Technical Report Wheat Field Days Edition- 2015

Agricultural Experiment Station

Colorado State University

College of Agricultural Sciences Department of Soil & Crop Sciences Extension

Crops Testing

Making Better Decisions

2014 Colorado Winter Wheat Variety Performance Trials

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Additional Resources on the Internet:

Colorado State University Crop Variety Testing Program: www.csucrops.com
Colorado State University Wheat Breeding Program: www.wheat.colostate.edu
Colorado Wheat Variety Performance Database (CSU Wheat Breeding Program): www.ramwheatdb.com
Colorado Wheat Administrative Committee (CWAC), Colorado Association of Wheat Growers (CAWG), and Colorado Wheat Research Foundation (CWRF): www.coloradowheat.org

Variety Performance in the 2015 Eastern Colorado Winter Wheat Trials

Jerry Johnson and Scott Haley

The Colorado State University Crops Testing and Wheat Breeding and Genetics programs provide current, reliable, and unbiased wheat variety information as quickly as possible to Colorado producers for making better variety decisions. CSU has an excellent research faculty and staff, a focused breeding program, graduate and undergraduate students, and dedicated agricultural extension specialists. Wheat improvement in Colorado would not be possible without the support and cooperation of the entire Colorado wheat industry. Strong producer support for our programs is critical for sustained public variety development and testing.
Our wheat variety performance trials and Collaborative On-Farm Tests (COFT) represent the final stages of a wheat breeding program where promising and newly released experimental lines are tested under an increasingly broad range of environmental conditions.

There were 44 entries in the dryland performance trials (UVPT) and 28 entries in the irrigated performance trials (IVPT). All trials included a combination of public and private varieties and experimental lines from Colorado, Texas, Kansas, Oklahoma, Nebraska, Wyoming, and Montana. Seed companies with entries in the variety trials included Westbred (Syngenta), AgriPro (Monsanto), Limagrain, AGSECO, and Watley Seed Company. There were entries from four marketing organizations, PlainsGold (Colorado), Husker Genetics (Nebraska), the Crop Research Foundation of Wyoming, and the Kansas Wheat Alliance. All dryland and irrigated trials were planted in a randomized complete block design with three replicates. Plot sizes were approximately 175 ft^2 (except the Fort Collins IVPT, which was 80 ft^2) and all varieties were planted at 700,000 viable seeds per acre for dryland trials and 1.2 million viable seeds per acre for irrigated trials. Yields were corrected to 12% moisture. Test weight information was obtained from an air blower-cleaned sample of the first replication or from a combine equipped with a Harvest Master measuring system.

2014 Dryland Variety Performance Trials – Southeast Locations

Walsh – Planted 10/2/2013. September precipitation and good emergence. Freezing events, but not too bad. Dry conditions from planting until May 2014. Blowing between the rows. Jointing was later than normal. Brown wheat mites were present around the trial. On May 23, the site received 1.5 inches of rain. In early June it received another 1.5 inches. The trial average yield of 33.3 bushels/acre was better than expected given an October date of planting.

Lamar – Planted 9/23/13. Brown wheat mites bad in April. Soil probe to 3”, very dry. Very small plants in June (average plant height at harvest was 18 inches). Soil was very dry. Brown wheat mites damaged plants and drought led to dry plants. Trial was highly variable for plant height (minimum 13 inches, maximum 24 inches). No weeds were present. Visit to trial by Tony Frank, president of CSU. The nearest weather station showed 8 inches of precipitation from September 2013 through June 2014. Another 6.5 inches fell in July. Average trial yield was 24.8 bushels/ acre.

Sheridan Lake – Planted 9/19/13 into good soil moisture conditions that led to good stands. By April, soil was very dry and frost damage was evident. In June the leaves were rolled from drought. There were no insect or disease pests. According to the nearest weather station, only 6.3 inches of rain fell from September 2013 through June 2014. Another 2.8 inches fell in July. Trial average yield was 41.4 bushels/acre. Given the low precipitation, yields were exceptionally high.

Arapahoe – Planted 9/19/13 in good soil moisture conditions. Very dry in April with distinct drought patches and very small plants. Some frost damage apparent. In June, the trial was very uneven within single plots and among plots within the trial. Patches of short plants more apparent in June and were highly variable. There were also white heads from frost or drought. Due to the variability, and no expectation of any meaningful data, this trial was not harvested.

2014 Dryland Variety Performance Trials – Northeast Locations

Burlington – Planted 9/24/13. In April, soil was very dry and no subsoil moisture. However, plots still looked good and did not seem stressed. There was no winterkill. Brown wheat mites were present in isolated spots. According to precipitation records at the nearest weather station there were 4.25 inches of rain in September 2013 and then 4.39 inches of rain in June 2014. In early June there was a very recent rain but it was obvious that the plants had been drought stressed before the rain. Brown wheat mite damage on one end of trial. There appeared to be some root rot. Freeze damage apparent in all varieties with some white heads. Trial average yield was 45.3 bushels/acre.

Genoa – Planted 9/30/13. In April there was very good moisture (probe down to 5 feet). Some leaf burning and winterkill. In early June there was moderate leaf rolling in some varieties and there had been a small amount of moisture. There was a severe hail event in June and the trial was abandoned.

Roggen – Planted 10/2/13. Sludge applied during the previous year, but no other fertilizer applied except starter at planting. In early April there was good subsoil moisture (probe went in easily). There was no winterkill, disease, or insect infestation. Plant stands were acceptable in all parts of the trial. According to the nearest weather station there was 15.5 inches of precipitation from September 2013 through June 2014. Trial received 1.25 inches of rain/snow moisture from May 10 to 12, 2014. Very uniform trial in early June with slight curling of the leaves. The trial received hail on June 24 (estimated yield loss of 10% to 30%). Trial average yield was 80.7 bushels/acre.

Akron – Planted 9/26/13. In April, soil was very dry and plants were drought stressed. The whole trial was affected by severe wind erosion that covered some plants. The wheat was blown out around the edges of the trial. No mites, winterkill, or disease. In early June there was some hail damage as well as wind erosion. Some freeze damage was evident. Some plots suffering from drought and others not. The weather station showed 15.8 inches of precipitation from September 2013 through June 2014. Trial average yield was 61.7 bushels/acre.

Yuma – Planted 9/20/13. In early April, minor winterkill could be seen and soil was dry. In early June the soil was very dry, and some varieties had curled leaves. Trial was very uniform and stands were good. Precipitation, according to the nearest weather station, from September 2013 through June 2014 was 10.2 inches. Trial average yield was 70.7 bushels/acre.

Orchard – Planted 10/1/13. In mid-October the emergence was very uniform due to moisture from recent rains. Leaf tips were burned from frost damage based on site visit in mid-April. Soil probe went down to 1.5 feet. According to the nearest weather station there was 10.2 inches of precipitation from September 2013 through June 2014. Very uniform trial. At harvest, some wheat stem sawfly damage was noted. Trial average yield was 58.2 bushels/acre.

Julesburg – Planted 9/26/13. In mid-November plant stands were good and there was good soil moisture. In April however, the trial was dry with some burning on leaf tips. Precipitation, according to the nearest weather station, from September 2013 through June 2014 was 14.3 inches. Trial average yield was 83.6 bushels/acre.

General Wheat Growing Conditions in Southeast Colorado - Wilma Trujillo

Wheat producers in the southeastern area of the state planted into some of the best soil moisture conditions that they have seen in several years. Rains in mid-August and early September restored farmers' hope after losses from drought in recent years. The good moisture conditions led to an increase in the number of wheat acres that were planted compared to 2012. The favorable conditions also resulted in good stands going into winter. During the winter months temperatures were colder than normal. The majority of the southeastern corner was still under severe and extreme drought conditions. Lack of moisture combined with high wind conditions (gusts reaching 60 miles-per-hour) produced dust storms and blow-out of wheat fields.

As wheat fields started to green up in the spring, some concerns continued regarding winterkill due to extremely cold temperatures. Cool temperatures experienced in March and April delayed crop development and it was one to two weeks behind normal. Record low-temperatures with little or no snow cover caused some damage to the wheat crop in mid-April. Fortunately, the wheat was not jointed yet and only minor freeze damage occurred. In mid-May, temperatures were in the mid- to low-20s, which was low enough to damage wheat in more advanced growth stages. At this time, more fields were in the jointing and pre-boot stage than during the freeze in April. Soil moisture conditions were still dry. In mid- to late-May, rain and the return of more seasonably warm weather helped wheat survive.

Accumulated precipitation was 4.45 inches from October 1, 2013 to June 30, 2014 at the CoAgMet weather station south of Lamar. During the spring and early summer, precipitation was largely isolated and insufficient, with no significant improvement in moisture supplies noted. In mid- to late-June, the area saw a fair amount of hail, ranging from light hail events to more major damage.

Wheat Growing Conditions in the Central High Plains – Ron Meyer

The 2014 wheat growing season in Eastern Colorado was one for the record books. The 2013 wheat crop had exceptionally disappointing yields. Some wheat fields averaged only 5 bushels per acre. The 2013 Colorado wheat crop came in at only approximately 50% of normal for the state. The dry weather continued into early September of 2013 with wheat planting on many farms delayed, waiting for moisture to drill into. Relief finally came with major precipitation occurring September 11 through 13. Weather stations throughout Eastern Colorado all recorded heavy rainfall, with some areas south of Burlington receiving 8 inches. The weather station, Burlington 3, recorded 3.79 inches over the three day period, 2.54 inches more than the long term average for the month of September. As a result of the prior dry growing season and reduced tillage strategies employed by producers, most areas in Eastern Colorado had only a limited amount of water runoff. Although isolated areas experienced water runoff, a major benefit of the reduced tillage practices employed by Eastern Colorado producers resulted in much of that precipitation percolating into soil profiles. That precipitation capture turned out to be a wheat crop maker.

From October 2013 until April 2014, the rest of the growing season continued to experience below normal precipitation. Finally, moisture relief was received in April and May at many locations and coupled with cooler than normal weather, wheat yields responded positively. As a result of September rainfall capture and cooler and wetter weather patterns in April and May, 2014 wheat yields across Eastern Colorado were double the previous year's yields. The driest period during the growing season was November 6 through January 4 when no precipitation was received during a 60 day period. Yet in June, the Burlington site reported 37% of the days had some precipitation. For the 2014 wheat growing season, precipitation at Burlington 3 from August through May was only 60% of normal. However, as a result of reduced tillage practices, cooler air temperatures and late season moisture, wheat yields were much better than expected.

Wheat Growing Conditions in the North Central High Plains – Bruce Bosley

Many dryland wheat producers in the north central High Plains experienced a once-in-a-lifetime wheat crop this year. Some wheat fields averaged over 80 bushels/acre. However, for a few, this year will be remembered with disappointment over their good prospects being thwarted by hail and unmarketable, disease-infested grain.

September's planting season started dry but rains came in the middle and latter part of the month. As a result of wet fields, many farmers were planting in October, and some planted after October 15. September rains were notably higher in fields near the Foothills and less or absent near the eastern state border. October had a slightly higher than normal rainfall, and averaged 5.5 degrees cooler for daytime high temperatures.

The period from November through February is typically the driest time of year for the High Plains region, normally receiving less than 1.5 inches of total precipitation. In November and December, the climate was slightly warmer and also drier than normal. However, snowfall amounted to higher than normal levels in both January and February. Warm spells melted some of this snow in January. February's snow cover helped protect wheat in those fields that had good stubble and crop residues during an exceptionally cold month. Wheat in tilled and low residue fields suffered cold and frost injury during the coldest days of February.

March and April were somewhat warmer than average. However, minimum temperatures dropped significantly once in late April. Due to late plantings and cold weather in February, jointing occurred about 10-14 days later than normal. Many farmers found high infestations of army cutworms stunting the spring regrowth in their fields. Winter-killed wheat was first noted during April, especially on late October planted wheat. Wheat die-back, in patches or large areas of the field, was due to wind damage on bare fields. The temperature dropped to below freezing on May 11, 12, and 13. Heavy snows in May packed down or flattened developing wheat stems. The cool and wet June helped most dryland wheat fields develop the record level wheat yields. However, some farms had significant hail storms that reduced yields and caused delays in maturation. Storms continued into July and harvest was delayed. Common bunt (stinking smut) became evident in some fields, especially in the northeast corner of Colorado. The delayed planting and cooler and wetter conditions at seeding contributed to the development of bunt.

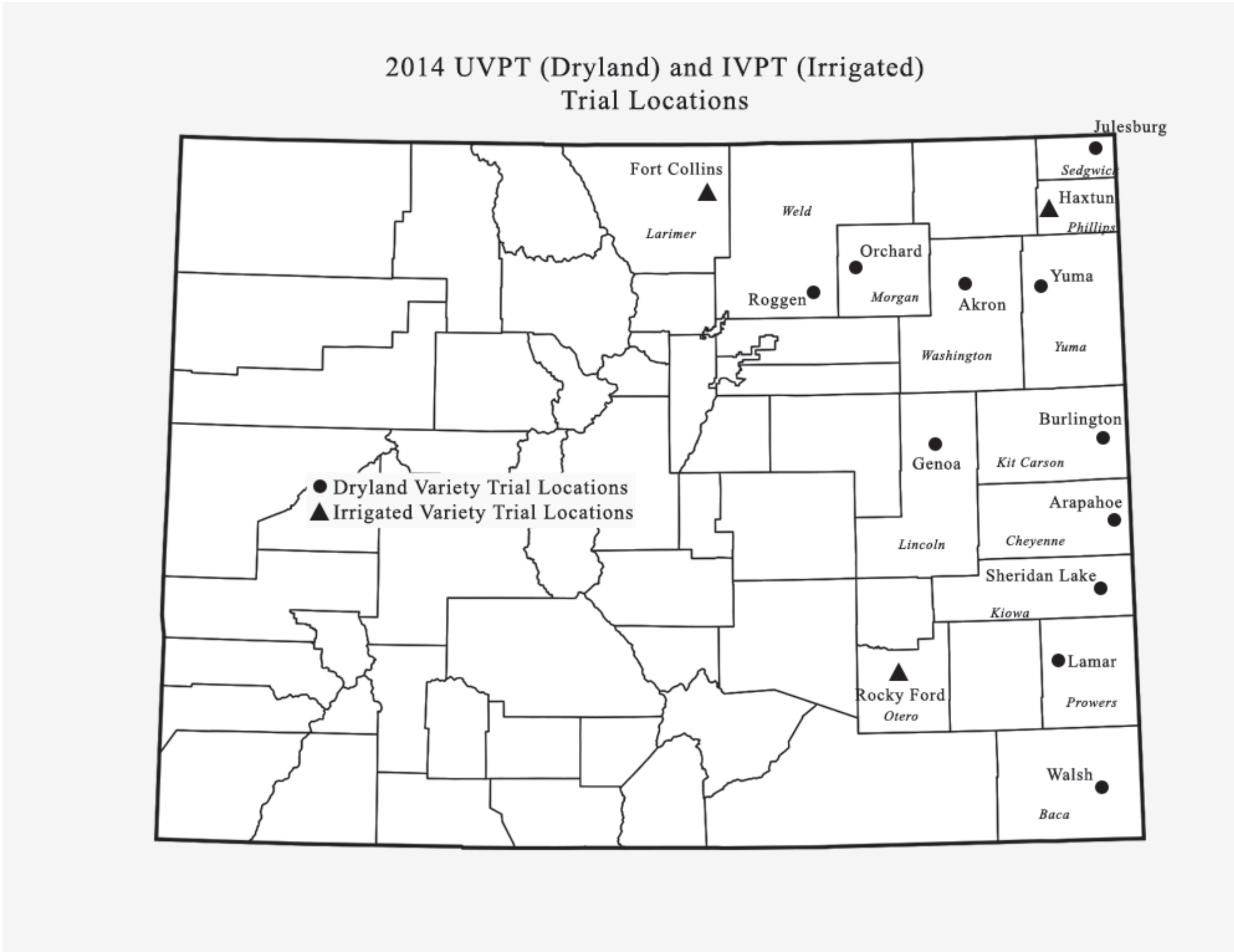
The exceptional yields harvested by many area farmers can be attributed to many factors, including adapted wheat varieties and good tillage, crop, pest, and plant nutrient management practices. However this year adequate soil moisture reserves, timely snows and rains and moderate temperatures during pollination and grain-fill helped to optimize the wheat potential.

2014 Irrigated Variety Performance Trials

Haxtun – Planted 10/23/13 after corn harvest. Leaf tips a little burned from frost on April 14, 2014. Stands were acceptable, but not great. No diseases or pests found. Managed for maximum yield by Servi-Tech and the cooperator. Harvested 7/22/14. Trial average yield was 122.7 bushels/acre. Very high yields given the late date of planting.

Fort Collins – Planted 10/2/13. Very uniform trial. Planting later than typical after 4.3" of rain in mid-September, good stand establishment. Good winter and spring moisture and timely irrigation with ample precipitation. No damage from freeze but wheat was laid down due to heavy May winds. Trial average yield was 101.4 bushels/acre.

Rocky Ford – Trial could not be harvested for the past two years. In 2013 the trial was highly variable for height, suffered from an early infestation of brown mites, had herbicide damage, and morning glory was a problem. In 2014, there was severe lodging due to heavy wind and rain, and the entire trial was lying flat on the ground.


2014 UVPT (Dryland) and IVPT (Irrigated)
Trial Locations
Julesburg
Sedgwick
Haxtun
Phillips
Fort Collins
Larimer
Weld
Orchard
Morgan
Roggen
Akron
Yuma
Washington
Yuma
Burlington
Kit Carson
Genoa
Lincoln
Arapahoe
Cheyenne
Sheridan Lake
Kiowa
Lamar
Prowers
Rocky Ford
Otero
Walsh
Baca
● Dryland Variety Trial Locations
▲ Irrigated Variety Trial Locations

Summary of 2014 Dryland Variety Performance Results

Variety[a]	Brand/Source	Market Class[b]	Yield[c]	Yield	Test Weight[c]	Plant Height[c]
			bu/ac	% trial average	lb/bu	in
CO11D174	CO State Univ. exp.	HRW	64.1	116%	61.5	27
Antero	PlainsGold	**HWW**	62.3	112%	60.0	27
Byrd	PlainsGold	HRW	60.4	109%	61.6	26
Cowboy	Crop Res. Foundation of WY	HRW	60.2	109%	61.4	26
CO09W040-F1	CO State Univ. exp.	**HWW**	59.6	107%	60.9	25
Denali	PlainsGold	HRW	59.2	107%	62.3	26
CO11D446	CO State Univ. exp.	HRW	58.9	106%	61.4	24
Settler CL	Husker Genetics	HRW	58.7	106%	59.2	24
CO09W009	CO State Univ. exp.	**HWW**	58.0	105%	62.0	24
Bond CL	PlainsGold	HRW	58.0	105%	55.7	27
Oakley CL	KS Wheat Alliance	HRW	58.0	105%	60.0	25
Bill Brown	PlainsGold	HRW	57.6	104%	61.6	25
Hatcher	PlainsGold	HRW	57.2	103%	60.3	25
SY Monument	AgriPro Syngenta	HRW	56.7	102%	60.8	26
CO11D346	CO State Univ. exp.	HRW	56.7	102%	61.4	26
Ripper	PlainsGold	HRW	56.5	102%	60.1	25
Sunshine	CO State Univ. exp.	**HWW**	56.4	102%	59.0	25
Snowmass	PlainsGold	**HWW**	56.4	102%	60.9	27
LCS Pistol	Limagrain exp.	HRW	56.1	101%	60.6	24
Clara CL	KS Wheat Alliance	**HWW**	55.6	100%	59.8	24
Winterhawk	WestBred Monsanto	HRW	55.5	100%	62.6	27
Brawl CL Plus	PlainsGold	HRW	55.4	100%	61.1	27
LCS Mint	Limagrain	HRW	55.4	100%	61.6	26
Akron	CO State Univ.	HRW	54.8	99%	60.8	26
TAM 112	Watley Seed	HRW	54.8	99%	62.3	25
TAM 113	AGSECO	HRW	54.8	99%	60.0	25
WB-Grainfield	WestBred Monsanto	HRW	54.7	99%	61.5	26
Iba	Oklahoma Genetics	HRW	54.7	99%	60.7	24
Prairie Red	PlainsGold	HRW	54.5	98%	59.5	24
Gallagher	Oklahoma Genetics	HRW	54.4	98%	58.4	24
Above	PlainsGold	HRW	54.3	98%	59.6	26
T158	Limagrain	HRW	54.1	97%	60.9	23
CSU Blend13	PlainsGold/MT State Univ.	HRW	54.0	97%	60.6	23
TAM 111	AgriPro Syngenta	HRW	54.0	97%	62.0	27
KS10HW78-1	Kansas exp.	**HWW**	53.6	97%	60.2	24
KanMark	KS Wheat Alliance	HRW	53.3	96%	61.6	22
Robidoux	Husker Genetics	HRW	51.3	93%	61.7	24
Yumar	PlainsGold	HRW	51.2	92%	60.3	25
1863	KS Wheat Alliance	HRW	50.6	91%	59.7	25
Bearpaw	Montana State Univ.	HRW	50.1	90%	60.6	24
LCH11-1064	Limagrain exp.	HRW	49.1	89%	61.5	23
Warhorse	Montana State Univ.	HRW	47.1	85%	60.6	24
Freeman	Husker Genetics	HRW	46.8	84%	61.1	24
		Average	**55.5**		**60.7**	**25**

[a]Varieties ranked according to average yield in 2014.

