AB-10

Optimal Time and Placement of Fertilizer on Winter Wheat

AARI Project 96M611

1996 Summary Report

by
A.B. Middleton and R.H. McKenzie

Agronomy Unit
Plant Industry Division
Alberta Agriculture, Food and Rural Development
Lethbridge

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1.0 Introduction

In the early 1980's, over 450,000 acres of winter wheat was grown annually in southern Alberta. However, because of drought conditions, poor fall weather and low grain prices, winter wheat acreage has dropped to less than 100,000 acres annually, in the last few years.

However, with improved fall moisture conditions in 1992 and 1993 and with the release of A.C. Readymade, a new winter wheat variety with up to a 20% yield advantage over spring wheat, there is a renewed interest in growing winter wheat.

Most farmers would also like to apply all their fertilizer while direct seeding rather than broadcasting nitrogen in the following spring. However, with fall applied nitrogen there is a risk of reduced winter survival. Producers need to know if fall applied and/or seed-placed nitrogen fertilizer will significantly affect plant populations, over-winter hardiness, weed competition, crop yield and crop quality.

2.0 Objective

The objective of this project is to examine the effects of conventional versus direct seeding to establish winter wheat, and to determine the effects of seed-placed fertilizer in the fall versus broadcast fertilizer in the spring. Results will be used to develop recommendations for best management practices for winter wheat production.

3.0 Materials and Methods

3.1 Experimental Design, Location and Treatments

This experiment was carried out at 5 locations near Bow Island, Chin, Claresholm, High River, and Pincher Creek. Because of winter kill only two sites were harvested (Chin and Pincher Creek). Readymade winter wheat was grown at all sites. Each site was divided into two experiments, core 1 and core 2. Core 1 was arranged as a split plot with 3 main plots (seed placement widths) and 9 sub plots (fertilizer rates) with 4 replications (Table 1). The three seed placement widths were band, 10% Seedbed Utilization (SBU) and 50% SBU. Band placement applied N fertilizer, using the 10% SBU opener, banding the fertilizer at a 3 to 4 inch depth, followed by seeding. The direct seeded 10% SBU treatment placed the seed and fertilizer together in a 1 inch band. The 50% SBU treatment applied the fertilizer and seed together in a 4 inch spread pattern. Phosphate, when applied, was placed with the seed.

Core 2 was arranged with 2 main plots (seed placement widths) and 9 sub plots (fertilizer treatments) with 4 replications. This portion of the experiment examined time of N application. Nitrogen was applied as a fall/spring split or spring only. Fall N was placed with the seed, while spring N was broadcast applied at the end of March. Phosphate was fall applied with the seed (Table 1).

All plots were seeded with a 10 row, 8 inch row spaced, plot air seeder. All plots were seeded directly into standing stubble except for the band placement treatments. Following seeding hanging harrows, rotary harrow and crowfoot packer were used to pack the seedbed.

Table 1 - Core 1 and 2 fertilizer and seed placement treatments.

Core 1 Treatments (kg/ha)			Core 2 Treatments (kg/ha)			
N	P_2O_5	Seed placement width	N fall	N spring	P_2O_5	Seed placement width
0	0	Band	0	0	20	Narrow
0	20	Narrow	0	30AN	20	4"
30AN	0	4"	30AN	30AN	20	
30AN	20		0	60AN	20	
60AN	20		0	90AN	20	
90AN	20		0	30U	20	
30U	20		30U	30U	20	
60U	20		0	60U	20	
90U	20		0	90U	20	

AN - Ammonium nitrate (34.5-0-0).
U - Urea (46-0-0).

3.2 Seeding, Spraying and Harvest dates

Table 2 lists all seeding, spraying and harvest dates.

Table 2 - Seeding, spraying, harvest dates and rainfall.

Site	Seeding Date	Spraying Date[1]	Harvest Date
Bow Island	Sept. 28	Not Sprayed	Not Harvested
Chin	Sept. 28	May 21	Aug. 19
Claresholm	Oct. 10	Not Sprayed	Not Harvested
High River	Oct. 10	Not Sprayed	Not Harvested
Pincher Creek	Oct. 10	May 29	Sept. 11

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3.3 Data Collection and Analysis

Rainfall was recorded on a weekly basis. Plant populations (plants/m^2) were measured at the 2-4 leaf stage.

After harvest the following data was collected on all treatments:

1) % moisture
2) grain yield
3) bushel weight
4) grain protein

An area of 9.72 m^2 was harvested with a plot combine, to determine yield. Yields were adjusted to 14%. All four replicates were used to arrive at a mean for each treatment.

4.0 Results

4.1 Soil Fertility and Soil Moisture

Table 3 describes soil moisture, growing season and average precipitation. Soil samples were taken in the fall of 1995 (Table 4).

Table 3. Available soil moisture (mm), growing season and average annual precipitation (mm).

