Printed: May 2015
Tested at Humboldt, Saskatchewan
ISSN 1188-4770, Group 9(f)

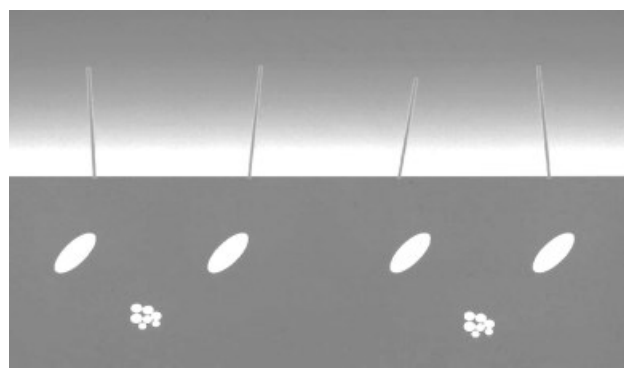
PAMI **Research Update** **768**

www.pami.ca

Emergence and Yield Comparison of Mid-Row and Side Banding Seeding/Fertilizer Systems

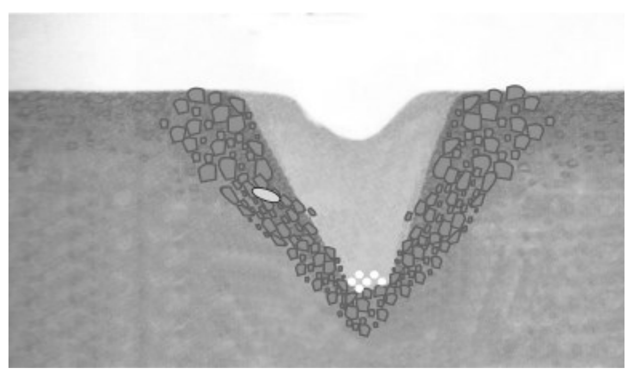
During the growing years of 2000, 2001, and 2002, PAMI, along with our research partners, conducted a major seeding research project in Saskatchewan. The results are presented in a major 257-page report titled "*The Effect of Nitrogen Fertilizer Placement, Formulation, Timing, and Rate on Greenhouse Gas Emissions and Agronomic Performance.*" It can be accessed on the Saskatchewan Agriculture and Food website (http://www.agr.gov.sk.ca/apps/adf/ADFAdminReport/19990028.pdf). To quickly get results to the public, a brief summary of the project was written in a PAMI Research Update and released in April of 2003. That report contained little data, so based on reader interest, PAMI prepared this more detailed Research Update using more project data with a special focus on an agronomic comparison of mid-row banding and side banding systems.

Mid-Row Banding (MRB) System.



Mid-Row Banding System Showing Seed and Fertilizer Placement.

Side Banding (SB) System.



Side Banding System Showing Seed and Fertilizer Placement.

SCOPE OF TEST

The project was conducted jointly by PAMI, Agriculture and Agri-Food Canada, and the Department of Soil Science at the University of Saskatchewan.

Plots were direct seeded in standing stubble to wheat, canola, and flax using the PAMI 10 foot wide, 4 rank pneumatic plot seeder configured to apply anhydrous ammonia (NH3) or urea in addition to seed and phosphate fertilizer.

The PAMI research seeder uses full-sized components to simulate actual full-scale seeders as much as possible. Although the height, front-to-back distances, and most components are full scale, the width is only 10 ft. This is considerably less than actual machines, which can be 70 ft wide. To maximize accuracy, openers are usually new or near to new. While this is very typical of research, farmers should be aware of this fact as results in the field with actual seeders under the same growing conditions may not be as good as those obtained in this research project.

EVALUATING A SEEDING SYSTEM

Rating the agronomic performance of a seeding system can be complex. While yield and quality ultimately convert into returns for the farmer, these are not solely dependant on the performance of the seeding system. The weather during the growing season can have a major effect on how a crop develops, irrespective of the seeding system's performance. As such, emergence is generally regarded as another good measurement of seeding system performance.

