FINAL PROJECT REPORT
Canola Agronomic Research Program (CARP)

The Final Report should fully describe the work completed for the year and note the personnel involved. It should also note any deviations from the original plan and next and/or corrective steps as may be required if deviations are noted. The report should also provide an update on the status of the Project including forecasted date of completion. A complete statement of expenses should be included. In the event major changes are anticipated within the budget supporting notes along with a proposed budget should also be included. The report should also capture a complete summary of activity for the year.

Project Title: Pre-harvest herbicide/desiccation options for straight-combining canola: Effects on crop dry-down and seed quality

Research Team Information

Lead Researcher:		
Name	***Institution***	***Project Role***
Chris Holzapfel	Indian Head Agricultural Research Foundation (HARF)	Lead of protocol development and reporting; Field trial management at Indian Head
Research Team Members (add rows as required)		
Name	***Institution***	***Project Role***
Jessica Pratchler / Brianne McInnes	Northeast Agriculture Research Foundation (NARF)	Assist with protocol development and reporting; Field trial management at Melfort
Jessica Weber	Western Applied Research Corporation (WARC)	Assist with protocol development and reporting; Field trial management at Scott
Scott Chalmers	Westman Agricultural Diversification Organization (WADO)	Assist with protocol development and reporting, Field trial management at Melita

Project Start Date: April 2017 **Project Completion Date:** March 2020

Reporting Period: April 1, 2017 **to** March 31, 2020

CARP Project Number: 2017.9

Instructions: This Final Project Report shall be completed and submitted on or about March 31st of the fiscal year that the agreement is in effect (upon completion of the project). The Lead Researcher of the project in question shall complete and submit the report on behalf of his/her complete research team.

This Report is a means by which to provide a detailed account upon completion of the project. Final project financial reporting should be provided at this time.

The following template is provided to assist you in completing this task. Please forward the completed document electronically to the CCC contact listed below.

In addition to the Final Project Report, a one-page Research Abstract including rationale, objective, methodology, summary and conclusions (with a summary graph/table or supporting image for the project), acknowledgement and references is due upon completion. The Research Abstract is intended for use in publications such as the *Canola Digest* and the CCC Research Hub and is intended to support messaging to all audiences.

Please include the funding acknowledgements outlined in your research agreement in all deliverables (publications, presentations, etc.) from this project.

1. Date of Completion:

March 31, 2020

2. Status of Activity: (please check one)

_____ Ahead of Schedule __X__ On Schedule _____ Behind Schedule _____ Completed

Comment: Field trials, data analyses, and reporting activities have been completed on schedule as per the original work plan.

3. Completed actions, deliverables and results; any major issues or variance between planned and actual activities.

Objectives

The project objectives were to evaluate the effectiveness of pre-harvest herbicide/desiccant applications for assisting plant and seed dry-down in the two dominant herbicide systems (Liberty Link® - LL and Roundup Ready® - RR). Although we did not include canola hybrids all herbicide groups, the pre-harvest options, and their relative efficacy, for other non-glyphosate tolerant canola types (i.e. Clearfield®, Falco™) would be similar to those available for LL canola.

Completed Actions / Methodology

Field trials were completed during each of three growing seasons (2017, 2018, and 2019) at four locations (Indian Head, Melfort, Scott, and Melita). The treatments were two hybrids (LL versus RR) and four pre-harvest application options plus an untreated control for each hybrid. In 2017, the two hybrids were L233P LL and 45M35 RR. In 2018 and 2019, L233P was replaced with L255PC in hopes that it would be more similar to 45M35 with respect to crop development throughout the season and maturity date. The ten treatments that were evaluated are described in Table 1 below. Timing of the pre-harvest treatments were targeted for 60-75% seed colour change (glyphosate and saflufenacil) or approximately 90% seed colour change (glufosinate ammonium and diquat); however, the actual crop stages varied to some extent due to differences between hybrids, logistic considerations and weather. For all products, excluding glyphosate applied alone (where lower application volumes were permitted but not required), the minimum solution volume was 187 l/ha (20 U.S. gallons per acre). Treatment 7 (RR – glufosinate ammonium) was not included at the 2017-Melfort site due to a misinterpretation of the protocol. Overall, the wide range of environmental conditions combined with a certain amount of variation in treatment application and harvest timing provided a robust evaluation of the treatments.

Table 1. Treatment list for Canola Pre-harvest Application Study (CARP 2017.9).

Treatment Name	
1) LL – untreated	**6)** RR – untreated
2) LL – glyphosate (890 g ai/ha) [Z]	**7)** RR – glufosinate ammonium (408 g ai/ha) [Y]
3) LL – saflufenacil (50 g ai/ha) [Z]	**8)** RR – saflufenacil (50 g ai/ha) [Z]
4) LL – glyphosate (890 g ai/ha) + saflufenacil (50 g ai/ha) [Z]	**9)** RR - glyphosate (890 g ai/ha) + saflufenacil (50 g ai/ha) [Z]
5) LL – diquat (40 g ai/ha) [Y]	**10)** RR – diquat (40 g ai/ha) [Y]

LL – Liberty Link® (glufosinate ammonium tolerant); RR – Roundup Ready® (glyphosate tolerant)
[Z] Target 60-75% seed colour change; [Y] Target 90% seed colour change

Selected agronomic information and dates of operations are provided in Tables A-1 through A-3 of the Appendices. Seeding was generally completed within the first three weeks of May with canola direct-seeded into cereal stubble, target seeding rates ranging from 120-125 seeds/m^2, and row spacing ranging from 24-30 cm. Plot size varied across locations depending on seeding equipment and other site-specific considerations. With the exception of 2017-Melfort where no herbicides were applied, weeds were controlled using registered pre-emergent and in-crop herbicides. At Indian Head and Melita, conventional canola herbicide options (i.e. Edge, Lontrel, Muster, etc.) were utilized while, at Scott and Melfort in 2018 and 2019, each variety was sprayed with its partner in-crop herbicide (i.e. glyphosate or glufosinate ammonium). Insecticides were only applied if necessary while foliar fungicides were applied preventatively to reduce the risks of sclerotinia stem rot at all locations except Melita where no foliar fungicides were applied. Harvest dates varied with site-year; however, all treatments were harvested on the same date for individual hybrids and, in most cases, both varieties were harvested on the same date. The intent was to give the earlier pre-harvest applications (glyphosate and saflufenacil) a minimum of 14 days to affect crop dry-down while also harvesting within 14 days of the later applications (i.e. diquat and glufosinate ammonium); however, actual timings of operations varied. The challenge was to find the right balance between giving the pre-harvest applications enough time to work while also harvesting the plots early enough that treatment effects (i.e. differences in whole plant and seed moisture content) would still be evident. In many cases, this meant harvesting when some plots were still relatively tough/green; however, in some, the canola dried down rapidly and harvest was completed relatively early after the treatment applications (i.e. 10 days at Melita 2019). In other cases, cold, wet late-season weather delayed maturity, treatment applications and harvest; thus, diminishing our ability to detect treatment differences (i.e. Melfort 2019).

Various data were collected to provide explanatory background information and assess treatment effects on both plant/seed dry-down and grain quality. As an indicator of overall site establishment and variability, plant densities were estimated by counting plants in two separate 1 m sections of crop row per plot. These measurements were completed in the spring, after emergence was complete, and the values were converted to plants/m^2. Visual stem dry-down ratings were completed prior to harvest where the front and back of each plot was rated on a scale of 0-100 where a rating of 100 indicated that the plants, focusing on the stems, visually appeared to be completely dried down. These values were very subjective and, therefore, of somewhat limited practical value. Whole plant moisture at combining was determined by harvesting all of the above-ground biomass from a minimum of 1 m of crop row within 24 hours of combining, determining both the fresh and dry weights, and calculating percent (wet basis) gravimetric water content [(fresh weight - dry weight)/fresh weight)]. At Indian Head, these samples were collected from unharvested crop rows while, at the other sites, the plots were smaller so samples were collected prior to combining where the entire plot areas were harvested. Seed moisture content was measured in a similar manner and using the same formula as opposed to using electronic meters. The rationale for using gravimetric water content for the seed was that we expected the values to occasionally fall outside of the testable limits of approximately 5.5-15%. While this approach generally worked well, there were cases where the absolute values were unusually low and it appeared that either some drying had occurred between sampling and fresh weight determination or the samples were not completely dried before dry weight determination (i.e. seed moisture and Scott and Melfort in 2017). This was also observed for the whole plant moisture measurements to a certain extent. Seed yields were corrected for dockage and to a uniform moisture content of 10%. Seed weight was determined by counting a minimum of 500 seeds using automated seed counters, weighing the counted seeds to the nearest 0.00 g, and calculating g/1000 seeds. Green seed was assessed by crushing 500 seeds per plot, counting any distinctly green seeds, and converting the values to percent green seed. Daily temperatures and precipitation amounts were compiled from the nearest Environment Canada weather station.

Exploratory statistical analyses and basic evaluation of the data confirmed that the results varied by site-year due to factors such as hybrid, weather, timing of operations, and the specific methods/equipment used for plant and seed moisture determination. As such, it was difficult to group site-years in a meaningful manner that would be advantageous over simply analyzing each site-year individually. While this approach creates challenges for summarizing the results in a simple and precise manner, it would be inappropriate to compare values directly across site-years for many variables and misleading to simply average data across sites given the high variability and, at times, contrasting results. Log and arcsine transformations were explored for the percentage data; however, none consistently improved model convergence and therefore the original, untransformed values were analyzed and summarized for simplicity. Data were analyzed using the Mixed procedure of SAS with the effects of treatment (hybrid x pre-harvest treatment) considered fixed and replicate effects considered random. Individual treatment means were separated using Fisher's protected LSD test. Additional contrasts were used to compared the control treatments to all treated plots (untreated versus treated) and individual pre-harvest herbicide/desiccant products directly to their respective control treatments, averaged across canola herbicide systems where applicable. For the most part, overall treatment effects and differences between individual means were considered significant at $P \leq 0.05$; however, for the contrasts, actual p-values are provided but sites where $P \leq 0.10$ were considered responsive when summarizing and interpreting these results.

Results – Weather

Growing season temperatures and precipitation amounts for the 2017-19 growing seasons (May-September) relative to the long-term averages are provided in Tables A-4 and A-5 of the Appendices, respectively. While data for September is unlikely to have ever impacted establishment or yield, it is relevant for providing information on general harvest conditions for most sites (i.e. except those where harvest was completed in August). Broadly speaking, harvest was completed earliest at Melita and the crop usually dried down reasonably well at that location while, at Melfort, the opposite sometimes occurred. For example, at Melfort-2019 there was a killing frost prior to maturity and the application of any treatments followed by an extended period of wet and cold weather. Consequently, there were quality issues in all treatments for this site-year and relatively little benefit to any of the pre-harvest treatments. Overall, the wide range of weather conditions encountered over the 3-year period at four locations provided a robust evaluation of the pre-harvest herbicide and desiccant applications that were evaluated.

