MB-09F

Final Report

The Influence of Fertilizer Placement on Crop and Weed Ecology in Direct-Seeding Systems

Agronomy Results

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EXECUTIVE SUMMARY

Agronomic responses of fertilizer placement and reduced herbicide rates were evaluated at Brandon, Manitoba, Melfort, Saskatchewan and Beaverlodge, Alberta in 2000, the last year of a 5-year study evaluating spring wheat and canola responses to N fertilizer placement and herbicide rates in a no-till canola-wheat rotation. Many of the crop responses recorded in 2000 were similar to those observed in previous years at each location, as well as across the three locations. Variation observed in crop establishment with N fertilizer placement was seldom reflected in final grain yields, indicating that large differences in crop stand are required before the final yield of spring wheat or canola are to be influenced. Fertilizer timing, fall vs spring application, did influence grain protein in many instances, with improved protein with spring application indicating that there were some over-winter losses of N from the system in some years at some locations. Either fertilizer N placement or herbicide rates in the study rarely influenced crop water use. In fact, the lack of many significant crop development or yield effects due to herbicide rates used in this study indicates that reducing herbicides was of little agronomic importance. However, a closer evaluation of the herbicide rates will be part of the weed population data. The results of this study will provide information on best management practice over time, at these differing environments, despite the differences from each year. Best management practice in this study combines the net value of a system over twelve station years and environments, resulting in a probability of placing fertilizer and seed in the right place and time most of the time.

RESULTS & DISCUSSION

WHEAT

Brandon

Significant placement effects were detected for crop stands, yield, protein and water use in 2000 at Brandon. Wheat seedling establishment on 9" row spacing where fertilizer was pre-plant banded in the fall, spring or side banded at the time of seeding was 20% higher than side banding with 12" row spacing (Table 1). Similar reductions in plant establishment were also observed with the 12" side band opener in 1998.

Pre-plant banded N applied in the fall of 1999 resulted in the highest wheat grain yields in 2000 at Brandon (Table 1) and similar to yield produced with 9" sideband and sweep seeding. Spring banded nitrogen and N placement banded on 12" row space resulted in the lowest yield. The poor grain yield response of the 12" side band treatment, which was also recorded in 1997 and 1998, is a concern to the authors and is being investigated in a related project. Seeding wheat with N side banded at 9" row space yielded 22% higher than side banded at 12" row space, similar to the yield difference in 1999. Wheat yield was 22% higher when fertilizer was fall banded than when fertilizer was spring banded, the second year in a row for this type of observation at the Brandon location. Sweep seeding also resulted in a 16% yield increase compared to spring banding N prior to seeding. The

reduced herbicide rate also resulted in a significantly lower yield than when the recommended rate was applied.

The fall banded N treatment resulted in significantly higher protein than the other treatments in 2000 (Table 1). Spring banded N and spreading N in the sweep seeding system resulted in the lowest grain protein content than banding N at 9" row space. Banding N in a 9" or 12" row resulted in protein content that was similar. The sweep seeded treatment resulted in lower grain protein than the fall banded N when the yield was similar, indicating that there are differences in efficiency in some years. There was also a herbicide effect on grain protein in 2000, where reducing the herbicide rate resulted in a lower protein content. Since there was only a 0.1 difference it is questionable whether there is an agronomic or economic significance.

Water use was lower on the 9" and 12" N banded treatments than the spring-banded treatment. Since grain yield varied among treatments there is an indication that water use efficiency was affected by N placement. Banding N fertilizer at seeding resulted in the lowest water use, however, seeding and fertilizing on 9" row space resulted in greater water use efficiency than seeding and fertilizing on 12" rows. There may be another mechanism that is causing this effect that is possibly reflected in the plant counts.

