2014 Final Project Report

for the

SASKATCHEWAN CANOLA DEVELOPMENT COMMISSION (SASKCANOLA)

PROJECT TITLE: QUANTIFYING GENETIC DIFFERENCES IN SEED LOSSES DUE TO POD DROP AND POD SHATTERING IN CANOLA

(CARP-SCDC 2011-20)

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Executive Summary:

Field trials were conducted from 2011-14 at Indian Head, Scott, Swift Current and Melfort (Saskatchewan) with the objective of quantifying relative resistance to yield loss due to pod shatter and pod drop amongst a wide range of straight-combined *B. napus* hybrids. An additional objective was to provide information on the overall risk of environmental yield loss in straight-combined canola, particularly in cases where harvest is delayed. The treatments were 10-11 canola hybrids and several entries were updated in 2013. Over the 4-year period, a total of 15 canola hybrids were evaluated including: 1) 5440, 2) L130, 3) L140P, 4) L150, 5) 45H29, 6) 45H31, 7) 45H32, 8) 73-75, 9) 73-45, 10) 74-44BL, 11) 6050, 12) 6060, 13) 9553, 14) 46H75 and 15) 5525. Yield losses were estimated using two separate methods; either by comparing the change in yields between optimal and delayed harvest dates and by using seed trays inserted beneath the crop canopy throughout the entire harvest period.

When harvest was completed early, environmental yield losses were below 5% at 93% of the 13 sites. Losses generally increased when harvest was delayed by 3-4 weeks; however, total losses were still ≤5% (averaged across hybrids) at 53% of the sites and 10% or lower at 77% of the 13 site-years. These results suggest that environmental yield losses with straight-combined canola are unlikely to exceed 10%, even with minor delays in harvest. Overall, environmental conditions had a large effect on the magnitude of yield losses and were generally of greater importance than hybrid differences within any given site. For example, straight-combined canola yields were reduced by 10-14% (depending on the method used to estimate losses) with a 3-4 week delay in harvest; however, average losses with delayed harvest at individual site ranged from essentially nil to as high as 54-60% at Indian Head in 2012. In contrast, the overall average losses for individual hybrids ranged from 12-24% in 2011-12 and from 2-9% in 2013-14. Averaging 42% overall, pod drop was an important contributor to environmental seed losses, but also largely affected by environment ranging from 12-60% at individual sites.

With delayed harvest, total yield losses were affected by hybrid at 77% of the individual site-years; however, the relative performance of the hybrids was not always consistent across the sites where differences were detected. Because environment was such an important factor and the entries were updated partway through the study, it was of limited value and not always possible to simply compare overall treatment averages. For example, the losses observed with hybrids evaluated exclusively in 2011-12 could not be directly compared to those that were introduced in 2013-14. In attempt to rank hybrids in a manner that allowed all of them to be compared simultaneously, total losses at the T2 date within each site-year were ranked on a scale of 1-3 where a value of 1 indicated that losses were not significantly higher those observed with the best hybrid. Hybrids assigned a value of 2 had significantly higher losses than the best hybrids, but lower losses than any hybrids assigned a ranking of 3. In cases where no significant differences amongst hybrids were detected, all received a ranking of 1. The derived values ranged from 1.0-2.2 and the relative rankings from lowest to highest total losses using this system were: L140 < 45H32 < 5440 < L150 < L130 < 74-44BL < 9553 < 45H29 < 6050 < 73-75 = 46H75 45H31 < 5525 < 73-45 < 6060.

To conclude, while varietal differences in resistance to pod drop and pod shatter were frequently detected, these differences were generally smaller than those observed either between harvest dates or across site-years. Furthermore, the observed differences were not always consistent from year to year or site to site. Overall, at the time of the first harvest date, losses were extremely low

(<5%) at 92% of the sites and, while occasional hybrid differences were detected, they were small and of little agronomic importance. However, with a 3-4 week delay in harvest, the overall average risk of yield loss increased substantially with an observed increase from 5% to 17% in 2011-12 and from 2% to 8% in 2013-14. While varietal differences in resistance to environmental seed losses do exist and can contribute towards reducing the overall risk of yield loss, all of the hybrids evaluated were straight-combined successfully provided that harvest was not delayed too long. New shatter tolerant hybrids such as L140P showed excellent potential for further reducing the risks of yield loss with straight-combining; however, factors such as overall yield potential, maturity and herbicide system continue to be important when choosing a canola hybrid, regardless of harvest method. While choosing a variety with reduced potential for pod shatter / drop can contribute to successful straight-combining of canola, growers should still strive to complete harvest as soon after the crop is fit to combine as possible.

Background / Introduction:

There is growing interest in straight-combining canola and mounting evidence that, on average, similar seed yields and losses can be expected to occur with straight-combining and the predominantly recommended practice of swathing (Holzapfel et al. 2010; Haile et al. 2014a). Past research on canola harvest management issues has largely overlooked genetic variability in resistance to shattering, instead focussing on other aspects including harvest method (ie: Price et al. 1996; Irvine and Lafond 2010), equipment configuration / header types (i.e. Hobson and Bruce 2002; Pari et al. 2012), timing of harvest operations (ie: Thomas et al. 1991, Vera et al. 2007), or general crop management (ie: Watson et al. 2008). Previous studies have made broader comparisons of oilseed crops (ie: Gan et al. 2008), but these were not focussed specifically on *B. napus* genotypes which comprise the vast majority of *Brassica* oilseed acres in the Prairies. Wang et al. (2007) provides one of the more comprehensive comparisons of pod shatter resistance amongst canola genotypes. While they did show yellow seeded *B. napus* canola and *B. juncea* to have greater shattering resistance than black seeded *B. napus* varieties as a whole; they also reported wide variability in environmental seed losses amongst the twenty-two *B. napus* genotypes evaluated. Another recent study in Saskatchewan evaluated pod sealant effects on canola seed yield and quantified losses amongst four *B. napus* hybrids and one open pollinated canola quality *B. juncea* cultivar (Holzapfel et al. 2010). While this research did not show a consistent benefit to *B. juncea* over *B. napus* (possibly due to disease at the wetter locations), the Argentine hybrid 5440 exhibited consistently lower losses than the other cultivars evaluated. This was especially evident when canola was left standing several weeks past the optimal harvest stage (6% versus 20% yield losses) but also at the time of harvest (2% versus 7%). A related project also showed variation in volunteer canola seedbank additions following different canola genotypes (Haile et al. 2014b). If reasonably consistent and repeatable, varietal differences in resistance to environmental yield loss due pod shattering and pod drop such as these are important to growers interested in minimizing the risks associated with straight-combining canola. In addition to potential genetic differences, growers interested in straight-combining canola stand to benefit from an improved, broader understanding of the frequency and magnitude of environmental seed losses that can occur under field conditions when *B. napus* hybrids are left to mature while standing.

Objectives:

A multiple location, four-year study was initiated in 2011 with the specific objectives of:

1) Quantifying the frequency and magnitude of environmental seed losses in straight-combined *B. napus* canola under a wide range of environmental conditions.

2) Evaluating the relative resistance to pod shatter / pod drop amongst modern *B. napus* hybrids to identify cultivars that may be well suited for straight-combining.

3) Quantifying environmental seed loss contributions from pods breaking off at the pedicle and dropping (pod drop) versus pod shatter in *B. napus* canola.

Materials & Methods:

Field trials were located near Indian Head (IH; 50˚33’N 103˚39’W), Scott (SC; 52˚21’N 108˚50’W) and Swift Current (SW; 50˚16’N 107˚44’W), Saskatchewan with an additional site at Melfort (ME; 52˚49’N 104˚36’W) added in 2013. In any given year, the treatments were 10-11 *Brassica napus* hybrids arranged in a modified Randomized Complete Block Design (RCBD) with four replicates. Where required for logistic considerations, the randomizations were modified to situate hybrids within herbicide groups adjacent to one another and simplify spraying operations. The canola hybrids were updated in 2013 in order to stay current and to accommodate new cultivars with potentially improved tolerance to shattering. The 15 hybrids that have been evaluated over the four-year study period are provided in Table 1. A seeding rate of 115 viable seeds m^{-2} was used in all cases and the plots were direct seeded into standing cereal stubble. The specific seeding equipment used and plot sizes varied depending on the location with row spacing ranging from 22-31 cm. In all cases, the plots were large enough to accommodate two separate harvest passes at two distinct dates. Fertilizer formulations and rates varied depending on the location; however, all fertilizer was soil-placed either prior to or during seeding. Weeds were controlled using registered herbicides at the recommended rates and stages with at least one application of the partner herbicide (ie: Liberty, Roundup or Odyssey) applied in-crop. Registered foliar fungicides applications were used as deemed necessary to keep sclerotinia stem rot infection at acceptably low levels. The plots were straight-combined using small plot combines at two separate dates. The first harvest date (T1) was targeted for at, or slightly before, the optimal harvest stage (seed dried to 10-12% moisture content with 2% or less green seed) while the second harvest date (T2) was targeted for 3-4 weeks later. When considering necessary, separate T1 harvest dates were permitted to accommodate differences in maturity in order to avoid biasing against any early maturing hybrids. Desiccation was also permitted for the first harvest date but not for the second. Dates of pertinent field operations and other agronomic information for individual sites are provided in Table 2.

Table 1. *Brassica napus* hybrids evaluated in 2011-14 canola seed loss trials.

----------	**Canola Hybrid Treatments**	----------
InVigor 5440 (LL) ^{Z}	Pioneer 45H31 (RR) ^{Y}	BY 6050 (RR) ^{X}
InVigor L130 (LL) ^{Z}	Pioneer 45H32 (RR) ^{X}	BY 6060 (RR) ^{Y}
InVigor L140P (LL) ^{X}	Dekalb 73-75 (RR) ^{Z}	Proven 9553 (RR) ^{Y}
InVigor L150 (LL) ^{Y}	Dekalb 73-45 (RR) ^{Y}	Pioneer 46H75 (RR) ^{Z}
Pioneer 45H29 (RR) ^{Z}	Dekalb 74-44BL (RR) ^{X}	BY 5525 (CL) ^{Z}

^{Z} 2011-14; ^{Y} 2011-2012; ^{X} 2013-2014

Several crop response variables were measured over the course of the growing season. The number of days from planting to maturity was recorded for each plot with maturity defined as when 60% of the seeds along the main raceme showed signs of colour change. Environmental seed losses due to pod shatter and/or pod drop were measured prior to each of the two harvest dates, with separate values recorded for each mechanism of yield loss at all sites except Melfort and Scott in 2013 where only total losses were recorded. These measurements were completed using shatter trays which placed beneath the crop canopy in advance of any potential seed losses with two trays per plot used at all locations except Swift Current where one tray per plot was used. The trays varied slightly in their precise dimensions but were designed to fit in between the crops rows and were inserted from the fronts and backs of each plot with care taken to ensure the additional losses were not caused by inserting and removing the trays. All seed losses were estimated on a kg ha^{-1} basis and, to account for differences in overall yield potential, were converted to percent seed yield loss. The percentage of environmental seed loss due to pod drop was calculated for the T2 measurement date by dividing the losses due to pod drop (kg ha^{-1}) by the total yield loss (kg ha^{-1}) and multiplying the values by 100. In addition to the seed loss measurements, yields at the two separate dates were also used to assess shattering losses with any lower yields observed at the second harvest date presumably being due to environmental seed losses (assuming equal header/threshing losses for both dates). At the first harvest date, any yield losses measured in the trays were added back on to the harvested yield to estimate the total yield if no shattering / pod drop losses had occurred and minimize any biases caused by differences in maturity or environmental conditions amongst hybrids. Grain yields were reported on a clean seed basis and at a uniform moisture content of 10%. Percent green seed means are presented to quantify differences in maturity were determined by crushing 500 seeds from each plot and counting the number of distinctly green seeds. Mean monthly temperatures and precipitation amounts along with daily weather parameters for the harvest/seed loss measurement period were estimated from the nearest Environment Canada weather station for each location (Environment Canada 2015).

All response data were analyzed using the Mixed procedure of SAS 9.3 with the effects of location and hybrid along with their interaction considered fixed and the effects of replicate considered random. The rational for considering site a fixed effect was because that environmental and crop conditions are known to have a large effect on environmental seed loss, the treatments were changed over time, and exploratory analyses with site as a random effect revealed that well over half of the residual variability was due to the effects of location. Due to the change in treatments over time, main effect means were not estimable and therefore the data were sliced by site-year with hybrid means separated using Fisher's protected LSD test. All treatment effects of differences between means were considered significant at $P \leq 0.05$.