Depth (cm)	Chin		Pincher Creek	
	Available	% Available	Available	% Available
0-5	3.8	43	13.5	129
5-10	5.0	51	12.3	118
10-15	4.3	46	13.3	121
15-30	15.5	53	29.3	93
30-45	14.0	48	11.3	36
45-60	8.8	32	2.0	6
60-75	9.5	33	3.3	10
75-90	14.3	50	2.5	8
Total Available	75		87	
Rainfall[1] (mm)	67.4		115.9	
Average[2] (mm)	218.4		251.5	

1. Growing season precipitation (May 1 to Harvest).
2. Average rainfall - Measured from May 1 to Aug. 31 - 30 year average.

Table 4. Mean soil analysis in lbs/ac.

Location	Depth Inches	N03-MA[1]	P-MA	P-NOR[2]	K	SO_4-S	pH	E.C.	Soil Texture
Chin	0-6	3	9	9	568	8.38	7.9	.5	Clay Loam
	6-12	2	0	4	181	5.1	8.3	.4	
	12-24	2				11.2			
	24-36	0							
	Total	7	9	13	749	25.1			
Pincher Creek	0-6	5	25	8	761	4.1	6.0	.3	Heavy Clay
	6-12	5	2	0	597	4.6	7.1	.5	
	12-24	4				6.8			
	24-36	4							
	Total	15	27	8	1358	15.0			

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4.2 Site Overview

Both sites had low levels of nitrogen. Soil moisture in the 0-6 inch zone was poor at Chin and very good at Pincher Creek.

4.3 Yield and plant populations

4.31 Core 1

All figures are in Appendix 1. Appendix 3 lists all the data in table form. Table 5 describes all statistics for Core 1 treatments.

Yield

Placement - Method of placement was not significant at Chin, but was at Pincher Creek. Here the highest yield was on the 10% SBU and the lowest on the band treatment. This was caused by the low plant population on the band treatment compared to the other placement methods.

Fertilizer - Response to fertilizer was significant at both sites. The urea treatment tended to yield higher at Chin except at the 90U rate where the yield dropped off. At Pincher Creek the urea tended to yield lower than the ammonium nitrate.

Plant Populations

Placement - Response to placement was significant at the Pincher Creek site. The band treatment was significantly lower than the other two placements. At Chin the band treatment was also lower than the other two treatments, but it was not significant. Plant populations at Pincher Creek were almost half that at the Chin site, but because rainfall during the growing season was so low at Chin compared to Pincher Creek, yields were negatively affected more at Chin.

Fertilizer -Response to fertilizer was not significant at either site, and there were no clear trend across treatments.

Table 5 - Mean yield, plant counts and statistical analysis of Core 1 experiments at Chin and Pincher Creek.

Treatment	Chin		Pincher Creek	
Placement	Yield (kg/ha)	plt/ m^2	Yield (kg/ha)	plt/ m^2
Band	1951 a†	122	3229 b	44 b
10% SBU	2025 a	133	3622 a	73 a
50% SBU	1939 a	133	3414 ba	72 a
Fertilizer				
0+0	1136 e	143	3183 c	65
0+20	1211 e	114	3460 bac	74
30AN+0	2085 cd	136	3750 a	84
30AN+20	1883 d	122	3379 bac	73
60AN+20	2180 cb	129	3708 a	67
90AN+20	2618 a	129	3661 ba	58
30U+20	2023 cd	133	3251 c	54
60U+20	2368 b	130	3275 bc	50
90U+20	2221 cb	128	3309 bc	60
Significance				
Placement	.26	.14	.03	.03
Fertilizer	.0001	.22	.004	.09
PXF	.44	.3	.11	.35
CV.	14.6	18.2	11.9	38.7

† For each factor, means followed by the same letter within a column are not significantly different at the 5% level using Duncan's Multiple Range test.
AN - Ammonium nitrate. U - Urea. plt/m^2 - plants per square metre.

4.32 Core 2

All figures are in Appendix 2. Appendix 3 lists all the data in table form. Table 6 describes all statistics for Core 2 treatments.

Yield

Placement -Response to placement was significant at Chin. The 50% SBU tended to yield lower than other treatments. At Pincher Creek there were no significant differences.

Fertilizer - Response to fertilizer was highly significant at Chin, but not significant at Pincher Creek. At Chin the ammonium nitrate treatments tended to yield higher than the urea treatments. At Pincher Creek the urea treatment yielded higher except at the 90U rate on the 50% SBU. Both split applications yielded higher than the spring application at Chin. At Pincher Creek, the 60AN split on the 50% SBU and the 60U split on the 10% SBU yielded lower compared to the same rate applied in the spring. The 60U split application on the 50% SBU and the 60AN split on the 10% SBU both yielded higher than the same rate applied in the spring.

Plant Populations

Placement - Response to placement was not significant at either site and there were no clear trends.

Fertilizer - Response to fertilizer was not significant at either site and there were no clear trends.

Table 6 - Mean yield, plant counts and statistical analysis of Core 2 experiments at Chin and Pincher Creek.

