Technical Report TR23-3 2023 Wheat Field Days Edition

Agricultural Experiment Station

College of Agricultural Sciences Department of Soil & Crop Sciences Extension

Making Better Decisions

2022 Colorado Winter Wheat Variety Performance Trials

Crops Testing

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Additional Resources

Colorado State University Crop Variety Testing Program: www.csucrops.com and on Twitter with the handle @CSUCrops

Colorado State University Wheat Breeding Program: www.agsci.colostate.edu/wheat/

Colorado Wheat Variety Performance Database: www.ramwheatdb.com

Overview of 2021-2022 Eastern Colorado Winter Wheat Trials

Sally Jones-Diamond

Colorado State University researchers provide current, reliable, and unbiased wheat variety information to Colorado producers. Support of our research keeps public variety testing thriving in Colorado. Our work in Colorado is possible due to the support and cooperation of the entire Colorado wheat industry, the Colorado Wheat Administrative Committee, the Colorado Wheat Research Foundation, seed companies who enter varieties, and Colorado farmers who donate their resources and time to host wheat variety trials.

We test under a broad range of environmental conditions to best determine expected performance of new varieties. We have a regional uniform variety testing program, meaning that dryland varieties entered in our northeast region are tested across our six test locations in northeast Colorado and varieties entered in our southeast region are tested across our five tests in southeast Colorado. All irrigated varieties are tested in all three irrigated trials across northeast Colorado. There were 41 varieties, including experimental lines, across the two regions of the 11 total dryland trials. The three irrigated trials each had 22 varieties. The variety trials included a combination of public and private varieties and experimental lines. Seed companies with entries in the variety trials included AgriPro Syngenta, CROPLAN, and Meridian Seeds. There were entries from the Colorado marketing organization PlainsGold, the Kansas Wheat Alliance, Montana State University, Oklahoma Genetics, Inc., and Crop Research Foundation of Wyoming.

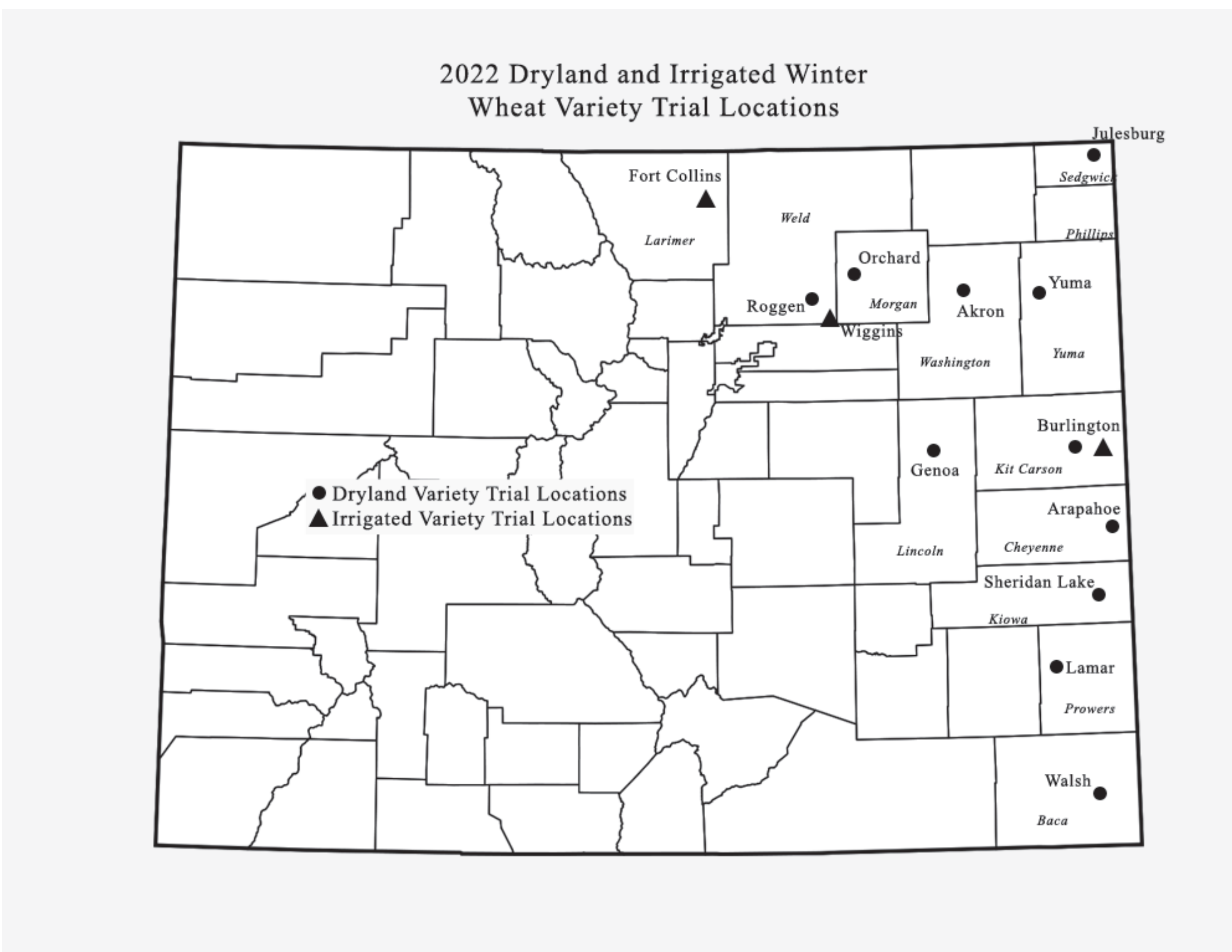
All dryland and irrigated trials were planted in a randomized complete block design with three replicates. Plot sizes were approximately 150 ft^2 (except the Fort Collins irrigated trial, which was 80 ft^2) and all varieties were planted at 700,000 seeds per acre for dryland trials and 1.2 million seeds per acre for irrigated trials. Plot sizes for the COFT ranged from 0.20 to 1.5 acres per variety in side-by-side strips with seeding rates conforming to the seeding rate used by the collaborating farmer. Yield is corrected to 12% moisture. Variety trial plot weight, test weight, and grain moisture content information were obtained from a Harvest Master H2 weighing system on a plot combine.

General Conditions Affecting the 2022 Colorado Wheat Crop

Fall 2021 was drier than normal in east-central and southeast Colorado, but scattered rainfall received in September allowed for most wheat to be planted into moisture. Soil moisture conditions quickly deteriorated throughout eastern Colorado, especially in Baca County in the southeast and Washington County in the northeast. Temperatures in the fall were above average. The entirety of eastern Colorado was under moderate to extreme drought conditions from December 2021 through harvest in July 2022. Little precipitation was received during the winter months and warmer than average temperatures and windy conditions occurred in the spring.

Many wheat acres were chiseled or abandoned in the spring due to severe wind erosion and/or poor emergence due to the lack of moisture. The northeast and east-central parts of Colorado experienced a hard, late freeze in mid-April that mainly caused cosmetic damage to the leaves of the wheat plants. Scattered rainfall in May and June helped the remaining wheat, but some severe storms with hail occurred later in the season which caused more losses, especially in southeast Colorado.

Stripe rust disease was not an issue this season due to hot and dry conditions. Brown wheat mites were observed at very low levels in east-central and northeast Colorado, and higher levels that required chemical control were noted in parts of southeast Colorado. Wheat Stem Sawfly (WSS) was devastating and widespread across many northeast Colorado counties, with some producers swathing wheat to avoid lodging and to decrease harvest losses. WSS appeared at higher levels than seen in prior years in east-central Colorado including Lincoln and Kit Carson counties.



2022 Dryland Wheat Trial Management and Characteristics

2022 Wheat Trial Management and Characteristics

		Dryland Locations											Irrigated Locations		
		Akron	Arapahoe	Burlington	Genoa	Julesburg	Lamar	Orchard	Roggen	Sheridan Lake	Walsh	Yuma	Burlington	Ft. Collins	Wiggins
	Average Yield (bu/ac)	Trial Abandoned	26	Trial abandoned	19	25	Trial abandoned	Trial Abandoned	32	27	Trial Abandoned	36	91	80	66
Location	GPS Coordinates (Lat/Long)	40.14931, -103.13738	39.0014, -102.24629	39.28575, -102.27902	39.35086, -103.50872	40.83809, -102.37339	38.00783, -102.61444	40.47944, -104.07112	40.08204, -104.30125	38.53838, -102.47213	37.429318, -102.31617	40.18659, -102.65709	39.40709, -102.15592	40.652947, -104.99922	40.0004, -104.10129
	County	Washington	Cheyenne	Kit Carson	Lincoln	Sedgwick	Prowers	Morgan	Weld	Kiowa	Baca	Yuma	Kit Carson	Larimer	Adams
Soil	Soil Type	Rago Silt Loam	Colby-Satant, Keith Richfield	Kuma-Keith silt loam	Weld silt loam	Rogo and Kuma silt loams	Wilid silt loam	Platner Sandy Loam	Weld loam	Wiley loam, Olney sandy loam	Wiley loam	Haxtun sandy loam	Kuma-Keith silt loams	Fort Collins loam	Truckton sandy loam
	Soil Organic Matter	1.6	1.8	1.9	2.2	1.7	1.4	0.9	1.2	1.1	-	1.8	2.1	-	1.3
	Soil pH	6.4	7.2	7.5	6.4	5.6	8.1	6.7	7.2	8	-	7.8	8.1	-	7.8
	Soil Nutrients at planting (N-P lb/ac)	126 - 50	96 - 22	141 - 22	142 - 79	95 - 40	38 - 22	100 - 79	158 - 68	6 - 22	-	108 - 72	43 - 11	-	94 - 82
Management	Applied Fertilizer in Season* (N-P-K lb/ac)	78 - 28 - 0 - 1S	8 - 28 - 0	8 - 28 - 0	36 - 28 - 0 - 5S	8 - 28 - 0	8 - 28 - 0	8 - 28 - 0	8 - 28 - 0	8 - 28 - 0	-	8 - 28 - 0	128 - 68 - 0 - 10S - 1Zn	-	8 - 28 - 0
	Pesticides Applied	None	-	-	-	-	-	-	None	None	None	-	Express XP herbicide and Palisade growth regulator	-	-
	Tillage	No-Till	Vertical Till	Tilled	No-Till	No-Till	No-Till	No-Till	No-Till	Tilled	No-Till	No-till	Tilled	Tilled	Tilled
	Previous Crop 2020/2021	Proso millet / Fallow	Corn / Fallow	Corn / Fallow	Proso millet / Fallow	Corn / Fallow	Wheat / Fallow	Proso millet / Fallow	Wheat / Fallow	Corn / Fallow	Wheat / Fallow	Wheat / Fallow	Corn in 2021	Wheat / Fallow	Corn in 2021
	Planting Date	9/27/2021	9/9/2021	9/9/2021	9/15/2021	9/16/2021	9/8/2021	9/23/2021	9/20/2021	9/8/2021	9/15/2021	9/16/2021	10/12/2021	9/21/2021	10/4/2021
	Harvest Date	Abandoned	7/1/2022	Abandoned	7/13/2022	7/7/2022	Abandoned	Abandoned	7/11/2022	6/30/2022	Abandoned	7/5/2022	7/13/2022	7/13/2022	7/12/2022
Environment	Biotic Stress	Wheat stem sawfly	None	None	Wheat stem sawfly	Brown wheat mites present at very low levels	Brown wheat mites, sprayed 2x	N/A	Brown wheat mites at low levels and wheat stem sawfly	None	N/A	None	Wheat stem sawfly at low levels	None	Wheat stem sawfly
	Abiotic Stress	Drought	Drought	Drought and hail	Drought	Drought	Drought and hail	Drought and wind erosion	Drought	Drought and minor freeze damage	Severe drought and wind erosion	Drought and minor freeze damage	None	None	Minor drought
	Total Rain: January 1 to Harvest	N/A	7.3"	N/A	8.4"	5.9"	N/A	N/A	7.9"	4.9"	N/A	6.2"	9.4"	5.5"	6.9"
	GDD (Jan 1 - Harvest, 32°F base)	N/A	3303	N/A	3494	3509	N/A	N/A	3543	3446	N/A	3345	3808	3401	3540
	General Comments	Planted about 2” deep, ground moist down to 3”. Hard soil. Shovels down at planting. Poor emergence in fall, what emerged had good growth. Mid-April top 3" dry and plants trying to emerge that didn't come up in the fall. Trial abandoned due to drought.	Loose soil at planting and heavy corn residue. Planted into moisture and had acceptable fall stands. In mid-April trial was drought stressed. By May trial had good moisture from recent rains. Hail occurred on June 24th, yield loss estimated between 20-40%.	Trial abandoned due to severe hail in June.	Planted 2" deep into good moisture. Fall emergence was average with little growth. In mid-April there was moisture 3" from the soil surface. In May the trial looked drought stressed.	Planted into moisture at 1.5" seeding depth. Excellent stands and fall growth. In mid-April trial was showing drought stress (top 6" of soil was dry) Brown wheat mites were present at very low levels (below threshold).	Planted into heavy wheat stubble into moisture. Good fall emergence, some thin spots due to soil compaction. Good fall growth. Mid-April had jointed. No moisture in top 4" of soil. Brown wheat mites present at low to med levels. Trial abandoned due to hail.	Planted 1.5” deep, moisture down to 5”, dry hard ground. Trial abandoned due to drought and blowing wind.	Planted 2” deep with moisture at 2.5”. Ground was hard so shovels were used on planter. Good fall emergence and growth with a few bare spots in the trial. In mid-April cosmetic freeze damage was noted and brown wheat mites were present at low levels. No moisture in top 5" of the soil in April and most of May.	Planted 1.5" deep into moisture and corn residue. Volunteer corn present at planting, but was controlled by spring. Stands were average with some thin spots and normal fall growth. By mid-April, the varieties were just jointing and the top 4" of soil was dry.	Planted into very little moisture. Trial abandoned due to drought.	Planted mostly into moisture at 2” seeding depth. Loose soil. Very good fall stands and growth. In mid-April trial was showing drought stress (top 5" of soil was dry) and plants had some cosmetic freeze damage on the leaves. No sawfly noted in trial.	Planted into tilled corn residue. Good fall emergence and some growth. In mid-May trial had more growth but was late in maturing due to Oct. planting date. Volunteer wheat was noted in the trial in the spring at low to moderate levels. Wheat stem sawfly present at low levels, but no lodging.	Planted into moisture from pre-plant irrigation. Good stands and average fall growth.	Planted into tilled corn residue. Good fall emergence and some growth. In late-April cosmetic freeze damage was noted. In May trial had more growth but was later maturing due to Oct planting date. Wheat stem sawfly present and caused severe lodging in some plots.

* 8 - 28 - 0 applied at planting as starter by Crops Testing
Dashes denote missing information, N/A means not applicable

Summary of 2022 Dryland Winter Wheat Variety Performance Results

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Brand/Source	Market Class	Variety[b]	2022 Individual Trial Yield[a]: Julesburg	Roggen	Yuma	2022 Multi-Location Average: Yield[c]	Yield	Test Weight	Protein[c]	Heading[d]
			bu/ac	bu/ac	bu/ac	bu/ac	% of avg	lb/bu	%	days from avg.
PlainsGold	HRW	Avery	28.0	**37.5**	**41.5**	35.7	115%	59	13.1	3
PlainsGold	HRW	Kivari AX	27.5	**37.5**	**41.0**	35.3	114%	59	13.4	2
PlainsGold	**HWW**	Monarch	**30.0**	**35.0**	**39.5**	34.8	112%	59	13.6	-1
PlainsGold	HRW	Whistler	**28.5**	33.0	**41.0**	34.2	110%	59	13.6	-1
PlainsGold	HRW	Byrd	27.0	**37.5**	37.5	34.0	110%	59	13.2	-1
PlainsGold	HRW	Canvas	**28.5**	32.5	**40.0**	33.7	108%	60	13.5	-1
PlainsGold	HRW	Crescent AX	28.0	**36.0**	37.0	33.7	108%	59	14.1	-1
PlainsGold	**HWW**	Valley	**28.5**	33.0	38.5	33.3	107%	59	13.8	3
PlainsGold	**HWW**	Breck	**29.5**	31.5	37.0	32.7	105%	61	14.1	0
Kansas Wheat Alliance	**HWW**	KS Silverado	26.0	31.0	**40.5**	32.5	105%	60	14.1	-6
PlainsGold	HRW	Langin	27.5	34.5	35.0	32.3	104%	59	13.9	-8
Crop Research Foundation of Wyoming, Inc.	HRW	Steamboat	22.0	**36.0**	39.0	32.3	104%	60	14.5	0
PlainsGold	HRW	Amplify SF	24.5	**35.5**	36.5	32.2	104%	59	13.8	-1
AgriPro	HRW	AP Solid	26.0	30.0	**40.0**	32.0	103%	61	13.9	1
PlainsGold	HRW	Guardian	27.0	30.5	38.0	31.8	103%	59	13.8	0
PlainsGold	HRW	Byrd CL Plus	23.0	**35.5**	35.5	31.3	101%	59	13.6	-1
CROPLAN	HRW	CP7017AX	27.0	29.5	37.0	31.2	100%	60	13.6	2
Meridian Seeds	HRW	MS Maverick	26.5	32.0	34.5	31.0	100%	59	13.7	3
Kansas Wheat Alliance	HRW	KS Hamilton	22.0	31.5	36.5	30.0	97%	59	13.7	-1
AgriPro	HRW	AP Roadrunner	23.0	29.5	35.5	29.3	94%	57	13.9	1
PlainsGold	HRW	Hatcher	22.0	32.0	34.0	29.3	94%	59	13.4	3
Kansas Wheat Alliance	HRW	KS Dallas	24.5	30.0	32.5	29.0	93%	59	13.8	-1
PlainsGold	**HWW**	Windom SF	24.5	29.5	33.0	29.0	93%	57	14.3	0
PlainsGold	HRW	Fortify SF	22.5	31.0	32.0	28.5	92%	60	13.9	1
AgriPro	HRW	AP Bigfoot	26.0	25.5	33.5	28.3	91%	59	14.1	1
PlainsGold	**HWW**	Snowmass 2.0	24.0	29.5	30.0	27.8	90%	59	13.4	3
PlainsGold	HRW	Brawl CL Plus	24.0	25.5	33.5	27.7	89%	60	14.2	-2
PlainsGold	**HWW**	Sunshine	20.5	26.5	35.0	27.3	88%	59	14.4	0
AgriPro	HRW	SY Legend CL2	22.5	27.5	32.0	27.3	88%	59	14.2	-4
CROPLAN	HRW	CP7266AX	21.5	28.5	30.0	26.7	86%	59	14.0	2
PlainsGold	HRW	Ray	14.0	25.0	27.0	22.0	71%	54	15.8	8
Experimentals										
Colorado State University exp.	HRW	CO18035RA	**29.5**	**35.5**	**41.5**	35.5	114%	59	13.0	-3
Colorado State University exp.	HRW	CO17449R	28.0	**35.0**	**41.0**	34.7	112%	60	13.7	3
Colorado State University exp.	HRW	CO18042RA	27.0	**37.0**	36.5	33.5	108%	59	13.6	3
Colorado State University exp.	HRW	CO18D297R	**29.0**	34.0	37.5	33.5	108%	59	13.9	2
Colorado State University exp.	**HWW**	CO18D007W	27.0	34.0	38.0	33.0	106%	60	13.8	-1
Colorado State University exp.	**HWW**	CO16D402W	25.0	32.5	37.0	31.5	101%	59	14.5	1
Colorado State University exp.	HRW	CO16SF032	26.0	31.0	35.0	30.7	99%	60	13.4	3
Colorado State University exp.	**HWW**	CO18D076W	21.5	29.0	31.5	27.3	88%	59	14.8	3
Colorado State University exp.	HRW	CO16SF067	17.0	30.0	30.0	25.7	83%	59	15.2	2
		Average	**25.2**	**31.9**	**36.0**	**31.0**	**100%**	**59**	**13.9**	**May 28, 2022**
		[e]LSD (0.30)	1.5	2.5	2.0					
		[e]LSD (0.05)	3.0	4.5	4.0					

[a]Varieties in the top LSD yield group in each location are in bold.

[b]Varieties ranked according to released varieties or experimentals, and then by average yield across three trials in 2022.

[c]Yield and protein adjusted to 12% moisture content. Protein averaged across three trials in 2022.

[d]Varieties with positive values headed later than the trial average and varieties with negative values headed earlier than the trial average of May 28th.

[e]Farmers selecting a variety based on yield should use the LSD (0.30) to protect from false negative decisions. Companies or researchers may be interested in the LSD (0.05) to avoid false positive conclusions. Any yield differences among varieties that are less than or equal to the LSD value are not statistically significant.