Results – Crop Establishment

Plant populations were measured and analyzed for supplemental background information and could not be affected by the pre-harvest herbicide/desiccant applications as these treatments had not yet been applied when the measurements were completed. Overall F-test results are provided with the individual treatment means for all sites in Table A-6 of the Appendices. Seeding rates were adjusted for seed size and germination with objective of achieving similar plant populations for both hybrids. Although the overall densities varied widely from site-to-site, the overall F-test was not significant at 10/12 site-years indicating that plant populations were similar regardless of treatment in the vast majority of cases. The exceptions were Indian Head-2017 and Melita-2017 where the responses were mainly due to generally lower plant densities with the RR compared to the LL hybrid.

Results – Visual Stem Dry-down Ratings

Detailed results for the final visual dry-down ratings (completed just prior to harvest) are provided in the Appendices. At Indian Head (Table A-7), final visual dry-down ratings were always affected by treatment ($P < 0.001$). The lowest ratings were generally observed in the control plots while the highest dry-down ratings tended to occur with diquat in 2017 and 2018 but not for LL canola in 2019 where values with diquat were intermediate between the control and the other pre-harvest options. In the majority of cases at Indian Head, visual dry-down ratings were intermediate with glyphosate, saflufenacil, and glufosinate ammonium. In the case of the RR canola at Indian Head 2019, visual dry-down ratings were lower for glufosinate ammonium than for the corresponding control; however, this could only be attributed to naturally occurring variability and/or the subjective nature of these ratings as it was inconsistent with expected results, other measurements from the same plots, and results from other site-years. At Melfort (Table A-10), these measurements were not completed in 2017 and all values were relatively high (90-100%) and not affected by treatment in 2018 and 2019 (P = 0.137-0.881). At Melita (Table A-13), visual stem dry-down ratings varied in 2017 and 2019 (P < 0.001), but not in 2018 where all values were rated as 100% (i.e. completely dried down) and not statistically analyzed. For both RR and LL canola in 2017 and 2019 at Melita, diquat led to the highest visual dry-down ratings. The remaining options generally resulted in intermediate values but the specific results varied to some extent. At Scott (Table A-16), visual dry-down ratings were affected by the treatments in all years (P < 0.001). Again, values were consistently lowest in the untreated control plots (as expected) but the relative rankings and whether or not values significantly differed from the control varied. To aid in interpreting these results, final visual dry-down ratings for all sites are provided for LL and RR canola in Figs. 1 and 2, respectively.

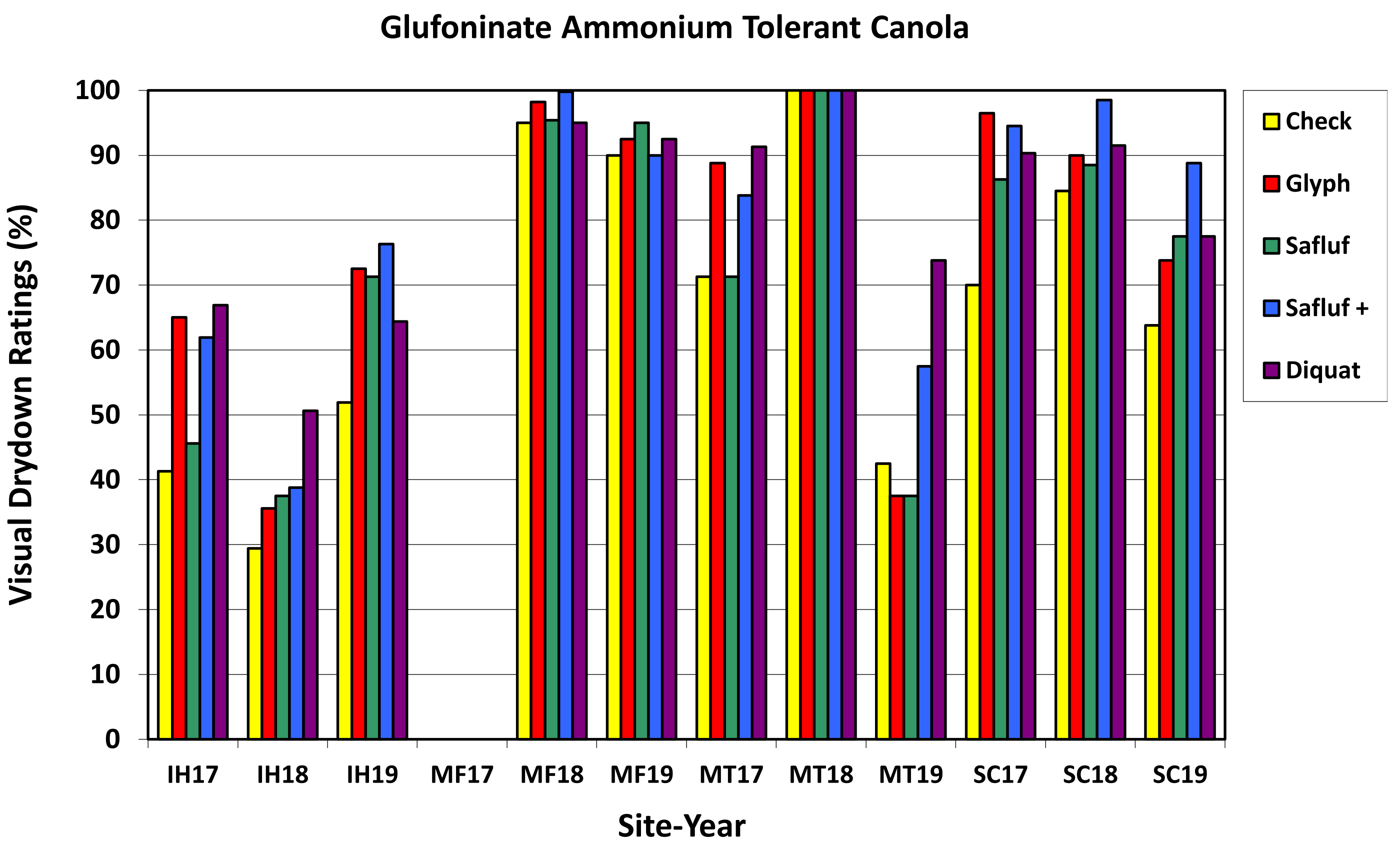

Figure 1. Visual dry-down ratings for glufosinate ammonium tolerant (LL) canola where higher values within a site-year indicate that there appeared to be greater stem dry-down. These measurements were not completed at MF17. Detailed results are provided in Tables A-7, A-10, A-13, and A-16 of the Appendices.

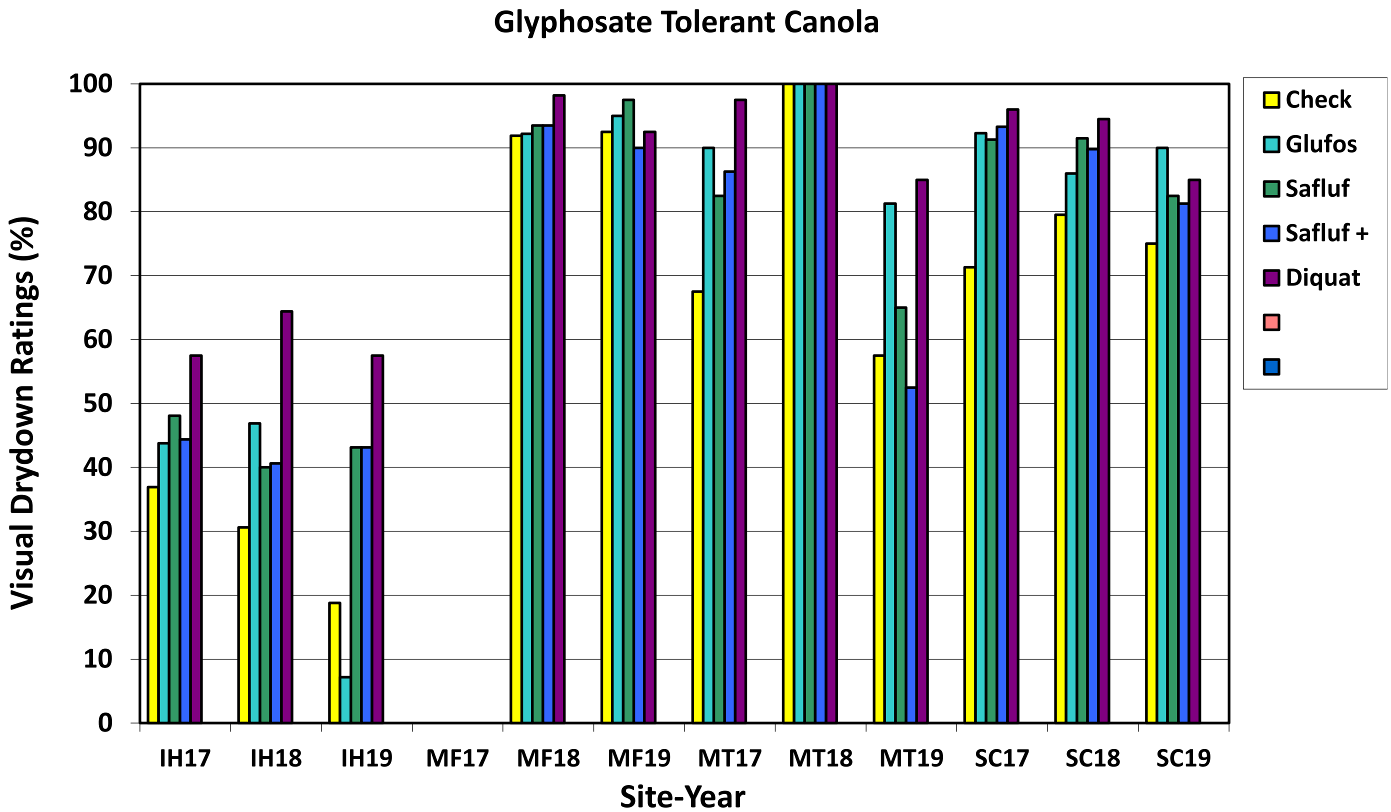

Figure 2. Visual dry-down ratings for glyphosate tolerant (RR) canola where higher values within a site-year indicate that there appeared to be greater stem dry-down. These measurements were not completed at MF17. Detailed results are provided in Tables A-7, A-10, A-13, and A-16 of the Appendices.

