

Milling and Baking Test Results for Hard Winter Wheat Harvested in 2017



68th Report on Wheat Quality Hard Winter Wheat Technical Board of the Wheat Quality Council

**A coordinated effort by wheat breeders, producers,
millers and bakers to improve wheat quality**

This program was carried out in cooperation with the Wheat Quality Council, Brighton, CO, The United States Department of Agriculture (USDA) - ARS, The Agricultural Experiment Stations of Colorado, Kansas, Montana, Nebraska, Oklahoma, South Dakota, and Texas, private wheat breeding companies including Syngenta (AgriPro Wheat), Monsanto (Westbred, LLC), Limagrain, Bayer CropScience LP, and laboratories from milling, baking, grain trade and other firms and research organizations. This annual technical report was prepared by the USDA-ARS, Hard Winter Wheat Quality Laboratory in Manhattan, KS. The Wheat Quality Council (WQC) provides funds for the program with great effort and support from collaborators who run bake tests. Trade names, if used, are used to identify products. No endorsement is intended, nor is criticism implied of similar products not mentioned.

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2017

Milling and Baking Test Results for Hard Winter Wheats

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The MISSION
of the WHEAT QUALITY COUNCIL:

**ADVOCATE THE DEVELOPMENT OF NEW
WHEAT VARIETIES THAT IMPROVE THE VALUE
OF WHEAT TO ALL PARTIES IN THE UNITED
STATES SUPPLY CHAIN.**

The GOAL
of the WHEAT QUALITY COUNCIL:

**IMPROVE THE VALUE OF ALL U. S. WHEAT
CLASSES FOR PRODUCERS, MILLERS, AND
PROCESSORS OF WHEAT.**

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Description of the 2017 Testing Program

Founded in 1949, this is the **68th** year for the Hard Winter Wheat Milling and Baking Evaluation Program. This program is sponsored by the Wheat Quality Council and coordinated by the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL) and Kansas State University Department of Grain Science and Industry. Wheat experimental lines and check varieties (including common check and internal check) were submitted by public and private breeding programs in the Great Plains growing region. This technical report includes GIPSA wheat market classification, physical grain testing, milling, analytical, rheological, and bread baking results.

A total of 32 entries this year were grown in special locations and submitted for small-scale testing by 8 wheat breeding programs. Wheat samples were milled on the Miag Multomat mill in the Kansas State University Department of Grain Science and Industry (Methods, Appendix A). The flours were distributed to 20 cooperators (18 for bread baking, 1 for tortilla, and 1 for noodle) for end-product quality evaluation. The wheat physical and chemical tests, flour quality analysis, and dough rheological tests (Mixograph, Farinograph, Alveograph, and Extensigraph) were conducted by the HWWQL.

Also included in this report is alkaline noodle and protein analysis data generated by the HWWQL and Dr. Mike Tilley in Manhattan, KS, as well as tortilla data generated by Texas A&M University. Methods used to evaluate wheat lines are listed in Appendix A.

2017 WQC HWW Entries & Breeding Programs

Breeding Programs	Entry Number	Sample Identification
SYNGENTA	17-2401	SY Monument
	17-2402	SY Achieve CL
	17-2403	SY 517 CL2
	17-2404	Jagalene (CC01)
TEXAS	17-2405	Jagalene (CC02)
	17-2406	TAM 111
	17-2407	TX11A001295
	17-2408	TX12M4068
COLORADO	17-2409	Byrd
	17-2410	CO12D1770
	17-2411	Jagalene (CC03)
	17-2412	CO13D1783
	17-2413	CO12D2011
KANSAS-HAYS	17-2414	Jagalene (CC04)
	17-2415	KS13HW92-3
	17-2416	Danby
	17-2417	KS14HW106-6-6
MONTANA	17-2418	Yellowstone
	17-2419	MT1465
	17-2420	Jagalene (CC05)
	17-2421	MTW1491
NEBRASKA	17-2422	NI13706
	17-2423	NE12561
	17-2424	Jagalene (CC06)

