Four Year Summary

1993-1996

DEVELOPMENT OF OPTIMAL FERTILIZER RATE RECOMMENDATIONS FOR USE WHEN DIRECT SEEDING CANOLA WITH AN AIRSEEDER

ADF-V-0699

Prepared for the

SASKATCHEWAN AGRICULTURE DEVELOPMENT FUND

CANOLA DIRECT SEEDING AND FERTILIZER RATE TRIAL

Objective

Development of seed placed fertilizer rate recommendations for use when direct seeding canola with air seeders that have wide distribution patterns of seed and fertilizer.

Background

In the past many canola growers have been following recommendations that limit the amount of fertilizer they apply during seeding. Consequently, they have made two or more passes over the land to be seeded where one pass may have been sufficient. These additional tillage operations have a negative effect not only on conserving soil moisture but also through increased economic costs.

Many modern air seeders have different types of openers with various spread pattern widths relating to the row spacing of the shanks. By having the proper row width utilization (RWU) we can minimize or eliminate damage resulting from seed applied fertilizer.

Row Width Utilization (RWU) - the effective spread width of a seeding opener divided by the machine opener spacing x 100 = %.

Method

Four different designs of air seeder openers were used, with various spread patterns of seed and fertilizer. The following is a description of the opener and spread pattern:

1). Knife opener with 3/4" spread pattern, (9% row width utilization).
2). Spoon opener with 2" spread pattern, (25% row width utilization).
3). Froc opener with 7" spread pattern, (88% row width utilization).
4). Swede side banding opener which separates the seed and fertilizer.
(All openers were placed on 8" centres)

Nitrogen (Urea) fertilizer was placed with the seed at rates of 35, 70, and 105 lbs/ac. of actual nitrogen.

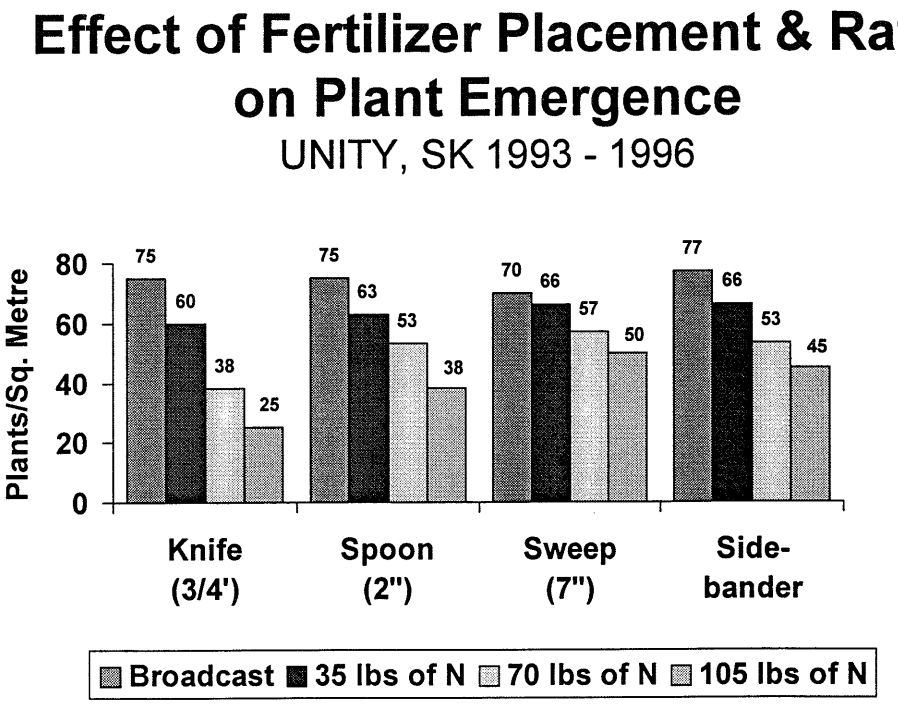
5). Broadcasting 70 lbs. of urea nitrogen was incorporated into the trial as a **Check** treatment in 1994. The Check was done with each type of opener with no urea nitrogen placed with the seed (Refer to Schematics).

All other nutrients of P, K, and S were seed placed at soil test recommendations.

A field scale randomized complete plot design was established, with 4 replications. Plot size was 30 ft. x 400 ft.

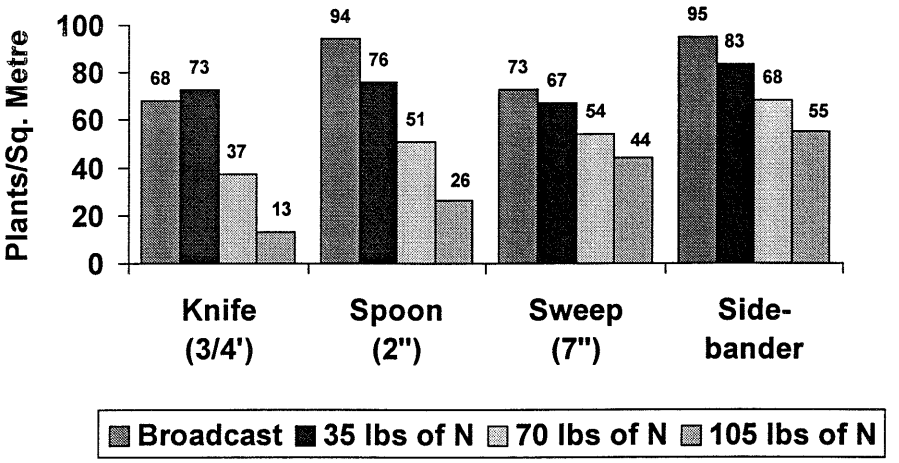
The following data was recorded at each site:
1). Plant counts taken at emergence and harvest.
2). Soil moisture recorded at seeding.
3). Moisture tabulation throughout the growing season.
4). Flowering dates, when blooming begins and when it is completed.
5). Days to reach maturity of each of the different treatments.
6). Yield and crop quality data.

