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WASHINGTON OILSEEDS COMMISSION
PROGRESS REPORT FORMAT FOR 2022 PROJECTS

Project No.: **Sponsor Award Ref. #: M813_14106700/Proposal ID #: 141067**

Title: **Do Winter Wheat Cultivars Impact Spring Canola Stand Establishment Differently?**

Personnel: **Dr. Clark Neely and Dr. Isaac Madsen**

Reporting Period: December 2021 through November 2022

Accomplishments: Following harvest of winter wheat variety trials in 2021 at Pullman and Reardan, bird netting was placed over the harvested plots to keep residue in place. Bird netting was then removed and spring canola planted over the top of the previous winter wheat variety trials on April 18 and 27 at Reardan and Pullman, respectively.

The 2021 harvest season was the driest season for the region since the 1970's. Dayton was one of our planned locations for this study, however, due to drought conditions, some varieties performed erratically across the trial producing variable grain and biomass yield. For this reason, we did not feel it would provide a good baseline to conduct the study. Therefore, we moved this site to our Pullman winter wheat variety trial site which included the same entries as Dayton. Reardan was used as our second site as planned, but does contain a slightly different set of wheat varieties as it is located in a lower rainfall zone. Cooperators at both Pullman and Reardan may not plant canola in the surrounding fields. We will plan to plant a 20' border around our plots of spring canola to hopefully avoid any drift issues once canola has emerged in the spring.

Prior to combine harvest, four linear row meters of wheat biomass was hand cut at approximately a 2" height from each plot and placed in paper bags for weighing and threshing to estimate straw production of each variety. Straw was only collected from released varieties and select experimental lines that were likely to be released in the near future. Following wheat harvest (Pullman: July 27, 2021; Reardan: August 6, 2021), residue from each plot was spread evenly across its respective plot area on the same day (Figure 1). Bird netting was then placed over the entire winter wheat variety trial to ensure residue stayed in place throughout the winter months. To capture inherent variability in cutting height by the combine across the field, stubble height was measured for each plot to use in statistical analysis in case it explained some of the variability captured in canola emergence and growth in the spring.

To complement the original project objectives, the team has collected chaff from the winter wheat variety trial at Dayton and placed 20 grams of residue from each variety into nylon mesh bags and replicated three times at both Pullman and Reardan. These bags were placed on the soil and staked down adjacent to the plots at the Pullman and Reardan sites on October 4 and October 8, respectively (Figures 3 and 4). They will be left out to weather over the winter months. At spring planting, these bags will be removed and weighed to estimate differences in residue decomposition among wheat varieties. This residue will then be soaked in water and used to generate extract solutions to test if chemical compounds in the straw negatively impact canola germination and early seedling growth in the lab.

Hand collected wheat biomass samples have not yet been weighed or threshed. This will be done over the winter months. Data on spring canola emergence and growth will be conducted in the spring.

Figure 1. Spreading wheat residue across respective plots at Pullman site.

Figure 2. Bird netting covering winter wheat residue to keep in place during the winter at Pullman.

Figure 3. Wheat residue bags placed on soil surface to weather and decompose over winter months.

Figure 4. Wheat residue from bags to be used to generate extract solutions for testing possible allelopathic properties on canola germination and seedlings.

Results:

<u>Field Study</u>
Differences were detected in spring canola for some measurements following different winter wheat varieties, however, these differences were inconsistent across locations and measurements taken. The use of a hoe type drill instead of a disk drill may also have led to greater variability within plots due to less precision in seed placement. Furthermore, an exceptionally cold and prolonged cold snap around planting severely delayed early growth and may have masked differences or led to greater unexplained variability within the trial.

At the Pullman site, very little difference was detected in the spring canola following the various winter wheat varieties for early season growth measurements or harvested samples, with the exception of canopy cover taken five weeks after planting following the soft white winter wheat trial. Here, AP Dynamic, LCS Shine, Nixon, and ARS-Selbu 2.0 were among the lowest treatments for canopy cover while AP Exceed, ARS09X492-6C (Cameo), ARS-Crescent, LWW17-5877, Purl, and TMC M-Press were among the highest (Fig 5). No differences were detected among the hard red winter wheat varieties for any measurements at Pullman.

