

# New Winter Wheat Varieties and Experimental Lines



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# CSU Wheat Varieties Released

## 1963 - present

Hard Red				Hard White		Clearfield*	
Baca	1973	Prairie Red	1998	Avalanche	2001	Above	2001
Lindon	1975	Prowers 99	1999	Snowmass	2009	AP502 CL	2001
Vona	1976	Ankor	2002	Antero	2012	Bond CL	2004
Wings	1977	Hatcher	2004	Sunshine	2014	Protection	2004
Sandy	1981	Ripper	2006	Breck	2017	Thunder CL (HWW)	2008
Duke	1981	Bill Brown	2007	Snowmass 2.0	2018	Brawl CL Plus	2011
Hail	1982	Denali	2011	Monarch	2018	Byrd CL Plus	2018
Carson	1986	Cowboy	2011				
Lamar	1988	LCS Mint	2011	<b>Wheat Stem Sawfly</b>		<b>CoAxiom*</b>	
Yuma	1991	Byrd	2011	CO15SFD107	2019?	Incline AX	2017
Jules	1993	Avery	2015	CO15SFD092	2019?	LCS Fusion AX	2017
Akron	1994	Langin	2016			Crescent AX	2018
Halt	1994	Canvas	2018				
Yumar	1997	Whistler	2018				
Prowers	1997						





### **Canvas – exp line CO12D1770**

- Denali/Antero//Byrd
- Medium-short, medium maturity, excellent straw strength for high management dryland or irrigation
- Very good resistance to stripe rust, stem rust, and wheat streak mosaic virus (carries WCM resistance from Byrd)
- Very good milling and baking quality



### **Whistler – exp line CO13D1783**

- CO08W218/Snowmass//Byrd
- Taller, medium-late maturity, below average test weight, fair straw strength
- Very good resistance to stripe rust, stem rust, and wheat streak mosaic virus (carries WCM resistance from Byrd)
- Excellent milling and baking quality (higher water absorption like Snowmass)

# Canvas, Whistler - Dryland

Entry	CSU Elite Trial						CSU Dryland Variety Trial				2 Yr	2 Yr	3 Yr	3 Yr
	2016 Yield	2017 Yield	2018 Yield	2 Yr Avg Yield	3 Yr Avg Yield	Avg TestWt	2017 Yield	2018 Yield	Avg Yield	Avg TestWt	Yield Avg	TestWt Avg	Yield Avg	TestWt Avg
Whistler	82.4	74.4	67.8	71.1	74.9	56.8	79.0	67.2	72.8	58.6	71.9	57.7	74.1	57.5
Langin	82.3	70.2	68.3	69.2	73.6	57.4	77.5	70.5	73.8	60.0	71.3	58.7	73.7	58.4
Canvas	79.7	71.0	66.7	68.9	72.5	58.2	77.0	64.7	70.4	60.5	69.6	59.2	71.7	59.1
Avery	78.1	68.3	68.6	68.4	71.7	57.5	73.6	65.5	69.3	60.0	68.9	58.6	70.8	58.4
Byrd	79.8	69.8	66.4	68.1	72.0	57.9	75.8	63.1	69.1	60.2	68.6	59.0	71.0	58.7
WB-Grainfield	81.7	63.8	66.1	65.0	70.5	57.8	67.9	63.0	65.3	60.0	65.1	58.6	68.6	58.6
Denali	78.5	60.5	65.8	63.2	68.3	57.8	65.1	64.5	64.8	60.0	63.9	58.5	67.0	58.6
SY Monument	--	60.6	64.1	62.4	--	--	63.0	64.8	64.0	59.0	63.1	57.3	--	--
Avg	79.9	68.2	66.6	67.4	71.9	57.8	73.2	65.6	69.2	60.1	68.2	58.7	71.1	58.7
Locations	10	10	10	20	30	30	8	9	17	17	37	37	47	47