Observations:



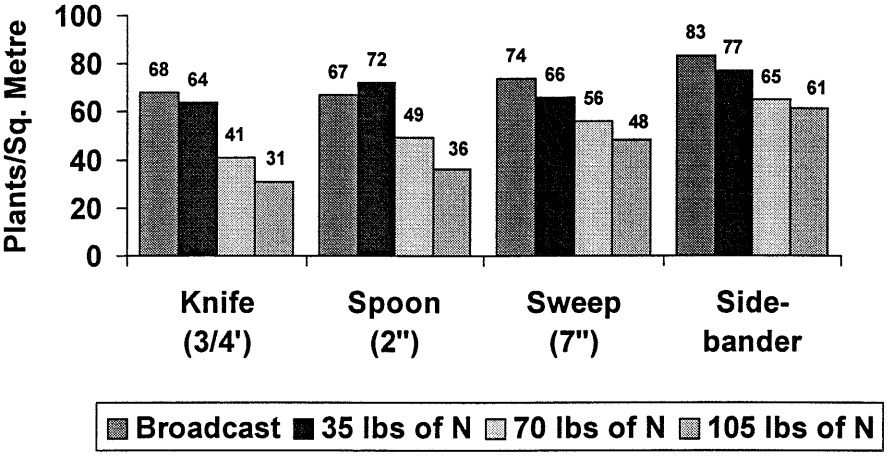
Effect of Fertilizer Placement & Rate on Plant Emergence

NAICAM, SK 1993 - 1996



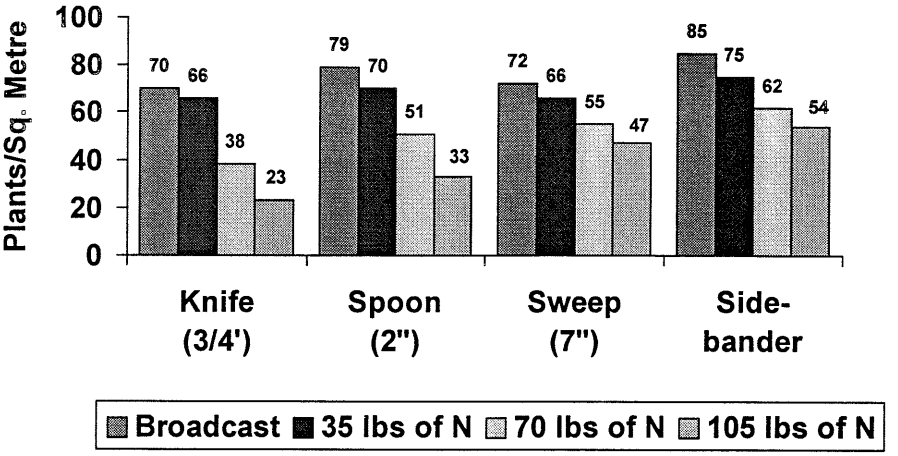
Effect of Fertilizer Placement & Rate on Plant Emergence

FOAM LAKE, SK 1993 - 1996



Effect of Fertilizer Placement & Rate on Plant Emergence

SASKATCHEWAN 1993 - 1996



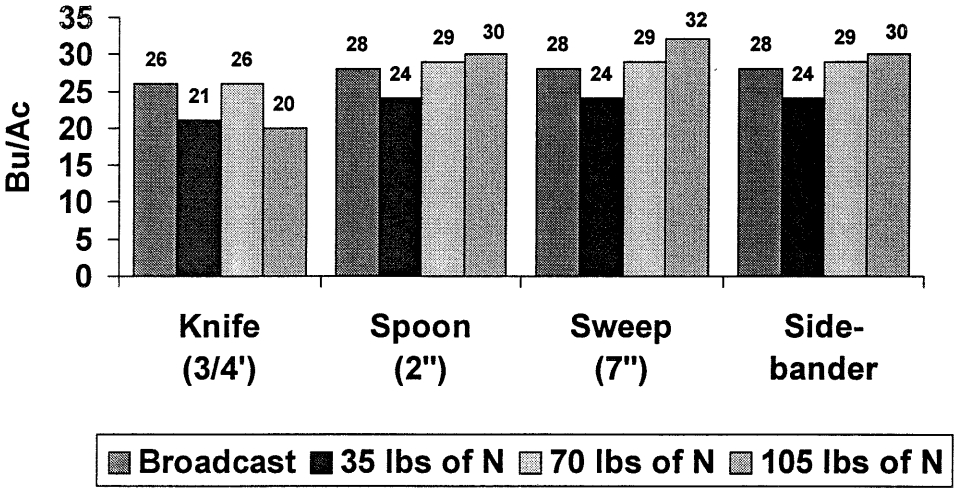
Over the four years this trial was conducted in Saskatchewan, emergence occurred as expected with dramatically fewer plants emerging as nitrogen rates increased coinciding with the opener used and its relative spread pattern. This can be seen in the emergence graphs shown above.

When high rates of seed placed nitrogen are applied there are two common occurrences which may result based on the soil moisture conditions at the time of seeding. If the soil moisture is limited at the time of seeding the nitrogen, because it is attracted to water, may bind with the water molecules in the soil. Consequently, soil moisture is not sufficient to allow germination to take place until additional moisture moves into the soil profile. When and if additional moisture moves into the soil profile more seeds may germinate but these later emerging plants cause problems with downgrading resulting from the green seeds. Maturity differences resulting from this has been approximately 5 - 12 days later. However, if the moisture conditions at the time of seeding are near field capacity it is apparent that the high rates of applied nitrogen quickly move through the soil profile creating "hot zones" around the seed. This causes the majority of the seedlings to be damaged, but the plants that do survive have an excessive amount of available nitrogen resulting in delayed maturity leaving the crop vulnerable to frost damage and therefore downgrading from the green seeds.