Melfort

Significant placement effects were detected for crop stand, yield and protein in 2000 at Melfort. In 2000 the sweep treatment resulted in an inferior plant establishment compared to 9" row space seeding and fertilizer applied in the previous fall, earlier in spring or at the time of seeding (Table 2). The 9" banded treatments resulted in wheat seedling establishment in 2000 that were 2.3 – 2.5 times the seedling count with the sweep treatment. Application of N with the 12" side banding drill resulted in a higher seedling count than observed with the sweep treatment and lower with the 9" placement of fertilizer. Banding N at the time of seeding on 9" rows resulted in a 27% increase in seedling counts compared to banding N on 12" spacing. A reduced herbicide rate resulted in more wheat seedlings than the full herbicide rate, a result that is unusual as the herbicide is applied after the wheat is out of the ground.

Differences in crop stand establishment were not reflected in final grain yield at Melfort in 2000 (Table 3). Wheat yields ranged from 2869 – 3159 kg/ha, somewhat similar to the 5 year mean. The treatments with the poorest stand establishment resulted in yields that were not significantly different from the other treatments or were significantly higher than the yield from the fall banded N treatment. It is obvious from the 2000 result that plant establishment is not the only or dominant factor reflecting the final grain yield.

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Grain protein was highest with the 9" banded N at seeding compared to the other seeding systems (Table 2). The usual lower grain protein with fall, relative to spring, pre-plant

banding that has been observed in a number of years at Melfort indicates that some over-winter loss of fall banded N did not occur in 2000.

There were no differences in water use among the treatments indicating that water use efficiency was somewhat better on some treatments than others.

Beaverlodge

Significant N fertilizer placement effects were recorded for seedling establishment and grain yield at Beaverlodge in 2000 (Table 3). Like Brandon and Melfort, crop stand was significantly different when fertilizer N was side banded on 9" compared to 12" row spacing. This result did not occur in previous years at Beaverlodge. There were no herbicide rate effects on emergence.

Wheat grain yield was also significantly affected by fertilizer N placement, with fall pre-plant banding and the 12" row placement of N resulting in lower wheat yields than side banding fertilizer on 9" row space at seeding (Table 3), a result that was opposite in 1999. Grain yield was similar where N was banded in the previous fall and where N was banded at the time of seeding on 12" row space. The sweep N placement treatment was grouped with the best yielding treatments at Beaverlodge in 2000, a result similar to 1996 and 1997. There were no herbicide rate effects on yield, a result that has significant economic implications.

There were no significant effects for grain protein or water use at Beaverlodge in 2000.

Discussion

Combined data over the 1996-2000 period for Brandon, Melfort and Beaverlodge are presented in Table 4. Averaged over the years there was no placement effect on crop stand, however, there was a significant Year x Placement interaction at all three locations (Table 4). This indicates crop establishment varied from year to year at all sites and some treatments will adversely affect crop emergence in some years and not others. Factors such as soil moisture at seeding, effectiveness of post-seeding packing of the sweep treatments and seeding depth can all contribute to the differences recorded. Combining all the information together from all of the sites may provide insight into why this occurs.

A similar situation was recorded with grain yield, except that was a significant placement effect on yield at Brandon (Table 4). Averaged over all the years there was a significant reduction in yield with the 12" row space at Brandon and no differences in yield occurred at Melfort and Beaverlodge. There were no significant effects for herbicide rate or placement x herbicide rate, indicating that fertilizer placement was much more important in affecting crop yield than applying the recommended rate of herbicide in this trial.

There was a fertilizer placement effect on grain protein at Brandon when averaged over five years and a year x placement effect at Brandon and Melfort. There was no consistent

pattern attributed to fertilizer placement on protein content at the sites and the type of year had an impact on protein content at Brandon and Melfort. Protein content was unaffected by fertilizer placement or time of application at the Beaverlodge site as there were no significant differences in main effects or interactive effects.

While there were minor differences in a few years, there didn't seem to be any trend in crop water use. This indicates that for the most part the crops were using all of the profile water at each trial location. Analyzing the data for water use efficiency may provide some insight as to how these fertilizer N treatments affect the relationship of water use with crop yield. Wheat yields were generally lower at Beaverlodge than either Melfort or Brandon; however, water use was generally lower than at Brandon and higher than Melfort for 1996 to 1999. The analysis of the other data accumulated throughout the study may provide the reasons for this observation. Grain protein differed at all the sites where N placement in the previous fall resulted in lower wheat protein content at Melfort, higher wheat protein content at Brandon and intermediate at Beaverlodge.