# Canvas - Irrigated

Entry	CSU Elite Trial					CSU Irrigated Variety Trial				Overall	Overall
	2016 Yield	2017 Yield	2018 Yield	Avg Yield	Avg TestWt	2017 Yield	2018 Yield	Avg Yield	Avg TestWt	Yield Avg	TestWt Avg
WB4303	--	--	--	--	--	96.1	99.1	97.3	55.8	--	--
Canvas	91.4	97.2	103.7	96.2	60.4	97.5	93.6	96.0	58.6	96.1	59.5
SY Wolf	--	--	--	--	--	97.4	93.4	95.8	57.8	--	--
Denali	85.8	95.4	96.6	91.8	60.5	95.5	93.0	94.5	58.9	93.1	59.7
SY Sunrise	--	--	--	--	--	92.8	91.2	92.1	59.5	--	--
WB-Grainfield	88.2	92.9	92.3	90.9	59.8	83.8	91.4	86.8	59.2	88.9	59.5
Avery	81.2	96.6	104.3	92.0	59.2	--	--	--	--	--	--
Byrd	79.2	94.7	100.8	89.7	59.5	--	--	--	--	--	--
Langin	82.1	95.7	109.0	92.9	59.4	--	--	--	--	--	--
Avg	88.5	95.2	97.5	93.0	60.2	93.9	93.6	93.8	58.3	92.7	59.6
Locations	2	2	1	5	5	3	2	5	5	10	10



### **Snowmass 2.0 – exp line CO13D1299**

- CO07W722-F5/Snowmass//Brawl CL Plus
- Good stripe rust resistance and WSMV resistance (carries *Wsm2* gene)
- Good test weight and pre-harvest sprouting tolerance, excellent quality
- Low polyphenol oxidase (PPO) than Breck
- Ardent has committed to pay same premium as Snowmass



### **Monarch – exp line CO13D1383**

- CO07W722-F5/Snowmass//CO07W722-F5
- Good stripe rust resistance, good test weight, intermediate wheat streak mosaic
- Good quality, very low PPO
- Excellent straw strength and has shown reduced cutting under sawfly infestation
- Not part of CWRF-Ardent Mills premium program, but will be accepted



# Snowmass 2.0, Monarch - Dryland

Entry	Adv Yield Trial		CSU Elite Trial					CSU Dryland Variety Trial				Overall	Overall
	2015 Yield	2015 Test Wt	2016 Yield	2017 Yield	2018 Yield	Three Yr Avg	Avg Test Wt	2017 Yield	2018 Yield	Two Yr Avg	Avg Test Wt	Yield Avg	Test Wt Avg
Snowmass 2.0	66.8	58.2	81.4	72.8	67.8	74.0	57.9	75.7	67.7	71.4	60.1	73.1	58.7
Monarch	65.6	57.7	80.5	67.3	68.0	71.9	57.6	71.6	66.4	68.8	60.0	70.8	58.5
Breck	--	--	79.3	67.4	67.7	71.4	59.8	72.0	67.3	69.5	61.4	70.7	60.4
Antero	66.4	58.2	80.6	65.2	62.6	69.5	57.8	72.9	69.5	71.1	59.5	70.1	58.4
Snowmass	61.3	57.4	76.1	64.8	62.6	67.8	57.3	70.5	60.9	65.4	60.2	66.9	58.3
Sunshine	57.6	56.3	78.2	63.2	--	--	--	68.3	66.6	67.4	58.9	--	--
Avg	64.0	57.7	79.3	66.9	65.8	70.9	57.9	70.4	64.4	67.2	59.7	68.8	58.4
Locations	6	6	10	10	10	30	30	8	9	17	17	47	47

# Snowmass 2.0, Monarch - Irrigated

Entry	CSU Elite Trial					CSU Irrigated Variety Trial				Overall	Overall
	2016 Yield	2017 Yield	2018 Yield	Three Yr Avg	Avg Test Wt	2017 Yield	2018 Yield	Two Yr Avg	Avg Test Wt	Yield Avg	Test Wt Avg
Monarch	93.8	101.0	97.7	97.4	59.8	109.0	92.4	102.3	58.7	99.9	59.3
Snowmass 2.0	88.4	98.0	99.9	94.5	59.6	103.7	91.6	98.9	58.6	96.7	59.1
Breck	91.8	90.0	94.7	91.7	60.9	97.3	91.4	94.9	59.7	93.3	60.3
Antero	79.0	91.4	88.7	85.9	59.1	83.4	--	--	--	--	--
Snowmass	77.9	92.3	90.1	86.1	59.6	--	--	--	--	--	--
Avg	86.4	94.7	95.5	91.5	59.9	95.2	91.4	96.2	58.9	94.7	59.5
Locations	2	2	1	5	5	3	2	5	5	10	10





