Canola response to side-banded N rate, source and NBPT addition

Cynthia Grant, Doug Derksen and Debra McLaren

Agriculture and Agri-Food Canada, Brandon Research Centre, Box 1000a, R.R.#3, Brandon, MB, R7A 5Y3, Canada cgrant@agr.gc.ca

Abstract

Field studies were conducted over three years on a clay loam (CL) and a fine sandy loam (FSL) soil near Brandon, Canada to evaluate effects of increasing rates of side-banded UAN and urea, with and without the urease inhibitor N-(*n*-butyl)thiophosphoric triamide (NBPT) on seedling damage, seed yield and seed quality of canola. Seedling damage occurred with side-banded urea and UAN on the CL soil. In contrast, rainfall after seeding on the FSL soil in two of the three years limited seedling damage. Seedling damage was similar with urea and UAN and was reduced with application of NBPT. Seed yield increased with application of urea or UAN in spite of the reduced stand density, but was not significantly affected by the use of NBPT when averaged over the three years of the study. However, when analysed separately, NBPT increased seed yield on the CL soil in two of three years. Seed quality generally declined with N application and with increasing seedling damage. Oil content decreased and glucosinolate content increased with N application. Oil content was higher with urea than UAN and increased with the use of NBPT. Glucosinolate content on the CL soil was lower with urea than UAN and decreased with the use of NBPT. Seedling damage from excess seed-placed N can lead to reductions in canola seed yield and quality, while the urease inhibitor NBPT can reduce damage, potentially improving yield and quality.

Media Summary

Loss of canola seed yield and quality due to seedling damage from side-banded urea or urea ammonium nitrate can be reduced by use of NBPT.

Key Words

Agrotain, toxicity, ammonia, stand density

Introduction

Canola (*Brassica napus* L.) has a high demand for crop nutrients, including nitrogen (Grant and Bailey 1993). Therefore, proper N fertilization is important in optimizing canola production. Canola is more sensitive than cereal grains to damage from seed-placed fertilizer (Dowling 1993) so it is generally recommended that N fertilizer be placed away from the seed. However, many producers are direct seeding with fertilizer seed-banded near the seed and moving to wider row spacings that increase the concentration of fertilizer near the seed. Seeding toxicity is normally believed to increase in the order ammonium nitrate<urea ammonium nitrate<urea. However, work conducted Alberta (Penny-Pers Comm) suggested damage in canola was similar with urea and ammonium nitrate. Urea toxicity can be reduced in barley and wheat by addition of the urease inhibitor N-(*n*-butyl)thiophosphoric triamide (NBPT) to the fertilizer (Grant 1998; Wang et al. 1995). This may or may not be effective in canola, depending on the importance of ammonia toxicity and the effect of slow release of the ammonia from the urea on salt concentration near the seed.

Seedling damage can have a major impact on crop yield and seed of canola. Therefore, this study was conducted to evaluate the effect of rate of side-banded urea and urea ammonium nitrate (UAN), with and without application of NBPT on seedling damage, seed yield and seed quality of canola on two soil types on the Canadian prairies.

Methods

Research trials were conducted for three years near Brandon, MB, Canada, on a clay loam (CL) (loamy, mixed, frigid Typic Hapludoll; (50E20'N 100?0' W) and a fine sandy loam (FSL) (coarse, loamy, mixed, frigid Typic Hapludoll; 49?50' N100?0' W) under no-till management. Glyphosate was applied at 144 g ha^{-1} for weed control prior to seeding. Roundup-ready canola (LG 3235 in year 1, LG 3295 in year 2 and LG 3455 in year 3) was seeded 2.5 cm deep at a seeding rate of 9 kg ha^{-1} in mid-May of each year using a plot seeder equipped with commercial 1.5 cm wide hoe openers on 20 cm row spacing. Fertilizer was banded during seeding approximately 2.0 cm to the side and 3.0 cm below the seed row at 0, 40, 80, 120, 160 or 200 kg/ha N ha applied as urea or urea ammonium nitrate (UAN) fertilizer with or without NBPT at 0.14% w/w. Monoammonium phosphate at 8.7 kg P ha^{-1} was applied to all treatments. Canola was grown with and without the application of in-crop weed control, but only the herbicide-treated plots will be discussed in this paper. In the herbicide-treated plots, glyphosate was applied at 72.0 g ha^{-1} at the 2- to 4-leaf stage. Canola plots were swathed when 10% of seeds in a majority of plots began to turn brown. Plots were harvested using a plot combine when seed was below 10% moisture. Seed was analysed for oil (F.O.S.F.A. 2001) and glucosinolate content (ISO 1992). The experimental design was a split plot design with 4 replications. Herbicide application was the main plot treatment and fertilizer the sub-plot treatment. Plot size was 2 m by 5 meters. Statistical analysis was conducted using contrast analysis with Proc Mixed of SAS with years treated as random effects.