It has been suggested that an ideal evaluation of a seeding system study would identify the relevant performance factors, then evaluate and qualify these factors as performance indicators with respect to selected reference points or benchmarks. If a complete comprehensive study was feasible, many more factors could be evaluated and quantified. Some of these agronomic factors are emergence time, root development, growth rate, seed placement, seed and fertilizer separation, row spacing, effects of crop type, seeding rate, soil pH, soil carbon, residue, soil tilth, soil moisture, and soil finish. Operational factors include opener wear, durability, maintenance, tractor draft, and operator skill requirements. Financial factors include seeder and tractor capital costs, fuel costs, seed costs, repairs, and maintenance. Calculation of these many factors would allow the farmer to determine their Return on Investment (ROI). In the comprehensive 257-page project report, some of these factors have been identified and reported on. However, many of these factors were beyond the scope of this study and were not included in this report, so farmers would need to obtain additional information for complete agronomic, operation, and financial assessments.

In this summarized Research Update, it is not practical to provide extensive information. As such, information is primarily provided on emergence and yield with some additional basic information on a few other factors. However, farmers should consider all availa-

TEST DESCRIPTION

Years:

2000, 2001, 2002

Locations in Saskatchewan

Indian Head (IH)	Black
Melfort (M)	Grey
Scott (SC)	Dark Brown
Swift Current (SW)	Brown

Nitrogen Fertilizer Form

Urea
Anhydrous Ammonia

Seeding/Fertilizer System

Bourgault Mid-Row Bander
Flexicoil Stealth Side Bander

Nitrogen Fertilizer rates (kg N/ha)

Low	40	@	IH & M
	30	@	SC & SW
Med	80	@	IH & M
	60	@	SC & SW
High	120	@	IH & M
	90	@	SC & SW

Growing Conditions (Temperature/Moisture)

	2000	2001	2002
Indian Head (IH)	cool and wet	very dry	initially dry then normal
Scott (SC)	initially dry	severe drought	severe drought
Melfort (M)	normal	severe drought	severe drought
Swift Current (SW)	hot and wet	hot very dry	dry in May then wet

ANALYSIS AND INTERPRETATION OF RESULTS

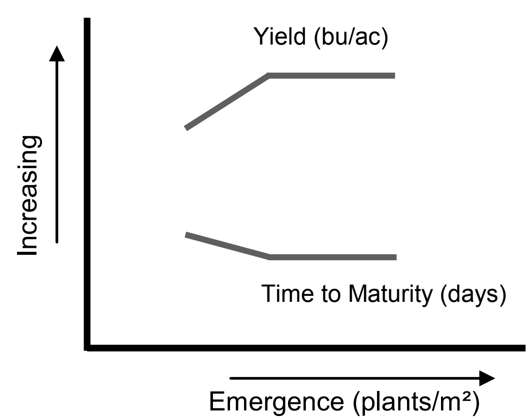
In this project, trials were conducted at the recommended fertilizer rate as well as 50% of the recommended rate and 150% of the recommended rate. This resulted in considerable data, so to simplify the presentation of the results, the analysis and discussion is initially provided on the results obtained when using the more common recommended fertilizer rate. However, tables of results from using 50% and 150% of the recommended rate are presented in Appendix I and II. Although discussion does not accompany these tables, the data in the appendices is presented in a similar way, which allows the reader to analyze the data using the same process used on the following data from recommended fertilizer rates.

