1.7 Seed Placed Urea Fertilizer for Cereals Using Discer and Air Seeding Implements

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(Project funded by Agriculture Development Fund through Innovative Acres)

BACKGROUND AND INTRODUCTION

Urea fertilizer (46-0-0) is the most common granular nitrogen (N) fertilizer source for cereal production in Saskatchewan. Urea is commonly deepbanded or broadcast and incorporated at high rates, and sometimes seed placed at low rates. However, urea is known to be toxic to germinating seeds and seedlings. After application to soil, urea reacts with water to form free ammonia (NH_3) in equilibrium with the ammonium (NH_4^+) cation in soil solution. Ammonia undergoes nitrification to form nitrite (NO_2) then nitrate (NO_3). The toxic effect has been attributed to urea itself, to ammonia, and to nitrite. Ammonia toxicity seems to be paramount and factors which reduce ammonia concentration near the seed are of most interest. Ammonia is toxic to seedling roots, thus reducing nutrient and water uptake and therefore plant growth and yield.

Both soil characteristics and agronomic practices play a role in ammonia formation and concentration. A high pH, presence of free lime, a low cation exchange capacity (CEC) and low soil water content will increase free ammonia levels. Generally, a surface soil with high organic matter and/or clay content will be preferable for seed placed urea application. These soils will have a higher CEC, so will be able to adsorb more ammonium from soil solution. Since ammonium is in equilibrium with ammonia, the ammonia level in the soil atmosphere will also be lower. These soils will typically also have a higher water holding capacity. If the soil moisture content is high, the NH_4^+ concentration will be more dilute, thus reducing volatilization to ammonia. The ammonia/ammonium equilibrium is dependent on soil pH, such that a lower soil pH will favor higher ammonium concentration, therefore reducing ammonia toxicity.

Agronomic practices play a major role in the effect of fertilizer urea on seedlings. Certainly, the choice of a fertilizer with a lower ammonium content (ammonium nitrate) would be safer than using urea. However, urea is a more common and readily available fertilizer. To reduce the toxic effect of ammonia on the seedling, the distance between fertilizer prills and the seeds must be increased. Seed and fertilizer dispersal is a variable and somewhat controllable factor in urea fertilizer use. High rates of urea placed near the seed can be very toxic, and should be avoided. However, the term "seed placed" is more loosely applied to discer seeders and air seeders. These implements usually provide a much wider dispersal than double disc seeders or hoe-drills, for which the present recommendations were developed.

The maximum Saskatchewan Soil Testing Laboratory recommendations for rates of seed placed N fertilizer are 25 lb N/acre under any conditions, and 40 lb N/acre if a hoe-drill or discer seeder is used, moisture is adequate, and a non-urea source of N is used. The recommendation takes no account of soil texture and organic matter, and air seeders are not mentioned nor is the dispersal pattern of fertilizer and seed considered.

The actual safe levels of seed placed N fertilizer for specific conditions is an important question to be answered. Farmers are interested in seed placement of N fertilizer as a method of reducing operating costs. If one or more tillage operations could be saved by seed placing fertilizer, substantial savings could result. For example, soils with a high clay content and/or high organic matter content could probably allow increased rates of seed placed fertilizer. In Saskatchewan, from a review of Soil Survey Reports 12 and 13, these soils cover up to 20 percent of the surveyed cultivated acreage (Table 1.7.1). Assuming that all of the Brown and Dark Brown soil zone acreage and two-thirds of the remaining acreage of these soils could have their N fertilizer seed placed, about eight million acres per year could be affected. At a cost of $4 per acre for applying N fertilizer separately, this

Table 1.7.1 Acreage with soils of high organic matter and/or heavy texture in Saskatchewan, from Soil Survey Reports 12 and 13.