Treatment	Chin		Pincher Creek	
Placement	Yield (kg/ha)	plt/ m^2	Yield (kg/ha)	plt/ m^2
10% SBU	1934 a†	134	3646	80
50% SBU	1882 a	130	3649	78
Fertilizer				
0 + 20	1202 e	131	3445	71
30AN+20	1820 cd	130	3742	86
30/30AN+20	2202 ab	134	3749	83
60AN+20	1922 c	120	3460	76
90AN+20	2191 ab	124	3821	81
30U+20	1569 d	139	3649	76
30/30U+20	2371 a	141	3727	78
60U+20	1852 cd	140	3649	85
90U+20	2125 abc	128	3573	81
Significance				
Placement	.02	.22	.96	.83
Fertilizer	.0001	.71	.91	.98
PXF	.72	.59	.59	.40
CV.	14.1	18.5	14.5	35.5

† For each factor, means followed by the same letter within a column are not significantly different at the 5% level using Duncan's Multiple Range test.
AN - Ammonium nitrate.U - Urea. plt/m^2 - plants per square metre.

Summary

Yields on core 1 treatments at Chin tended to be higher on urea than ammonium nitrate treatments, except at high rates (90U) where yields were reduced. When urea was broadcast in the spring the yields were lower than with ammonium nitrate (especially on the 50% SBU). Yields on fall/spring split versus spring application were higher regardless of spread or fertilizer source.

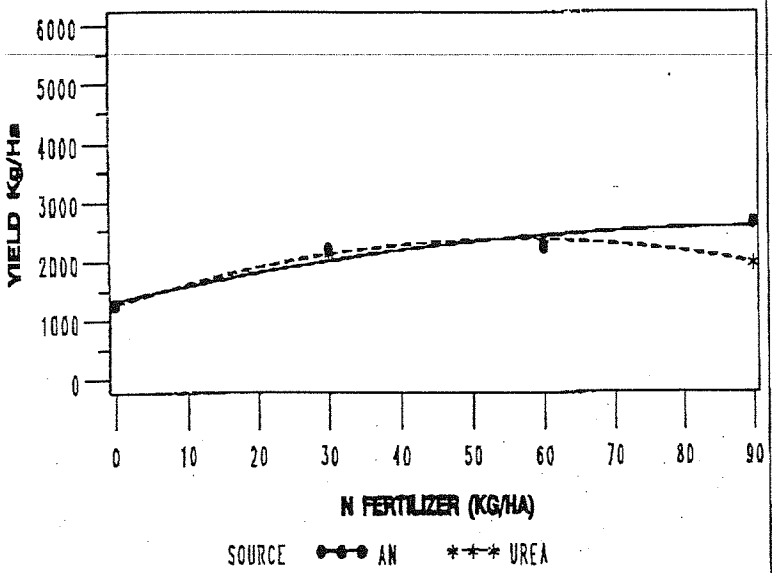
Yields on core 1 treatments at Pincher Creek tended to perform opposite to those at the Chin site. Here ammonium nitrate treatments yielded better under most rates and spread patterns. Broadcast urea yielded lower on the 50% SBU, while as good or better on the narrow. Yields of fall/spring vs spring application were lower half of the time.

Acknowledgements

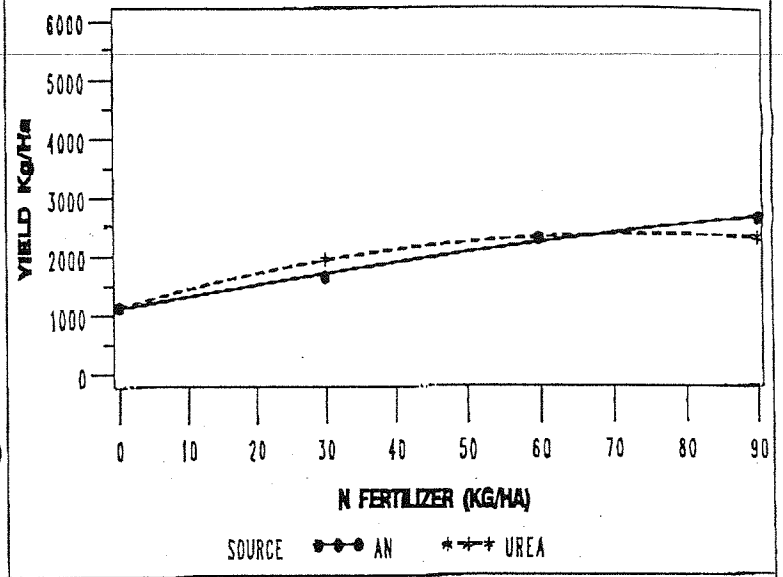
The authors gratefully acknowledge funding from the Alberta Agricultural Institute, the Potash Institute of Canada, Sherritt Ltd. and the Alberta Winter Wheat Producers Commision. We would also like to thank Zeneca and Dow Elanco for providing crop herbicides used in these trials.