DISSCUSSION:

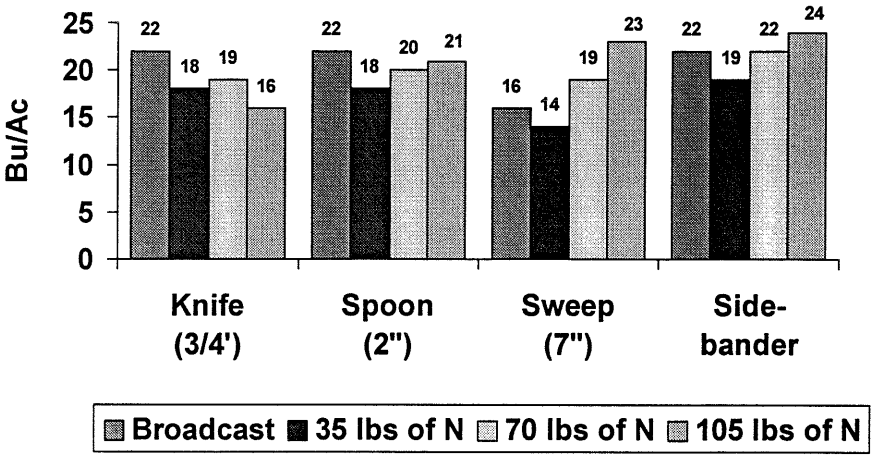
Effect of Fertilizer Placement & Rate on Yield

UNITY, SK 1993 - 1996



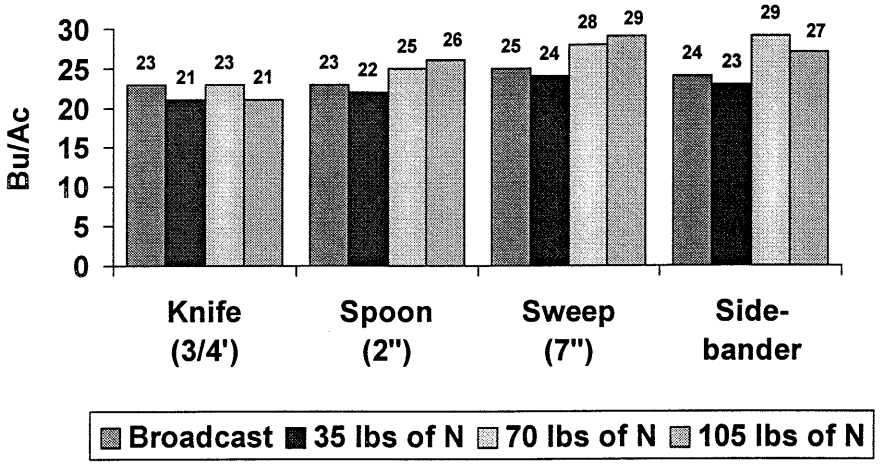
Effect of Fertilizer Placement & Rate on Yield

NAICAM, SK 1993 - 1996



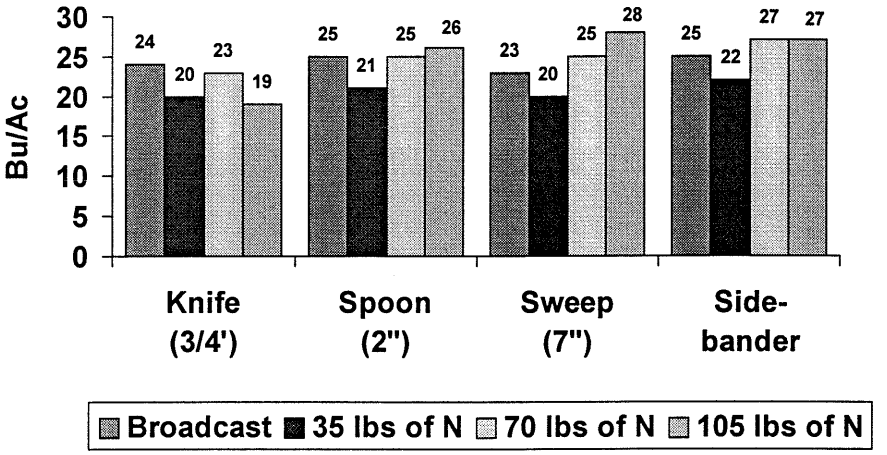
Effect of Fertilizer Placement & Rate on Yield

FOAM LAKE, SK 1993 - 1996



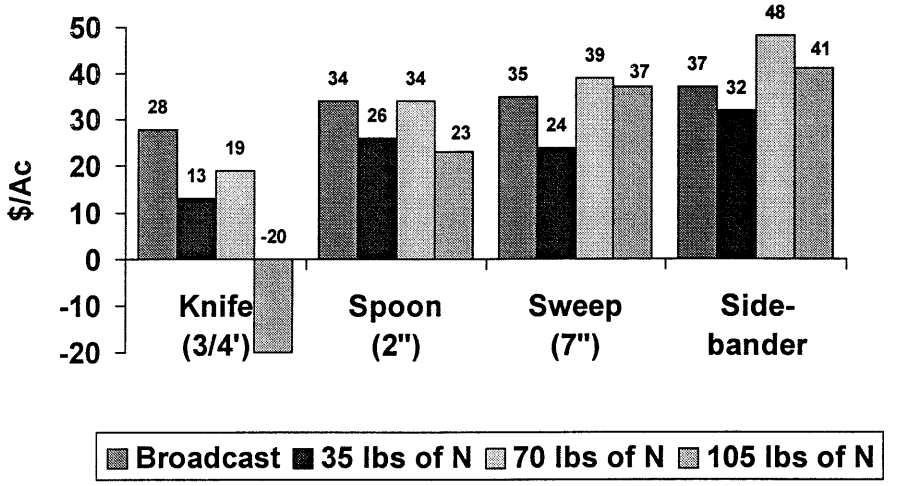
Effect of Fertilizer Placement & Rate on Yield