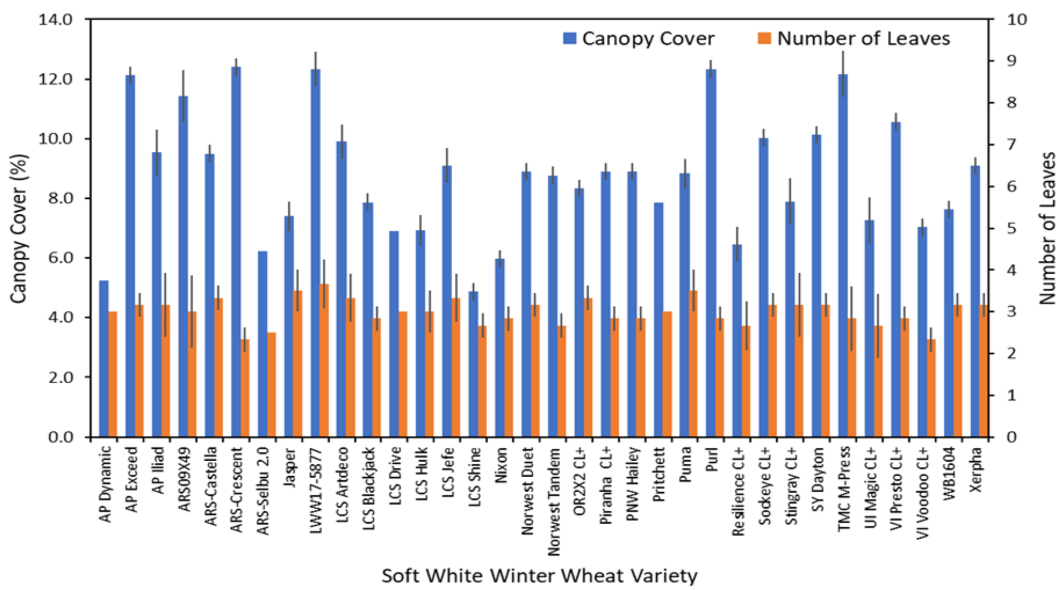

Figure 5. Previous soft white winter wheat variety impact on percent canopy cover and number of leaves plant^{-1} in subsequent spring canola at 5 WAP in Pullman, WA. Bars indicate standard deviation.

Wheat varietal impacts on subsequent canola were much more evident at the Reardan site for emergence, canopy cover, seed oil and seed protein. Like Pullman, differences were detected for canopy cover six and seven WAP following the SWW trial (Fig. 6). M-Idas, LWW18-5080, ARS Crescent were among the varieties that had the highest spring canola canopy cover seven WAP while WA8334, Puma, Devote, and AP Dynamic had some of the lowest. *Of the SWW varieties that were planted at both sites, AP Dynamic produced* *consistently lower canopy cover while ARS Crescent produced consistently higher canopy cover at both sites.* Hard red winter wheat varieties Whistler, OR217019, and Battle AX produced greater canola canopy cover while SY Clearstone CL2 produced the lowest seven WAP (Fig. 7).

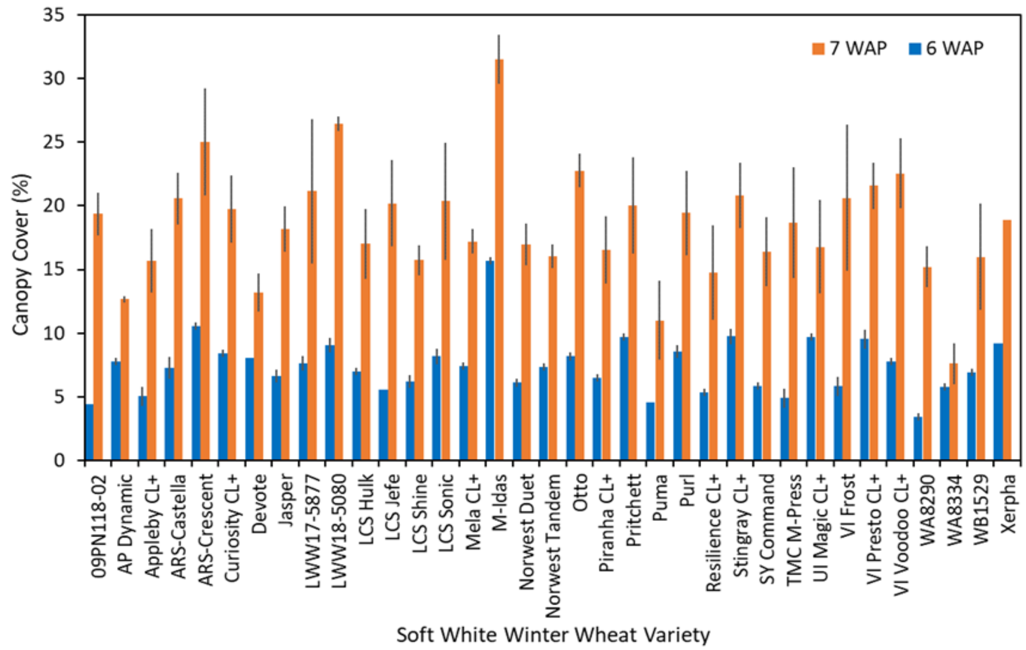

Figure 6. Previous soft white winter wheat variety impact on percent canopy cover in subsequent spring canola 6 and 7 WAP in Reardan, WA. Bars indicate standard deviation.