Table 2. Dates of field operations and selected agronomic information for SaskCanola shattering trials at various locations (2011-2014).								
Site-Year [Z]	**Seeding Date**	**Fertilizer** (kg N-P_2O_5-K_2O-S ha^{-1})	**In-crop Herbicide 1**	**In-crop Herbicide 2**	**Seed Losses Date T1**	**Harvest Date T1**	**Seed Losses Date T2**	**Harvest Date T2**
IH11	May-17	128-30-15-15	Jun-10	Jul-03[Y]	Sep-08	Sep-09	Oct-03	Oct-04
IH12	May-18	129-30-15-15	Jun-18	n/a	Aug-29 to Sep-10[W]	Aug-29 to Sep-10[W]	Sep-28	Sep-28
IH13	May-25	122-30-15-15	Jun-27 to Jun-28	Jun-29[Y]	Sep-20 to Sep-21	Sep-20 to Sep-21	Oct-15	Oct-15
IH14	May-22	122-30-15-15	Jul-5	Jul-7 [Y]	Sep-20	Sep-20	Oct-18	Oct-19
SC11	May-17	108-23-59-20	Jun-09	n/a	Sep-14	Sep-14	Oct-3	Oct-04
SC13	May-15	108-26-13-17	Jun-11	n/a	Sep-03	Sep-03	Sep-27	Sep-27
SC14	May-14	134-28-17-22	Jun-16	n/a	Sep-12	Sep-12	Oct-7	Oct-7
SW11	May-13	56-0-0-0	Jun-09	Jun-22 [X]	Aug-23	23-Aug	08-Sep	08-Sep
SW12	May-12	78-39-0-16	Jun-12	n/a	Aug-23	Aug-23	Sep-18	Sep-18
SW13	May-17	128-64-0-26	Jun-17	n/a	Aug-26	Aug-28	Sep-20	Sep-20
SW14	May-20	17-64-0-26	Jun-10	n/a	Sep-05	Sep-05	Oct-5	Oct-5
ME13	May-22	148-39-20-20	Jun-19 to Jun-24	n/a	20-Sep	Sep-13 to Sep-16 [W]	Oct-18	Oct-18
ME14	Jun-01	106-20-10-10	Jun-25 to Jun-26	n/a	Oct-9	Sep-23	Oct-31	Oct-30

[Z] IH – Indian Head; SC – Scott; SW – Swift Current; ME - Melfort

[Y] Graminicide only; [X] Liberty Link® hybrids only (first application was not effective)

[W] T1 harvest and seed loss measurements completed on separate days to account for maturity differences

Results and Discussion:

Growing Season Weather Conditions

Mean monthly temperatures (May-September) and total precipitation levels for each site-year are presented along with the long-term averages (1981-2010) in Tables 3 and 4. In addition, daily weather parameters, including wind speed, for the last thirty days leading up to the final harvest date are provided for all sites in the Appendices (Tables B-1 through B-13). Overall, the 13 site-years provided a wide range of environmental conditions to evaluate genetic differences in canola's resistance to environmental pod shatter and pod drop losses.

Table 3. Mean monthly temperatures at Indian Head, Scott, Swift Current and Melfort (2011-2014) along with the long-term normal temperatures (1981-2010; Environment Canada 2015).

Location	**Year**	**May**	**June**	**July**	**August**	**September**
		------------------------------- temperature (ºC) ---------------------------------				
Indian Head	2011	9.5	15.1	18.8	17.8	13.9
	2012	9.9	16.5	19.2	17.1	12.6
	2013	11.9	15.3	16.3	17.1	14.3
	2014	10.2	14.4	17.3	17.4	12.3
	LT	**10.8**	**15.8**	**18.2**	**17.4**	**11.5**
Scott	2011	10.1	14.4	17.0	16.3	13.7
	2012	9.7	15.1	18.6	17.0	12.2
	2013	12.6	14.8	16.5	17.4	14.0
	2014	9.3	13.9	17.4	16.8	11.2
	LT	**10.8**	**15.3**	**17.1**	**16.5**	**10.4**
Swift Current	2011	9.5	14.3	18.2	18.2	15.1
	2012	9.4	15.5	20.0	19.0	13.8
	2013	12.6	15.5	16.8	19.2	15.2
	2014	10.9	13.4	18.1	18.1	12.2
	LT	**10.9**	**15.4**	**18.5**	**18.2**	**12.0**
Melfort	2013	12.0	15.4	16.4	17.7	14.4
	2014	10.0	14.0	17.5	17.6	11.9
	LT	**10.7**	**15.9**	**17.5**	**16.8**	**10.8**

Table 4. Total monthly precipitation levels at Indian Head, Scott, Swift Current and Melfort (2011-2014) along with the long-term normal amounts (1981-2010; Environment Canada 2014).

Location	Year	May	June	July	August	September
		------------------------------ precipitation (mm) ------------------------------				
Indian Head	2011	71.3	133.2	42.3	44.2	15.7
	2012	79.4	51.0	124.6	30.4	0.0
	2013	17.1	103.8	50.4	6.1	14.8
	2014	36.0	199.2	7.8	142.2	42.3
	LT	**51.8**	**77.4**	**63.8**	**51.2**	**34.1**
Scott	2011	30.8	190.2	76.2	51.8	3.8
	2012	50.6	164.6	56.4	51.4	24.4
	2013	38.9	113.5	26.1	63.3	0.0
	2014	23.1	60.4	80.9	30.1	23.6
	LT	**36.3**	**61.8**	**72.1**	**45.7**	**32.0**
Swift Current	2011	56.9	117.3	68.0	30.4	10.6
	2012	98.3	107.0	17.2	8.2	4.9
	2013	11.2	103.0	50.4	13.5	42.8
	2014	27.5	108.6	29.9	104.0	46.7
	LT	**48.5**	**72.8**	**52.6**	**41.5**	**31.5**
Melfort	2013	18.0	96.9	100.0	10.6	17.0
	2014	24.4	169.8	94.6	60.4	9.4
	LT	**42.9**	**54.3**	**76.7**	**52.4**	**34.3**

Overall Tests of Fixed Effects

The results of the overall *F*-tests are provided in Table 5. For all the response variables analyzed, the interactions between site-year (S) and hybrid (H) were highly significant (P < 0.001-0.003), therefore indicating that hybrid effects were not always consistent across site-years. While main effects were also highly significant in the vast majority of cases, least squares means for site-year (across hybrids) or hybrid (across site-years) were not estimable because the treatments varied over time.

Table 5. Overall tests of fixed effects on selected response variables at Indian Head, Scott, Swift Current and Melfort (2011-2014). The combined data were analyzed using the mixed procedure as SAS 9.3.			
Variable	**Site-Year (S)**	**Hybrid (H)**	**S** × H
	----------------------------------	Pr > *F*	----------------------------------
Maturity (days from planting)	<0.001	<0.001	<0.001
Green Seed (T1)	<0.001	<0.001	<0.001
Seed Yield (T1)	<0.001	<0.001	<0.001
Seed Yield (T2)	<0.001	<0.001	<0.001
Yield Diff. (T1-T2; kg ha^{-1})	<0.001	<0.001	<0.001
Yield Diff. (T1-T2/T1; %)	<0.001	<0.001	<0.001
T1 Losses (kg/ha – dropped)	<0.001	0.098	0.003
T1 Losses (kg/ha – shattered)	<0.001	<0.001	<0.001
T1 Losses (kg/ha – total)	<0.001	<0.001	<0.001
T1 Losses (% – total)	<0.001	<0.001	<0.001
T2 Losses (kg/ha – dropped)	<0.001	<0.001	<0.001
T2 Losses (kg/ha – shattered)	<0.001	<0.001	<0.001
T2 Losses (kg/ha – total)	<0.001	<0.001	<0.001
T2 Losses (% – total)	<0.001	<0.001	<0.001
Dropped / Total (%)	<0.001	<0.001	<0.001

Days to Maturity

Days to maturity was affected by hybrid at all site-years (P < 0.001-0.024); however the observed range from the earliest to the latest treatments varied from approximately 2-7 days depending on the site-year (Table A-1). Averaged across hybrids, the number of days from planting to maturity ranged from 90-106 for the various site-years. Generally speaking, maturity was earlier and differences amongst genotypes were smaller under dry late-season conditions. The relative maturities of the individual hybrids varied somewhat across site-years but on average, 5440, L130 and 73-45 were the earliest maturing and 6060 was the latest during the 2011-12 period. Of the hybrids evaluated in 2013-14, the earliest to mature were typically 5440 and L130 while the latest included 5525, 46H75 and 45H32. Overall, the range of maturities observed amongst the hybrids evaluated in 2013-14 appeared to smaller than with those evaluated in the first two years of the study. Percent green seed for the individual hybrids at each site are presented in Table A-2 and are also a function of relative maturity at the T1 harvest date.

Seed Yield

Mean seed yields for the T1 (optimal) harvest dates are provided in Table 6. At this time, seed yield was affected by hybrid at 7/13 sites with no significant differences detected at Indian Head in 2011 and 2013 or Swift Current in all four years (P = 0.101-0.620). For the sites where the hybrid effect was significant, the relative rankings of the hybrids varied, presumably due to different genotypes being better suited to specific environmental conditions and potentially differences in weed populations/pressure amongst herbicide groups. Since doing so was not one of the study objectives, yield differences amongst hybrids are not discussed in detail; however, these results are presented to illustrate the range of crop conditions encountered and because these initial yields were used to calculate the relative seed losses. Across hybrids, the initial yields at each site ranged from as low as 1265 kg ha^{-1} at SW12 to over 3700 kg ha^{-1} at SC14 and ME13. When harvest was delayed by 3-4 weeks, mean yields were lowest at Indian Head and Swift Current in 2012 (806-830 kg ha^{-1}) where relatively serious losses occurred and tended to be highest at Melfort in 2013 and 2014 where yields were similar for the two harvest dates (Table A-3). At Scott in 2013, yields were substantially higher at the second harvest date which, with relatively high green seed observed for many hybrids (Table A-2), may have been partly due to harvesting too early. An additional bias in the yield data at this site arose in that two different combines and harvest areas were used for the two dates. Consequently, the yield differences from this site were not considered to be representative of the actual losses encountered and these data were removed prior to analyses.

Table 6. Least squares means and tests of hybrid effects on canola seed yield (T1 – optimal) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	T1 Grain Yield (kg ha^{-1})												
5440	3183 a	2976 b	2931 a	2301bc	1316 a	2505 a	1861 c	2505 a	3711 de	3387 ab	4222 a	1920 a	3719 a
L130	3095 a	2901 b	2983 a	2578 ab	1293 a	2485 a	1734 c	2298 a	3941 abc	3301 ab	4097 a	1922 a	3585 ab
L140P	—	—	—	—	—	2599 a	2110 c	2401 a	4046 ab	3357 ab	3852 ab	1859 a	3566 ab
L150	3123 a	2898 b	2846 a	1912 cd	1240 a	—	—	—	—	—	—	—	—
45H29	2984 a	3113 ab	2791 a	1960 de	1344 a	2371 a	2560 abc	2314 a	4044 ab	3421 ab	3899 ab	2056 a	3139 cd
45H31	3021 a	2889 b	2757 a	1907 de	1301 a	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	2436 a	2937 a	2184 a	3878 bcd	3345 ab	3703 ab	2178 a	3041 d
73-75	3415 a	3237 a	3089 a	1932 de	1274 a	2458 a	2768 ab	2371 a	4091 a	3300 b	3784 ab	2081 a	3352 bc
73-45	3271 a	2807 b	2936 a	2723 a	1218 a	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	2624 a	2917 ab	2408 a	4032 ab	3338 ab	3758 ab	2019 a	3506 ab
6050	—	—	—	—	—	2384 a	2907 ab	2349 a	3816 cde	3288 bc	3989 ab	2096 a	3707 a
6060	3080 a	2704 b	2731 a	2074 cd	1033 a	—	—	—	—	—	—	—	—
9553	3132 a	2711 b	2652 a	1767 e	1107 a	—	—	—	—	—	—	—	—
46H75	2960 a	2955 ab	2748 a	2217 cd	1269 a	2367 a	2197 c	2358 a	3658 e	3546 a	3471 bc	1927 a	2962 d
5525	3153 a	2996 ab	2810 a	1919 de	1091 a	2410 a	1984 c	2341 a	3295 f	3065 c	3135 c	1986 a	3188 cd
St. Error	143.3	121.7	119.8	112.8	94.2	94.9	175.4	104.6	82.8	94.0	196.1	111.7	96.7
Pr. > F	0.504	0.027	0.135	<0.001	0.101	0.278	<0.001	0.620	<0.001	0.020	0.005	0.475	<0.001

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Yield Reduction with Delayed Harvest

The mean differences in seed yield between the T1 and T2 harvest dates are presented for each hybrid in absolute terms (kg ha^{-1}) in Table A-4 of the Appendices and as a percentage of the total yield in Table 7 below. Across hybrids, the largest yield reductions with delayed harvest occurred at IH12 (~1290 kg ha^{-1} or 60% reduction on average) and, to a lesser extent, SW12 (~440 kg ha^{-1} or 35% reduction). In contrast, at all three locations (Indian Head, Swift Current and Scott) in 2011 and in both years (2013 and 2014) at Melfort, mean yields were within ±5% for the two harvest dates, indicating that the change in yield over time was minimal at these sites. Expressed as a percentage of the initial yield, the yield reductions with delayed combining varied amongst cultivars at 7/13 sites; however, no hybrid effects were detected at IH11 and SW11 where losses were negligible or at IH12 or SW12 where losses were relatively high (35-60%). There was no effect of hybrid at SW13 either, where the overall yield reduction with delayed harvest was considered intermediate, averaging 13% or 307 kg ha^{-1}.

