Optimizing Fertilizer Application Timing for Winter Canola in Northern Idaho

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INTRODUCTION

Two major factors that limit the expansion of winter canola acreage in the Pacific Northwest (PNW) are difficulties in establishing the crop due to dry soil conditions in the seed zone at planting and, to a lesser degree, crop loss due to winterkill. In PNW dryland cropping systems, winter canola must be seeded into summer fallow. One approach to avoiding establishment difficulties at traditional mid- to late August seeding times is to simply plant at an earlier time when soil moisture is still available in the seed zone. One concern with this approach is the potential for the crop to run out of moisture before fall rains. Research at the University of Idaho has shown that this is unlikely in the high rainfall zones of the Inland PNW that receive 16 or more inches of precipitation per year, but it has occurred in lower rainfall zones.

Early-planted winter canola will yield as much or more than that planted at traditional dates, but in some years reduced winter survival and reduced yields have been documented in early-planted winter canola. Winter survival and yield potential appears to depend on a number of factors including the amount of plant growth in the summer after planting, moisture availability in the late fall, the amount of growth during fall, the degree of hardening that occurs prior to the first hard freeze, and minimum winter temperatures and the duration of those temperatures at the soil surface. Limited moisture appears to decrease the ability of winter canola to harden. Key conditions for good hardening are gradually declining temperatures and good moisture availability for fall growth and biomass accumulation during the hardening time.

In general, lush growth can reduce hardening and cold tolerance, and it could increase moisture use as well. In winter canola, summer growth could potentially be limited by reducing the amount of available nitrogen during the summer and early fall. To see if varying the timing of fertilizer applications would have an effect on winter survival and yield, researchers at the University of Idaho initiated a trial in 2013 to examine the effects of five nitrogen application regimes on winter survival and seed yield in both early-planted winter canola and that planted at a traditional time. The trial was funded by the USDA-NIFA PNW Canola Research Program.

MATERIALS AND METHODS

The field trial was established near Moscow, Idaho using ‘Amanda’ and ‘Baldur’ winter canola. Plots were seeded into conventional summer fallow in mid-July and late August 2013 and 2014 for the 2014 and 2015 crop years, respectively. Planting dates were July 18, 2013; August 22, 2013; July 15, 2014; and August 18, 2014. The August 2013 planting had poor emergence due to dry seed zone soil and was replanted on September 12, 2013 after rain. The plots were 4 feet x 15 feet on 5-foot centers and were seeded with a six-row plot planter with John Deere double-disk openers in 2013 and a five-row planter with Flexicoil Stealth paired-row shank openers. Both planters were equipped with packer wheels. The seeding rate was 6 pounds of seed per acre.

Soil samples were taken before planting to determine pre-plant available nitrogen, which was approximately 50 lbs. in the top two feet both years. Nitrogen was applied at 160 lbs. per acre to each treatment to bring the total available N for the crop year to 210 lbs. per acre, except for a low nitrogen control that received only 35 lbs. of N at planting for 85 lbs. of total available N per acre. Sulfur and phosphorus were applied with the nitrogen at appropriate levels for the expected yield, using a 50/50 blend by weight of urea and ammonium phosphate-sulfate (31-10-0-7.5). Soil levels of potassium and boron were adequate without supplementation. The fertilizer applied at planting was broadcast and incorporated to six inches with a field cultivator just prior to the first planting date. The remaining treatments were broadcast as top-dress applications on the established plots at the appropriate times.

Five nitrogen application timing treatments were used. The low nitrogen treatment, which was applied at planting, had approximately 40% of the available nitrogen of the other treatments and was used as a control. The first full nitrogen treatment had all of the fertilizer applied at planting. The second full treatment had a split with 50% of the fertilizer applied in the fall and 50% applied in the spring. Other treatments were a 25:25:50 split (planting:fall:spring) and a 25:0:75 split. Fall application dates were November 1, 2013 and December 8, 2014; spring application dates were March 25, 2014 and April 2, 2014.