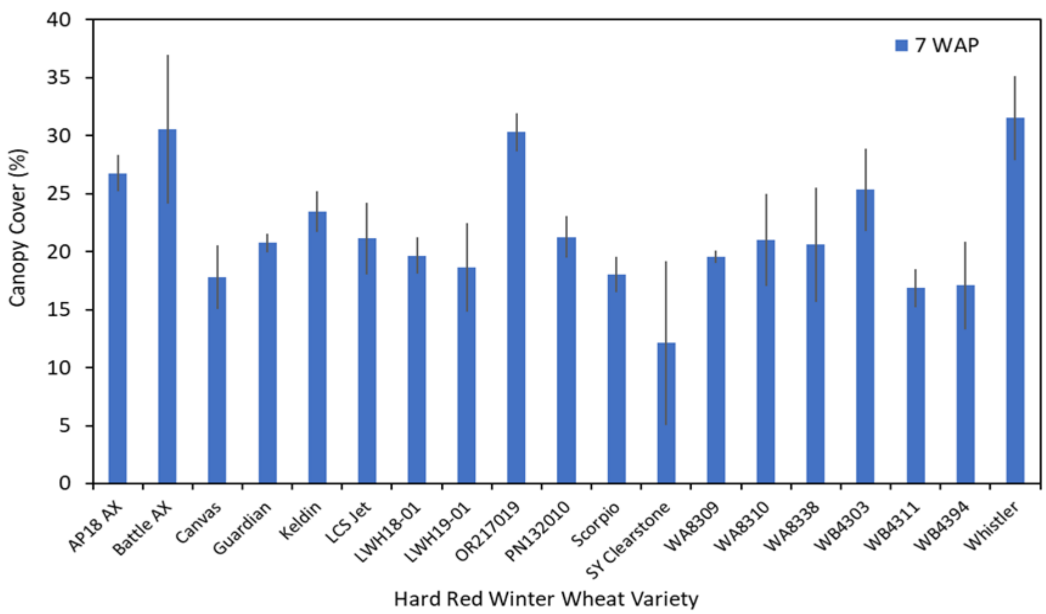

Figure 7. Previous hard red winter wheat variety impact on percent canopy cover in subsequent spring canola at 7 WAP in Reardan, WA. Bars indicate standard deviation.

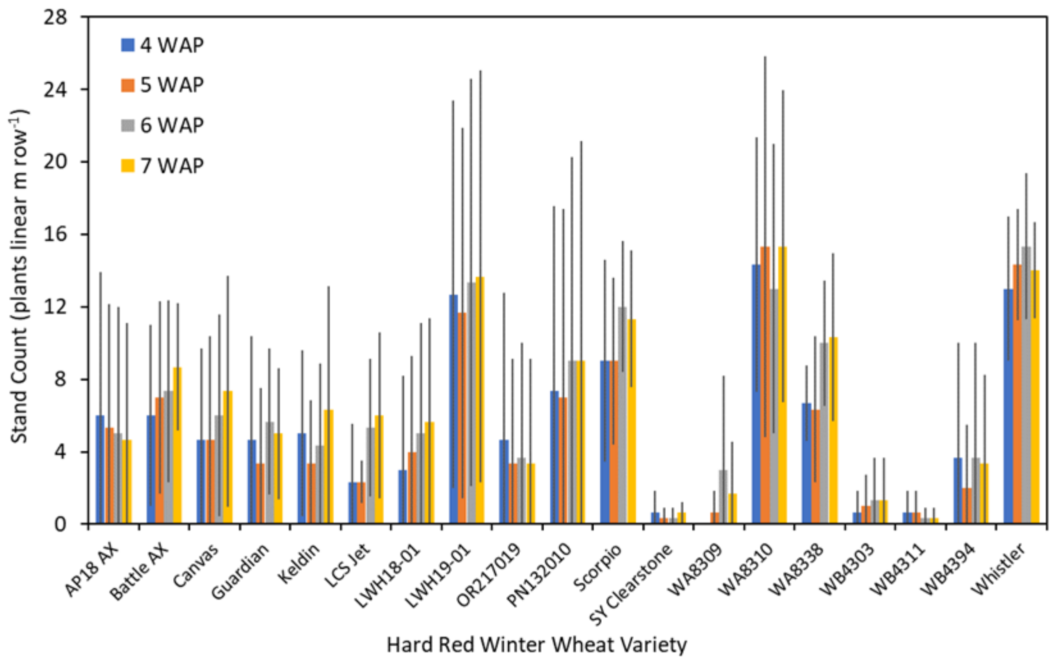

Figure 8. Previous hard red winter wheat variety impact on stand count in subsequent spring canola 4, 5, 6, and 7 WAP in Reardan, WA. Bars indicate standard deviation.

While no differences were detected for canola stand counts among soft white winter wheat varieties here, hard red winter wheat varieties SY Clearstone CL2, WA8309, WB4303, and WB4311 were all consistently lower for stand counts four weeks through seven weeks after planting (WAP) (Fig. 8). LWH19-01, WA8310, and Whistler were all higher on average than the rest of the entries. It is worth mentioning that variation from plot to plot was high as indicated by the large standard deviation bars in the graph, which lowers the confidence in these findings.

Importantly, no seed yield differences were detected for the spring canola at either site. Even though there were differences in early season growth in some cases, growing conditions were conducive for compensatory growth by the canola. Interestingly, winter wheat variety significantly impacted seed oil and seed protein at Reardan for both the SWW and HRW varieties (Figs 8 & 9). VI Frost, Stingray CL+, Jasper, WA8290 were lowest for seed oil and ARS Crescent and WB1529 were some of the highest for seed oil content in the SWW. AP18 AX and Battle AX were lowest for canola seed oil content in the HRW trial while Scorpio, LWH18-01, LCS Jet, and WB4303 were some of the highest. In general, there was an inverse relationship between seed oil and seed protein content in the spring canola. Another important finding was that spring canola following the HRW trial generally had 1-2 percentage units greater seed protein (1-2 percentage units lower seed oil) compared to spring canola following the SWW varieties. This is likely explained by greater residual soil N from additional N applied to the HRW trial.