### **Crescent AX – exp line CO14A050**

- *CoAXium*<sup>™</sup> - same parentage as Incline AX (66% Byrd/34% Hatcher)
- Yield equivalent to Byrd, +5 bu/a over Brawl CL Plus, +6 bu/a over Incline AX
- Early maturity, medium height, good milling and baking quality
- Much improved test weight compared to Incline AX



### **Byrd CL Plus – exp line CO13003C**

- *Clearfield*<sup>™</sup> genes backcrossed into Byrd using DNA marker assisted selection
- Very similar to Byrd, but slightly taller, slightly later, and slightly better straw strength
- Yield about +5 bu/a over Brawl CL Plus

# Crescent AX – Herbicide Tolerance

Entry	2016 Multi-Locational Yield Trial						
	SH	Ft Collins	Ft Collins	% Yield	Non Spray	Non Spray	
	Burlington	Lake	Control	20 oz+NIS	Loss	Yield Avg	TestWt Avg
Crescent AX	63.5	104.2	98.8	99.6	0.8	88.8	58.8
Byrd	62.5	110.3	101.8	--	--	91.6	58.9
Brawl CL Plus	55.3	105.3	84.3	--	--	81.6	59.2
Incline AX	58.2	102.2	99.6	94.7	-4.9	86.7	57.3
Avg	62.2	105.2	96.9	98.2	-0.2	88.1	58.4
Locations	--	--	--	--	--	2	2



# Crescent AX – Herbicide Tolerance

Treatment	Entry	Damage		Damage		Green		Green	
		Score 1		Score 2		Area 1		Area 2	
		(14 Days)	Sig	(38 Days)	Sig	(14 Days)	Sig	(38 Days)	Sig
Aggressor	Crescent AX	2.0	CD	2.0	BC	55	AB	82	A
Control	Crescent AX	1.0	D	1.0	C	65	A	85	A
Aggressor	Incline AX	4.2	AB	2.2	B	50	AB	80	A
Control	Incline AX	1.0	D	1.0	C	57	AB	84	A
Aggressor	LCS Fusion AX	3.0	BC	2.3	B	51	AB	83	A
Control	LCS Fusion AX	1.0	D	1.0	C	53	B	83	A
Treatment	Entry	Plant		Heading		2018		2018	
		Height	Sig	Date	Sig	Yield	Sig	TestWt	Sig
Aggressor	Crescent AX	35	ABCD	139	CD	103	A	62	A
Control	Crescent AX	35	AB	138	D	101	A	62	A
Aggressor	Incline AX	32	CDE	146	A	94	A	57	CD
Control	Incline AX	33	BCDE	145	A	91	A	57	D
Aggressor	LCS Fusion AX	34	ABCD	145	A	95	A	58	BCD
Control	LCS Fusion AX	35	ABCD	144	A	90	A	58	BCD

# Crescent AX - Dryland

Entry	CSU Elite Trial				CSU UVPT		Overall	Overall
	2017 Yield	2018 Yield	Avg Yield	Avg TestWt	2018 Yield	2018 TestWt	Yield Avg	TestWt Avg
Crescent AX	70.6	66.4	68.5	58.3	63.2	60.6	66.8	59.0
Byrd	69.8	66.4	68.1	57.9	63.1	60.3	66.6	58.6
WB-Grainfield	63.8	66.1	65.0	57.5	63.0	59.6	64.3	58.1
Brawl CL Plus	58.1	65.1	61.7	57.8	62.1	60.5	61.8	58.6
Incline AX	59.1	62.8	60.9	55.0	59.2	58.0	60.4	56.0
Avg	65.3	66.0	65.7	57.3	63.4	59.8	65.0	58.1
Locations	10	10	20	20	9	9	29	29