<u>Results – Whole Plant Dry-Down</u>

The whole plant moisture content measurements were intended to be an objective indicator of the treatment ability to enhance the dry-down of crop stem and leaf material; however, the values also include seed moisture since the plants were not threshed prior to moisture determination. While the relative differences between treatments within site-years were always considered valid, the absolute values should be interpreted cautiously and cannot generally be used to compare whole plant moisture content at harvest from one site-year to the next. For example, there were cases where values appeared to be impossibly low indicating that either some drying had occurred between harvest and fresh weight determination or that the samples still contained moisture when the oven-dry weights were determined. Amongst other factors, this is an important reason why the data were not combined across all locations for statistical analyses. Focusing on the specific results, the overall F-test was significant ($P \leq 0.05$) at 9/12 site-years and marginally significant ($P \leq 0.010$) at 11/12 site-years; thus, indicating that hybrid and/or the pre-harvest treatments affected whole plant moisture content at harvest time in the vast majority of cases. At Indian Head (Table A-7), the overall F-test was always highly significant ($P < 0.001$) and there was generally good treatment separation in all three years with the exception of the LL canola in 2017 where all treatments dried down quite well regardless of the pre-harvest herbicide/desiccant treatment. The observed values were consistently lowest with diquat but the other options tested also frequently reduced whole plant moisture content. At Melfort (Table A-10), the values were more variable and less frequently significant with a significant F-test in 2017 ($P = 0.004$) but not 2018 ($P = 0.220$) or 2019 ($P = 0.074$). With LL canola in 2017, all of the pre-harvest options reduced plant moisture content. The lack of treatment effects in 2018 and 2019 may have been due in part to wet weather and delays late in the season. At Melita (Table A-13), treatment effects were highly significant in 2017 and 2019 (P <0.001-0.032) but only marginally so in 2018 ($P = 0.079$). For LL canola at Melita, diquat provided the most consistent benefit, followed by glyphosate while whole plant moisture content with saflufenacil applied alone was always similar to the control. For RR canola at Melita, whole plant moisture content values were variable and the only significant effect of interest was a reduction with diquat in 2017. At Scott (Table A-16) there were highly significant ($P < 0.001$) treatment effects in all three years. Focusing on LL canola there were benefits in all years but the relative performance of the options varied. In 2017, the greatest benefit came from glyphosate, in 2019 both glyphosate and diquat were beneficial, and in 2019 only diquat significantly reduced the values relative to the control. For RR canola at Scott, the best results were with diquat in 2017 and 2018 but not in 2019 where the greatest reduction in whole plant moisture content was with glufosinate ammonium. Saflufenacil reduced whole plant moisture content at Scott for RR canola in 2018 but not in any other cases at this location.

Because this was such an important measurement and the effects of the treatments were not always consistent, the results were further summarized in Table 2. Furthermore, since the data were rather variable and analyzed for each site individually (which limits overall statistical power to some extent), p-values less than or equal to 0.10 were grouped together as significant. There was an overall average reduction in whole plant moisture content from 29% to 25% with pre-harvest applications (averaged across site-years, varieties and product options) and the response was significant at 67% of the individual site-years. Glyphosate applied alone reduced moisture content in LL canola 67% of the time (from 29% to 24% across all site-years) while glufosinate ammonium reduced plant moisture content in RR canola 45% of the time (from 28% to 24% on average). In order to keep the effects of glyphosate and saflufenacil separate (for LL canola in particular), only the results from saflufenacil applied alone are included in Table 2 and the results are averaged across both RR and LL canola. Saflufenacil significantly reduced whole plant moisture content relative to the control at 33% of the site-years, from approximately 29% to 27% when averaged across all 12 site-years and both canola herbicide systems. Finally, diquat reduced plant moisture content at 83% of the site-years, from 29% to 22% when averaged across herbicide systems and site-years. In addition, the overall averages were also calculated exclusively from the responsive sites to permit comparing the effects specifically in cases where benefits were observed.

Table 2. Contrasts comparing the effects of pre-harvest herbicide/desiccation options relative to untreated control plots along with overall averages for canola whole plant moisture content (%) at harvest for four locations (Indian Head, Melfort, Melita, and Scott) over a three-year period (2017, 2018, and 2019).

Location – Year	**Untreated vs treated (LL + RR)**	**Untreated vs Glyphosate (LL only)**	**Untreated vs Glufosinate Ammonium (RR only)**	**Untreated vs Saflufenacil (LL + RR)**	**Untreated vs Diquat (LL + RR)**
	-------------------	-------------------	p-value	-------------------	-------------------
Indian Head – 2017	0.252	**0.064**	0.675	0.835	**0.001**
Indian Head – 2018	**<0.001**	**0.026**	0.740	**0.010**	**<0.001**
Indian Head – 2019	**<0.001**	**0.010**	**0.002**	**0.001**	**<0.001**
Melfort – 2017	**<0.001**	**0.003**	–	**0.001**	**0.010**
Melfort – 2018	**0.062**	**0.010**	0.919	0.572	**0.083**
Melfort – 2019	0.690	0.746	0.349	0.611	0.343
Melita – 2017	**0.022**	**0.052**	**0.079**	0.827	**0.006**
Melita – 2018	0.830	0.502	0.901	0.737	0.506
Melita – 2019	0.676	0.296	0.621	0.604	**0.045**
Scott – 2017	**<0.001**	**<0.001**	**0.023**	0.280	**0.003**
Scott – 2018	**<0.001**	**<0.001**	**0.070**	**0.020**	**<0.001**
Scott – 2019	**0.008**	0.266	**0.003**	0.436	**0.001**
Frequency of Response ($P \leq 0.10$)	67%	67%	45%	33%	**83%**
Untreated Average (all sites)	28.7%	29.4%	28.0%	28.7%	28.7%
Treated Average (all sites)	24.5%	24.4%	24.3%	26.6%	21.9%
Untreated Average (responsive sites only)	33.4%	30.2%	37.7%	33.4%	33.5%
Treated Average (responsive sites)	27.4%	22.5%	29.2%	29.0%	25.4%

Results – Seed Dry-Down

Again, seed moisture content was determined using fresh/dry weights in a similar manner as was used for whole plant moisture content. There were sound reasons for determining seed moisture this way as opposed to using a moisture meter; however, in hind sight, doing so resulted in some unusual values at certain cases and the absolute values should be interpreted cautiously. Similarly, the absolute values should not be compared across site-years and therefore were not analyzed in a manner that facilitated doing so. At Indian Head (Table A-8), the overall F-test was always highly significant ($P < 0.001$) but the results varied depending on herbicide group. Focusing specifically on LL canola, both diquat and glyphosate were beneficial in 2/3 years while seed moisture content with saflufenacil applied alone was never significantly less than the control. That said, the tank-mix of glyphosate and saflufenacil was the only treatment to significantly reduce seed moisture content relative to the control for LL canola at Indian Head in 2019 despite a tendency for lower seed moisture with all of the options evaluated. For RR canola at Indian Head, diquat reduced seed moisture in all three years at Indian Head, glufosinate ammonium reduced seed moisture content in 1/3 years and saflufenacil (with or without glyphosate) never significantly reduced seed moisture content. At Melfort (Table A-11), the overall F-test for seed moisture content was not significant in 2018 or 2019 (P = 0.522-0.692) but was in 2017 (P = 0.004) where, for LL canola, all products tended to reduce seed moisture but the difference was only significant with glyphosate. For RR canola at Melfort 2017, saflufenacil had inconsistent results on seed moisture content while the reduction with diquat was significant. Again, glufosinate ammonium was not applied at Melfort 2017 due to a misinterpretation of the protocol. At Melita (Table A-14), the overall F-tests indicated treatment effects for seed moisture in 2017 and 2019 (P = 0.012-0.033) but not 2018 (P = 0.264). Specifically, for LL canola at Melita, the only notable effect on seed moisture content was a significant reduction with diquat in 2019. For the RR canola, both glufosinate ammonium and diquat reduced seed moisture in 2017 but no individual options had a significant impact in either 2018 or 2019. At Scott (Table A-17), the overall F-test for seed moisture content was significant in all three years (P < 0.001-0.008). For LL canola at Scott, both glyphosate and diquat at least tended to reduce seed moisture content in 2017 and 2018. In 2019, all options appeared to provide similar benefits and the seed at harvest time was generally significantly drier than the control. For seed moisture content of RR canola at Scott, the greatest reductions occurred with diquat in 2017 and 2018 while, in 2019, the only option to have a significant impact was glufosinate ammonium. Saflufenacil had inconsistent benefits with RR canola at Scott in 2018 and no impact on seed moisture in 2017 or 2019.

Similar to whole plant moisture content and to facilitate easier interpretation, the results for seed moisture were summarized across site-years in for individual products Table 3. The broader trends observed for seed moisture were consistent with those observed for whole plant moisture content. When averaged across all products and both herbicide systems, the reduction in seed moisture content was at least marginally significant ($P \leq 0.10$) at 75% of the site-years with overall averages of 10.0% and 8.8% for the untreated and treated canola, respectively. Glyphosate (LL only) reduced seed moisture at 50% of the site-years with an overall average reduction (across all 12 site-years) from 9.9% to 8.7%. Glufosinate ammonium (RR only) reduced seed moisture content at 36% of the site-years with an overall mean reduction from 10.1% to 9.1% when averaged across all 12 site-years. While the frequency of response with glufosinate ammonium was relatively low, it had quite a large effect in the cases where it did impact seed moisture content, reducing the mean values from an average of 9.8% to 6.8% at those four specific sites. Saflufenacil, when applied alone and averaged across both herbicide groups, reduced seed moisture content at 25% of the sites with an average overall reduction (across all sites) from 10% to 9.3%. Finally, diquat had the most consistent effect, reducing seed moisture content at 67% of the sites from an overall average of 10.0% to 8.2%.

Table 3. Contrasts comparing the effects of canola pre-harvest herbicide/desiccation options relative to untreated control plots along with overall averages for seed moisture content (%) at harvest time for four locations (Indian Head, Melfort, Melita, and Scott) over a three-year period (2017, 2018, and 2019).					
Location – Year	**Untreated vs treated (LL + RR)**	**Untreated vs Glyphosate (LL only)**	**Untreated vs Glufosinate Ammonium (RR only)**	**Untreated vs Saflufenacil (LL + RR)**	**Untreated vs Diquat (LL + RR)**
	---------- p-value ----------				
Indian Head – 2017	**<0.001**	0.851	**<0.001**	0.371	**<0.001**
Indian Head – 2018	**0.002**	**0.036**	0.765	0.325	**<0.001**
Indian Head – 2019	**0.011**	**0.069**	0.692	0.114	**0.006**
Melfort – 2017	**0.002**	**0.045**	–	**0.035**	**0.005**
Melfort – 2018	0.465	0.139	0.668	0.829	0.810
Melfort – 2019	0.645	0.957	0.282	0.618	0.422
Melita – 2017	**0.012**	0.285	**0.005**	0.284	**0.002**
Melita – 2018	0.407	0.486	0.250	0.622	0.146
Melita – 2019	**0.068**	0.404	0.191	0.521	**0.002**
Scott – 2017	**0.001**	**0.054**	**0.001**	0.611	**<0.001**
Scott – 2018	**<0.001**	**0.002**	0.113	**0.061**	**<0.001**
Scott – 2019	**0.012**	**0.05**	**0.019**	**0.083**	0.179
Frequency of Response ($P \leq 0.10$)	75%	50%	36%	25%	67%
Untreated Average (all sites)	10.0%	9.9%	10.1%	10.0%	10.0%
Treated Average (all sites)	8.8%	8.7%	9.1%	9.3%	8.2%
Untreated Average (responsive sites only)	10.6%	11.3%	9.8%	10.8%	10.0%
Treated Average (responsive sites)	9.1%	9.2%	6.8%	9.0%	7.5%