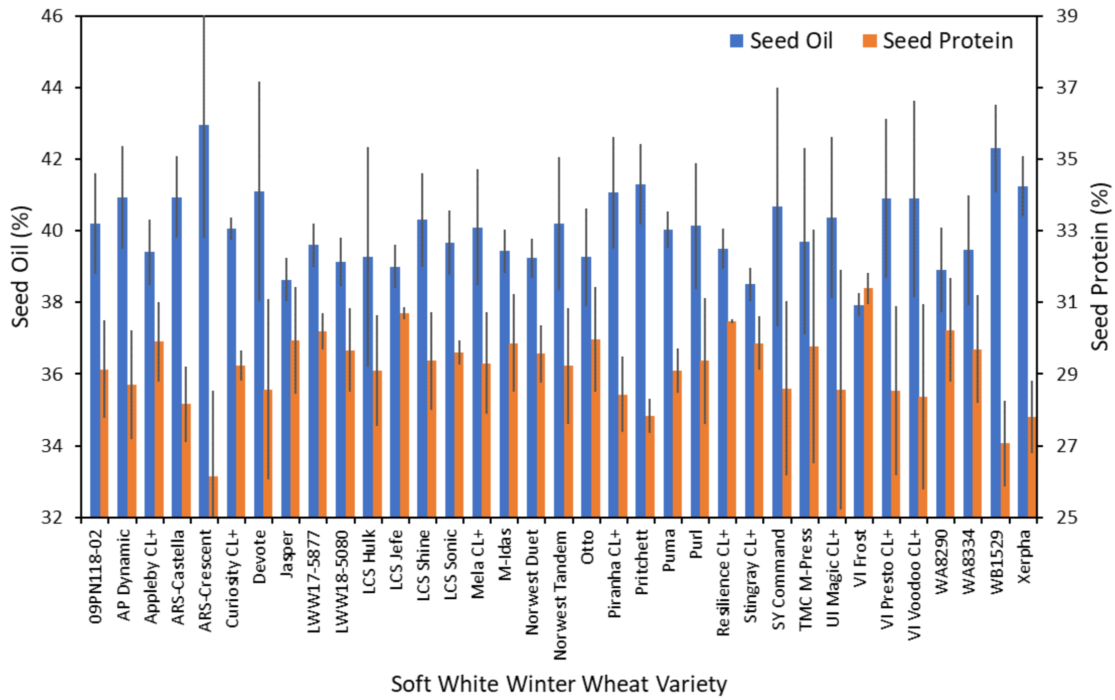

Figure 9. Previous soft white winter wheat variety impact on seed oil and protein in subsequent spring canola in Reardan, WA. Bars indicate standard deviation.

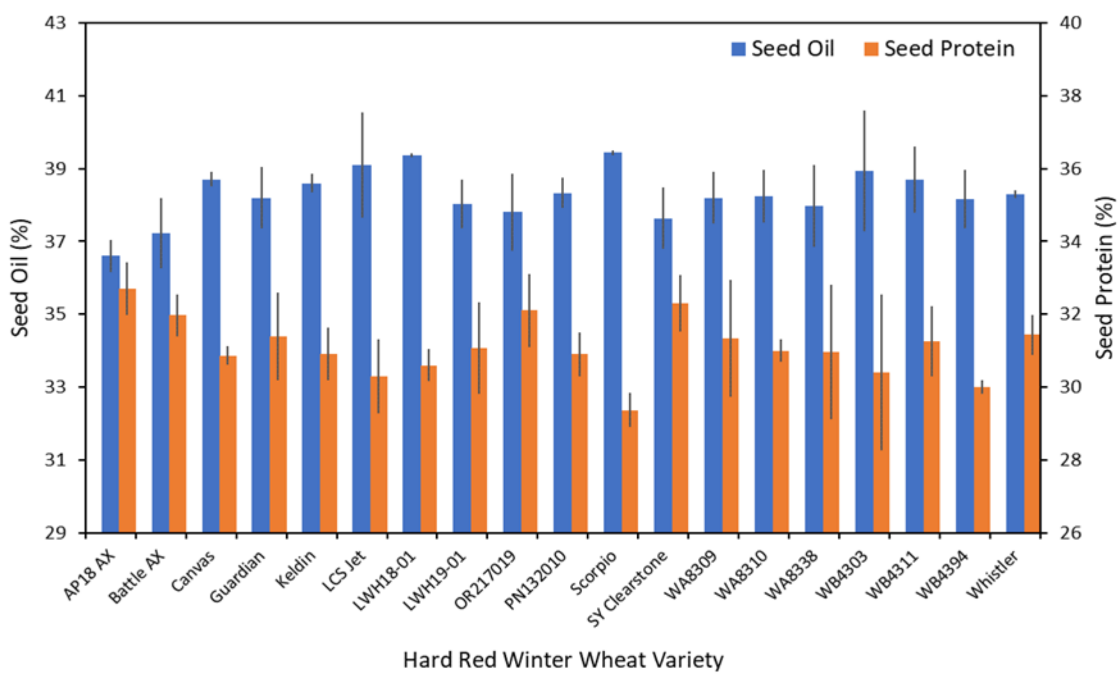

Figure 10. Previous hard red winter wheat variety impact on seed oil and protein in subsequent spring canola in Reardan, WA. Bars indicate standard deviation.