Summary of 2-Year (2021-2022) Dryland Winter Wheat Variety Performance Results

Variety[b]	Brand/Source	Market Class[c]	2-Year Average[a] Yield	Yield	Test Weight	Test Weight	Plant Height	Protein
			bu/ac	% trial average	lb/bu	% trial average	in	percent
KS Silverado	Kansas Wheat Alliance	**HWW**	53.2	107%	59	104%	28	13.6
Langin	PlainsGold	HRW	52.9	107%	57	100%	29	13.3
CO16D402W	Colorado State University exp.	**HWW**	51.8	105%	56	99%	28	13.3
Snowmass 2.0	PlainsGold	**HWW**	51.6	104%	57	100%	28	13.4
CO18D007W	Colorado State University exp.	**HWW**	51.3	104%	57	100%	29	13.7
Byrd	PlainsGold	HRW	51.1	103%	57	101%	30	12.9
Monarch	PlainsGold	**HWW**	51.0	103%	57	100%	28	12.4
CO18D297R	Colorado State University exp.	HRW	50.9	103%	57	101%	30	13.6
KS Dallas	Kansas Wheat Alliance	HRW	50.7	103%	57	100%	29	13.7
KS Hamilton	Kansas Wheat Alliance	HRW	50.7	102%	56	99%	28	13.4
Canvas	PlainsGold	HRW	50.6	102%	56	99%	29	13.5
Crescent AX	PlainsGold	HRW	50.6	102%	57	100%	31	13.7
Kivari AX	PlainsGold	HRW	50.5	102%	56	98%	30	13.1
Avery	PlainsGold	HRW	50.3	102%	56	99%	31	13.1
AP Solid	AgriPro	HRW	49.7	100%	58	102%	28	13.2
CP7017AX	CROPLAN	HRW	49.3	100%	57	100%	29	13.2
Amplify SF	PlainsGold	HRW	49.1	99%	57	101%	32	13.1
CO16SF032	Colorado State University exp.	HRW	49.0	99%	57	101%	32	12.9
CO18D076W	Colorado State University exp.	**HWW**	48.7	98%	57	99%	30	13.5
Breck	PlainsGold	**HWW**	48.5	98%	58	102%	31	14.1
AP Roadrunner	AgriPro	HRW	48.2	97%	55	97%	29	14.0
Whistler	PlainsGold	HRW	48.1	97%	55	97%	31	13.3
Fortify SF	PlainsGold	HRW	48.0	97%	58	102%	31	13.2
Byrd CL Plus	PlainsGold	HRW	47.9	97%	56	99%	31	13.7
Brawl CL Plus	PlainsGold	HRW	47.1	95%	58	102%	31	13.7
Guardian	PlainsGold	HRW	45.8	93%	57	100%	31	13.8
Hatcher	PlainsGold	HRW	45.5	92%	55	98%	29	12.9
CO16SF067	Colorado State University exp.	HRW	43.9	89%	57	100%	31	14.2
		Average	**49.5**	**100%**	**57**	**100%**	**30**	**13.4**

[a]The 2-year average yield and test weight are based on 12 trials (three 2022 and nine 2021 trials). Plant heights are based on 11 trials (three 2022 and eight 2021 trials). Protein is based on 9 trials (three 2022 and six 2021 trials).

[b]Varieties ranked according to average 2-year yield.

[c]Market class: HRW=hard red winter wheat; **HWW**=hard white winter wheat.

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Summary of 3-Year (2020-2022) Dryland Winter Wheat Variety Performance Results

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			3-Year Average[a]				
Variety[b]	Brand/Source	Market Class[c]	Yield	Yield	Test Weight	Test Weight	Plant Height
			bu/ac	% trial average	lb/bu	% trial average	in
Langin	PlainsGold	HRW	52.9	108%	57	100%	28
Snowmass 2.0	PlainsGold	**HWW**	52.4	107%	57	100%	28
KS Silverado	Kansas Wheat Alliance	**HWW**	51.6	106%	59	103%	27
Avery	PlainsGold	HRW	50.5	103%	56	99%	30
Byrd	PlainsGold	HRW	50.3	103%	57	100%	30
Monarch	PlainsGold	**HWW**	50.3	103%	57	100%	27
KS Dallas	Kansas Wheat Alliance	HRW	50.0	102%	57	100%	28
Kivari AX	PlainsGold	HRW	50.0	102%	56	98%	30
CP7017AX	CROPLAN	HRW	49.7	102%	57	100%	27
Whistler	PlainsGold	HRW	49.7	102%	55	97%	31
Canvas	PlainsGold	HRW	49.1	101%	56	99%	28
Breck	PlainsGold	**HWW**	48.5	99%	58	102%	30
Crescent AX	PlainsGold	HRW	48.3	99%	57	100%	29
Byrd CL Plus	PlainsGold	HRW	48.2	99%	56	99%	30
Brawl CL Plus	PlainsGold	HRW	47.7	98%	58	102%	30
Fortify SF	PlainsGold	HRW	47.6	97%	58	102%	29
CO16SF032	Colorado State University exp.	HRW	47.1	96%	57	101%	31
Guardian	PlainsGold	HRW	47.0	96%	57	101%	30
Amplify SF	PlainsGold	HRW	46.6	95%	57	100%	30
Hatcher	PlainsGold	HRW	44.9	92%	56	98%	27
CO16SF067	Colorado State University exp.	HRW	43.0	88%	57	100%	30
		Average	**48.8**	**100%**	**57**	**100%**	**29**

[a]The 3-year average yield and test weight are based on 21 trials (three 2022, nine 2021, and nine 2020 trials). Plant heights are based on 19 trials (three 2022, eight 2021, and eight 2020 trials).

[b]Varieties ranked according to average 3-year yield.

[c]Market class: HRW=hard red winter wheat; **HWW**=hard white winter wheat.

2022 Collaborative On-Farm Test (COFT) Variety Performance Results

Sally Jones-Diamond, Ron Meyer, Michaela Mattes, and Candace Talbert

In the fall of 2021, twenty-eight eastern Colorado wheat producers received seed of six varieties of wheat and planted them in side-by-side strips under the same conditions as the wheat in the rest of the field. Ten viable harvest results were obtained due to drought conditions and hail that occurred during the growing season. The objective of our on-farm testing program is to compare the performance of wheat varieties of interest to Colorado farmers under farmer conditions.

The COFT program is in its 26th year and the majority of Colorado's winter wheat acreage is planted to varieties that have been tested in the program. On-farm testing leads to more rapid replacement of older inferior varieties and wider and faster adoption of improved varieties. The varieties tested in COFT this year fit different farmer needs and readers are encouraged to study the tables in the Description of Winter Wheat Varieties in Eastern Colorado and the Dryland Decision Tree for more information.

The same six entries were included in all tests. All varieties were hard red winters and included: Warhorse, KS Dallas, Kivari AX, Fortify SF, Ray, and a Warhorse/Whistler blend.

KS Dallas is a KSU-Hays release (2019), marketed by the Kansas Wheat Alliance. It was first entered in CSU variety trials in 2020. It shows medium maturity, medium height, average straw strength, moderate to intermediate resistance to stripe rust, good leaf rust resistance, very good wheat streak mosaic virus resistance, and good quality. **Kivari AX** is a CSU release (2020) marketed by PlainsGold. Higher yielding and slightly later maturing than Crescent AX, it shows intermediate reaction to stripe rust and carries wheat curl mite resistance from Byrd parent. The CoAXium® Wheat Production System is based on the Aggressor® herbicide, a different class of compounds from Beyond®, and provides excellent control of winter annual grasses. Kivari AX is sold as certified seed only (CSO), with no saved seed allowed. **Ray** is a Montana State University release being licensed to PlainsGold. It is a dual-purpose forage/grain that is winter hardy, late maturing, tall, and awnless. It is resistant to stripe rust. It is sold as CSO - no saved seed allowed.

Fortify SF is a CSU release (2019). Fortify SF is the first Colorado-bred semi-solid wheat to combat the wheat stem sawfly (WSS). It has a medium-early maturity and carries wheat curl mite resistance. The thickened stem slows the feeding and movement of the WSS larvae to the crown of the plant where it cuts the stem before harvest. It's also CSO, no saved seed allowed. **Warhorse** is a Montana State University release (2013), first entered in CSU Variety Trials in 2014. It carries solid stem trait, conferring some protection against WSS damage. It is planted by some Colorado producers to reduce risk of total crop loss to WSS even though it only yields 80% of CSU trial average yield. Our last entry was a **50/50 mix of Warhorse and Whistler**. The mixture is intended to test the theory that the Warhorse will reduce WSS cutting and reduce the risk of WSS induced lodging, while regaining some yield with Whistler. Whistler is a CSU release (2018), marketed by PlainsGold. It is later maturing, tall, has marginal straw strength, good stripe and stem rust resistance, and carries wheat curl mite resistance from Byrd parent.

COLORADO STATE UNIVERSITY EXTENSION

Summary of 2022 Collaborative On-Farm Test (COFT) Winter Wheat Variety Performance Results

Crops Testing www.csucrops.com

2022 Varieties (ranked left to right by highest yield)

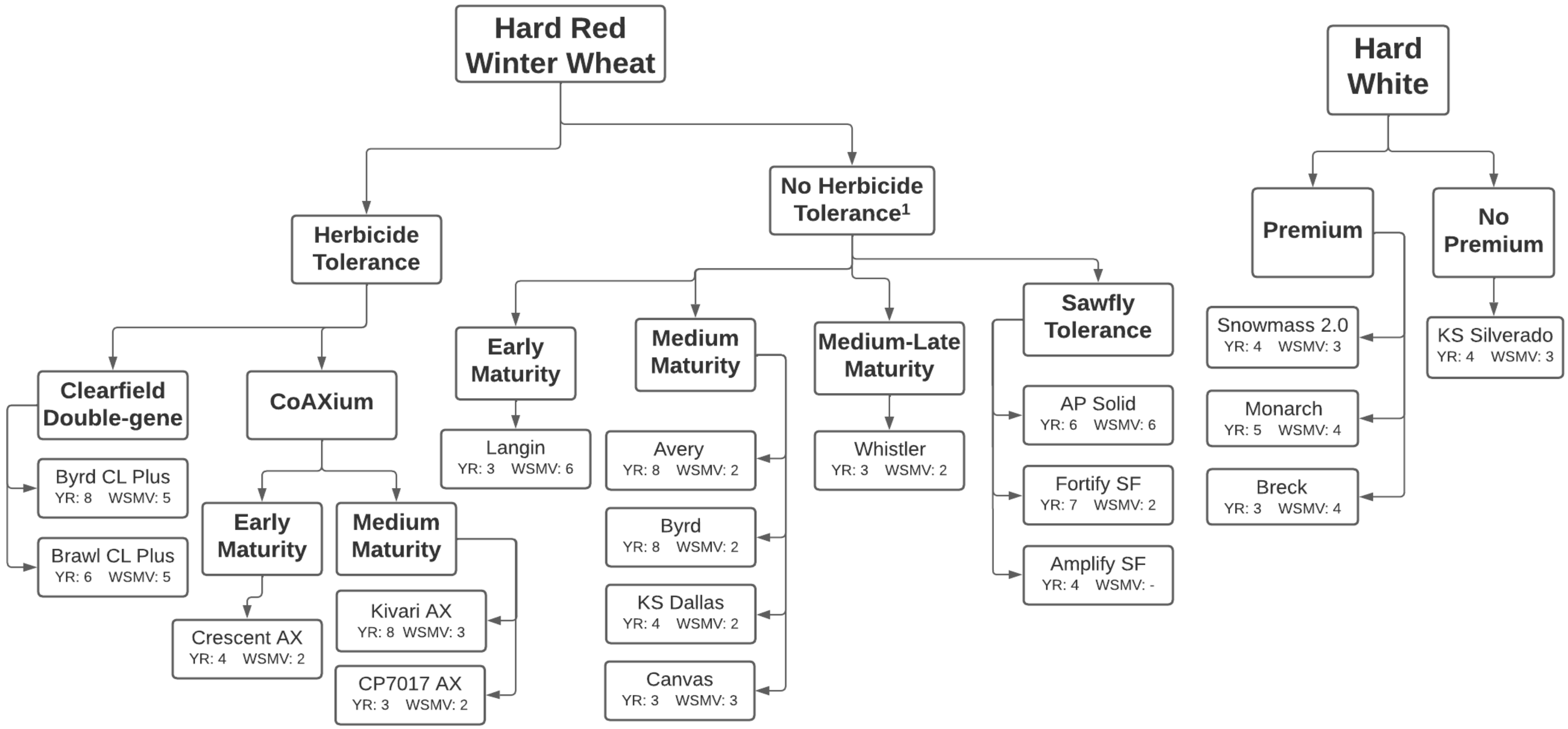
	Kivari AX			KS Dallas			Fortify SF			Warhorse & Whistler Blend (50/50)			Ray			Warhorse			COFT Average		
County/Nearest Town	Yield[a]	Test Weight	Protein	Yield[a]	Test Weight	Protein	Yield[a]	Test Weight	Protein	Yield[a]	Test Weight	Protein	Yield[a]	Test Weight	Protein	Yield[a]	Test Weight	Protein	Yield[a]	Test Weight	Protein
	bu/ac	lb/bu	percent	bu/ac	lb/bu	percent	bu/ac	lb/bu	percent	bu/ac	lb/bu	percent	bu/ac	lb/bu	percent	bu/ac	lb/bu	percent	bu/ac	lb/bu	percent
Adams/Bennett N	50	57	14	52	58	13	48	59	12	43	54	15	31	43	16	38	57	14	**44**	**55**	**14**
Adams/Prospect Valley	28	61	9	26	63	9	26	62	9	23	62	10	18	57	14	21	63	11	**24**	**61**	**10**
Arriba/Lincoln	45	59	12	46	59	13	44	58	12	43	56	14	30	51	15	36	59	15	**41**	**57**	**14**
Eads/Kiowa	33	57	8	24	59	9	25	58	9	28	58	9	30	57	10	26	59	9	**28**	**58**	**9**
Logan/Leroy	35	59	13	32	60	13	31	59	14	27	57	14	29	52	15	28	58	15	**30**	**58**	**14**
Phillips/Haxtun	35	56	15	35	57	16	32	56	15	30	53	17	25	51	18	24	54	18	**30**	**55**	**16**
Sedgwick/Julesburg	32	55	13	31	58	13	25	56	14	26	55	14	22	42	15	19	55	15	**26**	**54**	**14**
Seibert/Kit Carson	59	59	11	53	58	12	52	59	12	52	59	12	49	54	13	41	58	15	**51**	**58**	**13**
Stratton/Kit Carson	44	56	11	53	59	11	44	56	12	38	55	12	33	53	12	19	56	14	**39**	**56**	**12**
Washington/Akron	29	58	13	30	57	14	31	58	14	26	56	15	21	53	16	25	58	15	**27**	**57**	**14**
Average	**38.9**	**57.8**	**11.9**	**38.2**	**58.8**	**12.2**	**35.7**	**58.1**	**12.3**	**33.7**	**56.6**	**13.2**	**28.8**	**51.2**	**14.5**	**27.6**	**57.5**	**14.0**	**33.8**	**56.7**	**13.0**
Yield Significance[b]	A			A			B			C			D			D					

LSD $_{(P<0.30)}$ for yield = 1.9 bu/ac, for test weight = 0.9 lb/bu, and for protein = 0.3 per

[a]All yield and protein data are corrected to 12% moisture.

[b]Yield significance: varieties with different letters have yields that are significantly different from one another.

CSU Fall 2022 Dryland Winter Wheat Decision Tree



YR=stripe rust and WSMV=wheat streak mosaic virus. Rating scale is 1=resistant and 9=susceptible.
[1]No tolerance to herbicides used in Clearfield or CoAXium wheat production systems.
Varieties in each section are listed from highest to lowest yield based on multi-year trial averages.

Colorado State University EXTENSION

Crops Testing

Summary of 2022 Irrigated Winter Wheat Variety Performance Results

Brand/Source	Market Class	Variety[b]	2022 Individual Trial Yield[a]: Burlington	Fort Collins	Wiggins	2022 Multi-Location Average: Yield[c]	Yield	Test Weight	Protein[c]	Heading[d]
			bu/ac	bu/ac	bu/ac	bu/ac	% of avg	lb/bu	%	days from avg.
Kansas Wheat Alliance	**HWW**	KS Silverado	97.0	83.5	66.0	*82.2*	*104%*	*62*	*14.3*	*-4*
PlainsGold	HRW	Canvas	94.5	80.5	69.5	*81.5*	*104%*	*61*	*14.6*	*0*
PlainsGold	**HWW**	Breck	92.0	79.0	**72.0**	*81.0*	*103%*	*62*	*14.8*	*3*
CROPLAN	HRW	CP7017AX	92.5	86.0	64.5	*81.0*	*103%*	*62*	*14.5*	*0*
PlainsGold	**HWW**	Monarch	94.5	83.5	64.5	*80.8*	*103%*	*60*	*13.6*	*2*
PlainsGold	HRW	Crescent AX	97.0	77.0	68.0	*80.7*	*102%*	*61*	*13.9*	*-7*
PlainsGold	HRW	Kivari AX	89.0	84.5	68.0	*80.5*	*102%*	*61*	*13.0*	*-2*
PlainsGold	**HWW**	Windom SF	91.5	74.0	**75.5**	*80.3*	*102%*	*61*	*14.4*	*1*
PlainsGold	**HWW**	Valley	88.0	79.5	**71.5**	*79.7*	*101%*	*60*	*14.3*	*1*
PlainsGold	HRW	Byrd CL Plus	86.0	83.0	63.0	*77.3*	*98%*	*61*	*14.2*	*1*
Oklahoma Genetics, Inc.	HRW	Breakthrough	87.0	73.0	65.5	*75.2*	*95%*	*61*	*14.2*	*0*
PlainsGold	HRW	Brawl CL Plus	99.0	66.0	59.0	*74.7*	*95%*	*61*	*14.9*	*-4*
PlainsGold	HRW	Guardian	86.5	84.0	53.5	*74.7*	*95%*	*61*	*14.9*	*1*
PlainsGold	HRW	Fortify SF	77.0	74.0	**71.5**	*74.2*	*94%*	*60*	*14.5*	*-3*
PlainsGold	HRW	Ray	67.0	81.0	**71.0**	*73.0*	*93%*	*53*	*15.4*	*9*
CROPLAN	HRW	CP7266AX	85.0	72.0	59.5	*72.2*	*92%*	*61*	*14.3*	*0*
PlainsGold	**HWW**	Snowmass 2.0	75.5	69.5	56.5	*67.2*	*85%*	*61*	*14.0*	*2*
Experimentals										
Colorado State University exp.	**HWW**	CO18D007W	**110.5**	84.5	64.5	*86.5*	*110%*	*61*	*14.1*	*0*
Colorado State University exp.	HRW	CO18D297R	98.0	**92.0**	68.5	*86.2*	*109%*	*61*	*14.1*	*1*
Colorado State University exp.	HRW	CO17449R	99.5	80.5	66.5	*82.2*	*104%*	*62*	*14.0*	*3*
Colorado State University exp.	HRW	CO18035RA	97.5	83.5	62.5	*81.2*	*103%*	*60*	*14.0*	*-4*
Colorado State University exp.	HRW	CO18042RA	87.5	**89.5**	63.0	*80.0*	*102%*	*60*	*14.5*	*0*
		Average	**90.5**	**80.0**	**65.6**	**78.7**	**100%**	**61**	**14.3**	**May 26, 2022**
		[e]LSD (0.30)	6.0	2.5	4.5					
		[e]LSD (0.05)	11.5	5.0	9.0					

[a]Varieties in the top LSD yield group in each location are in bold.

[b]Varieties ranked according to released varieties or experimentals, and then by average yield across three trials in 2022.

[c]Yield and protein adjusted to 12% moisture content. Protein averaged across two trials in 2022.

[d]Varieties with positive values headed later than the trial average and varieties with negative values headed earlier than the trial average of May 26th.

[e]Farmers selecting a variety based on yield should use the LSD (0.30) to protect from false negative decisions. Companies or researchers may be interested in the LSD (0.05) to avoid false positive conclusions. Any yield differences among varieties that are less than or equal to the LSD value are not statistically significant.

COLORADO STATE UNIVERSITY EXTENSION

Summary of 2-Year (2021-2022) Irrigated Winter Wheat Variety Performance Results

Crops Testing www.csucrops.com

Variety[b]	Brand/Source	Market Class[c]	2-Year Average[a] Yield	Yield	Test Weight	Test Weight	Plant Height	Protein
			bu/ac	% trial average	lb/bu	% trial average	in	percent
CO18D007W	Colorado State University exp.	**HWW**	93.9	110%	60	100%	29	13.8
CO18D297R	Colorado State University exp.	HRW	88.7	104%	60	99%	29	13.7
KS Silverado	Kansas Wheat Alliance	**HWW**	87.7	103%	61	102%	28	13.7
Monarch	PlainsGold	**HWW**	87.7	103%	59	99%	29	12.8
Canvas	PlainsGold	HRW	86.7	102%	60	100%	29	13.1
CP7017AX	CROPLAN	HRW	86.1	101%	60	100%	27	14.1
Crescent AX	PlainsGold	HRW	85.4	101%	60	100%	32	13.3
Brawl CL Plus	PlainsGold	HRW	84.7	100%	60	100%	31	14.3
Breck	PlainsGold	**HWW**	84.7	100%	61	101%	29	13.9
Snowmass 2.0	PlainsGold	**HWW**	82.0	96%	60	99%	31	12.7
Kivari AX	PlainsGold	HRW	80.6	95%	59	98%	32	12.9
Breakthrough	Oklahoma Genetics, Inc.	HRW	80.2	94%	60	100%	28	14.3
Guardian	PlainsGold	HRW	76.6	90%	60	100%	31	13.9
		Average	**85.0**	**100%**	**60**	**100%**	**30**	**13.6**

[a]The 2-year average yield and test weight are based on six trials (three 2022 and three 2021 trials). Plant heights are based on five trials (three 2022 and two 2021 trials). Protein is based on four trials (two 2022 and two 2021 trials).

[b]Varieties ranked according to average 2-year yield.

[c]Market class: HRW=hard red winter wheat; **HWW**=hard white winter wheat.