Table 1. Agronomic response of wheat to fertilizer placement and herbicide rate at Brandon, 2000.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
Fertilizer Placement				
1. Fall Band - FBd	202 a	2354 a	13.1 a	24.2 ab
2. Spring Band - SBd	197 a	1922 b	12.6 c	27.3 a
3. Sideband 9" - SB9	202 a	2233 a	12.8 b	22.7 b
4. Sideband 12" - SB12	170 b	1836 b	12.7 bc	22.6 b
5. Sweep - SW	188 ab	2223 a	12.6 c	25.8 ab
Herbicide Rate				
1. Full Rate - F	192	2182 a	12.8 a	23.8
2. 2/3 Rate - R	191	2020 b	12.7 b	25.2
Placement x Herb Rate				
FBd x F	206	2549	13.3	24.9
FBd x R	197	2159	12.8	23.5
SBd x F	202	1987	12.7	24.5
SBd x R	192	1857	12.5	30.2
SB9 x F	201	2282	12.9	21.9
SB9 x R	204	2185	12.8	23.5
SB12 x F	168	2003	12.7	23.1
SB12 x R	172	1670	12.6	22.1
SW x F	185	2181	12.7	25.1
SW x R	191	2265	12.6	26.6
Study Mean	192	2101	12.7	24.5
Pr > F				
Placement	0.0068	0.0001	0.0055	0.0473
Herbicide	0.8232	0.0125	0.0155	0.2641
Plmt x Herb	0.8458	0.1759	0.2657	0.3253
C.V.	9	9	2	14
Treatment Comparisons				
FBd vs. SBd	0.6254	0.0002	0.0012	0.0938
SB9 vs. SB12	0.0014	0.0005	0.0921	0.9544
SBd vs. SW	0.3254	0.0054	0.8172	0.3950
SB9 vs SW	0.1360	0.9131	0.0582	0.0823

Table 2. Agronomic response of wheat to fertilizer placement and herbicide rate at Melfort, 2000.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
Fertilizer Placement				
1. Fall Band - FBd	243 a	2869 c	13.0 b	31.7
2. Spring Band - SBd	250 a	2959 bc	12.8 b	32.0
3. Sideband 9" - SB9	231 a	3159 a	13.4 a	31.5
4. Sideband 12" - SB12	182 b	2983 abc	13.0 b	32.5
5. Sweep - SW	100 c	3063 ab	13.0 b	32.2
Herbicide Rate				
1. Full Rate - F	184 b	3009	13.0	32.3
2. 2/3 Rate - R	219 a	3004	13.0	31.6
Placement x Herb Rate				
FBd x F	222	2844	13.2	32.8
FBd x R	264	2895	12.8	30.6
SBd x F	245	2930	12.7	32.1
SBd x R	255	2987	13.0	31.8
SB9 x F	200	3108	13.4	31.7
SB9 x R	261	3210	13.4	31.2
SB12 x F	171	3088	13.0	33.1
SB12 x R	194	2877	12.9	31.9
SW x F	81	3075	12.9	31.6
SW x R	120	3051	13.0	32.7
Study Mean	201	3006	13.0	31.9
Pr > F				
Placement	0.0001	0.0349	0.0249	0.9141
Herbicide	0.0010	0.9300	0.8059	0.3850
Plmt x Herb	0.5102	0.4429	0.4105	0.6559
C.V.	15	6	2	7
Treatment Comparisons				
FBd vs. SBd	0.6614	0.3247	0.3956	0.7907
SB9 vs. SB12	0.0033	0.0582	0.0153	0.3913
SBd vs. SW	0.0001	0.2533	0.4394	0.8682
SB9 vs SW	0.0001	0.2902	0.0153	0.5441