Results – Seed Yield

Unlike most agronomy studies, we were not particularly interested in effects on seed yield; however, data were statistically analyzed and summarized nonetheless to provide background information on overall productivity and, in certain cases, the relative harvestability of individual treatments. To be clear, none of the products that were evaluated should impact yield if used according to label directions and harvest is completed within a reasonably timely manner; however, treatment effects did occasionally occur in the current project. Yield differences between hybrids could be reasonably expected but pre-harvest treatment effects would indicate either improper timing (i.e. reduced yield when applied too early) or differences in harvest loss resulting from variation in crop dry-down (i.e. green crop more difficult to feed into combine and thresh. We monitored for pod shattering but no substantial losses or treatment differences were ever noted. At Indian Head (Table A-8), the overall F-test for yield was not significant in 2017 (P = 0.691) but was in both 2018 and 2019 (P = 0.007). In 2018, the response appeared to mostly be due to hybrid differences as yields were similar within both the RR and LL treatments regardless of the pre-harvest application. In 2019, there were no yield differences amongst the LL treatments but RR yields were lower in both the untreated control and the saflufenacil treatments (with or without glyphosate). At Melfort (Table A-11), the overall F-test for yield was not significant in 2017 or 2018 (P = 0.127-0.380) but was in 2019 (P = 0.018); however, again, the effects were due more to hybrid as opposed to the pre-harvest applications. At Melita (Table A-14), there was no effect on yield in 2017 or 2018 (P = 0.070-0.422) but in 2019 the effect was significant (P = 0.001). The observed differences at Melita 2019 were difficult to explain and are attributed to a combination of hybrid effects and naturally occurring variability. At Scott (Table A-17), the overall F-test for yield was significant in 2018 and 2019 (P < 0.001) but not 2017 (P = 0.267). In 2018, the effect was due to differences between hybrids while, in 2019, the variation was somewhat inconsistent but at least partly due to the pre-harvest applications for the LL canola in particular (i.e. lowest yields observed in the untreated control presumably due to tougher combining conditions).

Results – Seed Quality

Seed size is an important yield component and, similar to what occurs with swathing too early, applying pre-harvest herbicides or desiccants ahead of the recommended crop stage could conceivably lead to smaller seeds and subsequently lower yields. We would not generally expect any such impact when products are applied according to the label recommendations. Results for this variable are presented in Tables A-9, A-12, A-15, and A-18 for Indian Head, Melfort, Melita, and Scott, respectively. Significant overall F-tests occurred at 75% of the individual site-years; however, the responses were solely due to hybrid differences at all but three of them (Melfort-2018, Melfort-2019, and Scott-2019). To look at in another way, pre-harvest applications had no impact on seed size at 75% of the individual site-years. At Melfort-2018, only the glyphosate plus saflufenacil tank mix reduced seed size relative to the control for the LL hybrid while, for the RR canola, only diquat reduced seed size. At Melfort-2019, both saflufenacil and diquat at least marginally reduced seed size in the LL hybrid but no such effects occurred with the RR hybrid. At Scott-2019, both glyphosate and diquat reduced seed size in the LL hybrid while only glufosinate ammonium reduced seed size relative to the control in the RR hybrid. The effects of glufosinate ammonium at this site can likely be partly attributed to the earlier time; however, this response was not detected at other sites where glufosinate ammonium also went on relatively early (i.e. Indian Head-2017 due to later maturity in RR hybrid, Melita-2019 where all treatments were applied on the same date).

The other seed quality component that was assessed and potentially expected to be affected by the pre-harvest treatments was distinctly green seed. At Indian Head (Table A-9), the overall F-test for green seed was significant in 2017 and 2019 (P <0.001) but not 2018 (P = 0.586). In 2017, the only significant effect was a dramatic increase in green seed with diquat in the RR hybrid (i.e. 13% versus 0.7-2.1%). This was not observed to the same extent in the LL hybrid and was attributed to the diquat being applied too early in the later maturing RR hybrid. A similar response occurred in 2019 where 4.1% green seed was observed in RR canola compared to 1-1.6% with other treatments for this hybrid. At Melfort (Table A-12), the overall F-test for green seed was also significant in 2017 and 2019 (P <0.001-0.005) but not in 2018 (P = 0.237). In 2017, only the RR canola was affected and none of the treatments differed from the control; however green seed with diquat (1.5%) was higher than with saflufenacil (0.7-0.8%) while values in the control were intermediate (1.1%). At Melfort-2019, none of the pre-harvest applications specifically affected percent green seed but all values were high (due to fall frost prior to maturity) and percent green seed in the RR hybrid was generally higher than for the LL canola. At Melita (Table A-15), the overall F-test for green seed was significant in all three years (P <0.001-0.054) and the specific nature of the treatments was also consistent. In all three years, values for all LL treatments were similar to one another; however, for the RR treatments, percent green seed was always significantly higher with diquat than either the control or any other pre-harvest options. At Scott (Table A-18), the response was not significant in either 2017 or 2019 (P = 0.108-0.138) but was in 2018 (P < 0.001). For the LL canola in 2018, percent green seed with diquat (0.7%) was just marginally higher than the control (0.2%) while, for RR canola, 3.0% green seed was observed with diquat compared to 0.3-0.6% for the other RR treatments. Due to the reasonably high frequency (i.e. significant F-tests and consistent nature of the responses for this variable, contrast results are summarized for green seed at all sites in Table 4. Looking at the results in this manner clearly illustrates how only diquat had the potential to consistently affect green seed. The overall untreated versus treated comparison (averaged across all products and both canola herbicide systems) was only significant ($P < 0.10$) at 17% of the site-years while the contrasts comparing glyphosate, glufosinate ammonium, and saflufenacil to the control were never significant. By comparison, the untreated versus diquat comparison was significant 58% of the time. Averaged across all sites, percent green seed was 1.3% in the untreated plots and 2.3% with diquat while, specifically for the responsive sites, the values were 0.6% in the control treatments compared to 2.2% with diquat.

Table 4. Contrasts comparing the effects of canola pre-harvest herbicide/desiccation options relative to untreated control plots along with overall averages for green seed (%) at harvest for four locations (Indian Head, Melfort, Melita, and Scott) over a three-year period (2017, 2018, and 2019).

Location – Year	Untreated vs treated (LL + RR)	Untreated vs Glyphosate (LL only)	Untreated vs Glufosinate Ammonium (RR only)	Untreated vs Saflufenacil (LL + RR)	Untreated vs Diquat (LL + RR)
	---	---	p-value	---	---
Indian Head – 2017	**0.068**	1.000	0.466	0.979	**<0.001**
Indian Head – 2018	0.934	0.710	1.000	1.000	0.298
Indian Head – 2019	0.328	0.268	0.602	0.792	**0.005**
Melfort – 2017	0.772	0.868	–	0.248	0.297
Melfort – 2018	1.000	0.672	0.910	0.749	0.182
Melfort – 2019	0.527	0.745	0.200	0.492	0.882
Melita – 2017	0.701	0.668	0.568	0.271	**0.094**
Melita – 2018	0.198	0.790	1.000	0.140	**0.013**
Melita – 2019	0.134	0.150	0.625	0.304	**0.003**
Scott – 2017	0.356	0.926	1.000	0.744	**0.018**
Scott – 2018	**0.016**	1.000	0.845	0.729	**<0.001**
Scott – 2019	0.472	0.139	0.453	0.819	0.495
Frequency of Response ($P \leq 0.10$)	17%	nil	nil	nil	58%
Untreated Average (all sites)	1.3%	0.9%	1.8%	1.3%	1.3%
Treated Average (all sites)	1.5%	0.8%	1.4%	1.2%	2.3%
Untreated Average (responsive sites only)	0.6%	-	-	-	0.6%
Treated Average (responsive sites)	1.5%	-	-	-	2.2%

4. Significant Accomplishments & Acknowledgements

Field trials were completed at four locations (Indian Head, Melfort, Scott, and Melita) over three growing seasons (2017, 2018, and 2019) to evaluate various pre-harvest options for straight-combining canola with a focus on their effects on plant and seed dry-down. Despite weather related challenges and high variability for certain response variables (especially from site-year to site-year), the project was an overall success which has substantially improved our understanding of canola response to various pre-harvest herbicide/desiccation options.

The trial was introduced to approximately 200 guests at the 2017 Indian Head Field Day with a broader discussion of straight-combining canola and past experiences with pre-harvest herbicide/desiccant options to potentially improve upon this practice. Due to logistic considerations, the field trials could not be shown during IHARF's main field day in 2018; however, it was discussed during smaller tours which IHARF hosted for FCL, Richardson Pioneer, and the Saskatchewan Ministry of Agriculture Ag Awareness Unit (approximately 125 guests in total). In 2019, the plots were shown on multiple tours (including IHARF's primary Crop Management Field Day) with a discussion of results/progress to date and a combined attendance of approximately 200 guests. On February 7, 2019 (SIA Ag Update, Melfort, SK), Jessica Pratchler presented to approximately 120 attendees and highlighted that this work was in progress and being funded by canola growers through the CARP program. In early 2020, Chris Holzapfel presented preliminary results on February 4 (Independent Consulting Agronomists Network Meeting – Regina, SK), February 5 (IHARF Winter Meeting and AGM, Balgonie, SK), and March 4 (WARC Crop Opportunities, North Battleford, SK) with a combined attendance of 300-350 people. More recently, all response data collected over the entire study period was statistically analyzed, summarized, and interpreted with final conclusions and recommendations drawn. Final project results will be made publicly available to interested parties online (www.iharf.ca) and will continue to be incorporated into extension activities (i.e. oral presentations, crop tours, annual reports, popular press) where opportunities arise.

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Key Findings and Observations

1. With low weed populations, drier late-season weather, and early maturity (i.e. LL canola at Indian Head and Melita-2017, Melita-2018) there was relatively little benefit to using a pre-harvest application. The risks associated with later harvest are (within reason) arguably much lower with modern shatter tolerant canola hybrids than straight-combining research preceding this trait has suggested. This is more likely to be the case in more southern environments where both seeding and harvest tend to be earlier and, in general, the growing seasons are longer. With this in mind, growers planning to straight-combine shatter tolerant canola hybrids who have seeded early, achieved uniform stands, and kept the crop reasonably free of weeds should consider not spraying a viable and or even preferable option. In contrast, at Melfort-2019 the canola was prematurely terminated by fall frost and this was followed by unseasonably wet and cold. This resulted in delayed harvest, poor grain quality, and essentially no measurable benefit to the various pre-harvest options with respect to seed and crop dry-down. As a further testament to the efficacy of modern shatter tolerant hybrids, no shattering was reported for any treatments at any locations, despite the occurrence of occasional delays and unfavorable weather preceding harvest.
2. Glyphosate is registered as a pre-harvest herbicide, not specifically as a crop desiccant; therefore, growers should not expect any support if this product fails to meet expectations for canola plant and seed dry-down. That being said, pre-harvest glyphosate at least marginally reduced whole plant moisture content in LL canola 67% of the time (8/12 site-years) and reduced seed moisture content 50% of time (6/12 site-years). When averaged across all locations, whole plant moisture was reduced from 29% to 24% while seed moisture was reduced from 9.9% to 8.7%. Despite the reductions in seed and plant moisture that were frequently observed, glyphosate is initially slow and less likely to improve harvestability in drier falls or when applied at later crop stages. It is possible that at least some of the cases where glyphosate failed to provide a crop dry-down benefit could be partly attributed to there being insufficient time between application and harvest time for the glyphosate to fully take effect (i.e. 10 days at Melita 2019). Consistent improvements in harvestability or earlier harvest cannot necessarily be expected when glyphosate is applied alone; however, our results show that such benefits can

frequently occur with LL canola provided that the herbicide is given sufficient time to work.

