NITROGEN FERTILIZER MANAGEMENT FOR ALBERTA

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ABSTRACT

Field experiments were conducted in the southern, central, and north-central parts of Alberta to identify inefficiencies in presently used N fertilizing practices and the differences in barley responses to methods of N application designed to circumvent these inefficiencies. Broadcast methods of N addition were found to be less effective than deep-banded or nested N. When broadcast, ammonium nitrate produced greater barley yields than urea. When banded, no differences were observed in crop response between the fertilizers tested showing that method of application of N did not result in significant N losses in the central and north-central areas. Overwinter losses were reduced if N addition was conducted late in the fall.

OBJECTIVES

Much of the research in the Canadian prairies has been directed towards identifying the inefficiencies of present N fertilization practices and determining how to circumvent the problems. Consequently, much of the research effort has been focussed on fertilizer forms and methods and time of addition (1,2,3,4). This paper summarizes some of the work done in recent years by some of the soil fertility researchers in Alberta.

MATERIALS AND METHODS

Since this is a summary paper, it would be difficult to provide the methods used in each of the experiments separately. In general, all the experiments reported here were conducted using field plots, and in most cases using scaled down field machinery. Where novel application methods were used, hand application of fertilizers was performed. Rates, times and methods of addition varied between the experiments and in most cases were some of the parameters studied in the experiments. Commercial grades of N fertilizers were used in all cases.

RESULTS AND DISCUSSION

Comparison of yield increases resulting from broadcast application of urea and ammonium nitrate in the spring are shown for irrigated land in the southern part of the province (Fig. 1). Broadcast ammonium nitrate was more effective than broadcast urea, except at high levels of addition. In central Alberta without

irrigation, when the fertilizers were broadcast and incorporated to a depth of 10 to 12 cm, yield increases were greater than with a broadcast application without incorporation (Table 1). There were slight or no yield differences between the two N fertilizers when broadcast and incorporated into the soil, but when broadcast without incorporation, urea was less effective in increasing barley yield than ammonium nitrate. Under dry conditions, differences between fertilizers were minimal because water, not N, was limiting crop growth.

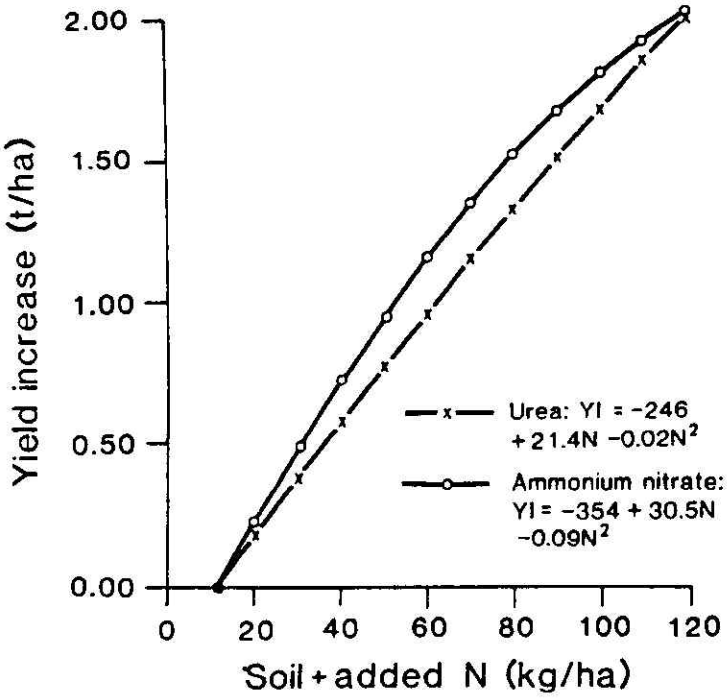

Fig. 1. Barley yield response to spring broadcast N fertilizer in southern Alberta -data from 7 exp. x 5 reps.

Table 1. Yield increase of barley from spring-applied urea and ammonium nitrate in central Alberta**

Method of application*	Yield increase (kg/ha)	
	Urea	Ammonium nitrate
Broadcast	990	1200
Broadcast and incorporated (10-12 cm)	1280	1340

*56 kg N/ha applied.
**Average of 4 experiments X 4 reps.

Research in southern Alberta has shown that banding of N fertilizers 15 cm below the surface has tended to eliminate differences in fertilizer effectiveness. For example, anhydrous ammonia, urea, and ammonium nitrate additions resulted in similar yields. Furthermore, the yield increases obtained were greater than those obtained with broadcast forms added at the same rates. The relative yield increases from N application by banding and broadcasting are shown in Fig. 2. If

the spring broadcast curve in Fig. 2 is considered to be the response curve for the standard method of adding N fertilizer, then the spring-banded curve clearly shows that yields can be increased by banding the same N rate.