# Byrd CL Plus - Dryland

Entry	CSU Elite Trial						CSU Dryland Variety Trial				Overall	Overall
	2015 Yield	2016 Yield	2017 Yield	2018 Yield	Avg Yield	Avg TestWt	2017 Yield	2018 Yield	Avg Yield	Avg TestWt	Yield Avg	TestWt Avg
Langin	67.7	82.3	70.2	68.3	72.4	57.4	77.5	70.5	73.8	60.0	72.8	58.2
Byrd	65.7	79.8	69.8	66.4	70.7	57.9	75.8	63.1	69.1	60.2	70.2	58.6
Avery	64.6	78.1	68.3	68.6	70.2	57.4	73.6	65.5	69.3	60.0	69.9	58.2
Byrd CL Plus	64.6	80.0	65.7	66.3	69.4	57.0	71.5	64.4	67.7	59.3	68.9	57.8
Denali	66.6	78.5	60.5	65.8	67.9	57.6	65.1	64.5	64.8	60.0	67.0	58.4
Brawl CL Plus	56.9	76.0	58.3	65.1	64.5	57.8	63.1	62.1	62.6	60.2	63.9	58.6
Avg	65.9	79.2	66.3	66.7	69.7	57.6	71.9	65.0	68.2	60.0	69.3	58.4
Locations	8	10	10	10	38	38	8	9	17	17	55	55