COLORADO STATE UNIVERSITY EXTENSION

Summary of 3-Year (2020-2022) Irrigated Winter Wheat Variety Performance Results

Crops Testing www.csucrops.com

			3-Year Average[a]				
Variety[b]	Brand/Source	Market Class[c]	Yield	Yield	Test Weight	Test Weight	Plant Height
			bu/ac	% trial average	lb/bu	% trial average	in
KS Silverado	Kansas Wheat Alliance	**HWW**	85.1	104%	61	102%	29
Canvas	PlainsGold	HRW	84.4	103%	60	100%	29
Monarch	PlainsGold	**HWW**	84.1	103%	59	99%	30
Crescent AX	PlainsGold	HRW	83.0	102%	60	101%	32
CP7017AX	CROPLAN	HRW	82.5	101%	60	100%	29
Breck	PlainsGold	**HWW**	81.1	99%	60	101%	30
Brawl CL Plus	PlainsGold	HRW	81.1	99%	60	101%	31
Snowmass 2.0	PlainsGold	**HWW**	80.4	98%	59	99%	31
Kivari AX	PlainsGold	HRW	79.8	98%	59	98%	32
Guardian	PlainsGold	HRW	75.4	92%	60	100%	31
		Average	**81.7**	**100%**	**60**	**100%**	**30**

[a]The 3-year average yield and test weight are based on nine trials (three 2022, three 2021, and three 2020 trials). Plant heights are based on seven trials (three 2022, two 2021, and two 2020 trials).

[b]Varieties ranked according to average 3-year yield.

[c]Market class: HRW=hard red winter wheat; **HWW**=hard white winter wheat.

Forage Wheats and Triticale Trial Results

Sally Jones-Diamond, Joe Brummer, and Ed Asfeld

The 2021-2022 growing season was the first season we tested winter annual forages for a potential dual-purpose crop. There is little information available on the quality and yield of forage and dual-purpose wheats and triticale as they historically have not been widely grown in our region. It is critical to possess local information about wheat varieties that have favorable forage characteristics with a potential for grain production and vice-versa.

Testing Methods:

We tested four treatments in small plots (6' by 30') next to the regular wheat variety trials at five dryland locations from Burlington to Julesburg. The four treatments were Ray, Willow Creek, T173, and SY 813 (winter triticale). The varieties were planted last fall at Akron, Burlington, Julesburg, Orchard, and Yuma. Forage sub-samples were cut from plots in May or June as each variety reached the early heading stage. We obtained forage wet and dry weights (used to calculate dry matter yield) along with hay forage quality information based on NIR analyses done at CSU. The remainder of the plots were harvested for grain, except for SY 813 to avoid triticale contamination in future wheat fields (these plots were desiccated immediately after forage harvest).

Results:

Out of the five locations that were planted, we were able to harvest forage samples from three sites: Burlington, Julesburg, and Yuma. The Akron and Orchard sites were both lost to drought and wind erosion in early spring. At Burlington, grain yield was not obtained due to a hailstorm that destroyed the trial in mid-June. Forage dry matter yield, moisture at harvest, and quality, along with grain yield from Julesburg and Yuma are shown on the next page.

COLORADO STATE UNIVERSITY EXTENSION

2022 Dryland Winter Forage Variety Performance Trials at Burlington, Julesburg, and Yuma

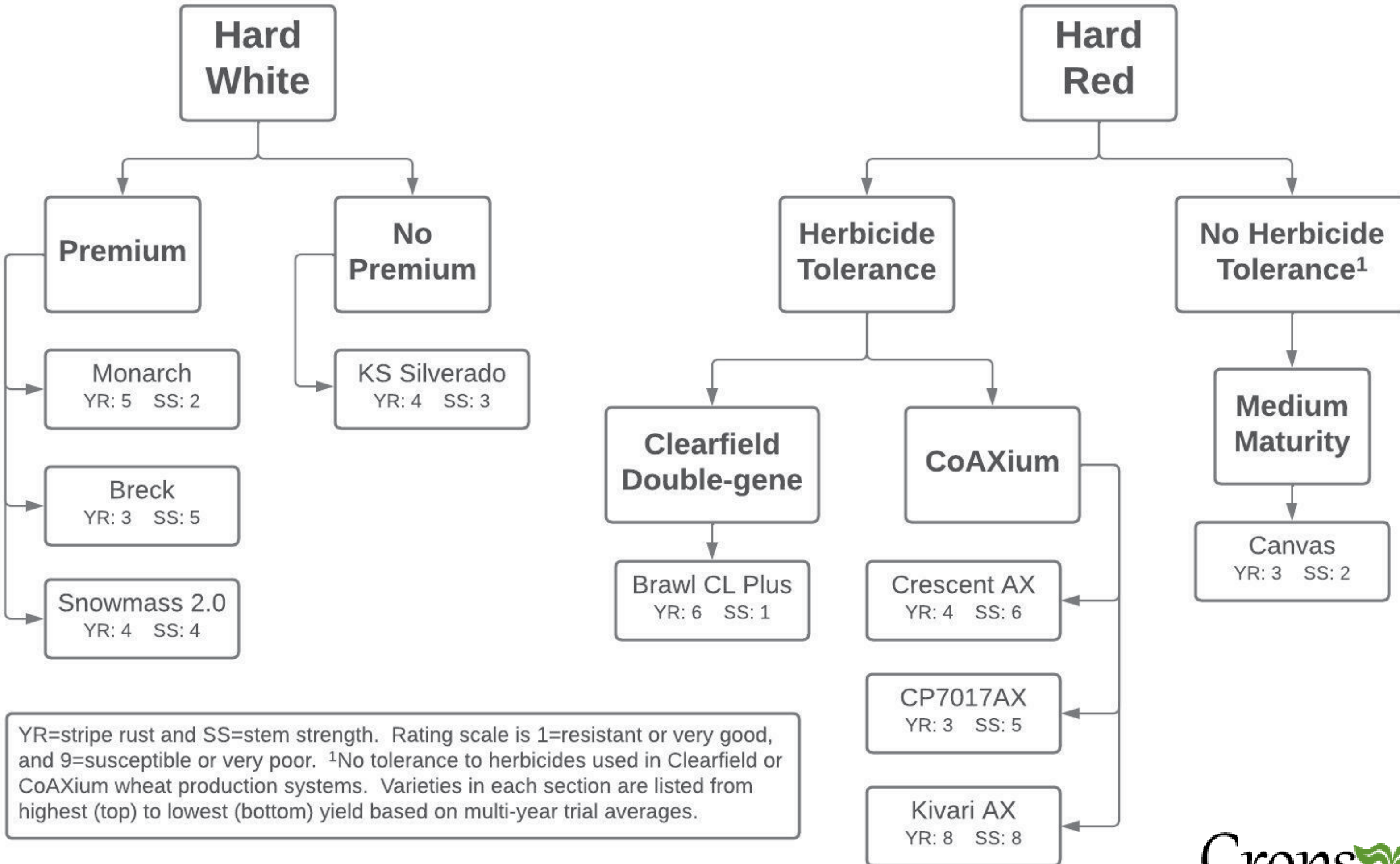
Crops Testing
www.csucrops.com

			Forage Harvest				Forage Quality[a]						
Brand/Source	Cultivar	Forage Type	Grain Yield	Dry Matter Yield	Moisture	Relative Maturity	CP	ADF	aNDF	NDFD48	LIGNIN	IVTDMD48	RFV
			bu/ac	lb/ac	% at harvest	Feekes	percent						
Burlington													
TriCal	SY 813	Winter Triticale	-	**5970**	77	10.5	14.3	28.8	53.4	35.3	2.4	84.4	115.7
PlainsGold	Ray	Winter Wheat	-	4970	74	10.2	15.4	26.2	49.0	35.8	1.6	89.4	129.9
Montana State Univ.	Willow Creek	Winter Wheat	-	4790	64	10.4	12.0	30.6	56.4	35.0	2.3	82.8	107.3
Limagrain	T173	Winter Wheat	-	4650	76	10.2	14.0	28.1	51.9	35.0	2.3	85.0	120.0
		Average		5095	73	10.3	13.9	28.4	52.7	35.3	2.2	85.4	118.2
		LSD (0.30)[b]		591									
		LSD (0.05)[b]		NS			NS	1.6	2.6	NS	0.2	2.2	6.5
Julesburg													
Limagrain	T173	Winter Wheat	**18.5**	3900	69	10.2	10.7	27.4	49.5	35.3	2.1	85.0	127.0
PlainsGold	Ray	Winter Wheat	10.5	4350	68	10.5	10.1	28.9	54.2	35.7	2.2	81.5	113.9
Montana State Univ.	Willow Creek	Winter Wheat	2.5	3390	73	10.1	11.5	28.4	51.7	34.9	2.3	84.3	120.2
TriCal	SY 813	Winter Triticale	-	4130	70	10.5	9.8	28.0	52.1	36.5	2.0	83.3	119.8
		Average	10.5	3943	70	10.3	10.5	28.2	51.9	35.6	2.1	83.5	120.2
		LSD (0.30)[b]	3	NS									
		LSD (0.05)[b]	7	NS			NS	1.3	2.2	0.4	NS	NS	6.9
Yuma													
Limagrain	T173	Winter Wheat	**21.0**	4280	68	10.4	11.8	26.2	49.9	34.7	2.4	84.7	127.6
PlainsGold	Ray	Winter Wheat	**19.0**	4110	64	10.3	12.1	25.6	47.6	34.7	1.9	87.5	134.9
Montana State Univ.	Willow Creek	Winter Wheat	11.5	3840	66	10.2	10.2	30.1	54.9	34.6	2.9	80.2	111.0
TriCal	SY 813	Winter Triticale	-	3920	76	10.5	10.2	27.2	52.4	37.0	1.9	83.9	120.3
		Average	17.2	4038	68	10.4	11.1	27.3	51.2	35.2	2.3	84.1	123.4
		LSD (0.30)[b]	3	NS									
		LSD (0.05)[b]	7	NS			1.4	2.0	2.0	0.8	0.2	2.6	6.8

[a]All forage quality analyses results are dry basis values. CP=crude protein; ADF=acid detergent fiber; aNDF=neutral detergent fiber; NDFD=neutral detergent fiber digestibility at 48 hours; IVTDMD48=in vitro true dry matter digestibility at 48 hours; and RFV=relative forage value.

[b]If the difference between two variety yields equals or exceeds the LSD value, the difference is significant. Farmers selecting a variety based on yield should use the LSD (0.30) to protect from false negative decisions. Companies or researchers may be interested in the LSD (0.05) to avoid false positive conclusions.

CSU Fall 2022 Irrigated Winter Wheat Decision Tree



YR=stripe rust and SS=stem strength. Rating scale is 1=resistant or very good, and 9=susceptible or very poor. [1]No tolerance to herbicides used in Clearfield or CoAXium wheat production systems. Varieties in each section are listed from highest (top) to lowest (bottom) yield based on multi-year trial averages.

Colorado State University EXTENSION

Crops Testing

Important Variety Selection Considerations

Sally Jones-Diamond

It is not possible to accurately predict which variety will perform best in each field every year. However, there are some selection guidelines to improve the ability to select superior varieties. The variety performance summary tables and decision trees in this report provide useful information to farmers for improving variety selections. Other guidelines that improve selections are below.

- Focus on multi-year and location yield summary results when selecting a variety – use results from the three-year variety performance trials or the collaborative on-farm tests. You can also use the wheat variety database, which is an excellent resource found online at www.ramwheatdb.com

- Pay attention to ratings for maturity, disease tolerance, insect resistance, and end-use quality characteristics that are relevant to you. Refer to the Description of Winter Wheat Varieties in Eastern Colorado Dryland and Irrigated Trials (2021-2022) for variety-specific information.

- Control volunteer wheat and weeds to avoid loss of valuable soil moisture and to avoid creating a green bridge. Green bridges can lead to serious virus disease infections vectored by the wheat curl mite (wheat streak mosaic virus, high plains wheat mosaic virus, and triticum mosaic virus) or vectored by aphids (barley yellow dwarf virus and cereal yellow dwarf virus).

- Be aware of current ratings for stripe rust resistance as well as the potential of new races of stripe rust to develop. If variety susceptibility, market prices, expected yield, and fungicide and application costs warrant an application, consult the North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) fungicide efficacy chart.

- Plant treated seed for protection against common bunt (stinking smut) and other seed-borne diseases. Information on seed treatments is available from Kansas State University at: tinyurl.com/jgeznub

- Soil sample to determine optimum fertilizer application rates. Sampling should be done prior to planting. Information on fertilizing winter wheat is available from Colorado State University Extension at: https://tinyurl.com/44fzbvek

- Plant seeds per acre and not pounds per acre. Different varieties and seed lots can vary widely in seed size. Reassess and adjust your seeding rate as necessary when changing varieties, switching seed lots, and as planting season progresses.

Description of Winter Wheat Varieties in Eastern Colorado Dryland and Irrigated Trials (2022-2023)

Name/Class/Pedigree	Origin	HD	HT	SS	COL*	YR	LR	SR	WSMV**	TW	WSS+	PRO++	MILL	BAKE	Comments
Amplify SF Hard red winter Bearpaw/Antero//Antero	CSU 2021	6	7	4	6	4	3	2	6	4	1	5	4	6	CSU release (2021), marketed by PlainsGold. Medium height, medium maturity. Carries the semi-solid stem trait (17 out of 25 rating) for partial resistance to the wheat stem sawfly. Certified seed only.
AP Bigfoot Hard red winter Undisclosed	AgriPro 2022	3	4	3	3	4	2	2	4	1	--	--	4	6	Agripro release (2021). First entered in CSU variety trials in 2022. Early to med-early variety with very good test weight and WSMV tolerance.
AP Roadrunner Hard red winter Undisclosed	AgriPro 2020	6	4	4	1	2	3	8	4	7	7	4	3	3	Agripro release (2020). First entered in CSU variety trials in 2020. Medium-late variety with good winter hardiness and resistance to WSMV. Good leaf and stripe rust resistance.
AP Solid Hard red winter Undisclosed	AgriPro 2021	8	2	2	4	6	6	5	5	2	1	3	1	4	Agripro release (2021). First entered in CSU variety trials in 2020. Medium-late semi-solid stem variety for use in managing wheat stem sawfly. Very good test weight and straw strength.
Avery Hard red winter TAM 112/Byrd	CSU 2015	6	7	8	5	8	8	8	2	5	6	6	4	3	CSU release (2015), marketed by PlainsGold. Doubled haploid-derived line, similar to Byrd with higher yield potential, larger kernels and slightly improved quality. Carries wheat curl mite resistance from TAM 112 parent. Susceptible to stripe rust.
Brawl CL Plus Hard red winter Teal 11A/Above//CO99314	CSU 2011	2	7	1	7	6	6	7	5	4	6	1	3	3	CSU release (2011), marketed by PlainsGold. Two-gene Clearfield wheat. Excellent test weight, straw strength, milling and baking quality. Early maturity, medium height, long coleoptile. Intermediate reaction to both stripe rust and leaf rust. Certified seed only.
Breck Hard white winter Denali/HV9W07-482W//Antero	CSU 2017	5	7	6	7	3	5	2	4	2	7	2	2	3	CSU release (2017), marketed by PlainsGold in CWRF-Ardent Mills UltraGrain Premium Program. Good stripe rust resistance, sprouting tolerance, straw strength, grain protein deviation, and quality. Very high test weight, lower polyphenol oxidase (PPO) activity for improved whole grain bread and noodle quality. Certified seed only.
Byrd Hard red winter TAM 112/CO970547-7	CSU 2011	4	6	6	4	8	7	8	2	5	8	5	4	3	CSU release (2011), marketed by PlainsGold. Excellent drought tolerance (from TAM 112) and quality. Average test weight and straw strength. Moderately susceptible to stripe rust. Carries wheat curl mite resistance from TAM 112 parent.
Byrd CL Plus Hard red winter CO06072/4*Byrd	CSU 2018	5	8	3	4	8	5	8	5	5	3	6	5	5	CSU release (2018), marketed by PlainsGold. Two-gene Clearfield wheat in Byrd background. Highly similar to Byrd with exception of tolerance to Beyond herbicide. Has shown some non solid-stem based tolerance to wheat stem sawfly. Certified seed only.

Column Key - heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), stem rust resistance (SR), wheat streak mosaic virus tolerance (WSMV), wheat stem sawfly tolerance (WSS), test weight (TW), protein (PRO), milling (MILL) and baking quality (BAKE). Rating scale: 1 - very good, very resistant, very early, or very short to 9 - very poor, very susceptible, very late, or very tall/long.

* Coleoptile length ratings range from 1=very short (~ 50 mm or ~2 in) to 9=very long (~100 mm or ~4 in). Coleoptile lengths should be interpreted for relative variety comparisons only.
** WSMV ratings are based on field evaluations in Colorado under pressure from wheat curl mite transmitted viruses. Scores may reflect both resistance to the wheat curl mite and resistance to mite-transmitted viruses.
+WSS ratings are based on field evaluation of tolerance to wheat stem sawfly cutting in Colorado. Values do not represent the level of stem solidness expression.
++ PRO ratings represent "grain protein deviation" (relative grain protein level accounting for differences in grain yield).

Description of Winter Wheat Varieties in Eastern Colorado Dryland and Irrigated Trials (2022-2023)

Name/Class/Pedigree	Origin	HD	HT	SS	COL*	YR	LR	SR	WSMV**	TW	WSS+	PRO++	MILL	BAKE	Comments
Canvas Hard red winter Denali/Antero//Byrd	CSU 2018	6	3	2	6	3	6	2	3	4	5	4	3	3	CSU release (2018), marketed by PlainsGold. Hard red winter, medium maturing, medium-short, good straw strength. Good stripe and stem rust resistance and carries wheat curl mite resistance from Byrd parent. Good test weight and milling and baking quality.
CO18035RA Hard red winter (AF28/Byrd//AF26/Byrd)//2*Byrd/(AF28/Byrd//AF10 M3/2*Byrd)//2*Byrd/Byrd//(AF10 M3/2*Byrd//AF26/Byrd)//2*Byrd/(AF28/Byrd//AF26/Byrd)//2*Byrd/Langin	CSU EXP	2	5	5	4	4	7	6	4	5	6	4	3	2	CSU experimental line. Three gene CoAXium wheat for winter annual grassy weed control. Acidic soil tolerance. Wheat curl mite resistance from Byrd. Very good milling and baking quality. Potential release in 2023.
CO18042RA Hard red winter (AF28/Byrd//AF26/Byrd)//2*Byrd/(AF28/Byrd//AF10 M3/2*Byrd)//2*Byrd/Byrd//(AF10 M3/2*Byrd//AF26/Byrd)//2*Byrd/(AF28/Byrd//AF26/Byrd)//2*Byrd/Langin	CSU EXP	5	6	6	5	2	--	6	4	5	6	6	3	2	CSU experimental line. Three gene CoAXium wheat for winter annual grassy weed control. Acidic soil tolerance. Wheat curl mite resistance from Byrd and excellent stripe rust resistance. Very good milling and baking quality. Potential release in 2023.
CO18D007W Hard white winter CO12D906/CO07W722-F5	CSU EXP	4	4	1	5	4	6	1	4	5	8	2	2	3	CSU experimental line. Hard white winter wheat. Excellent straw strength and overall performance in irrigated and dryland environments. Very good milling and baking. Potential release in 2023.
CO18D297R Hard red winter CO12D906/CO11D1353//Monarch	CSU EXP	5	6	6	6	2		1	5	3	8	3	2	3	CSU experimental line. Good overall performance and excellent resistance to stripe rust. Very good milling and baking quality. Potential release in 2023.
CP7017AX Hard red winter Undisclosed	Croplan 2020	4	3	8	4	3	4	1	2	4	6	6	2	6	CROPLAN by WinField United release (2020). First entered into CSU trials in 2020. CoAXium wheat for winter annual grassy weed control. Strong yield potential, strong drought tolerance, tolerates acid soils and resistant to soilborne mosaic virus. Certified seed only.
CP7266AX Hard red winter Undisclosed	Croplan EXP	5	5	1	6	2	1	5	--	5	--	6	3	5	CROPLAN by WinField United release (2021). First entered into CSU trials in 2022. CoAXium wheat for winter annual grassy weed control.
Crescent AX Hard red winter (AF28/Byrd)//(AF10/2*Byrd)	CSU 2018	3	7	7	4	4	6	--	2	4	6	7	3	3	CSU release (2018), marketed by PlainsGold. CoAXium wheat for winter annual grassy weed control. Approximately 66% Byrd and 34% Hatcher parentage. Earlier and much improved yield and test weight relative to Incline AX. Intermediate reaction to stripe rust and carries wheat curl mite resistance from Byrd parent. Certified seed only.
Fortify SF Hard red winter Byrd/Bearpaw//Byrd	CSU 2019	4	6	5	4	7	7	4	2	3	2	5	5	6	CSU release (2019), marketed by PlainsGold. Medium height, medium maturity. Carries wheat curl mite resistance from Byrd parent and semi-solid stem trait (13 out of 25 rating) for partial resistance to the wheat stem sawfly. Certified seed only.

Column Key - heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), stem rust resistance (SR), wheat streak mosaic virus tolerance (WSMV), wheat stem sawfly tolerance (WSS), test weight (TW), protein (PRO), milling (MILL) and baking quality (BAKE). Rating scale: 1 - very good, very resistant, very early, or very short to 9 - very poor, very susceptible, very late, or very tall/long.

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+WSS ratings are based on field evaluation of tolerance to wheat stem sawfly cutting in Colorado. Values do not represent the level of stem solidness expression.
++ PRO ratings represent “grain protein deviation” (relative grain protein level accounting for differences in grain yield).