MONSANTO	17-2425	Jagalene (CC07)
	17-2426	WB4623
	17-2427	WB4721
OKLAHOMA	17-2428	Ruby Lee
	17-2429	OK13621
	17-2430	OK12D22004-016
	17-2431	OCW04S7171T-6W
	17-2432	Jagalene (CC08)
COMMON CHECK	17-2433	Jagalene (CC01)
	17-2434	Jagalene (CC02)
	17-2435	Jagalene (CC03)
	17-2436	Jagalene (CC04)
	17-2437	Jagalene (CC05)
	17-2438	Jagalene (CC06)
	17-2439	Jagalene (CC07)
	17-2440	Jagalene (CC08)

CC = Common Check

**2017 Wheat Classification Results
from GIPSA**

GIPSA Wheat Market Classification

ID	CL	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	GRADE	REMARKS
17-2401	HRW	0.00	63.3	10.9	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%	
17-2402	XWHT	0.00	64.7	10.9	OK	0.0	0.0	0.0	0.0	0.0			U.S. NO. 1 XWHT, DKG 0.0%	76% HRW 24% HDWH
17-2403	HRW	0.00	64.5	11.0	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.2	U.S. NO. 1 HRW, DKG 0.0%	
17-2404	HRW	0.00	64.7	10.8	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%	
17-2405	HRW	0.00	63.1	11.0	OK	0.0	0.3	0.0	0.8	1.1	0.0	0.6	U.S. NO. 1 HRW, DKG 0.0%	
17-2406	HRW	0.00	63.4	11.3	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.2	U.S. NO. 1 HRW, DKG 0.0%	
17-2407	HRW	0.00	64.4	11.0	OK	0.0	0.5	0.0	0.4	0.9	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%	
17-2408	HRW	0.00	63.1	10.9	OK	0.0	0.1	0.0	0.1	0.2	0.0	0.2	U.S. NO. 1 HRW, DKG 0.0%	
17-2409	HRW	0.30	62.1	10.4	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.2	U.S. NO. 1 HRW, DKG 0.3%	
17-2410	HRW	0.10	63.8	10.7	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.5	U.S. NO. 1 HRW, DKG 0.1%	
17-2411	HRW	0.20	62.9	10.0	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	U.S. NO. 1 HRW, DKG 0.2%	
17-2412	HRW	0.10	60.5	10.5	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	U.S. NO. 1 HRW, DKG 0.1%	
17-2413	HDWH	0.00	64.6	10.3	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S. NO. 1 HDWH, DKG 0.0%	
17-2414	HRW	0.02	56.0	11.5	OK	0.0	0.0	0.0	1.0	1.0	0.0	0.3	U.S. NO. 3 HRW, DKG 0.0%	
17-2415	HDWH	0.00	59.0	11.5	OK	0.0	1.1	0.0	0.3	1.4	0.0	1.1	U.S. NO. 2 HDWH, DKG 0.0%	
17-2416	HDWH	0.00	60.4	11.6	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.1	U.S. NO. 1 HDWH, DKG 0.0%	
17-2417	HDWH	0.00	60.3	12.2	OK	0.0	0.3	0.0	0.1	0.4	0.0	0.1	U.S. NO. 1 HDWH, DKG 0.0%	
17-2418	HRW	0.00	61.7	9.3	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%	
17-2419	HRW	0.10	62.4	9.3	OK	0.0	0.0	0.0	0.1	0.1	0.0	1.3	U.S. NO. 1 HRW, DKG 0.1%	
17-2420	HRW	0.00	64.1	9.4	OK	0.0	0.0	0.0	0.1	0.1	0.0	1.5	U.S. NO. 1 HRW, DKG 0.0%	
17-2421	HDWH	0.20	61.9	9.6	OK	0.0	0.0	0.0	0.1	0.1	0.0	1.9	U.S. NO. 1 HDWH, DKG 0.2%	
17-2422	HRW	0.10	56.8	11.5	OK	0.0	0.2	0.0	0.6	0.8	0.0	0.2	U.S. NO. 3 HRW, DKG 0.1%	
17-2423	HRW	0.20	58.5	11.2	OK	0.0	0.2	0.0	0.3	0.5	0.0	0.1	U.S. NO. 2 HRW, DKG 0.2%	
17-2424	HRW	0.40	55.5	11.2	OK	0.0	0.3	0.0	1.4	1.7	0.0	0.0	U.S. NO. 4 HRW, DKG 0.4%	
17-2425	HRW	0.00	65.2	10.0	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.1	U.S. NO. 1 HRW, DKG 0.0%	
17-2426	HRW	0.00	64.4	9.9	OK	0.0	0.0	0.2	0.1	0.3	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%	
17-2427	HRW	0.00	65.4	10.4	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%	
17-2428	HRW	0.10	58.8	12.4	OK	0.0	0.3	0.0	0.3	0.6	0.0	0.0	U.S. NO. 2 HRW, DKG 0.1%	
17-2429	HRW	0.20	58.4	12.1	OK	0.0	0.0	0.0	0.7	0.7	0.0	0.4	U.S. NO. 2 HRW, DKG 0.2%	
17-2430	HRW	0.10	59.5	12.6	OK	0.0	0.0	0.1	0.4	0.5	0.0	0.0	U.S. NO. 2 HRW, DKG 0.1%	
17-2431	HDWH	0.50	59.1	12.1	OK	0.0	0.0	0.0	0.3	0.3	0.0	1.9	U.S. NO. 2 HDWH, DKG 0.5%	
17-2432	HRW	0.00	58.2	11.7	OK	0.0	0.2	0.0	1.1	1.3	0.0	1.9	U.S. NO. 2 HRW, DKG 0.0%	