# Doubled Haploid (DH) Breeding

Make cross, grow F1  
Pollinate with maize  
Treat with hormones



Collect immature seeds  
excise embryos  
transfer to tissue culture



Regenerate haploid  
plants in tissue culture



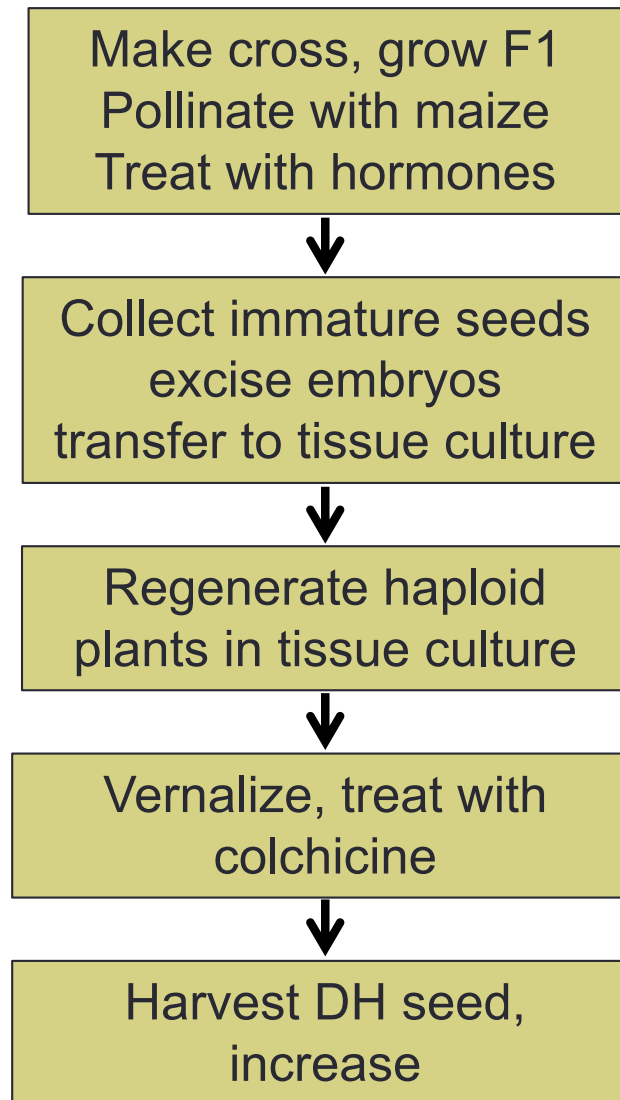
Vernalize, treat with  
colchicine



Harvest DH seed,  
increase



# Doubled Haploid (DH) Breeding

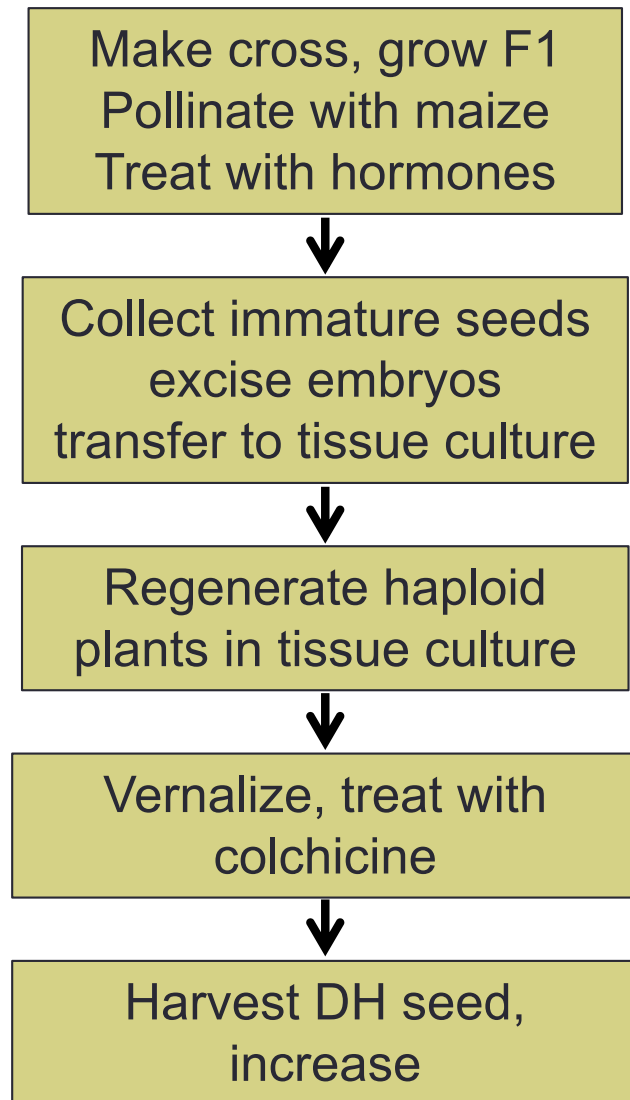


DNA marker-assisted enrichment  
for stem solidness prior to  
DH production



Image - Phil Bruckner, MT State

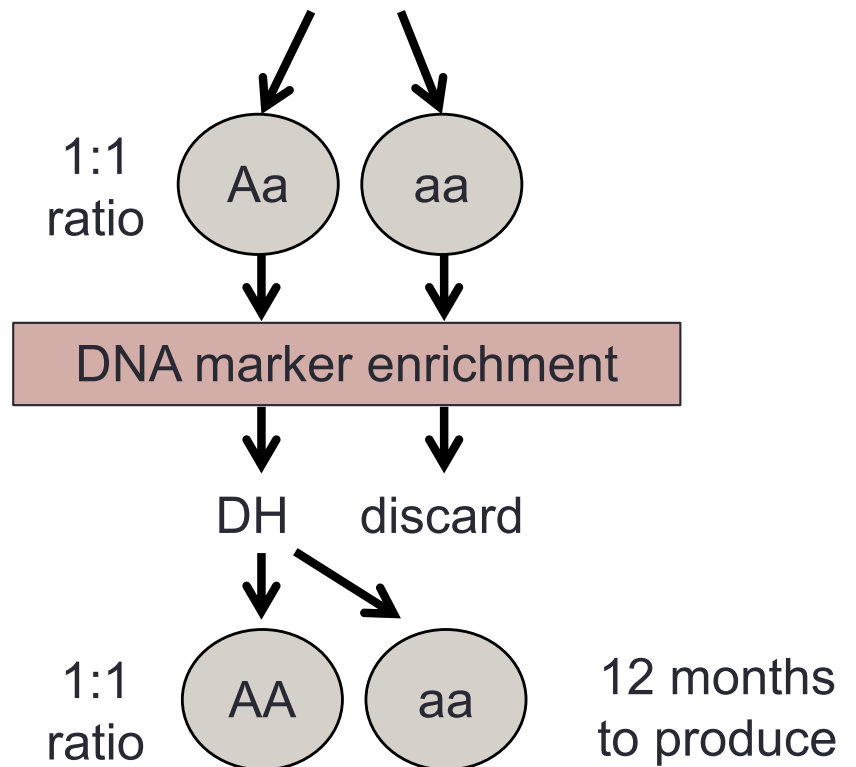
# Doubled Haploid (DH) Breeding



DNA marker-assisted enrichment  
for stem solidness prior to  
DH production

Byrd/Bearpaw//Byrd  
aa/AA/aa

Image - Phil Bruckner, MT State





# DH-Derived Semi-Solid Lines

- 264 DH lines generated, grown in field in 2015
  - Visual selection – 134 lines selected
  - Visually scored for solidness in the field at harvest, assayed for DNA markers associated with major solidness gene
  - Selection history: 2016 - 102 lines, 2017 - 12 lines, 2018 - 4 lines

Entry	2016	2017		2018		Average				
	Yield WSS	Yield Non WSS	Yield WSS	Yield Non WSS	Yield WSS	Yield Non WSS	Yield WSS	Test Weight	Stem Cutting	Solidness
Byrd	57.7	71.9	56.8	53.1	69.8	60.9	61.4	57.3	5.8	6.6
Denali	60.9	62.2	54.8	54.4	65.7	59.2	60.5	57.5	5.6	6.3
CO15SFD092	59.3	64.8	56.6	54.9	68.6	59.7	61.5	57.3	2.4	13.2
CO15SFD107	60.0	64.9	53.9	54.3	67.5	59.7	60.5	58.2	2.3	12.7
Average	57.3	65.3	55.2	67.5	55.2	66.4	55.9	57.4		
Locations	2	9	2	8	2	17	6	23		