For the 7/13 sites where the hybrid effect on percent yield difference was significant (P <0.001-0.022), mean overall losses ranged from essentially no yield reduction with delayed harvest (i.e. Melfort in both years) to over a 25% reduction (i.e. Scott in 2014). While the specific hybrid rankings varied across sites, some did appear to exhibit relatively low losses on a more consistent basis than others. L140P, which has been specifically marketed for improved pod shatter tolerance, had amongst the lowest yield reductions at 5/6 sites where differences were detected with an average yield reduction of 2.4% across all 8 sites where it was evaluated. 45H32, which was not commercially available (at the time of testing) but was submitted as a hybrid with potentially improved shattering resistance, also performed well with amongst the lowest yield reduction at 5/6 sites (where hybrid effects were detected) but amongst the highest at one site. The overall average yield reduction with delayed harvest for 45H32 of 5.8% averaged across the 8 sites. The relative yield reductions for L150, 45H31, 73-45 and 9553 were amongst the lowest at SC11; however, these hybrids were only tested in 2011-12 and there were no differences amongst hybrids at the remaining four sites from this period. Of the hybrids introduced in 2013, 74-44BL also performed relatively well with amongst the lowest losses at 4/6 sites, never amongst the highest losses and an overall reduction of 7% (similar to 5440) when averaged across all sites. Of the six hybrids evaluated across all 13 site-years, 5440, 45H29 and, to a lesser extent, 46H75 all performed relatively well, with frequently amongst the lowest losses at individual sites and average losses of 16-21% with delayed harvest in 2011-12 and 7-10% in 2013-14. Losses for 46H75 were somewhat less consistent in that this hybrid had amongst the highest losses in 3/7 cases where hybrid effects were significant while there was only such case for either 5440 (IH13) or 45H29 (ME13). Yield reductions with delayed harvest were considered intermediate for L130 and 5525, which were evaluated at all 13 sites with observed averaged yield reductions of 22% in 2011-12 and 9-11% in 2013-14. The largest and most frequent reductions in yield tended to occur with 6050, 6060 and 73-75 (23-27% in 2011-12 and 13-15% in 2013-14); however, both 6050 and 73-75 had amongst the lowest yield reductions at Indian Head in 2013, suggesting that higher losses were not always inevitable with these hybrids. Averaged across all site-years and hybrids, the imposed 3-4 week delay in straight-combining resulted in an overall yield reduction of 15% yield reduction.

Table 7. Least squares means and tests of hybrid effects on percent canola yield difference (T1 – T2/T1) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	----------	----------	----------	----------	----------	Percent Yield Diff. (T1-T2/T1)	----------	----------	----------	----------	----------	----------	----------
5440	1.9 a	-4.3 c	0.4 a	64.8 a	42.4 a	11.9 ab	—	9.3 a	-9.6 e	10.0 bcd	25.6 abc	4.6 bc	-0.2 b
L130	4.5 a	-2.2 bc	0.6 a	73.6 a	32.7 a	11.1 ab	—	10.0 a	0.6 a-d	10.4 bcd	20.3 bc	13.2 ab	-1.1 b
L140P	—	—	—	—	—	1.0 c	—	8.6 a	-5.4 de	2.1 e	13.5 c	-0.6 c	-2.1 b
L150	2.5 a	-4.3 c	-0.6 a	73.2 a	39.9 a	—	—	—	—	—	—	—	—
45H29	-3.5 a	4.8 abc	-0.8 a	58.1 a	39.0 a	5.7 bc	—	20.1 a	5.6 ab	9.0 cd	24.7 abc	7.3 bc	-5.8 bc
45H31	-2.4 a	2.1 abc	0.9 a	58.4 a	35.8 a	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	8.1 bc	—	10.9 a	-4.5 cde	6.6 de	20.7 bc	13.8 ab	-14.9 c
73-75	7.1 a	11.4 a	1.6 a	60.2 a	35.4 a	8.0 bc	—	16.3 a	7.0 a	15.6 ab	31.9 ab	14.3 ab	0.2 b
73-45	5.3 a	4.3 abc	-3.9 a	75.3 a	28.3 a	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	5.4 bc	—	7.3 a	-4.3 cde	13.2 bc	14.7 c	12.8 abc	-0.2 b
6050	—	—	—	—	—	0.5 c	—	14.2 a	4.0 abc	18.5 a	35.1 a	25.0 a	10.5 a
6060	1.7 a	12.1 a	5.9 a	67.9 a	50.3 a	—	—	—	—	—	—	—	—
9553	0.8 a	-4.0 c	-6.3 a	53.6 a	27.7 a	—	—	—	—	—	—	—	—
46H75	-2.9 a	2.1 abc	-0.2 a	45.8 a	33.3 a	16.7 a	—	7.1 a	-10.5 e	19.0 a	30.3 ab	3.8 bc	-10.6 c
5525	0.4 a	8.1 ab	-6.8 a	58.5 a	29.1 a	18.7 a	—	15.4 a	-2.7 b-e	11.8 bcd	29.1 ab	6.8 bc	-1.2 b
St. Error	4.12	4.35	3.79	7.43	5.48	3.59	—	4.6	3.77	2.89	4.93	5.30	3.60
Pr. > *F*	0.515	0.007	0.216	0.087	0.061	<0.001	—	0.347	<0.001	<0.001	0.006	0.022	<0.001

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Environmental Seed Loss Measurements

Using trays inserted beneath the crop canopy, environmental seed losses due to pod drop and pod shatter were estimated at both harvest dates. While all of the absolute (kg ha^{-1}) seed losses due to pod drop and pod shatter are presented for both harvest dates in the Appendices (Tables A-4 to A-10), this discussion will largely focus on percent total yield losses for simplicity. At the first harvest date, total losses (%) were affected by hybrid at 6/13 sites; however, overall mean total losses were below 5% at 12/13 sites, the exception being IH12. At this site heavy sclerotinia stem rot infection and severe winds late in August resulted in total yield losses averaging 20% (across hybrids) at T1 harvest date, biasing against the earliest maturing hybrids to some extent. With the exception of IH12, any differences in total yield losses at T1 were small and of little agronomic consequence. At Indian Head in 2012 (IH12), losses were highest (36-42%) for 5440 and 73-45 than for all of the other hybrids; however, again, this can largely be attributed to these hybrids being relatively early and, therefore, worse affected by severe winds (~80 km h^{-1} gusts) on August 24. Losses for 45H31, 6060 and 46H75 ranged from5-16% and were amongst the lowest at this site while losses for the remaining hybrids were intermediate (17-25%). While percent green seed at the T1 harvest (Table A-2) were somewhat high for certain sites and hybrids from a producer’s standpoint, the extremely low level of losses at 12/13 sites are encouraging. These results indicate that, provided harvest is not postponed by unfavourable weather or other factors, environmental losses with straight-combined canola will generally be negligible under normal circumstances.

However, total environmental yield losses at several sites increased substantially when harvest was delayed by 3-4 weeks and the frequency of sites with a significant hybrid effect increased to 10/13 (Table 9). These resulted were generally consistent with those observed for percent yield difference, estimated from the harvested yields at the two dates; however, the catch tray measurements tended to be more sensitive with hybrid effects detected at lower loss levels and also at IH12 where losses were extremely high. For the three sites where no hybrid effect was detected (SC11, SC13 and SW14), the estimates of total yield losses were negligible, ranging from approximately 2.3-3.2% when averaged across hybrids. Losses were also extremely low at IH11, SW13 and ME13, ranging from < 1-3% when averaged across hybrids; however, significant differences in percent total yield loss were detected amongst hybrids at these sites nonetheless ($P < 0.001$-0.052). At SC11, IH13 and ME14 losses were also affected by hybrid ($P < 0.001$-0.012) but total losses were more intermediate, averaging approximately 5-7%, at these sites. At SW12 and SC14, losses were considerably higher, with site averages ranging from 18-22% while, at IH12, extreme losses of over 50% were encountered. In all three of these latter cases, significant differences amongst hybrids were detected ($P < 0.001$-0.040).

Focussing on specific differences amongst individual hybrids, IH12 was somewhat unique in that 46H74, at 37%, exhibited significantly lower losses than all other hybrids where the observed losses ranged from 55-69%. Again, the losses at this site were unusually high and the observed treatment effects were not particularly consistent with those at other sites where the effect of hybrid was significant. For the remaining 9 sites where differences amongst hybrids existed, 5440 and L130 exhibited consistently low yield losses, being amongst the hybrids with the lowest losses at 8/9 and 7/9 site-years, respectively and, with the exception of IH12, never amongst the highest losses. Focussing on the remaining hybrids that were evaluated over the entire four year period, losses for 73-75 were amongst the lowest losses at 5/9 sites and amongst the highest at 2/9 while 45H29 had amongst the lowest losses at 4/9 sites and amongst the highest at 2/9 sites where differences were detected. Losses for 46H75 were somewhat less consistent, being amongst the lowest at 4/9 sites where the hybrid effect was significant but amongst the highest at the remaining 5/9 sites. Finally, for 5525, total shattering losses were amongst the highest losses in 6/9 sites where the effect was significant (excluding IH12) and amongst the lowest at 2/9 sites.

Again, the hybrids L150, 45H32, 73-45, 6060 and 9553 were only evaluated at the five 2011-12 sites. During that period, losses for L150 were amongst the lowest in 3/4 sites where the hybrid effect was significant, again, IH12 being the exception. For 9553, total losses with delayed harvest were considered low at 2/3 sites where differences were detected (not counting IH12) and intermediate at 1/3 sites. For 45H31, losses were amongst the lowest at 2/3 sites but amongst the highest at 1/3 sites. Losses tended to be consistently high for 6060 with amongst the highest of losses in all cases except SW11 where the hybrid effect was not significant. Hybrids exclusive to the 2013-14 sites were L140P, 45H32, 74-44BL and 6050. Of the new hybrids, L140P performed the most consistently, with amongst the lowest losses at 6/6 site-years where differences were detected. 45H32 also performed well with amongst the lowest losses at 5/6 sites but relatively high losses at 1/6 sites. The genotype 74-44BL had amongst the lowest losses in 4/6 cases where the hybrid effect was detected, but high and intermediate losses at 2/6 sites. Finally, total losses with 6050 were more variable with relatively low losses at 2/6 sites but amongst the highest at 2/6 sites and intermediate losses at 2/6 sites. To help put the results into perspective, mean (T2) losses for individual hybrids (averaged across sites) ranged from 12-24% in 2011-12 and from 2-9% in 2013-14.

Least squares means for site by hybrid effects on the percentage of total yield losses attributable to pod drop (as opposed to pod shatter) at the T2 harvest stage are presented in Table 10. Across the six representative hybrids, the percentage of total yield loss due to pod drop ranged from as low as 12% at ME14 to over 50% at IH12, IH13, SC11, SC14 and SW12. The effect of hybrid on this parameter was significant (P < 0.001-0.0234) at all sites except for SW11 (P = 0.345) and SW14 (P = 0.496). This ratio tended to be lowest for 5440, L150, 74-44BL and 6050 while it was frequently highest for L130, L140P, 45H29, 73-75 and 5525. However, in absolute terms (kg ha^{-1}) losses due to pod drop at the T2 date were also amongst the lowest with L130 and L140P (Table A-7). While the extent of pod drop losses appears to be largely affected by environmental conditions, differences amongst hybrids also appear to be a factor. While the end result is the same from a producer perspective, these results indicate that pod drop is an important mechanism for environmental seed losses and, in many cases, contributed as much or more to losses than pod shatter. Averaged across sites, 32-58% of the total losses were due to pod drop in 2011-12 and this range was 23-50% in 2013-14.

Table 8. Least squares means and tests of hybrid effects on percent total canola seed yield loss (T1) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$).

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	---------- T1 Total Losses (% of yield) ----------												
5440	0.2 bc	1.2 a	0.4 ab	20.2 cd	2.3 a	0.8 ab	0.4 a	0.6 a	0.4 abc	0.2 a	3.4 a	0.5 a	2.2 bc
L130	0.2 c	1.6 a	0.3 bc	35.7 ab	1.5 a	0.6 bc	0.7 a	0.0 a	0.7 ab	0.2 a	2.7 a	0.1 a	1.7 bc
L140P	—	—	—	—	—	0.1 c	0.6 a	0.6 a	0.1 c	0.1 a	0.5 a	0.1 a	0.9 c
L150	0.3 bc	1.7 a	0.1 bc	25.0 bc	1.4 a	—	—	—	—	—	—	—	—
45H29	0.3 bc	1.5 a	0.1 c	16.6 cde	2.7 a	1.2 a	0.4 a	0.4 a	0.4 abc	0.1 a	2.3 a	0.5 a	2.1 bc
45H31	0.2 bc	1.5 a	0.2 bc	10.6 de	2.7 a	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	0.9 ab	0.5 a	0.4 a	0.1 c	0.1 a	2.7 a	0.0 a	2.0 bc
73-75	0.2 bc	1.4 a	0.6 a	21.4 cd	1.3 a	0.8 ab	0.5 a	0.1 a	0.6 abc	0.2 a	4.0 a	0.3 a	3.2 abc
73-45	0.5 a	2.3 a	0.2 bc	41.5 a	2.3 a	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	0.5 bc	0.6 a	0.5 a	0.6 abc	0.1 a	4.6 a	0.1 a	2.9 bc
6050	—	—	—	—	—	0.9 ab	0.7 a	0.4 a	0.9 a	0.3 a	2.9 a	0.6 a	3.5 ab
6060	0.4 ab	1.5 a	0.2 bc	16.2 cde	2.9 a	—	—	—	—	—	—	—	—
9553	0.2 bc	1.7 a	0.2 bc	24.7 bc	3.2 a	—	—	—	—	—	—	—	—
46H75	0.2 bc	1.1 a	0.1 bc	5.0 e	1.7 a	0.8 ab	0.4 a	0.2 a	0.2 bc	0.2 a	2.7 a	0.5 a	3.6 ab
5525	0.1 c	1.6 a	0.3 bc	20.5 cd	1.6 a	1.1 ab	0.5 a	0.4 a	0.2 bc	0.1 a	4.2 a	0.3 a	5.7 a
St. Error	0.07	0.41	0.11	4.37	0.59	0.20	0.14	0.21	0.20	0.07	0.95	0.23	0.92
Pr. > *F*	0.001	0.886	0.015	<0.001	0.246	0.022	0.515	0.464	0.052	0.100	0.148	0.558	0.032

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table 9. Least squares means and tests of hybrid effects on percent total canola seed yield loss (T2) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$).