CL = Wheat class, DKG = Dockage (%), TW = Test weight (lb/bushels), DKT = Damaged kernels total (%), FM = Foreign materials (%), SHBN = Shrunken and broken kernels (%), DEF = Defects (%), CCL = Contrasting classes (%), WOCL = wheat of other classes. XWHT = mixed wheat

*Wheat Breeder Plot and Entry
Descriptions, Wheat and Flour
Analytical, Physical Dough, and
Bread Baking Data*

SYNGENTA (AGRIPRO)

17-2401	SY Monument
17-2402	SY Achieve CL2
17-2403	SY 517 CL2
17-2404	Jagalene (CC01)

Description of Test Plots and Breeder Entries

Syngenta – Jon Rich

Increase strips were planted on 10/19/16 at our location in Junction City, KS. Very good fall stand establishment. All increases had 80lbs of 11-52-0 applied with the planter with 70lbs of N applied prior to planting. An additional 60lbs of N and 20lbs of Sulfur was top dressed in the spring prior to jointing. All strips were sprayed with a 10.5oz rate of Quilt Excel at flag leaf to insure good quality seed. All samples harvested on 6/28/17.

SY Achieve CL2 was derived from the three-way cross (03B212#4/CL03040-6-1//OK Rising) 03B212#4 was a DH line derived from the cross between BC950811-2-6/BC98343-09-7. CL03040-6-1 is a cross between iW98-362A1 (Als3)/ AP502CL (Als1). OK Rising was a line developed by Oklahoma State University and released in 2008 with the pedigree KS96WGRC39/Jagger. OK Rising was tested under experimental OK02522W in the 2006 SRPN.

SY Achieve CL2 has Beyond herbicide tolerance with adaptation to South Central Kansas and North Central Oklahoma growing regions. SY Achieve CL2 is an early maturing variety similar to Everest. Medium height with average straw strength. Moderately resistant to stripe rust and moderately susceptible to leaf rust and powdery mildew. Decent tolerance to BYDV. Seems to hold its own under heavy BYDV pressure or we would not have seen some the yield results we have. Tolerance to aluminum toxicity and SBMV. Excellent test weight patterns with exceptional yields in its area of adaptation. Milling and baking data compiled over multiple locations in multiple years indicates good milling and baking properties. SY Achieve CL2 has shown good milling yields and gluten strength that produces bread with desirable grain and loaf volume, which are comparable to Jagalene. Overall we consider this variety good to very good for end-use quality.

SY 517 CL2 was derived from the three-way cross (03B212#4/CL03040-6-1//Art) 03B212#4 was a DH line derived from the cross between BC950811-2-6/BC98343-09-7. CL03040-6-1 is a cross between iW98-362A1 (Als3)/ AP502CL (Als1). Art was developed by Agripro in 2007 as the cross between Jagger and an experimental Agripro line.