To help explain any differences, winter wheat straw yield was measured from the previous trial prior to harvest. There was little separation among the highest straw yielding wheat varieties at Pullman, however ARS Selbu 2.0, LCS Drive, LCS Shine, WB4311 produced some of the lowest straw yields (Fig. 11). At Reardan, there again was little significant difference among winter wheat varieties for straw yield, though AP18 AX, LCS Jet, UI Bronze Jade, VI Presto CL+, WB1529, and WB4311 had some of the lowest straw yields.

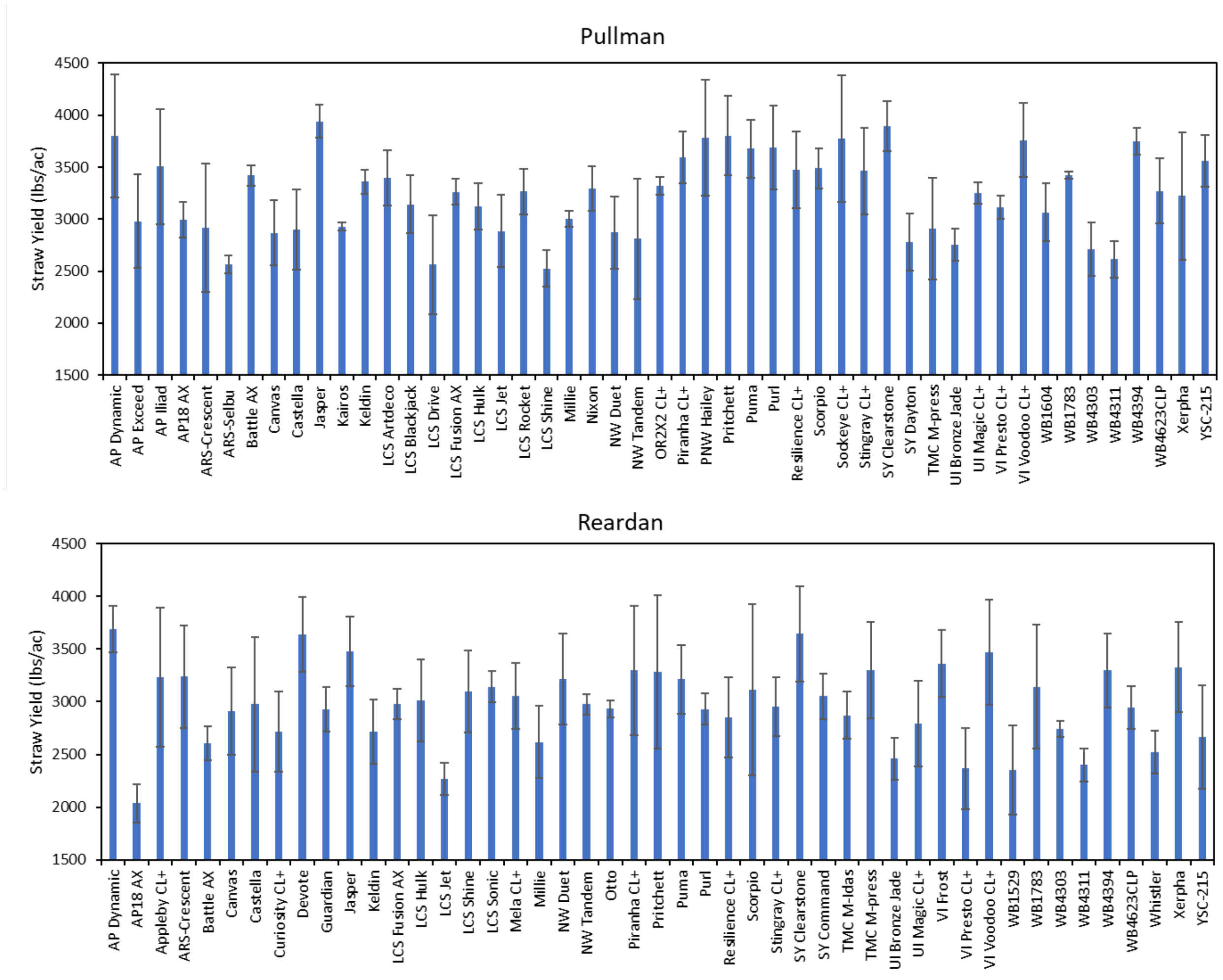

Figure 11. Straw yield for winter wheat varieties at trials in Pullman and Reardan, WA in 2021. Bars indicate standard deviation.

Lastly, straw samples placed adjacent to the trial near Reardan overwintered in the field and were retrieved in the spring to estimate differences in straw decomposition. Puma, Sockeye CL+, and LCS Blackjack all saw negligible decomposition near 1% loss or less (Fig. 12). Alternatively, varieties Millie, AP18AX, Cameo, Norwest Duet and WA8309 saw decomposition of 14-16%. Both straw yield and rate of decomposition may be important factors in establishing spring canola following winter wheat, especially in years with abundant straw production.

