The Effect of Urea and Cold and Hot Flow Anhydrous Ammonia on Emergence and Yield on Wheat, Barley and Canola

RL0396

ALBERTA FARM MACHINERY RESEARCH CENTRE

by

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November 1996

Abstract

Nitrogen fertilizer in the forms of anhydrous ammonia (82-0-0) liquid, anhydrous ammonia (82-0-0) vapour and granular urea (46-0-0) was evaluated to determine effect on crop emergence and yield. Cold flow convertors did not offer any emergence or yield advantage over hot flow anhydrous ammonia (NH_3) or granular urea. The type of opener had more influence on emergence and yield. In addition, nitrogen rate played an important role in the final yield for wheat, barley and canola.

Introduction

The objective of the study was to determine whether liquid or vapour NH_3 had any advantages in terms of crop emergence and yield. The popularity of NH_3 is increasing due to recent research on the safe use of NH_3 during seeding. In addition, NH_3 is usually the lowest priced form of nitrogen fertilizer. Little information is available about application of NH_3, specifically on whether liquid or gas NH_3 has better retention in the soil and any effects on crop injury. This research will assist in the effective use of NH_3 and outline information on double shoot opener performance.

Equipment and Procedure

Crop emergence and yield were evaluated when direct seeding wheat, barley and canola using 4 seeding systems, 3 fertilizer rates and 3 forms of nitrogen fertilizer.

Seeding Systems

The seeding systems included:

Bourgault Mid-Row Banding System: The Bourgault Mid-Row Banding System had point openers to seed on 25 cm (10 in) spacing and coulters for fertilizer placement between every other seed opener. The coulters placed the fertilizer 7.5 cm (3 in) deep and 13 cm (5 in) from the seed rows. Hot flow NH_3 was placed using 0.64 cm (0.25 in) outside diameter air line tubes which were placed behind the coulter scraper to inject NH_3 at the bottom of the coulter. Cold flow NH_3 was placed using 0.95 cm (.375 in) inside diameter hoses inserted into the tubes used for urea application. The hoses injected the cold flow NH_3 beside the coulter bottom. Urea was applied in a similar manner with a tube on the coulter scraper placing the urea at the bottom of the coulter.

Bourgault Double Shoot Side Bander: The Bourgault double shoot side bander placed fertilizer 3.8 cm (1.5 in) below the seed through a fertilizer point on the front of the opener. The seed was placed above and to the side of the fertilizer with a seed boot and the fertilizer was also placed through the same opener. Both forms of NH_3 were placed by inserting the tube into the urea fertilizer tube on the opener.

Sweep and Fertilizer Tube: The 30 cm (12 in) McKay sweep and fertilizer tube spread the seed in the sweep centre in a 7.6 cm (3 in) band. NH_3 fertilizer was placed at the wing tips of the sweep using 1.27 cm (0.50 in) outside diameter steel pipe bent to fit under the sweep wings. Urea fertilizer was placed at the wing tips using a New Noble seed boot which placed the seed between the fertilizer bands.

Conventional Tillage Seeding System: The conventional seeding system consisted of a tillage and fertilizer operation prior to seeding. Tillage and fertilizer operations were done with a 30 cm (12 in) sweep. Seeding was completed with hoe- type fertilizer points.

Three rates of actual nitrogen fertilizer were used:
0 kg-N/ha (control)
56 kg-N/ha (50 lbs-N/ac)
112 kg-N/ha (100 lbs-N/ac)

The nitrogen was applied in 3 different forms:
Cold flow (liquid)
Hot flow (vapour)
Granular urea

The cold flow system consisted of a tee splitting the NH_3 into 2 Engro cold flow converters. The Engro cold flow system output 2 hoses which split the NH_3 82% into the liquid line and 18% into the vapour line by weight. The liquid line was then split into 4 lines which delivered NH_3 to the openers. However, proportions of liquid and vapour in each line were not determined. The hoses used had a 1.27 cm (0.50 in) inside diameter

The hot flow system consisted of a vertical dam manifold with 7.6 m (25 ft) long, 0.95 cm (.375 in) inside diameter hoses to each opener.