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	---------- T2 Total Losses (% of yield) ----------												
5440	0.5 cd	4.3 e	1.1 a	54.5 a	18.8 b	3.7 bc	2.9 a	1.4 d	1.9 bc	4.5 cd	13.8 de	1.6 a	3.3 bcd
L130	0.4 d	5.0 de	1.2 a	66.3 a	13.1 b	4.6 b	3.8 a	1.0 d	2.0 abc	6.1 bc	11.6 e	1.8 a	2.5 cd
L140P	—	—	—	—	—	1.2 c	2.1 a	1.7 cd	0.8 c	0.7 e	4.3 e	2.7 a	1.3 d
L150	0.7 cd	4.7 e	1.6 a	63.5 a	11.0 b	—	—	—	—	—	—	—	—
45H29	1.2 b	8.4 bcd	4.8 a	56.8 a	16.6 b	4.6 b	1.9 a	5.5 a	1.6 bc	1.6 de	15.1 cde	3.3 a	6.4 abc
45H31	0.5 cd	9.3 abc	2.6 a	58.1 a	21.4 b	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	3.6 bc	1.5 a	5.0 ab	1.6 bc	0.9 e	12.6 e	3.6 a	3.4 bcd
73-75	0.6 cd	10.1 ab	2.3 a	54.7 a	23.7 ab	5.0 b	2.6 a	2.9 bcd	1.7 bc	7.4 bc	27.0 abc	1.5 a	5.2 a-d
73-45	0.9 bc	10.5 ab	4.4 a	69.1 a	14.8 b	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	1.6 c	1.9 a	2.6 cd	2.0 abc	3.0 de	20.6 bcd	0.7 a	6.0 abc
6050	—	—	—	—	—	3.4 bc	3.3 a	2.0 cd	2.6 ab	6.0 bc	17.9 cd	3.8 a	8.9 a
6060	1.7 a	12.9 a	2.8 a	68.5 a	35.5 a	—	—	—	—	—	—	—	—
9553	0.9 bc	7.1 b-e	1.6 a	54.5 a	23.3 ab	—	—	—	—	—	—	—	—
46H75	0.6 cd	5.6 cde	2.5 a	36.7 b	14.3 b	9.0 a	2.4 a	2.5 cd	2.5 ab	11.2 a	32.4 a	2.2 a	5.6 abc
5525	0.7 cd	8.4 bcd	1.6 a	56.0 a	19.3 b	9.3 a	3.1 a	3.8 abc	3.4 a	8.9 ab	28.8 ab	2.3 a	7.5 ab
St. Error	0.16	1.4	1.5	5.62	4.9	1.0	0.6	0.8	0.5	1.1	4.7	1.1	1.5
Pr. > *F*	<0.001	<0.001	0.674	<0.001	0.040	<0.001	0.097	<0.001	0.052	<0.001	<0.001	0.577	0.012

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table 10. Least squares means and tests of hybrid effects on the proportion of total yield loss due to pod drop (T2) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the lowest treatment while those highlighted yellow do not differ from the highest treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	---------- T2 Pod Drop Loss / Total Loss (%) ----------												
5440	10.4 c	33.2 e	32.8 a	43.6 d	41.7 d	34.8 ef	—	17.5 d	—	17.6 cd	61.0 ab	5.0 a	3.3 c
L130	43.1 ab	52.3 cd	46.0 a	44.2 d	50.7 cd	69.9 ab	—	41.9 abc	—	36.1 ab	54.3 bcd	18.9 a	0.0 c
L140P	—	—	—	—	—	62.3 bc	—	30.6 cd	—	47.2 a	65.3 ab	31.8 a	46.2 a
L150	37.4 abc	42.6 de	36.4 a	49.5 bcd	43.9 d	—	—	—	—	—	—	—	—
45H29	50.5 ab	72.2 a	36.4 a	55.3 a-d	67.2 abc	53.1 cd	—	45.4 abc	—	12.5 d	55.8 bcd	46.9 a	17.8 b
45H31	37.2 abc	61.7 abc	31.6 a	57.9 ab	52.2 bcd	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	78.6 a	—	52.7 ab	—	29.2 bc	72.6 a	56.7 a	11.5 bc
73-75	43.9 ab	56.8 a-d	38.4 a	56.1 a-d	73.6 a	58.6 bcd	—	64.8 a	—	28.4 bc	50.5 cd	22.2 a	11.8 bc
73-45	20.7 bc	53.9 bcd	42.7 a	28.5 e	68.7 abc	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	28.9 f	—	27.2 cd	—	11.2 d	55.3 bcd	19.2 a	8.0 bc
6050	—	—	—	—	—	38.2 ef	—	32.6 cd	—	23.1 bcd	44.1 d	43.0 a	9.8 bc
6060	51.0 a	54.6 bcd	25.8 a	59.5 ab	40.4 d	—	—	—	—	—	—	—	—
9553	61.8 a	67.1 ab	44.7 a	44.9 cd	72.5 ab	—	—	—	—	—	—	—	—
46H75	44.6 ab	69.7 ab	25.5 a	66.2 a	59.0 a-d	45.7 de	—	41.4 bc	—	27.4 bc	56.1 bc	40.2 a	10.5 bc
5525	37.6 ab	63.3 abc	58.0 a	57.2 abc	68.1 abc	60.5 bc	—	46.2 abc	—	37.6 ab	55.7 bcd	30.1 a	31.2 ab
St. Error	10.04	6.07	11.16	5.12	8.03	5.51	—	8.63	—	5.38	4.82	16.3	9.12
Pr. > *F*	0.023	<0.001	0.345	<0.001	0.003	<0.001	—	0.005	—	<0.001	<0.001	0.496	0.010

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Summary and Conclusions:

Overall, thirteen site-years provided a wide range of environmental conditions and extreme variation in the potential for yield losses due to pod drop and pod shatter in standing canola. The results of this project provide information on both the variation in environmental seed losses amongst current *B. napus* canola hybrids and also on the broader risks of environmental yield losses associated with straight-combining canola. Due to the strong interactions between site-year (environment) and hybrid for all variables and the fact that the hybrids evaluated changed over time, this was a complex dataset to interpret and summarize. Environment had a large effect on the overall magnitude of yield losses and was generally of greater importance than differences amongst hybrids. To illustrate the importance of environment, means from the six hybrids that were included over the entire study period (5440, L130, 45H29, 73-75, 46H75 and 5525) are presented for each site-year in Table 11. While the overall average across all 13 sites was 14%, reductions in seed yield with delayed harvest ranged from below 5% at 38% of the sites to as high as 60% in the cases of Indian Head 2012. The total environmental yield losses estimated using the catch trays tended to be slightly lower with losses below 5% at 46% of the sites, mean estimated losses of 54% at Indian Head 2012 and an overall mean of 10%. It is conceivable that the observed trend of lower loss estimates with the trays was partly due to the canola being overripe and generally drier, subsequently resulting in higher header losses with delayed harvest. Averaging 42% across the 13 sites, this project also showed that pod drop is an important contributor to environmental seed losses, but also variable with a range of only 12% at Melfort in 2014 up to 60% at Swift Current in 2012.

Because environment was such an important factor and the hybrids were updated partway through the study, it is of limited value to simply compare the overall averages of hybrids when assessing relative resistance to yield loss and suitability for straight-combining. Furthermore, it was not possible to directly compare the losses of hybrids evaluated exclusively in 2011-12 to those that were introduced in 2013-14. However, for broad comparisons and to help put the results into perspective, the overall hybrid averages for selected response variables are presented for 2011-12 and 2013-14 in Tables 12 and 13, respectively. With higher pod shatter/drop pressure, particularly in 2012, the average total losses for individual hybrids in 2011-12 ranged from 14-28% based on the yield difference method or 12-24% according to the catch tray estimates. For 2013-14, mean yield losses ranged from 2-15% (yield difference) or 2-9% (catch trays) depending on the method used to estimate them. The relative rankings of the estimated losses were reasonably consistent with the two methodologies; however, these averages are still of limited value since they provide no indication of the overall consistency of how hybrids performed or how frequently significant differences amongst hybrids were encountered. In attempt to rank the hybrids in a manner that allowed all of them to be compared simultaneously, the hybrids within each site-year were ranked on a scale of 1-3 when a value of 1 indicated that losses were not significantly higher than the best hybrid (i.e. the hybrid with the lowest mean losses within a site-year). Treatments assigned a value of 2 had significantly higher losses than the best hybrids, but significantly lower losses than any hybrids that were assigned a ranking of 3. In cases where no significant differences amongst hybrids were detected, all treatments received a ranking of 1. The average rankings for each hybrid are presented along with the number of site-years where the hybrid was evaluated in Table 13. The derived values ranged from 1.0-2.2 and the relative rankings from lowest to highest total losses using this system were:

L140 < 45H32 < 5440 < L150 < L130 < 74-44BL < 9553 < 45H29 < 6050 < 73-75 = 46H75
45H31 < 5525 < 73-45 < 6060.

To conclude, while varietal differences in resistance to pod drop and pod shatter were frequently detected within individual site-years, these differences were smaller than those observed either between harvest dates or across site-years. Furthermore, the observed differences between hybrids were not always consistent from site-to-site. Overall, at the time of the initial harvest, losses were extremely low (<5%) at 92% of the sites and, while occasional harvest differences were detected, they were small and of little agronomic importance. As expected, the risk of yield loss increased substantially with a 3-4 week delay in harvest; however, total losses were still ≤5% on average at 53% of the sites and 10% or lower at 77% of the 13 site-years. These results would suggest that, while varietal differences in environmental seed losses do exist and can contribute to reducing the overall risk of yield loss, all of the hybrids evaluated could be straight-combined successfully provided that harvest was completed in a reasonably timely manner. New shatter tolerant hybrids such as L140P showed excellent potential for reducing the risk of yield loss with straight-combining; however, factors such as overall yield potential, days to maturity and herbicide system continue to be important to consider when choosing a canola hybrid, regardless of the anticipated harvest method. While choosing a variety with reduced potential for pod shatter / drop can certainly contribute to successful straight-combining of canola, growers should still strive to complete harvest as soon after the crop is fit to combine as possible.

Table 11. Overall site-year averages for selected response variables. Data are averaged across the six hybrids which were present at all 13 site-years. Differences between main effect means within a column are not necessarily statistically significant.

Site-Year	Maturity	Seed Yield T1	Yield Diff. (T1-T2)/T1	Total Yield Loss T1	Total Yield Loss T2	Total Yield Loss T1	Total Yield Loss T2	Dropped / Total T2
	----- days -----	----- kg/ha -----	------- % -------	----- kg/ha -----	----- kg/ha -----	------- % -------	------- % -------	------- % -------
IH11	96.4	3132	1.3	6	21	0.2	0.7	38.4
IH12	93.2	2151	60.2	443	1008	19.9	54.2	53.8
1H13	102.8	2433	12.0	22	147	0.8	6.3	53.8
1H14	103.9	3337	12.6	5	221	0.2	6.6	26.6
SC11	101.9	3030	3.3	42	215	1.4	7.0	57.9
SC13	97.3	2184	—	16	91	0.5	2.8	—
SC14	—	3768	27.0	123	820	3.2	21.5	55.6
SW11	94.2	2892	-0.9	9	67	0.3	2.3	39.5
SW12	89.7	1265	35.3	23	222	1.9	17.6	60.1
SW13	97.2	2365	13.0	7	67	0.3	2.9	42.9
SW14	92.6	1982	8.3	8	43	0.4	2.1	27.2
ME13	103.0	3790	-1.6	17	81	0.4	2.2	—
ME14	97.2	3324	-3.1	104	172	3.1	5.1	12.4
Avg.	97.4	2742	14.0	63	244	2.5	10.1	42.6

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table 12. Overall hybrid averages for selected response variables in 2011-12. Data are averaged across five site-years and differences between means within a column are not necessarily statistically significant.								
Hybrid	**Maturity**	**Seed Yield T1**	**Yield Diff. (T1-T2)/T1**	**Total Yield Loss T1**	**Total Yield Loss T2**	**Total Yield Loss T1**	**Total Yield Loss T2**	**Dropped / Total T2**
	----- days -----	----- kg/ha ----	------- % -------	----- kg/ha -----	----- kg/ha -----	--------% -------	------- % -------	------- % -------
5440	95.3	2541	21.0	111.1	276.7	4.9	15.8	32.3
L130	93.7	2570	21.8	199.8	343.6	7.9	17.2	47.3
L140P	—	—	—	—	—	—	—	—
L150	95.0	2404	22.1	111.7	244.6	5.7	16.3	42.0
45H29	96.4	2438	19.5	86.4	349.9	4.2	17.6	56.3
45H31	94.4	2375	19.0	59.2	350.8	3.0	18.4	48.1
45H32	—	—	—	—	—	—	—	—
73-75	94.4	2589	23.1	100.2	341.4	5.0	18.3	53.8
73-45	94.4	2591	21.9	244.4	422.4	9.4	19.9	42.9
74-44BL	—	—	—	—	—	—	—	—
6050	—	—	—	—	—	—	—	—
6060	98.4	2324	27.6	87.4	464.0	4.2	24.3	46.3
9553	96.2	2274	14.4	105.8	287.2	6.0	17.5	58.2
46H75	96.1	2430	15.6	39.0	225.4	1.6	11.9	53.0
5525	94.6	2394	22.2	115.1	302.4	4.8	17.2	56.8

Table 13. Overall hybrid averages for selected response variables in 2013-14. Data are averaged across eight site-years and differences between means within a column are not necessarily statistically significant.								
Hybrid	**Maturity**	**Seed Yield T1**	**Yield Diff. (T1-T2)/T1**	**Total Yield Loss T1**	**Total Yield Loss T2**	**Total Yield Loss T1**	**Total Yield Loss T2**	**Dropped / Total T2**
	----- days -----	----- kg/ha -----	------- % -------	----- kg/ha -----	----- kg/ha -----	------- % -------	------- % -------	------- % -------
5440	97.8	2979	7.4	38.4	148.8	1.1	4.1	23.2
L130	97.0	2920	9.2	30.8	142.4	0.8	4.2	36.9
L140P	98.1	2974	2.4	10.8	56.2	0.4	1.9	47.2
L150	—		—	—	—	—	—	—
45H29	99.5	2976	9.5	30.6	164.0	0.9	5.0	38.6
45H31	—	—	—	—	—	—	—	—
45H32	100.3	2963	5.8	27.7	125.9	0.8	4.0	50.2
73-75	98.5	3026	13.3	43.2	238.0	1.2	6.7	39.4
73-45	—	—	—	—	—	—	—	—
74-44BL	98.4	3075	7.0	44.6	176.1	1.2	4.8	25.0
6050	98.5	3067	15.4	45.9	214.7	1.3	6.0	31.8
6060	—	—	—	—	—	—	—	—
9553	—	—	—	—	—	—	—	—
46H75	100.9	2811	8.0	32.9	282.2	1.1	8.5	36.9
5525	101.1	2676	11.1	49.6	255.9	1.6	8.4	43.6

Table 14. Overall hybrid rankings for resistance to environmental yield losses due to pod shatter/drop. For each site, each hybrid received a ranking of 1 (low losses), 2 (intermediate losses) or 3 (high losses) and in cases where no differences between means were significant, all hybrids received a ranking of 1.