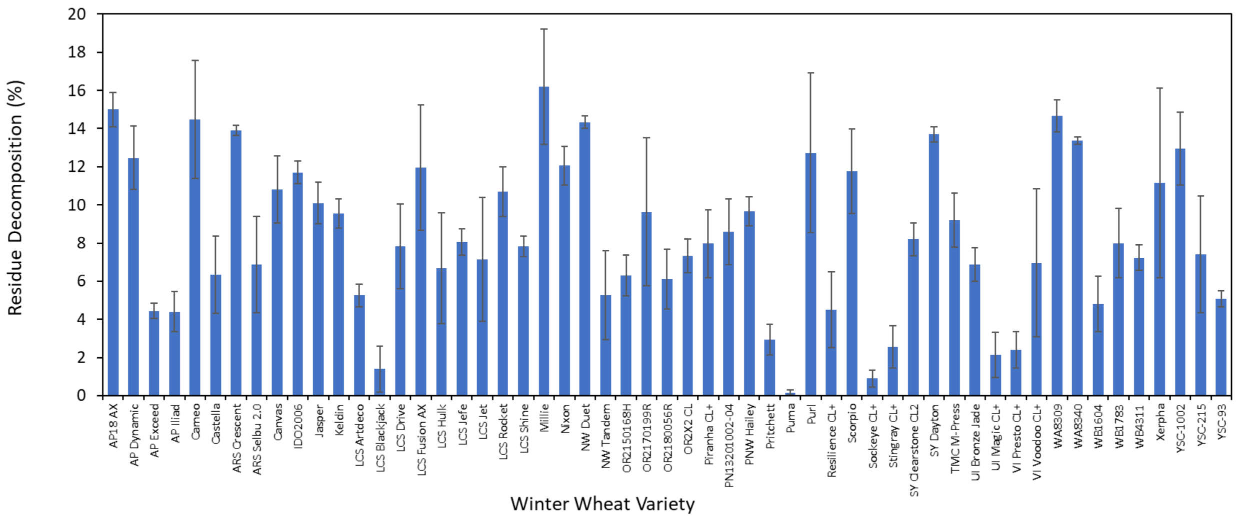

Figure 12. Percent residue decomposition at Reardan, WA based on winter wheat variety. Bars indicate standard deviation.

Lab Study

A complementary lab study was conducted with the field study looking at possible allelopathic impacts of winter wheat residue on spring canola under a more controlled environment. After applying wheat residue extracts to petri dishes with canola seeds, differences were detected among varieties and concentration rate for percent germination, radicle length, final seedling weight and extract electrical conductivity (Table 2).

Germination

On Day 1 after treatment application, the majority of variety extracts actually improved canola germination over the no treatment control (0% germination) with AP Exceed achieving the highest germination rate of 77%. However, by Day 2 most varieties were no different than the control (100% germination), while a few varieties had lower percent germination including, but not limited to, PNW Hailey (80%), Scorpio (84%), Sockeye CL+ (83%), OR2x2 (83%), LCS Shine (84%), LCS Jet (82%), and LCS Blackjack (83%). By Day 4, there were no differences among varieties for germination.

Increasing the extract concentration also decreased percent germination from 35% to 12% for rates of 1.5 and 6.0 g of residue/100mL H_2O, respectively, on Day 1. A similar trend was detected in Day 2, but no differences were present by Day 4.

Radicle Length

On Day 1, the majority of variety extracts produced longer radicles on canola seedlings compared to the control, while 18 varieties were no different. On Day 2, the majority of variety extracts still produced longer radicles compared to the control except for 16 varieties that were no different. By Day 4, no varieties were statistically greater compared to the control while five varieties produced shorter canola seedling radicles. These five varieties included LCS Blackjack, LCS Drive, Piranha CL+, Sockeye CL+, and YSC-215.

Seedling Biomass

All variety extracts produced between 16 and 30% greater seedling biomass compared to the control. Numerically, AP18AX, UI Magic CL+, Stingray CL+, Nixon, and LCS Drive had some of the highest seedling biomass values while Norwest Duet, Jasper, Sockeye CL+, Xerpha, YSC-215, and AP Exceed had some of the lowest. The highest extract rate (6.0 g residue/100 mL H_2O) also produced 3% greater biomass than the two lower rates of 1.5 and 3.0 g on average.

Extract Electrical Conductivity

Similar to other measurements, the electrical conductivity was significantly different among wheat residue extracts for both variety and concentration. As extract concentration increased from 1.5 g to 6.0 g of residue so did electrical conductivity from 243 to 627 µS/cm. Varieties with the greatest electrical conductivity were AP Dynamic, LCS Drive, and Scorpio while AP Exceed, Cameo, LCS Artdeco, Norwest Tandem, VI Presto CL+, and UI Magic CL+ had some of the lowest. Electrical conductivity served as a proxy for osmotic potential of the extracts and indicated substantial differences among varieties for leached solutes from residue. There were moderate negative correlations between electrical conductivity and percent germination and radicle length (Table 1). Only a slight positive correlation was present for seedling biomass with conductivity.