Experimental Constants

A Case 5240 tractor was used to pull the AFMRC plot air seeder at 6.7 km/h (4 mph). The 8 row air seeder was equipped with Bourgault Industries heavy duty cultivator shanks spaced at 25.4 cm (10 in). Gang mounted Flexi-coil 10.2 cm (4 in) wide rubber packers were used to pack the seed row.

Manifold Calibration

NH_3 split was measured by weighing the amount of NH_3 from each hose which was absorbed in pails of water. Hoses were placed into the water at known depths to maintain consistent pressure in each hose.

NH_3 was injected into pails for a known period of time and the increased mass of each pail was measured. The variation between pail weights determined the uniformity of the manifold distribution. For the hot flow system the manifold distribution at 112 kg-N/ha (100 lbs-N/ac), measured as coefficient of variation (cv), ranged from 18.6 to 24.4%. For the cold flow system, the manifold distribution ranged from 6.7 to 28.8%. For example, at a ate of 112 kg-N/ha (100 lbs-N/ac) and a CV of 24.4 percent, anhydrous ammonia distribution ranged from 85 to 139 kg-N/ha (75 to 124 lbs-N/ac).

Site Characteristics

Southern Alberta Site

The 2.43 ha (6 ac) southern site was located 6.7 km east and 3.3 km north (4 mi east and 2 mi) north of Lethbridge, Alberta, and consisted of a clay loam soil. The previous crop was barley. Soil moisture was located 1 cm (0.4 in) from the surface. AC Lacombe barley, Teal wheat and Hysyn 110 canola was seeded into moisture on 17 May at rates of 112, 84, and 5.6 kg/ha (100, 75 and 5 lbs/ac), respectively. Phosphate, in the form of 11-51-0, was placed with the seed at a rate of 67 kg/ha (60 lbs/ac). A pre-burn glyphosate (Roundup) treatment at 1 L/ac was completed on 13 May. Conventional tillage plots were worked on 10 May. Crops were sprayed with herbicide on 8 July. Canola was sprayed with recommended rates of clopyralid (Lontrel), sethoxydim (Poast) and ethametsulfuron-methyl (Muster). Wheat and barley plots were sprayed with tralkoxydim, bromoxynil and MCPA (Achieve Extra Gold) at recommended rates.

Northern Alberta Site

The 2.43 ha (6 ac) northern site was a loam soil located at the University of Alberta Farm in Edmonton, Alberta. The previous crop was barley. Soil moisture was located 1.5 cm (0.6 in) from the surface. Seeding was completed on 23 May using the same seed and seeding rates as the Southern Alberta site. All seeds were placed into moisture. The Edmonton site was sprayed at a 1 L/ac rate with glyphosate (Round-up) on 24 May. Conventional tillage plots were worked on 22 May. Phosphate in the form of 11-51-0 was placed with the seed at 67 kg/ha (60 lbs/ac). Emergence counts were taken on 4 July. Crops were sprayed with herbicide on 4 July. Canola was sprayed with recommended rates of clopyralid (Lontrel), sethoxydim (Poast) and ethametsulfuron-methyl (Muster). Wheat and barley plots were sprayed with tralkoxydim, bromoxynil and MCPA (Achieve Extra Gold) at recommended rates.

Emergence Counts

Emergence counts were taken for each plot. A random 1 m (39 in) count on each of the 6 seed rows was taken on each plot. Emergence counts were completed on 28 June and 4 July for the Lethbridge and Edmonton sites, respectively.

Crop Harvesting

Coaldale harvest dates were 26 August (barley), and 5 September (wheat and canola). Edmonton harvest dates were 8 October (canola) and 9 October (wheat and barley). The entire 9.14 m by 152 cm (30 ft x 60 in) plots were harvested using a Hege plot combine..