Table 3. Agronomic response of wheat to fertilizer placement and herbicide rate at Beaverlodge, 2000.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
Fertilizer Placement				
1. Fall Band - FBd	305 ab	2187 b	15.9	20.4
2. Spring Band - SBd	319 a	2388 ab	16.1	21.1
3. Sideband 9" - SB9	294 ab	2638 a	16.4	20.5
4. Sideband 12" - SB12	206 c	2225 b	15.9	19.9
5. Sweep - SW	249 bc	2710 a	16.8	20.3
Herbicide Rate				
1. Full Rate - F	262	2368	16.1	19.9
2. 2/3 Rate - R	287	2491	16.3	21.0
Placement x Herb Rate				
FBd x F	312	2296	15.6	19.6
FBd x R	299	2078	16.2	21.2
SBd x F	292	2462	15.9	20.3
SBd x R	346	2314	16.2	22.0
SB9 x F	318	2610	16.4	19.4
SB9 x R	270	2666	16.5	21.7
SB12 x F	177	1964	15.8	20.0
SB12 x R	235	2487	16.1	19.8
SW x F	211	2508	17.1	20.4
SW x R	286	2912	16.6	20.2
Study Mean	274	2429	16.2	20.4
Pr > F				
Placement	0.0079	0.0085	0.3341	0.8818
Herbicide	0.2222	0.2400	0.6298	0.1921
Plmt x Herb	0.2569	0.1148	0.8654	0.7428
C.V.	23	13	6	12
Treatment Comparisons				
FBd vs. SBd	0.6723	0.2266	0.7029	0.5410
SB9 vs. SB12	0.0098	0.0170	0.3557	0.5959
SBd vs. SW	0.0352	0.0577	0.1532	0.4889
SB9 vs SW	0.1644	0.6631	0.4198	0.8540

Table 4. Agronomic response of wheat to fertilizer placement and herbicide rate at Brandon, Melfort and Beaverlodge, 1996 to 2000.

	BRANDON, 1996 TO 2000				MELFORT, 1996 TO 2000				BEAVERLODGE, 1996 TO 2000			
	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	2837 a	13.9 a	33.0	250	3019	12.8	24.8	215	1692	14.4	25.3
2. Spring Band - SBd	183	2687 a	13.5 bc	32.3	245	3122	13.0	24.6	230	1779	14.7	26.3
3. Sideband 9" - SB9	182	2750 a	13.5 bc	31.4	246	3165	13.2	25.1	218	1750	14.8	25.9
4. Sideband 12" - SB12	155	2508 b	13.7 ab	30.3	194	3030	13.2	26.0	186	1501	14.6	26.2
5. Sweep - SW	176	2724 a	13.3 c	31.9	194	3181	12.8	24.6	153	1731	14.7	25.5
Herbicide Rate												
1. Full Rate - F	177	2736	13.6	31.8	222	3122	13.1	25.1	201	1703	14.6	25.6
2. 2/3 Rate - R	176	2664	13.5	31.8	229	3085	12.9	24.9	199	1679	14.7	26.1
Placement x Herb Rate												
FBd x F	190	2884	13.9	32.2	246	3012	12.8	25.0	222	1772	14.4	25.2
FBd x R	184	2791	13.9	34.0	253	3027	12.7	24.5	207	1612	14.5	25.4
SBd x F	184	2724	13.7	32.0	246	3118	12.9	24.9	222	1792	14.6	25.5
SBd x R	182	2650	13.4	32.6	244	3125	13.0	24.3	238	1767	14.7	27.0
SB9 x F	183	2777	13.5	31.1	240	3158	13.4	25.3	231	1740	14.7	26.1
SB9 x R	182	2722	13.4	31.6	251	3172	13.1	24.8	205	1761	14.9	25.8
SB12 x F	154	2547	13.6	30.8	192	3110	13.3	26.1	180	1478	14.7	25.7
SB12 x R	158	2470	13.7	29.9	195	2951	13.1	25.8	191	1524	14.6	26.6
SW x F	176	2754	13.4	32.9	188	3211	12.9	24.0	142	1733	14.8	25.3
SW x R	176	2694	13.3	31.0	199	3151	12.7	25.1	164	1730	14.7	25.8
Study Mean	177	2700	13.6	31.8	226	3103	13.0	25.0	200	1690	14.7	25.8
Pr > F												
Year	0.0526	0.0001	0.0001	0.0005	0.1567	0.0001	0.0001	0.0001	0.0048	0.0001	0.1800	0.0030
Placement	0.2163	0.0151	0.0048	0.3640	0.0603	0.3678	0.0661	0.1428	0.1885	0.2301	0.2089	0.8249
Herbicide	0.4179	0.1207	0.2112	0.7528	0.5662	0.5280	0.1190	0.2789	0.8556	0.6879	0.7565	0.1174
Plmt x Herb	0.6534	0.9795	0.2134	0.4983	0.8815	0.2729	0.3070	0.5335	0.1365	0.5180	0.9616	0.8943
Year x Placement	0.0001	0.0142	0.0172	0.8322	0.0001	0.0014	0.0070	0.5733	0.0001	0.0039	0.4674	0.4663
Year x Herbicide	0.8168	0.1799	0.2007	0.5109	0.0583	0.0308	0.3334	0.9475	0.1757	0.1388	0.6610	0.9121
Year x Plmt x Herb	0.8228	0.5159	0.5015	0.0004	0.1148	0.4407	0.3463	0.3733	0.7310	0.4662	0.5017	0.1015
C.V.	10	8	2	11	11	6	3	11	23	16	4	13
Treatment Comparisons												
FBd vs. SBd	0.8025	0.1187	0.0169	0.7279	0.8657	0.3161	0.3131	0.7778	0.6456	0.4965	0.1692	0.3286
SB9 vs. SB12	0.0694	0.0074	0.1840	0.5527	0.0527	0.1917	0.7925	0.1106	0.3434	0.0633	0.2584	0.7951
SBd vs. SW	0.6204	0.6435	0.0740	0.8772	0.0697	0.5576	0.5354	0.9664	0.0351	0.7064	0.6339	0.4475
SB9 vs SW	0.6550	0.7490	0.1457	0.3403	0.0817	0.8772	0.0409	0.4910	0.0690	0.8808	0.6223	0.6895