Variable	Site-Years Evaluated	Ranking [z]
1) L140P LL	8	1.00
2) 45H32 RR	8	1.13
3) 5440 LL	13	1.15
4) L150 LL	5	1.20
5) L130 LL	13	1.23
6) 74-44BL RR	8	1.25
7) 9553 RR	5	1.40
8) 45H29 RR	13	1.46
9) 6050 RR	8	1.50
10) 73-75 RR	13	1.54
11) 46H75 CL	13	1.54
12) 45H31 RR	5	1.60
13) 5525 CL	13	1.77
14) 73-45 RR	5	1.80
15) 6060 RR	5	2.20

[z] 1.00 is perfect – rankings are based on the cumulative losses measured at the T2 harvest date

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Appendices (A):

Table A-1. Least squares means and tests of hybrid effects on days to maturity for canola (T1) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the earliest treatment while those highlighted yellow do not differ from the latest treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	Maturity (days from planting)												
5440	95.5 e	104.5 ab	95.5 b	92.3 d	88.5 cd	102.1 def	96.3 cd	96.8 c	100.0 c	103.8 abc	—	92.8 abc	93.0 b
L130	95.5 e	100.5 f	93.3 c	90.8 e	88.5 cd	101.4 ef	95.5 d	95.0 e	100.0 c	102.8 c	—	91.5 c	93.0 b
L140P	—	—	—	—	—	102.6 b-e	96.3 cd	98.8 b	100.0 c	103.8 abc	—	92.3 bc	93.0 b
L150	96.1 de	102.5 de	91.8 d	94.6 bc	89.8 abc	—	—	—	—	—	—	—	—
45H29	97.5 bc	102.0 de	97.5 a	94.8 b	90.0 ab	103.0 a-d	97.3 bc	96.5 cd	104.0 b	104.3 ab	—	92.3 bc	99.0 a
45H31	96.5 cde	102.0 de	91.5 d	94.1 bcd	88.0 d	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	104.3 a	97.8 b	96.0 cde	107.0 a	104.0 abc	—	93.8 a	99.0 a
73-75	96.1 de	100.3 f	91.8 d	93.3 d	90.3 ab	102.8 b-d	97.3 bc	95.3 de	100.0 c	103.3 bc	—	91.5 c	99.0 a
73-45	96.0 de	103.5 bc	91.8 d	90.5 e	90.3 ab	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	101.0 f	97.0 bc	96.0 cde	100.0 c	103.0 bc	—	93.0 ab	99.0 a
6050	—	—	—	—	—	102.4 cde	97.3 bc	96.0 cde	100.0 c	103.0 bc	—	91.5 c	99.0 a
6060	99.1 a	105.5 a	98.5 a	97.8 a	91.0 a	—	—	—	—	—	—	—	—
9553	97.9 ab	103.3 bc	97.3 a	93.4 cd	89.0 bcd	—	—	—	—	—	—	—	—
46H75	97.1 bcd	102.5 cde	94.8 b	95.3 b	90.8 a	103.9 ab	99.3 a	98.3 b	107.0 a	105.0 a	—	94.0 a	99.0 a
5525	96.8 cde	101.3 ef	92.3 cd	92.4 d	90.0 ab	103.6 abc	98.3 ab	101.5 a	107.0 a	104.0 abc	—	93.3 ab	100.0 a
St. Error	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	—	0.56	0.56
Pr. > *F*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	—	<0.001	<0.001

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table A-2. Least squares means and tests of hybrid effects on percent green seed in canola (T1) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	---------- T1 Green Seed (%) ----------												
5440	0.4 b	0.7 d	1.4 cd	1.7 bc	0.0 b	0.2 a	1.5 d	1.5 de	4.0 c	1.5 a	3.3 bc	5.1 ab	0.3 bc
L130	0.3 b	0.3 d	1.2 cd	0.7 e	0.0 b	0.3 a	1.0 d	0.8 e	3.8 c	0.4 a	0.3 c	2.7 bc	0.1 c
L140P	—	—	—	—	—	0.3 a	5.3 cd	2.0 cde	4.2 c	1.2 a	4.3 bc	3.4 bc	0.6 abc
L150	0.4 b	1.1 cd	3.7 bcd	1.2 cde	0.3 b	—	—	—	—	—	—	—	—
45H29	0.5 b	1.3 cd	3.8 bcd	1.1 cde	0.0 b	0.5 a	16.8 ab	3.8 bcd	14.3 b	1.0 a	4.0 bc	4.8 ab	1.2 a
45H31	0.1 b	0.9 cd	1.3 cd	1.4 cde	0.1 b	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	0.5 a	15.0 abc	4.5 b	32.5 a	1.5 a	6.0 bc	3.4 bc	0.4 bc
73-75	0.2 b	1.1 cd	4.3 bc	2.5 a	0.1 b	0.3 a	7.3 cd	3.5 bcd	10.0 b	2.5 a	4.5 bc	2.9 bc	0.8 ab
73-45	0.2 b	0.9 cd	3.8 bcd	2.7 a	0.0 b	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	0.3 a	11.5 abc	2.0 cde	4.8 c	1.4 a	8.3 ab	4.4 ab	0.9 ab
6050	—	—	—	—	—	0.4 a	19.8 a	2.0 cde	15.8 b	1.8 a	2.5 bc	1.9 c	0.1 c
6060	2.2 a	3.8 a	8.2 a	2.1 ab	0.1 b	—	—	—	—	—	—	—	—
9553	0.3 b	2.7 ab	2.3 bcd	1.6 bcd	0.1 b	—	—	—	—	—	—	—	—
46H75	0.2 b	2.0 bc	5.3 ab	0.8 e	0.1 b	0.3 a	16.5 ab	8.0 a	33.8 a	0.8 a	13.8 a	6.8 a	0.4 bc
5525	0.4 b	1.4 cd	1.0 d	1.0 de	1.2 a	0.7 a	9.3 bcd	4.3 bc	14.0 b	1.2 a	6.5 bc	1.7 c	0.6 bc
St. Error	0.29	0.41	1.15	0.26	0.17	0.16	3.00	0.87	3.19	0.62	2.27	2.27	0.24
Pr. > *F*	<0.001	<0.001	<0.001	<0.001	<0.001	0.534	<0.001	<0.001	<0.001	0.604	0.005	0.002	0.017

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table A-3. Least squares means and tests of hybrid effects on canola seed yield (T2 – delayed) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	T2 Grain Yield (kg ha)												
5440	3099 a	3085 a	2909 a	797 b	745 ab	2203 bc	2613 c	2262 a	4060 abc	3036 ab	3138 ab	1803 a	3720 a
L130	2951 a	2961 abc	2970 a	679 b	860 a	2208 bc	2585 c	2070 a-d	3921 bcd	2973 b	3278 ab	1671 a	3617 ab
L140P	—	—	—	—	—	2562 a	2547 c	2192 ab	4262 a	3252 a	3314 a	1875 a	3637 ab
L150	3048 a	3021 ab	2860 a	513 b	723 b	—	—	—	—	—	—	—	—
45H29	3086 a	2944 abc	2817 a	796 b	821 a	2234 b	3748 ab	1846 e	3818 cd	3101 ab	2931 ab	1900 a	3317 cde
45H31	3094 a	2823 bc	2738 a	787 b	824 a	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	2244 b	3910 a	1943 de	4048 abc	3111 ab	2934 ab	1862 a	3484 bcd
73-75	3167 a	2847 bc	3035 a	759 b	824 a	2263 b	3902 a	1975 cde	3794 cd	2776 c	2532 b	1768 a	3348 cde
73-45	3084 a	2771 c	3051 a	673 b	862 a	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	2479 ab	3980 a	2212 ab	4204 ab	2895 bc	3182 ab	1751 a	3514 bc
6050	—	—	—	—	—	2379 ab	3619 ab	2016 b-e	3667 d	2676 c	2556 b	1578 a	3308 de
6060	3022 a	2348 d	2570 a	645 b	510 c	—	—	—	—	—	—	—	—
9553	3085 a	2815 bc	2824 a	773 b	796 ab	—	—	—	—	—	—	—	—
46H75	3041 a	2884 abc	2729 a	1160 a	846 a	1967 c	3594 ab	2169 abc	4043 abc	2871 bc	2393 b	1849 a	3249 e
5525	3134 a	2756 c	3000 a	788 b	741 ab	1957 c	3194 bc	1976 cde	3338 e	2695 c	2213 b	1851 a	3214 e
St. Error	127.4	103.9	137.4	130.9	85.0	119.0	262.5	105.3	125.7	108.6	189.4	121.1	101.3
Pr. > *F*	0.981	<0.001	0.101	0.022	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.366	<0.001

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table A-4. Least squares means and tests of hybrid effects on the absolute canola seed yield difference (T1 – T2) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	T1- T2 Yield Difference (kg ha^{-1})												
5440	84 a	-109 c	22 a	1504 bc	571 a	302 abc	—	243 a	-349 e	351 cde	1085 abc	117 bc	-2 b
L130	144 a	-60 bc	13 a	1899 ab	434 a	277 abc	—	228 a	20 a-d	358 cde	819 bc	252 abc	-32 bc
L140P	—	—	—	—	—	37 d	—	209 a	-216 de	105 f	539 c	-16 c	-71 bc
L150	75 a	-122 c	-13 a	1398 bc	518 a	—	—	—	—	—	—	—	—
45H29	-102 a	168 abc	-26 a	1164 c	523 a	137 cd	—	468 a	226 ab	321 de	968 abc	157 bc	-178 bc
45H31	-73 a	66 abc	18.6 a	1120 c	477 a	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	191 cd	—	241 a	-170 cde	234 ef	769 bc	314 ab	-443 d
73-75	249 a	390 a	52 a	1173 c	450 a	195 bcd	—	396 a	297 a	524 abc	1253 ab	313 ab	4 b
73-45	187 a	122 abc	-156 a	2050 a	356 a	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	145 cd	—	196 a	-172 cde	444 bcd	575 c	268 ab	-7 b
6050	—	—	—	—	—	5 d	—	332 a	149 abc	611 ab	1433 a	519 a	400 a
6060	59 a	355 a	160 a	1430 bc	524 a	—	—	—	—	—	—	—	—
9553	48 a	-104 c	-172 a	994 c	311 a	—	—	—	—	—	—	—	—
46H75	-81 a	70 abc	19 a	1056 c	423 a	400 ab	—	190 a	-384 e	676 a	1078 abc	71 bc	-288 cd
5525	19 a	240 ab	-190 a	1131 c	350 a	454 a	—	365 a	-89 b-e	370 cde	922 abc	135 bc	-26 b
St. Error	131.1	135.5	113.0	200.7	105.3	99.9	—	124.4	140.1	94.1	209.4	121.1	114.9
Pr. > *F*	0.454	0.009	0.244	<0.001	0.389	<0.001	—	0.568	<0.001	<0.001	0.035	0.018	<0.001