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

[c]The 2014 average yield and plant heights are based on nine 2014 trials and test weights are based on eight 2014 trials.

Summary of 2-Year (2013-2014) Dryland Variety Performance Results

			2-Year Average[a]			
Variety[b]	Brand/Source	Market Class[c]	Yield	Yield	Test Weight	Plant Height
			bu/ac	% trial average	lb/bu	in
Antero	PlainsGold	**HWW**	47.1	113%	58.6	25
Byrd	PlainsGold	HRW	45.8	110%	59.2	25
Settler CL	Husker Genetics	HRW	44.4	106%	57.5	23
Denali	PlainsGold	HRW	44.3	106%	60.2	25
Oakley CL	KS Wheat Alliance	HRW	43.9	105%	58.7	24
Bill Brown	PlainsGold	HRW	42.9	103%	59.0	24
LCS Mint	Limagrain	HRW	42.8	102%	60.2	25
Ripper	PlainsGold	HRW	42.7	102%	57.9	24
Brawl CL Plus	PlainsGold	HRW	42.5	102%	59.2	25
Bond CL	PlainsGold	HRW	42.4	101%	54.8	25
Winterhawk	WestBred Monsanto	HRW	42.3	101%	60.6	25
Clara CL	KS Wheat Alliance	**HWW**	42.1	101%	58.7	24
Hatcher	PlainsGold	HRW	42.0	101%	58.6	23
TAM 112	Watley Seed	HRW	41.9	100%	59.8	24
Iba	Oklahoma Genetics	HRW	41.9	100%	59.1	23
WB-Grainfield	WestBred Monsanto	HRW	41.7	100%	58.9	25
Above	PlainsGold	HRW	41.4	99%	57.6	24
T158	Limagrain	HRW	41.3	99%	58.6	22
TAM 113	AGSECO	HRW	41.0	98%	58.4	24
Gallagher	Oklahoma Genetics	HRW	40.9	98%	57.4	23
TAM 111	AgriPro Syngenta	HRW	40.9	98%	59.6	25
Snowmass	PlainsGold	**HWW**	40.7	97%	58.2	25
Robidoux	Husker Genetics	HRW	39.4	94%	59.3	23
1863	KS Wheat Alliance	HRW	38.4	92%	58.4	24
Bearpaw	Montana State Univ.	HRW	36.7	88%	58.9	22
Freeman	Husker Genetics	HRW	36.0	86%	58.2	23
		Average	**41.8**		**58.7**	**24**

[a]The 2-year average yield is based on nine 2014 trials and seven 2013 trials. Test weights are based on eight 2014 trials and five 2013 trials. Plant heights are based on nine 2014 trials and six 2013 trials.

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

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

Summary of 3-Year (2012-2014) Dryland Variety Performance Results

Variety[b]	Brand/Source	Market Class[c]	3-Year Average[a] Yield	Yield	Test Weight	Plant Height
			bu/ac	% trial average	lb/bu	in
Antero	PlainsGold	**HWW**	49.8	111%	59.8	26
Byrd	PlainsGold	HRW	49.1	110%	59.9	26
Denali	PlainsGold	HRW	45.9	103%	60.9	26
Settler CL	Husker Genetics	HRW	45.8	102%	58.9	24
Ripper	PlainsGold	HRW	45.7	102%	58.7	25
Brawl CL Plus	PlainsGold	HRW	45.5	102%	60.3	26
TAM 112	Watley Seed	HRW	45.4	101%	60.6	25
Bill Brown	PlainsGold	HRW	44.8	100%	60.1	25
TAM 113	AGSECO	HRW	44.5	99%	59.6	25
Winterhawk	WestBred Monsanto	HRW	44.5	99%	61.1	26
T158	Limagrain	HRW	44.4	99%	59.7	24
Hatcher	PlainsGold	HRW	44.3	99%	59.6	24
Above	PlainsGold	HRW	44.1	98%	58.7	25
TAM 111	AgriPro Syngenta	HRW	43.8	98%	60.2	26
Bond CL	PlainsGold	HRW	43.8	98%	56.1	26
Clara CL	KS Wheat Alliance	**HWW**	43.5	97%	60.1	25
Snowmass	PlainsGold	**HWW**	42.5	95%	59.2	26
Robidoux	Husker Genetics	HRW	42.5	95%	60.0	25
1863	KS Wheat Alliance	HRW	41.2	92%	59.2	25
		Average	**44.8**		**59.6**	**25**

[a]The 3-year average yield is based on nine 2014 trials, seven 2013 trials, and nine 2012 trials. Test weights are based on eight 2014 trials, five 2013 trials, and eight 2012 trials. Plant heights are based on nine 2014 trials, six 2013 trials, and eight 2012 trials.

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

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

Summary of 3-Year (2012-2014) Northeast Colorado Dryland Variety Performance Results

Variety[a]	Brand/Source	Market Class[b]	3-Year Average[c] Yield	Yield	Test Weight	Plant Height
			bu/ac	% trial average	lb/bu	in
Antero	PlainsGold	**HWW**	55.7	112%	59.6	27
Byrd	PlainsGold	HRW	53.6	108%	59.7	27
Denali	PlainsGold	HRW	51.4	104%	60.7	27
Settler CL	Husker Genetics	HRW	50.8	102%	58.6	25
Brawl CL Plus	PlainsGold	HRW	50.5	102%	60.1	27
TAM 112	Watley Seed	HRW	50.2	101%	60.4	26
SY Wolf	AgriPro Syngenta	HRW	50.2	101%	59.7	26
Ripper	PlainsGold	HRW	50.2	101%	58.5	26
T158	Limagrain	HRW	49.6	100%	59.6	25
Bill Brown	PlainsGold	HRW	49.5	100%	59.8	26
Winterhawk	WestBred Monsanto	HRW	49.1	99%	60.9	27
TAM 113	AGSECO	HRW	49.1	99%	59.6	26
TAM 111	AgriPro Syngenta	HRW	49.0	99%	60.0	27
Bond CL	PlainsGold	HRW	49.0	99%	56.0	28
Above	PlainsGold	HRW	48.9	99%	58.3	25
Hatcher	PlainsGold	HRW	48.5	98%	59.4	25
Clara CL	KS Wheat Alliance	**HWW**	48.2	97%	59.9	26
Snowmass	PlainsGold	**HWW**	47.3	95%	59.0	27
Robidoux	Husker Genetics	HRW	46.7	94%	59.9	26
1863	KS Wheat Alliance	HRW	45.8	92%	59.5	25
		Average	**49.7**		**59.5**	**26**

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

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

[c]The 3-year average yield and plant heights are based on six 2014 trials, six 2013 trials, and six 2012 trials in northeast Colorado. Average test weights are based on six 2014 trials, five 2013 trials, and six 2012 trials.

Summary of 3-Year (2012-2014) Southeast Colorado Dryland Variety Performance Results

Variety[a]	Brand/Source	Market Class[b]	3-Year Average[c] Yield	Yield	Test Weight	Plant Height
			bu/ac	% trial average	lb/bu	in
Byrd	PlainsGold	HRW	37.5	116%	60.8	22
Antero	PlainsGold	**HWW**	34.6	107%	60.6	22
Ripper	PlainsGold	HRW	34.2	106%	59.7	21
Hatcher	PlainsGold	HRW	33.5	104%	60.1	20
Settler CL	Husker Genetics	HRW	33.1	102%	59.8	20
TAM 113	AGSECO	HRW	32.9	102%	59.7	23
TAM 112	Watley Seed	HRW	32.9	102%	61.4	22
Winterhawk	WestBred Monsanto	HRW	32.8	101%	62.1	24
Brawl CL Plus	PlainsGold	HRW	32.7	101%	61.1	22
Bill Brown	PlainsGold	HRW	32.5	101%	61.6	19
Denali	PlainsGold	HRW	31.8	98%	61.8	21
Above	PlainsGold	HRW	31.7	98%	60.6	22
Robidoux	Husker Genetics	HRW	31.6	98%	60.5	20
Clara CL	KS Wheat Alliance	**HWW**	31.3	97%	60.9	21
T158	Limagrain	HRW	30.8	95%	60.4	23
TAM 111	AgriPro Syngenta	HRW	30.5	94%	61.1	25
Snowmass	PlainsGold	**HWW**	30.4	94%	60.2	23
Bond CL	PlainsGold	HRW	30.3	94%	56.7	21
1863	KS Wheat Alliance	HRW	29.3	91%	58.0	23
		Average	**32.3**		**60.4**	**22**

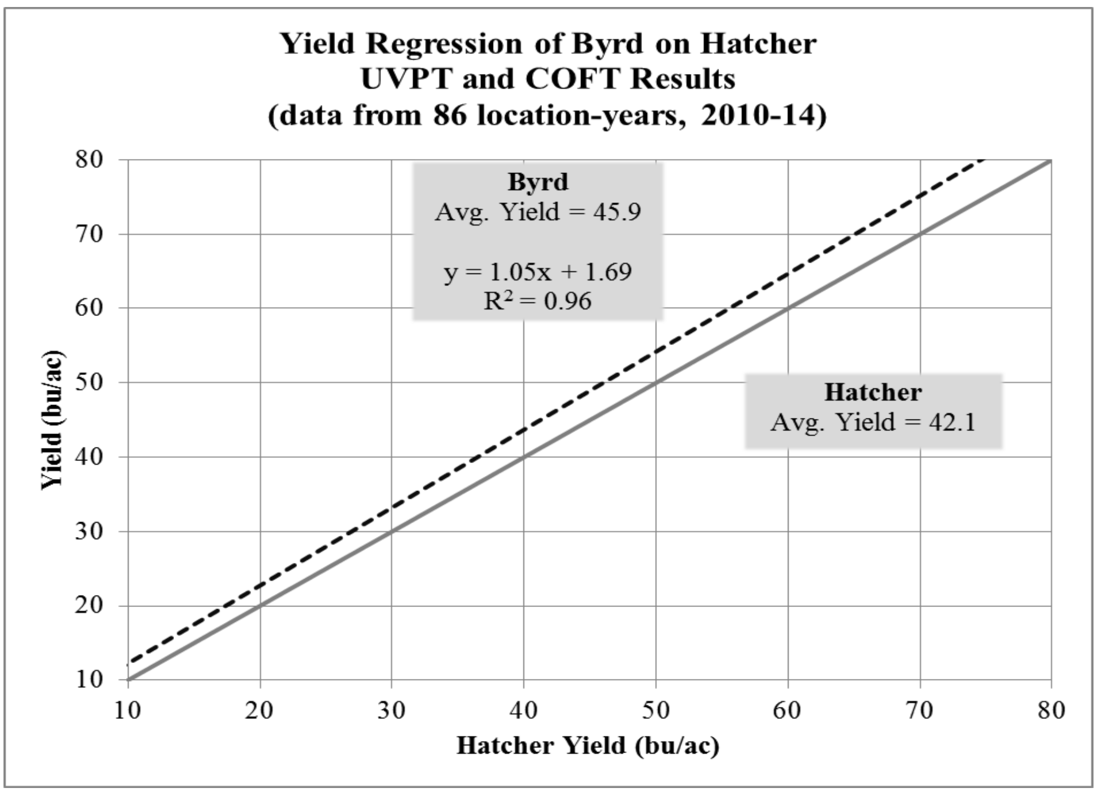
[a]Varieties ranked according to average 3-year yield.

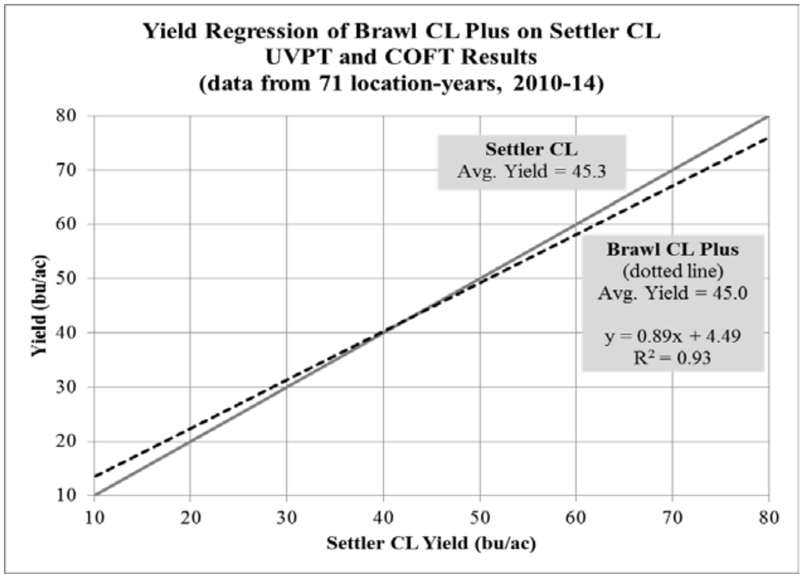
[b]Market class: HRW=hard red winter wheat; **HWW**=hard white winter wheat.

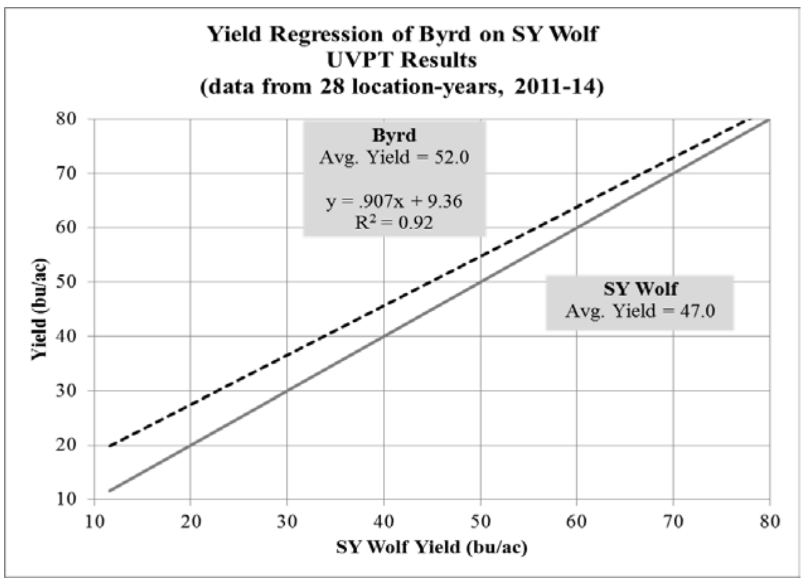
[c]The 3-year average yield is based on three 2014 trials, one 2013 trial, and three 2012 trials in southeast Colorado. Test weights are based on two 2014 trials and two 2012 trials, and plant heights are based on three 2014 trials and two 2012 trials in southeast Colorado.

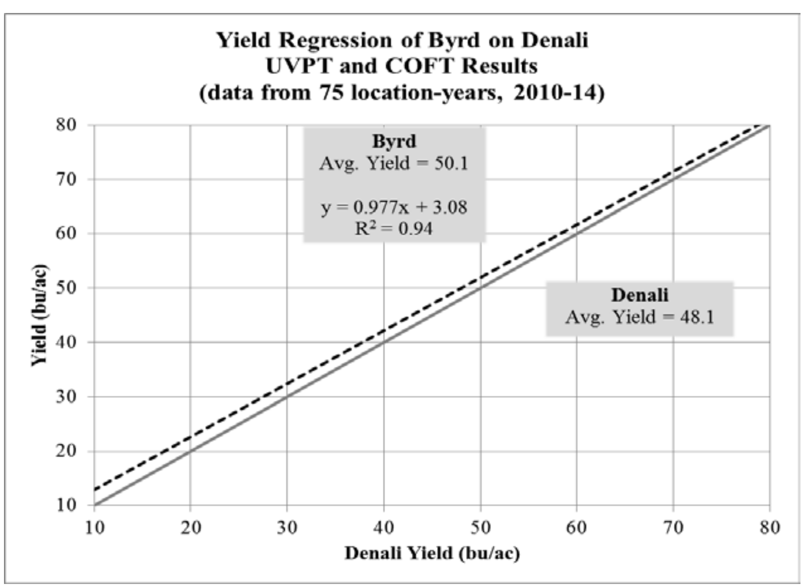
The Relative Performance of One Variety by Comparison to Another Variety

This study is based on results from multiple Uniform Variety Performance Trials (UVPT) and the Collaborative On-Farm Test (COFT) results from 2010 through 2014. They can be used as a tool to help growers visualize the expected performance of one variety relative to another variety. If the lines do not cross over one another, the yield of one variety would be expected to be consistently higher or lower than the yield of the other variety. Farmers can predict the yield of Byrd given the yield of Hatcher as shown on the first graph below. The equation shown in each graph is really neat because you can predict the yield of one variety given the yield of another variety. For example, in the first graph, the expected yield of Byrd equals 1.05 multiplied by the selected yield of Hatcher, plus 1.69 bu/ac. If the yield of Hatcher is 50 bu/ac then you would expect the yield of Byrd to be 54.2 bu/ac. The R^2 value of the regression is a statistical measure that represents how well a regression line fits the actual data. The comparisons are expected to be more reliable when they include more results over multiple locations from different years. Additional testing of varieties might change the relationships portrayed in the following graphs.