3. Glufosinate-ammonium is not a registered pre-harvest option for canola and, to our knowledge, there is no indication that it will become one in the foreseeable future; however, it was registered for this purpose in the 1990s (i.e. Harvest, 1995 Saskatchewan Crop Protection Guide). The performance of this product was somewhat variable with at least marginally significant reductions in whole plant moisture content 45% of the time (5/11 site-years) and seed moisture 36% of the time (4/11 site-years). It is probable that the relatively poor performance observed for this product is due in part to the late application stage that was specified in the protocol as it tended to be more effective in cases where it was applied earlier (i.e. Scott-2019). Interestingly, while the frequency for which plant or seed moisture was reduced with glufosinate ammonium was rather low, in the cases where there was a response it generally had quite a large impact. Again, this is not a registered application for glufosinate ammonium and, unless that status changes, growers cannot legally utilize glufosinate ammonium as a desiccant when straight-combining canola.

4. Saflufenacil is a registered harvest aid for canola with potential to provide crop dry-down benefits for all canola herbicide systems. Saflufenacil is usually tank-mixed with glyphosate, providing excellent weed control benefits and, for non-glyphosate tolerant canola, dual modes of action to assist in crop dry-down. In order to distinguish between the effects of glyphosate and saflufenacil in LL canola, it was applied both alone and as a tank-mix. When product effects were evaluated across canola herbicide systems, only those where saflufenacil was applied alone were considered in order to prevent the glyphosate effects on LL canola from biasing the results. When evaluated in this manner, saflufenacil at least marginally reduced whole plant moisture 33% of the time (4/12 site-years) and seed moisture 25% of the time. Averaged across all site-years and both canola herbicide systems (regardless of whether the response was significant, saflufenacil (applied alone) reduced whole plant moisture content from 29% to 27% and seed moisture content from 10.0% to 9.3%. When tank-mixed with glyphosate, the effects on crop dry-down were similar to when applied alone with glyphosate tolerant canola and usually similar to glyphosate applied alone in glufosinate ammonium tolerant canola. It was relatively rare that the saflufenacil plus glyphosate tank-mix provided a measurable benefit over glyphosate alone in the LL canola; however, this occasionally did occur (i.e. Indian Head 2019 for whole plant moisture content). While there appears to be some potential for enhanced crop-down with glyphosate plus saflufenacil versus glyphosate alone for LL canola, the benefits (relative to glyphosate applied alone) were inconsistent and may not always justify the higher cost of the tank-mix. For RR canola, saflufenacil effects on crop dry-down were also variable (particularly compared to diquat); however, glyphosate plus saflufenacil is the best available option for RR canola growers who prioritize both fall weed control benefits and potential for accelerated crop dry-down. While it was not specifically documented in the current project, anecdotally we have observed accelerated dry-down of certain broadleaf weeds (i.e. especially perennials such as Canada thistle) with glyphosate plus saflufenacil compared to glyphosate alone when applied in the fall.

5. Of the pre-harvest options for straight combined canola that were evaluated, diquat is a desiccant in the truest form working purely on contact and taking effect rapidly but with limited weed-control benefits, especially for perennials. With respect to whole plant and seed dry-down, diquat performed consistently well for both canola herbicide systems and generally better than any of other options evaluated, especially when considered across the broad range of environmental conditions encountered. Averaged across hybrids, diquat reduced whole plant moisture content 83% of the time (10/12 site-years) and seed moisture 67% of the time (8/12 site-years). When averaged across hybrids and site-years, diquat reduced whole plant moisture content from 29% to 22% and seed moisture content from 10.0% to 8.2%. With regard to seed quality, diquat was unique compared to the other products in that it frequently resulted in elevated green seed levels relative to the other treatments. In any of the cases where green seed levels were high enough to result in downgrading it could, however, be attributed to the diquat being applied too early. Nonetheless, this is an indication of how important proper staging is and how sensitive canola can be to down-grading if diquat is applied before the recommended crop stage. While no other products had the impact on green seed that we saw with diquat, various options did occasionally result in reduced seed size; however, such effects tended to be infrequent and inconsistent.

5. Research and Action Plans

Overall, this project has improved our understanding of how straight-combined canola responds to various pre-harvest herbicide/desiccation options with a focus on whole plant and seed dry-down. The project has also exemplified how difficult research of this nature can be due to challenges associated with accurately and objectively measuring crop dry-down and product efficacy in addition to difficulties in managing and accounting for the impacts of weather and relative timing of spraying and harvest operations. While we do not have any immediate plans for follow-up work on this specific topic at this time, examples of related research areas/questions that may be worthy of further exploration include:

- Investigating the effects of pre-harvest herbicide/desiccant options on key combining efficiency metrics (i.e. engine load, fuel use, harvest speed) relative to both untreated, straight combined and swathed canola as control treatments. Such work would need to completed using commercial equipment with large enough treatment areas to optimize combine settings and collect accurate data and, as such, could be rather costly; however, this is a topic that would be of interest and practical value to western Canadian canola producers.
- Investigating the effects of application timing for canola pre-harvest herbicide/desiccant options on both the rate of crop dry-down and seed quality (i.e. seed size, green soil, oil content). In the current project we only looked a single application time and a single harvest date for each site-year and our estimates of crop dry-down through the period leading up to harvest were very subjective. There would be value in bettering our understanding of application timing effects on the overall performance of the options with respect to crop/seed dry-down and also grain quality. This information is important from both a producer perspective and for the industry as a whole. With increased public scrutiny over pre-harvest applications in all crops it is important that producers use registered products properly and that we understand the potential impacts of failing to so on both yield and quality, including potential MRL issues.
- Investigating the effects of the various pre-harvest options for straight-combined canola on weed control over the longer-term. While we did monitor the plots for potential interesting visual differences in fall weed control, there was not typically enough time after harvest for such differences to fully develop and the project was not designed to facilitate any assessments of weed-control benefits over the longer term. For example, for perennial weeds, potential advantages of glyphosate (and glyphosate tank mixes) over diquat may not be apparent until well into the following growing season. In addition to the high costs associated with maintaining plots and completing measurements over multiple years, such work would be further complicated by the variable nature of weeds, especially perennials which can be particularly patchy. While it may not be feasible to conduct this work using small plots over multiple years, this information would be of value to producers and longer-term weed control benefits are an important factor for consideration when choosing appropriate pre-harvest products which the current study did not specifically quantify or take into consideration.

7. Appendices

Agronomic Information

Table A-1. Selected agronomic information for canola desiccation trials at four Western Canadian locations in 2017.

Factor / Operation	Location (2017)			
	Indian Head, SK	**Melfort, SK**	**Scott, SK**	**Melita, MB**
Previous Crop	Wheat	Wheat	Wheat	Rye
Variety	L233P (LL) / 45M35 (RR)	L233P (LL) / 45M35 (RR)	L233P (LL) / 45M35 (RR)	L233P (LL) / 45M35 (RR)
Pre-emergent Herbicide	890 g glyphosate/ha (May-10) 24 kg Edge/ha (May-14)	none	980 g glyphosate/ha + 280 g bromoxynil/ha (May-6)	890 g glyphosate/ha + 185 ml Centurion/ha (Apr-20)
Seeding Date	May-17	May-19	May-15	May-12
Seeding Rate	120 seeds/m^2	120 seeds/m^2	120 seeds/m^2	120 seeds/m^2
Row spacing	30 cm	30 cm	25 cm	24 cm
Fertility (kg N-P_2O_5-K_2O-S/ha)	140-35-18-18	134-56-0-28	81-22-0-25	126-35-25-10
In-crop Herbicide	561 ml Lontrel 360/ha (Jun-10) 30 g Muster/ha + 741 ml Assure 2/ha (Jun-18)	none	2 l Liberty 150 SN/ha (Jun-7) + 1.5 l Liberty/ha + 185 ml Centrurion/ha (Jun-20) 300 g glyphosate/ha (Jun-7) + 445 g glyphosate/ha (Jun-21)	20 g Muster/ha + 741 ml Assure 2/ha (Jun-7)
Fungicide	350 g Lance WDG/ha + 395 ml Headline E.C. (Jul-12)	865 ml Acapela/ha (Jul-18)	445 ml Priaxor/ha (Jul-8)	none
Insecticide	none	none	none	none
Pre-harvest Applications	Trt 2, 3, 4, 8, 9 (Aug-23) Trt 5, 7, 10 (Aug-28)	Trt 2, 3, 4, 8, 9 (Aug-29) Trt 5, 7, 10 (Sep-5)	Trt 2, 3, 4 (Aug-22) Trt 5, 7, 8, 9 (Aug-25) Trt 10 (Aug-28)	Trt 2, 3, 4, 8, 9 (Aug-16) Trt 5, 7, 10 (Aug-22)
Harvest date	Sep-8 (all treatments)	Sep-12 (all treatments	Sep-8 (LL) Sep-11 (RR)	Sep-1 (all treatments)

Table A-2. Selected agronomic information for canola desiccation trials at four Western Canadian locations in 2018.