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table A-5. Least squares means and tests of hybrid effects on absolute yield loss due to dropped pods (T1) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW12	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	------------------------------ T1 Pod Drop Losses (kg ha^{-1}) ------------------------------												
5440	0.6 a	9.3 a	11.3 a	78.6 a	11.3 a	7.4 bcd	—	0.1 a	—	1.9 b	102.1 a	102.1 a	5.9 b
L130	1.9 a	20.9 a	6.6 a	261.2 a	6.6 a	7.4 bcd	—	0.4 a	—	0.7 b	78.7 a	78.7 a	0.0 b
L140P	—	—	—	—	—	1.5 d	—	2.5 a	—	2.0 b	10.6 a	10.6 a	11.0 b
L150	4.0 a	16.4 a	12.9 a	163.8 a	12.9 a	—	—	—	—	—	—	—	—
45H29	3.6 a	23.1 a	28.5 a	134.5 a	28.5 a	20.9 a	—	4.1 a	—	0.9 b	57.6 a	57.6 a	25.3 b
45H31	2.2 a	20.3 a	16.6 a	65.7 a	16.6 a	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	17.7 ab	—	3.8 a	—	0.8 b	69.8 a	69.8 a	13.2 b
73-75	2.4 a	25.3 a	9.7 a	165.8 a	9.7 a	9.8 a-d	—	0.7 a	—	0.8 b	96.8 a	96.8 a	24.1 b
73-45	3.7 a	23.5 a	20.1 a	212.0 a	20.1 a	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	4.0 cd	—	3.5 a	—	1.2 b	122.3 a	122.3 a	19.1 b
6050	—	—	—	—	—	11.3 a-d	—	4.4 a	—	5.2 a	67.6 a	67.6 a	6.4 b
6060	2.3 a	14.6 a	13.5 a	191.7 a	13.5 a	—	—	—	—	—	—	—	—
9553	3.1 a	26.8 a	26.0 a	143.3	26.0 a	—	—	—	—	—	—	—	—
46H75	2.0 a	16.6 a	12.2 a	36.4 a	12.2 a	11.3 a-d	—	0.1 a	—	0.9 b	68.5 a	68.5 a	17.1 b
5525	1.0 a	26.0 a	11.9 a	160.4 a	11.9 a	15.2 abc	—	2.5 a	—	2.4 b	97.3 a	97.3 a	88.3 a
St. Error	1.32	6.45	6.03	60.75	6.03	4.2	—	1.68	—	0.96	27.71	27.71	18.04
Pr. > *F*	0.705	0.705	0.238	0.300	0.238	0.028	—	0.336	—	0.016	0.277	0.255	0.049

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table A-6. Least squares means and tests of hybrid effects on absolute yield loss due to pod shatter (T1) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	---------- T1 Pod Shatter Losses (kg ha^{-1}) ----------												
5440	6.0 b	25.0 a	7.2 a	395 c	19.1 a	11.9 a	—	15.7 a	—	5.0 a	44.9 ab	6.1 a	76.2 a-d
L130	3.2 b	24.7 a	8.8 a	656 b	14.1 a-d	7.5 ab	—	0.4 a	—	5.3 a	38.4 ab	1.4 a	60.2 bcd
L140P	—	—	—	—	—	2.0 c	—	11.9 a	—	0.7 a	7.0 c	1.7 a	10.7 d
L150	6.1 b	31.6 a	3.3 a	315 cd	4.7 de	—	—	—	—	—	—	—	—
45H29	5.0 b	21.0 a	2.8 a	206 d-f	7.9 b-e	8.1 ab	—	5.4 a	—	1.6 a	34.0 abc	6.6 a	44.7 bcd
45H31	4.9 b	20.7	3.3 a	144 ef	16.6 ab	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	3.6 bc	—	5.0 a	—	2.1 a	33.4 abc	0.8 a	50.6 bcd
73-75	4.3 b	20.1 a	6.6 a	248 cde	6.6 cde	11.1 a	—	1.3 a	—	4.7 a	59.0 a	4.7 a	86.4 abc
73-45	14.2 a	28.1 a	2.2 a	906 a	9.1 b-e	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	9.9 a	—	9.1 a	—	1.7 a	53.2 ab	1.9 a	84.0 abc
6050	—	—	—	—	—	9.7 a	—	5.4 a	—	5.8 a	47.7 ab	10.0 a	128.3 a
6060	8.7 ab	24.0 a	4.4 a	162 def	14.7 abc	—	—	—	—	—	—	—	—
9553	3.3 b	19.5 a	1.7 a	293 cde	8.5 b-e	—	—	—	—	—	—	—	—
46H75	4.3 b	15.6 a	3.3 a	78 f	8.0 b-e	7.4 ab	—	4.7 a	—	4.4 a	26.1 bc	3.4 a	91.1 ab
5525	3.2 b	22.7 a	5.5 a	240 cde	4.1 e	10.1 a	—	5.3 a	—	1.5 a	36.9 ab	5.0 a	106.5 ab
St. Error	2.29	6.56	2.58	56.01	3.55	2.01	—	4.17	—	1.67	10.1	3.50	22.30
Pr. > *F*	0.019	0.919	0.529	<0.001	0.027	0.003	—	0.251	—	0.113	0.027	0.699	0.038

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table A-7. Least squares means and tests of hybrid effects on absolute total canola yield loss (T1) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SW12	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	T1 Total Losses (kg ha^{-1})												
5440	6.6 bc	34.3 a	11.1 b	473 b	30.4 a	19.3 a-d	12.3 a	15.6 a	15.5 a-d	6.9 a	147.0 a	8.9 a	82.0 bc
L130	5.1 bc	45.6 a	9.4 bc	918 a	20.7 a	15.0 bcd	19.2 a	0.7 a	27.1 ab	6.0 a	117.1 a	1.4 a	60.2 bc
L140P	—	—	—	—	—	3.4 d	—	14.4 a	3.8 cd	2.6 a	17.6 a	2.0 a	31.7 c
L150	10.0 bc	48.0 a	3.9 bc	479 b	17.6 a	—	—	—	—	—	—	—	—
45H29	8.6 bc	44.1 a	2.8 c	340 b	36.3 a	30.0 a	15.1 a	9.4 a	15.9 a-d	2.5 a	91.6 a	10.3 a	70.0 bc
45H31	7.1 bc	41.0 a	5.5 bc	209 bc	33.2 a	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	21.3 abc	17.5 a	8.8 a	3.3 d	2.9 a	103.1 a	0.8 a	63.7 bc
73-75	6.7 bc	45.4 a	18.8 a	414 b	16.3 a	20.9 abc	21.3 a	1.9 a	23.7 abc	5.6 a	155.4 a	6.0 a	111 abc
73-45	17.9 a	51.6 a	5.5 bc	1118 a	29.1 a	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	13.9 cd	24.0 a	12.5 a	23.0 abc	2.9 a	175.5 a	1.9 a	103.1 bc
6050	—	—	—	—	—	20.9 abc	27.6 a	9.7 a	36.0 a	11.0 a	115.4 a	12.2 a	134.7 ab
6060	11.0 b	38.7 a	5.0 bc	354 bc	28.2 a	—	—	—	—	—	—	—	—
9553	6.4 bc	46.3 a	5.0 bc	437 b	34.5 a	—	—	—	—	—	—	—	—
46H75	6.7 bc	32.1 a	3.3 c	114 c	20.2 a	18.7 a-d	12.4 a	4.7 a	8.6 bcd	5.3 a	94.6 a	11.0 a	108 abc
5525	4.2 c	48.6 a	7.7 bc	400 b	16.0 a	25.3 ab	16.4 a	7.8 a	8.5 bcd	3.8 a	134.2 a	6.3 a	194.8 a
St. Error	2.45	11.84	3.22	98.85	6.72	4.91	4.64	4.78	7.70	2.28	36.64	4.8	32.89
Pr. > *F*	<0.001	0.988	0.002	<0.001	0.201	0.026	0.234	0.318	0.037	0.060	0.173	0.539	0.044

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table A-8. Least squares means and tests of hybrid effects on absolute seed yield loss due to pod drop (T2) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	---------- T2 Pod Drop Losses (kg ha^{-1}) ----------												
5440	1.6 d	42.8 d	8.3 a	408 b	85.5 a	32.6 cd	—	6.3 c	—	28.5 c	379 abc	2.8 a	5.8 a
L130	5.1 cd	76.4 d	14.1 a	593 ab	93.0 a	81.4 b	—	10.0 c	—	71.8 ab	276 bc	15.3 a	0.0 a
L140P	—	—	—	—	—	20.0 cd	—	13.5 c	—	10.7 c	116 c	24.7 a	21.0 a
L150	7.4 bcd	55.9 d	5.3 a	443 b	59.2 a	—	—	—	—	—	—	—	—
45H29	20.5 ab	186.8 a	89.8 a	591 b	164.7 a	61.2 bc	—	64.8 a	—	7.7 c	320 bc	31.9 a	55.2 a
45H31	6.5 bcd	173.8 ab	24.3 a	630 b	137.2	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	68.9 b	—	63.3 a	—	8.5 c	349 bc	47.3 a	15.9 a
73-75	8.0 bcd	180.3 ab	19.9 a	590 b	223.0 a	75.7 b	—	47.6 ab	—	76.0 ab	517 ab	9.1 a	26.3 a
73-45	6.8 bcd	166.5 ab	60.5 a	421 b	122.8 a	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	13.5 d	—	16.9 bc	—	11.3 c	460 ab	6.3 a	21.6 a
6050	—	—	—	—	—	31.0 cd	—	19.4 bc	—	45.3 bc	320 bc	52.6 a	47.9 a
6060	31.1 a	175.8 ab	18.8 a	881 a	167.9 a	—	—	—	—	—	—	—	—
9553	17.0 abc	135.8 bc	21.3 a	395 b	190.1 a	—	—	—	—	—	—	—	—
46H75	9.4 bcd	116.9 cd	15.5 a	470 b	110.6 a	102.2 ab	—	30.7 bc	—	113.3 a	634 a	20.4 a	19.1 a
5525	9.1 bcd	149 abc	27.1 a	568 b	137.5 a	136.6 a	—	41.6 ab	—	111.1 a	515 ab	10.4 a	93.5 a
St. Error	6.51	17.80	29.02	104.0	37.64	15.97	—	11.81	—	17.12	99.57	18.51	26.15
Pr. > *F*	0.004	<0.001	0.661	0.052	0.086	<0.001	—	<0.001	—	<0.001	0.022	0.525	0.324

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table A-9. Least squares means and tests of hybrid effects on absolute seed yield loss due to pod shatter (T2) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	------ T2 Pod Shatter Losses (kg ha^{-1}) ------												
5440	14.2 b	91.6 a	22.7 a	556 bc	152.8 ab	59.1 b	—	28.8 bcd	—	125.7 b	225 bc	28.3 a	117.7 bc
L130	7.1 c	75.2 a	21.6 a	748 b	83.6 bc	34.3 bcd	—	13.5 d	—	131.6 b	215 bc	22.4 a	92.2 bc
L140P	—	—	—	—	—	10.6 d	—	26.6 bcd	—	10.2 c	57 c	31.9 a	26.3 c
L150	13.3 b	86.4 a	61.3 a	448 c	78.3 c	—	—	—	—	—	—	—	—
45H29	15.2 b	79.5 a	52.2 a	480 c	60.1 bc	47.4 bc	—	65.4 a	—	47.9 c	286 abc	35.2 a	153.3 b
45H31	9.7 bc	109.4 a	48.4 a	477 c	138 abc	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	15.4 d	—	50.7 ab	—	23.3 c	127 bc	30.2 a	90.7 bc
73-75	12.0 bc	137.7 a	52.2 a	401 cd	83.9 bc	47.0 bc	—	21.0 cd	—	168.8 b	563 a	21.3 a	153.8 b
73-45	24.0 a	151.8 a	77.6 a	1086 a	54.8 c	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	26.9 cd	—	43.5 abc	—	90.8 bc	352 abc	8.3 a	195.8 ab
6050	—	—	—	—	—	48.6 bc	—	27.2 bcd	—	154.1 b	420 ab	25.8 a	299.9 a
6060	23.8 a	169.7	60.2 a	577 bc	216.1 a	—	—	—	—	—	—	—	—
9553	9.6 bc	74.8 a	21.3 a	500 c	70.8 bc	—	—	—	—	—	—	—	—
46H75	9.5 bc	51.5 a	52.2 a	223 d	66.2 bc	113.7 a	—	26.3 bcd	—	282.7 a	561 a	23.5 a	150.6 b
5525	12.0 bc	102.9 a	17.7 a	420 cd	68.6 bc	89.6 a	—	47.0 ab	—	160.6 b	428 ab	37.4 a	162.0 b
St. Error	2.54	28.31	25.40	80.27	33.06	10.76	—	9.04	—	20.38	119.81	11.1 a	41.40
Pr. > *F*	<0.001	0.091	0.748	<0.001	0.013	<0.001	—	0.001	—	<0.001	0.032	0.822	0.001

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Table A-10. Least squares means and tests of hybrid effects on absolute total seed yield loss (T2) at various locations (2011-2014). Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$). Values highlighted green do not significantly differ from the best treatment while those highlighted yellow do not differ from the worst treatment.