Table 1. Pearson correlation table among final seedling biomass, extract electrical conductivity, and percent germination and radical length over Days 1, 2, and 4 following treatment. Only significant correlations ($p<0.05$) are shown with red indicating negative and blue indicating positive correlations.

	Seedling Biomass	Extract Conduct-ivity	% Germination Day 1	% Germination Day 2	% Germination Day 4	Radicle Length Day 1	Radicle Length Day 2	Radicle Length Day 4
Seedling Biomass		0.10				-0.13		0.10
Extract Conduct-ivity			-0.26	-0.40			-0.34	-0.35
% Germination Day 1				0.23		0.71	0.77	0.42
% Germination Day 2					0.25	0.18	0.29	0.35
% Germination Day 4								
Radicle Length Day 1							0.60	0.28
Radicle Length Day 2								0.51
Radicle Length Day 4								

Table 2. Treatment averages over time for percent germination, radicle length, and seedling biomass of canola seeds treated with residue extracts created from different winter wheat varieties using different extract concentrations. Electrical conductivity (EC) was measured to indicate osmotic potential of each extract. Different letters indicate significant differences among treatment means within column.

Effect	Germination (%)			Radicle Length (mm plant^{-1})			Seedling Biomass (mg plate^{-1})	Extract EC (µS/cm)
	Day 1	Day 2	Day 4	Day 1	Day 2	Day 4		
`oncentration								
0.5x	35% A	95% A	100% A	0.09 A	8.5 A	42.1 A	40.7 B	243 C
1.0x	23% B	92% B	99% A	0.08 B	7.4 B	40.3 B	41.0 B	390 B
2.0x	12% C	78% C	99% A	0.00 C	5.8 C	34.8 C	41.9 A	627 A
Variety								
AP Dynamic	50% B-F	85% CDE	98% A	1.6 AB	10.3 B	43.0 ABC	41.4 A-H	646 A
AP Exceed	77% A	96% ABC	97% A	1.6 ABC	12.1 A	45.1 A	39.4 FGH	331 KL
AP Iliad	61% BC	85% CDE	100% A	1.6 ABC	10.2 BC	40.9 A-G	39.9 D-H	365 I-L
AP18AX	46% D-G	90% A-E	100% A	1.8 A	8.6 D-G	41.0 A-F	43.4 A	462 D-G
ARS Castella	53% B-E	88% A-E	98% A	1.4 A-E	8.8 C-F	38.2 E-L	40.5 A-H	421 D-I
ARS Crescent	58% BCD	92% A-D	98% A	1.4 A-E	9.8 BCD	42.7 A-D	39.9 D-H	422 D-I
ARS Selbu 2.0	63% B	90% A-E	99% A	1.3 A-G	9.8 BCD	41.0 A-F	39.5 E-H	380 G-K
Cameo	41% E-H	86% B-E	98% A	1.1 B-H	7.5 F-K	40.3 B-H	41.4 A-H	329 KL
Canvas	52% B-E	93% A-D	100% A	1.5 A-D	8.0 E-I	38.8 C-K	40.7 A-H	495 CD
Jasper	26% IJ	87% A-E	99% A	0.6 F-M	7.5 F-K	40.5 A-H	39.0 GH	408 D-K
Keldin	49% C-F	87% A-E	98% A	1.8 AB	9.5 B-E	39.1 C-K	41.7 A-H	430 D-I
LCS Artdeco	38% F-I	92% A-D	100% A	0.9 D-I	7.5 F-K	39.2 B-J	40.0 C-H	323 LK
LCS Blackjack	28% HIJ	83% DE	98% A	0.9 D-J	7.0 H-O	35.9 H-L	40.8 A-H	562 BC
LCS Drive	26% IJ	87% A-E	100% A	1.3 A-F	6.5 J-P	34.7 KL	43.3 ABC	638 AB
LCS Fusion AX	30% HIJ	87% A-E	98% A	1.2 A-G	7.9 F-J	43.5 AB	39.5 E-H	386 G-K
LCS Hulk	26% IJ	88% A-E	99% A	1.2 A-G	7.5 F-K	40.3 B-H	40.8 A-H	429 D-I
LCS Jet	25% IJK	82% DE	99% A	0.8 D-J	7.4 F-K	41.5 A-E	41.7 A-H	506 CD
LCS Rocket	33% G-J	88% A-E	98% A	0.9 D-J	8.4 D-H	38.8 C-K	42.8 A-D	499 CD
LCS Shine	23% JKL	84% DE	98% A	0.8 E-K	6.3 L-Q	37.7 E-L	41.6 A-H	482 C-F
M-press	23% J-M	85% CDE	98% A	1.6 ABC	7.1 H-N	39.9 B-I	42.1 A-H	419 D-J
Nixon	27% IJ	89% A-E	99% A	0.9 C-I	7.9 F-J	40.9 A-G	43.3 AB	492 CD
Norwest Duet	12% K-N	89% A-E	98% A	0.6 G-M	7.3 G-M	38.9 C-K	39.0 H	397 F-K
Norwest Tandem	24% JK	91% A-D	99% A	1.0 B-I	7.5 F-K	40.2 B-H	40.1 B-H	284 KL
OR2x2	10% L-N	83% DE	98% A	0.4 H-M	6.6 I-P	38.3 D-K	40.0 C-H	402 E-K
Piranha CL+	25% IJK	91% A-D	97% A	1.0 C-I	7.5 F-K	35.3 JKL	42.8 A-D	328 KL
PNW Hailey	12% K-N	80% E	100% A	0.3 I-M	6.6 I-P	38.8 C-K	41.1 A-H	482 C-F
Pritchett	11% K-N	90% A-E	98% A	1.0 B-I	6.0 L-Q	38.7 C-K	41.0 A-H	377 G-L
Puma	9% MN	87% A-E	98% A	0.7 F-K	6.7 I-P	37.3 E-L	41.2 A-H	361 I-L
Purl	5% N	87% A-E	99% A	0.6 G-M	5.3 PQ	40.1 B-I	41.3 A-H	495 CD
Resilience CL+	0% N	91% A-D	100% A	0.0 M	5.8 N-Q	39.6 B-J	40.1 B-H	478 C-F
Scorpio	2% N	84% DE	97% A	0.1 LM	5.9 M-Q	39.7 B-J	42.3 A-G	595 AB
Sockeye CL+	12% K-N	83% DE	99% A	0.4 H-M	5.6 OPQ	35.8 I-L	39.4 FGH	366 H-L
Stingray CL+	2% N	92% A-D	99% A	0.4 I-M	5.7 N-Q	39.3 B-J	43.3 AB	352 I-L
SY Clearstone CL2	0% N	93% A-D	99% A	0.0 M	6.2 L-Q	38.8 C-K	39.5 E-H	422 D-I
SY Dayton	0% N	91% A-D	99% A	0.0 M	4.9 Q	39.5 B-J	43.0 A-D	485 CDE
UI Magic CL+	0% N	97% AB	99% A	0.0 M	5.0 Q	37.2 E-L	43.5 A	335 JKL
VI Presto CL+	0% N	98% A	100% A	0.0 M	5.9 M-Q	39.4 B-J	43.0 A-D	312 KL
VI Voodoo CL+	2% N	86% B-E	99% A	0.1 KLM	6.0 L-Q	36.7 F-L	42.5 A-F	371 H-L
WB1604	1% N	93% A-D	99% A	0.0 M	6.0 L-Q	36.5 G-L	41.7 A-H	374 H-L
WB4311	0% N	89% A-E	99% A	0.0 M	5.7 N-Q	37.0 F-L	42.8 A-E	488 CD
Xerpha	0% N	91% A-D	98% A	0.0 M	6.0 L-Q	37.1 E-L	39.3 FGH	485 CDE
YSC-215	1% N	92% A-D	99% A	0.2 J-M	5.3 PQ	33.8 L	39.3 FGH	450 D-H
CONTROL (DI water)	0%	100%	100%	0.0	5.9	40.9	33.5	5