Description of Winter Wheat Varieties in Eastern Colorado Dryland and Irrigated Trials (2022-2023)

Name/Class/Pedigree	Origin	HD	HT	SS	COL*	YR	LR	SR	WSMV**	TW	WSS+	PRO++	MILL	BAKE	Comments
Guardian Hard red winter Antero/Snowmass//Byrd	CSU 2019	6	7	7	5	3	4	2	1	3	7	2	4	3	CSU release (2019), marketed by PlainsGold. Medium height, medium maturity. Excellent resistance to WSMV due to combination of resistance to wheat curl mite and the virus itself. Good combined resistance to all three rusts, good test weight, good milling and baking quality, high grain protein deviation. Certified seed only.
Hatcher Hard red winter Yuma/PI 372129//TAM-200/3/4*Yuma/4/KS91H184/Vista	CSU 2004	5	4	6	4	4	7	3	6	6	4	7	5	4	CSU release (2004), marketed by PlainsGold. Medium maturing semi-dwarf. Good test weight, moderate resistance to stripe rust, good milling and baking quality. Develops "leaf speckling" condition.
Kivari AX Hard red winter (AF28/Byrd)//(AF10/2*Byrd)	CSU 2020	6	6	8	5	8	8	5	3	6	5	8	5	3	CSU release (2020), marketed by PlainsGold. CoAXium wheat for winter annual grassy weed control. Higher yielding and slightly later maturing than Crescent AX. Intermediate reaction to stripe rust and carries wheat curl mite resistance from Byrd parent. Certified seed only.
KS Big Bow Hard white winter KS050223M-2/KS11W15	KS-Manhattan 2022	5	5	4	3	4	--	2	2	3	--	5	4	4	KSU release (2022), marketed by the Kansas Wheat Alliance. First tested in 2023. Medium maturity and medium height. Resistant to WSMV.
KS Dallas Hard red winter KS08HW112-6//TX03A0148/Danby TR	KS-Hays 2019	5	4	7	7	4	2	1	2	4	5	4	3	3	KSU release (2019), marketed by the Kansas Wheat Alliance. First entered in CSU variety trials in 2020. Medium maturity, medium height, average straw strength, medium-long coleoptile, moderate to intermediate resistance to stripe rust, good leaf rust resistance, very good wheat streak mosaic virus resistance, good quality.
KS Hamilton Hard red winter KS08HW176-4//Bill Brown/KS08HW61-2	KS-Hays 2020	5	1	5	3	5	5	4	3	5	3	4	5	5	KSU release (2020), marketed by the Kansas Wheat Alliance. First entered in CSU variety trials in 2020. Medium maturity, medium height, and good resistance to WSMV. Intermediate reaction to stripe rust and leaf rust.
KS Silverado Hard white winter KS05HW122-5-2//KS05HW15-2-2/KS06HW46-3	KS-Hays 2019	2	2	3	5	4	2	2	3	1	6	3	3	3	KSU release (2019), marketed by the Kansas Wheat Alliance. First entered in CSU variety trials in 2020. Early maturity, medium-short, good straw strength, good to moderate resistance to stripe rust, leaf rust, and wheat streak mosaic virus. Good test weight, good milling and baking quality, good pre-harvest sprouting tolerance.
KS Territory Hard red winter KS11HW15/TX10A001006	KS-Hays 2022	5	5	1	3	4	4	4	2	5	--	5	4	4	KSU release (2022), marketed by the Kansas Wheat Alliance. First tested in the trial in 2023. Medium maturity, excellent straw strength, and resistant to WSMV and Triticum mosaic virus (TriMV).
Langin Hard red winter CO050270/Byrd	CSU 2016	1	4	8	4	3	6	8	6	5	6	6	5	2	CSU release (2016), marketed by PlainsGold. Early maturing semi-dwarf. Good drought stress tolerance and winter hardiness, stripe rust resistance, and quality. Medium coleoptile. Carries wheat curl mite resistance from Byrd parent. Very high yield potential for irrigation, but straw strength requires use of growth regulator.

Column Key - heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), stem rust resistance (SR), wheat streak mosaic virus tolerance (WSMV), wheat stem sawfly tolerance (WSS), test weight (TW), protein (PRO), milling (MILL) and baking quality (BAKE). Rating scale: 1 - very good, very resistant, very early, or very short to 9 - very poor, very susceptible, very late, or very tall/long.

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Description of Winter Wheat Varieties in Eastern Colorado Dryland and Irrigated Trials (2022-2023)

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LCS Atomic AX Hard red winter Undisclosed	Limagrain 2019	2	5	3	3	1	2	9	--	4	8	4	2	4	Limagrain release (2019), first entered in CSU Variety Trials in 2021. CoAXium wheat for winter annual grassy weed control. Excellent straw strength and resistance to stripe rust. Certified seed only.
LCS Steel AX Hard red winter LCH13KSDH-20-87 / ACC 7-38	Limagrain 2021	9	7	1	5	8	2	8	--	3	--	--	3	5	Limagrain release (2021). First entered into the trials in 2023. CoAXium wheat for winter annual grass weed control. Broad adaptation, very good leaf rust resistance and excellent straw strength. Certified seed only.
Monarch Hard white winter CO07W722-F5/Snowmass//CO07W722-F5	CSU 2018	6	2	3	5	5	5	2	4	4	3	7	5	4	CSU release (2018), marketed by PlainsGold. Hard white winter with excellent straw strength and very high irrigated yield potential. Good stripe rust resistance. Quality more similar to Breck, but very low PPO. Certified seed only.
MS Maverick Hard red winter Undisclosed	Meridian Seeds 2022	7	5	3	5	1	1	3	--	2	--	5	3	5	Meridian Seeds Release (2021). Good overall disease package. Good grain quality
Ray Hard red winter Yellowstone*2/98X168E1	MT State 2018	9	9	7	3	2	--	8	--	6	--	4	4	4	Forage line available through the PlainsGold Brand with improved grain yield compared to other forage varieties.
Snowmass 2.0 Hard white winter CO07W722-F5/Snowmass//Brawl CL Plus	CSU 2018	3	4	4	5	4	5	1	3	5	5	4	4	1	CSU release (2018), marketed by PlainsGold in CWRF-Ardent Mills Ultragrain Premium Program. Hard white wheat, quality profile very similar to Snowmass but low PPO and better grain protein deviation. Good stripe and stem rust resistance and wheat streak mosaic virus resistance. Good straw strength, good test weight. Certified seed only.
Steamboat Hard red winter TAM 114/Antero//Byrd	CSU 2020	6	9	7	6	3	3	3	2	3	5	6	3	4	CSU release (2020), marketed by Crop Research Foundation of Wyoming. Medium maturing, tall, marginal straw strength. Good resistance to all three rusts and carries resistance to the wheat curl mite from Byrd. Good test weight and milling and baking quality.
Sunshine Hard white winter KS01HW152-6/HV9W02-267W	CSU 2014	3	6	7	5	5	6	2	7	6	6	4	4	3	CSU release (2014), marketed by PlainsGold in CWRF-Ardent Mills Ultragrain Premium Program. Hard white wheat. Excellent quality, good sprouting tolerance and straw strength, intermediate reaction to stripe rust. Very susceptible to mite-transmitted viruses. Certified seed only.
SY Legend CL2 Hard red winter Agripro Exp/AP503 CL2 sib	AgriPro 2018	4	3	5	2	3	3	--	4	5	7	2	6	5	Agripro release (2018), first entered in CSU trials in 2018. Two-gene clearfield herbicide tolerance technology. Medium early and medium tall with good test weight. Above average leaf disease package.

Column Key - heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), stem rust resistance (SR), wheat streak mosaic virus tolerance (WSMV), wheat stem sawfly tolerance (WSS), test weight (TW), protein (PRO), milling (MILL) and baking quality (BAKE). Rating scale: 1 - very good, very resistant, very early, or very short to 9 - very poor, very susceptible, very late, or very tall/long.

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Description of Winter Wheat Varieties in Eastern Colorado Dryland and Irrigated Trials (2022-2023)

Name/Class/Pedigree	Origin	HD	HT	SS	COL*	YR	LR	SR	WSMV**	TW	WSS+	PRO++	MILL	BAKE	Comments
SY Wolverine Hard red winter Everest/Platte//SY Wolf	Agripro 2019	4	1	2	5	4	2	2	4	5	6	2	2	6	Agripro release (2019), first entered in CSU trials in 2019. Good overall disease resistance, good straw strength. Similar to SY Wolf in reaction to wheat streak mosaic virus. Good test weight. Certified seed only.
Valley Hard white winter CO07W722-F5/Antero//Snowmass	CSU 2022	6	6	4	3	3	6	4	4	5	4	4	6	1	CSU release (2018) marketed by PlainsGold in CWRF-Ardent Mills Ultragrain Premium Program. White-seeded with excellent quality and good pre-harvest sprouting tolerance. Moderately resistant to stripe, leaf, and stem rust. Medium height and medium maturity.
Whistler Hard red winter CO08W218/Snowmass//Byrd	CSU 2018	7	8	9	5	3	6	1	2	6	6	5	7	3	CSU release (2018), marketed by PlainsGold. Hard red winter, later maturing, tall, marginal straw strength. Good stripe and stem rust resistance and carries wheat curl mite resistance from Byrd parent. Very good milling and baking quality.
Windom SF Hard white winter Warhorse/Breck//CO12D1028	CSU 2022	5	4	5	7	6	8	1	3	2	1	5	2	2	CSU release (2021), marketed by PlainsGold in CWRF-Ardent Mills Ultragrain Premium Program. White-seeded with strong mixing and baking properties. Semi-solid stem (16/25) for partial resistance to the wheat stem sawfly. Wsm2 for resistance to wheat streak mosaic virus. Very good test weight, long coleoptile, tolerance to lower pH. Certified

Column Key - heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), stem rust resistance (SR), wheat streak mosaic virus tolerance (WSMV), wheat stem sawfly tolerance (WSS), test weight (TW), protein (PRO), milling (MILL) and baking quality (BAKE). Rating scale: 1 - very good, very resistant, very early, or very short to 9 - very poor, very susceptible, very late, or very tall/long.

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Wheat Quality Evaluations from the 2022 CSU Dryland and Irrigated Variety Trials

John Stromberger, Esten Mason, and Sally Jones-Diamond

Introduction

End-use quality maintenance and improvement is an important objective of virtually all wheat breeding programs. Grain milling and product manufacturing industries have become increasingly sophisticated in both domestic and export markets and, while wheat producers may not always be rewarded for improved functional quality, technological advancements promise to increase the ability of the grain trade to identify and source good quality and discount poor quality wheat.

Breeding for wheat end-use quality is relatively complex in comparison to many other breeding objectives. Quality is a function of variety interacting with climate and agronomic practices and Colorado's harsh and variable climatic conditions often negatively impact quality. Quality assessment is commonly done through evaluation of multiple traits with many underlying genetic factors controlling their expression. Most experimental quality tests only approximate average quality needs of product manufacturers and don't exactly match specific requirements of different wheat product types and processes. For hard winter wheat, high grain protein content is an important criterion for baking quality but may be indicative of varieties with lower yield, if yield differences at a given location are not taken into account (through “grain protein deviation”). Finally, wheat quality testing must accommodate the reality of large sample numbers and small sample sizes that are typical of all wheat breeding programs. Despite these challenges, standard testing methodologies have been developed that are consistent, repeatable, and can be done on large numbers of relatively small samples. These analyses provide reliable assessments of functional quality characteristics for a broad array of potential product types and processes.

Our objective with providing quality data and summaries for entries in the CSU dryland and irrigated variety trials is to characterize the quality of public and private trial entries that are currently, or have the potential to be, marketed in Colorado. We hope that the data and resulting ratings will be included among the criteria by which wheat producers choose their varieties. At the very least, we encourage producers to carefully consider avoiding varieties that have lower wheat quality when other agronomically acceptable varieties with better quality are available.

Testing Methodology

In 2022, grain samples were collected from each of the dryland (UVPT) and irrigated (IVPT) variety trial locations. Preliminary small-scale quality analyses were carried out to determine suitability of each location for full-scale analyses. The selection criteria includes grain protein content not too far below or above 11.5%, sound grain that is free of visual defects, and good discrimination among samples at a given location for experimental dough mixing properties (using the Mixograph). In this process of sample selection, the following locations were retained for full scale testing:

UVPT – Arapaho, Julesburg, Roggen, Sheridan Lake

IVPT – Burlington, Fort Collins

Using standard protocols, analyses were done in the CSU Wheat Quality Laboratory on samples from the remaining locations. These tests, reported in the attached tables, include the following:

Milling-Related Traits

- Test weight: obtained by standard methodology on a cleaned sample of the harvested grain.
- Grain protein and protein recovery: obtained using near-infrared reflectance spectroscopy (NIRs) with a Foss NIRS™ DA1650 Feed and Forage analyzer. Grain protein is reported on a standard 12% moisture basis. High grain protein content is associated with higher water absorption of flours and higher loaf volumes in the bakery. Protein recovery represents the numerical difference between grain and flour protein content and a value closer to zero is most desirable by the milling industry.
- Single kernel characterization system (SKCS): the Perten SKCS 4100 provides data on kernel weight and hardness of a grain sample. From 100-300 kernels are analyzed to provide an average value and a measure of variability for each trait. Millers prefer a uniform sample with heavier (>30 grams per 1000 kernels, or <15,133 seeds per pound) kernels for improved milling performance. Hardness should be representative of the hard winter wheat class (60-80 hardness units).
- Flour yield: obtained using a modified Brabender Quadrumat Milling System. Flour yield represents the percentage of straight grade flour obtained from milling a grain sample (approximately one pound). In general, millers prefer high flour extraction values. Due to variation among different milling systems, valid comparison of values from different mills and establishment of a single target value is not possible.

Baking-Related Traits

- Mixograph mixing time and tolerance: obtained using a National Manufacturing Computerized Mixograph. The Mixograph measures the resistance of dough during the mixing process. Bakers generally prefer flours with moderate mixing time requirements (between 3 and 6 minutes) and good tolerance to breakdown of the dough with over-mixing (subjective score >3). Some varieties with exceptionally long mixing times (i.e., Snowmass) may not compare favorably with other varieties in conventional evaluations but have unique characteristics that merit handling in an identity-preserved program such as with the CWRF Ardent Mills Ultragrain® Premium Program.
- Pup loaf bake test: using a 100-gram straight-dough test, data on bake water absorption, mixing time, loaf volume, and crumb characteristics are obtained. In general, bakers prefer higher water absorption (> 62%), high loaf volume (> 850 cubic centimeters), and higher crumb grain and crumb color scores (score > 3). The crumb grain and color scores are subjective assessments of the color, size, shape, and structure of the small holes in a slice of bread.

Composite Scores

Because none of the traits measured can be used alone to represent overall milling or baking quality, development of a composite score has proven useful as a means to differentiate and characterize overall quality of different samples. The development of a composite score also has the advantage of accounting for differences in environmental conditions from year to year and utilizing all of the data generated on the samples collected at a given trial location.

Composite scores are generated through a two-step process. First, each trait is ranked from high to low (or "very good" to "very poor") at individual locations and a score from 1=very good to 9=very bad is assigned to each variety for each trait depending on the optimal orientation of the trait.

Second, these individual-trait scores are used to generate a composite score that weights the trait scores by the relative importance of that trait to overall milling or baking quality. The weights that we have used are similar to those developed by the USDA-ARS Hard Winter Wheat Quality Laboratory for the Wheat Quality Council evaluations. These weights are as follows:

Milling – test weight 30%, grain protein content 10%, protein recovery 10%, kernel weight 20%, grain hardness 10%, flour yield 20% (100% total)

Baking – bake absorption 20%, Mixograph mixing time 20%, Mixograph tolerance 20%, loaf volume 20%, crumb color 10%, crumb grain 10% (100% total)

Summary of composite milling and baking quality scores from four 2022 Uniform Variety Trial – (UVPT) Southern locations. Entries are ranked in ascending order (from 1=good to 9=poor) by the average baking quality score across all locations.

	Milling Quality Scores			Baking Quality Scores		
Entry	Julesburg	Roggen	Average	Julesburg	Roggen	Average
Snowmass 2.0	4	4	4.0	1	1	1.0
Guardian	2	1	1.5	1	2	1.5
KS Dallas	1	2	1.5	2	1	1.5
Ray	6	5	5.5	2	1	1.5
Windom SF	1	1	1.0	1	2	1.5
Byrd	4	4	4.0	3	1	2.0
CO18035RA	4	3	3.5	3	2	2.5
CO18042RA	4	4	4.0	2	3	2.5
Sunshine	2	3	2.5	3	2	2.5
Valley	5	4	4.5	4	1	2.5
Avery	3	2	2.5	3	3	3.0
Brawl CL Plus	1	1	1.0	3	3	3.0
Canvas	1	1	1.0	3	3	3.0
CO16D402W	3	1	2.0	3	3	3.0
AP Roadrunner	5	5	5.0	4	3	3.5
CO18D007W	2	2	2.0	4	3	3.5
Crescent AX	3	3	3.0	4	3	3.5
Whistler	3	4	3.5	4	3	3.5
Breck	1	1	1.0	6	2	4.0
CO18D297R	3	3	3.0	5	3	4.0
Monarch	3	4	3.5	5	3	4.0
Kivari AX	2	1	1.5	5	4	4.5
Langin	4	5	4.5	5	4	4.5
CO18D076W	1	2	1.5	6	4	5.0
KS Silverado	1	1	1.0	5	5	5.0
Byrd CL Plus	3	3	3.0	6	5	5.5
Hatcher	4	4	4.0	6	5	5.5
MS Maverick	1	4	2.5	7	4	5.5
Steamboat	2	2	2.0	7	4	5.5
AP Solid	2	1	1.5	6	6	6.0
CO17449R	2	3	2.5	7	5	6.0
KS Hamilton	4	2	3.0	7	5	6.0
Amplify SF	3	2	2.5	7	6	6.5
AP Bigfoot	3	3	3.0	8	6	7.0
CO16SF032	3	1	2.0	8	6	7.0
Fortify SF	2	3	2.5	8	6	7.0
CP7266AX	3	4	3.5	7	8	7.5
SY Legend CL2	5	4	4.5	8	7	7.5
CO16SF067	4	1	2.5	8	8	8.0
CP7017AX	3	2	2.5	9	8	8.5

Summary of composite milling and baking quality scores from four 2022 Uniform Variety Trial – (UVPT) northern locations. Entries are ranked in ascending order (from 1=good to 9=poor) by the average baking quality score across all locations.

	Milling Quality Scores			Baking Quality Scores		
Entry	Arapahoe	Sheridan Lake	Average	Arapahoe	Sheridan Lake	Average
Snowmass 2.0	4	3	3.5	1	1	1.0
Windom SF	1	3	2.0	1	1	1.0
KS Dallas	1	2	1.5	1	2	1.5
CO18D007W	2	1	1.5	3	1	2.0
Sunshine	3	4	3.5	3	1	2.0
Valley	4	3	3.5	1	3	2.0
Breakthrough	2	5	3.5	3	3	3.0
Breck	1	1	1.0	3	3	3.0
Canvas	1	1	1.0	3	3	3.0
CO16D402W	3	4	3.5	2	4	3.0
CO18035RA	-	6	6.0	-	3	3.0
Whistler	4	2	3.0	5	1	3.0
Byrd	5	6	5.5	4	3	3.5
Crescent AX	2	2	2.0	4	3	3.5
Guardian	2	2	2.0	5	2	3.5
Kivari AX	2	1	1.5	5	2	3.5
Ray	6	6	6.0	4	3	3.5
Avery	2	3	2.5	5	3	4.0
CO18D297R	3	3	3.0	5	3	4.0
KS Silverado	2	3	2.5	4	4	4.0
Langin	3	3	3.0	6	2	4.0
Monarch	4	3	3.5	3	5	4.0
CO18042RA	3	3	3.0	5	4	4.5
CO18D076W	3	3	3.0	5	4	4.5
Steamboat	2	4	3.0	4	5	4.5
AP Roadrunner	4	2	3.0	6	4	5.0
Hatcher	2	4	3.0	5	5	5.0
MS Maverick	4	4	4.0	6	4	5.0
Brawl CL Plus	1	2	1.5	7	4	5.5
KS Hamilton	2	3	2.5	6	5	5.5
CO16SF067	2	1	1.5	6	6	6.0
Byrd CL Plus	4	3	3.5	7	6	6.5
CO17449R	1	1	1.0	8	5	6.5
CP7266AX	2	4	3.0	8	5	6.5
Fortify SF	2	5	3.5	7	6	6.5
Amplify SF	3	1	2.0	8	6	7.0
CO16SF032	3	2	2.5	8	7	7.5
CP7017AX	2	1	1.5	9	6	7.5

Summary of composite milling and baking quality scores from 2022 Irrigated Variety Trial (IVPT) locations. Entries are ranked in ascending order (from 1=good to 9=poor) by the average baking quality score across all trial locations.

