WCFL RESEARCH EXPERIENCE WITH UREA FOR ANNUAL CROPS [1]

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A short 10 to 15 years ago, the western Canadian fertilizer market was dominated by use of relatively low rates of drill-in fertilizers and the majority of nitrogen was supplied by one nitrogen source. That source of nitrogen was ammonium nitrate, a fertilizer product ideally suited for a relatively immature fertilizer market where most of the fertilizer was placed directly with the seed.

Recognition at that time of the fact that in a market traditionally dominated by drill-in fertilizers, urea was forecast to soon become the major source of dry nitrogen fertilizer, lead to a great deal of concern in some parts of the fertilizer industry. This concern stemmed from the fact that limited research indicated inconsistent performance of urea compared to nitrate. This situation lead Western Co-operative Fertilizers Limited to commit substantial resources towards generating more research to help develop a better understanding of urea as a fertilizer and to help smooth the transition from nitrate to urea based fertilizers.

UREA VS AMMONIUM NITRATE

A review of all of the research data available in western Canada indicated that the substitution of urea for ammonium nitrate posed the most serious concerns in the area of seed placed fertilizers and forage fertilization. The summary of this review is presented in Table I. At the same time WCFL embarked on an extensive field research programme

TABLE I - Review of Western Canadian Research Comparing Efficiency of Urea to Ammonium Nitrate (WCFL, 1972)

	Site-Years of Data	Relative Efficiency
Broadcast for Annual Crops	176	87%
Drill-in for Annual Crops	182	85%
Broadcast for Forages	60	83%

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and initiated considerable research funding at Universities in the hopes of providing a better insight into the variable performance of urea as a fertilizer.

Although this presentation will concern itself mainly with the results of urea used as drill-in fertilizer for annual crops, some data indicating the temperamental behaviour of urea as a forage fertilizer is presented in Table II to help illustrate the scope of the problem.

TABLE II - Probability of Urea Performance as a Broadcast Forage Fertilizer in the Western Prairie Region (Toews, 1971)

Relative Efficiency (%) *	Probability (%)
less than or equal to 25	0
" " " " 35	1.5
" " " " 45	4.5
" " " " 55	7.0
" " " " 65	19
" " " " 75	43
" " " " 85	58
" " " " 95	72
96-105	19
greater than or equal to 106	8
" " " " 116	7
" " " " 126	4
" " " " 136	0

* Compared to ammonium nitrate

A review of initial WCFL field results indicated that the performance of urea as a drill-in fertilizer varied with soil texture as illustrated in Table III. It is apparent that on the heavier textured sites, urea performed much better than on the lighter textured soils.

TABLE III - Response to Drill-in Nitrogen Source of Barley Grown on Stubble (WCFL, 1969-74)

	Yield Increase (cwt/acre)	
	34-0-0	46-0-0
Light textured soils *	6.1	3.3
Heavier textured soils **	5.6	5.1

* Average of 19 plots on SL - L texture
** Average of 16 plots on HvL-C texture

In 1975, WCFL established a total of 20 trials evaluating urea as a nitrogen source for barley grown on stubble. The average data is presented in Table IV and an attempt to isolate the influence of texture is summarized in Table V. Based on this data, it is apparent that at the rate of 30 pounds of nitrogen per acre, drilling-in urea was the most efficient method of applying nitrogen on the heavier textured soils (ie. clay loams and clays). On the medium textured

Table IV - Response of Barley Grown on Stubble as Influenced by Placement and Source of Nitrogen (WCFL, 1975)

Nitrogen Rate (lbs/acre)	Placement Method	Average Yield Increase (cwt/acre)	
		Nitrate	Urea
30	D	5.6	5.4
30	B	5.2	5.1
45	D	8.0	6.8
45	B	6.4	6.2
45	B & I	6.6	5.9
60	B & I	8.3	8.0
90	B & I	10.2	9.4

Average check (ie. 0-45-0) yield - 11.3 cwt/acre (20 plots)