SASKATCHEWAN 1993 - 1996

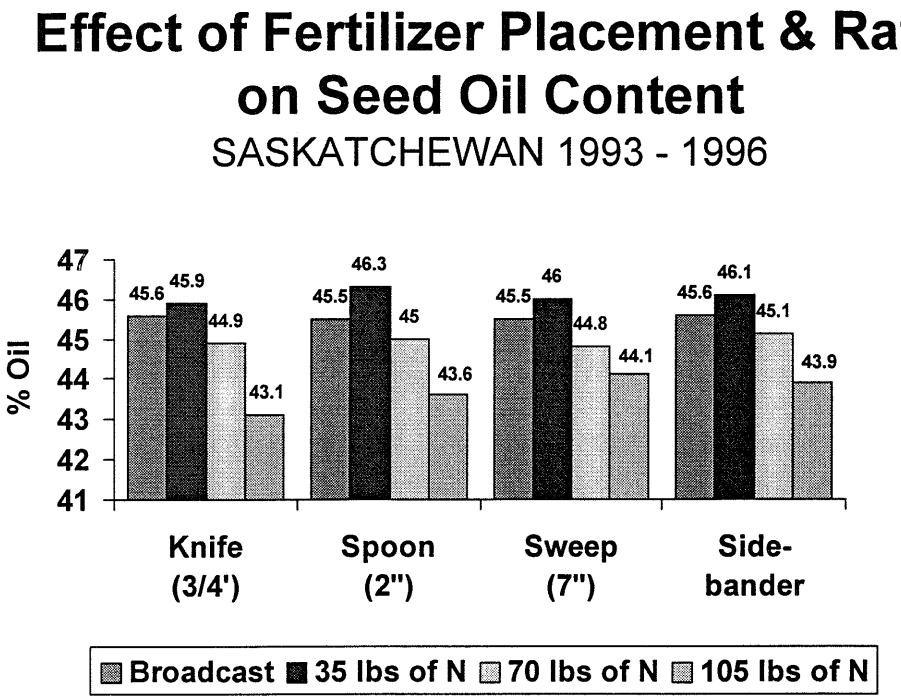


Effect of Fertilizer Placement & Rate on Contribution Margin

SASKATCHEWAN 1993 - 1996



Over the four years this trial was conducted in Saskatchewan, at the lower row width utilizations, as nitrogen rates increased, there was a reduction in plant emergence. This led to increased weed populations, increased days to maturity and negative effects on quality ie. green seed and a slight decline in oil content as illustrated in the graph below.



However, with the wider spread widths there is less effect on plant emergence. On average, 60 plants/m^2 are required to produce enough plants to be competitive, produce sufficient yields and be consistent in their days to maturity. (Canola Growers Manual Pg. 810)

Although there was dramatic decreases in plant emergence with the lower row width ulitization's as the nitrogen rates increased the plants were able to utilize the available nitrogen by producing more branches and pods, thus increasing its yield within the given treatments. Refer to the yield graphs show above.

On average in Saskatchewan there is a negative contribution margin with the knife at 105 lbs of nitrogen. This is due in part to the previously mentioned points, as well as the additional cost of the 105 lbs of nitrogen.

With the use of the Swede Side-Bander, the fertilizer is placed approximately one inch to the side of the seed. There appears to be not only a vertical effect, but also a lateral effect from the nitrogen on plant emergence.

There are other very important factors to consider when direct seeding and placing fertilizer with the seed such as the soil organic matter content, pH, conductivity, soil texture and its cation exchange capacity.

Soil moisture content is another important factor when considering placing nitrogen with the seed. Soil within the plots at the Canola Production Centres were sampled just prior to seeding to determine the moisture content at the zero to two inch depth. Twenty samples were taken in each rep of the trial area. They were analyzed at Enviro-Test Labs to determine moisture content, permanent wilting point and moisture holding capacity for each site.

Pre-Seeding Soil Moisture Conditions (1993-1996)

		Permanent Wilting Point %	Moisture %	Field Capacity %
Unity -	1993	11.4	17.1	21.0
	1994	12.8	18.4	25.5
	1995	14.2	24.3	28.2
	1996	14.5	19.9	30.8
	Average	13.2	19.9	26.4
Naicam -	1993	12.4	15.2	23.8
	1994	14.6	24.4	27.6
	1995	16.3	28.8	26.4
	1996	13.0	20.3	27.0
	Average	14.1	22.2	26.2
Foam Lake -	1993	17.7	22.0	28.9
	1994	16.3	23.6	27.7
	1995	14.6	25.1	27.1
	1996	15.5	17.2	26.5
	Average	16.0	22.0	27.6

Soil moisture conditions were adequate for germination and establishment of canola plants at all three locations. Average soil moisture was measured at 19.9% (13.2%) and 22.2% (14.1%) and 22.0% (16.0%) respectively at the Unity, Naicam and Foam Lake sites. Figures in the brackets represent the permanent wilting point of the soil at each location. Plant available moisture at the sites averaged 6.9% with 6.7% available at Unity, 8.1% available at Naicam and 6.0% at Foam Lake. It should be **noted** that the measured moisture content of the soils is the average of the 0" - 2" depth, so the available moisture at a seeding depth of 1 inch could be lower than the figures reported as the surface layer of soil is likely to have a lower moisture content than a deeper layer.