APPENDIX 1

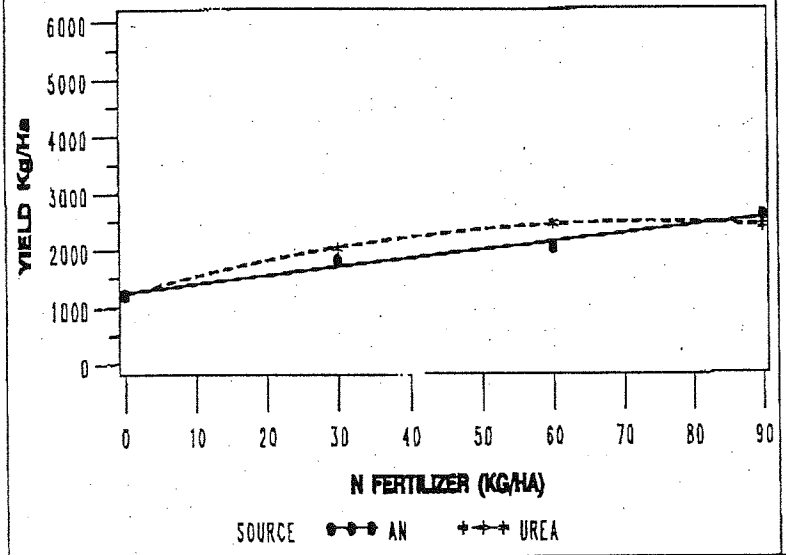
1996 CHIN 10% SBU



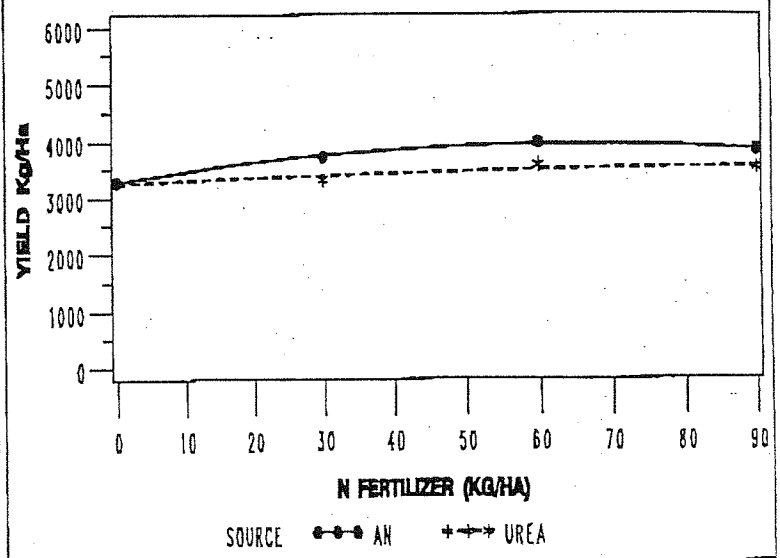
1996 CHIN 50% SBU



1996 CHIN BAND



1996 PINCHER_CREEK 10% SBU



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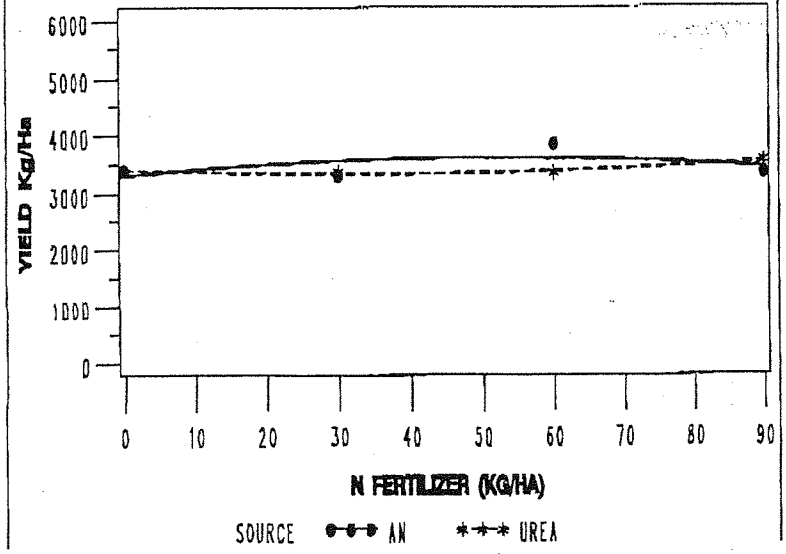
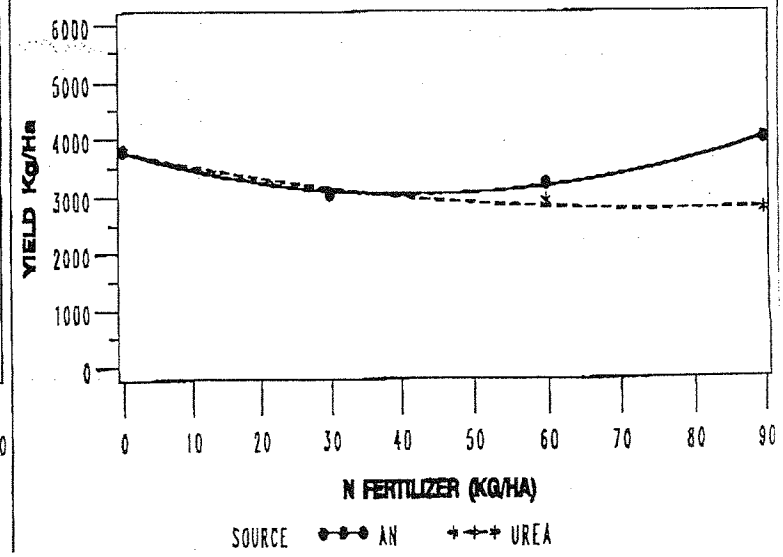