SY 517 CL2 also has Beyond herbicide tolerance and is adapted further North in the growing region. SY 517 CL2 will be broadly adapted from North Central Kansas, South Central Nebraska and all of South Dakota. Medium maturity similar to Jagalene with good straw strength. A weakness will be its stripe rust resistance which we have rated as moderately susceptible. Very good leaf rust resistance. We have also seen good winter hardiness and some tolerance to FHB. The tolerance to FHB seems to be coming from the Art pedigree and seems to be very similar to Art in that regard. We have also seen an upgrade in

BYDV tolerance compared to Art. SY 517 CL2 has tolerance to aluminum toxicity and SBMV. Slightly larger seeded variety with excellent test weight patterns. In our multi-year quality testing we have seen a variety that is an excellent miller with more mellow gluten with shorter mixing requirements and lower loaf volume than Jagalene. Overall we would rate this variety acceptable for end-use quality.

Syngenta: 2017 (Small-Scale) Samples

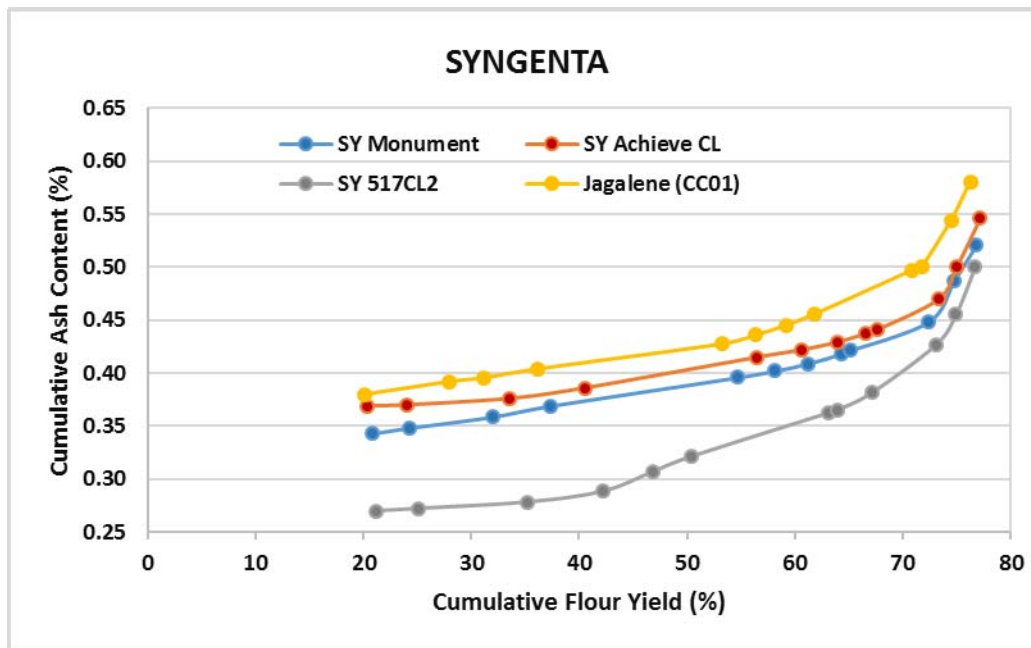
Test entry number	17-2401	17-2402	17-2403	17-2404
Sample identification	SY Monument	SY Achieve CL	SY 517 CL2	Jagalene (CC01)
Wheat Data				
GIPSA classification	1 HRW	1 XWHT*	3 HRW	2 HRW
Test weight (lb/bu)	63.3	64.7	64.5	64.7
Hectoliter weight (kg/hl)	83.2	85.0	84.8	85.0
1000 kernel weight (gm)	34.7	32.7	32.1	35.2
Wheat kernel size (Rotap)				
Over 7 wire (%)	89.3	68.7	59.5	77.5
Over 9 wire (%)	10.7	31.3	40.5	22.5
Through 9 wire (%)	0.0	0.0	0.0	0.0
Single kernel (skcs)^a				
Hardness (avg /s.d)	82.9/15.5	70.4/15.1	70.4/15.9	81.8/16.5
Weight (mg) (avg/s.d)	34.7/6.8	32.7/9.6	32.1/10.0	35.2/8.3
Diameter (mm)(avg/s.d)	2.79/0.31	2.69/0.26	2.62/0.27	2.80/0.25
Moisture (%) (avg/s.d)	10.7/0.4	10.1/0.5	10.1/0.6	10.2/0.4
SKCS distribution	00-01-05-94-1	01-05-16-78-01	02-05-17-76-01	00-02-07-91-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	13.0	13.8	13.4	13.6
Wheat ash (12% mb)	1.54	1.52	1.55	1.61
Milling and Flour Quality Data				
Flour yield (% , str. grade)				
Miag Multomat Mill	76.8	77.2	76.8	76.3
Quadrumat Sr. Mill	69.5	68.9	69.9	68.0
Flour moisture (%)	13.6	13.6	13.6	13.9
Flour protein (14% mb)	11.1	12.0	11.9	11.7
Flour ash (14% mb)	0.50	0.50	0.49	0.55
Rapid Visco-Analyser				
Peak Time (min)	6.1	6.2	6.3	6.1
Peak Viscosity (RVU)	183.3	223.3	221.3	167.3
Breakdown (RVU)	60.1	80.9	78.8	56.2
Final Viscosity at 13 min (RVU)	235.2	248.7	242.8	211.8
Minolta color meter				
L*	90.85	91.05	91.61	91.22
a*	-0.94	-1.08	-1.53	-1.11
b*	8.23	8.95	9.30	8.87
PPO	0.244	0.399	0.406	0.411
Falling number (sec)	468	430	461	415
Damaged Starch				
(AI%)	99.1	97.4	97.4	98.8
(AACC76-31)	8.9	7.4	7.4	8.6