Permanent Wilting Point is the moisture percentage in a soil type when the plant cannot absorb enough water through the roots to prevent permanent wilting. The permanent wilting point percentage of soil increases with the amount of clay in the soil.

Moisture % is the amount of moisture (water) available for plant uptake.

Field Capacity percentage is the maximum amount of water which soil can hold, or store when thoroughly wetted and free drainage of water has ceased due to natural forces (i.e. gravitational pull).

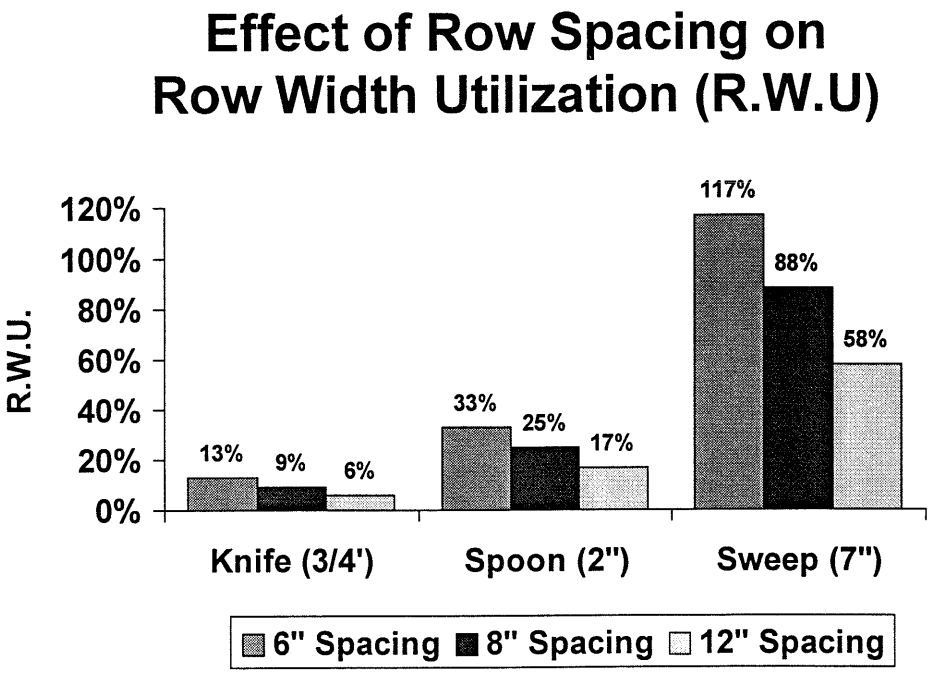
Recommendations/Guidelines:

This project indicates that urea nitrogen can be seed placed with canola up to 70 lbs/acre of actual nitrogen (152 lbs/ac of 46-0-0) based on a 8 inch row spacing and the amount of available moisture at the time of seeding. However guidelines need to be considered if the row spacing between the openers is different than 8 inches. If the row spacing is greater than 8 inches the R.W.U. will be less and therefore the amount of seed placed nitrogen would be higher. If the row spacing between the openers is less than 8 inches the R.W.U will be greater and therefore the amount of seed placed nitrogen would be less. The graph below indicates how altering the row spacing from six, eight and twelve inches dramatically effects the R.W.U with each individual opener.

As the R.W.U. decreases with the different openers, a dramatic reduction in plant emergence may occur. This may cause an increase in weed pressure and a reduction in yield.

High rates of seed placed nitrogen will cause increased days to maturity and a reduction in crop quality i.e. green seed and a decline in oil content.

Emphasis also has to be put on factors such as soil organic matter content, pH, conductivity, soil texture and cation exchange capacity when determining the amount of seed placed urea nitrogen that can be placed safely with the seed.



CPC Direct Seeding / Fertilizer Placement Trial Schematic
Area Required = 400 ft. x 1920 ft. for 4 reps. (17.6 acres)

REP.# 1 - Each rep. requires 480 ft. x 400 ft.

1. Broadcast @ 70 lbs/ac of Nitrogen seeded with knife opener *No Urea N with seed*
2. Knife - ¾" spread @ 35 lbs/ac of Nitrogen
3. Knife - ¾" spread @ 70 lbs/ac of Nitrogen
4. Knife - ¾" spread @ 105 lbs/ac of Nitrogen
5. Broadcast @ 70 lbs/ac of Nitrogen seeded with spoon opener *No Urea N with seed*
6. Spoon - 2" spread @ 35 lbs/ac of Nitrogen
7. Spoon - 2" spread @ 70 lbs/ac of Nitrogen
8. Spoon - 2" spread @ 105 lbs/ac of Nitrogen
9. Broadcast @ 70 lbs/ac of Nitrogen seeded with sweep opener *No Urea N with seed*
10. Froc Sweep - 7" spread @ 35 lbs/ac of Nitrogen
11. Froc Sweep - 7" spread @ 70 lbs/ac of Nitrogen
12. Froc Sweep - 7" spread @ 105 lbs/ac of Nitrogen
13.Broadcast @ 70 lbs/ac of Nitrogen seeded with sideband opener *No Urea N with seed*
14. Swede Side-band @ 35 lbs/ac of Nitrogen
15. Swede Side-band @ 70 lbs/ac of Nitrogen
16. Swede Side-band @ 105 lbs/ac of Nitrogen

Note: The remaining 3 blocks are randomized within the split-block design.