Results

Stand density decreased linearly with increasing rates of side-banded urea and UAN on the CL soil and with UAN on the FSL soil (Tables 1 and 2). Use of NBPT with both urea and UAN reduced seedling damage on the CL soil but the effect was not significant on the FSL soil, where damage was not as great. Rainfall in the first week after seeding on the FSL reduced seedling damage in two of the three study years. Decrease in stand density was greater with UAN than urea on the FSL soil, but not on the CL soil.

Table 1.Effect of N source, rate and NBPT application on canola stand density and seed yield on a clay loam (CL) and fine sandy loam (FSL) soil, averaged over three years.

		Stand density (plant m^{-2})				Seed Yield (t ha^{-1})			
Soil Type	N Rate (kg/ha)	UAN	UAN+ NBPT	Urea	Urea + NBPT	UAN	UAN+ NBPT	Urea	Urea + NBPT
CL	0	132	132	132	132	1.27	1.27	1.27	1.27
	40	143	136	135	134	1.63	1.64	1.48	1.57
	80	115	138	114	138	1.59	1.83	1.78	1.71
	120	85	125	104	136	1.85	1.98	1.78	1.85
	160	77	134	91	124	1.98	2.00	1.92	1.83
	200	68	120	72	128	1.80	1.98	1.79	1.89

	Mean	103	131	108	132	1.69	1.78	1.67	1.69
FSL	0	131	131	131	131	1.51	1.51	1.51	1.51
	40	107	109	112	128	1.89	1.73	1.73	1.67
	80	119	111	125	126	1.90	1.89	1.85	1.89
	120	109	103	125	132	1.60	1.85	1.79	1.85
	160	99	106	116	112	1.81	1.85	1.75	1.90
	200	98	108	110	111	1.73	1.70	1.75	1.78
	Mean	111	111	120	123	1.74	1.76	1.73	1.77

Seed yield on the CL soil increased linearly with urea or UAN application, with or without the use of NBPT (Tables 1 and 2). Canola seed yield on both soils was similar whether urea or UAN was the N source. Use of NBPT did not increase canola seed yield when results were averaged over the three years of the study, in spite of the beneficial effect on stand density, although there was a tendency ($p<0.0752$) for higher seed yield when NBPT was used with UAN. Seed yield on the CL soil was increased by NBPT applications in two of three years when data were analysed individually by year (data not presented). On the FSL soil, seed yield increased linearly when urea was applied with NBPT and showed the same tendency ($p<0.0875$) when UAN was applied with NBPT, but the linear response was not significant when urea or UAN ware applied without NBPT. In the absence of the NBPT, yield on the FSL soil decreased slightly when N rate was increased above 80 kg N ha^{-1}, but when the NBPT was used yield did not decrease until N rate exceeded 160 Kg N ha^{-1}.

Table 2. obability values for contrasts of N source, rate and NBPT application on canola stand density, seed yield, oil and glucosinolate content on a CL and FSL soil, averaged over three years.

	Stand Density		Seed Yield		Oil Content		Glucosinolate	
Contrast	CL	FSL	CL	FSL	CL	FSL	CL	FSL
Linear urea	<.0001	NS	<.0001	NS	<.0001	<.0001	<.0001	0.0003
Linear urea + NBPT	NS	0.0193	<.0001	0.0082	<.0001	<.0001	<.0001	0.0027
Linear UAN	<.0001	0.0010	<.0001	NS	<.0001	<.0001	<.0001	<.0001
Linear UAN + NBPT	NS	0.0328	<.0001	0.0875	<.0001	<.0001	<.0001	<.0001

Urea vs UAN	NS	0.0169	NS	NS	0.0018	0.0130	0.0036	NS
UAN vs UAN + NBPT	<.0001	NS	0.0752	NS	0.0002	0.0047	0.0003	NS
Urea vs urea + NBPT	<.0001	NS	NS	NS	NS	NS	NS	NS
NBPT vs no NBPT	<.0001	NS	NS	NS	0.0010	0.0054	0.0011	0.0563
SE	8.61	13.58	0.109	0.131	0.767	0.467	0.635	0.315

As canola is produced primarily for its high quality oil, the oil content of the seed is an important quality factor. Oil content decreased linearly with N application on both soils regardless of N source (Tables 2 and 3). Oil content on both soils was higher when urea rather than UAN was the N source. Application of NBPT with the UAN increased the oil content on both soils. Overall, oil content was increased by the use of NBPT, although the majority of the influence was when used with UAN rather than urea. Seedling damage may have led to slight delays in crop maturity, affecting oil production.

Table 3. ffect of N source, rate and NBPT application on canola seed oil and glucosinolate content on a clay loam (CL) and fine sandy loam (FSL) soil, averaged over three years.

