9306	0.2291	0.0006	0.0086	0.5999	0.0514	0.0001	0.3966	0.0463	0.1574
Herbicide	0.6537	0.7044	0.9062	0.8592	0.1066	0.9670	0.1055	0.8940	0.2072	0.3739	0.8403	0.1828
Plmt x Herb	0.5397	0.7217	0.6106	0.4311	0.7858	0.1306	0.7440	0.5538	0.0603	0.9574	0.9473	0.2508
C.V.	11	7	4	0.1618	20	12	2	11	9	16	3	14
Treatment Comparisons												
FBd vs. SBd	0.6342	0.6645	0.8108	0.6576	0.2375	0.0079	0.7324	0.0117	0.0181	0.1831	0.0695	0.1004
SB9 vs. SB12	0.0009	0.0579	0.5773	0.8951	0.0063	0.2820	0.1317	0.3044	0.0001	0.2759	0.7202	0.5659
SBd vs. SW	0.0369	0.0958	0.6901	0.8251	0.0004	0.6208	0.6085	0.6417	0.0001	0.6153	1.0000	0.0407
SB9 vs SW	0.0241	0.1018	0.7902	0.4680	0.0001	0.7733	0.7324	0.4944	0.0001	0.2760	0.2536	0.7871

Table 7. Agronomic response of canola to fertilizer placement and herbicide rate at Beaverlodge 1996, 1997 and 1998.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
	------- 1996 -------				------- 1997 -------				------- 1998 -------			
Fertilizer Placement												
1. Fall Band - FBd	94 bc	306	16.5	37.8	N/A	660	19.4	35.4	117 b	705	19.2	28.2
2. Spring Band - SBd	115 ab	406	16.2	38.4	N/A	529	19.6	34.7	109 b	674	19.4	27.4
3. Sideband 9" - SB9	102 b	263	16.4	37.3	N/A	667	19.4	35.6	107 b	756	19.4	27.4
4. Sideband 12" - SB12	130 a	300	16.5	37.5	N/A	502	19.1	33.9	208 a	613	19.6	26.0
5. Sweep - SW	73 c	267	16.3	38.9	N/A	347	19.1	34.4	89 b	822	19.7	26.1
Herbicide Rate												
1. Full Rate - F	103	286	16.3	38.5	N/A	556	19.1	34.9	127	665	19.4	27.0
2. 2/3 Rate - R	102	332	16.5	37.5	N/A	526	19.5	34.7	125	762	19.6	27.0
Placement x Herb Rate												
FBd x F	94	266	16.3	37.2	N/A	797	18.9	34.1	126	637	19.1	26.8
FBd x R	94	346	16.8	38.4	N/A	524	19.8	36.8	107	773	19.4	29.5
SBd x F	108	396	16.0	38.2	N/A	418	19.3	34.7	108	683	19.0	26.1
SBd x R	122	417	16.4	38.6	N/A	640	19.9	34.8	111	665	19.7	28.6
SB9 x F	101	211	16.3	38.8	N/A	563	19.5	35.9	114	767	19.1	27.8
SB9 x R	102	315	16.6	35.8	N/A	771	19.3	35.4	100	744	19.8	27.1
SB12 x F	138	352	16.9	37.8	N/A	531	19.1	35.0	191	577	19.6	27.6
SB12 x R	123	249	16.1	37.2	N/A	473	19.1	32.8	226	648	19.6	24.3
SW x F	74	204	16.1	40.6	N/A	472	18.9	34.8	95	663	20.0	26.7
SW x R	71	330	16.5	37.2	N/A	223	19.4	34.1	84	980	19.4	25.5
Study Mean	103	309	16.4	38.0	N/A	541	19.3	34.8	126	714	19.5	27.0
Pr > F												
Placement	0.0013	0.2334	0.7530	0.7421	N/A	0.1792	0.6212	0.6747	0.0001	0.1254	0.9417	0.7533
Herbicide	0.9281	0.2894	0.4154	0.2183	N/A	0.7455	0.1278	0.8723	0.9127	0.0659	0.5236	0.9935
Plmt x Herb	0.8407	0.4583	0.2426	0.3160	N/A	0.2620	0.4478	0.4531	0.6243	0.2189	0.7497	0.4835
C.V.	24	44	4	7	N/A	53	4	8	30	22	6	14
Treatment Comparisons												
FBd vs. SBd	0.1083	0.1471	0.2625	0.6699	N/A	0.3660	0.4961	0.5924	0.6928	0.6958	0.8572	0.6849
SB9 vs. SB12	0.0297	0.5834	0.9033	0.8958	N/A	0.2572	0.4544	0.2007	0.0001	0.0844	0.7192	0.4643
SBd vs. SW	0.0023	0.0479	0.7770	0.6906	N/A	0.2141	0.1789	0.8286	0.2943	0.0746	0.5903	0.5081
SB9 vs SW	0.0277	0.9513	0.5720	0.2404	N/A	0.0336	0.4344	0.3745	0.3497	0.4168	0.6534	0.4919

Table 8. Agronomic response of canola to fertilizer placement and herbicide rate at Brandon, Melfort and Beaverlodge, 1996 to 1998.