Statistical analysis was conducted on the results. This is a common practice used by researchers to ensure that differences measured between the results of different test configurations are real differences and not solely due to experimental variables. Researchers do the analysis at a "confidence level" that they feel is most applicable to the project. Using a high confidence level (such as 95%) is very typical in scientific research where the goal is to minimize the chance that a difference is considered to be a real when in fact it may be due to experimental variables. In this project, it would minimizes the chance that a farmer would modify their procedures or change their equipment to obtain an increased yield when, in fact, none will be obtained. Conversely, in this project, using a lower confidence level minimizes the chances that an actual yield increase that could be obtained from using modified procedures or different equipment, is not identified. Since the financial impact of yield differences can exceed the impact of modified practice or equipment, it was decided to use a significance level of 80% as a reasonable balance of the real-world implications. Also to assist the farmer in considering their options, the individual results from each plot (three years, three crops, four locations, two nitrogen forms, three fertilizer rates and two fertilizer/seeding systems) is provided in this report.

For each crop, a table reporting "emergence" and a table reporting "yield" is provided. While yield is the ultimate goal that results in final economic benefit for a farmer, emergence also provides useful information related to seeding/fertilizing system performance. Consequently, emergence and yield were both analyzed and reported on.

Previous research has identified minimum threshold emergence levels for crops that need to be obtained to maximize yield potential and minimize time to maturity (harvest). Emergence levels that are too low will likely result in reduced yield and/or delayed maturity, but emergence levels that exceed the minimum threshold will provide little or no extra yield benefit. Figure 1 provides a visual representation of this relationship. When analyzing results in the following section, the concept of a minimum threshold level for plant emergence will be referred to in order to help understand the relationship (or lack of) between emergence levels and yield.

Figure 1: Effect of Emergence on Yield and Time to Maturity



Results at Recommended Fertilizer Rates

For the growing conditions in Table 1, the following section provides emergence and yield results (Tables 2 to 7) when using the recommended fertilizer rates (71 lb N/ac at Indian and Melfort, 54 lb N/ac at Swift Current and Scott). Each pair of tables is for a different crop at four locations (Indian Head, Melfort, Swift Current, and Scott) using two fertilizer forms (NH3 and urea), over three years (2000, 2001, and 2002) for both fertilizing systems (MRB and SB). Each data point in the table represents the average of four small, randomly seeded plots. Each pair of MRB/SB data is either: unshaded, if there is no statistically significant difference between MRB and SB systems; lightly shaded and outlined with an oval if MRB exceeded SB by a statistically significant difference; or lightly shaded and outlined with a hexagon if SB exceeded MRB results by a statistically significant difference (see the legend below). Note that all emergence results are in plants/m² and all yield results are in bu/ac.

Table 1: Growing Conditions (Location, Temperature, Moisture)

	2000	2001	2002
Indian Head	cool and wet	very dry	initially dry then normal
Melfort	normal	severe drought	severe drought
Swift Current	hot and wet	hot, very dry	dry in May
Scott	initially dry	severe drought	severe drought

WHEAT

Table 2: Wheat Emergence Results at Recommended Fertilizer Rates

Wheat Emergence (plants/m²)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	257	219	286	217	193	268
	SB	245	120	306	254	132	273
Melfort	MRB	300	296	299	294	262	290
	SB	270	277	288	274	285	217
Swift Current	MRB	178	174	226	141	182	198
	SB	185	154	232	176	136	201
Scott	MRB	232	275	170	255	289	172
	SB	219	287	117	210	310	130

No significant difference

MRB significantly higher than SB

SB significantly higher than MRB

Note: Due to the variability of data from year to year and site to site, the difference required to be considered statistically significant varied considerably between the different pairs of data.

Table 3: Wheat Yield Results at Recommended Fertilizer Rates

Wheat Yield (bu/ac)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	34.1	28.0	33.3	33.9	31.1	33.2
	SB	32.6	29.6	34.8	35.5	33.0	34.8
Melfort	MRB	33.6	15.8	3.4	36.4	14.0	3.7
	SB	36.6	16.2	4.0	33.8	15.0	5.2
Swift Current	MRB	46.8	10.6	22.5	56.8	11.6	24.8
	SB	49.4	9.1	28.6	62.6	13.4	26.5
Scott	MRB	27.7	22.2	1.9	39.0	21.1	2.8
	SB	29.2	22.0	2.7	36.9	20.7	2.8

In the 24 pairs of wheat emergence comparisons, nine of the comparisons were significantly different and fifteen were not. Of the nine that were significantly different, MRB had significantly higher emergence seven times and SB had significantly higher emergence two times. Six out of the seven times that MRB was significantly higher were in the drier years of 2001 and 2002. Both times that the SB had significantly higher emergence were in the more typical moisture year 2000.