Yield Regression of Brawl CL Plus on Settler CL
UVPT and COFT Results
(data from 71 location-years, 2010-14)
Settler CL
Avg. Yield = 45.3
Brawl CL Plus
(dotted line)
Avg. Yield = 45.0
y = 0.89x + 4.49
R² = 0.93
Yield (bu/ac)
Settler CL Yield (bu/ac)


Yield Regression of Byrd on SY Wolf
UVPT Results
(data from 28 location-years, 2011-14)
Byrd
Avg. Yield = 52.0
y = .907x + 9.36
R² = 0.92
SY Wolf
Avg. Yield = 47.0
Yield (bu/ac)
SY Wolf Yield (bu/ac)


Yield Regression of Byrd on Denali
UVPT and COFT Results
(data from 75 location-years, 2010-14)
Byrd
Avg. Yield = 50.1
y = 0.977x + 3.08
R² = 0.94
Denali
Avg. Yield = 48.1
Yield (bu/ac)
Denali Yield (bu/ac)

2014 Collaborative On-Farm Test (COFT) Variety Performance Results

The objective of our on-farm testing program is to compare the performance of wheat varieties that are of interest to Colorado farmers. In 2014, the varieties included Antero (high-yielding HWW), Byrd (very high-yielding HRW), Brawl CL Plus (herbicide tolerant and high-yielding HRW), Denali (high-yielding HRW), Snowmass (extremely high quality HWW), and TAM 112 (stable-yielding HRW). Varieties are tested under unbiased, farm field-scale conditions, with farmer equipment. The COFT program is in its 16th year and the majority of Colorado's 2014 wheat acreage is planted to winter wheat varieties that have been tested in the COFT program. On-farm testing leads to wider and faster adoption of new varieties.

In the fall of 2013, thirty-five eastern Colorado wheat producers received seed for on-farm tests across eastern Colorado. Each farmer planted the six varieties in side-by-side strips at the same time and seeding rate as they seeded their own wheat using their own wheat drills. Twenty viable harvest results were obtained from the thirty-five sets of the seed that were distributed. Failed tests were due to drought conditions and hail. The COFT results need to be interpreted based on all tests within a year and not on the basis of a single variety comparison on a single farm in one year. Results from the twenty tests this year are powerful tools for selecting varieties for this fall.

The overall average yield was 54.8 bu/ac. The highest yielding variety, Antero, was 1.5 bu/ac higher-yielding than Byrd which was 0.2 bu/ac higher-yielding than Denali. Denali yielded 3 bu/ac higher than TAM 112. Most of these varieties fit specific conditions. For example, if a farmer wants a high-yielding white wheat that does not qualify for a premium, then Antero is the variety of choice. For farmers looking for control of winter annual grasses, Brawl CL Plus is the obvious choice. Farmers wanting to grow white wheat with exceptional quality and qualify for a premium should be growing Snowmass.

Test weights were generally high. Brawl CL Plus, Denali, and TAM 112 had significantly higher test weights than the other varieties (60.3, 60.1, and 60.2 lb/bu, respectively). Byrd and Snowmass had the lowest average test weights (59.5 and 59.4 lb/bu, respectively).

Grain protein contents were high with Brawl CL Plus having the highest content at 13.2%. TAM 112 and Snowmass averaged 12.7 and 12.1%, respectively. Byrd, Antero, and Denali (the three highest yielding varieties) had the lowest protein content at 12, 11.9, and 11.9%, respectively.

Colorado extension wheat educators who conducted the COFT program:

Jerry Johnson – Extension Specialist-Crop Production, Fort Collins
Bruce Bosley – Extension Agronomist, Logan County
Wilma Trujillo – Extension Agronomist, Prowers County
Brian Talamantes – Extension Agronomist, Sedgwick County
Ron Meyer – Extension Agronomist, Kit Carson County

2014 Collaborative On-Farm Test (COFT) Variety Performance Results

	2014 Varieties[a]																				
	Antero			Byrd			Denali			TAM 112			Brawl CL Plus			Snowmass			COFT Average		
County/Nearest Town	Yield[b]	Test Weight	Protein	Yield[b]	Test Weight	Protein	Yield[b]	Test Weight	Protein	Yield[b]	Test Weight	Protein	Yield[b]	Test Weight	Protein	Yield[b]	Test Weight	Protein	Yield[b]	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	71.8	-	-	69.1	-	-	79.2	-	-	68.2	-	-	72.1	-	-	70.7	-	-	*71.9*	-	-
Adams/Prospect Valley	65.0	58.5	11.6	59.9	57.5	10.8	61.8	57.5	11.7	61.1	59.5	12.5	58.8	58.0	12.4	56.6	57.5	12.1	*60.5*	*58.1*	*11.9*
Baca/Two Buttes	22.1	57.1	14.7	18.2	56.7	14.5	25.9	57.1	13.6	17.8	57.1	16.1	18.1	57.5	16.1	21.4	56.4	13.6	*20.6*	*57.0*	*14.8*
Baca/Vilas	42.1	62.3	13.3	40.5	60.9	14.0	36.2	59.5	13.7	31.5	60.6	14.7	36.4	61.5	15.2	35.4	59.4	13.8	*37.0*	*60.7*	*14.1*
Baca/Walsh	35.1	63.0	-	37.0	63.0	-	35.0	64.0	-	33.2	64.0	-	30.4	64.0	-	31.8	62.0	-	*33.8*	*63.3*	-
Cheyenne/Arapahoe	17.2	60.3	13.0	7.9	59.5	14.3	17.4	62.3	12.5	10.0	58.0	13.7	8.2	59.1	13.6	12.0	61.1	-	*12.1*	*60.1*	*13.4*
Logan/Leroy	67.8	61.5	10.1	73.0	61.0	10.0	75.8	61.5	10.0	64.3	62.0	10.9	59.6	62.5	12.2	65.0	61.0	10.7	*67.6*	*61.6*	*10.6*
Morgan/Orchard	63.0	59.0	10.7	60.9	58.5	11.4	55.7	60.0	11.3	55.5	60.0	11.2	59.8	59.5	11.9	53.3	57.5	10.7	*58.0*	*59.1*	*11.2*
Phillips/Haxtun	32.8	59.0	12.5	24.9	59.5	12.0	23.1	59.5	12.5	27.4	61.5	13.7	20.4	61.0	13.8	22.5	58.5	12.9	*25.2*	*59.8*	*12.9*
Prowers/Bristol	53.6	61.1	12.4	50.0	60.8	12.1	51.5	61.0	11.8	41.2	61.3	13.5	46.1	62.3	13.6	53.6	61.6	12.4	*49.3*	*61.4*	*12.6*
Washington/Akron	69.5	58.5	12.0	71.4	58.5	11.5	72.0	59.5	12.7	65.9	60.0	12.5	75.2	60.0	12.9	63.9	59.0	11.8	*69.7*	*59.3*	*12.2*
Washington/Akron S	81.5	60.0	12.4	87.7	61.0	11.9	83.8	61.5	11.6	83.7	62.0	-	82.2	61.5	13.7	81.3	61.0	12.7	*83.4*	*61.2*	*12.5*
Washington/Anton	28.0	59.5	12.7	29.3	59.0	12.5	29.4	60.0	12.4	28.7	59.0	13.7	28.3	60.0	13.4	25.0	57.0	13.4	*28.1*	*59.1*	*13.0*
Washington/Central	93.6	60.0	10.7	87.4	61.0	11.8	84.8	61.5	11.3	83.0	61.5	11.8	84.7	61.5	12.6	80.4	62.5	11.2	*85.6*	*61.3*	*11.6*
Washington/Lone Star	65.8	57.0	13.2	67.3	57.0	13.3	67.4	58.5	12.9	59.5	58.5	14.5	60.0	57.5	14.4	56.6	57.5	13.4	*62.8*	*57.7*	*13.6*
Weld/Keenesburg	85.8	58.7	11.6	85.2	58.0	11.5	79.4	59.4	11.6	88.5	59.3	11.8	83.6	59.6	12.9	77.2	57.6	11.5	*83.3*	*58.8*	*11.8*
Weld/New Raymer SE	60.3	60.5	10.2	63.6	60.5	10.4	58.6	60.0	10.2	56.8	61.5	11.1	53.0	61.0	12.0	57.2	59.5	10.4	*58.2*	*60.5*	*10.7*
Weld/New Raymer SW	55.5	60.0	11.9	52.9	59.5	12.3	49.5	61.5	12.6	51.7	60.5	13.2	50.5	61.0	13.2	46.2	60.0	12.5	*51.0*	*60.4*	*12.6*
Weld/Roggen	84.4	59.0	11.0	83.4	58.5	11.2	78.5	59.5	11.3	78.1	59.5	11.4	74.2	60.0	13.5	75.3	58.5	11.5	*79.0*	*59.2*	*11.7*
Yuma/Yuma	62.6	60.0	9.9	58.8	60.0	10.3	60.0	59.0	9.8	58.9	58.5	10.1	55.8	58.0	10.7	57.1	61.0	10.1	*58.9*	*59.4*	*10.2*
Average	**57.9**	**59.7**	**11.9**	**56.4**	**59.5**	**12.0**	**56.2**	**60.1**	**11.9**	**53.2**	**60.2**	**12.7**	**52.9**	**60.3**	**13.2**	**52.1**	**59.4**	**12.1**	***54.8***	***59.9***	***12.3***
Yield Significance[c]	A			B			B			C			C,D			D					

LSD $_{(P<0.30)}$ for yield = 1.0 bu/ac

LSD $_{(P<0.30)}$ for test weight = 0.3 lb/bu

LSD $_{(P<0.30)}$ for protein = 0.1 percent

[a]Varieties are ranked left to right by highest average yield.

[b]All yields are corrected to 12% moisture.

Summary of 2-Year (2013-2014) Irrigated Variety Performance Results at Fort Collins

Variety[a]	Brand/Source	Market Class[b]	2-Year Average: Yield	Yield	Test Weight	Plant Height	Heading	Lodging[c]
			bu/ac	% trial average	lb/bu	in	days from trial average	scale (1-9)[d]
Antero	PlainsGold	**HWW**	97.3	112%	61.8	32	0	2
Byrd	PlainsGold	HRW	95.6	110%	61.6	31	-1	3
Robidoux	Husker Genetics	HRW	89.4	103%	60.6	29	1	2
Thunder CL	PlainsGold	**HWW**	88.1	102%	61.0	29	0	2
T158	Limagrain	HRW	87.6	101%	60.9	28	-2	1
Hatcher	PlainsGold	HRW	87.5	101%	60.6	27	1	2
Denali	PlainsGold	HRW	86.9	100%	61.9	31	3	2
WB-Cedar	WestBred Monsanto	HRW	85.1	98%	59.4	27	-4	1
Yuma	CO State Univ.	HRW	84.6	98%	61.0	29	1	2
SY Wolf	AgriPro Syngenta	HRW	84.1	97%	60.9	29	2	1
Freeman	Husker Genetics	HRW	83.4	96%	59.1	28	-3	2
Settler CL	Husker Genetics	HRW	82.3	95%	60.4	30	2	2
Iba	Oklahoma Genetics	HRW	82.0	95%	61.6	31	2	1
Brawl CL Plus	PlainsGold	HRW	80.3	93%	61.3	31	-2	1
		Average	**86.7**		**60.9**	**29**		**2**

[a]Varieties ranked according to average 2-year yield at Fort Collins.

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

[c]Lodging scores based on 2014 trial data.

[d]Lodging scale: 1=no lodging, 9=severe lodging.

Summary of 3-Year (2012-2014) Irrigated Variety Performance Results at Fort Collins

Variety[a]	Brand/Source	Market Class[b]	Yield (3-Year Average)	Yield (3-Year Average)	Test Weight (3-Year Average)	Plant Height (3-Year Average)	Heading[c]	Lodging[d]
			bu/ac	% trial average	lb/bu	in	days from trial average	scale (1-9)[e]
Byrd	PlainsGold	HRW	88.2	112%	60.2	31	-1	3
Antero	PlainsGold	**HWW**	87.0	110%	60.3	32	0	2
Robidoux	Husker Genetics	HRW	81.7	104%	59.8	29	1	2
T158	Limagrain	HRW	80.0	101%	59.8	28	-2	1
Denali	PlainsGold	HRW	78.2	99%	60.6	31	3	2
Thunder CL	PlainsGold	**HWW**	78.1	99%	59.6	29	0	2
Hatcher	PlainsGold	HRW	76.8	97%	59.1	27	1	2
SY Wolf	AgriPro Syngenta	HRW	76.7	97%	59.4	29	3	1
Brawl CL Plus	PlainsGold	HRW	75.7	96%	59.9	31	-2	1
Yuma	CO State Univ.	HRW	75.2	95%	59.0	29	0	2
Settler CL	Husker Genetics	HRW	75.0	95%	59.2	30	1	2
WB-Cedar	WestBred Monsanto	HRW	73.3	93%	57.8	27	-4	1
		Average	**78.8**		**59.6**	**29**		**2**

[a]Varieties ranked according to average 3-year yield at Fort Collins.

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

[c]Heading averages based on 2013 and 2014 trial data.

[d]Lodging scores based on 2014 trial data.

[e]Lodging scale: 1=no lodging, 9=severe lodging.

Summary of 2-Year (2013-2014) Irrigated Variety Performance Results at Haxtun

			2-Year Average				
Variety[a]	Brand/Source	Market Class[b]	Yield	Yield	Test Weight	Plant Height	Lodging
			bu/ac	% trial average	lb/bu	in	scale (1-9)[c]
Denali	PlainsGold	HRW	132.5	110%	60.8	36	4
Antero	PlainsGold	**HWW**	128.8	107%	60.1	36	4
Brawl CL Plus	PlainsGold	HRW	122.5	102%	61.9	34	2
T158	Limagrain	HRW	122.0	101%	60.6	32	5
SY Wolf	AgriPro Syngenta	HRW	121.9	101%	58.2	33	1
Settler CL	Husker Genetics	HRW	121.7	101%	60.0	34	2
WB-Cedar	WestBred Monsanto	HRW	121.6	101%	61.8	29	2
Freeman	Husker Genetics	HRW	120.8	100%	59.7	34	4
Byrd	PlainsGold	HRW	120.2	100%	60.7	35	5
Iba	Oklahoma Genetics	HRW	118.8	98%	60.2	33	3
Robidoux	Husker Genetics	HRW	117.4	97%	60.7	34	3
Yuma	CO State Univ.	HRW	116.0	96%	61.5	35	3
Hatcher	PlainsGold	HRW	113.9	94%	60.1	33	6
Thunder CL	PlainsGold	**HWW**	111.6	92%	59.0	34	2
		Average	**120.7**		**60.4**	**33**	**3**

[a]Varieties ranked according to average 2-year yield at Haxtun.

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

[c]Lodging scale: 1=no lodging, 9=severe lodging.

Summary of 3-Year (2012-2014) Irrigated Variety Performance Results at Haxtun

			3-Year Average				
Variety[a]	Brand/Source	Market Class[b]	Yield	Yield	Test Weight	Plant Height	Lodging
			bu/ac	% trial average	lb/bu	in	scale (1-9)[c]
WB-Cedar	WestBred Monsanto	HRW	129.6	105%	61.7	31	2
Antero	PlainsGold	**HWW**	129.2	105%	60.5	36	5
Denali	PlainsGold	HRW	129.1	105%	61.0	37	4
Brawl CL Plus	PlainsGold	HRW	128.7	104%	62.4	35	3
SY Wolf	AgriPro Syngenta	HRW	125.8	102%	59.2	34	2
T158	Limagrain	HRW	125.0	101%	60.8	34	5
Byrd	PlainsGold	HRW	123.1	100%	61.0	36	5
Settler CL	Husker Genetics	HRW	122.1	99%	60.1	36	3
Thunder CL	PlainsGold	**HWW**	121.4	98%	60.1	35	3
Robidoux	Husker Genetics	HRW	116.7	95%	60.5	35	4
Yuma	CO State Univ.	HRW	115.9	94%	61.3	36	3
Hatcher	PlainsGold	HRW	114.1	93%	60.6	35	6
		Average	**123.4**		**60.8**	**35**	**4**

[a]Varieties ranked according to average 3-year yield at Haxtun.

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

[c]Lodging scale: 1=no lodging, 9=severe lodging.

Winter Wheat Variety Selection in Colorado for Fall 2014 Planting

The variety performance summary tables provide useful information to farmers, seed producers, and wheat industry representatives in Colorado and surrounding states. Variety selection and planting should be based on important guidelines.

- Producers should focus on multi-year and multi-location yield summary results when selecting a new variety. Farmers should select varieties based on three-year average performance and not on performance in a single year – and especially not on performance at a single location in a single year.

- Producers should plant more than one variety in order to minimize production risks from variable weather conditions and unexpected pest outbreaks.

- Producers should plant treated seed for protection against common bunt (stinking smut) and other seed borne diseases. There are many seed treatment fungicides that provide excellent control of this disease as well as loose smut. Use one that is labeled for control of common bunt.

- Producers should pay attention to other "non-yield" characteristics in making their variety selection decisions, including ratings for maturity, plant height, coleoptile length, disease and insect resistance, and end-use quality characteristics. These "non-yield" traits are useful to spread production risks due to the unpredictability of weather conditions and pest problems. Refer to the *Description of Winter Wheat Varieties in Eastern Colorado Trials* for variety-specific information for these and other traits.

- Producers should control volunteer wheat and weeds to avoid loss of valuable soil moisture as well as avoiding a green bridge that could lead to serious virus disease infections vectored by the wheat curl mite (wheat streak mosaic virus, High Plains virus, Triticum mosaic virus) or aphids (barley yellow dwarf virus).

- Producers should soil sample to determine optimum fertilizer application rates. Sampling should be done prior to planting so nitrogen and phosphorus fertilizer requirements can be met. The CSU Extension factsheet entitled *Fertilizing Winter Wheat* is available online at http://tinyurl.com/c88u3x2 for assistance with wheat fertilization.

- Producers should plant seeds per acre and not pounds per acre. A farmer planting 35 pounds per acre could be planting 350,000 seeds per acre or 630,000 seeds per acre depending on the number of seeds per pound. Different varieties and seed-lots can vary widely in seed size. Refer to the *How to Calibrate Your Drill* for information on how planter adjustments can be easily made (available online at www.csucrops.com/wheat).

- Producers should be aware that new races of stripe rust emerged in 2010 and again in 2012 and many varieties that were resistant before are now susceptible. Farmers should refer to the *Description of Winter Wheat Varieties in Eastern Colorado Trials* for updated information on variety susceptibility. If variety resistance/susceptibility, market prices, expected yield levels, and fungicide and application costs warrant an application, farmers should consult the

North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) fungicide efficacy chart. Regular updates to this chart can be found on the CSU Wheat Breeding Program "Wheat Links" page (http://wheat.colostate.edu/links.html). A useful publication from the USDA for identifying rust diseases in wheat can be found at: http://tinyurl.com/pyl428y.

Variety Selection Under Dryland Production Conditions

Many new varieties possessing multiple valuable traits and superior dryland or irrigated yields are currently available. The first six varieties are described in greater detail below, ranked based on their three-year average dryland yield performance. Snowmass is also highlighted because of specific traits it possesses.

Antero – A hard white wheat (HWW), released in 2012, and marketed by PlainsGold. It is very high-yielding and has a three-year average dryland yield that is essentially equivalent to Byrd and it was the top-yielding variety in the 2014 COFT. It has medium height and maturity, good drought stress tolerance, good test weight, very good stripe rust resistance, and moderate sprouting tolerance (similar to Hatcher). For the 2015 crop, a grower premium will not be offered by Ardent Mills for Antero grown in Colorado.

Byrd – A medium-maturing, medium-height, high-yielding hard red winter (HRW) wheat, marketed by PlainsGold. Byrd was the top-yielding variety across the dryland locations in 2010, 2011, and 2012 and second to Antero in 2013. It was the top yielder in the 2012 and 2013 COFT. Byrd has excellent drought stress tolerance and excellent milling and baking qualities. It has average test weight and an intermediate reaction to stripe rust. Byrd has relatively small kernels, similar to Bill Brown, so seed size should be monitored and planting rates should be adjusted to avoid excessively high plant populations.