^as.d. = standard deviation; skcs = Single Kernel Characterization System 4100. * 76% HRW and 24% HDWH.

Syngenta: Physical Dough Tests and Gluten Analysis 2017 (Small-Scale) Samples

Test Entry Number	17-2401	17-2402	17-2403	17-2404
Sample Identification	SY Monument	SY Achieve CL	SY 517 CL2	Jagalene (CC01)
MIXOGRAPH				
Flour Abs (% as-is)	68.9	70.3	70.1	68.8
Flour Abs (14% mb)	68.6	69.8	69.6	68.6
Mix Time (min)	11.8	5.9	3.8	6.4
Mix tolerance (0-6)	3	4	4	5
FARINOGRAPH				
Flour Abs (% as-is)	69.7	66.2	65.8	69.0
Flour Abs (14% mb)	69.3	65.7	65.3	68.8
Peak time (min)	7.1	9.3	6.7	7.4
Mix stability (min)	10.2	19.8	11.1	16.1
Mix Tolerance Index (FU)	31	14	18	15
Breakdown time (min)	12.0	20.2	13.3	17.6
ALVEOGRAPH				
P(mm): Tenacity	163	138	117	191
L(mm): Extensibility	26	82	74	39
G(mm): Swelling index	11.4	20.2	19.1	13.9
W(10 ⁻⁴ J): strength (curve area)	195	427	310	332
P/L: curve configuration ratio	6.27	1.68	1.58	4.90
Ie(P ₂₀₀ /P): elasticity index	0.0	63.4	56.3	0.0
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	643/991/976	495/644/701	293/354/395	518/707/755
Extensibility (mm at 45/90/135 min)	108/94/88	139/132/117	144/138/140	135/128/122
Energy (cm ² at 45/90/135 min)	101/117/93	124/143/126	74/87/97	124/144/141
Resist _{max} (BU at 45/90/135 min)	759/999/994	730/922/915	390/506/552	726/928/995
Ratio (at 45/90/135 min)	6.0/10.6/11.1	3.6/4.9/6.0	2.0/2.6/2.8	3.8/5.5/6.2
PROTEIN ANALYSIS				
HMW-GS Composition	2*,5+10,7+9	2*,5+10,17+18	2*,5+10,17+18/7+9	2*,1,5+10,17+18
TMP/TPP	0.82	0.76	0.77	0.88
SEDIMENTATION TEST				
Volume (ml)	56.8	62.7	50.3	55.9