Nitrogen source ***Urea.***

All seeding done on 8" row spacing.

17.6 acres required, this does **not** include 60 ft. pathways.

CPC Direct Seeding / Fertilizer Placement Trial Schematic

REP.# 2 - Each rep. requires 480 ft. x 400 ft.

17. Spoon - 2" spread @ 35 lbs/ac of Nitrogen
18. Swede Side-band @ 105 lbs/ac of Nitrogen
19. Broadcast @ 70 lbs/ac of Nitrogen seeded with sweep opener *No Urea N with seed*
20. Spoon - 2" spread @ 70 lbs/ac of Nitrogen
21. Froc Sweep - 7" spread @ 35 lbs/ac of Nitrogen
22. Broadcast @ 70 lbs/ac of Nitrogen seeded with knife opener *No Urea N with seed*
23.Broadcast @ 70 lbs/ac of Nitrogen seeded with sideband opener *No Urea N with seed*
24. Froc Sweep - 7" spread @ 70 lbs/ac of Nitrogen
25. Froc Sweep - 7" spread @ 105 lbs/ac of Nitrogen
26. Broadcast @ 70 lbs/ac of Nitrogen seeded with spoon opener *No Urea N with seed*
27. Swede Side-band @ 35 lbs/ac of Nitrogen
28. Knife - ¾" spread @ 35 lbs/ac of Nitrogen
29. Swede Side-band @ 70 lbs/ac of Nitrogen
30. Spoon - 2" spread @ 105 lbs/ac of Nitrogen
31. Knife - ¾" spread @ 70 lbs/ac of Nitrogen
32. Knife - ¾" spread @ 105 lbs/ac of Nitrogen

CPC Direct Seeding / Fertilizer Placement Trial Schematic

REP.# 3 - Each rep. requires 480 ft. x 400 ft.

33. Knife - ¾" spread @ 35 lbs/ac of Nitrogen
34. Spoon - 2" spread @ 105 lbs/ac of Nitrogen
35. Knife - ¾" spread @ 105 lbs/ac of Nitrogen
36. Froc Sweep - 7" spread @ 70 lbs/ac of Nitrogen
37. Knife - ¾" spread @ 70 lbs/ac of Nitrogen
38. Froc Sweep - 7" spread @ 35 lbs/ac of Nitrogen
39. Swede Side-band @ 105 lbs/ac of Nitrogen
40. Broadcast @ 70 lbs/ac of Nitrogen seeded with spoon opener *No Urea N with seed*
41.Broadcast @ 70 lbs/ac of Nitrogen seeded with sideband opener *No Urea N with seed*
42. Swede Side-band @ 70 lbs/ac of Nitrogen
43. Spoon - 2" spread @ 70 lbs/ac of Nitrogen
44. Broadcast @ 70 lbs/ac of Nitrogen seeded with sweep opener *No Urea N with seed*
45. Swede Side-band @ 35 lbs/ac of Nitrogen
46. Spoon - 2" spread @ 35 lbs/ac of Nitrogen
47. Froc Sweep - 7" spread @ 105 lbs/ac of Nitrogen
48. Broadcast @ 70 lbs/ac of Nitrogen seeded with knife opener *No Urea N with seed*

CPC Direct Seeding / Fertilizer Placement Trial Schematic

REP.# 4 - Each rep. requires 480 ft. x 400 ft.

49. Spoon - 2" spread @ 35 lbs/ac of Nitrogen
50.Broadcast @ 70 lbs/ac of Nitrogen seeded with sideband opener *No Urea N with seed*
51. Broadcast @ 70 lbs/ac of Nitrogen seeded with knife opener *No Urea N with seed*
52. Knife - ¾" spread @ 105 lbs/ac of Nitrogen
53. Froc Sweep - 7" spread @ 70 lbs/ac of Nitrogen
54. Spoon - 2" spread @ 70 lbs/ac of Nitrogen
55. Swede Side-band @ 35 lbs/ac of Nitrogen
56. Broadcast @ 70 lbs/ac of Nitrogen seeded with spoon opener *No Urea N with seed*
57. Froc Sweep - 7" spread @ 105 lbs/ac of Nitrogen
58. Froc Sweep - 7" spread @ 35 lbs/ac of Nitrogen
59. Knife - ¾" spread @ 70 lbs/ac of Nitrogen
60. Swede Side-band @ 105 lbs/ac of Nitrogen
61. Broadcast @ 70 lbs/ac of Nitrogen seeded with sweep opener *No Urea N with seed*
62. Spoon - 2" spread @ 105 lbs/ac of Nitrogen
63. Knife - ¾" spread @ 35 lbs/ac of Nitrogen
64. Swede Side-band @ 70 lbs/ac of Nitrogen