Denali – A medium-late maturing HRW variety marketed by PlainsGold for production in Colorado and marketed in Kansas by the Kansas Wheat Alliance. There was no significant difference for yield between Denali and Byrd in COFT this year. It has photoperiod sensitivity, which can cause excessively late heading. It is medium-tall, has excellent test weight and average milling and baking quality, and is moderately susceptible to the new races of stripe rust.

Settler CL – A later maturing HRW single-gene Clearfield® winter wheat, marketed by Husker Genetics in Nebraska. It is later maturing, has medium height, average test weight, good milling and baking quality, and is moderately susceptible to the new races of stripe rust. Very strong combined dryland and irrigated performance in CSU variety trials.

Ripper – An early-maturing HRW variety, marketed by PlainsGold. Ripper is high yielding, very drought stress tolerant, and has good milling and baking quality. It has a lower test weight, and is very susceptible to stripe rust. Ripper has shown extremely stable yields, being in the top five of the three-year dryland yield averages every year from 2005 to 2014.

Brawl CL Plus – A two-gene HRW Clearfield variety, marketed by PlainsGold. In combination with methylated seed oil (MSO), control of feral rye with Beyond® herbicide is much improved relative to control achieved with single-gene Clearfield wheat varieties. Brawl CL Plus has early maturity, medium height, and excellent test weight, an intermediate reaction to stripe rust, and excellent milling and baking quality.

Snowmass – A HWW variety, marketed by PlainsGold through the CWRF Ardent Mills Ultragrain® Premium Program. Snowmass has a very strong and unique quality profile, making it extremely valuable in whole-grain flour applications. It is medium maturing, has average test weight, and is a taller semi-dwarf which provides additional crop residue. It has good resistance to wheat streak mosaic virus, moderate sprouting tolerance (similar to Hatcher), and moderate susceptibility to the new races of stripe rust. It has shown lower yields in 2013 and 2014 dryland variety trials and the COFT, although farmers can get a premium (based on protein) when it is grown under contract with Ardent Mills.

Variety Selection For Irrigated Production Conditions at Haxtun and Fort Collins

The most important variety selection criteria for irrigated varieties are yield, straw strength, and stripe rust resistance. Under limited-irrigation conditions, drought stress tolerance can also be important. The top five yielding varieties at each trial location based on a three-year average are emphasized below. Variety selection recommendations are not included for Rocky Ford as trials could not be harvested for yield in the past two years. In 2013 the trial was highly variable for height, suffered from an early infestation of brown mites, and morning glory was a problem. In 2014, there was severe lodging due to heavy wind and rain, and the entire trial was lying flat on the ground.

Haxtun

WB-Cedar – An early-maturing HRW, marketed by WestBred Monsanto. It has good leaf and stripe rust resistance and excellent straw strength for high-input irrigated conditions.

Antero – See dryland description above. It has very high yields under dryland and irrigated conditions, average straw strength, and good resistance to stripe rust.

Denali – See dryland description above. It has average straw strength and moderate susceptibility to stripe rust.

Brawl CL Plus – See dryland description above. It has very good straw strength and an intermediate reaction to stripe rust.

SY Wolf – A medium-maturing HRW, marketed by AgriPro Syngenta. It has a very broad disease resistance package, with good protection for leaf spotting diseases (tan spot and Septoria), leaf rust, and moderate resistance to stripe rust. Very good straw strength and good milling and baking quality.

Fort Collins

Byrd – See dryland description above. It has average straw strength and intermediate reaction to stripe rust.

Antero – See descriptions above.

Robidoux – A medium-height, medium-maturing HRW variety, marketed by Husker Genetics in Nebraska. It has average test weight and straw strength, and moderate resistance to stripe rust. Very good milling and baking quality.

T158 – A medium-early maturing and medium height HRW variety, marketed by Limagrain. Average straw strength, excellent drought tolerance, and good stripe and leaf rust resistance.

Denali – See descriptions above.

Description of Winter Wheat Varieties in Eastern Colorado Dryland and Irrigated Trials (2014 and 2015)

Name, Class, and Pedigree	Origin	RWA*	HD	HT	SS	COL**	YR	LR	WSMV+	TW	MILL	BAKE	Comments
1863 Hard red winter KS940786-6-4/Karl92//Cutter	KSU 2012	S	5	4	--	4	3	7	--	5	4	5	KSU-Manhattan release (2012). First entered into CSU Variety Trials in 2012. Medium height and medium maturing, intermediate reaction to stripe rust, moderately susceptible to leaf rust. Good quality characteristics.
Above Hard red winter TAM 110*4/FS2	CSU-TX 2001	S	3	5	3	8	8	9	5	7	4	7	CSU/Texas A&M release (2001), marketed by PlainsGold. Single-gene Clearfield© wheat. Early maturing semidwarf. Leaf and stripe rust susceptible. Marginal baking quality.
Akron Hard red winter TAM 107/Hail	CSU 1994	S	5	6	5	4	8	9	9	5	5	6	CSU release (1994). Vigorous growth, closes canopy early in spring and competes well with weeds. Leaf and stripe rust susceptible. Lower yields relative to more recent wheat releases, entered as historical check.
Antero Hard white winter KS01HW152-1/TAM 111	CSU 2012	S	4	6	5	6	2	7	6	4	3	6	CSU release (2012), marketed by PlainsGold. High dryland and irrigated yield, medium height and maturity, good test weight, average straw strength, good resistance to stripe rust. Moderate sprouting tolerance.
Bearpaw Hard red winter DMS/Rampart//Pronghorn/3/2*Rampart	MT 2011	S	9	1	--	2	--	--	--	5	6	4	Montana State University release (2011). First entered in CSU Variety Trials in 2013. Carries solid stem trait conferring protection against wheat stem sawfly damage. Short plant stature, late maturing.
Bill Brown Hard red winter Yumar/Arlin	CSU 2007	R*	4	4	4	2	6	2	7	4	6	4	CSU release (2007), marketed by PlainsGold. High test weight, good leaf rust resistance, moderate susceptibility to new races of stripe rust. Very susceptible to stem rust. Good baking quality, short coleoptile.
Bond CL Hard red winter Yumar//TXGH12588-120*4/FS2	CSU 2004	R*	5	6	5	5	8	6	8	8	6	3	CSU release (2004), marketed by PlainsGold. Single-gene Clearfield© wheat. Slightly later, slightly taller than Above. High irrigated yields, good baking quality. Low test weight, leaf and stripe rust susceptible.
Brawl CL Plus Hard red winter Teal 11A/Above//CO99314	CSU 2011	S	2	6	2	8	7	5	8	3	3	2	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. Moderately susceptible to stripe rust, intermediate to leaf rust.
Byrd Hard red winter TAM 112/CO970547-7	CSU 2011	S	4	5	4	7	7	7	7+	5	3	3	CSU release (2011), marketed by PlainsGold. High dryland and irrigated yield, excellent drought tolerance and quality. Average test weight and straw strength. Moderately susceptible to stripe rust. Carries wheat curl mite resistance from TAM 112 parent.
Clara CL Hard white winter KS03HW154/KS03HW1	KSU 2011	S	7	6	6	4	5	2	2	2	5	2	KSU-Hays release (2011). First entered in CSU Variety Trials in 2012. Single-gene hard white Clearfield© wheat. Carries same WSMV resistance as Oakley CL and Snowmass. Moderate resistance to stripe rust, excellent test weight.

Russian wheat aphid resistance (RWA), heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), wheat streak mosaic virus tolerance (WSMV), test weight (TW), milling quality (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.

* RWA rating denotes resistance to the original biotype (biotype 1) of RWA. All available cultivars are susceptible to the new biotypes of RWA.

** 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 for Byrd and TAM 112 are based on mechanical WSMV inoculation and do not take into account their resistance to the wheat curl mite vector of WSMV.

Description of Winter Wheat Varieties in Eastern Colorado Dryland and Irrigated Trials (2014 and 2015)

Name, Class, and Pedigree	Origin	RWA*	HD	HT	SS	COL**	YR	LR	WSMV	TW	MILL	BAKE	Comments
CO11D174 Hard red winter TAM 112/Byrd	CSU EXP	S	4	5	4	7	6	7	--	5	4	2	CSU experimental, targeted for fall 2015 release. Doubled haploid-derived line, similar to Byrd except higher grain yield, larger kernels, and slightly improved quality. Carries wheat curl mite resistance from TAM 112 parent. Intermediate reaction to stripe rust.
Cowboy Hard red winter CO980829/TAM 111	WY-CSU 2011	R*	8	6	6	3	6	7	7	4	4	5	CSU release (2011), marketed by Crop Research Foundation of Wyoming. Sister selection to Denali, but slightly shorter, lower straw strength, and 1 lb/bu lower test weight. Similar disease reaction and quality (except RWA biotype 1 resistant).
CSU Blend13 Hard red winter Hatcher/Bearpaw Blend	CSU-MT 2004/2011	R*/S	5	4	--	--	--	--	--	5	5	3	50:50 blend of Hatcher (hollow stem wheat) and Bearpaw (solid stem wheat) for evaluation as a tool for wheat stem sawfly management. First entered into CSU Dryland Variety Trial (UVPT) in 2014. Yield intermediate between Byrd and Bearpaw.
Denali Hard red winter CO980829/TAM 111	CSU 2011	S	7	7	4	7	7	7	7	2	4	6	CSU release (2011), marketed by PlainsGold and Wildcat Genetics in Kansas. High yields, excellent test weight. Medium tall, medium-late, medium-long coleoptile. Good straw strength and average quality. Moderate susceptibility to stripe and leaf rust.
Freeman Hard red winter KS92-946-B-15-1=(ABI86*3414/JAG//K92)/ALLIANCE	NE 2012	S	4	6	6	4	5	5	--	5	8	3	Nebraska release (2012), first entered in CSU Variety Trials in 2013. Very low yield in CSU dryland trials in 2013 and 2014.
Gallagher Hard red winter Duster/OK99711	OK 2012	S	7	5	6	4	2	2	--	6	5	4	Oklahoma State release (2012), first entered in CSU Variety Trials in 2013. Good leaf disease resistance (leaf and stripe rust resistance). May show physiological leaf spotting in cool spring conditions. Poor winter survival in 2015 trials.
Hatcher Hard red winter Yuma/PI 372129//TAM-200/3/4*Yuma/4/KS91H184/Vista	CSU 2004	R*	6	2	7	4	3	7	8	4	4	3	CSU release (2004), marketed by Plainsgold. Medium maturing semidwarf. Good test weight, moderate resistance to stripe rust. Good dryland yield record, good milling and baking quality. Develops "leaf speckling" condition. Poor winter survival in 2015 trials.
Iba Hard red winter OK93P656-(RMH 3299)/OK99621	OK 2012	S	6	3	5	6	4	2	--	3	2	3	Oklahoma State release (2012), first entered in CSU Variety Trials in 2013. Good stripe rust resistance, good test weight, good quality. Average yield in two years of testing in CSU dryland trials. Poor winter survival in 2015 trials.
KanMark Hard red winter PRL/2*PASTOR//G980129W/3/KS970104-3-13	KSU 2014	S	5	2	2	5	5	3	7	2	3	3	KSU-Manhattan release (2014). First entered into CSU Variety Trials in 2014. Medium maturity, short semidwarf. Good test weight, good straw strength, good quality. Moderate resistance to stripe rust, good resistance to leaf rust.
LCS Mint Hard red winter Overley/CO980829	Limagrain 2011	S	4	8	4	4	3	8	3	2	2	2	Limagrain release (2011). First entered in CSU Variety Trials in 2013, previously tested in 2010 under experimental designation CO050175-1. Intermediate reaction to stripe rust, good test weight, good milling and baking quality. Poor winter survival in 2015 trials.

Russian wheat aphid resistance (RWA), heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), wheat streak mosaic virus tolerance (WSMV), test weight (TW), milling quality (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.

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LCS Pistol Hard red winter T158/T157	Limagrain 2014	S	3	5	4	5	1	2	4	5	8	6	Limagrain release (2014), first entered in CSU Variety Trials in 2014. Excellent stripe rust and leaf rust adult plant resistance. Broad adaptation.
Oakley CL Hard red winter Above/Danby//KS03HW10	KSU 2013	S	6	5	--	6	2	7	2	4	3	2	KSU-Hays release (2013). First entered in CSU Variety Trials in 2013. Single-gene hard red Clearfield© wheat. Good test weight, good stripe rust resistance, carries same WSMV resistance as Clara CL and Snowmass.
Prairie Red Hard red winter CO850034/PI372129//5*TAM 107	CSU 1998	R*	4	3	3	8	8	9	5	7	6	7	CSU release (1998), marketed by PlainsGold. Biotype 1 RWA-resistant version of TAM 107. Good stress tolerance, poor end-use quality, leaf and stripe rust susceptible. Lower yields relative to more recent wheat releases, entered as historical check.
Ripper Hard red winter CO940606/TAM107R-2	CSU 2006	R*	2	5	4	8	9	9	7	8	4	4	CSU release (2006), marketed by PlainsGold. Early-maturing, long coleoptile. Excellent drought stress tolerance, good baking quality. Very good recovery from stand reduction. Leaf and stripe rust susceptible, lower test weight.
Robidoux Hard red winter NE96644/Wahoo (sib)	NE 2010	S	5	5	6	7	4	6	8	4	4	2	Nebraska release (2010). First entered in CSU Variety Trials in 2011. Medium maturity, medium short. Moderate resistance to stripe rust. Better performance in CSU Irrigated Variety trials.
Settler CL Hard red winter N95L164/3/MILLENNIUM SIB//TXGH125888-120*4/FS2	NE 2008	S	7	4	2	6	6	8	7	6	3	4	Nebraska release (2008). Single-gene Clearfield© wheat. Good dryland and irrigated yield in CSU Variety Trials. Later maturing, medium height. Moderately susceptible to new races of stripe rust.
Snowmass Hard white winter KS96HW94//Trego/CO960293	CSU 2009	S	6	8	8	4	6	6	2	6	6	3	CSU release (2009), marketed by PlainsGold in CWRF-Ardent Mills Ultragrain Premium Program. Hard white winter wheat (HWW). Medium-maturing, medium-tall. Good WSMV resistance, moderately susceptible to stripe rust, moderate sprouting tolerance.
Sunshine Hard white winter KS01HW152-6/HV9W02-267W	CSU 2014	S	5	5	5	8	7	8	--	6	6	2	CSU release (2014), marketed by PlainsGold in CWRF-Ardent Mills Ultragrain Premium Program. Hard white, excellent quality, good sprouting tolerance and straw strength, moderate susceptibility to stripe rust. Yield intermediate to Snowmass and Antero.
SY Monument Hard red winter BC991149-11/00x0090-4	Agripro 2014	S	7	6	4	6	1	2	--	5	4	2	Agripro release (2014). First entered in CSU Variety Trials in 2014. Good drought tolerance, good quality, and resistance to both leaf and stripe rust.
SY Southwind Hard red winter W99-188$-1/BC950814-1-1	Agripro 2012	S	5	3	2	4	2	2	--	7	7	3	Agripro release (2012). First entered in CSU Irrigated Variety Trials in 2014. Positioned as high yielding irrigated wheat with very good straw strength. Resistant to stripe, leaf, and stem rust. Good winterhardiness.

Russian wheat aphid resistance (RWA), heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), wheat streak mosaic virus tolerance (WSMV), test weight (TW), milling quality (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.
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Name, Class, and Pedigree	Origin	RWA*	HD	HT	SS	COL**	YR	LR	WSMV	TW	MILL	BAKE	Comments
SY Sunrise Hard red winter BC98337-10-53/CDC Falcon//NE03458	Agripro 2015	S	7	2	1	5	2	3	--	2	2	5	Agripro release (2015). First entered in CSU Irrigated Variety Trials in 2015. High yield potential for irrigation, short with strong straw. High tillering with large seeds and high test weight. Good winterhardiness
SY Wolf Hard red winter W99-331/97x0906-8	Agripro 2010	S	7	5	3	4	5	1	--	3	4	5	Agripro release (2011). First entered in CSU Variety Trials in 2011. Good resistance to tan spot, septoria, and leaf rust. Moderate resistance to stripe rust. Best performance in Colorado trials under irrigation and higher moisture areas and conditions.
T158 Hard red winter KS93U206/2*T81	Limagrain 2009	S	2	5	5	3	2	6	5	4	3	5	Trio (Limagrain) release (2009). First entered in CSU Variety Trials in 2012. Good stripe rust and leaf rust resistance. Medium early maturity, excellent tolerance to drought, covers ground quickly in fall.
TAM 111 Hard red winter TAM-107//TX78V3630/CTK78/3/TX87V1233	TX 2002	S	6	6	3	8	8	8	7	3	4	5	Texas A&M release (2002), marketed by Agripro. Good test weight, good straw strength. Leaf rust susceptible, moderately susceptible to stripe rust. Best performance in Colorado trials under irrigation and higher moisture areas and conditions.
TAM 112 Hard red winter U1254-7-9-2-1/TXGH10440	TX 2005	S	2	4	7	5	8	7	3	3	5	2	Texas A&M release (2005), marketed by Watley Seed. Early maturing semi-dwarf. Good test weight, good quality. Susceptible to leaf and stripe rust. Carries a gene for wheat curl mite resistance for protection from wheat streak and other mite-vectored viruses.
TAM 113 Hard red winter TX90V6313/TX94V3724	TX 2010	S	7	3	8	3	4	4	5	5	4	2	Texas A&M release (2010), marketed by AGSECO. First entered in CSU Variety Trials in 2012. Good leaf and stripe rust resistance. Poor straw strength. Poor winter survival in 2015 trials.
TAM 114 Hard red winter TAM 111/TX98A0050	TX 2014	S	6	6	4	8	3	3	5	2	4	2	Texas A&M release (2014), marketed by Adaptive Genetics. First entered in CSU trials in 2015. Moderately resistant to leaf, stripe, and stem rust. Hessian fly resistant. Very good test weight and quality characteristics.
TAM 204 Hard red winter TAM 112/3/Mason/Jagger//Pecos	TX 2014	S	4	3	2	5	3	6	3	7	6	6	Texas A&M release (2014), marketed by Watley seed. First entered in CSU trials in 2015. Awnless for grazing/dual purpose. Moderately resistant to leaf and stripe rust. Carries wheat curl mite resistance from TAM 112 parent. Poor winter survival in 2015 trials.
Thunder CL Hard white winter KS01-5539/CO99W165	CSU 2008	R*	4	4	3	7	3	5	4	6	5	2	CSU release (2008), marketed by PlainsGold in CWRF-Ardent Mills Ultragrain Premium Program. Single-gene HWW Clearfield© wheat. Good straw strength for irrigation. Excellent quality, moderate stripe rust resistance, moderate sprouting susceptibility.
Warhorse Hard red winter MT9908//Nuplains/MTS9862	MT 2013	S	9	3	--	5	--	--	--	5	7	1	Montana State University release (2013). First entered in CSU Variety Trials in 2014. Carries solid stem trait conferring some protection against wheat stem sawfly damage.

Russian wheat aphid resistance (RWA), heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), wheat streak mosaic virus tolerance (WSMV), test weight (TW), milling quality (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.