	Milling Quality Scores			Baking Quality Scores		
Entry	Burlington	Fort Collins	Average	Burlington	Fort Collins	Average
Snowmass 2.0	3.0	3.0	3.0	1.0	1.0	1.0
Ray	7.0	5.0	6.0	2.0	1.0	1.5
CO18035RA	2.0	2.0	2.0	1.0	3.0	2.0
Valley	6.0	3.0	4.5	1.0	3.0	2.0
CO18042RA	4.0	2.0	3.0	1.0	4.0	2.5
Kivari AX	2.0	1.0	1.5	3.0	3.0	3.0
Crescent AX	3.0	3.0	3.0	4.0	3.0	3.5
Breakthrough	4.0	3.0	3.5	3.0	5.0	4.0
Canvas	1.0	1.0	1.0	3.0	5.0	4.0
CP7266AX	4.0	3.0	3.5	4.0	4.0	4.0
Windom SF	2.0	2.0	2.0	3.0	5.0	4.0
CO18D297R	2.0	2.0	2.0	4.0	5.0	4.5
Guardian	2.0	1.0	1.5	3.0	6.0	4.5
Breck	1.0	1.0	1.0	4.0	6.0	5.0
Monarch	2.0	4.0	3.0	3.0	7.0	5.0
Brawl CL Plus	2.0	4.0	3.0	5.0	6.0	5.5
KS Silverado	1.0	2.0	1.5	7.0	4.0	5.5
Byrd CL Plus	3.0	3.0	3.0	6.0	6.0	6.0
CO17449R	2.0	2.0	2.0	6.0	7.0	6.5
CO18D007W	2.0	2.0	2.0	8.0	6.0	7.0
CP7017AX	2.0	2.0	2.0	7.0	8.0	7.5
Fortify SF	3.0	1.0	2.0	9.0	6.0	7.5

Wheat Milling and Baking Quality Data - 2022 IVPT Burlington

* **Bold** indicates superior value, underlined indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Protein Recovery	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
Brawl CL Plus	59.7	14.0	**28.9**	67.5	71.1	-1.1	63.3	3.27	2	1075	4	**5**	**2**	5
Breakthrough	59.9	13.4	**27.5**	69.8	68.3	-1.1	64.1	4.37	4	1090	**5**	4	4	**3**
Breck	**60.8**	14.0	**28.9**	66.6	71.3	-0.8	63.2	3.24	2	**1175**	**5**	3	**1**	4
Byrd CL Plus	57.9	13.5	**26.4**	61.2	71.3	-1.2	63.1	3.60	3	995	3	3	**3**	6
Canvas	59.1	14.1	**26.3**	63.3	**72.5**	-1.1	63.2	4.42	4	1135	4	**5**	**1**	**3**
CO17449R	59.6	12.9	**30.4**	61.5	71.0	**-0.8**	61.3	3.29	1	1095	4	4	**2**	6
CO18035RA	58.4	13.4	**26.8**	61.3	71.5	-0.9	64.1	**5.91**	**5**	1140	**5**	**5**	**2**	**1**
CO18042RA	56.2	13.4	**24.8**	60.3	71.7	-1.0	**66.2**	**5.43**	**5**	1110	4	4	4	**1**
CO18D007W	**61.1**	12.9	**30.2**	67.3	**72.3**	-1.6	59.5	3.72	1	925	**5**	4	**2**	8
CO18D297R	59.5	13.3	**26.4**	63.5	70.4	-0.9	63.1	4.35	3	1065	**5**	3	**2**	4
CP7017AX	60.2	13.9	**30.1**	60.1	71.7	-1.0	62.1	2.51	1	1050	3	3	**2**	7
CP7266AX	57.0	13.5	**27.9**	55.8	71.4	**-0.8**	62.3	3.91	3	1055	4	4	4	4
Crescent AX	59.4	13.0	**30.1**	56.5	**72.7**	-1.2	62.3	3.48	3	1140	4	**6**	**3**	4
Fortify SF	57.9	14.0	**24.8**	55.1	72.2	-0.9	61.3	2.82	1	940	4	3	**3**	9
Guardian	60.0	13.8	**28.6**	66.1	71.4	-1.2	64.2	3.85	4	1115	4	4	**2**	**3**
Kivari AX	57.5	12.5	**27.5**	58.5	**73.1**	**-0.5**	63.2	4.35	4	**1165**	4	4	**2**	**3**
KS Silverado	**61.2**	13.5	**30.3**	63.2	72.2	-1.1	61.3	2.97	1	1035	**5**	4	**1**	7
Monarch	59.4	13.2	**29.8**	63.7	70.5	-1.0	64.3	4.37	3	1080	**6**	**6**	**2**	**3**
Ray	55.8	**15.2**	**27.0**	76.9	70.0	-1.8	**65.4**	5.13	**5**	1025	3	**5**	7	**2**
Snowmass 2.0	58.8	13.4	**29.0**	66.9	70.1	-1.1	**66.2**	**7.38**	**6**	**1220**	4	**5**	**3**	**1**
Valley	57.3	14.1	**25.5**	71.5	69.7	-1.5	64.2	**6.37**	**5**	1095	**5**	**6**	6	**1**
Windom SF	**61.0**	**14.3**	**31.1**	65.8	70.4	-1.5	64.4	3.88	3	**1175**	**5**	3	**2**	**3**
Average	59.0	13.6	28.1	63.8	71.2	-1.1	63.3	4.21	3.1	1086	4.3	4.2		
Minimum	55.8	12.5	24.8	55.1	68.3	-1.8	59.5	2.51	1	925	3	3		
Maximum	61.2	15.2	31.1	76.9	73.1	-0.5	66.2	7.38	6	1220	6	6		

Wheat Milling and Baking Quality Data - 2022 IVPT Fort Collins

* **Bold** indicates superior value, underlined indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Protein Recovery	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
Brawl CL Plus	61.1	**16.2**	**35.3**	68.5	67.9	-1.7	62.9	1.94	0	**1200**	**5**	3	4	6
Breakthrough	62.7	13.5	**33.2**	74.4	68.4	-1.3	63.3	2.92	2	1045	4	2	**3**	5
Breck	**63.0**	14.6	**33.3**	70.4	71.4	-1.2	62.2	2.57	0	1150	**5**	3	**1**	6
Byrd CL Plus	62.1	14.2	**37.2**	65.4	70.8	-1.6	62.1	2.20	0	1110	**5**	**5**	**3**	6
Canvas	62.5	13.7	**31.3**	71.2	**72.4**	**-0.9**	62.2	2.97	1	1105	**5**	4	**1**	5
CO17449R	62.6	13.9	**35.6**	66.9	70.2	-1.6	61.0	2.16	0	1030	4	4	**2**	7
CO18035RA	61.9	13.9	**35.2**	72.6	71.3	**-0.8**	63.3	**4.50**	4	1135	4	4	**2**	**3**
CO18042RA	62.1	14.1	**34.2**	71.1	71.2	-1.6	63.1	3.45	2	1175	**5**	4	**2**	4
CO18D007W	62.4	13.9	**34.7**	68.7	69.5	-1.4	62.3	2.75	0	1000	**5**	4	**2**	6
CO18D297R	62.4	13.7	**34.2**	70.1	68.9	-1.4	63.5	2.61	1	1040	**5**	3	**2**	5
CP7017AX	62.3	13.7	**33.2**	75.5	71.1	-1.4	60.1	1.98	1	955	4	4	**2**	8
CP7266AX	61.1	14.9	**34.5**	72.5	69.1	-1.0	64.3	2.63	1	1170	**5**	3	**3**	4
Crescent AX	61.7	14.3	**37.7**	63.9	71.2	-1.5	64.2	3.45	3	**1215**	**6**	4	**3**	**3**
Fortify SF	61.5	14.7	**31.6**	73.9	**71.6**	-1.2	63.0	2.15	0	1180	4	2	**1**	6
Guardian	62.6	14.9	**32.2**	74.7	71.4	-1.5	62.0	2.88	1	1025	**5**	3	**1**	6
Kivari AX	62.0	13.8	**36.9**	68.8	**71.8**	**-0.8**	63.4	3.42	2	**1200**	**5**	4	**1**	**3**
KS Silverado	61.8	**15.1**	**35.9**	67.4	70.6	-1.6	64.0	2.70	1	**1230**	**6**	3	**2**	4
Monarch	61.6	12.9	**33.0**	73.7	68.3	-1.4	60.3	2.94	1	925	**5**	4	4	7
Ray	58.0	14.2	**34.6**	76.3	69.9	**-0.9**	**66.3**	**5.30**	**5**	1050	**5**	4	5	**1**
Snowmass 2.0	60.9	**16.2**	**33.2**	72.6	67.7	-1.2	**70.1**	**5.95**	**5**	**1250**	**5**	3	**3**	**1**
Valley	61.7	14.4	**31.6**	73.9	69.1	-1.4	65.1	**4.61**	4	1130	4	2	**3**	**3**
Windom SF	62.7	13.7	**36.8**	80.2	69.1	**-0.3**	63.3	2.77	1	1030	**5**	4	**2**	5
Average	61.8	14.3	34.3	71.5	70.1	-1.3	63.3	3.13	1.6	1107	4.8	3.5		
Minimum	58.0	12.9	31.3	63.9	67.7	-1.7	60.1	1.94	0	925	4	2		
Maximum	63.0	16.2	37.7	80.2	72.4	-0.3	70.1	5.95	5	1250	6	5		

Wheat Milling and Baking Quality Data - 2022 UVPT Arapahoe

* **Bold** indicates superior value, underlined indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Protein Recovery	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
Amplify SF	58.1	14.0	**28.2**	56.6	69.3	-0.9	60.1	2.87	1	945	4	3	**3**	8
AP Roadrunner	57.1	**15.0**	**27.7**	67.0	68.8	-0.9	65.1	2.95	2	930	2	3	4	6
Avery	58.8	14.6	**27.0**	59.9	68.0	-0.7	64.2	3.47	2	980	3	3	**2**	5
Brawl CL Plus	60.0	**15.5**	**29.4**	64.0	68.6	-0.8	64.1	3.13	1	915	4	3	**1**	7
Breakthrough	59.2	14.6	**28.9**	64.5	65.7	-0.6	**66.0**	3.99	3	1020	4	4	4	**3**
Breck	**60.2**	14.6	**27.5**	66.0	69.4	-0.7	65.2	3.58	2	**1075**	4	4	**1**	**3**
Byrd	58.6	13.7	27.2	56.2	**70.6**	-0.9	63.4	4.09	3	1015	3	4	4	4
Byrd CL Plus	57.3	13.7	**28.1**	57.1	68.9	-0.8	62.2	3.11	1	920	2	3	4	7
Canvas	59.8	14.5	**25.8**	62.4	**71.4**	-0.6	**66.3**	4.32	3	1020	**5**	4	**1**	**3**
CO16D402W	58.0	14.3	**29.6**	58.3	68.3	-1.1	**66.0**	4.54	4	1015	**5**	3	4	**2**
CO16SF032	58.2	14.4	**28.0**	58.2	69.7	-0.9	62.0	2.83	0	945	2	3	**2**	8
CO16SF067	58.6	**15.2**	**26.5**	63.3	68.0	-1.2	62.1	3.19	1	960	**5**	4	**3**	6
CO17449R	**60.2**	13.5	**27.9**	60.4	69.4	-1.1	61.1	2.94	1	855	4	3	**1**	8
CO18035RA	59.1	12.7	**29.3**	54.9	69.6	-0.9	61.2	4.66	**5**	**1075**	4	4	**3**	**3**
CO18D007W	59.6	13.6	**28.3**	57.5	69.3	-0.6	64.2	4.56	4	1035	4	3	**2**	**3**
CO18D076W	58.4	14.2	**27.9**	52.6	69.7	-0.8	63.2	3.87	1	1040	4	3	**3**	5
CO18D297R	59.3	13.2	**26.2**	65.0	68.1	-1.0	62.4	3.43	2	925	**5**	3	**3**	5
CP7017AX	59.9	13.3	**29.3**	58.9	**70.6**	-0.7	61.1	2.35	2	825	1	2	**1**	9
CP7266AX	58.6	14.6	**25.9**	63.9	68.6	-0.8	63.1	2.74	0	935	2	1	**2**	8
Crescent AX	59.5	13.5	**29.8**	51.6	69.7	**-0.3**	63.1	3.82	2	1060	4	4	**2**	4
Fortify SF	58.9	14.6	**27.3**	57.9	**70.5**	-1.0	61.1	2.99	0	990	**5**	4	**2**	7
Guardian	58.7	**15.1**	**27.0**	59.8	69.8	-1.0	64.1	3.85	2	1025	**5**	3	**1**	5
Hatcher	59.8	11.7	**30.4**	58.2	68.1	**-0.3**	63.3	3.17	3	910	**5**	4	**2**	5
Kivari AX	**60.1**	13.0	**31.8**	56.7	**71.3**	-0.9	62.3	3.09	1	1040	**5**	**5**	**1**	5
KS Dallas	59.6	13.6	**33.2**	59.0	69.9	**0.1**	65.3	**6.05**	**5**	**1200**	**5**	4	**1**	**1**
KS Hamilton	58.6	14.3	**30.2**	66.0	68.6	**-0.4**	64.2	3.65	2	945	2	2	**2**	6
KS Silverado	59.0	14.3	**28.5**	65.1	69.8	**-0.4**	64.2	3.67	2	1040	**5**	3	**2**	4
Langin	58.6	**15.0**	**30.4**	50.7	69.0	-1.2	64.5	3.18	1	955	3	3	**3**	6
Monarch	59.3	12.8	**27.0**	68.2	68.3	-1.2	62.1	4.40	4	1000	**5**	**5**	4	**3**
MS Maverick	57.2	14.3	**30.0**	49.7	68.0	**-0.3**	63.0	3.16	1	960	3	3	5	6
Ray	53.5	14.4	**29.9**	65.7	69.2	-1.3	64.9	**5.12**	**5**	875	3	2	6	4
Snowmass 2.0	59.1	12.8	**28.6**	74.4	66.4	-0.7	**67.3**	**7.58**	**6**	**1140**	4	4	6	**1**
Steamboat	59.9	12.7	**30.1**	59.5	68.9	-0.7	63.2	3.31	2	**1110**	4	3	**2**	4
Sunshine	58.6	14.0	**30.3**	53.9	69.3	**-0.5**	**66.1**	4.48	4	1000	3	2	**3**	**3**
Valley	58.5	13.9	**26.4**	67.8	67.7	-1.3	65.2	**5.38**	**5**	1025	4	4	4	**1**
Whistler	57.4	14.6	**26.9**	63.1	67.9	-1.2	64.3	3.75	2	995	4	4	4	5
Windom SF	**60.4**	14.3	**31.3**	65.1	68.7	-0.8	**67.1**	4.23	3	**1110**	**5**	**5**	**1**	**1**
Average	58.8	14.0	28.6	60.5	69.0	-0.8	63.7	3.82	2.4	995	3.8	3.4		
Minimum	53.5	11.7	25.8	49.7	65.7	-1.3	60.1	2.35	0	825	1	1		
Maximum	60.4	15.5	33.2	74.4	71.4	0.1	67.3	7.58	6	1200	5	5		

Wheat Milling and Baking Quality Data - 2022 UVPT Julesburg

* **Bold** indicates superior value, underlined indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Protein Recovery	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
Amplify SF	54.4	**14.8**	**23.7**	46.9	67.0	-1.5	62.2	3.34	1	875	2	2	**3**	7
AP Bigfoot	55.1	13.3	**23.7**	46.2	67.0	-0.3	62.4	3.33	1	870	2	1	**3**	8
AP Roadrunner	53.1	13.4	**24.0**	58.7	66.9	-0.3	**65.2**	3.83	4	910	2	2	5	4
AP Solid	**56.2**	13.5	**25.8**	59.0	66.2	-0.4	64.2	3.64	2	855	3	2	**2**	6
Avery	54.0	13.0	**25.0**	46.5	66.4	-0.4	63.0	4.29	4	**975**	4	3	**3**	**3**
Brawl CL Plus	**56.1**	13.8	**26.3**	50.1	66.9	**0.1**	**66.0**	3.45	3	960	4	4	**1**	**3**
Breck	**57.1**	14.3	**26.5**	51.4	**67.9**	-0.7	64.2	3.29	2	900	3	2	**1**	6
Byrd	55.1	13.7	23.5	48.0	**68.5**	-0.5	63.2	4.80	**5**	900	3	3	4	**3**
Byrd CL Plus	54.0	13.2	**24.8**	45.0	66.8	-0.6	64.4	3.13	3	880	1	2	**3**	6
Canvas	**56.2**	13.8	**22.7**	51.7	**69.6**	-0.5	63.2	**5.46**	4	920	2	2	**1**	**3**
CO16D402W	54.1	13.2	**25.0**	49.5	65.7	**0.1**	64.2	4.34	4	**990**	3	3	**3**	**3**
CO16SF032	54.4	13.8	**26.3**	45.1	66.8	-0.7	62.2	3.11	1	840	3	3	**3**	8
CO16SF067	54.5	**15.8**	**25.9**	50.3	64.1	-1.3	62.1	3.19	1	880	1	1	4	8
CO17449R	**56.4**	13.4	**27.2**	42.4	66.9	-0.4	63.2	3.35	2	785	2	3	**2**	7
CO18035RA	53.9	12.5	**24.9**	45.7	**67.9**	-0.9	62.0	**6.18**	**5**	960	2	3	4	**3**
CO18042RA	53.7	12.6	**24.5**	42.5	**67.9**	**-0.0**	64.2	**4.83**	**5**	**970**	3	3	4	**2**
CO18D007W	55.3	14.0	**26.4**	44.9	66.3	-0.2	64.3	4.21	3	900	3	4	**2**	4
CO18D076W	55.6	**15.0**	**27.0**	44.9	67.5	-0.6	**65.3**	3.35	1	840	4	2	**1**	6
CO18D297R	54.8	13.6	**23.5**	50.0	65.5	-0.6	64.3	4.20	4	890	2	2	**3**	5
CP7017AX	55.0	13.4	**23.4**	54.9	66.9	-0.4	62.2	2.74	1	750	1	2	**3**	9
CP7266AX	54.3	13.0	**24.9**	49.2	66.6	-0.1	63.1	3.43	2	900	1	2	**3**	7
Crescent AX	55.1	13.9	**27.8**	38.6	67.5	-0.4	**65.2**	3.95	3	925	3	3	**3**	4
Fortify SF	55.1	13.4	**24.1**	40.4	**68.7**	-0.1	61.2	3.33	1	920	3	2	**2**	8
Guardian	54.7	13.6	**23.9**	48.5	66.6	-0.6	64.0	**5.33**	**5**	**975**	3	4	**2**	**1**
Hatcher	54.7	13.3	**27.4**	43.5	64.9	-0.4	64.3	3.11	3	860	2	2	4	6
Kivari AX	54.9	12.5	**27.8**	41.8	**68.5**	**0.4**	63.4	3.55	2	905	2	3	**2**	5
KS Dallas	**56.1**	14.4	**31.0**	49.6	66.1	-0.4	64.1	**4.89**	4	**975**	4	3	**1**	**2**
KS Hamilton	55.7	14.4	**25.5**	61.6	65.3	-0.6	63.2	3.42	1	860	2	2	4	7
KS Silverado	**56.5**	13.8	**25.4**	53.6	**68.2**	**0.2**	64.2	3.94	3	850	3	2	**1**	5
Langin	53.9	13.4	**26.2**	41.5	67.2	-0.2	64.2	4.68	3	850	1	2	4	5
Monarch	54.4	13.2	**24.0**	54.9	66.5	-0.2	64.2	4.18	3	915	3	3	**3**	5
MS Maverick	**56.7**	13.8	**28.2**	45.0	66.5	-0.5	63.2	3.16	2	865	2	2	**1**	7
Ray	53.0	**14.7**	**25.2**	65.2	64.9	-0.4	**67.2**	**4.96**	**5**	835	2	3	6	**2**
Snowmass 2.0	54.6	13.7	**25.1**	57.5	65.6	-0.6	**66.2**	**5.88**	**5**	**1100**	**5**	4	4	**1**
Steamboat	55.6	13.9	**26.5**	48.1	66.4	-0.6	62.3	3.10	1	890	3	2	**2**	7
Sunshine	**56.1**	14.3	**29.1**	42.2	66.7	-1.1	**65.4**	3.76	3	885	3	4	**2**	**3**
SY Legend CL2	54.4	**14.8**	**25.8**	55.3	64.0	-0.8	64.0	2.72	1	815	1	2	5	8
Valley	54.0	13.3	**22.9**	54.9	64.7	-0.8	62.1	4.81	4	900	4	4	5	4
Whistler	54.1	13.7	**24.9**	49.5	65.0	-0.4	64.1	4.34	4	940	2	2	**3**	4
Windom SF	**56.6**	13.8	**25.8**	57.6	66.5	-0.3	**65.2**	4.24	4	**1030**	4	3	**1**	**1**
Average	55.0	13.7	25.5	49.3	66.6	-0.4	63.8	3.97	2.9	901	2.6	2.6		
Minimum	53.0	12.5	22.7	38.6	64.0	-1.5	61.2	2.72	1	750	1	1		
Maximum	57.1	15.8	31.0	65.2	69.6	0.4	67.2	6.18	5	1100	5	4		