In the 24 pairs of wheat yield comparisons, only two were significantly different and 22 were not. Of the two times where there was a significant difference, SB had significantly higher yield both times. Only one of the significant differences in yield correlated with a significant difference in emergence. Factors beside the absolute emergence difference must have had a greater effect on yield.

CANOLA

Table 4: Canola Emergence Results at Recommended Fertilizer Rates

Canola Emergence (plants/m²)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	96	52	67	109	40	61
	SB	105	14	61	90	25	76
Melfort	MRB	117	58	48	106	62	53
	SB	109	51	49	103	68	55
Swift Current	MRB	70	49	50	76	49	42
	SB	54	42	49	70	46	61
Scott	MRB	53	57	38	39	67	23
	SB	56	51	34	64	60	25

Table 5: Canola Yield Results at Recommended Fertilizer Rates

Canola Yield (bu/ac)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	39.1	33.7	25.0	48.9	36.1	24.3
	SB	41.8	13.7	28.0	38.7	23.4	16.8
Melfort	MRB	49.1	11.4	30.3	37.8	12.0	29.1
	SB	49.3	13.7	30.7	43.5	15.0	32.7
Swift Current	MRB	31.8	14.8	20.9	34.1	12.0	22.1
	SB	30.7	13.6	21.2	29.1	8.9	27.3
Scott	MRB	16.8	17.0	4.5	24.5	16.2	5.4
	SB	19.8	13.2	5.0	24.5	14.3	3.7

No significant difference

MRB significantly higher than SB

SB significantly higher than MRB

Note: Due to the variability of data from year to year and site to site, the difference required to be considered statistically significant varied considerably between the different pairs of data.

In the 24 pairs of canola emergence comparisons, only three were significantly different and 21 were not. Of the three that were significantly different, MRB had higher emergence two times and SB had higher emergence one time. Both times that MRB was significantly higher were in the dry seeding conditions of 2001 in Indian Head's heavy clay soils. The one time when SB was significantly higher was at Scott during 2000.

In the 24 pairs of canola yield comparisons, only four of the comparisons were significantly different, and 20 were not. Of the four that were significantly different, MRB had significantly higher yield two times, and SB had significantly higher yield two times. For the two times when the SB system had significantly lower yield, with an average difference of 16 bu/ac, the lower yields corresponded with much lower plant emergence. Both events occurred at Indian Head in 2001, where the top one inch of heavy clay soil was dry, with better soil moisture below.

The time when the SB had significantly higher emergence, no significant difference in final yield occurred. Conversely, the two times when the SB had significantly higher yield, there had been no significant difference in emergence.

FLAX

Table 6: Flax Emergence Results at Recommended Fertilizer Rates

Flax Emergence (plants/m²)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	648	**377**	498	670	**416**	393
	SB	581	**293**	442	590	**265**	437
Melfort	MRB	527	523	473	426	538	**456**
	SB	483	469	446	445	533	**548**
Swift Current	MRB	517	380	**496**	**394**	457	425
	SB	544	477	**383**	**547**	366	445
Scott	MRB	268	397	206	260	476	179
	SB	236	454	178	315	415	147

Table 7: Flax Yield Results at Recommended Fertilizer Rates

Flax Yield (bu/ac)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	25.5	**15.3**	32.8	26.8	19.4	32.3
	SB	24.4	**19.8**	30.6	26.0	18.2	30.4
Melfort	MRB	30.0	19.6	14.2	29.8	18.3	14.0
	SB	31.6	19.0	14.7	30.9	19.4	14.3
Swift Current	MRB	32.2	10.2	20.7	26.3	**15.0**	21.0
	SB	30.3	11.3	18.5	26.1	**11.3**	22.1
Scott	MRB	**31.7**	22.3	3.2	35.2	19.1	3.0
	SB	**34.9**	22.3	3.8	36.8	20.4	4.0

No significant difference

MRB significantly higher than SB

SB significantly higher than MRB

Note: Due to the variability of data from year to year and site to site, the difference required to be considered statistically significant varied considerably between the different pairs of data.