Soil zone	Potential acreage (',000,000 acres)	% of zone acreage
Brown[1]	2.14	10.7
Dark Brown[2]	2.19	11.4
Black[3]	4.65	26.9
Degraded Black[4]	1.62	31.0
Grey[5]	0.70	14.9
Total	11.4	18.0

[1] Includes Sceptre Association.

[2] Includes Regina Association.

[3] Includes Naicam, Yorkton, Blaine Lake, Canora, Melfort, Lloydminster and Meadow Lake Associations.

[4] Includes Kamsack, Tisdale and Pelly Associations.

[5] Includes Duck Mountain, Kelvington, Arborfield, Paddockwood and Weirdale Associations.

would represent $32 million in reduced fuel and machinery costs, not including time and labour savings. Obviously, seed placed fertilizer is an important subject to be better understood.

METHODS

To address this subject, Innovative Acres undertook a field scale project to study maximum rates of seed placed urea fertilizer for cereals with discer and air seeder seeding implements. Over three years, 15 sites were studied mainly on high CEC soils (Table 1.7.2). Barley, spring wheat and durum wheat were included, and farmers conducted the trials with their own implements. Several rates of seed placed urea were set out in side by

Table 1.7.2 Site information for seed placed urea fertilizer trials, 1987-1989.

Cooperator	Campbell	Dumonceaux	McAllister	Robb	Wilfing	Campbell	Dumonceaux	Kruger
Location	Sceptre	Langbank	Regina	Mossbank	Meadow Lake	Sceptre	Langbank	Aberdeen
Year	1989	1989	1989	1989	1989	1988	1988	1988
Crop	Durum wheat	Spring wheat	Spring wheat	Spring wheat	Barley	Spring wheat	Spring wheat	Durum wheat
Implement	Discer	Air seeder	Discer	Discer	Air seeder	Discer	Air seeder	Air seeder
Soil Zone	Brown	Thin Black	Dark Brown	Brown	Thick Black	Brown	Thin Black	Dark Brown
Association	Sceptre	Oxbow	Regina	Sceptre	Meadow Lake	Sceptre	Oxbow	Sutherland
Texture	Heavy clay	Loam	Heavy clay	Clay	Loam	Heavy clay	Loam	Clay
0-15 cm								
CEC[1]	39	27	48	38	38	37	30	32
OM %	2.6	4.7	3.0	2.7	10.1	2.2	5.3	2.9
Sand %	5	46	2	15	28	11	44	25
Silt %	32	29	24	35	39	33	30	29
Clay %	63	25	74	49	33	56	27	47
NO_3-N (kg/ha)								
0-15 cm	76	70	66	34	20	24	15	88
0-60 cm	182	151	162	150	40	72	41	177
Available soil H_2O @ seeding (cm)								
0-15 cm	4.1	2.0	2.9	3.8	2.7	3.0	3.6	2.4
30-60 cm	14.8	5.7	8.5	10.5	7.7	7.7	12.7	8.8
Rainfall (cm)								
1st 2 weeks	NA	2.0	3.5	2.4	2.6	NA	14.1	1.8
Season	12.5	18.5	26.4	18.2	19.6	4.4	20.1	8.5

Table 1.7.2 Continued.