CANOLA

Brandon

Significant fertilizer N placement and herbicide rates effects were detected for canola seedling stands at Brandon again in 2000 (Table 5). Sweep seeding resulted in lower canola plant establishment than the other treatments, a response that has been observed in 1997, 1998 and 1999 as well. However, unlike in some previous years of the study at Brandon, side banding N on 12" rows did not result in a reduced crop establishment relative to side banding on 9" spacing. Given that herbicides have not been applied when the crop emergence is determined, the reduced herbicide rate appears to have lowered crop stand as a result of previous weed populations. This response is small and generally unexpected.

Canola grain yields at Brandon in 2000 were unaffected by N fertilizer treatment or herbicides rate (Table 5). Yields were generally low from this site in 2000. However, there was a significant fertilizer placement effect on grain protein (Table 5). Grain protein was lowest when fertilizer and seed were side banded on 9" row spacing at the time of seeding, and highest when fertilizer was fall banded (Table 5), a result similar to 1999. Fall banding fertilizer resulted in higher grain protein than spring banding fertilizer, and sweep seeding and fertilizing resulted in protein content that was higher than side banding fertilizer on 9" row spacing. Canola crop water use was unaffected by the fertilizer and herbicides treatments in 2000, a result to what occurred in 1999.

Melfort

At the Melfort location in 2000 significant N fertilizer placement effects were recorded for crop establishment only (Table 6). At this site, placement of fertilizer at the time of seeding, either in a 12" side band or with the seed under a sweep, reduced canola stand compared to pre-plant banding of the fertilizer in the fall or spring and 9" side banded N (Table 6). The reduced emergence with side banding on 12" rows, relative to 9" rows that was recorded in 1998 and 1997 was not present in 1999 but occurred again in 2000. Even with a 50% reduction in crop emergence with sweep seeding and fertilizer placement there was a significantly higher seed yield compared to fertilizing in the previous fall (Table 6). Again, as at Brandon and Beaverlodge, there was no effect on yield when herbicide rate was reduced to 2/3 of recommended.

There was no placement or herbicide effects on grain yield, grain protein and water use, a result that has not been observed in previous years.