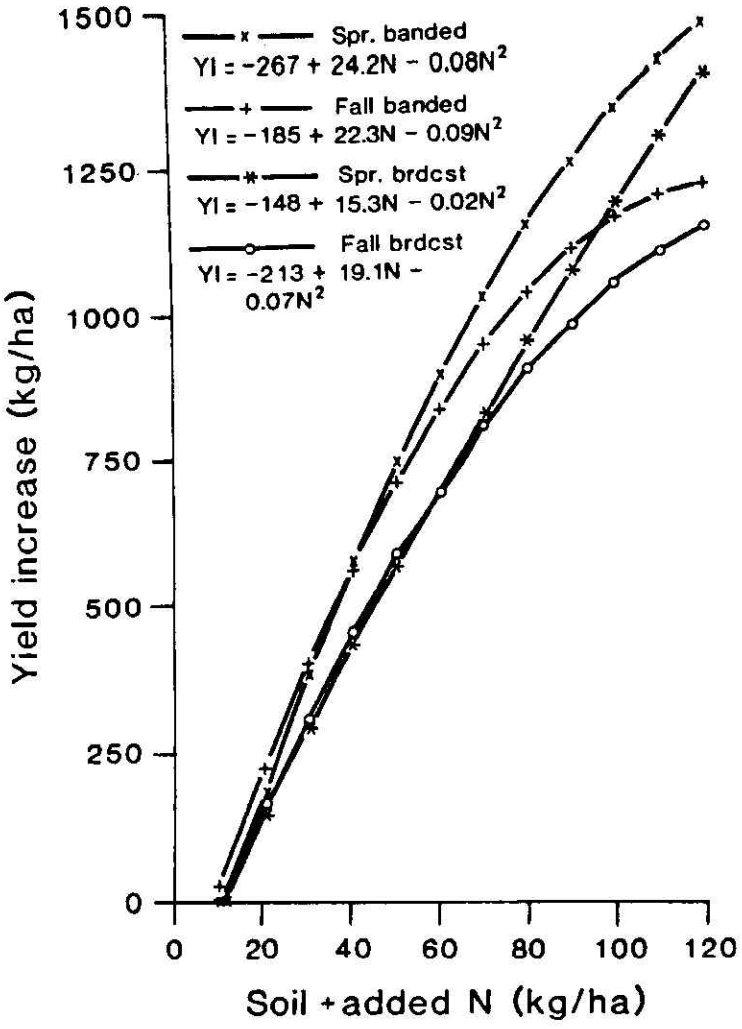

Fig. 2. Barley yield responses to N fertilizer banded and broadcast in spring and fall in southern Alberta.
-data from 7 exp. x 5 reps.

Fig. 2 also shows the yields obtained from fall application of N in the southern part of Alberta. Basically, it shows that at low to moderate rates of N addition, little if any reduction in yield was observed relative to the spring-applied treatment. At higher levels of N addition, the fall curves tail off. Care must be used in interpreting these curves since the fall-applied N was added very late in the season (soil temp. $<5^{o}C$). Earlier fall application can result in 20-30% losses of N over the winter, particularly in the more northern parts of Alberta where precipitation is greater (Table 2). Substantial amounts of mineral N have been shown to be lost from fall-applied urea when it was incorporated into soil in field experiments in north and north-central Alberta. Consequently, fall-applied treatments gave lower yields of grain than did similar applications of urea in spring. Delaying applications from early fall to late fall increased yields relative to the earlier application. The relative efficiency of fall- vs. spring-applied urea was approximately 30% for urea applied in late September and approximately 70% for urea applied in late October under these conditions.

Placing urea in concentrated "nests" (spot application) has also been shown to increase grain yields and N uptake efficiency (Table 2). The yields from fall-applied bands or nests were greater than from fall-applied broadcast-and-incorporated urea but were still lower than those obtained from spring-applied treatments in the north and north-central parts of the province.

Table 2. Effect of N placement on barley grain yield increase in central Alberta#

Method of application*	Time of application	Yield increase (kg/ha)
Broadcast and incorporated	fall**	830
Banded (5-cm depth 46 cm apart)	fall	1140
Nested (1 spot in 46x46) cm area, 5-cm depth)	fall	1480
Broadcast and incorporated (10-12 cm)	spring	1710

#Average of 20 experiments x 4 reps.
*N added at 56 kg N/ha.
**Fall application between Sept. 27 and Oct. 23.
#Average of 20 experiments x 4 reps.

Other data show fall banding to be the most effective method for applying fertilizer in years with less than ideal seedbed moisture supply (Table 3). This kind of response to N fertilizer is common to southern Alberta, but is also found throughout the province where the seedbed moisture is low and the young plants continue to be stressed by lack of moisture for several weeks. The young plant roots make little contact with the shallowly incorporated fertilizer, but are able to contact the deeper banded N more easily.

Table 3. Relative performance of fall- and spring-applied N fertilizer in situations where seedbed moisture conditions are less than optimal

Method of application*	Barley yield increase (kg/ha)	
	Fall	Spring
Broadcast and incorporated**	672	717
Banded	907	806

*N added at 56-67 kg N/ha as 34-0-0 or 46-0-0.
**Incorporated to a depth of 5-7 cm.
Seedbed prepared by cooperating farmers with standard farm equipment.
Average of 15 experiments x 3 reps.

Our research shows that there are two main separate mechanisms which reduce the effectiveness of N fertilizers in Alberta: 1) winter or early spring loss of fall-applied N by denitrification or occasionally by leaching; and 2) stranding of broadcast or shallowly incorporated spring-applied N in dry surface soil layers. Band placement greatly helps both situations. The choice of fall or spring application depends on the area and the soil moisture levels.

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