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WB-Cedar Hard red winter TAM 302/B1551W	Westbred 2010	S	2	2	1	5	3	4	7	7	4	6	Westbred release (2010). First entered in CSU Variety Trials in 2011. Hard red selection from Aspen HWW. Good stripe rust resistance, excellent straw strength for high-input/full irrigation. Very drought susceptible, lower test weight.
WB-Grainfield Hard red winter G982231/G982159//KS920709W	Westbred 2012	S	2	7	4	2	5	3	7	5	3	6	Westbred release (2012). First entered into CSU Trials in 2013. Early maturing tall semi-dwarf. Good leaf and stripe rust resistance, lower test weight, shorter coleoptile. Poor winter survival in 2015 trials.
Winterhawk Hard red winter 474S10-1/X87807//HBK736-3	Westbred 2007	S	4	7	5	8	7	7	7	2	2	4	Westbred release (2007). Medium maturing, medium tall, long coleoptile. Moderately susceptible to new races of stripe rust, susceptible to leaf rust, very susceptible to stem rust. Good drought tolerance, test weight, and quality.
Yuma Hard red winter NS14/NS25//2*Vona	CSU 1991	S	6	3	3	1	5	5	6	6	5	4	CSU release (1991). Medium maturity, semidwarf, short coleoptile, good baking quality characteristics. Intermediate reaction to stripe rust. Higher yield under irrigation.
Yumar Hard red winter Yuma/PI 372129,F1//CO850034/3/4*Yuma	CSU 1997	R*	5	5	4	2	5	4	6	4	5	2	CSU release (1997). RWA-resistant version of Yuma. Medium-maturing semidwarf. Good straw strength, good baking quality. Lower yields relative to more recent wheat releases, entered as historical check.

Russian wheat aphid resistance (RWA), heading date (HD), plant height (HT), straw strength (SS), coleoptile length (COL), stripe rust resistance (YR), leaf rust resistance (LR), wheat streak mosaic virus tolerance (WSMV), test weight (TW), milling quality (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.

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Wheat Quality Evaluations from the 2014 CSU Dryland and Irrigated Variety Trials

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Introduction

End-use quality maintenance and improvement is an important objective of virtually all wheat breeding programs. Grain buying and end-use industries have become increasingly sophisticated in both domestic and export markets and, while wheat producers are seldom rewarded for improved functional quality, technological advancements promise to increase the ability of the trade to identify and source good quality and discount poor quality.

Breeding for wheat end-use quality is relatively complex in comparison to many common 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 involved in expression of each. 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 improved quality but is often associated with lower yields (and vice versa). 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 Colorado variety trials is to fully characterize the quality of public and private trial entries that are currently or have the potential to be marketed in Colorado. We hope that these data and ratings will be included among the criteria by which wheat producers make their variety selection decisions. 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 2014, grain samples were collected from six dryland (UVPT) variety trial locations (Akron, Julesburg, Orchard, Roggen, Walsh, Yuma) and two irrigated (IVPT) variety trial locations (Fort Collins, Haxtun). Preliminary small-scale quality analyses were carried out to determine sample suitability for full-scale analyses, with criteria including grain protein not too far below or above 12% grain protein content, sound grain free of visual defects, and good discrimination among samples at a given location for experimental dough mixing properties. In this process of sample selection, three of the dryland locations (Orchard Roggen, Yuma) were excluded from analyses beyond protein content with the primary issue being protein values well below the level conductive for meaningful dough mixing and baking quality evaluations.

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:

<u>Milling-Related Traits</u>

- Test weight: obtained by standard methodology on a cleaned sample of the harvested grain.
- Grain protein and ash content: obtained by prediction using whole-grain near-infrared reflectance spectroscopy (NIRs) with a Foss NIRSystems 6500. Both grain protein and ash are 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. Grain ash represents the remaining weight of a grain sample following incineration in a high-temperature oven. Millers prefer low wheat ash (values < 1.6%), as this provides low-ash flour after milling and products with improved color properties.

- 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 and a measure of variability (standard deviation, STD) for each trait. Millers prefer a uniform sample with heavier (>30 grams/1000 kernels) 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 percentage with low flour ash 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.

<u>Baking-Related Traits</u>

- 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 overmixing (subjective score >3). Some varieties with exceptionally long mixing times (i.e., Snowmass, Thunder CL) 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 ConAgra 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 a higher crumb grain score and crumb grain color (score > 3). The crumb grain and color scores are subjective assessments of the color and 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 may be used as a means to differentiate and characterize quality of different samples. The development of a composite score also has the advantage of "smoothing" out differences in environmental conditions from year to year and utilizing all of the data generated on the samples from year to year.

Composite scores are generated through a two-step process. First, each trait is ranked from high to low (or "good" to "bad") at individual locations and a score from 1=good to 9=bad is assigned to each variety for each 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%, kernel weight 20%, grain hardness 10%, flour yield 20%, grain ash content 10% (100% total)

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

Wheat Milling and Baking Quality Data - 2014 Akron

* Value in **bold** indicates superior value, value in *italics* indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Grain Ash	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
1863	57.9	14.0	27.9	64.0	73.4	**1.31**	63.6	**4.03**	3	1045	4	3	4	**3**
Above	56.7	13.9	29.1	65.0	72.6	1.35	*61.3*	3.24	*2*	*935*	3	3	5	6
Akron	56.9	14.3	28.3	69.6	*70.3*	*1.46*	62.7	**4.08**	3	**1120**	4	4	6	**2**
Antero	58.4	13.7	**32.2**	65.0	72.8	1.38	62.8	**4.81**	3	965	4	3	**3**	4
Bearpaw	58.4	14.6	*26.1*	77.2	72.9	*1.54*	63.9	**3.64**	*2*	970	4	3	6	4
Bill Brown	57.7	14.6	*27.3*	71.7	72.2	1.39	**64.5**	**4.33**	3	1010	3	4	5	**2**
Bond CL	*56.4*	*13.4*	*27.4*	64.0	*71.2*	1.38	*61.4*	**3.67**	4	1020	**5**	3	*7*	**3**
Brawl CL Plus	58.7	14.7	30.6	64.7	73.4	1.36	62.8	3.39	*2*	**1165**	4	4	**2**	**3**
Byrd	57.4	14.3	28.7	67.5	**74.3**	1.43	62.7	*6.10*	4	**1220**	4	4	**3**	**3**
Clara CL	**59.1**	14.3	28.8	72.5	72.3	1.45	63.7	**4.08**	3	**1105**	**5**	**5**	4	**1**
CO09W009	58.9	14.2	28.4	63.6	72.4	1.37	63.6	**4.89**	4	1070	4	4	4	**2**
CO09W040-	57.9	*13.0*	31.3	*56.2*	**74.0**	1.34	*59.6*	2.81	*1*	*875*	3	3	4	*9*
CO11D174	57.4	13.8	29.3	67.0	73.7	1.36	63.3	5.64	**5**	**1140**	**5**	4	4	**2**
CO11D346	56.8	14.0	**31.4**	63.9	73.5	1.34	63.7	**3.71**	3	*920*	3	3	**3**	5
CO11D446	57.2	13.9	28.0	64.7	**74.0**	1.39	62.6	*7.79*	**6**	**1145**	**5**	4	4	**3**
Cowboy	58.0	14.1	29.6	67.1	73.4	1.36	**64.4**	**3.84**	3	*925*	*2*	*2*	**3**	4
CSU Blend13	57.3	14.2	28.3	68.7	72.0	1.39	63.7	**4.18**	3	1005	4	3	5	**2**
Denali	58.7	13.8	29.0	67.8	73.0	1.42	62.8	3.21	3	*895*	*2*	*2*	**3**	6
Freeman	*54.5*	**15.2**	*27.4*	*57.8*	*71.5*	1.39	**65.3**	**4.63**	4	1080	4	3	*9*	**1**
Gallagher	57.7	14.1	29.3	75.8	72.1	*1.46*	63.2	**3.99**	*2*	*930*	4	4	6	4
Hatcher	58.0	13.9	29.7	69.3	71.6	1.33	63.6	**4.38**	4	*955*	4	3	4	**3**
Iba	58.8	13.9	28.6	63.0	73.6	1.44	*60.8*	**3.94**	*2*	995	4	3	4	5
KanMark	58.4	14.2	*27.2*	70.2	**74.2**	1.36	63.7	**4.11**	3	1040	4	3	4	**2**
KS10HW78-1	**59.1**	14.1	**33.6**	65.9	**75.0**	1.36	*61.3*	2.74	*0*	*865*	4	3	**1**	*9*
LCH11-1064	*55.7*	14.4	29.5	64.7	71.9	1.38	62.2	3.00	*2*	*870*	3	3	6	*7*
LCS Mint	58.6	14.0	30.5	66.2	73.5	1.32	**64.7**	**4.48**	4	**1135**	**5**	4	**2**	**1**
LCS Pistol	56.8	14.7	*25.0*	*51.6*	*67.7*	1.45	62.6	3.03	*1*	*955*	3	3	*9*	*7*
Oakley CL	**59.2**	14.2	**32.8**	71.2	73.2	1.43	63.6	**4.04**	4	1000	4	3	**2**	**2**
Prairie Red	*56.2*	13.8	29.8	69.5	71.9	1.43	63.6	**3.68**	3	1050	4	4	6	**3**
Ripper	*56.4*	14.4	**31.6**	69.6	72.7	1.34	**64.7**	3.38	3	*935*	3	*2*	4	4
Robidoux	57.0	14.2	27.8	64.6	73.4	1.38	63.6	5.06	4	**1120**	**5**	**5**	4	**1**
Settler CL	58.2	13.9	**31.6**	70.9	72.1	1.44	62.9	5.05	4	1025	4	3	4	**3**
Snowmass	57.2	14.1	30.4	78.7	71.7	1.39	**64.6**	*7.54*	**6**	**1130**	**5**	**5**	5	**2**
Sunshine	58.4	13.9	**34.9**	62.1	73.0	1.34	62.8	5.06	**5**	**1120**	4	4	**2**	**2**
SY Monument	*56.4*	13.9	28.8	72.2	**74.0**	**1.29**	63.4	5.28	**5**	1090	**5**	4	5	**2**
SY Wolf	57.2	14.5	29.2	69.1	72.7	1.40	*60.7*	**4.47**	*1*	1000	3	3	4	6
T158	57.6	*13.4*	**31.4**	62.3	**74.6**	1.35	*61.7*	3.40	*2*	1055	4	3	**3**	5
TAM 111	57.4	14.7	28.4	65.6	*71.5*	1.33	**64.6**	**3.94**	3	*945*	*2*	3	5	4
TAM 112	58.4	14.3	30.3	74.6	*71.1*	*1.50*	63.7	**4.19**	4	**1125**	4	**5**	6	**1**
TAM 113	57.6	14.6	29.5	71.5	72.5	1.40	62.4	**3.65**	*2*	1025	4	4	4	4
Warhorse	57.7	**15.8**	*26.7*	*86.2*	*71.2*	*1.47*	**65.8**	**3.71**	3	1085	4	3	6	**2**
WB-Grainfield	57.4	13.9	30.1	67.9	**73.9**	1.37	*61.6*	3.25	*1*	1010	4	3	**3**	6
Winterhawk	58.9	14.4	**33.3**	68.9	**73.9**	1.39	62.8	3.44	*2*	1030	4	3	**1**	4
Yumar	58.4	13.9	29.2	68.5	71.9	1.36	63.7	**4.41**	4	1050	4	4	4	**2**
Average	57.7	14.2	29.5	67.7	72.7	1.39	63.1	4.21	3.1	1026	3.9	3.4		
Minimum	54.5	13.0	25.0	51.6	67.7	1.29	59.6	2.74	0	865	2	2		
Maximum	59.2	15.8	34.9	86.2	75.0	1.54	65.8	7.79	6	1220	5	5		

Wheat Milling and Baking Quality Data - 2014 Julesburg

* Value in **bold** indicates superior value, value in *italics* indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Grain Ash	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
1863	60.2	14.3	37.5	*55.7*	73.9	**1.40**	62.6	**3.38**	*1*	1015	3	3	4	5
Above	60.1	*13.2*	**40.9**	62.1	73.1	1.54	*60.2*	2.65	*1*	*885*	3	3	**3**	*8*
Akron	60.1	14.5	*34.5*	61.6	*72.6*	1.53	64.6	**3.67**	3	**1105**	4	4	5	**2**
Antero	60.4	*12.4*	38.8	*54.0*	74.9	1.49	*59.5*	**3.43**	*1*	*925*	3	3	5	*7*
Bearpaw	60.5	14.4	*35.9*	73.9	74.3	*1.60*	62.6	**3.13**	*1*	1045	4	4	6	5
Bill Brown	61.1	*13.3*	*35.4*	62.2	74.7	1.51	*61.2*	**3.21**	*1*	985	4	3	5	6
Bond CL	59.6	14.3	37.2	*57.3*	*72.1*	1.55	62.4	2.46	*2*	*880*	4	3	6	*7*
Brawl CL Plus	60.3	14.2	36.1	*59.8*	74.3	1.55	*61.6*	**3.30**	*2*	1050	**5**	**5**	4	4
Byrd	61.3	13.6	36.6	*58.9*	**76.4**	1.48	63.7	5.01	**5**	**1145**	4	4	**3**	**2**
Clara CL	60.8	**15.5**	37.0	64.2	*72.3*	*1.68*	**66.5**	**3.48**	3	1075	4	4	5	**1**
CO09W009	**62.0**	13.9	**40.2**	*57.5*	73.7	1.48	64.4	**4.54**	3	**1120**	4	4	**2**	**2**
CO09W040-	61.4	13.6	**39.7**	*51.8*	**75.3**	**1.42**	*61.4*	3.08	*1*	*875*	3	3	**3**	*8*
CO11D174	60.7	13.4	37.5	64.4	**75.1**	1.54	63.4	4.78	4	**1090**	**5**	**5**	**3**	**2**
CO11D346	60.4	*13.3*	**42.7**	*53.8*	74.8	1.49	*61.4*	**3.34**	*1*	*930*	*2*	*2*	**3**	*7*
CO11D446	60.7	13.6	*34.4*	65.1	**75.3**	1.50	64.4	*6.52*	**5**	1075	**5**	4	5	**3**
Cowboy	61.4	13.6	**40.2**	61.7	74.4	1.56	63.5	**3.15**	3	*925*	*2*	3	**3**	5
CSU Blend13	60.4	13.5	38.6	62.1	74.0	1.54	62.5	**3.84**	*2*	970	3	3	4	4
Denali	61.8	13.5	36.9	*58.6*	73.9	1.52	*60.6*	2.62	*1*	*900*	*2*	3	4	*9*
Freeman	*58.9*	**15.2**	*35.7*	*51.4*	73.4	1.50	**65.2**	**4.27**	4	*940*	3	3	*7*	**3**
Gallagher	61.2	*13.0*	**42.7**	70.0	74.0	1.54	63.4	**3.47**	*2*	*935*	3	4	4	4
Hatcher	60.4	14.6	38.5	*58.8*	*72.7*	1.47	64.5	4.60	3	1030	**5**	4	4	**3**
Iba	61.1	**15.0**	*35.8*	*54.4*	74.3	1.54	**65.6**	**4.41**	3	1075	4	4	5	**2**
KanMark	61.1	14.5	*35.8*	61.2	**75.8**	1.51	63.5	**3.92**	*2*	1065	3	3	**3**	**3**
KS10HW78-1	61.3	14.0	**39.8**	61.7	**75.7**	**1.45**	62.3	2.92	*0*	*915*	*2*	*2*	**2**	*7*
LCH11-1064	60.1	*12.9*	**41.2**	67.4	*72.3*	1.52	62.5	**4.14**	4	**1090**	**6**	**5**	5	**1**
LCS Mint	60.8	13.9	36.9	*58.7*	73.7	**1.43**	63.8	**4.11**	3	1070	4	4	4	**2**
LCS Pistol	60.0	14.4	*31.9*	*52.2*	*71.1*	1.52	63.3	**3.27**	*2*	1045	3	3	*8*	4
Oakley CL	61.3	**15.8**	**39.9**	67.6	74.6	1.54	**65.4**	**3.35**	*1*	990	3	3	**3**	4
Prairie Red	60.9	14.2	*35.4*	65.5	*72.3*	1.56	64.4	**4.10**	*2*	1040	3	4	6	**3**
Ripper	60.0	14.0	39.5	*57.5*	**75.3**	1.48	62.5	2.64	*1*	990	*2*	3	**3**	6
Robidoux	59.7	14.0	36.1	*55.6*	74.8	**1.42**	64.6	**4.00**	4	1075	4	3	5	**2**
Settler CL	60.6	13.5	38.9	60.2	74.1	1.58	63.5	**4.40**	3	1025	**5**	4	4	**3**
Snowmass	60.8	13.4	**43.5**	64.6	73.2	1.48	64.3	5.48	**5**	1075	**5**	**5**	**3**	**2**
Sunshine	60.6	13.5	**39.8**	*53.2*	73.8	1.50	63.6	5.22	**5**	1050	4	4	4	**3**
SY Monument	60.1	**15.1**	39.0	68.0	74.5	1.56	**65.3**	4.66	**5**	1070	4	**5**	4	**1**
SY Wolf	61.2	**15.0**	37.5	67.7	73.3	*1.65*	*61.5*	**3.96**	*1*	1000	3	3	5	5
T158	60.9	13.8	39.4	*55.0*	74.4	1.47	63.7	**3.77**	3	*925*	3	3	**3**	4
TAM 111	61.2	14.3	36.5	60.8	73.5	1.55	63.6	**3.63**	*2*	*900*	3	*2*	4	5
TAM 112	61.1	14.2	38.1	62.3	*71.7*	1.58	**65.5**	**4.07**	4	**1160**	4	4	5	**1**
TAM 113	61.0	13.9	*35.5*	64.8	73.5	1.51	63.5	**3.49**	*2*	**1100**	**5**	4	5	**2**
Warhorse	60.6	13.7	*33.4*	77.9	*72.4*	*1.61*	64.5	**4.27**	3	**1130**	4	**5**	*8*	**1**
WB-Grainfield	60.7	13.9	*35.2*	63.5	74.6	**1.43**	62.6	**3.40**	*1*	990	*2*	*2*	4	5
Winterhawk	61.4	14.3	**42.3**	*55.9*	75.0	1.55	64.6	**3.26**	3	965	3	3	**2**	4
Yumar	60.4	**15.4**	*35.5*	64.7	*72.0*	1.53	**66.4**	4.88	**5**	1080	4	3	6	**1**
Average	60.7	14.0	37.8	61.0	73.9	1.52	63.4	3.85	2.6	1016	3.6	3.5		
Minimum	58.9	12.4	31.9	51.4	71.1	1.40	59.5	2.46	0	875	2	2		
Maximum	62.0	15.8	43.5	77.9	76.4	1.68	66.5	6.52	5	1160	6	5		