In the 24 pairs of flax <u>emergence</u> comparisons, only five were significantly different and 19 were not. Of the five that were significantly different, MRB had significantly higher emergence three times and SB had significantly higher emergence two times. All the times that MRB was significantly higher were in the drier years of 2001 and 2002. Of the two times that the SB had significantly higher emergence, one was in the more typical moisture year (2000) and the other was in the dry year of 2002.

In the 24 pairs of flax <u>yield</u> comparisons, only three were significantly different and 21 were not. Of the three times that were significantly different, MRB had significantly higher yield one time and SB had significantly higher yield two times. Only one of the significant differences in emergence correlated with a significant difference in yield. Factors beside the absolute emergence difference must have had a greater effect on yield.

STUDY OBSERVATIONS

For the overall project, including all three fertilize rates, where there were 216 pairs of emergence comparisons, there were 42 that were significantly different. Of the 42 that were significantly different, MRB was significantly higher 33 times and SB was significantly higher 9 times. Differences in plant emergence for MRB and SB occurred more frequently when soil conditions immediately before and after seeding were dry, and were more often in favour of MRB than for SB. For the SB system, this difference was sometimes greater with NH3 compared to urea. The higher plant emergence with MRB could be especially important when seeding conditions, such as dry soil, would tend to otherwise reduce emergence below desired emergence threshold levels. In those conditions, higher emergence could offer an extra level of risk reduction toward maximizing yield, and minimizing the occurrence of a delayed harvest and the associated quality reduction.

In this project there was no consistent trend for the significant differences observed in emergence to convert into significant differences in yield. Overall, there were 216 pairs of yield comparisons and 30 were significantly different. Of those 30 occurrences, MRB was significantly higher 15 times and SB was significantly higher 15 times. The fact that differences in emergence did not generally convert into differences in yield likely relates to the absolute levels of emergence obtained, and potentially the weather conditions that prevailed during the growing season. When the minimum threshold emergence level (Figure 1) was achieved on both seeding-fertilizing systems, no significant yield difference typically occurred, despite plant emergence differences. At Indian Head in 2001, when canola emergence on SB fell below the minimum threshold emergence but MRB did not, large yield differences occurred with NH3 and urea. In the remainder of cases, other factors that contribute to plant growth and development combined to produce very similar yields.

An early frost or wet harvest can seriously deteriorate crop quality and the potential to even complete harvest in the fall. The resulting impact on financial returns can be large if a crop matures and is harvested before a wet period or a frost. In this project, the researchers determined that they would harvest the crops when they were suitably mature and were prepared to use multiple harvest dates. No obvious differences in crop maturity between the two systems were observed, although precise maturity dates for the respective plots were not determined and frost was not a factor in the study.

In addition to the general trends above, considerable specific information is available in the many tables of results. This will allow farmers to fine-tune their specific practices to align with their overall strategies towards risk management. For example, if they decide that substantial emergence reduction is a possibility in dry spring conditions for their particular situation with SB, they have the option to use alternative methods for applying nitrogen, such as fall banding, pre-seeding banding, and post-seeding application of nitrogen to maximize emergence and minimize cropping risks. Conversely, their risk management strategy and specific situation may lead to no special action for dry spring conditions.

This work was done on 10-inch row spacing. Decreasing the row spacing decreases the amount of nitrogen that will be placed in the side or mid-row band and, conversely, increasing the row spacing increases the amount of nitrogen being deposited in the side or mid-row band. As a result, farmers should be aware the results obtained on this project may not be the same as the results that will occur on a different row spacing.