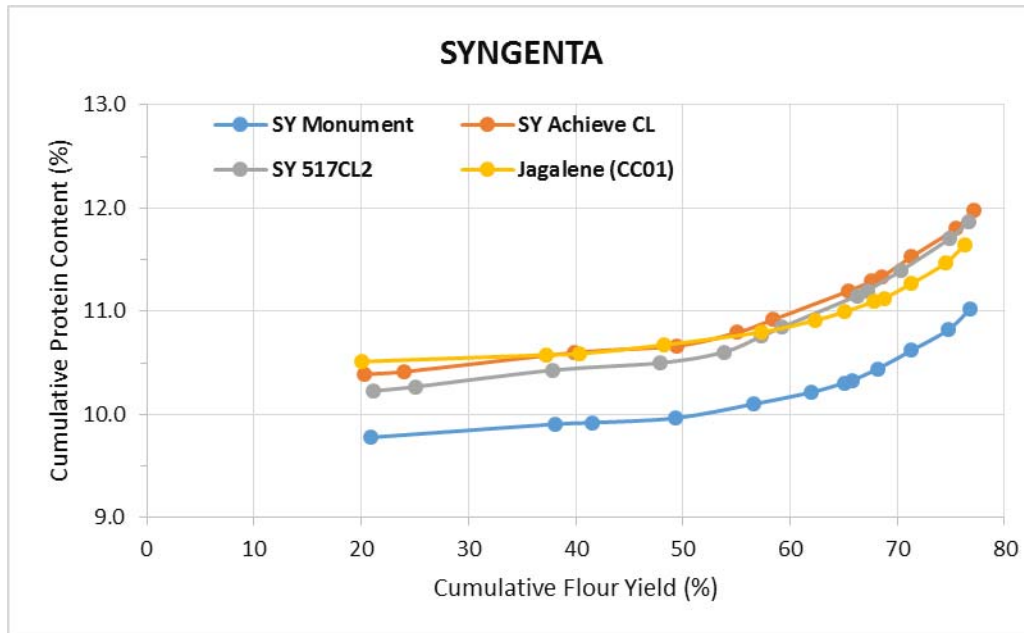
Syngenta: Cumulative Ash Curves



SY Monument					SY Achieve CL				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
2M	20.8	9.78	20.8	9.8	2M	20.3	10.39	20.3	10.4
3M	17.3	10.06	38.1	9.9	1M Red	3.7	10.54	24.0	10.4
1M Red	3.5	10.08	41.6	9.9	3M	15.9	10.88	39.9	10.6
1M	7.7	10.20	49.3	10.0	1M	9.5	10.94	49.4	10.7
4M	7.3	11.01	56.6	10.1	4M	5.7	11.93	55.1	10.8
1BK	5.4	11.42	61.9	10.2	Grader	3.3	12.98	58.4	10.9
Grader	3.1	12.11	65.0	10.3	1BK	7.0	13.50	65.4	11.2
FILTER FLR	0.8	12.59	65.8	10.3	5M	2.2	14.16	67.6	11.3
5M	2.3	13.58	68.2	10.4	FILTER FLR	1.0	14.42	68.6	11.3
3BK	3.1	14.45	71.3	10.6	3BK	2.7	16.36	71.3	11.5
2BK	3.4	15.00	74.7	10.8	2BK	4.1	16.55	75.4	11.8
BRAN FLR	2.0	18.43	76.8	11.0	BRAN FLR	1.7	19.56	77.2	12.0
Break Shorts	3.3	15.36	80.1	11.2	Break Shorts	3.5	15.97	80.7	12.1
Red Dog	1.6	14.50	81.8	11.3	Red Dog	2.0	14.37	82.6	12.2
Red Shorts	0.4	13.72	82.1	11.3	Red Shorts	0.3	14.20	82.9	12.2
Filter Bran	0.8	13.03	82.9	11.3	Filter Bran	0.8	14.22	83.7	12.2
Bran	17.1	17.20	100.0	12.3	Bran	16.3	17.36	100.0	13.1
Wheat		12.2							13.0
St. Grd. Fl		11.1							12.0