Cooperator	Markusson	McAllister	McGrath	Wilfing	Campbell	McAllister	Robb
Location	Foam Lake	Regina	Leroy	Meadow Lake	Sceptre	Regina	Mossbank
Year	1988	1988	1988	1988	1987	1987	1987
Crop	Spring wheat	Durum wheat	Spring wheat	Spring wheat	Spring wheat	Durum wheat	Spring wheat
Implement	Air seeder	Discer	Air seeder	Air seeder	Discer	Discer	Discer
Soil Zone	Thick Black	Dark Brown	Thin Black	Thick Black	Brown	Dark Brown	Brown
Association	Yorkton	Regina	Oxbow	Meadow Lake	Sceptre	Regina	Sceptre
Texture	Loam	Heavy clay	Loam	Loam	Heavy clay	Heavy clay	Clay
0-15 cm							
CEC[1]	25	45	26	40	38	44	38
OM %	4.2	2.4	4.5	10.2	2.1	3.0	3.0
Sand %	62	2	47	26	6	1.0	15
Silt %	22	24	33	39	30	22	35
Clay %	16	75	20	35	64	77	49
NO_3-N (kg/ha)							
0-15 cm	66	15	72	NA	10	17	13
0-60 cm	102	48	119	NA	35	50	54
Soil H_2O @ seeding							
0-15 cm	1.7	2.4	2.1	NA	3.9	2.5	3.6
30-60 cm	7.0	14.5	8.0	NA	14.0	12.0	10.6
Rainfall (cm)							
1st 2 weeks	NA	3.3	1.4	2.5	2.2	3.8	Trace
Season	10.4	9.8	12.7	21.3	19.0	9.2	22.4

1 - Cation Exchange Capacity (meq/100 g).

side comparisons, including the highest rate which the farmer could apply with his implement. In most cases up to 100 kg N/ha were applied. At most sites additional urea was broadcast on each strip to balance the total fertilizer N applied and to eliminate differences in yield due to N fertility. For example, if the farmer seed placed strips with 0, 25, 50, 75 and 100 kg N/ha, an additional application of 100, 75, 50, 25 and 0 kg N/ha were broadcast, respectively.

Crop measurements included seedling counts, using 10 $^1/_4$-m^2 samples on each strip. Grain yield samples were measured with 10 1-m^2 samples per strip. Surface soil samples were collected at each site for measurement of CEC, % organic matter, and % sand, silt and clay. The sites were also sampled in spring to measure available nitrates and gravimetric water to 60 cm. Rainfall data was collected by the cooperating farmers from seeding to harvest.

RESULTS

Neither plant count nor grain yield was consistently affected by high rates of seed placed urea fertilizer applied with discers and air seeders (Figures 1.7.1 and 1.7.2). At the 1989 Kruger site the seedling count decreased with increased urea rates. However, the effect did not manifest itself in grain yield. The only pronounced and consistent reduction in yield occurred for the 1989 Dumonceaux site. However, seedling count was not significantly affecsted by seed placed urea at the Dumonceaux site (Figure 1.7.1). The high rates of seed placed urea may have stimulated early vegetative growth, thereby using soil moisture and subsequently reducing grain yield. Overall for the 15 sites there was little if any negative effect of up to 100 kg N/ha seed placed as urea with discers and air seeders.

DISCUSSION

There appears to be little risk in seed placing urea fertilizer at normal agricultural rates with air seeders and discers, especially if the soil has a high CEC. This is in contrast