D - Drill-in
B - Broadcast
I - Incorporated

Table V - Response of Barley Grown on Stubble as Influenced by Nitrogen Source, Placement and Soil Texture (WCFL, 1975)

	Average Yield Increase (cwt/acre)			
	Drill-in		Broadcast	
Textured Grouping	Nitrate	Urea	Nitrate	Urea
	30-45-0			
Heavy	5.8	6.3	5.6	5.0
Medium	5.5	5.0	4.6	4.9
Light	5.6	4.3	4.5	5.8
	45-45-0			
Heavy	9.8	5.7	7.6	7.4
Medium	6.8	5.9	4.8	5.5
Light	6.0	5.1	6.8	4.8

Average check (0-45-0) yield
Heavy - 11.1 cwt/acre (9 plots)
Medium - 9.9 cwt/acre (7 plots)
Light - 14.2 cwt/acre (4 plots)

soils (loams) drill-in nitrate was the most efficient method. At the higher rate of application (ie. 45 pounds of nitrogen per acre), drill-in nitrate was the best method of applying the nitrogen except on the lighter textured soils (ie. loamy sands and sandy loams) where broadcast placement of nitrate was the most efficient method.

The average results for the 42 plots harvested in 1976 are presented in Table VI and confirm the limited and inconsistent benefit of shallow incorporation (light harrowing) observed in previous years. The influence of soil texture is summarized in Table VII and clearly

TABLE VI - Response of Barley Grown on Stubble as Influenced by Placement and Source of Nitrogen (WCFL, 1976)

Nitrogen Rate (lbs/acre)	Placement Method	Average Yield Increase (cwt/acre)	
		Nitrate	Urea
15	D	2.5	1.9
30	D	4.3	4.1
30	B	3.7	3.7
45	D	6.0	3.7
45	B	5.4	5.0
45	B & I	5.7	5.1
60	B	6.8	6.4
60	B & I	6.3	6.4
90	B & I	8.7	8.0

Average check (ie. 0-45-0) yield - 15.5 cwt/acre (42 plots)
D - Drill-in
B - Broadcast
I - Incorporated

illustrates the importance of soil texture when applying drill-in urea containing fertilizers, particularly at higher rates of application. On the heavier textured soils (clays and clay loams), seed placed urea was superior to broadcast urea at both the 30 and 45 pound per acre rates. At the 30 pound rate, drill-in urea performed quite well on the medium textured soils but performed unsatisfactorily at this rate on the lighter soils.

No effort was made to locate these trials on soils with above average seed-bed moisture conditions. Therefore a range of soil moisture conditions were encountered at the time of seeding. In view of the importance of seed-bed moisture as well as soil texture, it is obvious that with proper precautions, higher rates of urea containing fertilizers could be applied under specific conditions.

TABLE VII - Response of Barley Grown on Stubble as Influenced by Nitrogen Source, Placement and Soil Texture (WCFL, 1976)

	Average Yield Increase (cwt/acre)			
	Drill-in		Broadcast	
Textural Grouping	Nitrate	Urea	Nitrate	Urea
	15-45-0			
Heavy	2.8	2.3		
Medium	2.6	1.8		
Light	2.4	1.8		
	30-45-0			
Heavy	6.1	6.0	5.0	5.1
Medium	4.8	4.6	4.3	3.7
Light	3.9	2.0	2.8	3.7
	45-45-0			
Heavy	8.4	7.1	6.9	6.2
Medium	6.3	3.8	5.7	5.1
Light	4.7	0.8	5.2	4.5

Average check (0-45-0) yield
Heavy - 11.2 cwt/acre (5 plots)
Medium - 15.3 cwt/acre (29 plots)
Light - 15.0 cwt/acre (9 plots)

In WCFL's research plots, all of the nitrogen was supplied by the nitrogen source (ie. urea or ammonium nitrate) since no nitrogen was combined with the phosphate carrier (ie. 0-45-0). All prairie phosphate fertilizers contain some combined nitrogen. The nitrogen combined with phosphate would have less effect on germination than urea. Therefore, it can be assumed that slightly higher rates of a commercially available urea containing fertilizer (eg. 46-0-0 plus 11-48-0) than indicated based on the research plot data (ie. 46-0-0 plus 0-45-0), could be safely applied under similar conditions because a significant percentage of the nitrogen in a commercially blended fertilizer could be from a source other than urea.