GENERAL OBSERVATIONS

SB has greater soil disturbance than MRB. Under certain dry conditions, any extra soil disturbance, such as that associated with SB openers, compared to MRB knives, would be expected to cause greater drying of the seedbed with potential negative impact on crop emergence and yield.

MRB places the fertilizer further from the seed than SB, eliminating the risk of N damage to seeds or plants. However, a concern has been expressed by some that MRB may delay seed or plant access to N in dry soil conditions with low residual N levels. This seldom occurs, and in any event, may be prevented by adjusting the depth of placement of the mid-row nitrogen band to ensure that it is in moisture or placing some starter N with seed.

APPENDIX I

RESULTS AT 50% OF RECOMMENDED FERTILIZER RATES

The following section provides emergence and yield results when using 50% of recommended fertilizer rates (36 lb N/ac at Indian Head and Melfort, 27 lb N/ac at Swift Current and Scott). Each pair of tables is for a different crop at four locations (Indian Head, Melfort, Swift Current and Scott) using two fertilizer forms (NH3 and urea), over three years (2000, 2001 and 2002) for both fertilizing systems (MRB and SB). Each data point in the table represents the average of four small, randomly seeded plots. Each pair of MRB/SB data is either: unshaded, if there is no statistically significant difference between MRB and SB systems; lightly shaded and outlined with an oval if MRB exceeded SB by a statistical difference; or lightly shaded and outlined with a hexagon if SB exceeded MRB results by a statistical difference (see legend below). Note that all emergence results are in plants/m² and all yield results are in bu/ac.

Table 8: Wheat Emergence Results at 50% Recommended Fertilizer Rates

Wheat Emergence (plants/m²)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	241	**217**	270	253	191	264
	SB	255	**150**	280	255	164	250
Melfort	MRB	281	277	301	294	310	289
	SB	279	272	273	289	265	269
Swift Current	MRB	178	156	224	153	176	204
	SB	190	134	213	166	163	218
Scott	MRB	242	279	**166**	242	285	156
	SB	243	277	**110**	241	274	133

No significant difference

MRB significantly higher than SB

SB significantly higher than MRB

Note: Due to the variability of data from year to year and site to site, the difference required to be considered statistically significant varied considerably between the different pairs of data.

Table 9: Wheat Yield Results at 50% Recommended Fertilizer Rates

Wheat Yield (bu/ac)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	28.9	26.0	**30.5**	32.6	28.6	32.6
	SB	31.5	29.0	**34.8**	33.2	30.2	33.9
Melfort	MRB	28.6	17.0	3.6	31.7	13.1	3.1
	SB	28.3	15.3	3.1	30.5	13.7	5.2
Swift Current	MRB	48.8	11.6	14.3	52.8	11.0	18.3
	SB	54.1	8.8	19.2	52.8	10.6	18.9
Scott	MRB	19.3	**25.6**	2.5	25.7	23.1	2.8
	SB	22.9	**20.7**	3.3	28.1	22.2	3.3

Table 10: Canola Emergence Results at 50% Recommended Fertilizer Rates

Canola Emergence (plants/m²)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	100	**51**	81	109	45	54
	SB	102	**10**	63	95	29	57
Melfort	MRB	122	59	51	117	59	58
	SB	110	64	45	120	60	59
Swift Current	MRB	52	54	61	58	43	58
	SB	65	50	67	63	58	45
Scott	MRB	49	59	24	62	**74**	28
	SB	50	73	18	66	**46**	30

Table 11: Canola Yield Results at 50% Recommended Fertilizer Rates

Canola Yield (bu/ac)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	36.6	**28.2**	18.6	37.5	**33.9**	17.7
	SB	42.1	**10.7**	19.3	39.8	**23.4**	21.4
Melfort	MRB	43.5	11.6	22.5	40.9	12.0	23.0
	SB	40.2	9.6	20.7	44.6	13.4	24.8
Swift Current	MRB	27.8	9.6	15.2	27.7	**7.7**	16.1
	SB	30.7	9.6	20.5	27.8	**13.4**	20.0
Scott	MRB	15.9	14.6	5.7	21.6	13.7	**5.5**
	SB	17.8	12.8	5.5	23.6	13.9	**3.2**

No significant difference

MRB significantly higher than SB

SB significantly higher than MRB

Note: Due to the variability of data from year to year and site to site, the difference required to be considered statistically significant varied considerably between the different pairs of data.