Conclusions
In summary, while there were differences detected among varieties on subsequent spring canola growth, it was difficult to pick out many varieties that had consistent, negative or positive impacts on canola growth in the field or laboratory setting, and importantly, any differences measured did not translate into yield penalties. Of the SWW varieties that were planted at both sites, AP Dynamic produced consistently lower canopy cover while ARS Crescent produced consistently higher canopy cover at both sites. Also, SY Clearstone CL2 reduced both canopy cover and stand at one location. LCS Shine reduced canopy cover at one site and delayed germination in the lab while AP Exceed did just the opposite. One of the most consistent varieties to lower canola performance in the laboratory was Sockeye CL+, which delayed germination, decreased radicle length and lowered final seedling biomass.

Regardless of the documented impact, or lack thereof, on early season growth of canola in this study, planting canola into heavy residue is a major obstacle in establishing canola. Selecting winter wheat varieties that either produce less straw, or straw that decomposes quicker would be advantageous. Based on our results, residue from Puma, Sockeye CL+, and LCS Blackjack all saw negligible decomposition over the winter months while varieties Millie, AP18AX, Cameo, Norwest Duet and WA8309 had some of the greatest decomposition. Also, ARS-Selbu 2.0, LCS Drive, LCS Shine, WB4311, AP18AX, LCS Jet, UI Bronze Jade, VI Presto CL+, WB1529 and WB4311 all produced some of the lowest straw yields in at least one location. Differences were likely less detectable in 2021, however, due to the extreme drought and limited yields.

A larger, field scale trial focusing on some of the previously mentioned varieties would be an interesting follow up to see if any of these results are reproducible or impact canola yield under a different environment.

Lastly, growers should be cognizant of fertility programs. Based on the field results from Reardan, nitrogen fertility may influence seed protein, and indirectly, seed oil content. In some instances where seed oil content is marginal and premiums are offered for a minimum seed oil content, there may be an economic penalty for excessive applied or residual soil nitrogen.

Future work to be completed:
Field data collection is complete. The lab portion of the study will need to be replicated in 2023 using residue bags from the Pullman site. The previous lab data was generated using the Reardan residue bags.

Publications: Two scientific posters summarizing these findings were presented at the annual Crop Science Society of America Conference in Baltimore, MD on November 8, 2022. These findings will be summarized into a peer-reviewed scientific paper and an extension bulletin in the coming year once the study is complete.