Factor / Operation	Location (2018)			
	Indian Head, SK	Melfort, SK	Scott, SK	Melita, MB
Previous Crop	Wheat	Wheat	Wheat	Soybean
Variety	L255PC (LL) / 45M35 (RR)	L255PC (LL) / 45M35 (RR)	L255PC (LL) / 45M35 (RR)	L255PC (LL) / 45M35 (RR)
Pre-emergent Herbicide	890 g glyphosate/ha (May-14) 26 kg Edge/ha (May-13)	667 g glyphosate/ha (May-18)	980 g glyphosate/ha + 62 ml Aim/ha (May-15)	none
Seeding Date	May-19	May-17	May-18	May-9
Seeding Rate	125 seeds/m^2	125 seeds/m^2	120 seeds/m^2	120 seeds/m^2
Row spacing	30 cm	30 cm	25 cm	24 cm
Fertility (kg N-P_2O_5-K_2O-S/ha)	135-35-18-18	196-61-0-17	95-23-0-22	124-39-27-10
In-crop Herbicide	830 ml Lontrel 360/ha + 30 g Muster/ha + 749 ml Assure 2/ha (Jun-13)	3.34 l Liberty 150 SN/ha + 196 ml Centurion/ha (Jun-7) 681 g glyphosate/ha (Jun-7) 494 ml Asssure 2/ha (Jun 25)	4.0 l Liberty 150 SN/ha + 190 ml Centurion/ha (Jun-18) 894 g glyphosate/ha (Jun-18)	494 ml Assure 2/ha (Jun-6)
Fungicide	350 g Lance WDG/ha + 395 ml Headline E.C. (Jul-6 and Jul-9)	1.2 l Acapela/ha (Jul-9)	445 ml Priaxor/ha (Jul-12)	none
Insecticide	none	none	148 ml Decis/ha (Aug 13)	158 ml Pounce/ac (Jun-5)
Pre-harvest Applications	Trt 2, 3, 4 (Aug-18) Trt 8, 9 (Aug-15) Trt 7, 10 (Aug-20) Trt 5 (Aug-22)	Trt 2, 3, 4, 8, 9 (Aug-24) Trt 5, 7, 10 (Sep-5)	Trt 2, 3, 4, 8, 9 (Aug-20) Trt 5, 7, 10 (Aug-31)	Trt 2, 3, 4, 8, 9 (Aug-3) Trt 5, 7, 10 (Aug-8)
Harvest date	Aug-29 (all treatments)	Oct-3 (all treatments)	Sep-26 (all treatments)	Aug-23 (all treatments)

Table A-3. Selected agronomic information for canola desiccation trials at four Western Canadian locations in 2019.				
Factor / Operation	**Location (2019)**			
	Indian Head, SK	**Melfort, SK**	**Scott, SK**	**Melita, MB**
Previous Crop	Canaryseed	Wheat	Wheat	Oat
Variety	L255PC (LL) / 45M35 (RR)	L255PC (LL) / 45M35 (RR)	L255PC (LL) / 45M35 (RR)	L255PC (LL) / 45M35 (RR)
Pre-emergent Herbicide	890 g glyphosate/ha (May-16) 26 kg Edge/ha (May-14)	890 g glyphosate/ha (May-16)	1334 g glyphosate/ha + 86 ml Aim/ha (May-19)	none
Seeding Date	May-19	May-17	May-22	May-8
Seeding Rate	125 seeds/m^2	120 seeds/m^2	120 seeds/m^2	125 seeds/m^2
Row spacing	30 cm	30 cm	25 cm	24 cm
Fertility (kg N-P_2O_5-K_2O-S/ha)	135-35-18-18	206-47-0-17	89-67-30-22	121-39-22-8 + 2Zn
In-crop Herbicide	420 ml Lontrel 360/ha + 30 g Muster/ha + 494 ml Assure 2/ha (Jun-18)	3.34 l Liberty 150 SN/ha + 196 ml Centurion/ha (Jul-7) 681 g glyphosate/ha (Jul-7)	4.0 l Liberty 150 SN/ha + 185 ml Centurion/ha (Jun-26) 440 g glyphosate/ha (Jun-26)	297 ml Centurion/ha + 20 g Muster/ha (Jun-6)
Fungicide	350 g Lance WDG/ha + 395 ml Headline E.C. (Jul-20)	803 ml Acapella/ha (Jul-12)	445 ml Priaxor/ha (Jul-15)	none
Insecticide	83 ml/ Matador 120EC (Jun-12)	198 ml Decis 5EC (Jun-??)	none	198 ml Pounce 384 EC/ha (May-27) 133 ml Pounce 384 EC/ha (Jun-6)
Pre-harvest Applications	Trt 2, 3, 4, 8, 9 (Sep-15) Trt 7, 5, 10 (Sep-22)	Trt 2, 3, 4, 8, 9 (Sep-28) Trt 5, 7, 10 (Oct-7)	Trt 2, 3, 4, 7, 8, 9 (Sep-3) Trt 5, 10 (Sep-16)	All treatments (Aug 13)
Harvest date	Oct-6 (all treatments)	Oct-22 (all treatments)	Sep-23 (all treatments)	Aug-23 (all treatments)

Growing Season Weather Data and Long-Term Averages

Table A-4. Mean monthly temperatures for the 2017, 2018 and 2019 growing seasons relative to the long-term averages (1981-2010) at four locations in western Canada.

		Mean Monthly Temperature					
Location	**Year**	**May**	**June**	**July**	**August**	**September**	**Average**
		-- ºC --					
Indian Head	2017	11.6	15.5	18.4	16.7	11.3	14.7
	2018	13.9	16.5	17.5	17.6	7.6 [z]	14.6
	2019	8.9	15.7	17.4	15.8	11.9	13.9
	LT	*10.8*	*15.8*	*18.2*	*17.4*	*11.5*	*14.7*
Melfort	2017	10.8	15.2	18.7	17.2	12.5	14.9
	2018	13.9	16.8	17.5	15.9	6.9	14.2
	2019	8.8	15.3	16.9	14.9	11.2	13.4
	LT	*10.7*	*15.9*	*17.5*	*16.8*	*10.8*	*14.3*
Scott	2017	11.5	15.1	18.3	16.6	11.5	14.6
	2018	13.6	16.6	17.5	15.9	6.4	14.0
	2019	9.1	14.9	16.1	14.4	11.3	13.2
	LT	*10.8*	*15.3*	*17.1*	*16.5*	*10.4*	*14.0*
Melita	2017	12.2	16.7	20.1	17.4	13.8 [z]	16.0
	2018	15.1	19.1	19.4	18.9	10.0 [z]	16.5
	2019	9.7	16.9	19.5	17.6	13.4 [z]	15.4
	LT	*10.7*	*16.1*	*19.3*	*18.4*	*12.8*	*15.5*

[z] All plots harvested in August therefore September weather is irrelevant to results/harvest conditions

Table A-5. Mean monthly precipitation amounts for the 2017, 2018, and 2019 growing seasons relative to the long-term averages (1981-2010) at 4 locations in western Canada.

		Total Monthly Precipitation					
Location	**Year**	**May**	**June**	**July**	**August**	**September**	**Average**
		---- mm ----					
Indian Head	2017	10.4	65.6	15.4	25.2	12.4	129
	2018	23.7	90.0	30.4	3.9	39.6 [Z]	188
	2019	13.3	50.4	53.1	96.0	120.8	334
	LT	*51.8*	*77.4*	*63.8*	*51.2*	*35.3*	*280*
Melfort	2017	46.4	44.1	33.3	3.1	13.2	140
	2018	38.5	46.6	69.5	43.2	42.0	240
	2019	18.8	87.4	72.7	30.7	43.0	253
	LT	42.9	54.3	76.7	52.4	38.7	265
Scott	2017	69.0	34.3	22.4	53.0	18.9	198
	2018	29.6	58	85.8	20.2	57.3	251
	2019	38.9	69.7	69.4	48.7	41.8	267
	LT	*36.3*	*61.8*	*72.1*	*45.7*	*36.0*	*252*
Melita	2017	6.1	64.2	44.8	39.5	52.0 [Z]	207
	2018	11.4	100.8	54.1	23.5	55.4 [Z]	245
	2019	15.6	84.6	74.1	100.5	137.3 [Z]	412
	LT	*61.9*	*76.4*	*56.9*	*43.2*	*32.0*	*270*

[Z] All plots harvested in August therefore September weather is irrelevant to results/harvest conditions

Crop Establishment – All Site-Years

Table A-6. Treatment means and tests of fixed effects for plant density at Indian Head, Melfort, Melita, and Scott from 2017-2019. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola and not yet applied at the time of these measurements; however, full results are provided to provide insights in the overall canola establishment and stand variability for each site-year. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment [Z]	IH-17	IH-18	IH-19	MF-17	MF-18	MF-19	MT-17	MT-18	MT-19	SC-17	SC-18	SC-19
	Plant Density (plants/m^2)											
1) LL – Control	33.2 ab	73.0 a	57.0 a	88.6 a	154.8 a	57.4 a	37.8 bc	34.7 a	87.6 a	76.0 a	77.3 a	53.5 a
2) LL – Glyphosate	30.4 b	71.0 a	56.6 a	73.9 a	120.9 a	68.1 a	34.7 cd	43.0 a	74.6 a	71.5 a	76.3 a	66.5 a
3) LL – Saflufenacil	41.8 a	63.2 a	55.8 a	84.1 a	148.9 a	62.3 a	43.5 abc	35.2 a	77.2 a	76.5 a	81.7 a	66.8 a
4) LL – Safl + Glyph	32.0 b	68.9 a	50.9 a	62.3 a	172.7 a	72.2 a	56.0 a	40.9 a	80.3 a	70.5 a	68.6 a	52.8 a
5) LL – Diquat	33.2 ab	62.0 a	55.4 a	79.6 a	147.2 a	62.3 a	50.8 ab	38.9 a	78.2 a	73.3 a	77.0 a	56.0 a
6) RR – Control	25.0 b	58.6 a	39.0 a	71.0 a	125.9 a	58.7 a	20.7 de	53.9 a	73.6 a	67.3 a	76.0 a	57.5 a
7) RR – Gluf. Amm.	31.6 b	60.7 a	45.5 a	–	129.1 a	53.3 a	15.0 e	42.0 a	73.1 a	71.3 a	82.0 a	53.8 a
8) RR – Saflufenacil	26.3 b	61.9 a	45.1 a	78.3 a	133.7 a	57.0 a	19.2 e	42.5 a	69.9 a	71.0 a	70.2 a	57.8 a
9) RR – Safl + Glyph	29.1 b	60.7 a	47.6 a	58.3 a	128.4 a	60.3 a	13.0 e	50.8 a	74.6 a	64.0 a	78.0 a	63.5 a
10) RR – Diquat	27.9 b	65.2 a	48.4 a	67.7 a	154.7 a	54.5 a	19.2 e	52.8 a	70.0 a	71.8 a	73.8 a	58.8 a
S.E.M.	3.49	5.68	5.15	9.14	13.23	6.17	5.76	6.16	6.19	6.64	7.91	4.10
LSD [X]	8.76	ns	ns	ns	ns	ns	14.25	ns	ns	ns	ns	ns
Pr > *F* (p-value)	**0.035**	0.678	0.333	0.277	0.175	0.507	**<0.001**	0.230	0.640	0.927	0.952	0.159

[Z] Pre-harvest herbicide/desiccant treatments were not yet applied at the time of these measurements; only differences between hybrids may be logically explained by anything other than background variability and experimental error