Table 12: Flax Emergence Results at 50% Recommended Fertilizer Rates

Flax Emergence (plants/m²)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	**737**	**417**	494	661	**435**	450
	SB	**605**	**324**	420	584	**247**	436
Melfort	MRB	443	557	479	467	586	434
	SB	480	577	478	505	591	495
Swift Current	MRB	484	495	434	459	399	371
	SB	518	433	430	494	379	455
Scott	MRB	307	403	161	**355**	441	217
	SB	241	477	192	**255**	510	170

Table 13: Flax Yield Results at 50% Recommended Fertilizer Rates

Flax Yield (bu/ac)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	25.7	19.1	33.1	27.1	19.9	32.7
	SB	25.8	19.9	32.0	27.2	19.6	30.3
Melfort	MRB	31.1	22.0	13.9	31.2	19.8	14.3
	SB	31.1	22.3	14.2	31.6	20.7	11.8
Swift Current	MRB	25.7	12.6	16.6	29.5	11.0	19.6
	SB	29.8	13.7	19.3	27.7	9.7	18.3
Scott	MRB	26.5	21.4	3.7	**27.9**	24.1	4.5
	SB	27.7	19.1	4.0	**31.2**	20.7	4.1

APPENDIX II

RESULTS AT 150% OF RECOMMENDED FERTILIZER RATES

The following section provides emergence and yield results when using 150% of the recommended fertilizer rates (107 lb N/ac at Indian Head & Melfort, 80 lb N/ac at Swift Current and Scott). Each pair of tables is for a different crop at four locations (Indian Head, Melfort, Swift Current and Scott) using two fertilizer forms (NH3 and urea), over three years (2000, 2001 and 2002) for both fertilizing systems (MRB and SB). Each data point in the table represents the average of four small, randomly seeded plots. Each pair of MRB/SB data is either: unshaded, if there is no statistically significant difference between MRB and SB systems; lightly shaded and outlined with an oval if MRB exceeded SB by a statistically significant difference; or lightly shaded and outlined with a hexagon if SB exceeded MRB results by a statistical difference (see legend below). Note that all emergence results are in plants/m² and all yield results are in bu/ac.

Table 14: Wheat Emergence Results at 150% Recommended Fertilizer Rates

Wheat Emergence (plants/m²)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	248	228	270	235	187	209
	SB	245	136	272	273	149	264
Melfort	MRB	318	302	310	282	259	221
	SB	262	264	280	277	257	246
Swift Current	MRB	164	166	184	172	161	197
	SB	176	150	198	155	172	222
Scott	MRB	247	276	156	223	275	128
	SB	258	256	120	216	277	153

No significant difference

MRB significantly higher than SB

SB significantly higher than MRB

Note: Due to the variability of data from year to year and site to site, the difference required to be considered statistically significant varied considerably between the different pairs of data.

Table 15: Wheat Yield Results at 150% Recommended Fertilizer Rates

Wheat Yield (bu/ac)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	35.2	30.2	34.1	33.5	30.3	33.6
	SB	32.7	29.3	36.3	36.3	33.3	35.0
Melfort	MRB	39.9	16.8	3.9	41.0	14.6	5.1
	SB	38.1	15.9	4.2	37.5	17.4	5.8
Swift Current	MRB	64.3	10.4	21.6	56.7	8.8	25.1
	SB	57.7	9.4	26.5	49.2	10.4	26.6
Scott	MRB	31.7	26.6	2.1	41.2	22.8	2.4
	SB	44.2	18.7	2.5	47.3	18.0	2.8