1996 PINCHER_CREEK BAND



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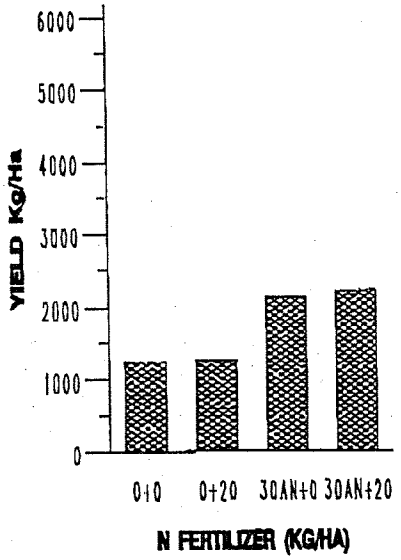

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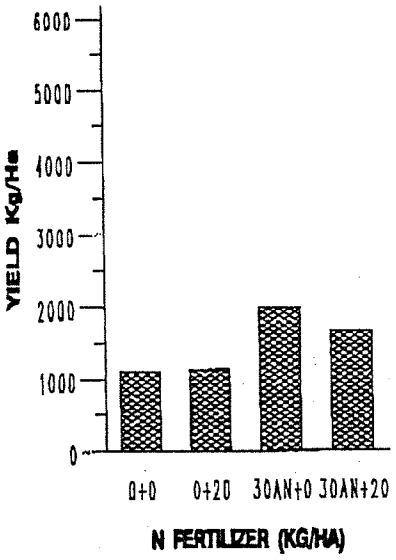

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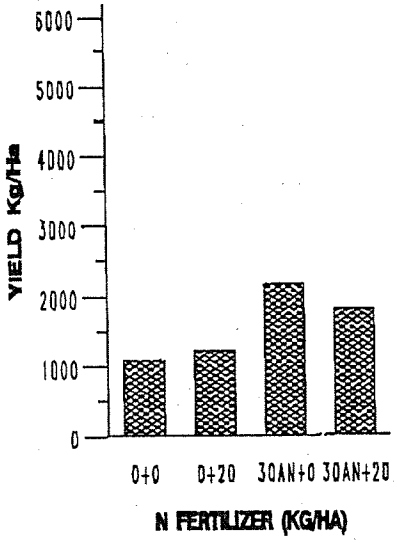

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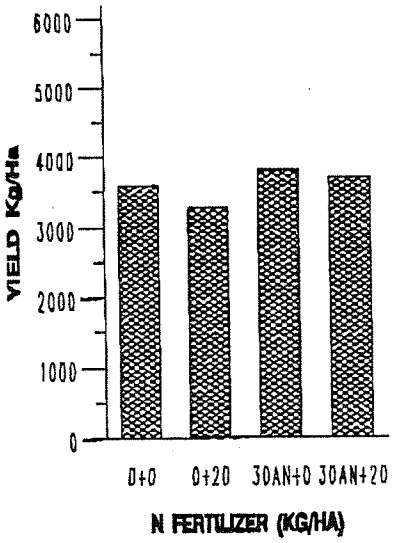

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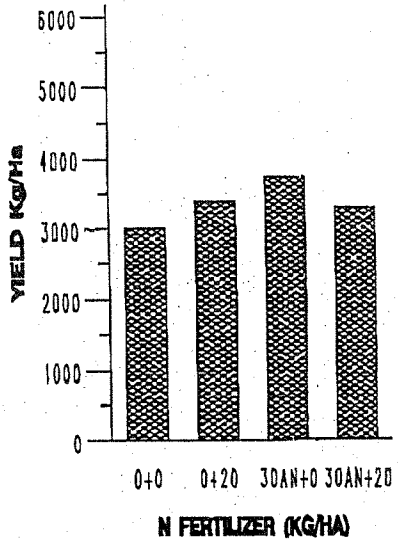