Beaverlodge

Significant placement effects were detected for crop stand and yield at Beaverlodge in 2000 (Table 7). The sweep treatment resulted in canola emergence that was 3-fold lower than placing N in a band or prior to seeding and the seed in a row (Table 7). It would appear that problems were encountered at the Beaverlodge location again in 2000 with the establishment of canola using the sweep seeding system. Similar poor crop establishment was also recorded in 1997, 1998 and 1999. Given that the low stand establishment in the sweep seeding system was

reflected in lower grain yield compared to other treatments it is apparent that the plasticity of canola cannot always fully compensate for poor emergence. Banding fertilizer on 9" row-space produced higher canola yield than spreading in the seed row with the sweep (Table 7). There were no significant effects of placement or herbicide on grain protein or water use.

Discussion

Averaged over all the years there was no significant difference in crop stand at Brandon, although individual years produced results that showed differences in emergence with the different N fertilizer placement treatments. There was a significant difference in canola stand at Melfort and Beaverlodge, largely a result of poor emergence with the sweep treatment in several years (Table 8). There was a Year x N Placement interactions for crop stand at all locations indicating that differences were apparent under different seeding conditions for the placement of fertilizer and seed. Again this indicates that there may not be one system for all locations in Western Canada over all years and that an indication of the probability of success may be more suitable.

Seeding on 9"row-space and placing fertilizer N in the band at the time of seeding or the previous fall resulted in higher grain yield at Brandon compared to the sweep treatment, indicating that placement may be important for grain yield at Brandon (Table 8). Despite the differences observed in canola establishment, similar grain yield was observed at Melfort and Beaverlodge, which indicated that placement, was relatively unimportant in these environments. However, fall banding N appeared to reduce canola yield compared to placing N at the time of seeding at Melfort. The effect on other agronomic characteristics was recorded and may have an impact on year to year variation. There were significant effects of year x placement on grain yield at Brandon and Beaverlodge. It is interesting that reducing herbicide rate had very little impact on yield in this study. Rather it was fertilizer N placement that had a bigger impact from year to year, likely as a result of environmental variation.

It appears that at Brandon, grain protein is adversely affected by spring N placement in 9" row spacing compared to the other treatments, as indicated by the placement and year x placement significant effects (Table 8). Melfort or Beaverlodge N placement treatments did not influence protein content as indicated by the lack of interaction with placement and year. However, there was a significant herbicide effect at Beaverlodge when averaged over all years that indicated protein content was higher when herbicide rates were reduced. A more thorough analysis will be conducted over the next year and the relationship with weeds and other parameters may indicate the reason for such a result.

There was no effect on water use by the treatments in this study at any of the sites, except for a significant placement x herbicide rate effect at Beaverlodge (Table 8). This is an indication of the compensation that occurs with canola and will be more adequately described with water use efficiency. The interaction at Beaverlodge was a result of more water use with reduced herbicide rates when N was applied in the fall. Weed populations could have possibly resulted in the higher water use in this treatment.

Table 5. Agronomic response of canola to fertilizer placement and herbicide rate at Brandon, 2000.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
Fertilizer Placement				
1. Fall Band - FBd	103 ab	855	21.6 a	34.8
2. Spring Band - SBd	108 a	849	20.8 bc	33.2
3. Sideband 9" - SB9	91 b	936	20.6 c	27.6
4. Sideband 12" - SB12	98 ab	924	21.0 bc	31.6
5. Sweep - SW	66 c	823	21.4 ab	31.2
Herbicide Rate				
1. Full Rate - F	98 a	928	21.1	32.3
2. 2/3 Rate - R	88 b	827	21.1	31.1
Placement x Herb Rate				
FBd x F	103	958	21.7	38.5
FBd x R	102	752	21.6	31.2
SBd x F	120	877	21.0	32.6
SBd x R	95	821	20.7	33.9
SB9 x F	92	1041	20.9	29.7
SB9 x R	91	830	20.3	25.4
SB12 x F	108	868	21.1	29.6
SB12 x R	88	981	20.9	33.6
SW x F	68	894	20.9	31.1
SW x R	64	752	21.9	31.4
Study Mean	93	877	21.1	31.7
Pr > F				
Placement	0.0001	.6367	.0110	.1383
Herbicide	0.0355	.0813	.8255	.4772
Plmt x Herb	0.3271	.3399	.0764	.2514
C.V.	16	20	3	11
Treatment Comparisons				
FBd vs. SBd	.5172	.9470	.0100	.5440
SB9 vs. SB12	.3715	.8975	.1980	.1449
SBd vs. SW	.0001	.7698	.0756	.4508
SB9 vs SW	.0021	.2095	.0151	.1814