Hybrid	IH11	SC11	SW11	IH12	SW12	IH13	SC13	SW13	ME13	IH14	SC14	SW14	ME14
	-- T2 Total Losses (kg ha^{-1}) --												
5440	15.8 e	135 d	30.9 a	964 cde	238 a	91.6 bc	80.0 a	35.1 d	70.7 a	154.1 cd	604 bcd	31.2 a	124 bc
L130	12.2 e	152 cd	35.6 a	1341 abc	177 a	116 b	95.2 a	23.5 d	80.0 a	203.4 bc	491 cd	37.7 a	92.2 bc
L140P	—	—	—	—	—	30.6 c	50.6 a	40.1 cd	31.2 a	20.9 e	172 d	56.7 a	47.3 c
L150	20.6 cde	142 d	31.2 a	891 e	138 a	—	—	—	—	—	—	—	—
45H29	35.7 b	266 abc	151 a	1072 b-e	225 a	110 b	69.0 a	130 a	66.2 a	55.6 e	605 bcd	67.2 a	209 ab
45H31	16.2 de	283 ab	72.7 a	1107 a-d	275 a	—	—	—	—	—	—	—	—
45H32	—	—	—	—	—	85.3 bc	53.5 a	114 ab	61.8 a	31.8 e	476 d	77.5 a	107 bc
73-75	20.0 cde	318 a	72.1 a	990 cde	307 a	123 b	105 a	68.6 bcd	72.3 a	244.8 bc	1080 ab	30.4 a	180 bc
73-45	30.7 bc	318 a	138.2 a	1507 a	118 a	—	—	—	—	—	—	—	—
74-44BL	—	—	—	—	—	40.4 c	80.9 a	60.4 cd	81.0 a	102.1 e	812 abc	14.6 a	217 ab
6050	—	—	—	—	—	79.6 bc	125 a	46.7 cd	100.5 a	199.4 bc	740 abc	78.4 a	348 a
6060	54.9 a	345 a	79.0 a	1457 ab	384 a	—	—	—	—	—	—	—	—
9553	26.6 bcd	211 bc	42.6 a	895 de	261 a	—	—	—	—	—	—	—	—
46H75	18.9 cde	168 bcd	70.2 a	693 e	177 a	216 a	85.4 a	57.0 cd	94.1 a	396.0 a	1195 a	43.8 a	170 bc
5525	21.1 cde	252 abc	44.8 a	988 cde	206 a	226 a	114 a	88.6 abc	100.6 a	271.7 b	943 abc	47.6 a	256 ab
St. Error	5.1	41.7	45.7	146.0	61.5	23.1	21.4	19.1	19.0	34.9	197.9	23.1	56.2
Pr. > *F*	<0.001	<0.001	0.620	0.001	0.215	<0.001	0.233	<0.001	0.292	<0.001	0.013	0.575	0.010

IH – Indian Head; SC – Scott; SW – Swift Current; ME – Melfort

Appendices (B):

Table B-1. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Indian Head 2011. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------ ºC	------------------------		----- mm -----	---- km/h ----	--- degrees ---
Sept-04	21.2	0.9	11.1	0	35	20
Sept-05	26.8	8.7	17.8	0	37	20
Sept-06	28.6	5.8	17.2	0	<31	−
Sept-07	30.2	7.1	18.7	0.7	<31	−
Sept-08	29.4	11.3	20.4	2.4	<31	−
Sept-09	30	6.9	18.5	0.5	<31	−
Sept-10	31.2	10.8	21	3	33	27
Sept-11	32	6.5	19.3	1.3	54	34
Sept-12	17.7	8.7	13.2	0	48	34
Sept-13	12.1	-3.1	4.5	0	52	35
Sept-14	12.7	-5.1	3.8	0	<31	−
Sept-15	18.1	-2.2	8	0	56	17
Sept-16	15.6	5.6	10.6	0	52	18
Sept-17	18.2	8.8	13.5	0	43	18
Sept-18	19.2	3.4	11.3	0	48	29
Sept-19	19.1	3.8	11.5	0	37	34
Sept-20	14.8	8.5	11.7	0	46	35
Sept-21	14.1	2.8	8.5	0	<31	−
Sept-22	20.9	2.5	11.7	0	54	19
Sept-23	28.8	6.3	17.6	0	37	20
Sept-24	31	11	21	3	32	19
Sept-25	31.5	7.6	19.6	1.6	39	18
Sept-26	26	7.5	16.8	0	50	20
Sept-27	28.2	6.9	17.6	0	35	20
Sept-28	20.9	8.1	14.5	0	56	32
Sept-29	15.6	1.8	8.7	0	33	31
Sept-30	21.2	0.9	11.1	0	57	18
Oct-01	23.4	9.9	16.7	0	52	20
Oct-02	18.3	9.1	13.7	0	39	9
Oct-03	18.4	0.8	9.6	0	<31	−

Table B-2. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Indian Head 2012. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------ ºC	------------------------		----- mm -----	---- km/h ----	--- degrees ---
Aug-24	25.8	10.7	18.3	2.8	52	18
Aug-25	20.9	9.4	15.2	0	78	26
Aug-26	22.2	8.7	15.5	0	50	28
Aug-27	27.5	4.9	16.2	0	<31	–
Aug-28	32.6	8.5	20.6	0	44	16
Aug-29	31.5	12.7	22.1	0	56	19
Aug-30	26.2	9.1	17.7	0	37	27
Aug-31	30.2	10.1	20.2	0	46	19
Sep-01	27.6	9.8	18.7	0	44	14
Sep-02	25.4	8.7	17.1	0	54	26
Sep-03	25.0	9.7	17.4	0	56	29
Sep-04	20.9	10.5	15.7	0	63	27
Sep-05	20.5	7.5	14.0	0	41	31
Sep-06	14.2	4.8	9.5	0	35	36
Sep-07	23.2	2.7	13.0	0	41	29
Sep-08	20.0	2.7	11.4	0	48	36
Sep-09	28.6	6.1	17.4	0	54	18
Sep-10	29.5	12.1	20.8	0	59	29
Sep-11	18.5	5.1	11.8	0	74	28
Sep-12	17.5	3.7	10.6	0	70	33
Sep-13	18.7	1.9	10.3	0	37	34
Sep-14	25.0	1.5	13.3	0	48	18
Sep-15	24.8	3.1	14.0	0	50	35
Sep-16	16.0	2.4	9.2	0	37	35
Sep-17	15.1	-3.4	5.9	0	41	19
Sep-18	25.7	5.8	15.8	0	63	31
Sep-19	15.9	5.1	10.5	0	59	33
Sep-20	18.0	5.0	11.5	0	43	32
Sep-21	17.2	-3.1	7.1	0	50	35
Sep-22	14.5	-5.8	4.4	0	<31	–
Sep-23	21.9	-1.1	10.4	0	32	20
Sep-24	22.7	0.6	11.7	0	35	35
Sep-25	18.7	-4.9	6.9	0	<31	–
Sep-26	-	-2.6	-	-	<31	–
Sep-27	22.8	0.5	11.7	0	<31	–

Table B-3. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Indian Head 2013. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.						
Date	**Max Air Temp**	**Min Air Temp**	**Mean Air Temp**	**Precipitation**	**Peak Gust Speed**	**Peak Gust Direction**
	------------------------- ºC -------------------------			----- mm -----	---- km/h ----	--- degrees ---
Sep-15	19.2	-3	8.1	0	33	18
Sep-16	25.3	5.3	15.3	0	54	18
Sep-17	29.2	10.2	19.7	0	50	19
Sep-18	–	–	–	–	<31	–
Sep-19	11	1.9	6.5	11.6	44	31
Sep-20	17.1	-1.9	7.6	0	<31	–
Sep-21	21.1	1.3	11.2	0	50	15
Sep-22	21.5	6.1	13.8	0	<31	–
Sep-23	18.9	6	12.5	0	32	24
Sep-24	21.1	5.2	13.2	0	46	26
Sep-25	19.7	9.6	14.7	1.5	39	9
Sep-26	13.3	8.5	10.9	1.7	54	30
Sep-27	13.5	1.9	7.7	0	32	27
Sep-28	17.2	1.1	9.2	0	43	30
Sep-29	24.1	3.8	14	0	63	24
Sep-30	20.1	5.2	12.7	0	57	23
Oct-01	16.7	2	9.4	0	67	27
Oct-02	14.3	-1.9	6.2	0	43	29
Oct-03	6.5	-3.9	1.3	0	<31	–
Oct-04	9.8	-8.5	0.7	0	32	1
Oct-05	12.2	-8.9	1.7	0	<31	–
Oct-06	17.5	-1.1	8.2	0	43	32
Oct-07	22.6	0.6	11.6	0	48	18
Oct-08	17.6	1.4	9.5	0	43	25
Oct-09	12.4	-2.3	5.1	0	37	33
Oct-10	17.8	-0.2	8.8	0	46	16
Oct-11	10.2	2.1	6.2	0	56	35
Oct-12	10.8	-3.8	3.5	0	59	31
Oct-13	10.6	-6.3	2.2	0	<31	–
Oct-14	12.2	-8.5	1.9	0	<31	–

Table B-4. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Indian Head 2014. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------	ºC	------------------------	----- mm -----	---- km/h ----	--- degrees ---
Sep-18	25.1	6.1	15.6	0	46	18
Sep-19	21.1	8.8	15	—	<31	—
Sep-20	19.7	6	12.9	3.2	65	31
Sep-21	23.1	2.2	12.7	0	32	26
Sep-22	27.3	7.4	17.4	0	35	18
Sep-23	28.4	10.5	19.5	0	33	20
Sep-24	27	7.2	17.1	0	32	18
Sep-25	33.6	13.9	23.8	0	43	19
Sep-26	31.2	12.4	21.8	0	37	18
Sep-27	12.7	7.2	10	0.3	33	34
Sep-28	8.7	5	6.9	0	<31	—
Sep-29	12.2	6	9.1	0	43	17
Sep-30	11.6	9.2	10.4	21.7	35	15
Oct-01	13.5	4.1	8.8	3.5	52	31
Oct-02	7.1	1.8	4.5	1.2	65	32
Oct-03	4.1	-6.1	-1	0	54	32
Oct-04	6.3	-6.4	-0.1	0	<31	—
Oct-05	7.6	0.6	4.1	0	61	31
Oct-06	11.8	3.9	7.9	0	56	32
Oct-07	13.6	-3.1	5.3	0	63	31
Oct-08	9.2	-4.4	2.4	0	<31	—
Oct-09	11	-6.1	2.5	0	<31	
Oct-10	18.7	-0.7	9	0	35	19
Oct-11	22.2	5.3	13.8	0	57	19
Oct-12	15.5	3	9.3	0	48	31
Oct-13	17.2	-0.2	8.5	0	<31	—
Oct-14	20.7	3.2	12	0	57	19
Oct-15	15.8	2.7	9.3	0	<31	—
Oct-16	10.4	4.5	7.5	10.1	46	34
Oct-17	5	-2	1.5	0	<31	—

Table B-5. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Scott 2011. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.						
Date	**Max Air Temp**	**Min Air Temp**	**Mean Air Temp**	**Precipitation**	**Peak Gust Speed**	**Peak Gust Direction**
	------------------------ ºC ------------------------			----- mm -----	---- km/h ----	--- degrees ---
Sept-04	23.4	4	13.7	0	39	21
Sept-05	28.3	2.2	15.3	0	<31	–
Sept-06	29.7	4.5	17.1	0	<31	–
Sept-07	32.3	6.2	19.3	0	35	23
Sept-08	31.5	6.6	19.1	0	<31	–
Sept-09	32.1	7.7	19.9	0	<31	–
Sept-10	28.9	10.9	19.9	0	<31	–
Sept-11	26.7	9.1	17.9	0.2	61	34
Sept-12	18.1	4.5	11.3	0.2	37	30
Sept-13	9.9	-3.8	3.1	0	35	36
Sept-14	14.7	-6.8	4	0	41	15
Sept-15	20.9	0	10.5	0	39	15
Sept-16	21.6	8.2	14.9	0	44	28
Sept-17	19.3	0.8	10.1	2.6	48	27
Sept-18	18.5	3.9	11.2	0	37	25
Sept-19	14.5	3	8.8	0	32	29
Sept-20	17.1	3	10.1	0	<31	–
Sept-21	20.5	0.6	10.6	0	54	16
Sept-22	25.8	6.8	16.3	0	<31	–
Sept-23	29.7	6.8	18.3	0	37	20
Sept-24	31.7	6.7	19.2	0	<31	–
Sept-25	31.6	6.4	19	0	44	15
Sept-26	22.3	8.8	15.6	0	41	30
Sept-27	24.5	5.6	15.1	0	39	25
Sept-28	17.6	4.8	11.2	0	57	27
Sept-29	16.3	-1.7	7.3	0	35	16
Sept-30	27.3	5.3	16.3	0	35	14
Oct-01	14.4	5	9.7	2.3	44	36
Oct-02	13.1	4.3	8.7	1.7	37	10
Oct-03	19.3	0.9	10.1	0	46	10

Table B-6. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Scott 2013. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------ ºC	------------------------		----- mm -----	---- km/h ----	--- degrees ---
Aug-28	29.6	8.9	19.3	0	44	8
Aug-29	29.6	12	20.8	0	33	17
Aug-30	26.2	13	19.6	0	44	24
Aug-31	20.4	10.9	15.7	0	41	34
Sep-01	24.7	7.2	16	0	<31	–
Sep-02	30.1	7	18.6	0	<31	–
Sep-03	24.1	10.9	17.5	0	<31	–
Sep-04	30.6	12.1	21.4	0	41	17
Sep-05	32.6	10.2	21.4	0	33	1
Sep-06	22.1	13.6	17.9	0	<31	–
Sep-07	20.9	12.1	16.5	0	<31	–
Sep-08	23.9	12.2	18.1	0	<31	–
Sep-09	26	11	18.5	0	37	28
Sep-10	23.4	9.6	16.5	0	39	31
Sep-11	21.9	4.4	13.2	0	<31	–
Sep-12	26.7	4.4	15.6	0	32	18
Sep-13	30.2	7.9	19.1	0	35	2
Sep-14	20.4	6.3	13.4	0	<31	–
Sep-15	22.5	2.4	12.5	0	37	14
Sep-16	29.6	9	19.3	0	48	16
Sep-17	22	8.6	15.3	0	41	28
Sep-18	12.9	6.3	9.6	0	33	33
Sep-19	15.6	2	8.8	0	<31	–
Sep-20	21.8	-0.2	10.8	0	46	15
Sep-21	26.1	4.6	15.4	0	32	15
Sep-22	20.7	6	13.4	0	<31	–
Sep-23	20.6	4.9	12.8	0	50	25
Sep-24	18	2.5	10.3	0	<31	–
Sep-25	15.3	3.1	9.2	0	39	1
Sep-26	11.3	2.9	7.1	0	50	32

