Effect of paraquat and diquat applied preharvest on canola yield and seed quality

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The concept of straight combining canola is gaining favor among growers in North Dakota. The majority of canola acres are swathed; however, it has been estimated that at least 15% were straight combined in 2006. Growers have indicated they would increase their canola acres if they could eliminate swathing, which is very time consuming and leaves the crop susceptible to strong winds for 2-4 weeks depending on weather conditions and work load.

A series of studies conducted by NDSU's Kent McKay in 2005 and 2006 demonstrated that timely straight combining can achieve similar or better canola yields compared to swathing. Straight-combined canola tended to have lower harvest moisture, darker seed color, lower green seed, and higher test weight. Under optimal conditions and management, it appears that straight combining is a feasible option for many growers.

However, under certain environmental conditions such as the very cool, wet conditions we experienced in 2004 in North Dakota, straight combining may not be advisable without the assistance of a desiccant to help dry down the crop. In 2004, we experienced record cool temperatures that significantly delayed maturity and the dry-down of many crops. In this case, swathing helped to dry down the pods, branches, and stalks. Growers that might have planned to straight combine may have found the crop too immature or wet to cut. However, applying a desiccant could accelerate dry down and allow growers to straight combine within 7-10 days. Following the cold 2004 season in North Dakota, the 2005 season was among the wettest on record. In 2005, a Section 18 emergency exemption was approved allowing growers to use Reglone as a canola pre-harvest desiccant. Reglone was selected as the desiccant of choice over Gramoxone by the manufacturer. However, essentially no Reglone was used due to lack of information and experience with applying a desiccant followed by straight combining.

Currently, there are no herbicides labeled for use as a canola desiccant in the U.S. Reglone is labeled for use in Canada, but not Gramoxone. Research trials were initiated in 2005 to provide residue data that EPA will use for a future label for Gramoxone as a pre-harvest canola desiccant. Currently, Gramoxone is considerably less expensive than Reglone. Given that a desiccant will be labeled in the coming years, there are questions to be answered regarding its use. For example, what is the proper canola stage to apply the desiccant? After the application, how many days must one wait to harvest the canola? Will a desiccant increase shattering potential or pod drop? Does application timing or harvest date affect green seed count, yield, test weight, oil content, or grade? How does canola overall yield and seed quality compare when using a desiccant vs. swathing?

These questions were addressed in a two-year study conducted at Minot and Langdon, ND and Bozeman, MT. Only the ND data will be presented below. This study evaluating the use of desiccants as a harvest aid in canola was conducted in 2005 and 2006 at the North Central Research Extension Center, Minot, ND, and the Langdon Research Extension Center, Langdon, ND.

OBJECTIVES

- Determine the effect of Gramoxone and Reglone applied pre-harvest at three timings on canola yield, seed moisture, and seed quality.
- Compare Gramoxone and Reglone-treated canola to swathed canola.
- Determine the effect of harvest timing following a Gramoxone or Reglone application on canola yield, seed moisture, and seed quality.

PROCEDURES USED

Gramoxone (paraquat) and Reglone (diquat) were applied pre-harvest at three timings approximately as outlined in Tables 1 and 2. Gramoxone was applied at 1.3 pt/A with NIS at 0.25% v/v. Reglone was applied at 1.5 pt/A with NIS at 0.25% v/v. One treatment was swathed with a plot swather on the same days the Gramoxone and Reglone treatments were applied as a comparison to current grower practices. The Gramoxone, Reglone, and swath treatments were harvested approximately 7 and 14 days after treatment (DAT).

The study evaluated three factors (desiccant, timing, harvest date) and was arranged in a randomized complete block design. Individual plots were 10 by 30 ft with four replications. Data collected included seed loss due to shattering prior to harvest, canola yield, test weight, seed moisture content at harvest, percent oil content, green count, seed damage, and grade. Four sticky cards (6-inch by 12-inch) were placed on the ground under the canopy just prior to or following the desiccant treatment. Sticky cards were collected just prior to harvest and seeds were counted and the numbers converted to estimate yield loss per acre. Plots were harvested with a plot combine to determine canola yield and test weight. Samples from all locations were analyzed for oil content in Minot, then sent to Archer Daniels Midland, Velva, ND for green count, seed damage and grade analyses.

Table 1. Target canola stages for pre-harvest Gramoxone and Reglone

Canola seed color	Application #1	Application #2	Application #3
Top 1/3	Green	Green to light green	Light green to yellow
Middle 1/3	Light green with a few just starting to turn reddish brown	Fewer light green with most light brown or reddish brown	Some light brown, but most reddish brown
Bottom 1/3	Light brown to reddish brown, some purple	Fewer light brown, mostly reddish brown to purple	Reddish brown or purple

Table 2. Actual desiccant application and swath dates for Langdon and Minot, ND.