Statistical Analysis

Statistical analysis was carried out on the data using a split plot design analysis of variance. The experiment had 4 complete replications for a total of 864 plots at 2 sites. Each block contained 1 complete replication. Each plot was 2.43 x 15.24 m (8 x 30 ft). A 12.2 m (40 ft) strip was left between each block to allow for turning and starting implements. Border effects were controlled through plot randomization, winter crops on the edge of each plot and 6.1 m (20 ft) strips between blocks.

The fixed effects of the ANOVA table were the experimental factors and levels as outlined in Table 1. The 4 experimental blocks were considered random effects nested within the fixed ANOVA format and applied to the error term of the ANOVA. An analysis was completed to determine if the blocks are insignificant to the ANOVA effects. A Duncan’s Multiple Range Test was used to outline statistically significant differences.

Table 1. Experimental Factors and Levels

Factor	Level
Nitrogen Fertilizer Type (3)	Cold Flow (Converters) Hot Flow (Gas) Urea (46-0-0)
Seeding and Fertilizer Method (4)	Mid-Row Banding Sweep and Tube Side Band Conventional Tillage (narrow points)
Fertilizer Rate (3)	0 kg/ha (0 lbs/ac) 56 kg/ha (50 lbs/ac) 112 k/h (100 lbs/ac)
Seed Type (3)	Barley Wheat Canola
Replications (4)	

Emergence and yield were analysed using a split plot design analysis with the openers and nitrogen type in the main plot and nitrogen rate as the subplot factor. Table 2 outlines the error terms and degrees of freedom on the split plot analysis.

Table 2. Error Terms /Degrees of Freedom

Source	Degrees of Freedom
Replication (r)	3
Main Plot Factor	
Opener (v)	3
Nitrogen Type (w)	2
Opener x Nitrogen Type (vw)	6
Error (a)	33
Error (a) = rv + rw + rvw	
Subplot Factor	
Rate (n)	2
Rate x Opener (nv)	6
Rate x Nitrogen Type (nw)	4
Error (b)	72
Error (b) = rn + rvn + rwn + rvwn	
Total	143

Results and Discussion

Results of the experiment were reviewed in terms of crop emergence and final yield. In general there were no consistent differences in emergence or yield because of the type of nitrogen source used. As such, it was concluded the cold flow converters offered no benefit in terms of crop emergence and final crop yield. Emergence was affected by opener type for the wheat and barley at the Edmonton site and general trends were apparent across all crops. Yield was only affected by the rate of nitrogen used.

Emergence Results

Figures 1 and 2 outline the emergence results for the Edmonton and Coaldale sites in terms of the type of nitrogen fertilizer. No statistically significant differences were found due to the type of nitrogen fertilizer used. In addition, no general trends were apparent. In summary, there was no difference in emergence when using cold flow converters, a hot flow NH3 system or granular urea.