Table B-7. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Scott 2014. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------	ºC	------------------------	----- mm -----	---- km/h ----	--- degrees ---
Sep-08	10.6	1.8	6.2	9.8	37	1
Sep-09	6.2	1.6	3.9	0	<31	—
Sep-10	6.2	0.3	3.3	0	32	3
Sep-11	9.5	0	4.8	0	32	21
Sep-12	12.9	-1	6	0.3	37	20
Sep-13	12.7	0.9	6.8	0.2	<31	—
Sep-14	16.4	2.1	9.3	0	35	26
Sep-15	22	3	12.5	0	33	22
Sep-16	24.2	2	13.1	0	<31	—
Sep-17	19.1	6.4	12.8	0	33	12
Sep-18	21.9	5.4	13.7	0	<31	—
Sep-19	22	8.6	15.3	2.6	54	29
Sep-20	19.5	6.7	13.1	0.2	46	29
Sep-21	25.7	3.6	14.7	0	37	21
Sep-22	28.7	6.6	17.7	0	32	15
Sep-23	24.8	5.3	15.1	0	33	29
Sep-24	27.7	5.5	16.6	0	41	16
Sep-25	25	9.9	17.5	0	32	6
Sep-26	17.5	8.5	13	0	39	29
Sep-27	8.5	3.3	5.9	0	33	33
Sep-28	10	1.1	5.6	0	32	15
Sep-29	17.5	0.1	8.8	0	54	15
Sep-30	12.7	9	10.9	1.8	35	15
Oct-01	14.8	5.3	10.1	0	46	28
Oct-02	6.4	-2.3	2.1	0	56	32
Oct-03	6.5	-6.9	-0.2	0	32	29
Oct-04	15.5	1.9	8.7	1.9	39	28
Oct-05	15.9	0.1	8	0	33	32
Oct-06	16.8	4.1	10.5	0.6	67	32
Oct-07	13.7	0.5	7.1	0.0	39	31

Table B-8. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Swift Current 2011. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------ ºC	------------------------		----- mm -----	---- km/h ----	--- degrees ---
Aug-11	22.3	11.1	16.7	6.6	46	29
Aug-12	22.4	11.8	17.1	1.2	<31	–
Aug-13	26.7	10.2	18.5	0	37	19
Aug-14	30.4	12.5	21.5	1.4	50	18
Aug-15	25	12.5	18.8	0.5	46	28
Aug-16	21.4	7.5	14.5	0	44	30
Aug-17	26.8	7.2	17	0	44	28
Aug-18	20.4	9.6	15	0	54	34
Aug-19	20.5	5.8	13.2	0	39	30
Aug-20	23	6	14.5	0	<31	–
Aug-21	30.7	9.9	20.3	0	<31	–
Aug-22	33.1	14.3	23.7	0	44	26
Aug-23	26.8	14.2	20.5	0	52	30
Aug-24	29.2	6.9	18.1	0	44	20
Aug-25	27	12.9	20	0	43	28
Aug-26	25.1	9	17.1	0	32	9
Aug-27	28.2	10.5	19.4	2.5	43	5
Aug-28	29.7	12.6	21.2	0.3	<31	–
Aug-29	31.5	12.1	21.8	0	39	19
Aug-30	26.9	13.7	20.3	0	43	28
Aug-31	16.6	9.4	13	15	41	7
Sep-01	15.9	7.6	11.8	0	<31	–
Sep-02	17.4	7.4	12.4	7.4	61	28
Sep-03	16.6	6.3	11.5	0	43	31
Sep-04	22.8	4.8	13.8	0	48	18
Sep-05	27.1	8.7	17.9	0	35	19
Sep-06	29.2	10.1	19.7	0	<31	–
Sep-07	30.5	11.1	20.8	0	39	25
Sep-08	30.9	13	22	0	<31	–
Sep-09	30.1	12.1	21.1	0	<31	–

Table B-9. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Swift Current 2012. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------	ºC	------------------------	----- mm -----	---- km/h ----	--- degrees ---
Aug-19	30.2	10.5	20.4	0	<31	–
Aug-20	33.0	12.7	22.9	0	32	9
Aug-21	33.2	11.7	22.5	0	43	21
Aug-22	28.1	14.7	21.4	0	57	27
Aug-23	30.2	10.3	20.3	0	32	17
Aug-24	20.7	9.1	14.9	0	63	25
Aug-25	21.1	7.1	14.1	0	69	29
Aug-26	23.3	6.8	15.1	0	<31	–
Aug-27	31.1	10.9	21.0	0	52	13
Aug-28	34.2	16.7	25.5	0	<31	–
Aug-29	25.6	10.3	18.0	0	67	29
Aug-30	26.7	7.1	16.9	0	43	23
Aug-31	31.5	9.9	20.7	0	44	13
Sep-01	24.1	8.6	16.4	1.9	48	32
Sep-02	23.7	6.0	14.9	0	63	28
Sep-03	22.7	8.0	15.4	0	44	29
Sep-04	17.1	8.5	12.8	-	<31	–
Sep-05	18.8	5.3	12.1	0	41	34
Sep-06	17.6	6.2	11.9	0	32	34
Sep-07	24.9	5.7	15.3	0	41	25
Sep-08	23.3	2.1	12.7	0	35	18
Sep-09	30.8	11.3	21.1	0	69	26
Sep-10	26.9	6.5	16.7	0	70	27
Sep-11	16.0	3.5	9.8	0	74	28
Sep-12	16.1	3.5	9.8	0	56	29
Sep-13	21.0	6.1	13.6	0	46	30
Sep-14	28.8	8.7	18.8	0	52	19
Sep-15	22.0	6.6	14.3	0	37	1
Sep-16	15.8	3.2	9.5	0	44	30
Sep-17	19.7	-0.1	9.8	0	33	26

Table B-10. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Swift Current 2013. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------	ºC	------------------------	----- mm -----	---- km/h ----	--- degrees ---
Aug-21	–	7.2	–	–	< 31	–
Aug-22	29.1	8.8	19	0	48	17
Aug-23	27.8	12.3	20.1	0.4	<31	–
Aug-24	29.4	14.1	21.8	0	46	25
Aug-25	32.4	12.1	22.3	0	39	16
Aug-26	32.1	15.4	23.8	0	44	24
Aug-27	31.5	12.8	22.2	0	44	18
Aug-28	35.6	15.5	25.6	0.6	43	26
Aug-29	31.9	15.2	23.6	0	44	26
Aug-30	29.9	14.8	22.4	0	59	28
Aug-31	18.6	9.7	14.2	0.7	54	31
Sep-01	26.2	7.6	16.9	0	32	15
Sep-02	35.1	11.4	23.3	0	33	17
Sep-03	25	16	20.5	0	41	8
Sep-04	30.5	13.4	22	0	37	13
Sep-05	33.3	15.7	24.5	0	<31	–
Sep-06	27.6	16.8	22.2	1.9	43	4
Sep-07	17.4	11.4	14.4	0.9	44	10
Sep-08	19.9	11	15.5	0	<31	–
Sep-09	23.7	13.3	18.5	3.3	52	29
Sep-10	24.7	10.5	17.6	0	39	29
Sep-11	23.1	7.6	15.4	0	33	32
Sep-12	25.8	7.2	16.5	0	35	16
Sep-13	30.2	11.1	20.7	0	43	20
Sep-14	21	6.1	13.6	0	44	5
Sep-15	23.4	3.4	13.4	0	44	16
Sep-16	28.9	10.5	19.7	0	56	17
Sep-17	–	11.2	–	–	<31	–
Sep-18	15.7	7.3	11.5	10.3	35	7
Sep-19	15.4	4.3	9.9	0	41	31

Table B-11. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Swift Current 2014. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------ ºC	------------------------		----- mm -----	---- km/h ----	--- degrees ---
Sep-06	22.1	8.1	15.1	0	<31	—
Sep-07	27	9.7	18.4	0	41	20
Sep-08	13.3	2.9	8.1	2.4	48	5
Sep-09	4.9	0.9	2.9	6.4	46	5
Sep-10	6.2	1.2	3.7	0.2	33	1
Sep-11	6.4	-1.8	2.3	0	<31	—
Sep-12	14.3	-1.4	6.5	0.2	44	22
Sep-13	12.3	0.4	6.4	0.2	41	34
Sep-14	15.5	0.1	7.8	0	<31	—
Sep-15	20.1	5	12.6	0	<31	—
Sep-16	24.2	6.8	15.5	0	<31	—
Sep-17	26	6.2	16.1	0	35	17
Sep-18	28.2	12.3	20.3	0	41	28
Sep-19	—	—	—	—	<31	—
Sep-20	19.4	6.8	13.1	0	52	29
Sep-21	23.8	4.6	14.2	0	35	18
Sep-22	27.9	9.4	18.7	0	44	20
Sep-23	27.3	10	18.7	0	35	27
Sep-24	29.3	7.8	18.6	0	43	18
Sep-25	31.4	11.5	21.5	0	<31	—
Sep-26	22.9	9.3	16.1	0	57	27
Sep-27	11.5	4.7	8.1	0	33	35
Sep-28	11.4	-0.2	5.6	0	<31	—
Sep-29	14.2	2.1	8.2	0	57	17
Sep-30	16.9	8.5	12.7	0.2	52	31
Oct-01	15.1	7	11.1	0.2	48	29
Oct-02	7.5	-3.6	2	0.2	63	31
Oct-03	6.8	-6.8	0	0	39	32
Oct-04	16.4	-0.3	8.1	0	59	31
Oct-05	16.1	4.4	10.3	0	52	32

Table B-12. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Melfort 2013. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------ ºC ------------------------			----- mm -----	---- km/h ----	--- degrees ---
Sep-18	14.1	5.8	10	0	<31	–
Sep-19	13.7	1.3	7.5	0	35	32
Sep-20	17.2	-0.1	8.6	0	<31	–
Sep-21	23.2	4.8	14	0	52	14
Sep-22	21.2	11	16.1	0	41	16
Sep-23	20.6	5	12.8	0	35	24
Sep-24	20.8	4.7	12.8	0	43	24
Sep-25	10.2	4.4	7.3	9.6	37	4
Sep-26	10.5	8	9.3	7.4	41	36
Sep-27	12.2	3.7	8	0	33	27
Sep-28	15.2	-0.4	7.4	0	<31	–
Sep-29	22.5	3.3	12.9	0	69	24
Sep-30	17.2	5.4	11.3	0	50	27
Oct-01	10.9	5.2	8.1	0	33	26
Oct-02	7.6	2.1	4.9	2	<31	–
Oct-03	7.3	0.2	3.8	0	<31	–
Oct-04	10.9	-2.3	4.3	0	<31	–
Oct-05	13.8	0.9	7.4	0	48	22
Oct-06	14.5	2.8	8.7	0	39	33
Oct-07	18.3	1.3	9.8	0	52	15
Oct-08	16.4	1.8	9.1	0	37	26
Oct-09	11.1	1.5	6.3	0	33	26
Oct-10	17	1.6	9.3	0	46	17
Oct-11	13.5	2.6	8.1	0	43	32
Oct-12	9.7	-1.1	4.3	0	41	29
Oct-13	11.7	-4	3.9	0	43	26
Oct-14	9.6	-3.1	3.3	0	<31	–
Oct-15	13.8	-2.6	5.6	0	50	26
Oct-16	8.9	-1.9	3.5	0	37	33
Oct-17	7	-2.9	2.1	0	35	32

Table B-13. Daily temperature, precipitation and wind data for the 30 day period leading to the T2 harvest at Melfort 2014. Data were logged at the nearest Environment Canada weather station (Environment Canada 2015). Precipitation amounts ≥ 2.5 mm and peak wind gusts ≥ 60 km are highlighted.

Date	Max Air Temp	Min Air Temp	Mean Air Temp	Precipitation	Peak Gust Speed	Peak Gust Direction
	------------------------ ºC ------------------------			----- mm -----	---- km/h ----	--- degrees ---
Oct-01	13.1	4.3	8.7	14	50	30
Oct-02	6.2	-0.1	3.1	1.7	48	33
Oct-03	2.4	-3.2	-0.4	0	43	34
Oct-04	5.1	-4.5	0.3	0	<31	—
Oct-05	9.1	-0.5	4.3	0	44	29
Oct-06	10.6	0.7	5.7	0	44	31
Oct-07	10.9	-1.8	4.6	0.3	52	32
Oct-08	6.7	-5.2	0.8	0	<31	—
Oct-09	10.6	-1.1	4.8	0	<31	—
Oct-10	16.8	0.4	8.6	0	32	20
Oct-11	17	6	11.5	0	46	18
Oct-12	16.4	2.4	9.4	0	37	32
Oct-13	16.9	1.5	9.2	0	<31	—
Oct-14	17.7	3.9	10.8	0	44	15
Oct-15	14.8	2.2	8.5	1.2	48	11
Oct-16	8.9	3.9	6.4	0	37	5
Oct-17	7.4	0.7	4.1	0.2	44	17
Oct-18	13.5	1.2	7.4	0	54	18
Oct-19	18.1	3.9	11	0	<31	—
Oct-20	21.1	4.6	12.9	0	46	17
Oct-21	22.1	7.4	14.8	0	37	20
Oct-22	11.1	6.5	8.8	14.1	<31	—
Oct-23	10.7	4.2	7.5	0.2	37	22
Oct-24	9.8	1.5	5.7	0.2	50	29
Oct-25	7.5	-0.3	3.6	0	32	30
Oct-26	6.5	0.1	3.3	0	44	10
Oct-27	3.2	-1.6	0.8	2.5	33	4
Oct-28	-1.4	-3.8	-2.6	0	<31	—
Oct-29	0.9	-1.7	-0.4	0	<31	—
Oct-30	1.5	-4.8	-1.7	0	<31	—