WCFL UREA RECOMMENDATIONS

Because of the anticipated rapid surge in the use of urea based fertilizers instead of the traditional nitrate based fertilizers, WCFL has attempted to provide information to farmers on how to best use urea containing fertilizers. A series of brochures have been prepared describing the behaviour of urea and outlining the conditions under which urea could be expected to perform satisfactorily. For annual crops, the use of urea is most critical when it is placed directly with the seed rather than broadcast.

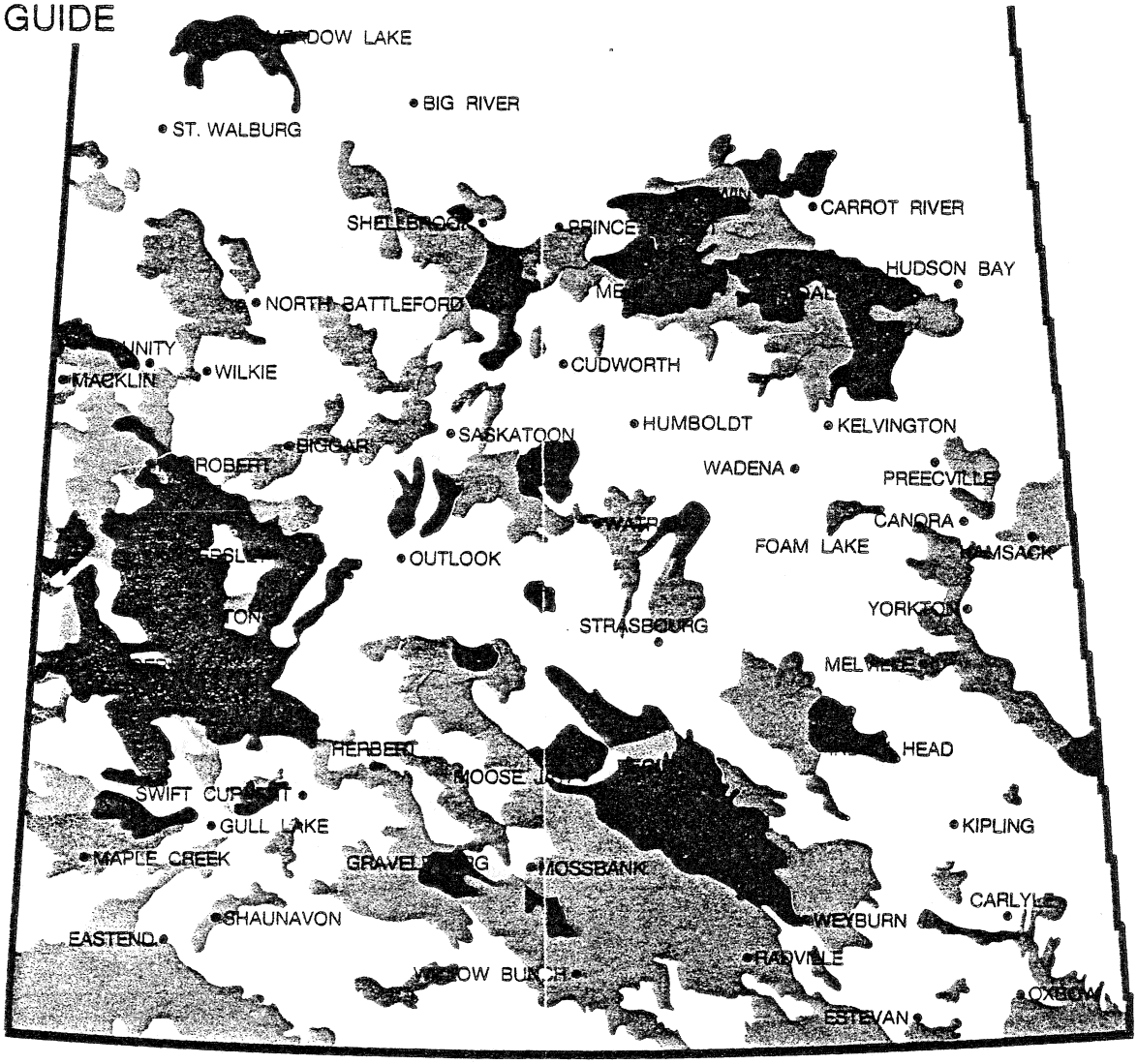
Maps have been developed as a guide for farmers who plan to use urea based fertilizers directly with the seed (see Figure 1). Caution is recommended on the lighter textured soils and preferably, on these soils the nitrogen would be broadcast applied. Based on WCFL research results, excellent results can be expected when urea based fertilizers are drilled-in for cereals on heavier textured soils. In fact, on these soils, urea-based fertilizers on average will perform as well or better than nitrate based fertilizers. To the best of our knowledge, this fact has not been demonstrated elsewhere.