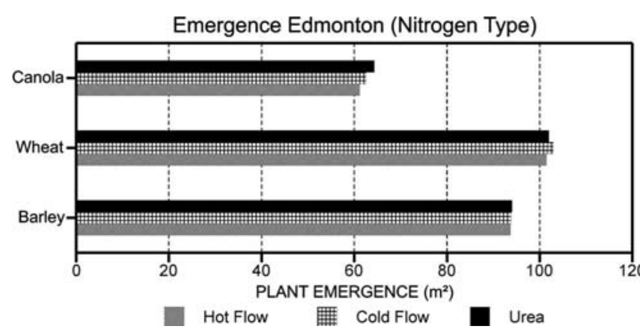

Figure 1. Nitrogen Type - Edmonton Emergence

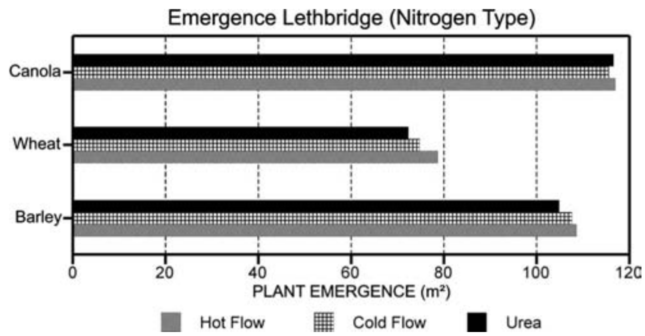

Figure 2. Nitrogen Type - Coaldale Emergence

An analysis of nitrogen rate indicated nitrogen application rate did not effect emergence of wheat, barley or canola. No statistically significant differences were found whether rates of 0, 56 or 112 kg/ha (0, 50 or 100 lbs/ac) of fertilizer were used. Figures 3 and 4 outline the results.

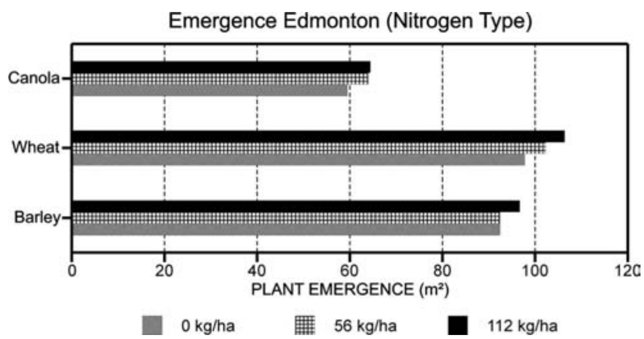

Figure 3. Nitrogen Rate - Edmonton Emergence

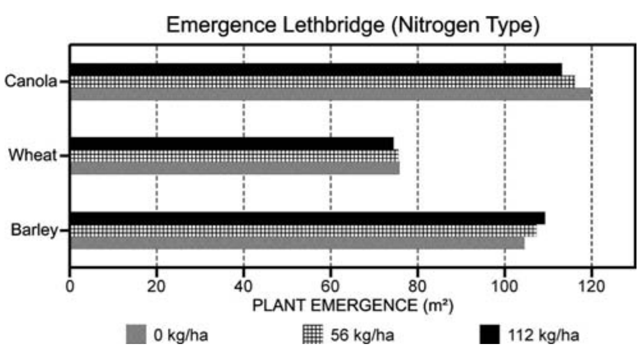

Figure 4. Nitrogen Rate - Coaldale Emergence

The side band, sweep, mid-row bander and conventional seeding systems resulted in significantly different emergence counts at the Edmonton site for wheat and barley. While no statistical differences were found at the Coaldale site, the emergence trends were similar to the results at the Edmonton Site. In general, the sweep had lower emergences than the side band, mid-row bander and conventional seeding systems. In addition, the emergence of the side band system tended to be lower than the mid-row bander and conventional systems.

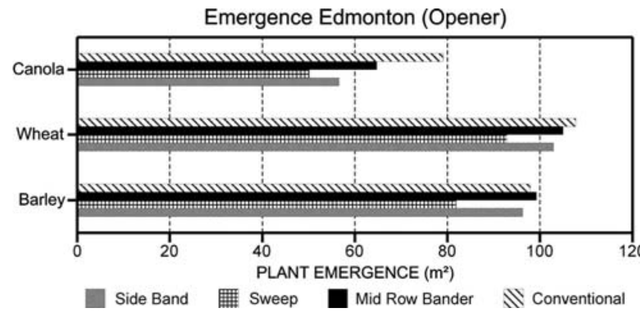

Figure 5. Opener -Edmonton Emergence

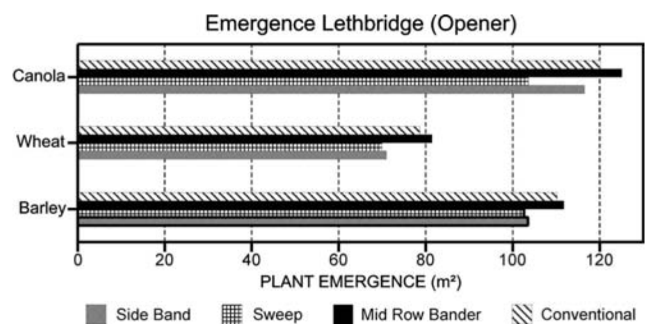

Figure 6. Opener - Coaldale Emergence

Yield Results

As outlined in Figures 7 and 8, the type of nitrogen used did not significantly affect the yield of wheat, barley or canola at either the Edmonton or Coaldale sites. In addition, no trends in final yield were apparent.