Table 6. Agronomic response of canola to fertilizer placement and herbicide rate at Melfort, 2000.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
Fertilizer Placement				
1. Fall Band - FBd	144 a	1333	25.4	32.7
2. Spring Band - SBd	135 a	1524	25.3	34.6
3. Sideband 9" - SB9	128 a	1611	25.5	33.5
4. Sideband 12" - SB12	109 b	1592	25.5	33.4
5. Sweep - SW	70 c	1609	25.6	33.1
Herbicide Rate				
1. Full Rate - F	120	1548	25.4	33.9
2. 2/3 Rate - R	114	1520	25.4	33.0
Placement x Herb Rate				
FBd x F	153	1230	25.4	33.1
FBd x R	135	1437	25.4	32.4
SBd x F	142	1563	25.2	34.8
SBd x R	129	1485	25.5	34.3
SB9 x F	131	1675	25.5	34.7
SB9 x R	126	1547	25.4	32.3
SB12 x F	103	1596	25.2	34.1
SB12 x R	116	1587	25.8	32.8
SW x F	73	1676	26.0	32.9
SW x R	67	1543	25.2	33.2
Study Mean	117	1534	25.4	33.5
Pr > F				
Placement	.0001	.0917	.9211	.6995
Herbicide	.2410	.6938	.8788	.2803
Plmt x Herb	.3390	.5357	.0952	.8780
C.V.	13	15	2	8
Treatment Comparisons				
FBd vs. SBd	.2680	.0983	.8470	.1737
SB9 vs. SB12	.0025	.8648	.9615	.9395
SBd vs. SW	.0001	.4482	.3885	.2687
SB9 vs SW	.0001	.9893	.6999	.7402

Table 7. Agronomic response of canola to fertilizer placement and herbicide rate at Beaverlodge, 2000.

	Crop Stand (plants/m^2)	Grain Yield (kg/ha)	Grain Protein (%)	Water Use (cm)
Fertilizer Placement				
1. Fall Band - FBd	154 a	1159	25.6	20.9
2. Spring Band - SBd	162 a	1150	26.4	22.3
3. Sideband 9" - SB9	153 a	1224	25.5	21.0
4. Sideband 12" - SB12	141 a	1090	25.5	21.7
5. Sweep - SW	45 b	894	25.8	22.5
Herbicide Rate				
1. Full Rate - F	135	1101	26.1	22.1
2. 2/3 Rate - R	127	1106	25.4	21.2
Placement x Herb Rate				
FBd x F	153	1098	26.0	22.3
FBd x R	156	1221	25.1	19.5
SBd x F	201	1125	26.7	24.2
SBd x R	124	1175	26.1	20.4
SB9 x F	131	1333	25.3	20.7
SB9 x R	176	1114	25.8	21.2
SB12 x F	152	1075	26.1	21.7
SB12 x R	130	1106	24.9	21.7
SW x F	40	876	26.3	21.7
SW x R	51	913	25.2	23.3
Study Mean	131	1103	25.8	21.7
Pr > F				
Placement	.0016	.2452	.5053	.8935
Herbicide	.6596	.9629	.0776	.4917
Plmt x Herb	.3065	.8168	.6380	.6125
C.V.	43	27	4.5	18.5
Treatment Comparisons				
FBd vs. SBd	.7837	.9500	.1555	.4838
SB9 vs. SB12	.6697	.3754	.9660	.7254
SBd vs. SW	.0003	.0960	.2922	.9361
SB9 vs SW	.0008	.0349	.6708	.4540

Table 8. Agronomic response of canola to fertilizer placement and herbicide rate at Brandon, Melfort and Beaverlodge, 1996 to 2000.