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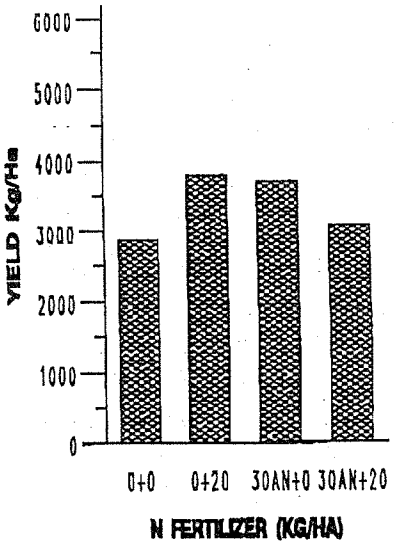
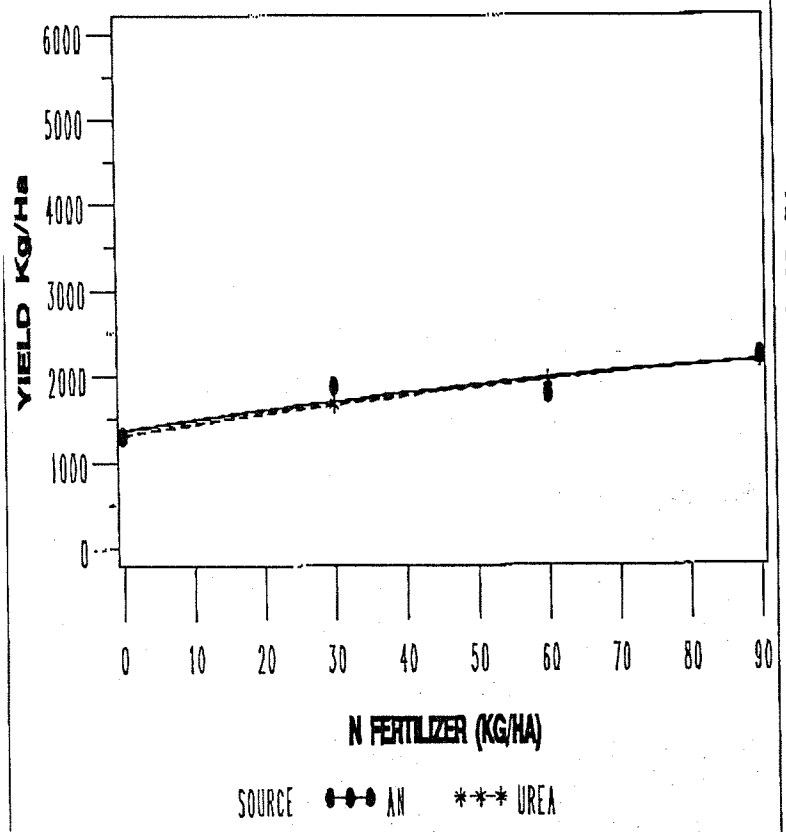
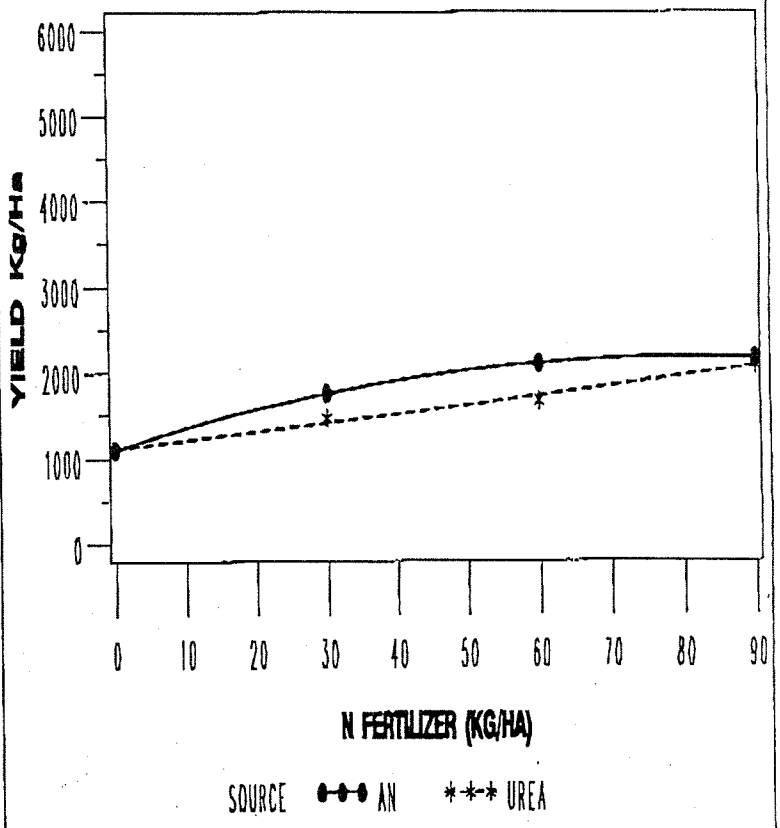


