Canola Response to Polymer-Coated Urea versus Urea in a Four-Year Zero-Tillage Cropping System on the Canadian Prairies

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INTRODUCTION

Canola (*Brassica napus* L.) is very responsive to increasing soil N levels, thus N fertilizer is an essential but costly input required to attain high yields. Hybrid cultivars of canola have been widely adopted by Canadian farmers in recent years and there is some evidence than even greater amounts of N fertilizer are required to optimize hybrid canola yield. However, indiscriminate use of higher rates of N fertilizer can inadvertently increase weed growth and weed competition and lead to higher herbicide costs. Additionally, higher N fertilizer rates can potentially increase nitrate movement into groundwater or N_2O emissions to the atmosphere.

Controlled release fertilizer is one strategic approach to increasing fertilizer efficiency by synchronizing nutrient release with crop demand and thereby reducing environmental losses. Polymer-coated urea is one such type of controlled release fertilizer. A polymer-coated urea product named Environmentally Smart Nitrogen (ESN) is now commercially available in North America (Agrium Inc.) but limited information is available on the merits of its use in canola.. Thus, a multi-site field study was conducted to determine the merits of ESN compared with urea applied at recommended and higher than recommended rates on weed management plus yield of canola grown in a zero-tillage system on the Canadian prairies

MATERIALS AND METHODS

A four-year field experiment was conducted at five sites in western Canada: Lethbridge, AB (49°38′ N, 112°47′ W), Lacombe, AB (52°27′ N, 113°45′ W), Beaverlodge, AB (55°13′ N, 119°24′ W), Melfort, SK (52°79′ N, 104°30′ W), and Scott, SK (52°21′ N, 108°50′ W). Treatments included a) open-pollinated (OP) and hybrid canola, b) urea and polymer-coated urea (ESN), c) 100 and 150% of soil test N fertilizer rates, and d) 50 and 100% of registered in-crop herbicide rates. Canola and barley (*Hordeum vulgare* L.) were grown in rotation in a zero-tillage production system and both crops of the rotation were present each year. Fertilizer and herbicide rate treatments were applied to the same plots in four consecutive years. Treatments were arranged in a factorial design with four replications. Individual plot size was 4.5 m wide × 12 m long.

Glyphosate at 890 g ae ha^{-1} was applied 1 week before planting each spring to kill any existing vegetation. Canola at 150 seeds m^{-2} was planted 2 cm deep in 23-cm rows in May using a zero-till drill equipped with knife openers capable of simultaneously seeding and applying fertilizer. Glufosinate-resistant canola was grown in all years with the hybrid cultivar being 'Invigor 5020LL' and the open-pollinated (OP) cultivar being 'LBD2393LL' in the first two years and '84S00LL' in the latter two years. In the first year only, wild oat (*Avena fatua* L.) at 50 seeds m^{-2} and wild buckwheat (*Polygonum convolvulus* L.) at 35 seeds m^{-2} were sown to the entire plot area at all sites to supplement natural weed infestations.

Available soil N was determined in each N fertilizer rate treatment before planting each spring and recommended N fertilizer rates were then calculated according to the target canola yield at each site (Table 1). Urea and ESN fertilizer were side-banded 3 cm away and 5 cm below the seed row

during the seeding operation. Phosphorus at 18 kg ha^{-1} and sulphur at 10 kg ha^{-1} were placed in the canola seed row in all years. Herbicides and registered rates applied to canola at the 3 to 4 leaf stage consisted of glufosinate at 500 g ai ha^{-1} + clethodim at 7.5 g ai ha^{-1} + methylated seed oil adjuvant at 0.5% v/v. The 50% herbicide rates were one-half these respective doses but the adjuvant rate remained at 0.5% v/v. Herbicides were applied in a spray volume of 100 L ha^{-1}.

Table 1. N fertilizer rates applied to attain 100% and 150% of soil test rates according to target canola yield at each site†.