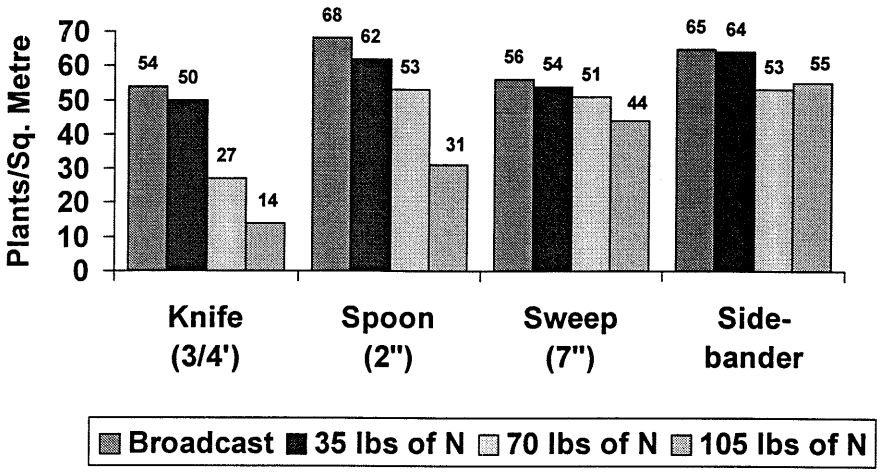
Appendix

Direct Seeding and Fertilizer Rate Trial Unity 1996					
Treatment	**Yield (bu/ac)**	**Yield (%)**	**Oil (%)**	**Contribution Margin ($/ac)**	**Total Damaged Seed %**
3/4" Spread - Knife					
Broadcast 70 lbs of N	13.0	100	42.7	(32.00)	1.3
35 lbs of N	12.5	96	44.1	(22.00)	1.7
70 lbs of N	12.7	98	41.0	(35.00)	1.3
105 lbs of N	8.4	65	40.6	(85.00)	1.1
2" Spread - Spoon					
Broadcast 70 lbs of N	21.7	100	41.9	39.00	0.9
35 lbs of N	18.8	87	42.9	30.00	0.8
70 lbs of N	24.6	113	41.9	63.00	1.0
105 lbs of N	22.9	106	39.2	35.00	0.8
7" Spread - Sweep					
Broadcast 70 lbs of N	23.5	100	42.3	54.00	1.5
35 lbs of N	21.4	91	42.9	51.00	1.6
70 lbs of N	26.3	112	40.8	77.00	1.0
105 lbs of N	26.9	114	39.7	68.00	0.3
Side Bander					
Broadcast 70 lbs of N	24.0	100	42.0	58.00	1.4
35 lbs of N	21.1	88	43.4	49.00	0.6
70 lbs of N	26.6	111	41.2	80.00	1.1
105 lbs of N	26.8	112	39.7	67.00	0.7
L.S.D. (For Spread)	0.78		0.51		0.50
(For Nitrogen)	0.88		0.41		0.40
C.V. %	7.04		1.64		60.71

*Note: Brackets in contribution margin reflect a negative value

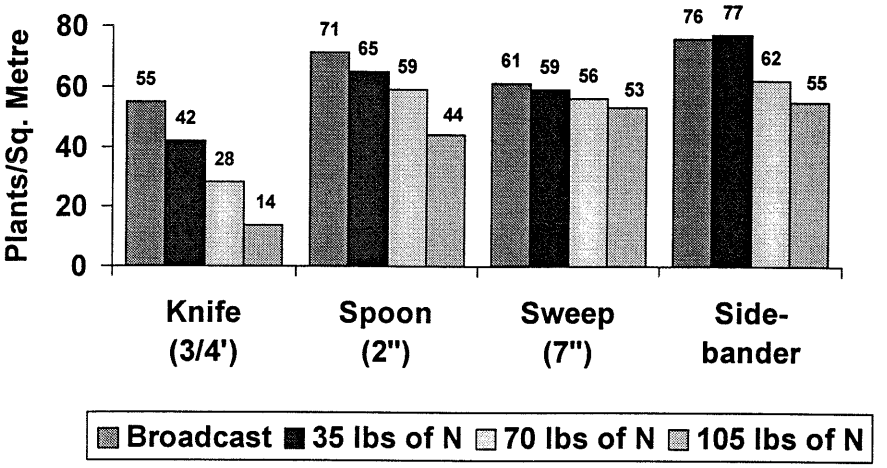
Effect of Fertilizer Placement & Rate on Plant Emergence