Additional Results Tables – Indian Head

Table A-7. Treatment means and tests of fixed effects for final visual stem dry-down ratings and whole plant gravimetric moisture content at Indian Head, Saskatchewan. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	IH-2017	IH-2018	IH-2019	IH-2017	IH-2018	IH-2019
	-- Visual Stem Dry-Down Ratings (0-100)[Z] --			----- Whole Plant Moisture Content (%)[Y] -----		
1) LL – Control	41.3 cd	29.4 e	51.9 de	30.8 c	37.0 a	40.7 ab
2) LL – Glyphosate	65.0 a	35.6 de	72.5 ab	26.8 c	33.5 b	32.9 c
3) LL – Saflufenacil	45.6 c	37.5 d	71.3 ab	30.3 c	33.3 b	34.3 c
4) LL – Safl + Glyph	61.9 ab	38.8 d	76.3 a	30.0 c	33.7 b	25.7 d
5) LL – Diquat	66.9 a	50.6 b	64.4 bc	28.2 c	30.0 c	22.2 d
6) RR – Control	36.9 d	30.6 e	18.8 f	38.6 ab	29.5 c	44.4 a
7) RR – Gluf. Amm.	43.8 cd	46.9 bc	7.2 g	39.5 ab	29.0 c	34.7 c
8) RR – Saflufenacil	48.1 c	40.0 d	43.1 e	38.5 b	27.3 c	36.0 bc
9) RR – Safl + Glyph	44.4 c	40.6 cd	43.1 e	42.8 a	27.1 cd	38.0 bc
10) RR – Diquat	57.5 b	64.4 a	57.5 f	30.7 c	24.8 d	23.0 d
S.E.M.	3.01	2.46	4.32	1.47	1.27	2.04
LSD [X]	7.20	6.55	11.38	4.24	3.05	5.73
Pr > *F* (p-value)	**< 0.001**	**<0.001**	**<0.001**	**< 0.001**	**<0.001**	**<0.001**

[Z] Final ratings completed at harvest [Y] Gravimetric water content of above-ground plant material (including grain) at harvest

Table A-8. Treatment means and tests of fixed effects for seed moisture content and yield at Indian Head, Saskatchewan. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	IH-2017	IH-2018	IH-2019	IH-2017	IH-2018	IH-2019
	---------- Seed Moisture Content (%)[Z] ----------			--------------- Seed Yield (kg/ha)[Y] ---------------		
1) LL – Control	7.1 cd	17.1 a	13.7 cd	3226 a	2498 d	3119 b-e
2) LL – Glyphosate	7.2 bc	15.3 b	11.6 de	3222 a	2564 cd	3191 a-d
3) LL – Saflufenacil	6.7 cde	16.8 ab	12.6 cde	3275 a	2532 d	3248 abc
4) LL – Safl + Glyph	6.5 cde	15.5 ab	11.4 e	3217 a	2657 bcd	3266 abc
5) LL – Diquat	5.8 de	13.0 c	12.3 de	3204 a	2618 bcd	3318 ab
6) RR – Control	11.9 a	11.1 d	18.0 a	3098 a	2707 abc	2954 e
7) RR – Gluf. Amm.	8.5 b	10.9 d	17.6 a	3306 a	2787 ab	3360 a
8) RR – Saflufenacil	11.4 a	10.3 d	16.6 ab	3196 a	2728 abc	3005 de
9) RR – Safl + Glyph	11.1 a	11.0 d	16.6 ab	3225 a	2668 a-d	3093 cde
10) RR – Diquat	5.3 e	7.2 e	14.8 b	3263 a	2835 a	3318 ab
S.E.M.	0.47	1.00	1.02	72.0	85.5	83.4
LSD [X]	1.35	1.70	2.28	ns	172.4	221.7
Pr > *F* (p-value)	**< 0.001**	**<0.001**	**<0.001**	0.691	**0.007**	**0.007**

[Z] Gravimetric water content of canola seed at harvest [Y] Corrected for dockage and to 10% seed moisture content

Table A-9. Treatment means and tests of fixed effects for seed weight and percent distinctly green seed at Indian Head, Saskatchewan. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	**IH-2017**	**IH-2018**	**IH-2019**	**IH-2017**	**IH-2018**	**IH-2019**
	--------- Seed Weight (g/1000 seeds) ---------			----------------- Green Seed (%) -----------------		
1) LL – Control	3.28 bcd	2.74 b	3.18 a	0.1 b	0.3 a	0.6 b
2) LL – Glyphosate	3.19 d	2.69 b	3.23 a	0.1 b	0.3 a	1.4 b
3) LL – Saflufenacil	3.26 bcd	2.70 b	3.18 a	0.0 b	0.2 a	0.6 b
4) LL – Safl + Glyph	3.24 bcd	2.74 b	3.20 a	0.1 b	0.2 a	1.1 b
5) LL – Diquat	3.22 cd	2.71 b	3.18 a	0.5 b	0.2 a	1.0 b
6) RR – Control	3.36 ab	2.94 a	3.11 a	1.7 b	0.2 a	1.6 b
7) RR – Gluf. Amm.	3.33 abc	3.04 a	3.23 a	0.7 b	0.2 a	1.3 b
8) RR – Saflufenacil	3.35 ab	3.00 a	3.19 a	1.8 b	0.1 a	1.4 b
9) RR – Safl + Glyph	3.42 a	3.02 a	3.31 a	2.1 b	0.1 a	1.0 b
10) RR – Diquat	3.32 a-d	3.03 a	3.28 a	13.2 a	0.1 a	4.1 a
S.E.M.	0.048	0.041	0.045	0.97	0.10	0.47
LSD [X]	0.134	0.105	0.131	2.78	ns	1.36
Pr > *F* (p-value)	**0.038**	**<0.001**	0.199	**< 0.001**	0.586	**<0.001**

Additional Results Tables – Melfort

Table A-10. Treatment means and tests of fixed effects for final visual stem dry-down ratings and whole plant gravimetric moisture content at Melfort, Saskatchewan. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	MF-2017	MF-2018	MF-2019	MF-2017	MF-2018	MF-2019
	-- Visual Stem Dry-Down Ratings (0-100)[Z] --			----- Whole Plant Moisture Content (%)[Y] -----		
1) LL – Control	–	95.0 a	90.0 a	30.7 a	16.9 a	12.3 a
2) LL – Glyphosate	–	98.2 a	92.5 a	25.9 bcd	9.1 a	12.5 a
3) LL – Saflufenacil	–	95.4 a	95.0 a	24.7 cd	15.2 a	13.0 a
4) LL – Safl + Glyph	–	99.8 a	90.0 a	23.7 d	14.5 a	13.6 a
5) LL – Diquat	–	95.0 a	92.5 a	26.8 bc	12.1 a	12.4 a
6) RR – Control	–	91.9 a	92.5 a	27.9 ab	14.8 a	12.5 a
7) RR – Gluf. Amm.	–	92.2 a	95.0 a	–	14.5 a	11.8 a
8) RR – Saflufenacil	–	93.5 a	97.5 a	26.5 bcd	14.5 a	11.3 a
9) RR – Safl + Glyph	–	93.5 a	90.0 a	25.5 bcd	11.3 a	11.8 a
10) RR – Diquat	–	98.2 a	92.5 a	26.2 bcd	13.0 a	11.5 a
S.E.M.	–	2.04	3.62	1.44	1.80	0.59
LSD [X]	–	ns	ns	2.94	ns	ns
Pr > *F* (p-value)	–	0.137	0.881	**0.004**	0.220	0.074

[Z] Final ratings completed at harvest [Y] Gravimetric water content of above-ground plant material (including grain) at harvest

Table A-11. Treatment means and tests of fixed effects for seed moisture content and yield at Melfort, Saskatchewan. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	**MF-2017**	**MF-2018**	**MF-2019**	**MF-2017**	**MF-2018**	**MF-2019**
	---------- Seed Moisture Content (%)[Z] ----------			--------------- Seed Yield (kg/ha)[Y] ---------------		
1) LL – Control	3.5 bc	10.8 a	9.5 a	3596 a	3101 a	1736 d
2) LL – Glyphosate	0.5 d	10.1 a	9.5 a	3715 a	2840 a	1768 d
3) LL – Saflufenacil	1.3 cd	11.0 a	9.4 a	3849 a	3083 a	2044 bcd
4) LL – Safl + Glyph	1.0 cd	10.3 a	9.8 a	3805 a	2768 a	1885 cd
5) LL – Diquat	1.3 cd	10.8 a	9.1 a	4059 a	3027 a	1678 d
6) RR – Control	6.8 a	10.8 a	9.2 a	3517 a	2644 a	2267 a-d
7) RR – Gluf. Amm.	–	10.6 a	8.7 a	–	2676 a	2744 a
8) RR – Saflufenacil	4.5 ab	10.8 a	9.0 a	3673 a	2708 a	2558 abc
9) RR – Safl + Glyph	2.8 bcd	10.8 a	9.4 a	3705 a	2610 a	2204 a-d
10) RR – Diquat	2.8 bcd	10.7 a	9.1 a	4233 a	2541 a	2628 ab
S.E.M.	1.16	0.32	0.35	268.3	167.3	233.6
LSD [X]	2.93	ns	ns	ns	ns	677.8
Pr > *F* (p-value)	**0.004**	0.692	0.522	0.380	0.127	**0.018**

[Z] Gravimetric water content of canola seed at harvest [Y] Corrected for dockage and to 10% seed moisture content

Table A-12. Treatment means and tests of fixed effects for seed weight and percent distinctly green seed at Melfort, Saskatchewan. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	**MF-2017**	**MF-2018**	**MF-2019**	**MF-2017**	**MF-2018**	**MF-2019**
	--------- Seed Weight (g/1000 seeds) ---------			----------------- Green Seed (%) -----------------		
1) LL – Control	3.55 a	3.10 c	2.90 abc	0.4 c	0.1 a	6.5 bc
2) LL – Glyphosate	3.55 a	3.07 cd	2.70 bcd	0.4 c	0.0 a	5.8 c
3) LL – Saflufenacil	3.50 a	3.05 cd	2.40 d	0.3 c	0.1 a	5.5 c
4) LL – Safl + Glyph	3.61 a	2.83 d	2.50 cd	0.4 c	0.1 a	6.3 bc
5) LL – Diquat	3.56 a	3.05 cd	2.40 d	0.4 c	0.2 a	6.8 bc
6) RR – Control	3.66 a	3.88 a	3.00 ab	1.1 ab	0.3 a	13.1 a
7) RR – Gluf. Amm.	–	3.83 ab	3.25 a	–	0.3 a	10.3 ab
8) RR – Saflufenacil	3.66 a	3.70 ab	3.20 a	0.7 bc	0.2 a	12.0 a
9) RR – Safl + Glyph	3.67 a	3.75 ab	2.90 abc	0.8 bc	0.1 a	13.3 a
10) RR – Diquat	3.69 a	3.60 b	3.20 a	1.5 a	0.4 a	12.3 a
S.E.M.	0.048	0.091	0.140	0.21	0.10	1.51
LSD [X]	ns	0.267	0.406	0.62	ns	4.37
Pr > *F* (p-value)	0.075	**<0.001**	**<0.001**	**0.005**	0.237	**<0.001**