Table 16: Canola Emergence Results at 150% Recommended Fertilizer Rates

Canola Emergence (plants/m²)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	98	38	74	86	48	39
	SB	84	7	59	88	23	63
Melfort	MRB	127	54	61	105	58	59
	SB	103	51	41	103	72	54
Swift Current	MRB	48	55	47	62	55	67
	SB	72	47	67	68	43	37
Scott	MRB	59	53	33	54	57	29
	SB	51	58	22	60	58	25

Table 17: Canola Yield Results at 150% Recommended Fertilizer Rates

Canola Yield (bu/ac)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	39.8	**33.0**	26.4	53.2	**36.1**	23.0
	SB	52.6	**12.3**	29.4	48.7	**21.6**	27.3
Melfort	MRB	50.0	13.4	34.3	**49.4**	15.5	28.4
	SB	48.0	15.0	31.6	**42.7**	15.2	31.6
Swift Current	MRB	37.1	18.4	26.8	33.2	13.9	**23.2**
	SB	32.1	16.8	20.2	32.3	11.1	**12.7**
Scott	MRB	**21.6**	18.9	**4.3**	27.3	16.6	4.8
	SB	**28.0**	16.1	**7.1**	29.8	17.3	4.1

No significant difference

MRB significantly higher than SB

SB significantly higher than MRB

Note: Due to the variability of data from year to year and site to site, the difference required to be considered statistically significant varied considerably between the different pairs of data.

Table 18: Flax Emergence Results at 150% Recommended Fertilizer Rates

Flax Emergence (plants/m²)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	**682**	**368**	**489**	666	**403**	365
	SB	**537**	**251**	**399**	579	**220**	364
Melfort	MRB	472	**591**	443	474	**607**	435
	SB	495	**456**	516	454	**502**	473
Swift Current	MRB	530	402	**484**	419	414	**326**
	SB	441	348	**376**	412	355	**418**
Scott	MRB	237	409	233	351	451	123
	SB	220	406	185	297	510	151

Table 19: Flax Yield Results at 150% Recommended Fertilizer Rates

Flax Yield (bu/ac)		Nform					
		NH3			Urea		
		Year			Year		
		2000	2001	2002	2000	2001	2002
Indian Head	MRB	26.0	**17.8**	31.9	26.0	19.4	33.3
	SB	24.1	**22.6**	30.9	25.2	19.6	33.9
Melfort	MRB	31.7	20.1	14.5	30.0	17.2	11.8
	SB	30.9	19.6	11.6	30.9	15.9	14.5
Swift Current	MRB	25.8	11.2	20.6	31.2	9.2	19.6
	SB	29.0	8.6	18.0	30.4	8.6	20.4
Scott	MRB	**33.5**	23.4	4.1	38.2	24.2	4.1
	SB	**37.6**	22.1	4.5	38.7	20.7	4.0

Acknowledgements:

PAMI expresses sincere appreciation to Dr. Reynald Lemke and Dr. William Laverty for contributing their respective agronomic and statistical expertise to this publication.

Funding for this project was provided by Agriculture and Agri-Food Canada's (AAFC); Canadian Fertilizer Institute; Saskatchewan Agriculture and Food; Western Grains Research Foundation; Bourgault Industries; and Saskatchewan Flax Development Commission. In-kind contributions were provided by Flexi-Coil Ltd., Big Quill Resources, and Western Ag Innovations.

PRAIRIE AGRICULTURAL MACHINERY INSTITUTE
Corporate Services: P.O. Box 1150, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555 Toll Free: 1-800-567-PAMI Web Site: http://www.pami.ca

Saskatchewan Operations:
P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
FAX: (306) 682-5080
email: humboldt@pami.ca

Manitoba Operations:
PO Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone (304) 239-5445
FAX: (204) 239-7124
email: portage@pami.ca

In Cooperation With:

Agricultural Technology Centre

3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 328-5562

Printed in Canada