Unity, SK 1996



Effect of Fertilizer Placement & Rate on Plant Harvest Counts

Unity, SK 1996

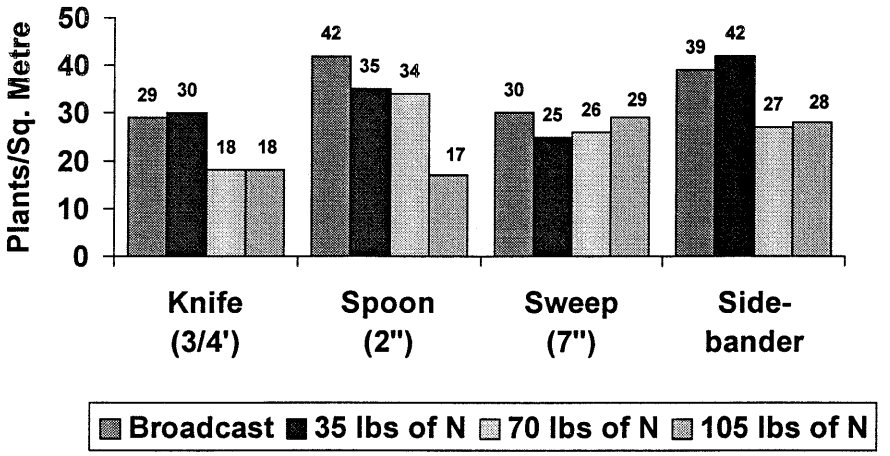


Direct Seeding and Fertilizer Rate Trial Naicam 1996					
Treatment	**Yield (bu/ac)**	**Yield (%)**	**Oil (%)**	**Contribution Margin ($/ac.)**	**Total Damaged Seed (%)**
3/4" Spread - Knife					
Broadcast 70 lbs of N	16.4	100	43.8	3.00	4.5
35 lbs of N	16.0	98	43.3	(6.00)	6.4
70 lbs of N	16.0	98	41.8	(20.00)	8.3
105 lbs of N	12.4	76	39.3	(62.00)	11.6
2" Spread - Spoon					
Broadcast 70 lbs of N	20.3	100	43.2	34.00	2.7
35 lbs of N	19.1	94	44.2	39.00	2.8
70 lbs of N	19.0	94	43.2	24.00	5.0
105 lbs of N	18.2	90	40.6	(24.00)	10.5
7" Spread - Sweep					
Broadcast 70 lbs of N	19.9	100	43.9	31.00	3.1
35 lbs of N	18.2	91	43.6	32.00	2.3
70 lbs of N	18.5	93	42.3	20.00	4.8
105 lbs of N	20.0	101	41.2	(7.00)	8.7
Side-Bander					
Broadcast 70 lbs of N	20.0	100	43.3	32.00	3.5
35 lbs of N	20.5	103	43.7	50.00	2.4
70 lbs of N	18.5	93	42.7	20.00	3.9
105 lbs of N	21.2	106	41.8	1.00	8.6
L.S.D (spread)	.73		.67		
(nitrogen)	.67		.47		
C.V.	6.04		1.85		

*Note: Brackets in contribution margin reflect a negative value

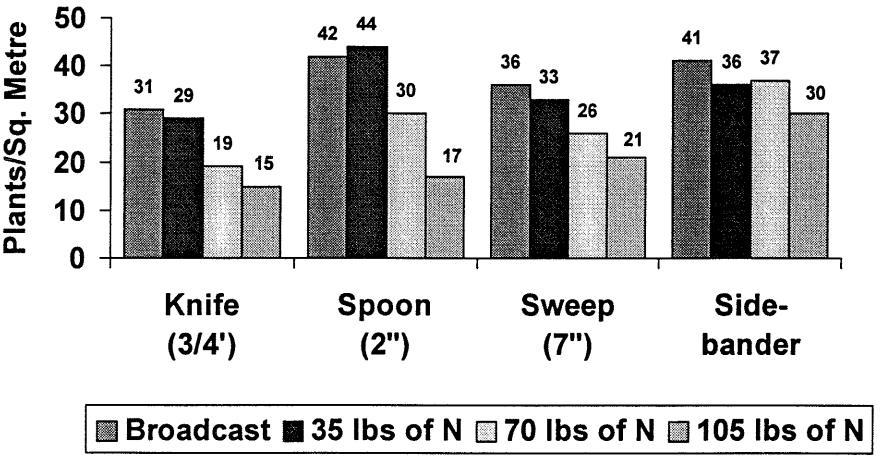
Effect of Fertilizer Placement & Rate on Plant Emergence

Naicam, SK 1996



Effect of Fertilizer Placement & Rate on Plant Harvest Counts

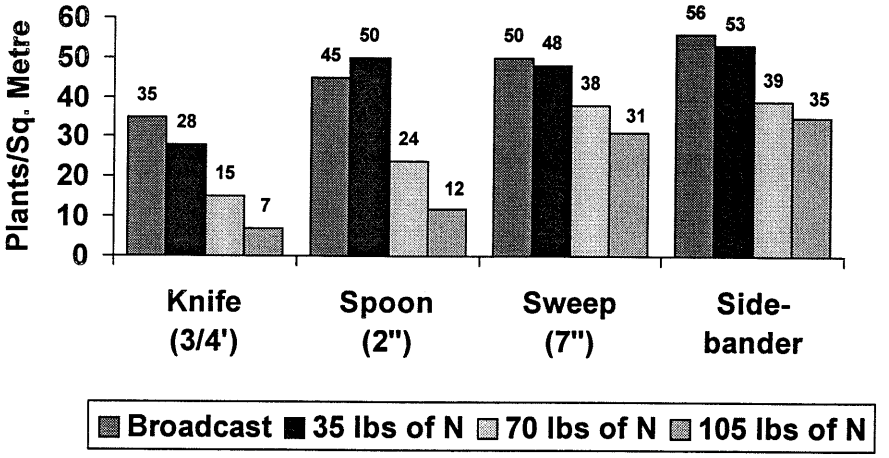
Naicam, SK 1996



Direct Seeding and Fertilizer Rate Trial Foam Lake 1996					
Treatment	**Yield (bu/ac)**	**Yield (%)**	**Oil (%)**	**Contribution Margin ($/ac.)**	**Total Damaged Seed (%)**
3/4" Spread - Knife					
Broadcast 70 lbs of N	20.7	100	44.7	14.00	0.8
35 lbs of N	20.7	100	44.5	29.00	0.5
70 lbs of N	21.4	103	44.4	20.00	1.5
105 lbs of N	22.4	108	43.7	9.00	4.0
2" Spread - Spoon					
Broadcast 70 lbs of N	26.7	100	44.5	64.00	1.2
35 lbs of N	23.1	87	45.1	48.00	0.7
70 lbs of N	27.3	102	44.7	69.00	0.9
105 lbs of N	31.4	118	43.2	81.00	2.1
7" Spread - Sweep					
Broadcast 70 lbs of N	29.9	100	43.8	90.00	1.2
35 lbs of N	24.4	82	45.1	59.00	0.7
70 lbs of N	27.6	92	44.1	71.00	1.4
105 lbs of N	33.0	110	43.0	102.00	1.4
Side-Bander					
Broadcast 70 lbs of N	27.9	100	44.5	74.00	0.7
35 lbs of N	23.5	84	45.1	52.00	0.6
70 lbs of N	30.2	108	44.3	93.00	0.7
105 lbs of N	32.9	118	43.0	101.00	1.5
L.S.D (spread)	1.58		.34		
(nitrogen)	1.59		.36		
C.V.	9.95		1.37		

Effect of Fertilizer Placement & Rate on Plant Emergence

Foam Lake, SK 1996



Effect of Fertilizer Placement & Rate on Plant Harvest Counts

Foam Lake, SK 1996