Wheat Milling and Baking Quality Data - 2014 Walsh

* Value in **bold** indicates superior value, value in *italics* indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Grain Ash	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
1863	59.2	14.1	28.9	*50.5*	72.9	**1.34**	*61.1*	2.98	*1*	*955*	3	3	4	*7*
Above	59.2	*13.2*	30.5	64.1	72.3	*1.60*	*59.8*	2.51	*1*	*910*	4	4	6	*8*
Akron	58.3	**14.9**	29.2	*54.6*	*70.9*	1.51	62.5	**3.64**	*1*	1105	**5**	4	6	**3**
Antero	60.7	13.3	30.4	*47.0*	**74.3**	**1.39**	*61.0*	**3.45**	*0*	1005	**5**	4	**3**	5
Bearpaw	58.8	**15.0**	*27.3*	64.1	72.8	*1.57*	62.1	**3.60**	*1*	1075	**5**	3	5	4
Bill Brown	60.1	*13.2*	28.4	62.1	72.8	1.48	61.9	**4.30**	*2*	*965*	4	4	5	5
Bond CL	59.3	*12.7*	29.6	*59.0*	*71.1*	1.48	61.8	**3.59**	4	1025	**5**	3	5	**3**
Brawl CL Plus	59.6	**15.4**	28.9	*52.6*	72.7	1.43	**66.0**	**3.24**	*1*	**1300**	**5**	4	4	**1**
Byrd	58.9	14.1	*25.2*	*56.9*	**74.7**	1.49	**65.0**	*5.70*	**5**	**1320**	**5**	4	4	**1**
Clara CL	60.7	14.0	30.9	63.8	*71.0*	*1.54*	62.8	**3.36**	*2*	1090	4	4	5	**3**
CO09W009	60.7	*13.1*	**32.3**	*48.7*	73.9	1.50	62.8	**4.24**	3	1075	**5**	4	**3**	**3**
CO09W040-	59.9	*12.9*	30.9	*50.7*	**74.5**	**1.30**	*60.2*	2.67	*0*	*960*	3	3	**3**	*8*
CO11D174	58.7	13.5	28.5	*54.4*	**74.0**	1.44	63.7	5.30	**5**	**1235**	**6**	**5**	4	**1**
CO11D346	60.0	*12.5*	**31.9**	*52.5*	**74.6**	**1.39**	62.0	**3.43**	3	*840*	*2*	*2*	**3**	6
CO11D446	59.1	*13.1*	*26.9*	*58.3*	**74.1**	1.47	62.9	*5.56*	**5**	**1215**	4	4	5	**2**
Cowboy	59.8	13.7	**32.3**	*53.3*	73.8	1.44	63.8	**3.36**	3	*840*	*2*	*2*	**3**	5
CSU Blend13	59.8	14.1	*28.1*	*59.3*	72.8	1.46	61.9	**3.75**	*2*	1075	**5**	4	5	**3**
Denali	**60.8**	*13.1*	28.5	*57.5*	73.1	1.43	*61.1*	2.95	*1*	*870*	4	3	**3**	*7*
Freeman	*57.5*	14.4	28.6	*46.3*	72.2	1.53	63.5	4.83	**5**	1020	4	3	*8*	**3**
Gallagher	59.8	13.5	**32.0**	66.2	73.8	1.52	62.8	**3.74**	*1*	*940*	4	3	4	5
Hatcher	59.6	14.0	28.9	*54.0*	72.8	1.42	**65.3**	**3.95**	4	1000	**5**	3	4	**1**
Iba	**60.8**	13.4	29.4	*56.5*	**74.0**	1.49	62.8	**3.61**	4	1010	4	4	**2**	**3**
KanMark	60.2	14.5	28.2	*59.1*	**74.6**	1.46	62.9	**3.91**	*2*	**1150**	**5**	4	**3**	**2**
KS10HW78-1	59.9	*13.1*	**32.7**	*58.3*	**75.4**	1.52	*59.8*	2.73	*0*	*815*	4	*2*	**2**	*9*
LCH11-1064	58.8	13.9	*27.8*	65.7	*71.2*	1.44	*61.6*	2.26	*0*	*950*	3	3	6	*8*
LCS Mint	**60.9**	13.5	**31.9**	*52.7*	73.2	**1.37**	63.0	**4.01**	3	**1150**	**5**	4	**2**	**2**
LCS Pistol	59.4	14.3	*27.3*	*46.8*	*68.3*	*1.60*	62.6	2.35	*0*	1035	3	3	*8*	*7*
Oakley CL	59.9	14.4	**33.0**	69.7	72.4	1.50	**64.9**	**4.08**	4	1020	4	4	4	**1**
Prairie Red	*58.2*	**15.2**	*27.2*	64.8	71.7	*1.55*	63.3	2.71	*2*	1065	4	4	*7*	4
Ripper	*57.9*	14.3	**33.2**	*55.7*	**74.4**	**1.39**	63.6	2.64	*2*	*970*	4	3	**2**	5
Robidoux	59.1	14.1	29.3	*50.8*	73.8	1.43	63.8	**3.83**	4	1075	**5**	4	4	**1**
Settler CL	59.2	13.9	30.3	*56.5*	72.7	*1.58*	63.1	**3.77**	*2*	1120	4	4	4	**3**
Snowmass	58.7	13.6	30.4	67.5	*71.1*	1.45	**65.0**	*7.44*	**6**	**1150**	**5**	4	*7*	**2**
Sunshine	58.8	**15.0**	**31.8**	*43.8*	*71.6*	**1.39**	**66.9**	5.36	**5**	**1190**	4	**5**	4	**1**
SY Monument	59.7	13.6	30.9	62.4	**74.1**	1.42	62.7	5.41	**5**	1095	**5**	4	**3**	**3**
SY Wolf	59.0	14.5	30.3	*59.3*	71.8	1.47	*59.9*	4.58	*1*	1025	4	4	4	6
T158	59.5	13.5	**32.2**	*51.9*	73.8	1.42	*59.9*	2.70	*0*	1050	**6**	**5**	**3**	6
TAM 111	59.7	14.5	29.4	*56.6*	71.9	1.47	63.2	2.75	*1*	*940*	3	*2*	4	*7*
TAM 112	60.3	**15.3**	30.3	62.7	*69.8*	*1.61*	**66.9**	**3.59**	4	**1220**	4	3	6	**1**
TAM 113	59.8	14.3	30.0	*58.8*	72.3	1.51	64.0	**3.57**	*2*	**1225**	4	4	4	**1**
Warhorse	58.6	**15.7**	*27.1*	77.5	*70.8*	1.47	**65.9**	**3.85**	*2*	**1190**	4	4	*7*	**1**
WB-Grainfield	59.4	*12.9*	31.6	*57.8*	**74.5**	**1.38**	*60.6*	**3.04**	*0*	1000	4	4	**2**	6
Winterhawk	60.1	13.8	**32.1**	*58.0*	**74.2**	1.45	62.8	**3.47**	*2*	1040	**5**	**5**	**2**	**3**
Yumar	60.5	13.5	30.8	*59.6*	72.1	1.45	63.6	**3.97**	4	1065	**5**	4	4	**2**
Average	59.5	13.9	29.9	57.5	72.8	1.47	62.9	3.77	2.4	1054	4.3	3.6		
Minimum	57.5	12.5	25.2	43.8	68.3	1.30	59.8	2.26	0	815	2	2		
Maximum	60.9	15.7	33.2	77.5	75.4	1.61	66.9	7.44	6	1320	6	5		

Wheat Milling and Baking Quality Data - 2014 Fort Collins

* Value in **bold** indicates superior value, value in *italics* indicates inferior value.

Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Grain Ash	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
Antero	61.1	*11.7*	37.8	60.0	73.1	**1.18**	*58.0*	**3.47**	*2*	*815*	**5**	3	**3**	5
Brawl CL Plus	60.9	**14.4**	*34.1*	61.6	71.6	1.37	**61.9**	**2.94**	*1*	**1130**	**5**	4	4	**1**
Byrd	60.5	12.4	35.8	*59.3*	**75.6**	1.29	59.7	**4.04**	4	**1095**	**5**	4	**3**	**1**
CO09W009	**62.4**	12.7	37.2	60.8	*71.0*	1.33	*58.0*	**3.55**	*2*	**1040**	**6**	4	**3**	**2**
CO09W040-	61.5	12.3	**39.2**	*59.4*	72.7	1.28	59.0	**2.74**	*2*	910	**5**	4	**3**	4
CO11D174	60.9	12.2	37.2	63.1	**74.3**	1.26	60.9	4.90	3	**1075**	**6**	4	**3**	**2**
CO11D346	60.1	*10.8*	**38.6**	*48.9*	**75.0**	1.27	*57.7*	**3.29**	3	*725*	4	3	4	5
CO11D446	60.2	12.4	*34.3*	65.4	**73.8**	1.33	59.6	**3.90**	3	**1075**	**5**	4	4	**1**
Cowboy	61.0	*11.6*	36.4	*54.3*	73.4	1.30	58.9	**3.56**	3	*760*	4	3	5	5
Denali	61.8	*11.6*	36.3	*57.3*	73.1	*1.39*	*57.0*	**2.92**	*2*	*740*	4	3	4	*7*
Freeman	*58.4*	12.8	*33.3*	*44.1*	72.1	1.26	58.7	**3.95**	*2*	955	**5**	4	*9*	4
Hatcher	60.7	12.0	35.2	60.3	72.4	**1.21**	59.7	**4.09**	4	*840*	**5**	**5**	4	**3**
Iba	61.7	12.9	35.2	*59.5*	73.2	1.39	60.1	**3.60**	*2*	915	4	4	**3**	**3**
KanMark	61.8	13.1	*32.3*	68.2	73.1	1.35	**61.0**	**3.70**	3	**1040**	**5**	**5**	5	**1**
LCH11-1064	60.3	12.7	37.9	67.1	*70.5*	1.38	59.6	1.82	*0*	890	4	4	5	6
LCS Mint	**62.2**	12.5	37.6	62.8	**73.7**	**1.25**	**61.0**	**4.14**	3	**1035**	**5**	4	**1**	**1**
LCS Pistol	60.6	13.1	*32.9*	*47.3*	*67.9*	*1.44*	58.7	*1.74*	*0*	1005	**5**	3	*8*	6
Oakley CL	61.3	**13.8**	**39.8**	68.8	72.2	1.39	**62.9**	**3.67**	3	**1065**	**6**	4	**3**	**1**
Robidoux	60.8	12.6	*32.7*	63.3	73.4	**1.23**	58.9	**4.03**	*2*	915	**5**	**5**	4	4
Settler CL	60.7	12.6	**38.5**	66.8	72.1	*1.41*	**61.0**	**3.84**	4	925	**5**	4	4	**1**
Snowmass	61.4	12.7	**42.1**	76.8	*70.4*	1.33	**62.1**	*6.87*	**6**	*825*	**5**	4	5	4
Sunshine	60.6	13.1	**42.0**	*55.5*	72.0	1.33	**62.1**	4.27	3	**1040**	**5**	4	**3**	**1**
SY Southwind	*59.4*	12.2	*29.7*	67.7	**74.5**	1.29	59.9	2.58	3	955	4	4	6	4
SY Wolf	61.2	**13.6**	34.7	70.5	72.1	*1.48*	59.1	**3.31**	*1*	990	4	4	6	4
T158	61.4	13.2	37.2	*59.9*	71.8	1.35	*56.9*	2.16	*1*	915	**5**	4	4	6
Thunder CL	60.5	12.9	35.1	64.0	72.2	1.28	**61.1**	4.55	4	**1050**	**5**	4	4	**1**
WB-Cedar	*59.5*	**13.7**	38.0	*58.4*	*69.6*	1.33	60.0	2.19	*0*	*855*	**5**	3	6	6
WB-Grainfield	60.8	12.1	37.1	61.1	72.4	1.30	58.8	2.38	*1*	945	**5**	4	**3**	5
Winterhawk	61.1	12.8	**39.0**	63.9	72.4	1.37	59.9	**3.19**	*2*	915	**5**	**5**	**3**	**3**
Yuma	61.2	*11.5*	36.6	65.9	71.8	1.32	58.6	2.68	3	*825*	**6**	**5**	5	4
Average	60.9	12.6	36.5	61.4	72.4	1.32	59.7	3.47	2.4	942	4.9	4.0		
Minimum	58.4	10.8	29.7	44.1	67.9	1.18	56.9	1.74	0	725	4	3		
Maximum	62.4	14.4	42.1	76.8	75.6	1.48	62.9	6.87	6	1130	6	5		

Wheat Milling and Baking Quality Data - 2014 Haxtun

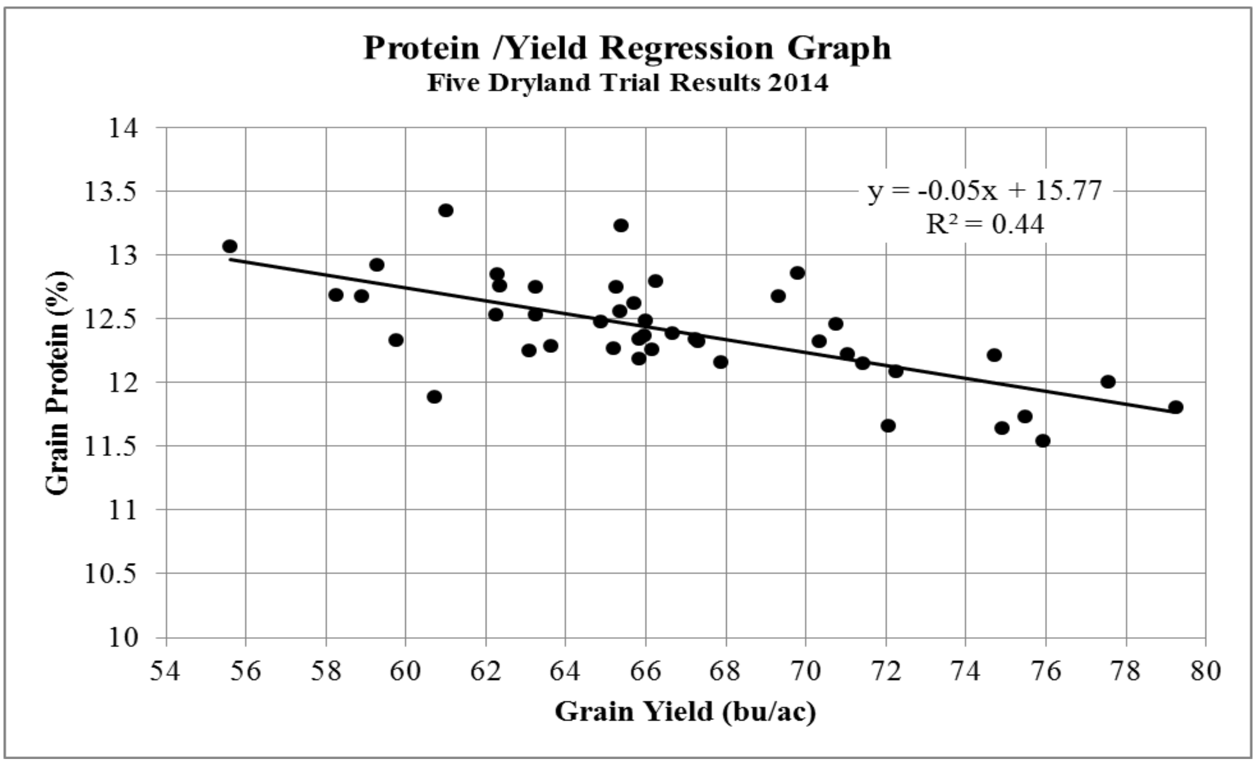
* Value in **bold** indicates superior value, value in *italics* indicates inferior value.

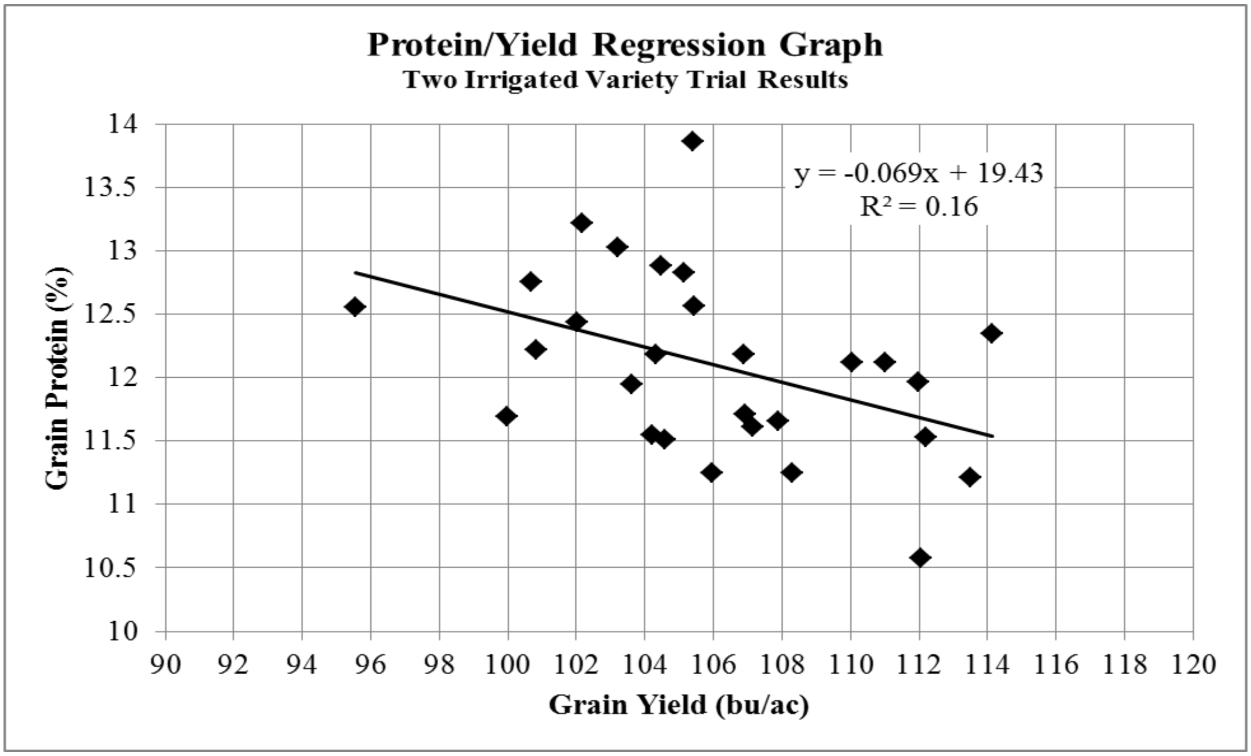
Entry	Test Weight	Grain Protein	SKCS Weight	SKCS Hardness	Flour Yield	Grain Ash	Bake Absorption	Mixograph Mix Time	Mixograph Tolerance	Loaf Volume	Crumb Color	Crumb Grain	**Milling Score**	**Baking Score**
Antero	59.1	*10.7*	34.9	*49.2*	74.6	1.43	*56.1*	**3.95**	*2*	*755*	*2*	*2*	4	*8*
Brawl CL Plus	59.4	**13.3**	*29.7*	63.1	73.7	1.48	**63.4**	3.62	3	**1045**	4	3	5	**1**
Byrd	58.3	12.3	*29.0*	63.6	**75.6**	1.48	**61.1**	**4.74**	**5**	**995**	4	3	6	**1**
CO09W009	60.2	11.7	35.2	61.0	73.0	1.54	59.4	**4.51**	4	**995**	4	4	4	**1**
CO09W040-	60.4	*10.2*	34.0	*53.3*	74.9	**1.36**	*56.2*	**4.35**	*2*	*725*	*2*	*2*	**3**	*7*
CO11D174	58.8	*10.3*	34.9	*51.5*	74.9	1.48	58.2	*6.81*	4	**960**	3	4	4	5
CO11D346	58.6	*10.3*	35.7	*49.7*	**75.2**	1.50	*57.1*	5.20	3	*720*	*2*	*2*	4	*7*
CO11D446	58.6	*10.9*	33.6	*53.7*	74.5	1.52	58.1	*7.38*	**6**	880	4	3	4	5
Cowboy	58.9	11.5	32.3	*58.9*	73.7	1.50	58.1	**4.33**	*2*	*800*	*2*	*2*	4	5
Denali	59.6	**12.3**	32.5	60.6	73.3	1.51	59.2	*2.66*	*2*	*790*	3	*2*	4	*7*
Freeman	*57.3*	*10.3*	35.2	*38.6*	73.9	1.49	*57.1*	**4.63**	4	825	3	3	*7*	4
Hatcher	58.7	**13.1**	*32.1*	61.3	*72.4*	1.48	**62.2**	3.00	4	950	**5**	3	5	**2**
Iba	60.3	12.0	32.8	*54.4*	**75.4**	1.47	60.2	**4.81**	3	930	3	*2*	**3**	**3**
KanMark	60.0	**13.0**	*30.8*	68.7	74.3	1.47	**63.3**	**3.92**	4	**1060**	**5**	4	5	**1**
LCH11-1064	59.5	**12.8**	34.4	77.4	*71.9*	1.52	60.1	2.85	*1*	*785*	3	*2*	6	*7*
LCS Mint	**60.7**	11.0	**36.4**	*48.5*	74.4	1.51	58.2	**4.79**	3	910	4	4	**3**	**3**
LCS Pistol	59.3	**12.7**	*30.2*	*54.3*	*69.8*	1.56	58.1	2.91	*1*	*810*	3	*2*	*7*	*7*
Oakley CL	59.2	**12.7**	**37.0**	69.3	73.8	1.53	**61.5**	**3.75**	3	**990**	4	4	4	**1**
Robidoux	59.1	*10.8*	35.0	*56.4*	73.5	1.55	58.3	**4.70**	4	915	4	3	4	**3**
Settler CL	59.6	11.7	34.8	*59.3*	74.4	1.56	59.1	**5.14**	4	875	4	3	**3**	**3**
Sunshine	58.9	*10.8*	**40.4**	*44.8*	74.2	1.47	58.2	5.72	**5**	900	4	4	4	**3**
SY Southwind	*56.9*	12.1	*26.9*	64.0	**75.2**	1.49	**60.6**	3.40	3	935	4	3	*7*	**3**
SY Wolf	**60.6**	12.1	34.6	72.8	74.3	*1.58*	59.3	5.19	3	845	3	3	**3**	5
T158	58.5	11.2	**37.0**	*53.5*	**75.1**	1.50	*57.2*	**3.95**	*2*	860	3	3	**2**	5
Thunder CL	58.3	11.6	33.1	63.4	73.4	**1.38**	60.3	**4.37**	4	940	4	4	5	**1**
WB-Cedar	58.8	11.4	**38.5**	*58.3*	73.6	1.46	58.2	**4.40**	*2*	*800*	3	3	**2**	5
WB-Grainfield	60.1	10.9	35.0	*56.1*	74.2	1.47	58.1	5.25	3	*795*	*2*	*2*	**3**	6
Yuma	59.5	11.8	33.5	63.6	73.2	1.53	**60.4**	3.46	4	875	**5**	3	5	**2**
Average	59.2	11.6	33.9	58.2	73.9	1.49	59.2	4.42	3.2	881	3.4	2.9		
Minimum	56.9	10.2	26.9	38.6	69.8	1.36	56.1	2.66	1	720	2	2		
Maximum	60.7	13.3	40.4	77.4	75.6	1.58	63.4	7.38	6	1060	5	4		