	----- BRANDON, 1996 to 1998 -----				----- MELFORT, 1996 to 1998 -----				----- BEAVERLODGE, 1996 to 1998 -----			
	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
Fertilizer Placement												
1. Fall Band - FBd	98	1394	23.3	31.9	105	1695	24.2	20.8	105	557	18.4	33.8
2. Spring Band - SBd	92	1341	22.7	31.6	101	1830	24.4	23.0	112	536	18.4	33.5
3. Sideband 9" - SB9	87	1429	22.5	33.8	104	1882	24.5	22.3	104	562	18.4	33.5
4. Sideband 12" - SB12	62	1152	23.6	31.3	90	1855	24.6	22.0	169	472	18.4	32.5
5. Sweep - SW	108	952	23.3	32.5	75	1870	24.3	21.6	81	479	18.3	33.1
Herbicide Rate												
1. Full Rate - F	89	1236	23.1	32.3	97 a	1844	24.4	21.6	115	502	18.3	33.5
2. 2/3 Rate - R	90	1271	23.0	32.1	93 b	1809	24.3	22.3	114	540	18.5	33.1
Placement x Herb Rate												
FBd x F	95	1411	23.0	32.7	111	1667	24.1	20.5	110	567	18.1	32.7
FBd x R	100	1377	23.6	31.0	99	1723	24.3	21.1	101	548	18.7	34.9
SBd x F	91	1330	22.9	32.1	104	1843	24.5	21.9	108	499	18.1	33.0
SBd x R	92	1352	22.5	31.2	98	1818	24.3	24.1	116	574	18.7	34.0
SB9 x F	90	1399	22.4	34.6	104	1928	24.7	22.6	108	514	18.3	34.2
SB9 x R	84	1458	22.5	33.0	105	1837	24.4	21.9	101	610	18.5	32.8
SB12 x F	67	1083	23.8	30.0	96	1897	24.5	22.2	165	486	18.5	33.5
SB12 x R	58	1220	23.4	32.5	83	1812	24.4	21.9	174	457	18.3	31.5
SW x F	103	956	23.4	32.2	72	1884	24.3	20.8	85	446	18.3	34.0
SW x R	113	948	23.2	32.8	77	1856	24.4	22.5	77	511	18.4	32.3
Study Mean	89	1253	23.1	32.2	95	1826	24.4	21.9	114	521	18.4	33.3
Pr > F												
Year	0.0111	0.0001	0.0559	0.0111	0.0001	0.0001	0.0006	0.9973	0.1894	0.0217	0.3152	0.0061
Placement	0.7773	0.0965	0.2530	0.3364	0.2388	0.1645	0.6812	0.2699	0.0985	0.7230	0.9950	0.2914
Herbicide	0.7460	0.3394	0.4240	0.7399	0.0301	0.2814	0.4497	0.2289	0.1811	0.4127	0.0519	0.3591
Plmt x Herb	0.5637	0.0655	0.4419	0.7307	0.1403	0.6455	0.5733	0.6846	0.7907	0.8903	0.2295	0.0127
Year x Placement	0.0001	0.0001	0.1798	0.8214	0.0004	0.1823	0.1763	0.7561	0.0710	0.4271	0.5852	0.3847
Year x Herbicide	0.9055	0.0505	0.6982	0.4971	0.7690	0.6188	0.5175	0.7453	0.9650	0.6030	0.7919	0.4152
Year x Plmt x Herb	0.4211	0.9779	0.4583	0.0475	0.6323	0.6825	0.8036	0.1075	0.5314	0.0896	0.7625	0.9427
C.V.	21	13	3	12	12	12	3	14	28	39	5	9
Treatment Comparisons												
FBd vs. SBd	0.3175	0.2487	0.0657	0.8081	0.3412	0.0328	0.5070	0.0165	0.5588	0.7242	1.0000	0.7277
SB9 vs. SB12	0.0001	0.0001	0.0003	0.0402	0.1025	0.6574	0.7555	0.7957	0.0001	0.1293	0.9590	0.2687
SBd vs. SW	0.0338	0.0001	0.0882	0.3325	0.0001	0.5235	0.9009	0.1334	0.0080	0.3309	0.8773	0.6964
SB9 vs SW	0.0034	0.0001	0.0064	0.4242	0.0001	0.8421	0.3514	0.4888	0.0421	0.1616	0.7707	0.7238