	Lethbridge		Lacombe		Beaverlodge		Melfort		Scott	
	100%	150%	100%	150%	100%	150%	100%	150%	100%	150%
	kg ha^{-1}									
2005	30	85	65	145	110	175	-	-	-	-
2006	90	145	110	170	90	160	110	190	85	140
2007	80	130	105	170	120	165	125	200	70	125
2008	65	110	95	150	70	135	90	120	70	105
2009	-	-	-	-	-	-	125	180	60	120

†Target canola yields for Lethbridge, Lacombe, Beaverlodge, Melfort, and Scott were 1.7, 2.5, 2.2, 2.5, and 1.7 tonnes ha^{-1}, respectively.

Canola and weed shoot N concentration was determined at 8 weeks after emergence (WAE) at the three Alberta sites by randomly collecting 5 to 10 plants per plot, drying at 50°C for 10 d, grinding to 0.5 mm, and analyzing for N using an automated combustion analyzer coupled with a mass spectrometer (Carlo-Erba Model NA2100, Milan, Italy). Weed biomass was determined immediately before crop harvest by hand-cutting plants at ground level in two 0.5 m^2 quadrats per plot, drying at 30°C for 10 d, and weighing. Canola was swathed at maturity and subsequently harvested with a small-plot combine. Harvested samples were cleaned of any extraneous material and weighed.

RESULTS AND DISCUSSION

Weed Tissue Nitrogen Concentration and Biomass

Wild oat and wild buckwheat N concentration at 8 WAE was usually lower when competing with hybrid than with OP canola (data not shown). Additionally, weed N concentration was often lower with ESN compared with urea fertilizer. These are desirable findings as reduced N uptake by weeds means that weed competition may be reduced and greater amounts of soil N will potentially be available to the crop.

Weed biomass was lower with hybrid than with OP canola in 13 of 16 site-years (data not shown). Weed biomass was greater with the 50% compared with the 100% herbicide rate in 16 of 18 site-years. This is an expected result with OP canola but other studies have indicated that reduced herbicide rates might be efficacious with more competitive hybrid cultivars. However, this was not the case in our study.

Canola N concentration was sometimes lower with ESN compared with urea at 8 WAE (data not shown) but remained above the critical 20 g kg^{-1} in 90% of the cases. An increase in N fertilizer rate from 100 to 150% of the soil test recommendation increased canola N concentration in 95% of the cases.

Canola yield was greater with hybrid compared with OP cultivars in 15 of 20 site-years (Table 2). The mean yield increase with hybrid canola was 257, 670, 428, 290, and 338 kg ha^{-1} at Lethbridge, Lacombe, Beaverlodge, Melfort, and Scott, respectively. Canola yield was similar with ESN and urea fertilizer in 14 of 20 site-years. ESN compared with urea resulted in greater canola yields in four site-years and there was one additional site-year where this result occurred with hybrid canola. An increase in N fertilizer rate from 100 to 150% of the soil test recommendation resulted in a greater canola yield in 10 of 20 site-years. This higher N rate effect occurred in three additional site-years with hybrid but not OP canola, suggesting that hybrid cultivars have a greater N demand than OP cultivars under some conditions. A 50% herbicide rate reduction reduced canola yield in 11 of 20 site-years.

CONCLUSIONS

Canola yields were greater with hybrid than with OP cultivars in 75% of the cases, confirming the higher yield potential of hybrid cultivars in most situations. Additional noted advantages of hybrid cultivars included reduced weed tissue N concentration and lower weed biomass production.

Previous research has indicated that higher N fertilization rates may be required for hybrid compared with OP canola. However, this only occurred in 3 of 20 site-years in our study. It is noteworthy that both hybrid and OP cultivars expressed a positive yield response to 150% of the recommended soil test N rate in 10 of 20 site-years. Canola growers will need to consider the economics of higher N fertilizer rates but they currently may be under fertilizing their canola crops.