RESULTS

Averaged over the two years of the trial, Amanda yielded higher that Baldur and Amanda had a higher winter survival score. (See Table 1.) The late planting date resulted in increased winter survival compared to the July planting in 2014, but in spite of that, the seed yield was higher with the early planting. In 2015, planting date did not have an effect on winter survival, and seed yield was higher with the traditional August planting date. When averaged across both years, the mean winter survival score was higher for the mid-August planting than for the July planting due to the strong difference in 2014, but the seed yields of the two planting dates were similar.

Table 1. Seed yield and winter survival scores of two winter canola cultivars with two planting dates near Moscow, Idaho in the 2014 and 2015 crop years.

Treatment	**Seed Yield**			**Winter Survival**		
	2014	**2015**	**Mean**	**2014**	**2015**	**Mean**
Cultivar		*-- lbs. per acre --*			*-- score --*[1]	
Amanda	1945 a[2]	3536 b	2710 b	7.5 a	5.9 b	6.7 b
Baldur	2323 b	2776 a	2538 a	7.5 a	5.0 a	6.2 a
Planting Time						
Mid-July	2358 b	2834 a	2583 a	5.6 a	5.3 a	5.6 a
Mid- August	1911 a	3480 b	2665 a	9.0 b	5.5 a	7.3 b

[1] Scored on a scale of 1 to 9 with one equaling no survival and 9 equaling complete survival.
[2] Means within columns with different letters are significantly ($P<0.05$) different.

As expected, the reduced nitrogen treatment resulted in a lower seed yield, but winter survival was not affected. (See Table 2.) Winter survival and seed yield were reduced when all of the recommended nitrogen was applied at planting. The remaining treatments had winter survival and yields that were similar to each other. The only deviation from this pattern was in the 2013-2014 late-planted treatment, where no winter damage was observed with any of the treatments. (Data not shown.) The yield reduction associated with applying all of the nitrogen at planting (160 lbs. N per acre) was so great that the two-year mean yield of that treatment was equivalent to the low nitrogen treatment that received only 35 lbs. of N per acre.

Table 2. Mean seed yield of two canola cultivars with five nitrogen fertility timing regimes grown near Moscow, Idaho in the 2014 and 2015 crop years.

Fertilizer Timing Treatment	**Seed Yield**			**Winter**
	2014	**2015**	**Mean**	**Survival**
	------------ *lbs. per acre* -----------			- -*score*[1]--
Reduced N at Planting Only	1680 a[2]	2695 a	2154 a	6.5 b
All at Planting	1978 b	2405 a	2178 a	5.4 a
None at Planting, 50% in Fall, 50% in Spring	2346 c	3775 b	3038 b	6.9 b
25% at Planting, 25% in Fall, 50% in Spring	2306 c	3594 b	2929 b	6.7 b
25% at Planting, 75% in Spring	2360 c	3257 b	2794 b	6.8 b

[1] Scored on a scale of 1 to 9 with one equaling no survival and 9 equaling complete survival.
[2] Means within columns with different letters are significantly ($P<0.05$) different.

The numerically best fertilizer timing regime based on two-year mean seed yields was the one with no nitrogen applied at planting and a 50:50 fall-spring split; however, this regime was not significantly different from the 25:25:50 and the 25:0:75 treatments. The worst approach was to apply all the fertilizer at seeding. The decreased winter survival seen in that treatment suggests that extra vegetative growth in the summer does reduce hardening in winter canola. The yield decrease seen with the all-at-planting treatment could be due to decreased winter survival, loss of nitrogen during the summer from volatilization of the urea, loss of nitrogen and sulfur during the winter, or more likely a combination of all three. We observed no effects from the fertilizer treatments on seedling emergence. To maximize yield, the rate of fertilizer applied at planting should be kept low, especially when planting at dates that are earlier than traditional, and the remaining fertilizer should be split between late fall and early spring applications.

Further research could better explain the differences between the treatments observed in this trial. Additional fall and spring soil tests would document over-winter fertilizer losses. Measuring plant biomass would quantify any additional vegetative growth caused by high fertilizer applications at planting, and periodic soil moisture measurements would show any differences in soil moisture use among the treatments during summer and fall growth.