	BRANDON, 1996 TO 2000				MELFORT, 1996 TO 2000				BEAVERLODGE, 1996 TO 2000			
	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	114	1300 a	22.1 a	30.5	127 a	1578	24.4	23.0 b	141 a	704	20.1	27.9
2. Spring Band - SBd	109	1213 ab	21.3 b	30.5	122 ab	1671	24.5	24.6 a	133 ab	672	20.0	27.7
3. Sideband 9" - SB9	100	1356 a	21.3 b	30.8	112 ab	1733	24.7	24 3 a	127 ab	704	20.0	28.0
4. Sideband 12" - SB12	84	1124 ab	21.9 a	29.9	104 bc	1706	24.7	24.1 ab	183 a	609	19.9	27.2
5. Sweep - SW	99	1002 b	21.7 ab	30.6	84 c	1737	24.6	23.8 ab	67 b	548	20.0	27.6
Herbicide Rate												
1. Full Rate - F	102	1200	21.7	30.5	112	1694	24.6	23.9	130	636	19.9 b	27.9
2. 2/3 Rate - R	101	1197	21.7	30.3	108	1676	24.6	24.0	130	659	20.1 a	27.5
Placement x Herb Rate												
FBd x F	112	1316	21.9	31.4	131	1546	24.4	22.8	144	724	19.8	26.9
FBd x R	116	1285	22.2	29.5	123	1611	24.5	23.1	138	685	20.5	28.9
SBd x F	111	1216	21.4	31.0	125	1688	24.5	23.8	129	647	19.7	27.4
SBd x R	107	1209	21.2	30.0	120	1654	24.5	25.4	137	696	20.2	27.9
SB9 x F	99	1365	21.4	31.4	111	1763	24.7	25.1	132	662	19.9	28.9
SB9 x R	100	1348	21.2	30.2	114	1703	24.6	23.6	121	746	20.1	27.3
SB12 x F	89	1069	22.1	28.9	108	1719	24.7	24.5	181	618	20.0	28.2
SB12 x R	80	1178	21.8	30.9	101	1692	24.8	23.7	185	599	19.9	26.2
SW x F	98	1020	21.7	30.0	84	1754	24.6	23.3	66	526	19.9	28.1
SW x R	100	983	21.8	31.1	84	1719	24.5	24.3	69	569	20.0	27.1
Study Mean	101	1199	21.7	30.4	110	1685	24.6	24.0	130	647	20.0	27.7
Pr > F												
Year	.0006	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0002	.0066	.0001
Placement	.6720	.0350	.0496	.9334	.0075	.0557	.2605	.0999	.0433	.2295	.8210	.6370
Herbicide	.7058	.8063	.6144	.5497	.1396	.4124	.8777	.8058	.6581	.4865	.0099	.1870
Plmt x Herb	.5933	.0804	.3790	.2967	.6270	.5332	.7534	.1593	.6535	.8068	.0607	.0126
Year x Placement	.0001	.0001	.0815	.5189	.0001	.0820	.3824	.6719	.0004	.1732	.3397	.3295
Year x Herbicide	.4622	.0225	.8823	.6394	.6904	.6146	.4246	.4846	.9763	.5818	.8589	.6721
Year x Plmt x Herb	.3481	.9553	.3507	.0845	.5149	.8511	.6386	.3752	.8491	.2282	.9073	.9120
C.V.	17	14	3.1	11.8	14	13	2.5	11.7	27.2	31	4.0	10.5
Treatment Comparisons												
FBd vs. SBd	.8236	.4408	.0238	.8551	.6522	.1067	.7826	.0122	.7914	.6712	.3525	.6379
SB9 vs. SB12	.4563	.0421	.0318	.6913	.7234	.6213	.8396	.7074	.0882	.2296	.7479	.1603
SBd vs. SW	.6001	.0753	.1662	.9252	.0027	.2422	.6076	.1798	.0532	.1251	.9849	.9749
SB9 vs SW	.9065	.0054	.1157	.7696	.0159	.9493	.3730	.3863	.0757	.0597	.7911	.4307