	Langdon		Minot	
	2005	2006	2005	2006
Timing 1	August 5	July 27	August 2	July 24
Timing 2	August 8	August 1	August 5	July 27

Timing 3	August 15	August 7	August 9	July 28

RESULTS

Desiccant comparison:
Gramoxone- and Reglone-treated plots produced similar results to swathing when comparing canola yield and seed quality parameters, with the exception of green seed content. Swathing generally had lower green content and thus less total damage. At Langdon, green content was generally higher in the desiccant-treated plots compared to swathing, especially in application timings 1 and 2 (Tables 3, 4, and 7). It should be noted that there was severe lodging at Langdon in 2005, which inhibited canopy penetration by the desiccant. Crop lodging resulted in the upper portion of the canopy being desiccated, while the underside of the canopy remained green and resulted in higher green content. There was less lodging at Minot in 2005, but lodging was a contributing factor in the high green content of some plots, especially the early Reglone treatment harvested 7 DAT (Tables 5 and 6) .

Timing comparison:
One of the major objectives of this study was to determine the correct crop stage to safely apply a desiccant where there would be little effect on crop yield or quality. Desiccant-treated plots produced similar canola yield, test weight, and oil content to swathing at all timings at both locations in both years. However, at Langdon in 2005, swathing or desiccating at timing 1 and 2 resulted in lower yield and test weight. In 2006, desiccant applications and swathing were done slightly later and did not affect yield or test weight. It should be noted that conditions were very wet in 2005, while 2006 was very dry. As would be expected, green content generally was slightly lower at timing 3 compared to timings 1 and 2.

Based on these data, it appears that optimal timing for a desiccant may be when seeds in the middle pods have started to turn in color. At Langdon, application prior to color-turn in seeds of the middle pods resulted in lower yield and seed quality.

Harvest date comparison:
There was minimal seed lost due to shattering at either harvest date at either location. Statistically, there was more seed lost at 14 DAT compared to 7 DAT, but the loss was minimal from an agronomic standpoint generally being less than 50 lb/A. Delaying the harvest date until 14 DAT did not affect yield at Minot in either year. Canola yield was actually higher at Langdon in 2005 when harvested 14 DAT compared to 7 DAT. This may be due, in part, to the fact that the desiccation, swathing, and harvest in timings 1 and 2 were done when plants were still considerably green. Unfortunately, data from the 2nd harvest date in Langdon in 2006 was lost to a hail storm. At Minot and Langdon, both desiccated and swathed canola harvested 14 DAT had lower green count and less total damage than canola harvested 7 DAT.

Conclusions:
Based on these two-year results, there may be potential to successfully use a desiccant such as Gramoxone or Reglone to desiccate canola without suffering drastic losses due to shattering or lower seed quality. In these studies, if the desiccant or swathing operations were done when seed in the middle pods had started to turn color, crop quality parameters including canola yield, test

weight, oil content, seed loss, green count, and grade were generally similar for desiccant treatments compared to swathing. However, the data indicate that very early applications could result in lower yield and seed quality, most specifically higher green content. This study will be conducted again in 2007 to determine the effect of different years and environmental conditions.

Table 3. Effect of desiccation vs. swathing on canola yield and seed quality. Harvested 7 days after treatment (Langdon, ND 2005).

	Timing	Harvest Moisture	Yield	Kernel weight	Oil content	Seed loss	Green count	Total damage	Grade
		%	lb/A	g/1000	%	lb/A	%	%	
Gramoxone	1	28.3 a	2160 a	3.10 a	45.5 a	3 b	3.7 a	4.0 a	2.0 a
Reglone	1	24.1 b	2271 a	3.08 a	45.7 a	15 b	2.3 a	2.4 a	1.5 a
Swath	1	21.1 c	2352 a	3.05 a	45.1 a	54 a	2.7 a	2.8 a	1.5 a
Gramoxone	2	24.3 a	2315 a	3.28 a	47.4 a	19 ab	7.6 a	8.3 a	2.5 a
Reglone	2	22.3 ab	2600 a	3.25 a	47.2 a	14 b	9.2 a	9.6 a	2.5 a
Swath	2	21.5 b	2511 a	3.28 a	46.2 a	36 a	1.9 b	1.9 b	1.3 b
Gramoxone	3	16.1 a	2922 a	3.60 a	46.6 a	12 ab	2.4 a	2.5 a	1.7 a
Reglone	3	18.1 a	3053 a	3.70 a	46.4 a	3 b	3.7 a	4.4 a	1.8 a
Swath	3	16.6 a	3066 a	3.55 a	45.9 a	21 a	1.5 a	1.9 a	1.0 b

*Means followed by same letter within each timing do not significantly differ (P=0.05, LSD)

Table 4. Effect of desiccation vs. swathing on canola yield and seed quality. Harvested 14 days after treatment (Langdon, ND 2005).