		Oil Concentration (g/kg)				Glucosinolate content (?mole/g d.b.)			
Soil Type	N Rate (kg/ha)	UAN	UAN + NBPT	Urea	Urea + NBPT	UAN	UAN + NBPT	Urea	Urea + NBPT
CL	0	4.83	4.83	4.83	4.83	10.0	10.0	10.0	10.0
	40	4.75	4.76	4.81	4.77	10.7	10.7	10.4	10.4
	80	4.70	4.72	4.72	4.76	11.4	10.5	10.5	10.4
	120	4.55	4.61	4.58	4.62	11.8	11.2	10.8	11.1
	160	4.51	4.58	4.53	4.54	11.8	11.4	12.0	11.8
	200	4.37	4.50	4.47	4.51	13.4	11.7	12.5	11.5
	Mean	4.62	4.67	4.66	4.67	11.5	10.9	11.0	10.9
FSL	0	4.78	4.78	4.78	4.78	11.8	11.8	11.8	11.8

40	4.63	4.74	4.71	4.72	12.3	11.5	12.3	11.8
80	4.56	4.62	4.60	4.59	12.5	12.4	12.8	12.7
120	4.51	4.53	4.55	4.57	12.3	13.0	12.9	12.8
160	4.46	4.52	4.49	4.54	13.2	12.8	13.0	12.7
200	4.41	4.48	4.49	4.55	13.7	13.1	13.2	12.7
Mean	4.56	4.61	4.60	4.62	12.6	12.4	12.7	12.4

Glucosinolates are a major antinutritional factor in canola meal. Therefore, increasing glucosinolate content in canola seed decreases meal quality. Glucosinolate content in all treatments was within acceptable levels, but increased linearly with N applications on both soils, regardless of N source or NBPT treatment (Tables 2 and 3). On the CL soil, glucosinolate content was higher with UAN than with urea and was reduced when NBPT was applied with UAN. Use of NBPT reduced glucosinolate content on the CL soil and tended ($p<0.0563$) to reduce glucosinolate content on the FSL soil. The greatest reduction in glucosinolate content from NBPT use occurred at the 200 kg N ha^{-1} rate of application.

Conclusions

Urea or UAN fertilizer side-banded at high rates near the seed-row produced seedling damage in canola. Damage was similar or slightly higher with UAN as compared to urea. Where seedling damage occurred, use of the urease inhibitor NBPT reduced damage from both urea and UAN. Seed yield increased with application of urea or UAN in spite of the reduced stand density, but was not significantly affected by the use of NBPT when results were averaged over the three years of the study. However, on the CL soil, seed yield increased with use of NBPT in two of the three years of the study. Seed quality generally declined with N application and with increasing seedling damage. Oil content decreased and glucosinolate content increased with N application. Oil content was higher with urea than UAN and increased with the use of NBPT. Glucosinolate content on the CL soil was lower with urea than UAN and decreased with the use of NBPT. Seedling damage from excess seed-placed N can lead to reductions in canola seed yield and quality, while the urease inhibitor NBPT can reduce damage, potentially improving yield and quality.

Acknowledgements

This project was supported by Manitoba Canola Growers, Fluid Fertilizer Foundation, Westco Fertilizers, Cargill, Ltd. and the Matching Investment Initiative of Agriculture and Agri-Food Canada.

References

Dowling CW (1993). Tolerance of ten crop species to atmospheric ammonia during seed germination, radicle and coleoptile growth. (Ed. NJ Barrow) Plant nutrition - from genetic engineering to field practice: roceedings of the Twelfth International Plant Nutrition Colloquium, 21-26 September 1993, Perth, Western Australia. pp.?541-544.

F.O.S.F.A. (2001). Oilseeds-Determination of Oil Content-Solvent Extraction (Reference Method). pp. 64-72. .O.S.F.A. International Technical Manual, Part Two, Standard Contractual Methods. Federation of Oils, Seeds and Fats Association Limited, London.

Grant CA and Bailey LD (1993). Fertility management in canola production. Can. J. Plant Sci. 73, 651-670.

Grant CA and Bailey LD (1999). Effect of seed-placed urea fertilizer and N-(*n*-butyl)thiophosphoric triamide (NBPT) on emergence and grain yield of barley. Can. J. Plant Sci. 79, 491-496.

ISO (1992). Rapeseed-Determination of glucosinolate content-Part 1: Method using high performance liquid chromatography. Method number ISO 9167-1:1992. International Organization for Standardization. 9 pp.

Wang X, Xin, J, Grant, CA and Bailey LD (1995). Effects of placement of urea with a urease inhibitor on seedling emergence, N uptake and dry matter yield of wheat. Can. J. Plant Sci. 75, 449-452.