# 2017 Irrigated Variety Performance Trial (IVPT)

Entry	Burlington Yield	Fort Collins Yield	Haxtun Yield	Burlington Lodging	Fort Collins Lodging	Average Yield	Average TestWt
Monarch	127.9	116.5	82.5	2.7	1.0	109.0	58.6
CO12D296	112.0	118.7	86.8	8.0	1.0	105.8	58.6
CO13D0787	111.7	104.0	97.0	8.3	2.0	104.2	59.2
Snowmass 2.0	124.5	103.8	82.9	5.3	2.0	103.7	58.2
Whistler	107.1	108.0	81.1	9.0	8.0	98.7	55.7
CO13D1638	110.1	97.2	88.7	8.3	4.0	98.7	57.0
CO12D597	112.9	95.0	86.3	7.7	5.0	98.1	57.6
Canvas	101.2	108.2	83.2	7.3	1.0	97.5	57.4
SY Wolf	115.9	102.3	74.1	4.0	1.0	97.4	57.0
Breck	118.9	94.9	78.0	6.3	2.0	97.3	59.0
WB4303	108.0	108.2	72.0	2.7	1.0	96.1	55.4
Denali	106.8	105.0	74.6	5.0	2.0	95.5	58.5
Byrd	110.1	96.2	78.8	6.3	4.0	95.0	58.2
Langin	114.4	87.8	82.4	7.7	2.0	94.9	57.9
KanMark	111.6	103.0	68.5	2.0	3.0	94.4	58.0
Cowboy	109.4	103.7	67.8	8.7	8.0	93.6	55.1
CO13W187	108.3	94.7	75.5	7.0	3.0	92.8	58.3
SY Sunrise	110.9	94.3	73.1	8.0	1.0	92.8	58.9
Brawl CL Plus	113.3	83.5	75.4	1.0	2.0	90.7	58.1
CO13D1479	100.8	101.7	67.3	8.3	7.0	89.9	56.6
Avery	98.0	91.4	79.9	8.0	8.0	89.8	57.0
CO13D1379	104.8	97.1	66.4	5.3	5.0	89.4	56.6
Larry	110.4	96.0	60.7	2.0	5.0	89.0	57.1
CO13D2042	98.7	93.8	72.5	8.3	1.0	88.3	58.3
Sunshine	116.1	74.4	74.1	7.3	3.0	88.2	56.2
CO13D1164	94.8	86.2	81.9	8.0	4.0	87.6	58.1
CO12M0367	96.7	98.8	65.5	6.7	2.0	87.0	56.2
CO13D1714	103.3	76.1	80.7	7.0	2.0	86.7	59.2
Thunder CL	109.5	85.8	57.9	1.3	1.0	84.4	57.6
WB-Grainfield	106.2	78.1	67.1	5.7	2.0	83.8	58.8
Antero	92.7	77.8	79.8	8.3	5.0	83.4	58.0
WB4458	99.4	88.0	61.4	1.7	2.0	82.9	56.3
Average	108.3	95.9	75.7	6.0	3.1	93.3	57.6
LSD (P<0.30)	8.0	5.1	4.2				