SY 517 CL2					Jagalene (CC01)				
Mill Streams	Strm-yld	Protein	Cumulative (14%)		Mill Streams	Strm-yld	Protein	Cumulative (14%)	
	(14%mb)		Yield	Protein		(14%mb)		Yield	Protein
2M	21.2	10.23	21.2	10.2	2M	20.1	10.51	20.1	10.5
1M Red	4.0	10.49	25.1	10.3	3M	17.1	10.65	37.2	10.6
3M	12.7	10.74	37.9	10.4	1M Red	3.1	10.73	40.4	10.6
1M	10.0	10.77	47.9	10.5	1M	7.9	11.11	48.3	10.7
4M	5.9	11.45	53.8	10.6	4M	9.0	11.46	57.3	10.8
Grader	3.5	13.13	57.3	10.8	1BK	5.0	12.22	62.3	10.9
5M	1.9	13.44	59.2	10.8	Grader	2.8	12.87	65.1	11.0
1BK	7.1	13.73	66.3	11.2	5M	2.7	13.42	67.8	11.1
FILTER FLR	0.9	14.76	67.2	11.2	FILTER FLR	0.9	13.48	68.7	11.1
3BK	3.2	15.54	70.3	11.4	3BK	2.6	15.05	71.3	11.3
2BK	4.6	16.51	74.9	11.7	2BK	3.1	15.94	74.5	11.5
BRAN FLR	1.7	18.90	76.7	11.9	BRAN FLR	1.8	18.96	76.3	11.6
Break Shorts	3.7	15.34	80.4	12.0	Break Shorts	3.6	14.91	79.9	11.8
Red Dog	2.7	13.86	83.2	12.1	Red Dog	2.1	14.32	82.0	11.9
Red Shorts	0.5	13.64	83.7	12.1	Red Shorts	0.4	13.72	82.4	11.9
Filter Bran	0.6	13.49	84.3	12.1	Filter Bran	0.8	13.58	83.2	11.9
Bran	15.7	17.05	100.0	12.9	Bran	16.8	18.13	100.0	12.9
Wheat		12.6					12.7		
St. Grd. Fl		11.9					11.7		

Syngenta: Cumulative Protein Curves



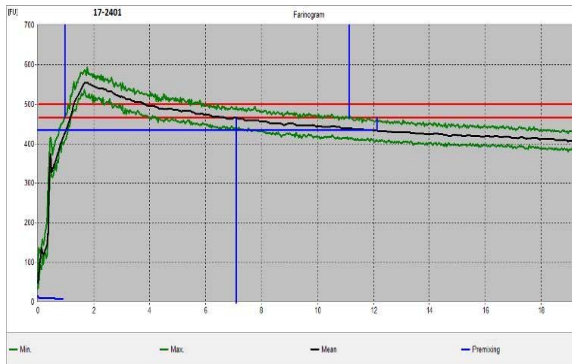
SY Monument					SY Achieve CL				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%)		Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%)	
			Yield	Protein				Yield	Protein
2M	20.8	9.78	20.8	9.8	2M	20.3	10.39	20.3	10.4
3M	17.3	10.06	38.1	9.9	1M Red	3.7	10.54	24.0	10.4
1M Red	3.5	10.08	41.6	9.9	3M	15.9	10.88	39.9	10.6
1M	7.7	10.20	49.3	10.0	1M	9.5	10.94	49.4	10.7
4M	7.3	11.01	56.6	10.1	4M	5.7	11.93	55.1	10.8
1BK	5.4	11.42	61.9	10.2	Grader	3.3	12.98	58.4	10.9
Grader	3.1	12.11	65.0	10.3	1BK	7.0	13.50	65.4	11.2
FILTER FLR	0.8	12.59	65.8	10.3	5M	2.2	14.16	67.6	11.3
5M	2.3	13.58	68.2	10.4	FILTER FLR	1.0	14.42	68.6	11.3
3BK	3.1	14.45	71.3	10.6	3BK	2.7	16.36	71.3	11.5
2BK	3.4	15.00	74.7	10.8	2BK	4.1	16.55	75.4	11.8
BRAN FLR	2.0	18.43	76.8	11.0	BRAN FLR	1.7	19.56	77.2	12.0
Break Shorts	3.3	15.36	80.1	11.2	Break Shorts	3.5	15.97	80.7	12.1
Red Dog	1.6	14.50	81.8	11.3	Red Dog	2.0	14.37	82.6	12.2
Red Shorts	0.4	13.72	82.1	11.3	Red Shorts	0.3	14.20	82.9	12.2
Filter Bran	0.8	13.03	82.9	11.3	Filter Bran	0.8	14.22	83.7	12.2
Bran	17.1	17.20	100.0	12.3	Bran	16.3	17.36	100.0	13.1
Wheat		12.2					13.0		
St. Grd. Fl		11.1					12.0		