ESN compared with urea expressed a few positive benefits. Weed N concentration was often lower with ESN than with urea, indicating that crop-weed competition for soil N might be reduced. Canola tissue N concentration was often lower with ESN compared with urea but remained above the critical N concentration required for high yields in most cases. Reduced canola N concentration with ESN early in the growing season could be beneficial if more soil N was available during the reproductive phases of canola development. Canola yield was greater with ESN compared with urea in 4 of 20 site-years with both cultivars and in one additional site-year with hybrid canola. Farmers will be advised of these findings to facilitate development of improved canola production practices.

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Table 2. Canola yield response to cultivar, N fertilizer formulation, N fertilizer rate, and herbicide rate.

	Cultivar		N formulation		N rate		Herbicide rate	
	OP†	Hybrid	Urea	ESN	100%	150%	50%	100%
	kg ha^{-1}							
Lethbridge								
2005	1230 b	1520 a	1390 b	1590 a	1460 a	1530 a	1520 a	1470 a
2006	2510 b	2690 a	2520 b	2670 a	2520 a	2660 a	2510 b	2680 a
2007	1020 b	1490 a	1230 a	1290 a	1170 b	1340 a	990 b	1410 a
2008	1530 a	1650 a	1600 a	1570 a	1410 b	1760 a	1340 b	1830 a
Lacombe								
2005	3540 b	4280 a	3780 a	3830 a	3690 b	3920 a	3830 a	3780 a
2006	3210 a	3290 a	- ‡		3180 a	3370 a	3210 a	3350 a
2007	2020 b	2310 a	2230 a	2140 a	2090 a	2230 a	2090 b	2310 a
2008	2480 b	3460 a	3060 a	2900 a	2760 b	3190 a	- §	
Beaverlodge								
2005	2570 b	3420 a	2900 b	3110 a	2820 b	3440 a	2910 a	3080 a
2006	960 b	1500 a	1220 a	1240 a	1260 a	1200 a	1120 b	1340 a
2007	1420 b	1580 a	1600 a	1410 b	1430 b	1620 a	1440 b	1590 a
2008	670 b	830 a	690 a	800 a	620 b	870 a	730 a	770 a
Melfort								
2006	2300 b	2590 a	2470 a	2410 a	2340 b	2550 a	2470 a	2490 a
2007	2470 a	2360 a	2440 a	2380 a	- ¶		2370 a	2440 a
2008	2110 a	2130 a	2100 a	2130 a	2090 a	2130 a	2040 b	2190 a
2009	1530 a	1580 a	1590 a	1510 a	- ¶		1460 b	1650 a
Scott								
2006	2040 b	2360 a	2110 b	2270 a	2180 a	2240 a	2160 a	2240 a
2007	1910 b	2240 a	2020 a	2050 a	1920 b	2230 a	1880 b	2260 a
2008	1400 b	1720 a	1480 a	1590 a	1450 b	1670 a	1460 b	1660 a
2009	640 b	1020 a	840 a	820 a	- ¶		510 b	1160 a

†Means within a site, year, and treatment followed by the same letter are not significantly different ($P > 0.05$) according to Fisher's protected LSD.

‡Canola yield was greater with ESN compared with urea fertilizer (3420 vs. 3160 kg ha^{-1}) with hybrid but not with OP canola at Lacombe in 2006.

§Canola yield was greater with 100% compared with 50% herbicide (3340 vs. 2190 kg ha^{-1}) with OP but not with hybrid canola at Lacombe in 2008.

¶Canola yield was greater with 150% compared with 100% N fertilizer rate (2790 vs. 2510 kg ha^{-1} at Melfort in 2007; 1720 vs. 1430 kg ha^{-1} at Melfort in 2009; 1120 vs. 930 kg ha^{-1} at Scott in 2009) with hybrid but not with OP canola.