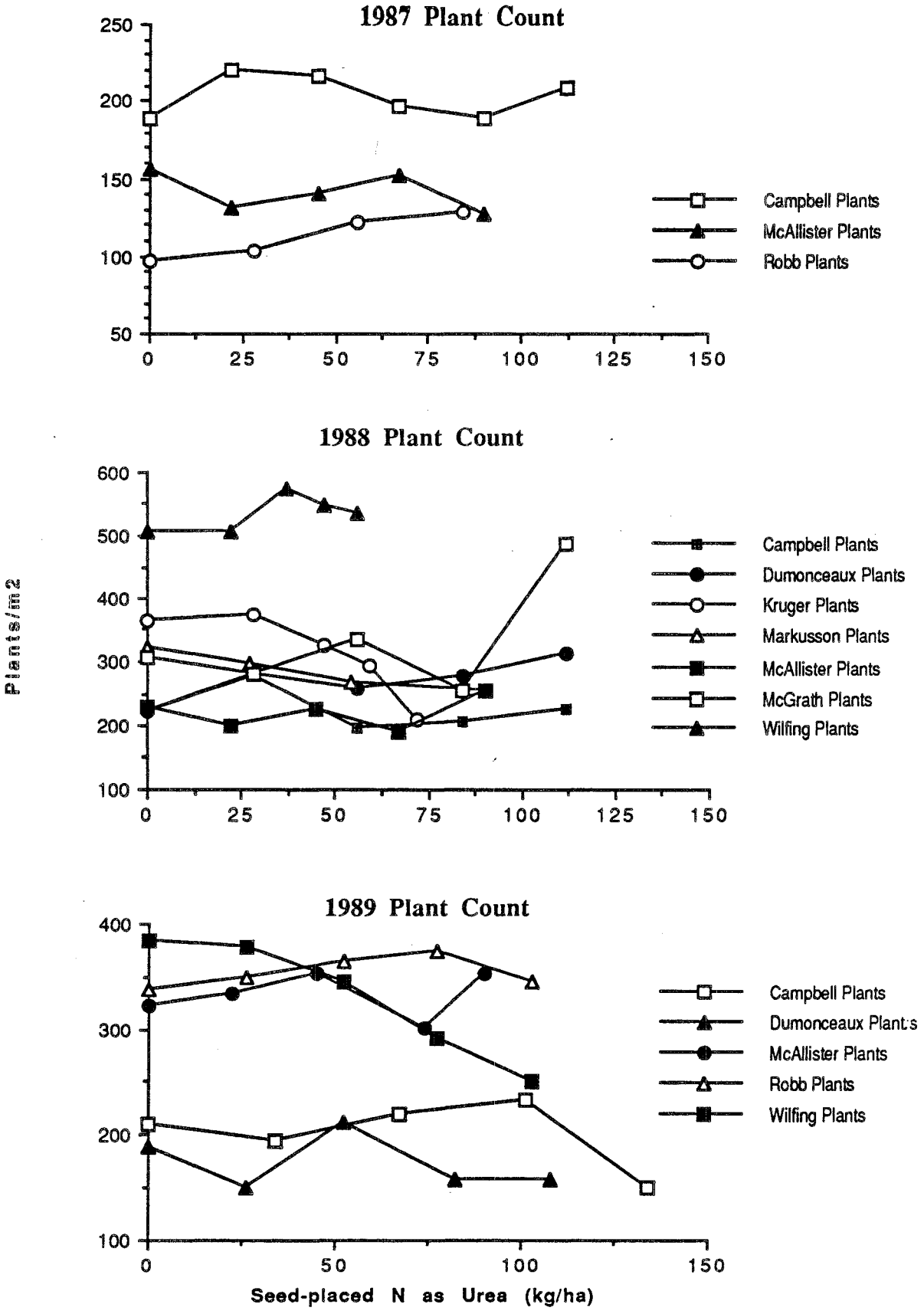

Fig. 1.7.1. Seedling count as affected by seed-placed urea fertilizer.