	Timing	Harvest Moisture	Yield	Kernel weight	Oil content	Seed loss	Green count	Total damage	Grade
		%	lb/A	g/1000	%	lb/A	%	%	
Gramoxone	1	11.3 a	2286 a	3.05 a	46.3 a	28 b	0.8 a	1.2 a	1.0 a
Reglone	1	9.6 a	2342 a	2.95 ab	46.0 a	65 a	0.8 a	0.9 a	1.0 a
Swath	1	11.2 a	2178 a	2.88 b	44.5 b	42 b	2.2 a	2.5 a	1.3 a
Gramoxone	2	10.4 a	2735 a	3.35 a	45.6 b	26 a	4.2 a	4.7 a	2.0 a
Reglone	2	8.5 a	2736 a	3.28 a	47.0 a	42 a	3.9 a	3.9 a	2.0 a
Swath	2	8.8 a	2409 b	3.38 a	46.3 ab	37 a	0.4 b	0.4 b	1.0 b
Gramoxone	3	8.6 a	3153 a	3.88 a	45.8 a	13 b	1.9 a	1.9 a	1.5 a
Reglone	3	8.4 a	3228 a	3.75 a	46.3 a	12 b	1.1 a	1.8 a	1.0 a
Swath	3	6.7 a	3374 a	3.88 a	45.7 a	41 a	0.7 a	0.7 a	1.0 a

*Means followed by same letter within each timing do not significantly differ (P=0.05, LSD)

Table 5. Effect of desiccation vs. swathing on canola yield and seed quality. Harvested 7 days after treatment (Minot, ND 2005).

	Timing	Harvest Moisture	Yield	Test weight	Oil content	Seed loss	Green count	Total damage	Grade
		%	lb/A	lb/bu	%	lb/A	%	%	
Gramoxone	1	11.9 a	2750 a	53.3 a	46.0 a	13 a	1.0 b	1.1 b	1.3 a
Reglone	1	9.1 c	2616 a	53.8 a	45.5 a	15 a	5.6 a	5.7 a	2.3 a
Swath	1	10.4 b	2656 a	53.5 a	45.4 a	9 a	0.8 b	0.8 b	1.0 a
Gramoxone	2	11.6 a	2238 a	53.6 a	45.9 a	10 a	0.6 a	0.8 a	1.8 a
Reglone	2	10.8 a	2081 a	54.0 a	44.8 a	12 a	0.5 a	0.5 a	1.3 a
Swath	2	11.0 a	2289 a	53.7 a	45.4 a	5 a	1.0 a	1.1 a	1.3 a
Gramoxone	3	9.5 a	2760 a	53.6 a	45.1 a	48 a	1.0 a	1.1 a	1.5 a
Reglone	3	9.5 a	2576 a	53.5 a	45.4 a	36 a	1.4 a	1.5 a	1.8 a
Swath	3	9.7 a	2582 a	53.5 a	45.1 a	25 a	0.6 a	0.7 a	1.0 a

*Means followed by same letter within each timing do not significantly differ (P=0.05, LSD)

Table 6. Effect of desiccation vs. swathing on canola yield and seed quality. Harvested 14 days after treatment (Minot, ND 2005).

	Timing	Harvest Moisture	Yield	Test weight	Oil content	Seed loss	Green count	Total damage	Grade
		%	lb/A	lb/bu	%	lb/A	%	%	
Gramoxone	1	9.4 a	2502 a	53.6 a	45.3 a	36 a	0.7 ab	0.7 a	1.0 a
Reglone	1	9.0 a	2464 a	53.5 a	45.8 a	29 a	1.5 a	1.5 a	1.3 a
Swath	1	7.6 b	2447 a	53.6 a	45.2 a	27 a	0.4 b	0.6 a	1.5 a
Gramoxone	2	12.8 a	2480 a	53.6 a	45.4 a	37 a	0.4 a	0.7 a	1.8 a
Reglone	2	12.6 a	2576 a	53.6 a	45.9 a	26 a	0.4 a	0.4 a	1.0 a
Swath	2	12.1 a	2324 a	53.4 a	45.1 a	13 a	0.3 a	0.3 a	1.0 a
Gramoxone	3	9.0 a	2421 a	53.8 a	44.8 a	75 a	0.3 a	0.7 a	2.0 a
Reglone	3	9.4 a	2800 a	53.6 a	45.2 a	29 b	0.3 a	0.7 a	1.5 a
Swath	3	9.2 a	2859 a	53.5 a	45.1 a	27 b	0.2 a	0.3 a	1.3 a

*Means followed by same letter within each timing do not significantly differ (P=0.05, LSD)

Table 7. Effect of desiccation vs. swathing on canola yield and seed quality. Harvested 7 days after treatment (Langdon, ND 2006).