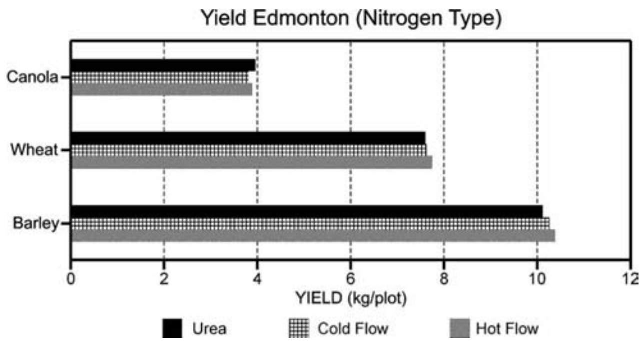

Figure 7. Nitrogen Type - Edmonton Yield

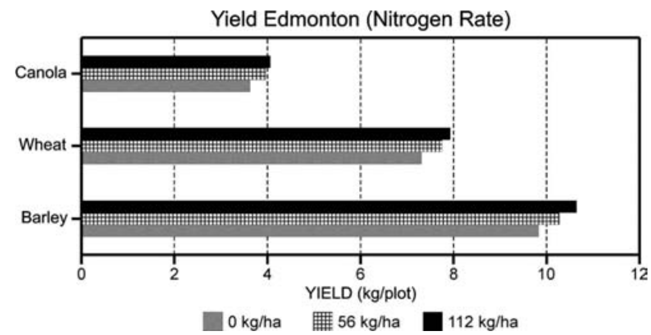

Figure 9. Nitrogen Rate - Edmonton Yield

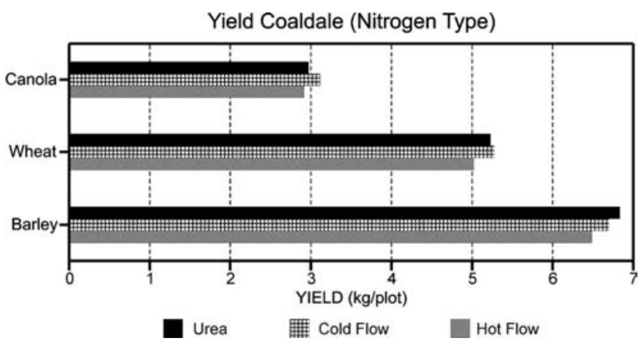

Figure 8. Nitrogen Type - Coaldale Yield

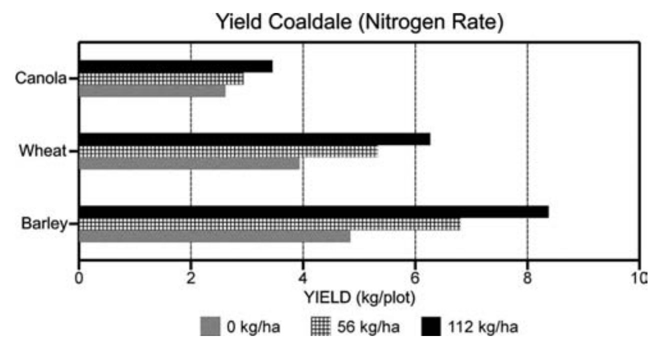

Figure 10. Nitrogen Rate - Coaldale Yield

The rate of nitrogen used significantly affected final yield of wheat and barley at both the Edmonton and Coaldale sites. Canola yields were statistically affected at the Coaldale site but not at the Edmonton site. Lack of statistically significant nitrogen response at the Edmonton canola site was attributed to hail after flowering took place. In all crops and both sites, the 112 kg/ha (100 lbs/ac) nitrogen produced higher yields than either the 56 kg/ha (50 lbs/ac) rate or the control. Additionally, the 56 kg/ha (50 lbs/ac) rate produced higher yields than the control. Figures 9 and 10 outline the yield results as affected by nitrogen fertilizer rate.