The Relationship between Yield and Protein in the 2014 Dryland and Irrigated Trials

The following graphs are based on five dryland and two irrigated variety performance trials in 2014. They are intended to show the relationship between yield and grain protein. In general, as yield increases, the protein content decreases. Using our dryland trials, the expected grain protein is -0.05 multiplied by the expected grain yield, plus 15.77. For example, if the yield is 55 bu/ac, then the expected protein content would be 13%. If the yield was 80 bu/ac, then the predicted protein content would be 11.8%.

The R^2 value is a statistical measure of how well yield is related to grain protein. Additional testing of varieties might change the relationships portrayed in the graphs. It is also important to note that available nitrogen in the soil, growing conditions, and other environmental factors can impact the grain protein content in addition to the yield.




Protein/Yield Regression Graph
Two Irrigated Variety Trial Results
y = -0.069x + 19.43
R² = 0.16
Grain Protein (%)
Grain Yield (bu/ac)
14
13.5
13
12.5
12
11.5
11
10.5
10
90
92
94
96
98
100
102
104
106
108
110
112
114
116
118
120

Evaluating the Ripple Effect of Cropping Systems Research

Meagan Schipanski

In 1985 and 1986, Drs. Gary Peterson and Dwayne Westfall initiated the long-term Dryland Agroecosystem Project (DAP) at three locations in eastern Colorado near Walsh, Stratton, and Sterling. This experiment is unique on many fronts. It is one of the few long-term experiments replicated at multiple locations to evaluate cropping systems across a climate gradient. Each site includes a summit, midslope, and toeslope across all treatments. The experiment has also been generously hosted on producer fields at each location and maintained through collaboration between CSU and the USDA-ARS Agricultural Systems Research Unit in Fort Collins. As we celebrate the 30th anniversary of this experiment, we are embarking on research to evaluate the impact of this and other dryland cropping systems studies on the broader landscape of the Central Great Plains and to help inform the future of the DAP.

Results from the first phase of the experiment demonstrated that intensified, no-till rotations can build soil carbon and improve profitability. The increase in soil carbon is related to increased crop residues in more intensified rotations (less frequent fallow). For example, switching from a wheat-fallow to wheat-corn-millet-fallow or continuous cropping without a fallow period increased soil carbon in the top 4 inches by about 20% over 15 years, increased precipitation use efficiency, and improved profitability. In the past two decades, more intensive rotations including corn, grain sorghum, and/or proso millet in rotation with winter wheat have been adopted using no-till management on approximately 30% of dryland acres in Colorado. In addition, a smaller number of producers have eliminated fallow all together.

We are looking at whether similar results found in the long-term field experiments hold true across the variability represented by working farms. In particular, we are measuring shifts in fallow frequency over the past decade using cropland databases, whether producers are experiencing the same benefits of rotation intensity on soil carbon and precipitation use efficiency, and the factors that influence cropping choices. My graduate student, Steve Rosenzweig, is driving across the region to talk with no-till producers using a variety of crop rotations from wheat-fallow to continuous cropping about their management practices, yields, and the factors that influence their crop rotation choices. In addition, he will be collecting soil samples to measure cropping intensity effects on soil carbon, aggregation, mycorrhizal fungal biomass and colonization, and drought stress.

Long-term research studies are critical for comparing management systems across year-to-year climate variability and effects on variables that change slowly, such as soil carbon. Integrating research station studies with on-farm research helps keep us honest in evaluating the adoption potential of different systems. In addition, developing close collaborations with producers helps keep our long-term studies relevant as we identify the next generation of management systems to evaluate.

False Wireworms in Winter Wheat

Frank Peairs

Several species of false wireworms, *Eleodes* spp., occur in the drier areas of the Great Plains. More than one species may be found in a given field and which species are present may be due, in part, to soil type. The flightless adult false wireworms are known as darkling beetles. These are large black or reddish brown beetles, which can be recognized by the odd angle that the body is held at when they run. The larvae are similar in appearance to wireworm larvae, except they have longer legs and antennae. False wireworm adults lay their eggs in loose soil and most of the life cycle is spent as adults. Larvae will be found at varying depths in the soil, depending on temperature and moisture. Life cycles are variable, depending on the species.

False wireworm larva (photo courtesy of Sarah Zukoff, Kansas State University)

In a typical life cycle (*Eleodes suturalis*), adults, which feed on a variety of seeds and other plant material, may live for several years. They lay eggs in the spring. Larvae will feed on germinating seeds, seedlings, and larger plants from a variety of species. Egg laying takes place again in late summer. These larvae will feed on germinating seeds and seedlings, often of winter wheat. They will overwinter along with adults. In the spring, they will resume feeding until they pupate in the soil.

False wireworm larvae typically damage wheat in the fall by feeding on seeds, seedlings and young plants, resulting in lost stand. Yield losses occur if plant population losses are large enough to overcome the compensatory ability of the crop. The spring damage is depicted in the photos.

False wireworm spring damage (photo courtesy of Sarah Zukoff, Kansas State University)

No applied biological controls exist for the control of false wireworms, however, they are affected by a variety of pathogens, parasitic insects, and predatory insects and birds. They also are cannibalistic.

Cultural practices that promote rapid germination and seedling growth help to shorten the period that the plant is most vulnerable to attack. Since the larvae and adults generally are associated with living plants, the use of tillage during the fallow period seems to have little potential. Given that wheat is a highly favorable and susceptible host for these species, rotation to less susceptible crops may be an important method to reduce damage. Piles of decomposing straw and other vegetation provide attractive shelter for adults and thus should be avoided when possible.

Abundant false wireworm (darkling) beetles in the summer would signal the potential for problems in the fall if weather remains hot and dry. In addition, soil samples can be sifted in the fall prior to planting to look for larvae. An average of one larva per three square feet suggests an infestation of economic importance

Seed protectants containing imidacloprid or thiamethoxam are labeled for control of wireworms in wheat, at rates lower than those recommended for aphids and Hessian fly. False wireworms are related to true wireworms, so it is possible that these products also may be used to control false wireworms, however, no data are available to confirm this. Nonetheless, Australian data suggest that both of these active ingredients are effective against several false wireworm species (same family but different species and environment). If effective, seed protectants would limit fall damage and reduce the number of overwintering larvae. It is unlikely that seed treatment would have any effect on spring damage (other than reducing the abundance of overwintering larvae).

Searching for Useful Diversity in Wheat's Family Tree

Patrick Byrne and Angela Moore

Wheat breeding has had dramatic success over the past century in improving the crop's yield and quality. However, this improvement has been accompanied by a reduction of genetic diversity among elite breeding materials. Because genetic diversity is the foundation of gains made through plant breeding, there is concern that the narrowing of the gene pool may limit the potential for future progress. One place to look for a wider diversity of genes is wheat's family tree, the ancestral species from which wheat evolved.

Head of bread wheat (left) compared to heads of the ancestral species *Aegilops tauschii.*

Wheat originated through a series of hybridization events among wild grass species, beginning about 10,000 years ago in the Fertile Crescent of the Middle East. The first hybridization occurred between a species known as *Triticum urartu* (whose genome, or genetic constitution, is designated AA) and a progenitor species related to *Aegilops speltoides* (which possesses the BB genome). The result was the tetraploid wheat *T. turgidum* (AABB). Then about 7,000 years ago, very likely in what is now Iran, this tetraploid wheat hybridized with another wild grass, *Ae. tauschii*, which has the DD genome. The resulting hexaploid plants (AABBDD) gave rise to the bread wheat we grow today (*T. aestivum*). Hexaploid wheat is vigorous, has broad adaptation, and its grain has characteristics that make it more suitable for bread making than its ancestors.

The genetic diversity of the D genome, in particular, is considered to be very narrow, indicating that only a small number of plants were involved in the AABB x DD hybridization event. Therefore, considerable attention has been devoted to incorporating a wider diversity of *Ae. tauschii* genes into hexaploid wheat. Colorado State University is now involved in a novel project with Kansas State University's Wheat Genetic Resource Center (WGRC) to do just that.

The WGRC has a collection of over 500 accessions of *Ae. tauschii* collected from Syria to China and many countries in between. After analysis of DNA sequences of these accessions, a 'mini-core' subset of 40 accessions was identified that represents most of the genetic diversity in the entire collection. CSU's part of the project is to evaluate this wild germplasm for drought tolerance in a two-part strategy:

- The 40 accessions in the mini-core will be evaluated for root traits when grown in a greenhouse environment under moisture stress. Improved water acquisition as a result of size, depth, and architecture of roots has been related to increased drought tolerance in small grain cereals. Therefore, plants with deeper roots, especially small diameter roots that are better for water absorption, are considered advantageous in most years in semi-arid environments like Colorado's.

- The most promising of the 40 accessions will then be crossed into a hexaploid wheat background for evaluation in field trials for vigor, yield, and water use efficiency.

At KSU, the same materials will be evaluated for disease resistance, heat tolerance, and adaptation to more humid environments. Results of this project will be breeding lines containing novel *Ae. tauschii* genes related to environmental stress tolerance, disease resistance, and productivity, which have been incorporated into elite germplasm adapted to the Great Plains region.

Another innovative aspect of this project is that it is jointly funded by the U.S. National Science Foundation and a group of private sector organizations. These organizations include the Colorado Wheat Research Foundation, Colorado Wheat Administrative Committee, Kansas Wheat Alliance, Ardent Mills, General Mills, Bayer Crop Science, Dow AgroSciences, Syngenta Cereals, Dupont Pioneer, and Heartland Plant Innovations. In return for their funding contributions, the private-sector group helps set the research agenda for the project. Together with the universities involved, the private group will get a two-year head start in access to any results that arise from the project before the results become publicly available.

Wheat Performance Index: A Fresh Look at Variety Selection

Jerry Johnson and Sally Sauer

Yield alone is not always the best criterion for variety selection. Other factors like test weight, insect resistance, or disease resistance should be taken into account. Following the example of Joe Lauer, leader of the crop variety testing program in Wisconsin, we developed a Performance Index for wheat modeled after his index for corn hybrid selection. In order to combine yield, test weight, stripe rust resistance, milling quality, baking quality, and wheat streak mosaic virus tolerance into one Performance Index number for each variety we had to develop a weighting system similar to how Scott Haley determines varietal milling and baking scores. Our weights for determining our Performance Index are:

Yield = 77%
Test Weight = 7%
Stripe rust resistance = 7%
Milling Quality = 3%
Baking Quality = 3%
Wheat streak mosaic virus tolerance = 3%
Total = 100%

The Performance Index values were calculated by multiplying the percent of the trial average for each characteristic and variety and adding together the weighted averages of each characteristic for each variety.
For example:
Byrd PI of 109.1 = (49.1/44.8)*77 + (59.9/59.6)*7 + (5/4.6)*7 + (7/6.3)*3 + (7/6.2)*3 + (5/4.3)*3

The table on the following page shows the Performance Index (PI) values for nineteen varieties that have been tested in our dryland trials for three consecutive years (2012-2014). The varieties are ranked according to the highest Performance Index value. The two varieties with the highest Performance Index values had very high yields compared to all of the other varieties, Antero and Byrd. T158 had average yield and average test weight but above average stripe rust and wheat streak mosaic virus scores. Brawl CL Plus had average scores across the board except for above average milling and baking. Different people might assign different weights to different traits.

Variety Performance Index Scores

Based on 3-Year (2012-2014) Dryland Trial Results

Variety[b]	Brand/Source	Market Class[c]	Performance Index	3-Year Average[a] Yield	Yield	Test Weight
				bu/ac	% trial average	lb/bu
Antero	PlainsGold	**HWW**	114.5	49.8	111%	59.8
Byrd	PlainsGold	HRW	109.1	49.1	110%	59.9
T158	Limagrain	HRW	104.5	44.4	99%	59.7
Brawl CL Plus	PlainsGold	HRW	103.5	45.5	102%	60.3
Clara CL	KS Wheat Alliance	**HWW**	102.5	43.5	97%	60.1
TAM 113	AGSECO	HRW	101.8	44.5	99%	59.6
Hatcher	PlainsGold	HRW	101.2	44.3	99%	59.6
Winterhawk	WestBred Monsanto	HRW	100.0	44.5	99%	61.1
Settler CL	Husker Genetics	HRW	100.0	45.8	102%	58.9
TAM 112	Watley Seed	HRW	99.6	45.4	101%	60.6
Denali	PlainsGold	HRW	99.4	45.9	103%	60.9
Snowmass	PlainsGold	**HWW**	98.8	42.5	95%	59.2
1863	KS Wheat Alliance	HRW	98.5	41.2	92%	59.2
Robidoux	Husker Genetics	HRW	97.2	42.5	95%	60.0
Bill Brown	PlainsGold	HRW	96.9	44.8	100%	60.1
Ripper	PlainsGold	HRW	94.7	45.7	102%	58.7
Above	PlainsGold	HRW	93.5	44.1	98%	58.7
TAM 111	AgriPro Syngenta	HRW	92.8	43.8	98%	60.2
Bond CL	PlainsGold	HRW	91.5	43.8	98%	56.1
		Average	**100.0**	**44.8**		**59.6**

[a]The 3-year average yield is based on nine 2014 trials, seven 2013 trials, and nine 2012 trials. Test weights are based on eight 2014 trials, five 2013 trials, and eight 2012 trials.

[b]Varieties ranked according to average performance index value.

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

What to Consider When Deciding Whether to Treat Stripe Rust in Wheat

Stephen Wegulo

The decision to apply a fungicide to control stripe rust on wheat is based on:

- weather conditions,
- presence of stripe rust in the field,
- wheat growth stage,
- resistance level of the variety planted,
- yield potential, and
- the price of wheat.


Figure 1. Stripe rust in a field in south central Nebraska in late April. (Photos by Stephen Wegulo)

The first appearance of stripe rust pustules in a field indicates that spores arrived in the field and initiated infections at least seven days earlier. Apply a fungicide if stripe rust is seen in a field and the following conditions or factors exist:

1. wet, cool weather,
2. the flag leaf has emerged (or earlier depending on the situation),
3. it's a susceptible variety, and
4. a positive net return on investment based on the yield potential and the price of wheat.

Not all four factors have to exist to warrant treatment. Base your decision on the combination of factor No. 1 with any or all of the other three factors.

Table 1 illustrates the potential net profit from foliar fungicide treatment of wheat based on a $5 or $8 per bushel selling price at the elevator. Research conducted by the author in 2007 in Nebraska (wet growing season with foliar diseases — rust and leaf spots) provided estimates of how much yield increase or net profit to expect from spraying at the beginning of stem elongation (growth stage Feekes 6) compared to spraying at flag leaf (growth stage Feekes 9). Averaged across five fungicides (Quilt, Headline, Tilt, Quadris, and Stratego) and four locations (Mead, Clay Center, North Platte, and Sidney), spraying at Feekes 6 resulted in a net yield increase of 19 bu/ac and a net profit of $67/ac. Spraying at flag leaf resulted in a net yield increase of 22 bu/ac and a net profit of $85/ac. In a dry growing season with little disease (2006), yield increase was the same (6 bu/ac) from spraying at Feekes 6 or Feekes 9 and net profit was also about the same (about $5/ac) from spraying at Feekes 6 or Feekes 9.

The fungicide spray should be timed to protect the flag leaf. The concept of a threshold level of stripe rust above which a fungicide should be applied is not very helpful because in general, plant diseases are best controlled preventively. In addition, because rust spores are numerous and microscopic and it takes 7 to 10 days from infection to appearance of pustules (the incubation period), waiting until a certain threshold is reached based on appearance of pustules gives the pathogen more time to infect and produce more spores which spread and cause new infections.

In fields in which stripe rust appears at the heading growth stage, or when heading is starting, it is better to apply a fungicide at full heading that will control stripe rust as well as Fusarium head blight (scab). One of the conditions favoring stripe rust (wetness) also favors Fusarium head blight. The fungicides Prosaro and Caramba have good efficacy on Fusarium head blight. A list of fungicides and their efficacies on wheat diseases is provided in a table developed by the North Central Regional Committee on Management of Small Grain Diseases (NCERA-184).

Table 1. An illustration of the potential net profit from foliar fungicide treatment of wheat based on a $5.00 or $8.00 per bushel selling price at the elevator[1].