Additional Results Tables – Melita

Table A-13. Treatment means and tests of fixed effects for final visual stem dry-down ratings and whole plant gravimetric moisture content at Melita, Manitoba. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	MT-2017	MT-2018	MT-2019	MT-2017	MT-2018	MT-2019
	-- Visual Stem Dry-Down Ratings (0-100)[Z] --			----- Whole Plant Moisture Content (%)[Y] -----		
1) LL – Control	71.3 cd	100	42.5 ef	30.4 a-d	12.2 a	24.4 abc
2) LL – Glyphosate	88.8 ab	100	37.5 f	21.6 d	14.5 a	29.1 a
3) LL – Saflufenacil	71.3 cd	100	37.5 f	31.2 ab	16.2 a	28.5 a
4) LL – Safl + Glyph	83.8 b	100	57.5 cde	25.1 bcd	14.5 a	24.9 ab
5) LL – Diquat	91.3 ab	100	73.8 abc	21.8 cd	9.2 a	15.3 cde
6) RR – Control	67.5 d	100	57.5 cde	36.1 a	8.5 a	16.1 b-e
7) RR – Gluf. Amm.	90.0 ab	100	81.3 ab	28.2 a-d	8.1 a	18.4 cde
8) RR – Saflufenacil	82.5 bc	100	65.0 bcd	33.9 ab	6.2 a	8.7 e
9) RR – Safl + Glyph	86.3 ab	100	52.5 def	30.7 abc	9.2 a	16.8 b-e
10) RR – Diquat	97.5 a	100	85.0 a	26.5 bcd	8.3 a	12.0 de
S.E.M.	5.23	–	6.57	3.06	2.59	0.31
LSD [X]	12.34	–	18.87	8.89	ns	0.91
Pr > *F* (p-value)	**<0.001**	–	**<0.001**	**0.032**	0.079	**<0.001**

[Z] Final ratings completed at harvest [Y] Gravimetric water content of above-ground plant material (including grain) at harvest

Table A-14. Treatment means and tests of fixed effects for seed moisture content and yield at Melita, Manitoba. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	MT-2017	MT-2018	MT-2019	MT-2017	MT-2018	MT-2019
	---------- Seed Moisture Content (%)[Z] ----------			--------------- Seed Yield (kg/ha)[Y] ---------------		
1) LL – Control	8.7 abc	5.0 a	10.0 a	3584 a	2219 a	3060 bc
2) LL – Glyphosate	8.1 bcd	4.9 a	9.4 abc	3496 a	2123 a	2993 cd
3) LL – Saflufenacil	8.2 bcd	5.0 a	9.9 ab	3502 a	2088 a	3065 bc
4) LL – Safl + Glyph	8.5 a-d	5.0 a	9.7 ab	3689 a	2171 a	3140 bc
5) LL – Diquat	8.1 bcd	4.8 a	7.4 d	3648 a	2025 a	2818 d
6) RR – Control	9.5 a	5.0 a	9.0 abc	3613 a	2145 a	3196 bc
7) RR – Gluf. Amm.	7.8 cd	5.1 a	8.0 cd	3524 a	2278 a	3443 a
8) RR – Saflufenacil	9.1 ab	4.9 a	8.5 bcd	3436 a	2248 a	3225 ab
9) RR – Safl + Glyph	8.7 abc	4.8 a	8.9 abc	3304 a	2237 a	3242 ab
10) RR – Diquat	7.5 d	4.9 a	8.2 cd	3577 a	2127 a	3209 bc
S.E.M.	0.43	0.08	0.63	122.4	77.2	92.6
LSD [X]	1.13	ns	1.45	ns	ns	230.7
Pr > *F* (p-value)	**0.033**	0.264	**0.012**	0.070	0.422	**0.001**

[Z] Gravimetric water content of canola seed at harvest [Y] Corrected for dockage and to 10% seed moisture content

Table A-15. Treatment means and tests of fixed effects for seed weight and percent distinctly green seed at Melita, Manitoba. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	MT-2017	MT-2018	MT-2019	MT-2017	MT-2018	MT-2019
	--------- Seed Weight (g/1000 seeds) ---------			----------------- Green Seed (%) -----------------		
1) LL – Control	3.28 a	2.25 b	2.28 b	0.3 bc	0.3 bc	0.1 b
2) LL – Glyphosate	3.21 a	2.27 b	2.21 b	0.1 c	0.3 c	0.4 b
3) LL – Saflufenacil	3.20 a	2.25 b	2.29 b	0.1 c	0.7 ab	0.5 b
4) LL – Safl + Glyph	3.18 a	2.28 b	2.24 b	0.4 bc	0.4 abc	0.2 b
5) LL – Diquat	3.21 a	2.31 b	2.15 b	0.1 c	0.5 abc	0.3 b
6) RR – Control	3.24 a	2.57 a	2.59 a	0.9 b	0.2 c	0.3 b
7) RR – Gluf. Amm.	3.21 a	2.59 a	2.57 a	0.7 bc	0.2 c	0.2 b
8) RR – Saflufenacil	3.27 a	2.57 a	2.64 a	0.5 bc	0.3 c	0.2 b
9) RR – Safl + Glyph	3.27 a	2.58 a	2.60 a	0.2 bc	0.2 c	0.2 b
10) RR – Diquat	3.29 a	2.52 a	2.62 a	1.9 a	0.7 a	1.1 a
S.E.M.	0.073	0.037	0.084	0.24	0.13	0.14
LSD [X]	ns	0.091	0.153	0.71	0.38	0.42
Pr > *F* (p-value)	0.864	**<0.001**	**<0.001**	**< 0.001**	**0.054**	**0.004**

Additional Results Tables – Scott

Table A-16. Treatment means and tests of fixed effects for final visual stem dry-down ratings and whole plant gravimetric moisture content at Scott, Saskatchewan. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	SC-2017	SC-2018	SC-2019	SC-2017	SC-2018	SC-2019
	-- Visual Stem Dry-Down Ratings (0-100)[Z] --			----- Whole Plant Moisture Content (%)[Y] -----		
1) LL – Control	70.0 f	84.5 ef	63.8 e	28.5 ab	26.9 ab	62.5 a
2) LL – Glyphosate	96.5 a	90.0 bcd	73.8 d	11.9 f	17.9 c	57.2 ab
3) LL – Saflufenacil	86.3 e	88.5 cde	77.5 cd	29.5 a	24.6 b	59.8 a
4) LL – Safl + Glyph	94.5 abc	98.5 a	88.8 a	13.7 f	17.0 c	54.1 abc
5) LL – Diquat	90.3 d	91.5 bc	77.5 cd	25.2 a-d	18.8 c	47.8 bcd
6) RR – Control	71.3 f	79.5 f	75.0 d	27.6 abc	30.1 a	50.1 bc
7) RR – Gluf. Amm.	92.3 bcd	86.0 de	90.0 a	21.9 de	26.3 ab	34.7 e
8) RR – Saflufenacil	91.3 cd	91.5 bc	82.5 bc	22.9 cde	25.4 b	47.5 cd
9) RR – Safl + Glyph	93.3 a-d	89.8 bcd	81.3 bc	24.3 b-e	28.7 ab	49.5 bcd
10) RR – Diquat	96.0 ab	94.5 ab	85.0 ab	20.0 e	19.1 c	40.4 de
S.E.M.	1.94	1.78	1.83	1.92	1.41	3.32
LSD [X]	3.95	5.18	5.30	4.88	4.10	9.52
Pr > *F* (p-value)	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**

[Z] Final ratings completed at harvest [Y] Gravimetric water content of above-ground plant material (including grain) at harvest

Table A-17. Treatment means and tests of fixed effects for seed moisture content and yield at Scott, Saskatchewan. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	**SC-2017**	**SC-2018**	**SC-2019**	**SC-2017**	**SC-2018**	**SC-2019**
	---------- Seed Moisture Content (%)[Z] ----------			--------------- Seed Yield (kg/ha)[Y] ---------------		
1) LL – Control	3.6 bc	12.2 a	17.9 a	3450 a	3304 a	3242 d
2) LL – Glyphosate	2.7 c	11.2 cde	13.7 ab	3440 a	3248 a	3607 bc
3) LL – Saflufenacil	3.5 bc	12.1 ab	13.4 b	3482 a	3180 ab	3495 cd
4) LL – Safl + Glyph	2.9 bc	10.8 def	12.1 b	3385 a	3266 a	3936 ab
5) LL – Diquat	2.8 c	10.7 ef	13.3 b	3563 a	3182 abc	4064 a
6) RR – Control	5.5 a	12.0 ab	12.3 b	3712 a	2994 d	3591 bcd
7) RR – Gluf. Amm.	3.7 b	11.6 bc	7.1 c	3743 a	3079 bcd	3348 cd
8) RR – Saflufenacil	5.2 a	11.3 cd	11.5 b	3992 a	2953 d	3487 cd
9) RR – Safl + Glyph	5.3 a	12.1 ab	11.7 b	3908 a	2998 d	3427 cd
10) RR – Diquat	2.9 bc	10.3 f	12.8 b	3487 a	3009 cd	3919 ab
S.E.M.	0.33	0.25	1.46	234.5	72.7	125.0
LSD [X]	0.92	0.59	4.24	530.8	170.2	357.2
Pr > *F* (p-value)	**0.001**	**<0.001**	**0.008**	0.267	**<0.001**	**<0.001**

[Z] Gravimetric water content of canola seed at harvest [Y] Corrected for dockage and to 10% seed moisture content

Table A-18. Treatment means and tests of fixed effects for seed weight and percent distinctly green seed at Scott, Saskatchewan. The treatments were pre-harvest/desiccation options for glufosinate ammonium (LL) and glyphosate (RR) tolerant canola. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; *P* ≤ 0.05).

Treatment	SC-2017	SC-2018	SC-2019	SC-2017	SC-2018	SC-2019
	--------- Seed Weight (g/1000 seeds) ---------			----------------- Green Seed (%) -----------------		
1) LL – Control	3.40 c	3.06 c	3.50 bc	0.3 a	0.2 bc	1.4 a
2) LL – Glyphosate	3.40 c	2.99 c	3.23 d	0.4 a	0.2 bc	0.7 a
3) LL – Saflufenacil	3.37 c	3.00 c	3.37 cd	0.3 a	0.3 bc	1.1 a
4) LL – Safl + Glyph	3.40 c	2.97 c	3.18 d	0.3 a	0.2 c	0.2 a
5) LL – Diquat	3.39 c	2.99 c	3.20 d	0.5 a	0.7 b	1.1 a
6) RR – Control	3.77 ab	3.64 ab	3.72 ab	0.2 a	0.5 bc	0.9 a
7) RR – Gluf. Amm.	3.65 b	3.57 b	3.37 cd	0.2 a	0.4 bc	0.6 a
8) RR – Saflufenacil	3.77 ab	3.64 ab	3.82 a	0.5 a	0.3 bc	1.3 a
9) RR – Safl + Glyph	3.83 a	3.74 a	3.83 a	0.3 a	0.6 bc	1.0 a
10) RR – Diquat	3.78 ab	3.62 ab	3.75 ab	1.9 a	3.0 a	1.7 a
S.E.M.	0.079	0.055	0.087	0.40	0.18	0.327
LSD [X]	0.166	0.131	0.253	1.10	0.52	ns
Pr > *F* (p-value)	**<0.001**	**<0.001**	**<0.001**	0.108	**<0.001**	0.138