Wheat Milling and Baking Quality Data - 2022 UVPT Roggen

* **Bold** indicates superior value, underlined indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Protein Recovery	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
Amplify SF	58.1	13.4	**28.6**	53.3	70.7	-0.4	62.4	3.27	1	955	4	4	**2**	6
AP Bigfoot	57.2	13.8	**26.7**	53.0	69.1	-0.5	61.4	3.73	1	1000	**5**	**5**	**3**	6
AP Roadrunner	57.0	13.8	**27.2**	64.7	70.1	-0.9	65.3	3.78	3	980	**5**	**5**	5	**3**
AP Solid	**59.9**	14.3	**30.9**	60.0	69.2	-1.3	62.3	2.84	1	990	**5**	4	**1**	6
Avery	57.7	13.3	**28.6**	55.8	69.7	-0.6	63.4	4.98	4	1040	4	4	**2**	**3**
Brawl CL Plus	**59.1**	14.1	**28.0**	55.4	69.5	-0.7	63.4	3.13	3	**1165**	**5**	4	**1**	**3**
Breck	**59.2**	**14.7**	**28.8**	58.9	**71.5**	-0.6	**67.5**	3.73	3	1065	**5**	4	**1**	**2**
Byrd	57.6	12.6	27.2	49.8	**71.6**	-0.5	63.4	4.89	**5**	**1140**	**5**	4	4	**1**
Byrd CL Plus	57.5	13.9	**27.6**	52.2	69.8	-1.1	64.3	3.21	3	915	4	3	**3**	5
Canvas	58.3	13.6	**25.5**	55.0	**71.7**	-0.4	64.5	4.06	4	1030	**5**	4	**1**	**3**
CO16D402W	57.5	14.1	**28.1**	57.0	**71.3**	-0.4	65.9	4.83	4	1040	4	4	**1**	**3**
CO16SF032	58.4	13.0	**27.4**	53.3	**71.7**	-1.0	61.5	3.01	2	1025	4	4	**1**	6
CO16SF067	58.3	**14.8**	**30.0**	53.3	68.8	**-0.3**	63.2	2.92	1	890	2	2	**1**	8
CO17449R	58.1	13.0	**29.0**	55.4	70.1	-1.2	62.4	3.40	2	1010	**5**	**5**	**3**	5
CO18035RA	57.3	13.7	**24.6**	60.1	69.9	-1.0	64.3	**5.86**	**5**	**1140**	3	3	**3**	**2**
CO18042RA	57.4	12.7	**26.7**	50.5	70.5	-0.9	62.4	4.57	4	1065	4	4	4	**3**
CO18D007W	57.8	13.0	**27.1**	55.2	70.2	-0.7	64.4	4.83	4	1035	**5**	4	**2**	**3**
CO18D076W	58.1	12.7	**26.6**	53.5	**71.0**	-0.7	63.5	3.70	3	1000	**5**	4	**2**	4
CO18D297R	57.9	13.0	**26.4**	53.8	68.9	-1.0	63.4	4.19	3	990	**5**	**5**	**3**	**3**
CP7017AX	57.9	13.1	**27.0**	54.8	**71.4**	-0.8	62.4	2.81	2	850	2	2	**2**	8
CP7266AX	56.8	13.9	**25.9**	58.3	68.4	-0.8	62.4	2.91	1	875	3	3	4	8
Crescent AX	57.5	13.6	**27.5**	52.2	70.3	-0.6	63.3	3.90	4	1010	**5**	4	**3**	**3**
Fortify SF	57.6	14.0	**28.0**	48.3	70.6	-0.8	63.2	2.98	1	960	4	4	**3**	6
Guardian	58.2	**14.5**	**25.2**	55.5	69.4	-0.7	**66.3**	4.58	4	1060	**5**	**5**	**1**	**2**
Hatcher	58.2	12.6	**29.3**	48.9	68.6	-0.6	62.5	3.73	3	975	**5**	4	4	5
Kivari AX	**58.6**	12.1	**29.1**	46.6	**72.2**	**-0.2**	62.5	3.95	3	1060	**5**	**5**	**1**	4
KS Dallas	58.0	12.8	**32.7**	54.5	70.0	**0.3**	**66.5**	**5.95**	**5**	**1115**	**5**	4	**2**	**1**
KS Hamilton	57.8	13.4	**26.0**	62.1	69.5	**-0.4**	65.4	3.70	3	905	3	3	**2**	5
KS Silverado	58.2	14.2	**29.0**	57.7	69.8	-0.4	64.5	3.43	2	975	4	4	**1**	5
Langin	56.2	**15.0**	**26.4**	52.9	69.0	-1.3	**66.2**	3.39	3	945	4	3	5	4
Monarch	57.4	13.2	**28.2**	61.0	69.5	-0.8	64.5	4.53	3	1075	4	**5**	4	**3**
MS Maverick	57.3	13.6	**27.4**	54.6	68.7	-0.7	64.3	3.36	3	1100	**5**	3	4	4
Ray	56.4	**14.6**	**28.3**	71.1	68.9	-0.6	**69.4**	**5.40**	**5**	990	4	3	5	**1**
Snowmass 2.0	57.9	13.2	**29.4**	64.4	68.1	**-0.2**	65.3	**9.97**	**6**	**1155**	4	4	4	**1**
Steamboat	58.2	13.6	**28.9**	55.2	70.3	-1.0	62.3	4.58	4	1085	**5**	4	**2**	4
Sunshine	57.1	14.1	**28.6**	50.3	70.7	-1.0	64.5	4.26	4	**1125**	**5**	4	**3**	**2**
SY Legend CL2	57.5	13.8	**28.2**	60.2	68.0	-0.7	64.4	2.97	1	930	4	3	4	7
Valley	57.7	13.4	**26.2**	63.7	69.3	-1.2	64.3	**5.57**	**5**	**1105**	**5**	**5**	4	**1**
Whistler	57.0	14.3	**28.7**	54.5	69.0	-0.8	64.5	4.22	4	1080	4	**5**	4	**3**
Windom SF	**59.0**	**14.9**	**29.0**	62.8	68.6	-0.7	**69.4**	3.90	3	**1125**	**5**	3	**1**	**2**
Average	57.8	13.6	27.9	56.0	69.9	-0.7	64.2	4.13	3.1	1024	4.4	3.9		
Minimum	56.2	12.1	24.6	46.6	68.0	-1.3	61.4	2.81	1	850	2	2		
Maximum	59.9	15.0	32.7	71.1	72.2	0.3	69.4	9.97	6	1165	5	5		

Wheat Milling and Baking Quality Data - 2022 UVPT Sheridan Lake

* **Bold** indicates superior value, underlined indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Protein Recovery	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
Amplify SF	60.5	12.4	**27.9**	68.7	**71.0**	-1.2	62.5	3.69	1	895	4	**5**	**1**	6
AP Roadrunner	59.7	12.7	**29.1**	72.1	69.0	-0.4	65.4	3.12	3	1025	4	4	**2**	4
Avery	59.1	10.7	**25.1**	60.8	68.6	-0.5	61.5	5.15	4	**1045**	4	**5**	**3**	**3**
Brawl CL Plus	60.0	**13.6**	**26.4**	72.3	68.8	-0.5	62.5	3.34	2	**1070**	**5**	**5**	**2**	4
Breakthrough	59.5	11.8	**25.6**	76.6	65.4	-0.8	64.2	4.43	4	970	**5**	4	5	**3**
Breck	**61.4**	11.6	**28.4**	73.0	68.9	-1.0	64.4	4.18	4	930	**6**	4	**1**	**3**
Byrd	58.8	10.9	24.8	60.3	**71.0**	-1.1	60.5	**5.97**	**5**	990	**5**	4	6	**3**
Byrd CL Plus	58.9	11.4	**28.2**	64.7	69.4	-0.8	62.6	4.14	3	915	3	3	**3**	6
Canvas	**60.7**	12.7	**26.0**	72.0	**71.4**	-0.3	64.4	5.12	4	1020	4	4	**1**	**3**
CO16D402W	59.3	9.8	**26.4**	71.6	67.0	-0.5	63.5	5.29	**5**	910	3	3	4	4
CO16SF032	60.1	12.0	**29.5**	65.3	69.6	-1.3	61.5	3.29	3	915	4	3	**2**	7
CO16SF067	60.5	12.4	**29.2**	65.1	67.9	**-0.2**	63.5	3.37	2	915	4	4	**1**	6
CO17449R	**61.2**	10.7	**28.2**	65.3	69.1	-0.9	62.5	4.41	4	915	4	4	**1**	5
CO18035RA	58.2	11.4	**27.5**	55.4	69.2	-1.5	62.5	5.23	**5**	1005	3	3	6	**3**
CO18042RA	58.7	10.4	**28.2**	59.4	69.7	**-0.1**	59.5	**5.60**	4	1000	4	**5**	**3**	4
CO18D007W	**60.7**	12.4	**29.2**	66.4	69.7	-0.7	**66.4**	5.32	**5**	1025	4	4	**1**	**1**
CO18D076W	59.1	**13.7**	**28.4**	59.9	69.5	-1.1	**66.4**	4.10	3	1005	4	3	**3**	4
CO18D297R	60.3	12.1	**26.3**	71.0	67.6	-1.2	63.6	5.23	4	960	**5**	**5**	**3**	**3**
CP7017AX	60.3	11.7	**27.6**	72.0	**70.6**	-0.4	63.5	3.55	3	920	2	3	**1**	6
CP7266AX	57.9	11.7	**25.2**	62.9	69.0	-0.5	63.3	4.04	2	965	4	3	4	5
Crescent AX	58.9	12.6	**27.1**	65.8	69.6	-0.4	63.5	4.61	4	1015	4	4	**2**	**3**
Fortify SF	57.9	12.7	**23.7**	57.7	69.7	-0.9	61.5	3.31	1	950	**5**	4	5	6
Guardian	60.3	12.4	**27.7**	71.9	69.1	-0.6	64.4	5.10	4	1035	**5**	4	**2**	**2**
Hatcher	59.5	10.7	**27.3**	61.2	67.6	-0.7	63.5	3.89	3	900	**5**	**5**	4	5
Kivari AX	59.4	12.0	**27.6**	67.0	**70.8**	-0.9	63.6	4.97	4	**1055**	4	**5**	**1**	**2**
KS Dallas	60.0	11.2	**32.2**	70.7	68.6	-0.4	65.2	**6.18**	**5**	1000	4	3	**2**	**2**
KS Hamilton	59.6	11.7	**28.3**	70.5	67.6	-0.6	64.2	4.48	3	935	3	4	**3**	5
KS Silverado	58.5	10.9	**26.6**	64.6	68.7	**-0.0**	63.4	4.11	3	1025	**5**	4	**3**	4
Langin	58.2	**13.7**	**26.7**	65.4	68.9	-0.8	64.2	4.64	4	**1090**	**5**	4	**3**	**2**
Monarch	59.5	11.0	**28.5**	68.8	68.3	-1.0	59.7	**5.64**	4	830	4	4	**3**	5
MS Maverick	59.6	10.6	**28.2**	59.1	68.1	**-0.1**	61.4	3.80	3	1000	**5**	**6**	4	4
Ray	58.1	12.7	**28.9**	80.4	67.4	-0.8	**67.5**	4.66	4	895	4	3	6	**3**
Snowmass 2.0	60.1	10.5	**31.7**	74.4	67.2	-0.4	65.2	**7.58**	**6**	975	4	**5**	**3**	**1**
Steamboat	59.0	9.5	**27.6**	58.5	68.6	**0.1**	60.5	4.28	4	945	4	3	4	5
Sunshine	59.0	**13.0**	**29.7**	57.5	69.1	-0.6	**67.4**	4.57	**5**	**1085**	4	4	4	**1**
Valley	59.9	10.5	**25.9**	65.9	66.9	-0.9	62.6	5.20	**5**	950	4	4	**3**	**3**
Whistler	60.5	12.5	**30.6**	70.7	68.5	-1.2	64.4	4.58	**5**	**1135**	**5**	**5**	**2**	**1**
Windom SF	**61.2**	11.5	**27.2**	76.9	67.0	-0.9	**67.6**	5.01	**5**	1005	**5**	4	**3**	**1**
Average	59.6	11.7	27.7	66.9	68.8	-0.7	63.5	4.61	3.7	979	4.2	4.0		
Minimum	57.9	9.5	23.7	55.4	65.4	-1.5	59.5	3.12	1	830	2	3		
Maximum	61.4	13.7	32.2	80.4	71.4	0.1	67.6	7.58	6	1135	6	6		

Colorado Wheat Update
Brad Erker

Three organizations serve the wheat growers of Colorado through a shared staff and dedicated Boards of Directors. The **Colorado Wheat Administrative Committee** (CWAC) collects an assessment of two cents per bushel at first point of sale, and invests those funds in research, education, and promotional activities. Board members serve on the boards of US Wheat Associates, Wheat Marketing Center, and Plains Grains, Inc. The **Colorado Association of Wheat Growers** (CAWG) is funded by voluntary membership fees and sponsorships. CAWG lobbies at the state and national level on policies that affect wheat, and board members serve on the Board of the National Association of Wheat Growers. CAWG does not utilize assessment funds for lobbying. The **Colorado Wheat Research Foundation** takes ownership of wheat varieties and traits developed at Colorado State University and markets them in Colorado and regionally under the PlainsGold brand.

Colorado wheat producers planted 2.25 million acres to wheat in the Fall of 2022, up 300,000 acres from the previous year's crop. **Langin**, a hard red winter variety released by CSU in 2016, was the top planted variety for the fourth year in a row with 21% of the acreage (NASS Winter Wheat Seedings by Variety Survey, 2023 Crop). **Avery and Fortify SF** tied for second place at 8.1%, followed by **Byrd** at 6.4%, and **Crescent AX** at 4.1%. Of varieties reported by name, 84% of the acreage was planted to varieties supported by the 2-cent/bushel wheat assessment (those released by CSU and marketed by PlainsGold). Colorado producers also reported that 44% of their seed planted was Certified wheat seed.

As one of its primary goals, CWAC provides consistent funding to researchers at Colorado State University for wheat breeding and wheat-related research. CWAC, in partnership with CSU, is currently supporting programs in wheat breeding, entomology, pathology, weed science, novel herbicide resistance, crops testing, and foundation seed. CWAC is excited to partner with all the researchers at CSU to face the challenges of the future.

CWRF released one new PlainsGold variety last fall, a new semi-solid stemmed variety called '**Windom SF**'. It is a hard white winter wheat which has an increased amount of pith in the stem (relative to hollow stem wheats), designed to resist wheat stem sawfly feeding and cutting. It will complement Fortify SF, Amplify SF and other semi-solid varieties to give growers options in areas affected by wheat stem sawfly. Windom SF will be exclusively available for production in the CWRF/Ardent Mills Ultragrain® Premium program. Growers will need to buy certified seed every year and sign a contract with Ardent Mills for delivery to an elevator associated with the program. Certified seed will be available in limited supply in Fall 2023 and full supply in Fall 2024.

In 2008, Colorado wheat growers initiated a novel trait development project with CSU that led to the **CoAxium® Wheat Production System**, which provides control of winter annual grass weeds in wheat through tolerance to Aggressor AX® herbicide. CoAxium® acres continue to grow in the region. There are seven practices that growers should follow for the best performance:

- Wheat stage of growth for Aggressor AX® applications – apply from 4-leaf stage up to stem elongation (first node detected).

- Aggressor AX® rate by weed species – Spring applications: use 8-12 oz/acre on brome species, use 12 oz/acre for feral rye or jointed goatgrass. Adjust Aggressor AX® herbicide rates based on weed size and weed populations. For heavy infestations use a split application of 8 oz/ac (fall) followed by 8 oz/ac (spring).
- Surfactant use by weed species – Only use non-ionic surfactant (NIS) in all fall applications. For feral rye and jointed goatgrass use methylated seed oil or crop oil concentrate at 1 gallon/100 gallons on spring applications; for brome species use NIS at 1-2 quarts/100 gallons.
- Volume of application – Coverage is critical with Aggressor AX®. Colorado is an arid environment and the herbicide needs 15 gallons of water/acre (minimum) to provide the best control. High density and large weed size require 20 gallons.
- Do not apply more than 30% of the spray volume as fertilizer.
- Crop and weed growth activity – the wheat crop and grassy weeds need to be actively growing to maximize crop safety and grassy weed control. Do not apply Aggressor AX® when freezing temperatures are expected five days prior to or after applications of Aggressor AX® herbicide.
- Timing – to maximize return on investment, control grassy weeds before they compete with the crop for space, nutrients, and water.

CWRF/Ardent Mills UltraGrain® Premium Program: CWRF continues to partner with Ardent Mills to provide hard white winter wheat varieties with sound agronomics and superior quality to farmers throughout the region, along with variety and protein premiums. The Ultragrain® family of flour delivers whole grain nutrition in mainstream foods with the taste, texture and color consumers prefer. It starts with exclusive varieties of white wheat for a sweeter, milder flavor that is uniquely milled to the granulation of white flour. This is one of the largest and most successful identity-preserved grain programs in the country.

For the 2023 crop year, five varieties are included in the program (Snowmass 2.0, Breck, Monarch, Snowmass and Thunder CL). CSU continues to put significant breeding effort into hard white wheat. Certified seed is required on all Ardent Mills contracts, and the use of glyphosate for pre-harvest crop desiccation is prohibited. A Yuma-CHS delivery point was added for 2023.

Ardent Mills is currently paying premiums as follows for the 2023 crop. Future year contracts are subject to markets and may change. For 2023, all varieties are paid at the same premium levels:

$0.40/bushel base grower premium, regardless of protein level
$0.60/bushel @ 12.0% protein
+$0.02 per 0.5% from 12.2% to 13.0% protein

For further details on delivery points and seed availability from your local seed grower, visit **coloradowheat.org** or **plainsgold.com**, or call the Colorado Wheat office at (970) 449-6994.

For more information on any of the work being done by Colorado Wheat, stay in touch with us:

Phone: (970) 449-6994 Email: info@coloradowheat.org
Websites: **www.coloradowheat.org** | **www.plainsgold.com** | **www.coaxium.com**

Social media: @coloradowheat @PlainsGold Facebook.com/coloradowheat Facebook.com/PlainsGold

Communicating to Seed Users About Pesticide Treated Seed

Laura Pottorff

Seed treatments are extremely popular in Colorado and nationally. A report from the United States Department of Agriculture states that 97.7 percent of winter wheat seed planted in Colorado for harvest in 2023 was treated with fungicide or insecticide (USDA-NASS Winter Wheat Seedings by Variety Survey, 2023).

The conversation about seed treatments is gaining momentum. Pesticide regulators have concerns about how seed treatments are labeled and whether people who apply seed treatments and use treated seed are following proper handling and disposal mandates.

Some people outside the seed industry are concerned that treated seed is not regulated appropriately or at all. This concern stems from two rules:

1. FIFRA (Federal Insecticide, Fungicide, Rodenticide Act) regulation 40 CFR 152.152 (a) exempts seed treated with pesticides from pesticide labeling requirements, as these seeds are interpreted to fall under the treated article exemption by EPA.
2. Labeling of treated seed falls under the purview of the Federal and State Seed Act, which is enforced by federal and state seed regulatory officials.

Pesticides used to treat seed are regulated by FIFRA and the people who apply the pesticides are regulated by FIFRA, either as registered commercial pesticide applicators with credentials in Seed Treatment category 104 or as licensed private pesticide applicators. However, once the seed is treated it is considered an 'article' exempt from FIFRA. At this stage all labeling laws are enforced via the State and Federal Seed Act. The only requirements in Seed Law for labeling treated seed are that the precise name of the chemical and the signal word ("danger" for severe hazards, "warning" for less severe hazards") are listed along with the statement "DO NOT USE FOR FOOD, FEED, OR OIL PURPOSES" on the seed container or tote. See Figure 1 on the next page for an example of a pesticide treatment label.

State pesticide regulatory officials have had concerns about how treated seed is regulated, specifically that this exemption of treated seeds from pesticide laws leaves states with a regulatory gap related to environmental protection, disposal, enforcement, complaints, questions, and potential lawsuits related to treated seed.

Last fall, the EPA responded to a petition filed in 2017 by the Center for Food Safety, which expressed the same concerns. In their response, the EPA said that while they would not change the exemption of treated seed, they did agree with the petitioner's claims that labeling of treated seed is not being clearly communicated to users of the pesticides and treated seed.

Why should you pay attention?

As the EPA and the state pesticide and seed regulatory officials begin to gather information, make sure you are the one setting a good example. Show that you are knowledgeable. Participate in surveys and sampling whenever possible.

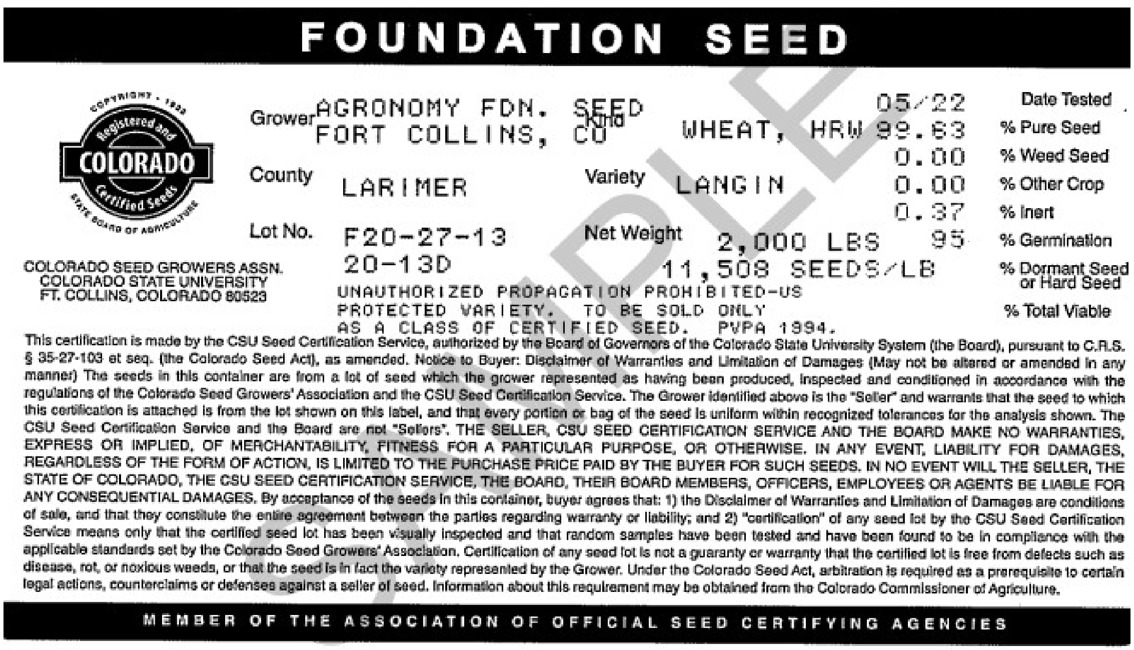
If you treat seed, set a good example!

1. Only treat high quality conditioned seed that is free from excessive dust.
2. Calibrate seed treatment equipment.
3. Follow manufacturer's recommendations for the use of appropriate coatings to prevent dust-off as needed.
4. Follow pesticide label directions.
5. Provide and attach the appropriate labeling for pesticide-treated seed for your customers (Figure 1).