	Timing	Harvest Moisture	Yield	Test weight	Oil content	Seed loss	Green count	Total damage	Grade
		%	lb/A	lb/bu	%	lb/A	%	%	
Gramoxone	1	9.6 b	1613 a	53.6 a	47.7 a	58 ab	2.3 ab	2.4 a	1.5 a
Reglone	1	9.3 b	1728 a	53.5 a	48.4 a	71 a	4.0 a	4.0 a	1.8 a
Swath	1	14.2 a	1750 a	52.9 b	47.0 a	26 b	0.8 b	1.1 a	1.0 a
Gramoxone	2	11.5 a	1778 a	53.4 ab	48.4 a	68 a	1.4 a	1.7 a	1.3 a
Reglone	2	11.5 a	1858 a	53.6 a	47.6 a	63 a	2.2 a	2.6 a	1.5 a
Swath	2	10.7 a	1920 a	52.8 b	49.7 a	14 b	1.0 a	1.1 a	1.0 a
Gramoxone	3	12.6 a	1750 a	52.6 a	47.8 a	19 b	0.1 a	0.3 a	1.0 a
Reglone	3	12.8 a	1840 a	52.6 a	47.8 a	41ab	0.0 a	0.8 a	1.0 a
Swath	3	13.5 a	1720 a	52.3 a	47.7 a	71 a	0.2 a	1.1 a	1.0 a

*Means followed by same letter within each timing do not significantly differ (P=0.05, LSD)
**The 14 DAT harvest data from Langdon in 2006 is not available due to hail.

Table 8. Effect of desiccation vs. swathing on canola yield and seed quality. Harvested 7 days after treatment (Minot, ND 2006).

	Timing	Harvest Moisture	Yield	Test weight	Oil content	Seed loss	Green count	Total damage	Grade
		%	lb/A	lb/bu	%	lb/A	%	%	
Gramoxone	1	9.7 a	2325 a	52.6 a	46.1 a	4 a	1.5 a	1.7 a	1.0 a
Reglone	1	9.9 a	2452 a	52.6 a	46.6 a	2 a	1.2 a	1.3 a	1.0 a
Swath	1	10.5 a	2294 a	52.9 a	44.8 a	12 a	0.8 a	1.0 a	1.0 a
Gramoxone	2	9.8 b	2571 a	53.1 a	45.3 a	7 a	0.8 b	1.2 a	1.0 a
Reglone	2	9.9 b	2481 a	53.0 a	46.6 a	8 a	2.1 a	2.2 a	1.5 b
Swath	2	11.0 a	2223 a	52.9 a	46.1 a	7 a	0.6 b	0.8 a	1.0 a
Gramoxone	3	8.2 b	2415 a	53.2 a	46.2 a	9 a	0.8 a	1.1 a	1.0 a
Reglone	3	8.8 b	2608 a	53.3 a	46.6 a	7 a	1.1 a	1.5 a	1.3 a
Swath	3	10.1 a	2453 a	53.0 a	46.8 a	10 a	0.5 a	0.9 a	1.0 a

*Means followed by same letter within each timing do not significantly differ (P=0.05, LSD)

Table 9. Effect of desiccation vs. swathing on canola yield and seed quality. Harvested 14 days after treatment (Minot, ND 2006).

	Timing	Harvest Moisture	Yield	Test weight	Oil content	Seed loss	Green count	Total damage	Grade
		%	lb/A	lb/bu	%	lb/A	%	%	
Gramoxone	1	8.2 a	2368 a	53.4 a	45.1 a	45 a	0.6 a	0.8 a	1.0 a
Reglone	1	7.9 a	2403 a	53.4 a	45.9 a	22 b	0.6 a	1.0 a	1.0 a
Swath	1	7.7 a	2407 a	52.7 b	45.0 a	16 b	0.4 a	0.6 a	1.0 a
Gramoxone	2	8.1 a	2345 a	53.3 a	46.3 a	25 a	0.3 a	0.7 a	1.0 a
Reglone	2	8.3 a	2396 a	53.3 a	46.3 a	32 a	0.5 a	0.9 a	1.0 a
Swath	2	8.3 a	2459 a	52.9 a	45.7 a	34 a	0.7 a	1.0 a	1.0 a
Gramoxone	3	8.1 a	2379 a	53.5 a	46.0 a	24 a	0.1 a	0.5 a	1.0 a
Reglone	3	8.2 a	2678 a	53.5 a	46.9 a	34 a	0.7 a	1.1 a	1.0 a
Swath	3	8.2 a	2274 a	52.9 b	46.1 a	39 a	0.1 a	0.4 a	1.0 a