# 2017 Irrigated Variety Performance Trial (IVPT)

Entry	Burlington Yield	Fort Collins Yield	Haxtun Yield	Burlington Lodging	Fort Collins Lodging	Average Yield	Average TestWt
CO13D0787	111.7	104.0	97.0	8.3	2.0	104.2	59.2
CO13D1638	110.1	97.2	88.7	8.3	4.0	98.7	57.0
CO12D296	112.0	118.7	86.8	8.0	1.0	105.8	58.6
CO12D597	112.9	95.0	86.3	7.7	5.0	98.1	57.6
Canvas	101.2	108.2	83.2	7.3	1.0	97.5	57.4
Snowmass 2.0	124.5	103.8	82.9	5.3	2.0	103.7	58.2
Monarch	127.9	116.5	82.5	2.7	1.0	109.0	58.6
Langin	114.4	87.8	82.4	7.7	2.0	94.9	57.9
CO13D1164	94.8	86.2	81.9	8.0	4.0	87.6	58.1
Whistler	107.1	108.0	81.1	9.0	8.0	98.7	55.7
CO13D1714	103.3	76.1	80.7	7.0	2.0	86.7	59.2
Avery	98.0	91.4	79.9	8.0	8.0	89.8	57.0
Antero	92.7	77.8	79.8	8.3	5.0	83.4	58.0
Byrd	110.1	96.2	78.8	6.3	4.0	95.0	58.2
Breck	118.9	94.9	78.0	6.3	2.0	97.3	59.0
CO13W187	108.3	94.7	75.5	7.0	3.0	92.8	58.3
Brawl CL Plus	113.3	83.5	75.4	1.0	2.0	90.7	58.1
Denali	106.8	105.0	74.6	5.0	2.0	95.5	58.5
SY Wolf	115.9	102.3	74.1	4.0	1.0	97.4	57.0
Sunshine	116.1	74.4	74.1	7.3	3.0	88.2	56.2
SY Sunrise	110.9	94.3	73.1	8.0	1.0	92.8	58.9
CO13D2042	98.7	93.8	72.5	8.3	1.0	88.3	58.3
WB4303	108.0	108.2	72.0	2.7	1.0	96.1	55.4
KanMark	111.6	103.0	68.5	2.0	3.0	94.4	58.0
Cowboy	109.4	103.7	67.8	8.7	8.0	93.6	55.1
CO13D1479	100.8	101.7	67.3	8.3	7.0	89.9	56.6
WB-Grainfield	106.2	78.1	67.1	5.7	2.0	83.8	58.8
CO13D1379	104.8	97.1	66.4	5.3	5.0	89.4	56.6
CO12M0367	96.7	98.8	65.5	6.7	2.0	87.0	56.2
WB4458	99.4	88.0	61.4	1.7	2.0	82.9	56.3
Larry	110.4	96.0	60.7	2.0	5.0	89.0	57.1
Thunder CL	109.5	85.8	57.9	1.3	1.0	84.4	57.6
Average	108.3	95.9	75.7	6.0	3.1	93.3	57.6
LSD (P<0.30)	8.0	5.1	4.2				

## Experimental line CO13D0787

- Antero/Snowmass//Byrd
- Medium height, medium maturing, fair straw strength
- Carries resistance to wheat streak mosaic virus via two different mechanisms
  - $WCM_{T112}$  gene for resistance to the wheat curl mite (from Byrd)
  - $Wsm2$  gene for virus resistance (from Snowmass)
- Very good resistance to stripe rust (2), leaf rust (3), and stem rust (2)
- Very good test weight, grain protein deviation, and milling/baking quality

# Acknowledgements



Colorado Wheat  
Administrative Committee



Colorado  
State  
University



**Ardent Mills™**

*Nourishing what's next.™*





Questions?