If you use treated seed, make sure the tote/bag has two labels when you receive it.
In addition to the required seed label, pesticide labels must also be attached to the container or tote. The seed will have two labels, one to communicate the quality of the seed to the end user, the other to communicate what the seed was treated with and any environmental hazards and special handling and disposal information. READ THE LABELS. Ask questions if the information is not clear.

Figure 1. Example of Proper Treated Seed Labeling.

Required seed label:



FOUNDATION SEED

Grower AGRONOMY FDN. SEED
FORT COLLINS, CO

Kind WHEAT, HRW

County LARIMER

Variety LANGIN

Lot No. F20-27-13
20-13D

Net Weight 2,000 LBS
11,508 SEEDS/LB

Date Tested 05/22
% Pure Seed 99.63
% Weed Seed 0.00
% Other Crop 0.00
% Inert 0.37
% Germination 95
% Dormant Seed or Hard Seed
% Total Viable

COLORADO SEED GROWERS ASSN.
COLORADO STATE UNIVERSITY
FT. COLLINS, COLORADO 80523

UNAUTHORIZED PROPAGATION PROHIBITED-US PROTECTED VARIETY. TO BE SOLD ONLY AS A CLASS OF CERTIFIED SEED. PVPA 1994.

This certification is made by the CSU Seed Certification Service, authorized by the Board of Governors of the Colorado State University System (the Board), pursuant to C.R.S. § 35-27-103 et seq. (the Colorado Seed Act), as amended. Notice to Buyer: Disclaimer of Warranties and Limitation of Damages (May not be altered or amended in any manner) The seeds in this container are from a lot of seed which the grower represented as having been produced, inspected and conditioned in accordance with the regulations of the Colorado Seed Growers' Association and the CSU Seed Certification Service. The Grower identified above is the "Seller" and warrants that the seed to which this certification is attached is from the lot shown on this label, and that every portion or bag of the seed is uniform within recognized tolerances for the analysis shown. The CSU Seed Certification Service and the Board are not "Sellers". THE SELLER, CSU SEED CERTIFICATION SERVICE AND THE BOARD MAKE NO WARRANTIES, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE. IN ANY EVENT, LIABILITY FOR DAMAGES, REGARDLESS OF THE FORM OF ACTION, IS LIMITED TO THE PURCHASE PRICE PAID BY THE BUYER FOR SUCH SEEDS. IN NO EVENT WILL THE SELLER, THE STATE OF COLORADO, THE CSU SEED CERTIFICATION SERVICE, THE BOARD, THEIR BOARD MEMBERS, OFFICERS, EMPLOYEES OR AGENTS BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES. By acceptance of the seeds in this container, buyer agrees that: 1) the Disclaimer of Warranties and Limitation of Damages are conditions of sale, and that they constitute the entire agreement between the parties regarding warranty or liability; and 2) "certification" of any seed lot by the CSU Seed Certification Service means only that the certified seed lot has been visually inspected and that random samples have been tested and have been found to be in compliance with the applicable standards set by the Colorado Seed Growers' Association. Certification of any seed lot is not a guaranty or warranty that the certified lot is free from defects such as disease, rot, or noxious weeds, or that the seed is in fact the variety represented by the Grower. Under the Colorado Seed Act, arbitration is required as a prerequisite to certain legal actions, counterclaims or defenses against a seller of seed. Information about this requirement may be obtained from the Colorado Commissioner of Agriculture.

MEMBER OF THE ASSOCIATION OF OFFICIAL SEED CERTIFYING AGENCIES

Required pesticide treatment label:

Colorado State University Agronomy Foundation Seed

TREATED SEED

Cereals

This seed has been treated with Imidacloprid (Resonate™ 480, EPA Reg. 42750-134), Difenoconazole (Difenoconazole 3L ST, EPA Reg 42750-256), (Metalaxyl 265 ST, EPA Reg.42750-208), Thiabendazole (Thiabendazole 4L ST, EPA Reg. 42750-226), Tolclofos-methyl (Rizolex™ EPA Reg. 59639-178), Albaugh Cereals F4 Premix (EPA Reg. 42750-334) at the rates specified by the manufacturer.

WARNING

TREATED SEED DO NOT USE TREATED SEED FOR FEED, FOOD OR OIL PURPOSES. STORE AWAY FROM FEEDS AND FOODSTUFFS. KEEP OUT OF REACH OF CHILDREN. USE WITH AN EPA-APPROVED DYE OR COLORANT THAT IMPARTS AN UNNATURAL COLOR TO THE SEED.

PRECAUTIONARY INFORMATION FOR TREATED SEED

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Wear long-sleeved shirt, long pants and chemical resistant gloves when handling treated seed. Causes skin and moderate eye irritation. Harmful if swallowed, absorbed through skin or inhaled. Avoid contact with eyes, skin or clothing. Avoid breathing vapor or spray mist. Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet. Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

FIRST AID

IF SWALLOWED: Call a poison control center or doctor immediately for treatment advice. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give any liquid to the person. Do not give anything by mouth to an unconscious person.

ENVIRONMENTAL HAZARDS

This pesticide is highly toxic to birds and aquatic invertebrates. For terrestrial uses, do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash waters. Exposed treated seeds may be hazardous to birds. Cover or incorporate spilled treated seeds.

Pollinator Precautions: Imidacloprid is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Ensure that planting equipment is functioning properly in accordance with manufacturer specification to minimize seed coat abrasion during planting to reduce dust which can drift to blooming crops or weeds.

MACHO 480 ST treated seed, the field may be replanted immediately to artichoke, barley, Brassica (cole) leafy vegetables, canola, cilantro, corn (field or sweet), cotton, cranberry, cucurbits, eggplant, groundcherry, leafy petiole vegetables, leafy vegetables, legume vegetables (succulen dried), mustard seed, oats, okra, pepinos, pepper, popcorn potato, rapeseed, sorghum, soybean, strawberry, sugarbe tomatillo, tomato, triticale, turnip greens, root and tuber vegetables, watercress, and wheat. For cereals including buckwheat, millet, rice and rye and for safflower; the mini plant-back interval is 30 days from the date MACHO 480 S treated seed was planted. Cover crops for soil building or erosion control may be planted at any time; but do not gra harvest for food or feed. For all other crops not listed on a imidacloprid label, or for crops for which no imidacloprid tolerance for the active ingredient has been established, a month plant-back interval must be observed.

- Green wheat, oats, rye or triticale forage may not be graze until 55 days after planting.
- Green barley forage may not be grazed until 30 days after planting.
- Do not plant any crop other than those on this label within days to fields in which treated seeds were planted.
- Excess treated seed may be used for ethanol production o (1) by-products are not used for livestock feed and
- (2) no measurable residues remain in ethanol by-products are used in agronomic practice.
- Do not plant any crop, other than soybeans, dry peas, barl wheat, oats, rye, and triticale, brassica head and stem subgroup 5A, cucurbit vegetable cropgroup 9, root vegetal (except sugarbeets) subgroup 1B, bulb vegetables subgrou 07A, spinach and alfalfa, within 30 days to fields in which treated seeds were planted.
- Use crop-specific seeding rates according to local agricultu practice.
- Regardless of type of application, do not apply more than lb thiabendazole per acre (68.0 grams ai/A) per year.

Disposal

Do not allow children, pets or livestock to have access to treated se Exposed treated seed may be hazardous to birds and wildlife. Cove collect treated seeds spilled during loading and planting. Dispose c excess treated seed by burying seed away from bodies of water. Do contaminate bodies of water when disposing of planting equipment water. Dispose of seed packaging or containers in accordance with requirements. Excess treated seed may be used for ethanol produc only if (1) by-products are not used for livestock feed and (2) no m surable residues of pesticide remain in ethanol by-products that are in agronomic practice.

For Chemical Spill, Leak, Fire, or Exposure
Call CHEMTREC (800) 424-9300.
Albaugh, LLC. Ankeny, IA 50021

Both labels are placed inside the pocket located on the tote or attached to the seed container.

Colorado Wheat Stem Sawfly Survey

Adam Osterholzer and Dr. Punya Nachappa

The wheat stem sawfly (WSS), *Cephus cinctus* Norton, has been a pest of growing concern in Eastern Colorado since it was found in wheat fields in 2010 near New Raymer, Colorado. Adult sawflies emerge from wheat stubble in spring while the crop is jointing and lay eggs over their flight period, which lasts 4 to 6 weeks. The eggs hatch and develop into larvae that chew the interior pith of the growing wheat stems. As the crop matures and dries, the larvae create a chamber near the root crown and cut the stems, causing lodging before the crop is harvested. Grain yield losses from wheat stem sawfly damage in Colorado are estimated to be $31-33 million in 2020-2021 and $41 million in 2022.

A statewide survey of wheat stem sawfly infestation has been conducted since 2013 by Colorado State University entomologists to determine the scope of infestations across the state. Changes to the pests range are also monitored. Approximately 100 sites are surveyed each year after the adult sawflies have completed their flight, with the number of sites collected from each county being proportional to the amount of wheat grown in the county. Collection sites are wheat fields directly adjacent to the previous year's wheat stubble, and collection sites are a minimum of 10 miles apart. For each site surveyed, 100 tillers are collected and dissected to check for the presence of wheat stem sawfly larvae. The percentage of infested tillers is reported for each sample location, with low infestation being less than 10% of total tillers having WSS infestation, medium having between 10% and 50% infestation, and high infestation being any site with more than 50% of tillers infested.

Throughout the study the total number of infested sites has increased over the years (Table 1). The number of sites with medium (10%-50%) and high infestation (>50%) levels has also grown over this period. After a drop in infested sites during 2021, the number of sites with sawfly infestation rebounded in 2022. Of note, the number of sites with severe infestation significantly increased, from three sites to 21 sites.

	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Not Infested	56	50	32	81	42	46	41	33	44	34
<10%	20	30	48	11	36	26	29	41	33	15
10-50%	13	15	16	4	13	12	22	20	20	24
>50%	5	5	3	3	5	12	14	11	3	21
Total Sites	94	100	99	99	96	96	106	105	100	94

Table 1: Number of Colorado wheat fields in each infestation category using WSS larval infestations from 2013-2022.

The habitat range of the wheat stem sawfly has increased as well. In 2013, WSS was not detected in Kiowa, Prowers, or Baca counties. In several of the following years, WSS was then detected in all sampled counties. Severe drought conditions in 2022 made many of the survey sites in southeastern Colorado unusable for data collection due to lack of wheat plants, possibly contributing to the current absence of observed sawfly activity in that region.

Full survey results for 2013-2020 can be found at: https://doi.org/10.1093/jee/toab015. Additional results for 2021-2022 can be found at: www.csuwheatentomology.com.

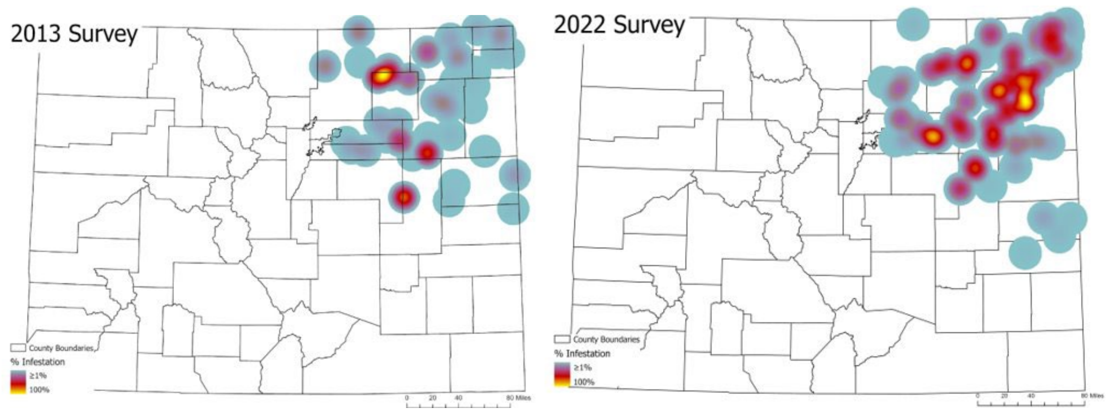


Figure 1: Percentage infestation of wheat fields sampled in 2013 and 2022 for wheat stem sawfly larvae.

Acknowledgements

We would like to acknowledge the work of Dr. Frank Peairs, Terri Randolph, Erika Peirce and Darren Cockrell for their methodology development and authorship of the complete results. We would also like to thank Jeff Rudolph and Laura Newhard for their technical support. Numerous lab technicians have collected and processed these samples. We would further like to acknowledge the wheat growers of Colorado and the Colorado Wheat Administrative Committee that provided their support for this project.

Wheat Stem Sawfly in Colorado – Frequently Asked Questions

Dr. Punya Nachappa and Adam Osterholzer

Q: What type of insect is the wheat stem sawfly?

A: Wheat stem sawflies (WSS) aren't flies but wasps! They belong to a group of insects called Hymenoptera, alongside ants, bees, and other wasps. Wheat stem sawflies cannot sting. The name "sawfly" comes from the saw-like appearance of the ovipositor, which the females use to cut into plants and lay their eggs. Males lack this trait.

Q: How do I know if I have wheat stem sawflies in my field? What do they look like?

A: Starting in early to mid-May, look for small yellow and black wasps (7-12mm) on wheat plants along the edges of your field. Resting sawflies will sit on the stem facing the ground. There are other insects that are similar in appearance, but they typically won't exhibit this resting posture or be abundant in field edges. In mid to late-June, stems can be cut open to look for their white, S-shaped larvae. Compacted sawdust-like material called "frass", which collects in stems as a result of WWS feeding, is also an indication of sawfly infestation.

Adult female wheat stem sawfly sitting facing the ground (left). Wheat stem sawfly larvae in stub (right).

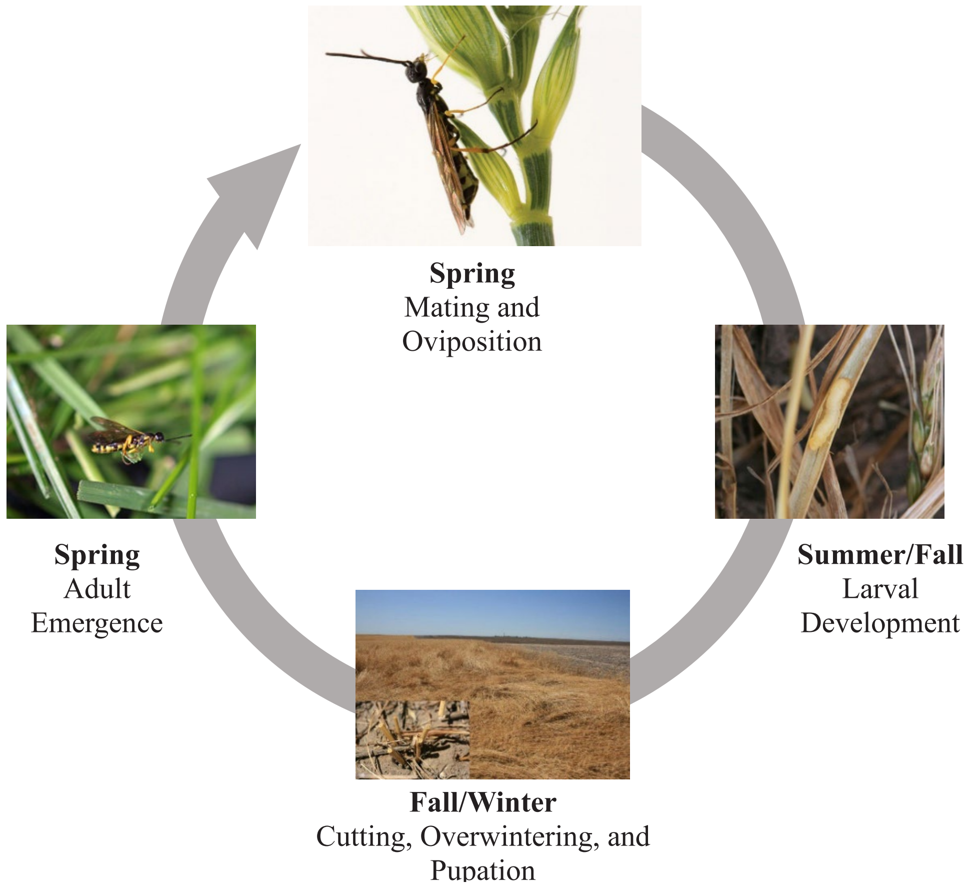
Q: What does wheat stem sawfly damage look like?

A: Before your wheat crop dries, you can cut open stems and find larvae, as well as sawdust-like frass from their feeding. Nutrients and tissue are being stolen from the plant by the larvae, decreasing crop yield. When the larvae finish feeding, they then cut the insides of the stems horizontally near the soil, making the stems prone to lodging. Lodging is especially common during strong winds and precipitation events. Unlike stems lodged from other causes, sawfly-cut stems are no longer connected to the plant.

Q: What is the life cycle of the wheat stem sawfly?

A: Wheat stem sawflies have a single generation per year. Adult wheat stem sawflies emerge from the previous year's stubble from May to June. Females lay their eggs inside wheat stems.

Although several eggs may be laid within a stem, only a single larva survives to maturity. As the plant matures, the larva moves down to the base of the stem and chews a notch around the inside of the stem. The notch usually causes the stem to break, producing a small stub that remains anchored in the ground. This stub is then filled with frass, which creates a protective chamber where the larva overwinters and undergoes pupation. The new adult either chews through the frass plug or the side of the wheat stub in the spring to start the cycle again.



Life cycle of wheat stem sawfly. Photo credits: Bugwood.wiki, Kelsey Dawson

Q: How do weather patterns impact sawfly movement and would severe cold temperatures kill off larvae?

A: Dry weather favors wheat stem sawflies. Excessively wet conditions tend to be detrimental to both sawfly and parasitic wasp populations. Severe cold as seen during the winter storm of 2020 typically does not affect wheat stem sawfly populations, as they are known to tolerate much colder temperatures in Canada. We are currently studying how weather trends impact the emergence timelines of adult sawflies.

Q: Do we find wheat stem sawfly in all wheat-producing counties?
A: Yes, as of 2020 wheat stem sawfly has been found in wheat in all wheat-producing counties in eastern Colorado. Most damaging infestations have been found in north central Colorado, with a few lighter infestations occurring as far south as Baca County. Drought conditions limited our use of southeastern survey sites in 2022. We hope to gain a more comprehensive understanding of the situation in this region in 2023.

Q: Where are the wheat stem sawflies coming from?
A: The wheat stem sawfly is native to Colorado and was first discovered in 1872 on non-cultivated grasses. Many believe that the insect adapted to wheat as European settlers began large-scale cultivation of cereal crops. It has long been a threat to spring wheat production in the Northern Plains and has become a significant pest of winter wheat as well.

Q: Why are we starting to have wheat stem sawfly problems now?
A: There is no good answer to this question, but it likely is due to some combination of the changes in the wheat stem sawfly's preference for wheat, changes in production practices (e.g., reduced tillage), and changes in climate.

Q: What is the estimated crop loss due to wheat stem sawfly in Colorado?
A: The annual economic loss in Colorado is conservatively estimated at $31-$33 million.

Q: How fast can wheat stem sawflies spread?
A: According to CSU survey results, damage in wheat was mostly limited to the New Raymer area in 2012. By 2020, wheat stem sawfly was found in all eastern Colorado wheat-producing counties. Heavily damaging populations can be found as far south as I-70, with most hotspots centering in the northern part of the state.

Q: Can we predict/react to wheat stem sawfly infestations ahead of time?
A: According to Canadian guidelines, observing greater than 10-15% sawfly cutting in wheat stems from the previous year indicates that adjacent fields should be planted with something other than wheat. If wheat is planted, resistant commercial varieties should be utilized.

Q: What are the hosts of wheat stem sawfly?
A: The cultivated hosts of wheat stem sawfly are limited to cereal grains with similar life cycles to wheat (winter/spring wheat, triticale, barley, rye). Wheat stem sawfly is not known to survive on oats or flax. The list of native and non-native grass hosts of the wheat stem sawfly is extensive and includes bromegrasses, wheatgrasses, wild ryes, and many other species commonly found in the state.

Q: What rotation crops can reduce the level of wheat stem sawfly infestation?
A: None of the common rotational crops (corn, proso millet, sorghum, sunflower) are affected by wheat stem sawfly. It is very important to plan rotations to avoid planting new wheat immediately adjacent to stubble infested during the previous crop. Crop rotation also has disease and pest management implications, and soil fertility benefits.

Q: How long do I have to stay out of wheat to reduce the problem, so I can go back to wheat with minimal loss of yield?
A: Wheat stem sawflies infest wheat fields in May and June and will remain in the field until adults emerge the following spring. At that time, adult sawflies disperse from the field looking for new wheat to infest, so the field could be planted with wheat that fall without risk of infestation by the sawflies of the previous year. However, sawflies from adjacent fields or greater distances may infest the new crop, and sawflies can still survive in nearby native grasses.