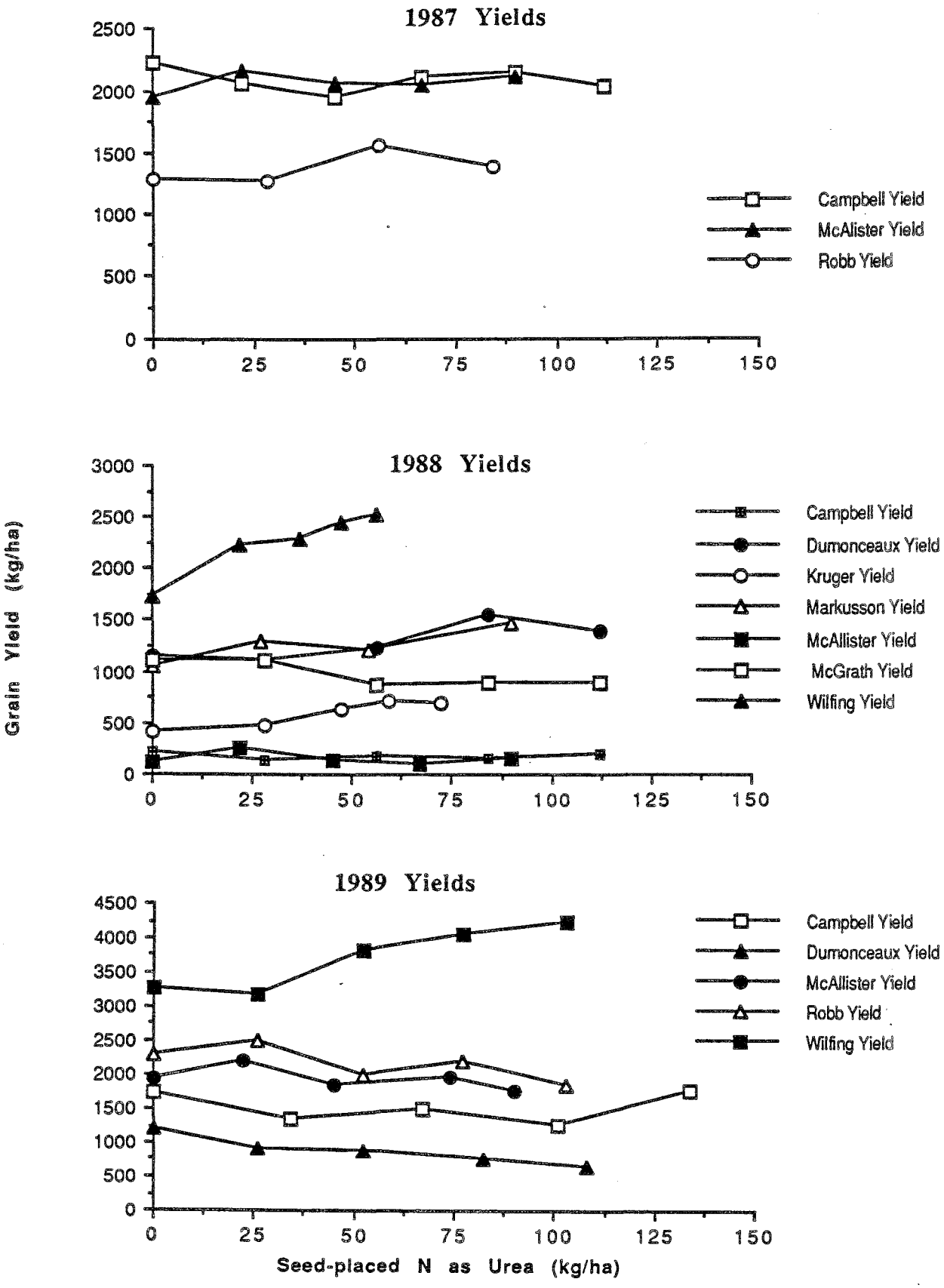

Fig. 1.7.2. Grain yield response to seed-placed urea fertilizer.

with seed placement of urea using a double disc drill in which case large yield reductions may occur at even low rates of seed placed urea (Toews and Soper, 1978; Black et al., 1980). Even with the double disc implement yield reduction does not always occur for cereal crop (McGill, 1973; McGill and Henry, 1974).

Other projects have shown potential for applying higher than currently recommended increased rates of urea with the seed if discers or air seeders are used. On a silty clay soil in North Dakota, 80 kg N/ha seed placed as urea using an air seeder caused little damage to spring wheat (Diebert et al., 1985). Research with discer seeders in Manitoba showed some reduction in plant stand with 105 kg N/ha as urea, but yield was not always reduced (Siemens, 1989).

The data from this project and similar research indicates that up to 100 kg N/ha as urea can be safely seed placed with cereals if an air seeder or discer implement is used, the soil has a high CEC (>25 meq/100 g) and the surface soil moisture is adequate. This research must be incorporated into standard recommendations for fertilizer placement.

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