The maximum amount of urea nitrogen that can be placed with the seed has been demonstrated to be dependant on soil texture. With excellent seed-bed moisture, much more urea nitrogen can be placed with the seed of cereal crops than previously recommended.

With increasingly higher rates of nitrogen, the farmers of western Canada have been switching away from drill-in application of nitrogen in favour of a separate pre-plant application since there is a limit to the amount of nitrogen that can be placed with the seed without causing germination damage. This practice also reduces the amount of fertilizer applied at the seed-drill and speeds the seeding operation considerably.

It is not possible to determine the percentage of fertilizer applied with the seed as blends, however, as illustrated in Figure 2, the proportion of nitrogen pre-blended at the manufacturing level has decreased rapidly since 1968. Although these figures do not take into account nitrogen that is blended at the retail level, it is nevertheless felt to be a meaningful trend. It points out the fact that the fertilizer practices of farmers have changed a great deal in recent years. It also illustrates that the substitution of urea for nitrate as a major source of nitrogen would have much less serious repercussions in the current market than in the relatively immature fertilizer market that existed in western Canada 10 to 15 years ago.

SASKATCHEWAN SOIL TEXTURAL MAP AND DRILL-IN UREA USE GUIDE



TEXTURAL GROUPING	MAP COLOUR CODE	MAXIMUM WITH SEED RATE OF UREA CONTAINING FERTILIZER	GENERAL UREA USE RECOMMENDATION
Coarse textured (eg. loamy sands)	Dark Ochre	15 - 20 lbs. N/acre	Broadcast only
Moderately coarse textured (eg. sandy loams)	Light Ochre	20	Broadcast only
Medium textured (eg. loams)	Uncoloured	25	Broadcast or Drill-in
Moderately fine textured (eg. clay loams)	Light Green	25 - 30	Broadcast or Drill-in
Fine textured (eg. clays)	Dark Green	30 - 40	Broadcast or Drill-in

Figure 1.

YEAR	% PRE-BLENDED
1959/60	19.8%
1961	20.4
1962	23.0
1963	25.6
1964	27.0
1965	30.3
1966	42.6
1967	45.0
1968	40.4
1969	35.6
1970	24.2
1971	19.8
1972	23.0
1973	20.4
1974	20.4
1975	19.6
1976	15.3
1977	11.4

Figure 2. PROPORTION OF NITROGEN (EXCLUDING NITROGEN IN PHOSPHATES) THAT IS PRE-BLENDED WITH PHOSPHATES AT THE MANUFACTURING LEVEL