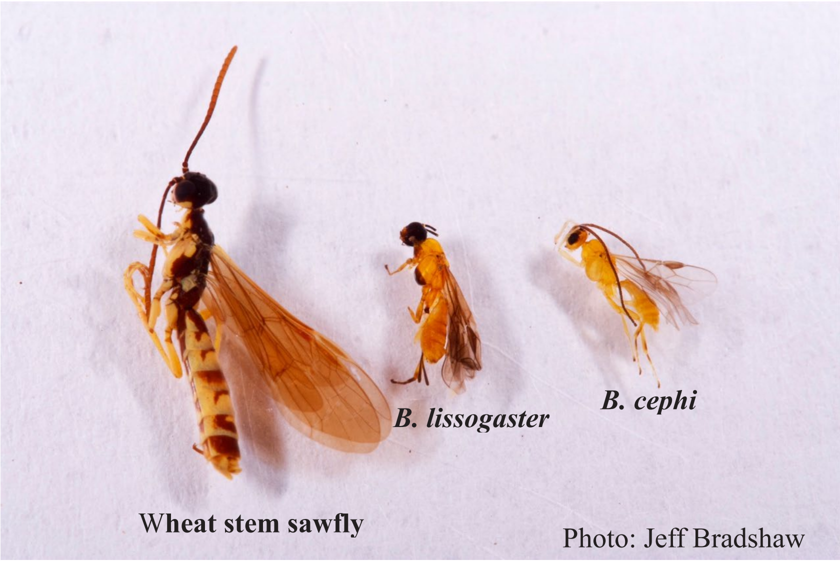
Q: How effective is tillage in controlling the wheat stem sawfly?
A: Both fall and spring tillage have been used to expose crowns containing overwintering larvae to moisture and temperature extremes, but it has not been particularly effective. Also, tillage will negatively impact the natural enemies that also overwinter in the stubs. If tillage is utilized, it is a tool best reserved for use in fields with low-to-moderate infestation.

Q: Are there wheat varieties that are resistant to wheat stem sawfly?
A: Yes, there are sawfly-resistant varieties that have a trait called "solid stem". In these plants, the center of the stems is filled up entirely with tissue, making it difficult for eggs to be laid inside it. Solid stem varieties of wheat have also shown to be effective in impeding larval development and movement, thus reducing larval survival. CSU has released a semi-solid variety, Fortify SF, a medium maturity variety with wheat curl mite resistance and a similar yield potential to Byrd under normal field conditions. It is not highly resistant to sawflies because it has only a semi-solid stem. However, it is substantially more resistant than other locally adapted varieties. Breeding wheat varieties for WSS resistance remains a high priority for CSU.

Q: What is known about the consistency of expression of stem solidness, and the degree of resistance conferred by the new semi-solid varieties?
A: Reports from Montana and Canada suggest that certain environmental conditions, such as lower light intensity from increased cloud cover or lower elevation, may result in reduced expression of solidness. We do not yet know for certain how much of an issue this will be here in Colorado with our higher light intensities. The level of expression of semi-solidness observed has provided significant reductions in stem cutting during field trials.

Q: Is there a yield drag associated with the new semi-solid varieties?
A: There is a yield drag, based on our CSU Elite trials. When comparing the semi-solid plants to non-resistant varieties, we estimated the yield drag to be about 4.5% in the absence of wheat stem sawfly. Semi-solid varieties should outyield susceptible varieties if both are infested with sawflies.

Q: Does the wheat stem sawfly have any natural enemies?
A: There are a few insect species that feed on the wheat stem sawfly. The most important of these are two parasitic wasps, *Bracon cephi* and *Bracon lissogaster*, whose larvae can be found feeding on wheat stem sawfly inside wheat stems.



Comparison of wheat stem sawfly and its parasitoids.

Q: How important are these parasitic wasps in Colorado?
A: To date, in Colorado few specimens of either wasp species have been found feeding on wheat stem sawfly in wheat. They are more easily found on wheat stem sawfly larvae infesting non-cultivated grasses. The parasitic wasps are considered to be important management tools in the Northern Plains, which have a longer history of wheat stem sawfly infestations in wheat.

Q: Are there practices that will encourage the parasitic wasps to attack wheat stem sawfly?
A: These parasitic wasps are expected to become more important as they adapt to wheat stem sawfly infestations in wheat. Tillage and swathing fields are two practices known to affect them negatively. However, if provided with sugar resources, such as flowers, adult parasitoid wasps can live longer and produce more offspring. Research has shown that incorporating buckwheat into cover crop mixes could enhance parasitoid performance.

Q: How can I control existing wheat stem sawfly infestations in my wheat?
A: Little can be done to eradicate the sawflies once your wheat is infested. No effective chemical controls are currently available. Stem cutting can be reduced by swathing, and stripper headers are better at picking up cut stems than traditional headers. Planting resistant varieties of wheat and using proper crop rotations can further mitigate losses.

Q: Can wheat stem sawflies be controlled with insecticides?
A: The egg, larval, and pupal stages are found within the stem, making them inaccessible to most insecticides. To date, no insecticides have been found to be very cost-effective at controlling wheat stem sawfly. More research into the topic is currently underway. Of note, it is suspected that the exact timing of pesticide applications will dramatically impact their effectiveness.

Q: Will swathing my wheat reduce losses to wheat stem sawflies?
A: Wheat can be swathed before stem cutting starts. Disadvantages to swathing include the cost of an extra field operation and negative effects on the parasitic wasps that are feeding on sawfly larvae. Costs can be reduced by swathing just the field margins, where infestations generally are more severe. Effects on natural enemies of the sawflies can be minimized by leaving the lower third of the stem intact.

Q: What is the best way to recover cut stems during harvest?
A: Combines equipped with stripper headers are the most efficient means of retrieving cut stems at harvest.

Q: Can the wheat stem sawfly be eradicated?
A: No. To date, we have no appropriate management methods that can eliminate this insect from fields. Further, this insect is native to Colorado and is well-adapted to our environment. Finally, you would need to eradicate them from all non-cultivated grasses as well as from wheat, since they can reside in either type of host.

Q: How do I prevent wheat stem sawfly infestations in my wheat?
A: Current preventive measures include planting semi-solid varieties, reducing the amount of wheat in your rotations, avoiding planting new wheat plants next to wheat stubble, and planting larger blocks of wheat to minimize the severe infestations found in field edges.

Q: What research is being conducted at CSU in response to the wheat stem sawfly outbreak?
A: CSU is emphasizing the development of high quality, productive wheat varieties resistant to wheat stem sawfly. Other research projects include screening for novel sources of resistance, improving biological controls, testing the use of trap crops, and trying new approaches to chemical control. We also conduct surveys to track the spread of this pest, to help growers see if their regions are hotspots for infestation.

Acknowledgements:
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Thanks to Frank Peairs, Scott Haley, Esten Mason, Tyler Benninghoven, Brad Erker, Assefa Gebre-Amlak, Jerry Johnson, and Sally Jones-Diamond for providing questions and for reviewing earlier versions of this work.

Additional Resources:
https://wiki.bugwood.org/HPIPM:Wheat_Stem_Sawfly https://extension.colostate.edu/topic-areas/insects/wheat-stem-sawfly-a-new-pest-of-colorado-wheat-5-612/
https://www.ag.ndsu.edu/publications/landing-pages/crops/wheat-stem-sawfly-e-1479

More information available at www.csuwheatentomology.com

News From the CSU Soil, Water, Plant Testing Laboratory

Dr. Wilma Trujillo

Colorado State University's Soil, Water, and Plant Testing Laboratory (SWPTL) is part of the Department of Soil and Crops Sciences in the College of Agricultural Sciences. In the Fall of 2022, the SWPTL moved to a new state-of-the-art facility at the CSU Spur campus at the National Western Stock Show Complex in Denver. The Colorado State University System made a significant investment in this new facility so we can provide world-class services at a location that is more accessible to farmers, gardeners, crop and environmental consultants, urban agriculturists, and lawn and landscape professionals.

Cutting-Edge Testing

We have transformed the lab. Given the ample space and resources at our new location, we have been able to embrace the most modern and innovative technology. We will continue offering cutting-edge soil, water, and plant tests with outstanding customer service. The SWPTL is dedicated to providing the best science-based actionable insights to support sustainable management decisions for healthy soils and nutritious food crops.

Dedicated Scientists

With over 50 years of experience, a dedicated team of soil scientists, plant biologists, agronomists, biochemists, and watershed scientists continue working on expanding the impact and visibility of CSU's work to safeguard Colorado's agricultural resources as well as engaging and providing education to rural and urban populations beyond traditional agricultural clientele (K-12 youth, teachers, and families).

Currently, the SWPTL has three full-time technicians. The technicians are primarily responsible for the preparation and testing of samples as well as for the maintenance and calibration of laboratory instruments and testing devices. The SWPTL also employs, on an hourly basis, three undergraduate students to assist in sample preparation, data entry, and customer service. As students help with many of the basic day-to-day tasks, they also gain invaluable laboratory experience which will contribute to their career success after graduation.

Serving Agriculture

The growing season is upon us and the SWPTL is gearing up to offer comprehensive analyses of soil, water, plant tissue, manure, compost, and other agricultural material. The lab is open to the public Monday to Thursday from 9 am to 5 pm. Customers are welcome to mail or drop samples. The web page (https://agsci.colostate.edu/soiltestinglab/) is updated with new submission forms, a price list and other important information. Fee-based services are available to the general public, as well as CSU faculty, researchers, students, extension agents, and staff.

Please contact us by visiting our website, emailing, or calling.
Tel: 970-491-5061
Email: soiltestinglab@colostate.edu

The Wheat Mosaic Virus Complex,
Emerging Issues, and Disease Management

Matt West and Dr. Robyn Roberts

In Colorado, a major problem in cereal crops is the wheat streak mosaic virus complex, which is a group of viruses that causes major yield losses in wheat. This complex is made up of three viruses: *Wheat streak mosaic virus* (WSMV), *Triticum mosaic virus* (TriMV), and *High Plains wheat mosaic virus* (HPWMoV). When plants are infected with more than one virus, the symptoms get worse, and the yield is greatly reduced. The symptoms include stunted growth, chlorotic streaks, mosaics, and speckles. The severity of the symptoms depends on the environment and when the plant was infected.

Virus Incidence

In 2022, the Roberts Lab received wheat samples with suspected wheat streak disease. These samples originated from Colorado's High Plains region and presented severe symptoms.

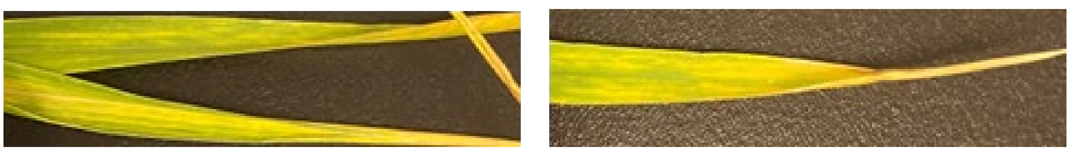
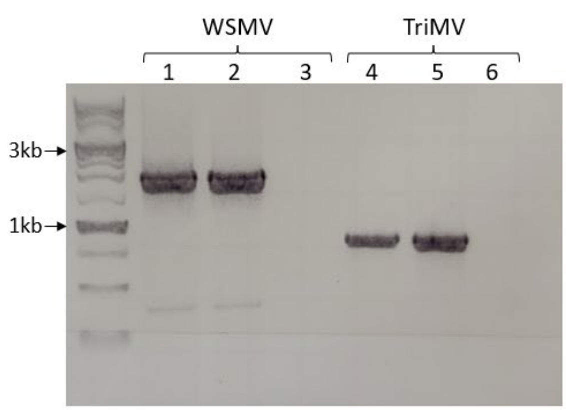


Figure 1. Hard red winter wheat variety Byrd CL+ showing wheat mosaic symptoms.

The wheat samples were tested for WSMV, TriMV, and HPWMoV. PCR results were positive for WSMV and TriMV. An ELISA assay was performed for HPWMoV which tested negative.



Lane	Sample	Expected Size
1	Byrd CL+	1698bp
2	Positive control	1698bp
3	Negative control	
4	Byrd CL+	880bp
5	Positive control	880bp
6	Negative control	

Figure 2. PCR results from the above Byrd CL+ sample detected both WSMV and TriMV in the wheat mosaic virus complex.

The Roberts lab is currently investigating the increasing incidence of TriMV in the mosaic virus complex and the mechanistic drivers of resistance to WSMV and TriMV. We hope to uncover new resistance mechanisms which could be effective against the virus complex.

Vector

The wheat curl mite (*Aceria tosichella*) is the vector for the mosaic virus complex, which includes WSMV, TriMV, and HPWMoV. These mites move from infected plants to healthy ones, spreading the virus along the way. As a result, infected plants are smaller and have yellow streaks on their leaves.

The mites can survive the winter inside infected plants and move to other plants when the weather warms up in the spring and summer, continuing to spread the virus. They create a protective space for themselves by causing the leaf edges to curl toward the midvein, which can be a visible border effect or gradient extending from the mite and virus source. Mites survive as adults, larvae, and eggs. Therefore, to prevent the spread of this disease, it is essential to manage volunteer plants between harvest and planting that serve as overwintering hosts to the wheat curl mite.

Weather factor and mite movement

Weather conditions can have a significant impact on the activity and transmission of wheat curl mite and the resulting spread of WSMV, TriMV, and HPWMoV.

Hot, dry weather is particularly conducive to the spread of wheat curl mites. During periods of high temperatures, mites become more active and move around more easily. This can result in a higher rate of transmission of viruses from infected plants to healthy plants.

Additionally, strong winds can carry mites from infected plants to nearby healthy plants, increasing the spread of viruses. Mites can also spread viruses from one plant to another through direct contact, such as when plants are touching or are close enough for mites to crawl from one to another.

Conversely, cooler temperatures and rainfall can have a suppressing effect on the activity of wheat curl mites, which can reduce the transmission of these viruses. This is because mites are less active and have a harder time moving from plant to plant in cooler, wetter weather.

Prevention

Preventing wheat streak disease involves, 1) using disease-resistant varieties, and 2) managing the wheat curl mite. To reduce the number of wheat curl mites, stop the "green bridge" between harvest and planting by controlling volunteers and waiting two weeks between volunteer management and planting, and avoid early fall planting. No pesticides are effective against the wheat curl mite.

Protecting Our Water Resources: The Colorado State University Agricultural Water Quality Program

Erik Wardle and A.J. Brown

What is the Agricultural Water Quality Program (AWQP)?

In Colorado and across the United States, agricultural inputs are being identified as one source of nutrient pollution. Nutrients can run off farmlands and accumulate in surface waterways, causing water quality issues. Most agricultural nutrient pollution is considered nonpoint source (NPS) or difficult to attribute to a particular point of origin. The AWQP protects Colorado state waters and the environment from contamination or degradation due to the improper use of agricultural chemicals, while supporting their proper and correct use.

The AWQP is composed of teams within three different organizations: Colorado State University (CSU), Colorado Department of Agriculture (CDA), and the Colorado Department of Public Health and Environment (CDPHE). The CSU branch of the AWQP is responsible for providing research, education, and training on agricultural Best Management Practices (BMPs). These BMPs feature methods that minimize the impact of fertilizer and pesticide applications on Colorado's water sources. These include conservation tillage, fertility management, irrigation scheduling, precision agriculture techniques, and other common modern farming practices. See the following page for explanation of terms.

The AWQP program builds on a foundation of nearly three decades of research experience, evaluating farmer-driven practices, and using ongoing stakeholder feedback and contributions. Agriculture is an unpredictable and ever changing industry, and the AWQP seeks to adapt, change, and focus on the most current needs of our stakeholders using the latest technologies available. As an unbiased science-based program, the AWQP pursues data to support producer and policy-maker decisions in Colorado.

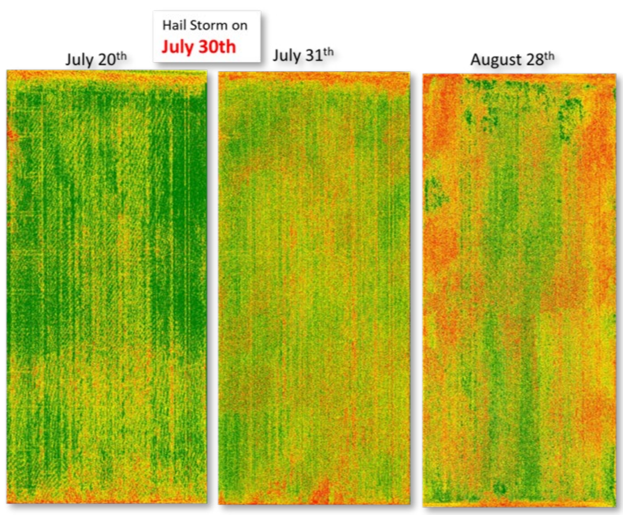


Figure 1. Example of the AWQP using drone technologies to map the crop damage from hail and Mexican bean beetle damage on dry beans using the Normalized Difference Vegetation Index (NDVI).

The success of our program is rooted in the strong relationships cultivated by working closely with the agricultural community and numerous private and public entities in the state of Colorado. The program has worked with growers for decades with support from the state, agricultural commodity groups, and special interest groups.

Statewide efforts to protect water quality.

Nitrogen (N) and phosphorus (P) are two major essential nutrients required for crop growth. When these nutrients are lacking in soils, they are added as supplemental fertilizer. Excess nitrogen and phosphorus that runs off farmland may enter surface and groundwater causing:

- Harmful algal blooms
- Reduced dissolved oxygen content which can be harmful to aquatic life.
- Contaminated drinking water supplies

Starting in 2012, Regulation 85, also known as the “Nutrient Management Control Regulation” began a more stringent statewide regulation of “point source” nutrient dischargers, such as wastewater treatment plants. Nonpoint sources, including most of agriculture, are discussed in the regulation, but mandatory requirements are currently not implemented. Instead, nonpoint sources are encouraged to adopt BMPs that can help reduce nutrient pollution in surface waterways.

The Colorado Water Quality Control Commission is expected to rule on NPS contributors, including agriculture, in 2023. The expectation is that no new regulations will be proposed due to the work of the AWQP and engagement from entities like the CSU Agricultural Experiment Station, United States Department of Agriculture National Resources Conservation Service (USDA-ARS), Colorado Corn Council, Colorado Ag Water Alliance, Western Sugar, Farm Bureau, and Colorado Livestock Association among others. Together, these groups provide unbiased scientific data to assess and decrease nonpoint water pollution and support the agricultural community and state decision-makers, thus protecting one of our most critical resources, water.

What can producers do?

Many agricultural producers already utilize BMPs that reduce agricultural nonpoint source pollution and nutrient losses. In addition, producers are encouraged to take an active role by:

- Continuing to adopt BMPs
- Participating in projects to monitor and collect water quality data
- Attending water quality control division meetings
- Encouraging fellow producers to become involved and stay engaged

Some notable BMPs for Colorado’s wheat growers include:

- **Conservation Tillage:** Conservation tillage helps to reduce soil erosion, reduce water loss to evaporation, and maintain soil structure, thereby reducing sediment and nutrient runoff into nearby water bodies.

- **Nutrient Management:** Proper nutrient management is essential to maintain soil fertility while minimizing the risk of nutrient pollution. Growers should conduct regular soil tests to determine the nutrient needs of the soil and apply fertilizers accordingly. Use the 4 R’s of nutrient management: 1) Right source, 2) Right time, 3) Right place, 4) Right amount.

- **Cover Crops**: Cover crops have been shown to reduce soil erosion, improve soil health, and minimize nutrient leaching. Use when feasible, as it may not always make sense due to moisture limitations.
- **Integrated Pest Management:** Integrated Pest Management (IPM) involves using a combination of cultural, biological, mechanical, and chemical methods to manage pests. This approach helps to minimize the use of pesticides, thereby reducing the risk of pesticide contamination in water bodies.
- **Buffer Zones:** Buffer zones, such as vegetated strips along streams or at the edge of fields, can help to trap and filter sediment and pollutants before they enter the water.
- **Irrigation Management:** Efficient irrigation practices, such as irrigation scheduling using the water balance method and soil moisture monitoring, help to reduce water use and minimize runoff.

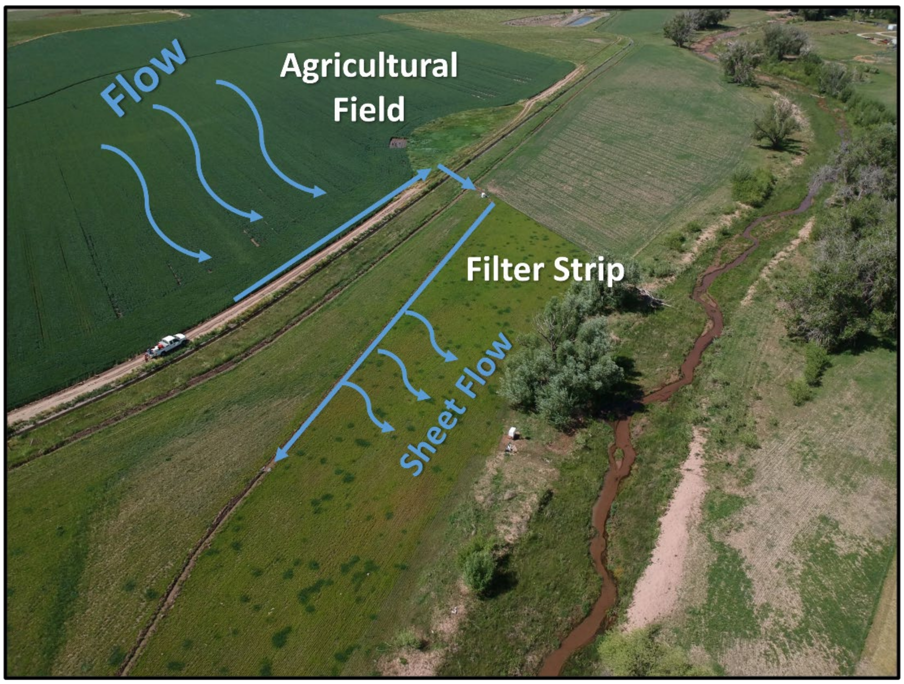


Figure 2: Example of a vegetative buffer zone, using perennial grasses and other species, filtering runoff water from a neighboring agricultural field prior to entering the return water body.

For any questions about the AWQP, or to get engaged with water quality, please reach out to our research and outreach coordinator, Christina Welch at christina.welch@colostate.edu.

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notes

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