APPENDIX 2

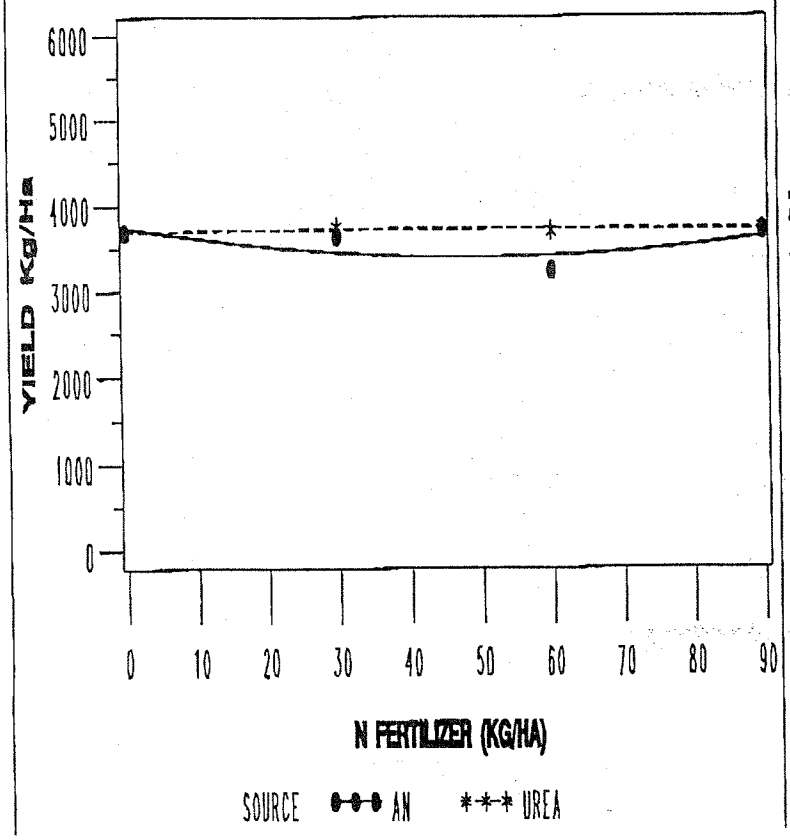
1996 CHIN 10% SBU



1996 CHIN 50% SBU



1996 PINCHER CREEK 10% SBU



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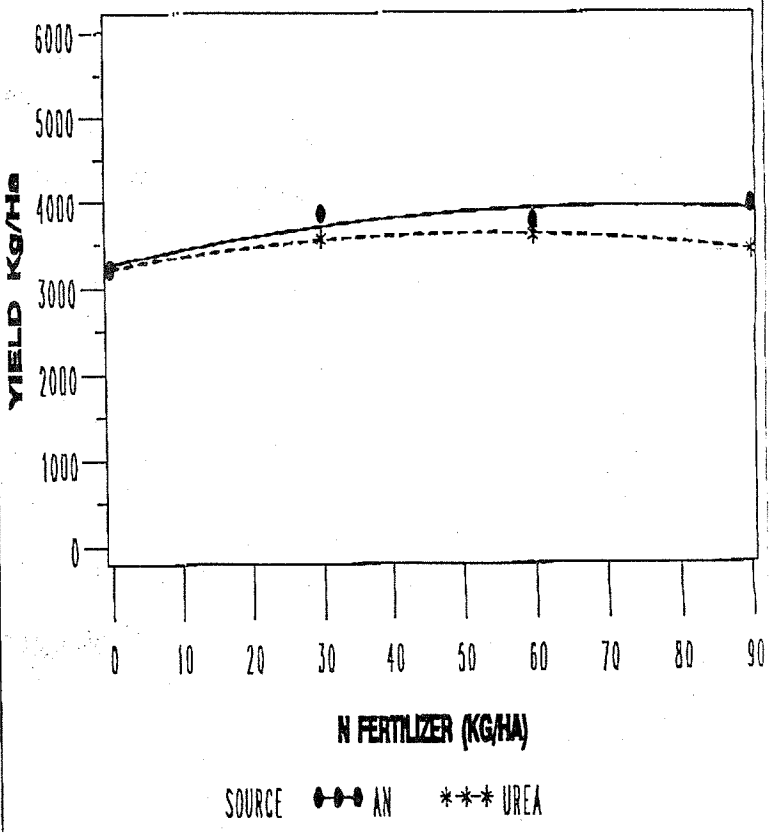
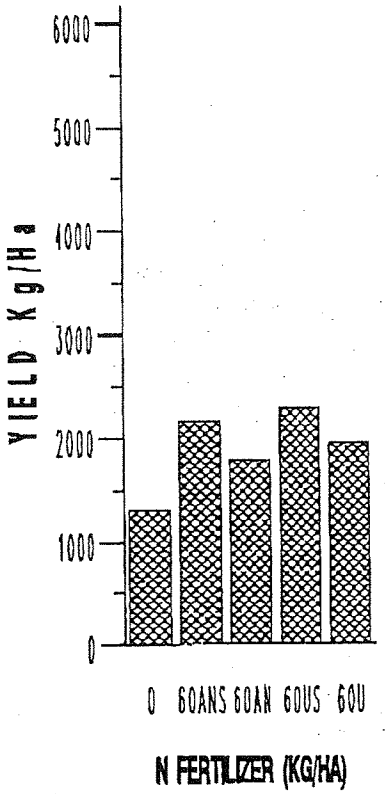
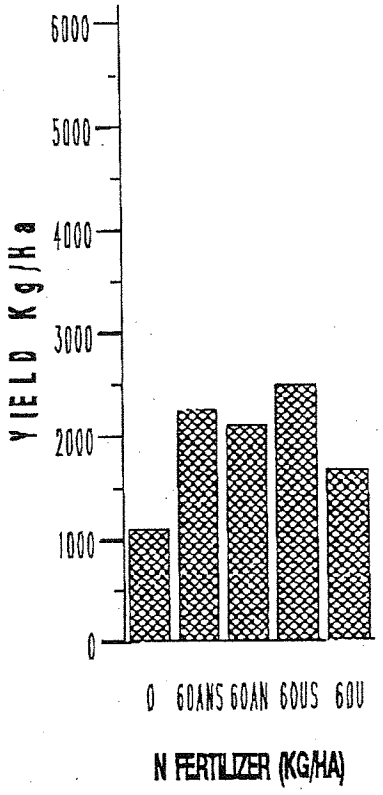