Potential yield (bu/ac)	Expected yield increase in % or bu/ac due to treatment		$ increase based on a wheat price of:		Net profit/loss ($) at a $20 treatment cost based on a wheat price of:		Net profit/loss ($) at a $25 treatment cost based on a wheat price of:	
	%	bu/ac	$5.00	$8.00	$5.00	$8.00	$5.00	$8.00
30	5	1.50	7.50	12.00	-12.50	-8.00	-17.50	-13.00
30	10	3.00	15.00	24.00	-5.00	+4.00	-10.00	-1.00
30	20	6.00	30.00	48.00	+10.00	+28.00	+5.00	+23.00
30	30	9.00	45.00	72.00	+25.00	+52.00	+20.00	+47.00
45	5	2.25	11.25	18.00	-8.75	-2.00	-13.75	-7.00
45	10	4.50	22.50	36.00	+2.50	+16.00	-2.50	+11.00
45	20	9.00	45.00	72.00	+25.00	+52.00	+20.00	+47.00
45	30	13.50	67.50	108.00	+47.50	+88.00	+42.50	+83.00
60	5	3.00	15.00	24.00	-5.00	+4.00	-10.00	-1.00
60	10	6.00	30.00	48.00	+10.00	+28.00	+5.00	+23.00
60	20	12.00	60.00	96.00	+40.00	+76.00	+35.00	+71.00
60	30	18.00	90.00	144.00	+70.00	+124.00	+65.00	+119.00
75	5	3.75	18.75	30.00	-1.25	+10.00	-6.25	+5.00
75	10	7.50	37.50	60.00	+17.50	+40.00	+12.50	+35.00
75	20	15.00	75.00	120.00	+55.00	+100.00	+50.00	+95.00
75	30	22.50	112.50	180.00	+92.50	+160.00	+87.50	+155.00
90	5	4.50	22.50	36.00	+2.50	+16.00	-2.50	+11.00
90	10	9.00	45.00	72.00	+25.00	+52.00	+20.00	+47.00
90	20	18.00	90.00	144.00	+70.00	+124.00	+65.00	+119.00
90	30	27.00	135.00	216.00	+115.00	+196.00	+110.00	+191.00
105	5	5.25	26.25	42.00	+6.25	+22.00	+1.25	+17.00
105	10	10.50	52.50	84.00	+32.50	+64.00	+27.50	+59.00
105	20	21.00	105.00	168.00	+85.00	+148.00	+80.00	143.00
105	30	31.50	157.50	252.00	+137.50	+232.00	+132.50	+227.00

[1]The net profit does not reflect the government subsidies for wheat as outlined in the farm bill and is based on preventive fungicide treatment before flag leaf disease levels become severe enough to affect yield and test weight.
Source: Foliar Diseases of Winter Wheat: Management with Fungicides (Nebraska Extension NebGuide G1979)

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Reference

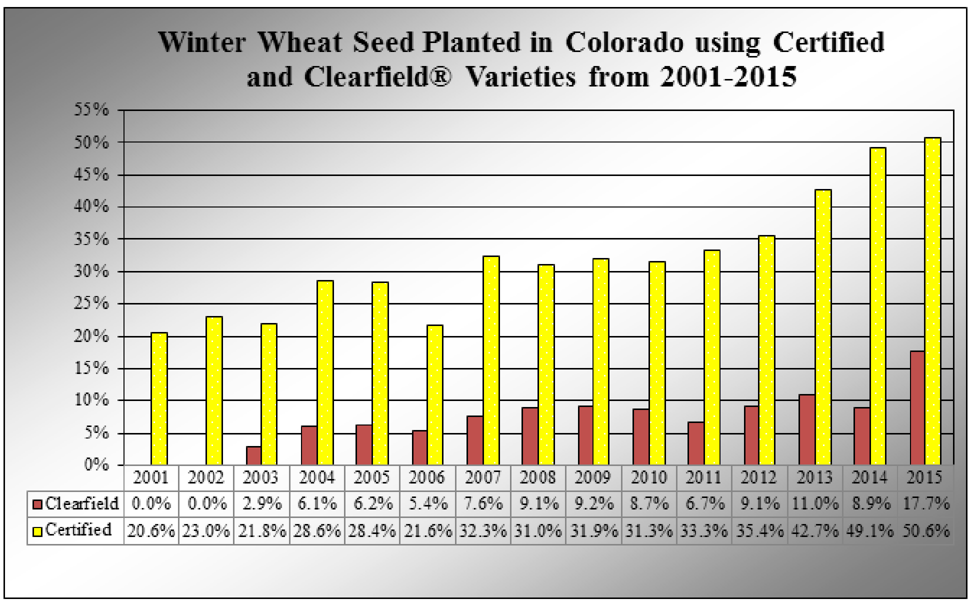
Wegulo, S., J. Stevens, M. Zwingman, and P.S. Baenziger. 2011. Yield response to foliar fungicide application in winter wheat. Pages 227-244 in: Fungicides for Plant and Animal Diseases. D. Dhanasekaran, N. Thajuddin and A. Panneerselvam (Eds.). InTech. Rijeka, Croatia.

Certified Seed Updates and Common Bunt Comments

Rick Novak

Certified Seed use Increases

The USDA National Agricultural Statistics Service reports that Colorado farmers planted 2.5 million acres of winter wheat during the fall of 2014, a 14 percent drop from 2013 when 2.85 million acres were planted. Even though planted wheat acres decreased, the continued demand for higher yielding varieties continued to fuel the purchasing of Certified Seed. The graph below reflects the continuous steady increase in Certified Wheat Seed usage. We have tracked the last 15 years of wheat seed planting activity including the varieties that carry the Clearfield trait. Colorado has currently exceeded a level of 50% Certified Wheat Seed usage and of that total, nearly 17% were varieties incorporating the Clearfield trait. Farmers seem to be adopting the Clearfield technology as a tool for controlling unwanted grassy weeds. The values used in this graph were based on annual USDA fall planting acreage reports along with the annual Colorado Seed Growers Association Annual Seed Distribution Reports.



Common Bunt

In 2014 in the northeast corner of our state there was an outbreak of common bunt, otherwise known as stinking smut. This disease can be economically devastating to farmers if the harvested wheat has a high enough level of infection. Heavily infected grain may be unsaleable at the elevator.

Common bunt, caused by two closely related fungal species, Tilletia tritici and Tilletia laevis, was named after French agronomist Mathieu Tillet, who experimented with the pathogen in 1755. Infections caused more losses than any other wheat disease in the first half of the 20th century, but decreased dramatically in frequency in the 1950s with the use of seed treatment fungicide. Common bunt is usually a seed-borne disease. When conditions are favorable, spores will germinate at the same time as the wheat seed. This timing allows the spores to penetrate the coleoptile prior to seedling emergence. The fungus continues to develop in the plant until it has infected the head and the developing ovaries. The wheat seed tissue is replaced by the fungus as the plant reaches maturity. During harvest handling, spores are released from the diseased head, contaminating the grain load.

Common bunt infections can occur in both spring and winter wheat and in some grasses. Hosts include wheat, rye, triticale, barley and grassy weeds. In order to effectively manage this disease, one must break the “disease cycle”. The farmer can simply plant seed that has been treated with a fungicide. Most seed treatments on the market today are extremely effective in the control of this disease.

Here is a list of benefits that can result from the use of a fungicide seed treatment on wheat seed:

- Helps to ensure maximum potential yield
- Helps to manage individual field issues
- Ensures good healthy stand establishment
- Reduces frequency of bunts and loose smut
- Reduces frequency of root rot and root disease
- Improves stands when low seeding rates are used
- Improves stands when seeds have poor quality or poor germination
- Reduces the impact of soil pathogens on the seedling

Another option for breaking the disease cycle is to introduce different crops into the rotation, such as a forage or corn.

As a result of last year’s outbreak, common bunt has become a serious issue in the northeast part of the Colorado. This should be a reminder to all of us that both prevention and diligent scouting are needed to control the many plant diseases that can affect production and profit.

Diagnosis and Treatment of Stunted Yellow Wheat on Hilltops

Jessica G. Davis

Chlorosis and stunting of wheat on hilltops is a common sight in Colorado. The poor growth on these knolls causes reduced yield, not only of wheat, but of many dryland crops.
Chlorosis is the term used to describe leaf yellowing, and can be caused by many different factors, some of which are soil fertility related. In an effort to better understand the cause of this problem on knolls in wheat fields, we sampled nine wheat fields in the springtime in a four-county area: Adams, Morgan, Washington, and Weld. At each site, we sampled plant tissue and soil (from 0-6 and 6-12 inch depths) from chlorotic knolls and an adjacent productive area.
In the top 6 inches of the affected knolls, the soil had a higher pH and lower P, K, Zn, and Mn concentrations (Table 1). This trend continued in the 6-12 inch depth with higher pH, lower organic matter content, and lower Mn. Therefore, it seems that erosion of the hilltops has exposed higher pH subsoil that is also lower in several essential nutrients. Even though the soil K levels were lower on the hilltops, they were still well above the critical level of 120 ppm.
On the other hand, soil NO_3-N concentrations were higher on the knolls than in the healthy adjacent areas (Table 1). Why? Apparently, the knolls were fertilized similarly to the rest of the field, but because the plants were stunted, less nitrate was taken up, leaving higher levels in the soil.

Table 1. Soil analyses averaged across nine wheat fields exhibiting chlorosis on the knolls and healthy plants in the adjacent areas.

		0-6 Inches			6-12 Inches		
		Slope Position			Slope Position		
Soil Analysis	Units	Knolls	Adjacent Area	Significance†	Knolls	Adjacent Area	Significance
pH		7.7	7.4	**	7.8	7.5	**
EC	mmhos/cm	0.9	0.6	NS	0.8	0.6	NS
OM	%	1.3	1.4	NS	0.9	1.2	*
NO_3-N	ppm	21	10	***	15	9	*
P	ppm	2.6	6.4	**	1.4	4.0	NS
K	ppm	401	528	***	357	440	NS
Zn	ppm	0.4	0.8	*	0.3	0.5	NS
Fe	ppm	4.2	8.1	NS	4.3	7.3	NS
Mn	ppm	3.2	4.3	*	2.0	3.2	*

† Asterisks represent statistical significance (* $p<0.1$, ** $p<0.05$, *** $p<0.01$), and NS means Not Significant.

Plant nutrient concentrations were also different on the knolls as compared to the adjacent areas (Table 2). Specifically, Ca and Mg concentrations were higher in wheat plants on the knolls. This is interesting because there was not a significant difference in Ca or Mg concentrations in soil, but there was a significant soil pH effect which influenced plant uptake of Ca and Mg.

There is another interesting result in the plant analyses called the Steenberg Effect. The Steenberg Effect describes how when plants are stunted, they sometimes have higher nutrient concentrations than healthy, full-size plants nearby because the smaller size of the plants leads to higher nutrient concentrations. Zinc, Fe, and Mn all tended to have higher plant concentrations on the knolls than in the adjacent areas (Table 2), although the difference was only significant for Zn. Even though the soils on the knolls were lower in these elements, those nutrients were concentrated in the stunted plants, due to the Steenberg Effect.

Table 2. Plant analyses averaged across nine wheat fields exhibiting chlorosis on the knolls and healthy plants in the adjacent areas.

		Slope Position		
Plant Analysis	Units	Knolls	Adjacent Area	Significance†
Total N	%	3.9	3.8	NS
NO_3-N	ppm	1003	1170	NS
P	%	0.2	0.2	NS
K	%	3.1	3.2	NS
Ca	%	0.52	0.41	**
Mg	%	0.20	0.16	***
Zn	ppm	19	12	**
Fe	ppm	239	173	NS
Mn	ppm	102	77	NS

† Asterisks represent statistical significance (* $p<0.1$, ** $p<0.05$, *** $p<0.01$), and NS means Not Significant.

How can we manage the hilltops to minimize chlorosis, stunting, and subsequent yield reductions?

- First of all, when soil sampling, it is wise to sample the knolls separately to diagnose the specific problems on an individual farm.
- Next, if you have access to manure, but it's not enough to spread on the entire field, consider spreading it on the knolls prior to land preparation to begin to restore the soil fertility of these eroded areas.
- Consider applying additional phosphorus fertilizer to the knolls to overcome the high pH and low concentration of available soil P in those sensitive areas.

Some farmers may be wondering whether it's worth it to apply micronutrients in these areas. In recent years, we have seen that high-value crops such as fruit trees sometimes respond to applications of Mn when applied with Zn and Fe. However, in annual crops such as wheat whose growth is often limited by rainfall not by micronutrients, the fertilizer price is likely to be more costly than any potential yield improvements.

Bringing the Lab to the Field—How Plant Biochemistry can Improve Wheat

Courtney Jahn, Adam Heuberger, Darren Cockrell, Harish Manmathan,
Terri Randolf, Scott Haley, Frank Peairs, and Corey Broeckling

Plant biochemistry is an important target to improve crops

Plant chemicals are the engine of wheat growth, development, and yield. Within the plant, specific chemicals are produced in response to environmental cues like light, temperature, and water. The production and movement of these chemicals throughout the plant ultimately decides when it is time to put down roots, grow upward, outward, produce seed, and dry down. Plant chemicals also determine the 'how much' – that is, how many roots, tillers, and ultimately, seeds are produced by the crop.

Research into plant chemistry has allowed us to exploit individual chemicals rather than just the final food and fiber products. An early example of this was the study started in 1896 at the University of Illinois to increase oil and protein levels in corn. One hundred selection cycles allowed plant breeders to raise the oil content from 10% to 30%. This and many similar experiments have shown us how to develop new plant varieties with their chemistry altered to meet many specific needs. We now know that there are more than 100,000 different plant chemicals that can be exploited to improve the usefulness of our crops. At CSU, we are looking into how some of these chemicals contribute to pest resistance and grain yield in wheat.

Wheat Stem Sawfly in Colorado

A diverse group of researchers (entomologists, chemists, wheat breeder, geneticists) at CSU have come together to tackle the emerging wheat stem sawfly (WSS) problem in Colorado. WSS has been one of the most important economic insect pests of spring wheat in the northern Great Plains for more than a century. Since the early 1980s, damage in winter wheat has been observed in these areas, and this damage has been moving southward. In 2011 major damage was first reported in winter wheat in Colorado. Annual field surveys have shown that the WSS infestation and damage in eastern Colorado is expanding and intensifying.

Apart from the adult flight, WSS is found inside wheat stems. WSS infestations result in yield losses due to reduced kernel weight (reductions of 10-20% due to stem-boring) and late-season stem cutting that causes wheat to lodge before harvest (additional losses of 25-80%). Currently, there are no insecticides effective against WSS due to the extended adult flight and the inaccessibility of the larvae. Wheat lines containing a solid-stem trait are less affected by WSS, however these lines do not always yield well and the solidness may be affected by the environment.

In 2014, the CSU Wheat Breeding Program added a WSS evaluation site near New Raymer, CO in cooperation with Jim and Cole Mertens. Significant damage has been noted since 2011 in this area, which is where most CSU field research on WSS is conducted. Trials included a hollow stem/solid stem wheat blend study (in collaboration with the CSU Entomology program) and a CSU Elite Trial which included 75 hollow stem entries. The results of the blend study were inconclusive, however some interesting results were found in the Elite trial. We found some varieties with lower WSS-induced lodging and better grain yield and test weight.

Applying plant biochemistry to study resistance to Wheat Stem Sawfly

The team at CSU, partially funded by the Colorado Wheat Research Foundation and Colorado Wheat Administrative Committee, is applying plant biochemistry tools to study why some wheat lines are less affected by WSS than others. All plants release chemicals into the air, called 'volatiles.' These volatiles can be 'smelled' by WSS, and some wheat varieties may produce different types or amounts of volatiles that would make them more or less attractive to the sawfly. Another possibility is that some wheat varieties produce toxic chemicals in response to infestation, essentially poisoning the larval diet.

The CSU team is studying chemical differences between the resistant and susceptible wheat lines before and after infestation at the New Raymer, CO field site and in greenhouses at CSU. For the field study, chemicals are being sampled from wheat tillers throughout the growing season (Figure 1). To do this, researchers hauled 10 gallons of liquid nitrogen to the field to freeze tillers after sampling. Liquid nitrogen, at -320 °F, is used to immediately freeze the plant chemicals, because they can be unstable and may change within seconds after tissues are sampled. Frozen tillers will be taken back to the laboratory for chemical analyses that will allow us to identify chemicals produced in response to WSS and chemicals associated with superior grain yield. We have already identified large differences in waxes between susceptible and resistant wheat varieties. These waxes, already known to be important for drought tolerance, also cause behavioral changes in sawfly adults (obsessive grooming) and have the potential to make winter wheat varieties that are well adapted to Colorado and that are repellent to the sawfly. This biochemical profiling technique is also being looked into for new trait discovery in wheat. It is possible biochemical changes in tillers at specific growth and developmental stages are related to better yield or quality.

So by bringing the lab to the field, we may be able to predict how different wheat lines respond to environmental cues. This will allow us to develop new wheat lines with unique biochemical properties that increase yield, improve quality, and result in reduced losses to pests, pathogens, drought and other stresses.

Dr. Adam Heuberger (right) and undergraduate Brent Warneke (left) flash-freezing wheat tillers in New Raymer, CO.

Detecting Herbicide Resistant Weeds in Colorado

Todd Gaines, Eric Westra, Scott Nissen, and Philip Westra

As herbicides continue to be an essential tool for weed control, ongoing herbicide sustainability is essential in Colorado cropping systems. Research projects pertaining to the evolution and management of resistance in important species including kochia, Palmer amaranth, waterhemp, giant ragweed, and barnyardgrass are ongoing in the CSU weed science program. Several Colorado kochia samples collected in 2011 showed glyphosate resistance when tested in glyphosate dose response studies in the CSU weed science greenhouse. Some individual plants survived up to 1.25 gallons of glyphosate, although the general level of increased resistance appears to be in the 3-6 fold range. Glyphosate-resistant kochia in Colorado contains extra copies of the gene EPSPS, which encodes the protein inhibited by glyphosate. The resistant plants produce enough extra enzyme to survive normal glyphosate applications. Glyphosate-resistant kochia sampled from Colorado usually has 4 to 10 extra copies of the EPSPS gene. We have sampled glyphosate-resistant kochia from other states and Canada, and some samples are more resistant and have 15 or more copies of the EPSPS gene. This indicates that higher resistance levels can be selected if diversity is not incorporated into kochia management programs. The CSU weed science program is conducting surveys to understand the distribution of glyphosate-resistant kochia in Colorado and numerous studies to look for other herbicides that can be used to control this resistant kochia. One of our new projects is sequencing the genome of kochia with the goal of understanding the genetic basis of herbicide resistance and other weedy traits of kochia, including drought and salt tolerance. We are also heavily involved in projects with the CSU Wheat Breeding program including spraying field plots of Clearfield breeding lines and developing novel herbicide resistance traits in wheat.

We have conducted surveys to test for glyphosate and dicamba resistance in kochia from eastern Colorado in 2011, 2012, and 2013. In 2011, 10% of kochia samples were classified as glyphosate-resistant (defined as when >20% of tested individuals from a sample are deemed resistant). In 2012, 24% of kochia samples were classified as glyphosate-resistant, and in 2013, 12% of kochia samples were glyphosate-resistant. For dicamba, 11% of samples in 2012 and 9% of samples in 2013 were classified as dicamba-resistant. For both glyphosate and dicamba, the samples usually contain both resistant and susceptible individuals. Importantly, some samples were resistant to both glyphosate and dicamba. Both dicamba and glyphosate are important tools for weed management in no-till and reduced tillage cropping systems. The occurrence of glyphosate-resistant and dicamba-resistant kochia populations highlights the need to incorporate diversity into weed management practices, and to take efforts to remove surviving individuals from fallow fields before they can set seed and potentially spread resistance.

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