Figures 11 and 12 outline how opener type affected yields at Edmonton and Coaldale sites, respectively. Canola yield was significantly affected at the Coaldale site. No other statistically significant yields were found due to the opener used. However, the mid-row banding systems resulted in lower yields, while not statistically significant, at both sites with all crops compared to the side band, sweep and conventional seeding systems. An analysis to determine the cause of the lower mid-row bander yields was completed. The effects of NH_3 form on mid-row bander yield showed no obvious trends between the hot, cold or granular nitrogen. While the actual conclusion can not be reached with the data presented, the wide separation between the fertilizer and seed row may have contributed to the lower yield as compared to the side band, sweep and conventional system. Further work should be completed to determine the effects of fertilizer placement and row spacing on crop yield.

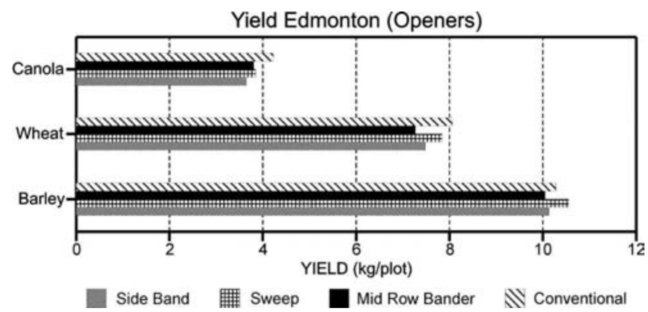

Figure 11. Opener - Edmonton Yield

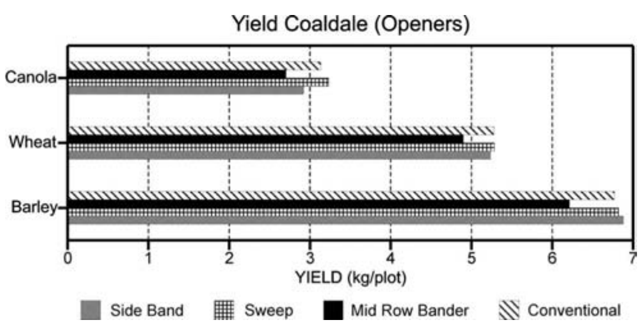

Figure 12. Opener - Coaldale Yield

Conclusion

In most conditions tested, emergence was not significantly affected by the type or rate of nitrogen fertilizer. Opener type effected the emergence of wheat and barley at the Edmonton site. In general, the sweep opener had lower emergence than the side band, mid-row bander and conventional system in wheat, barley and canola. Final crop yields were only affected by the rate of nitrogen used. In all conditions tested, 112 kg/ha (100 lbs/ac) had higher yield than the 56 kg/ha (50 lbs/ac) and 0 kg/ha rates. In addition, the 56 kg/ha (50 lbs/ac) rate had higher yields than the control (0 kg/ha). Openers also caused some trending differences in yields. The mid-row banding system caused lower yields in all treatments tested. An analysis indicated that NH_3 form did not contribute to the lower yields. Further research should be completed to determine if row spacing or seed and fertilizer separation impacted yield using the mid-row banding system.

In summary, cold flow converters did not offer any emergence or yield advantage over hot flow NH_3 or granular urea. In general, openers had more influence on emergence and final yields. Nitrogen rate played an important role in yields for the wheat, barley and canola.

Acknowledgements

The Alberta Farm Machinery Research Centre would like to express appreciation to the following groups for funding and other financial assistance throughout this project:

Agrium
Bourgault Industries
Prairie Seeds
Zeneca