1996 CHIN 10% SBU



1996 CHIN 50% SBU



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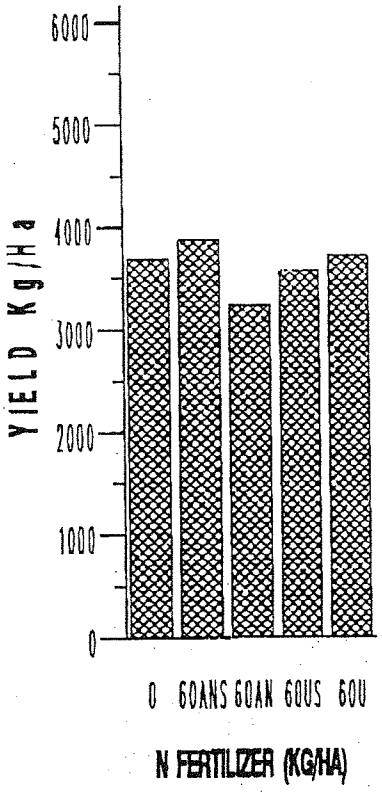

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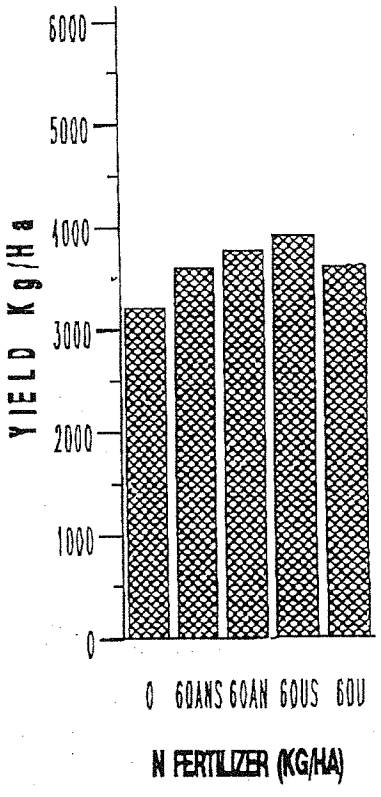

APPENDIX 3

Table 1 - CORE 1 yield and plant populations.

Treatment	Yield (kg/ha)						Plants/m^2					
Fertilizer	Chin			Pincher Creek			Chin			Pincher Creek		
(kg/ha)	Band	10%	50%	Band	10%	50%	Band	10%	50%	Band	10%	50%
0+0	1094	1253	1091	2868	3607	2997	133	163	137	53	72	68
0+20	1215	1267	1132	3785	3274	3386	121	113	111	57	69	93
30AN+0	2155	2112	1989	3695	3810	3731	151	128	131	49	105	92
30AN+20	1796	2207	1646	3051	3715	3292	117	119	133	31	91	87
60AN+20	2026	2238	2291	3217	3969	3817	118	139	132	43	76	77
90AN+20	2564	2650	2643	3974	3838	3329	106	134	147	64	75	38
30U+20	2014	2111	1945	3044	3305	3353	114	142	145	41	57	62
60U+20	2436	2369	2299	2919	3560	3331	119	127	146	25	60	60
90U+20	2384	1968	2311	2763	3513	3516	126	139	122	41	58	79

Table 2 - CORE 2 yield and plant populations.

Treatment	Yield (kg/ha)				Plants/m^2			
Fertilizer	Chin		Pincher Creek		Chin		Pincher Creek	
(kg/ha)	10%	50%	10%	50%	10%	50%	10%	50%
0+0	1307	1098	3680	3211	142	122	79	64
30AN+20	1886	1754	3632	3854	122	140	77	96
30/30AN+20	2167	2241	3868	3591	146	124	84	83
60AN+20	1793	2095	3233	3764	128	114	56	98
90AN+20	2232	2150	3686	3956	120	129	86	78
30U+20	1679	1460	3744	3555	146	134	83	70
30/30U+20	2283	2488	3554	3901	143	140	78	80
60U+20	1945	1668	3699	3601	145	135	94	76
90U+20	2182	2083	3720	3427	120	138	89	66

AN - Ammonium nitrate

U - Urea