SY 517 CL2					Jagalene (CC01)				
Mill Streams	Strm-yld	Protein	Cumulative (14%)		Mill Streams	Strm-yld	Protein	Cumulative (14%)	
	(14%mb)		Yield	Protein		(14%mb)		Yield	Protein
2M	21.2	10.23	21.2	10.2	2M	20.1	10.51	20.1	10.5
1M Red	4.0	10.49	25.1	10.3	3M	17.1	10.65	37.2	10.6
3M	12.7	10.74	37.9	10.4	1M Red	3.1	10.73	40.4	10.6
1M	10.0	10.77	47.9	10.5	1M	7.9	11.11	48.3	10.7
4M	5.9	11.45	53.8	10.6	4M	9.0	11.46	57.3	10.8
Grader	3.5	13.13	57.3	10.8	1BK	5.0	12.22	62.3	10.9
5M	1.9	13.44	59.2	10.8	Grader	2.8	12.87	65.1	11.0
1BK	7.1	13.73	66.3	11.2	5M	2.7	13.42	67.8	11.1
FILTER FLR	0.9	14.76	67.2	11.2	FILTER FLR	0.9	13.48	68.7	11.1
3BK	3.2	15.54	70.3	11.4	3BK	2.6	15.05	71.3	11.3
2BK	4.6	16.51	74.9	11.7	2BK	3.1	15.94	74.5	11.5
BRAN FLR	1.7	18.90	76.7	11.9	BRAN FLR	1.8	18.96	76.3	11.6
Break Shorts	3.7	15.34	80.4	12.0	Break Shorts	3.6	14.91	79.9	11.8
Red Dog	2.7	13.86	83.2	12.1	Red Dog	2.1	14.32	82.0	11.9
Red Shorts	0.5	13.64	83.7	12.1	Red Shorts	0.4	13.72	82.4	11.9
Filter Bran	0.6	13.49	84.3	12.1	Filter Bran	0.8	13.58	83.2	11.9
Bran	15.7	17.05	100.0	12.9	Bran	16.8	18.13	100.0	12.9
Wheat		12.6					12.7		
St. Grd. Fl		11.9					11.7		

Physical Dough Tests

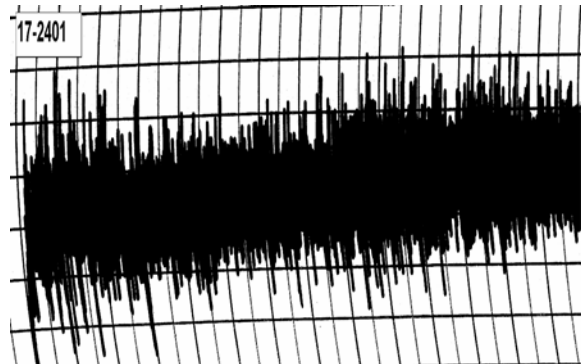
2017 (Small Scale) Samples – Syngenta

Farinograms



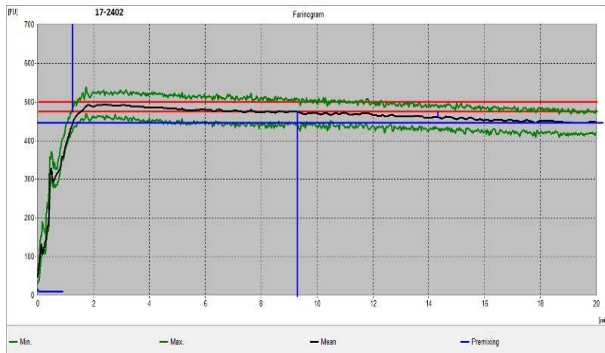
Water abs = 69.3%, Peak time = 7.1 min
Mix stab = 10.2 min, MTI = 31 FU

Mixograms

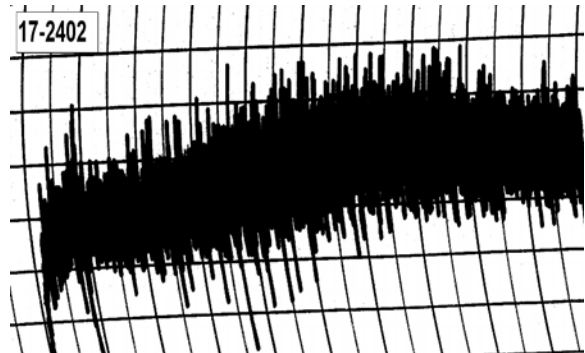


Water abs = 68.6%
Mix time = 11.8 min

17-2401, SY Monument



Water abs = 65.7%, Peak time = 9.3 min,
Mix stab = 19.8 min, MTI = 14 FU



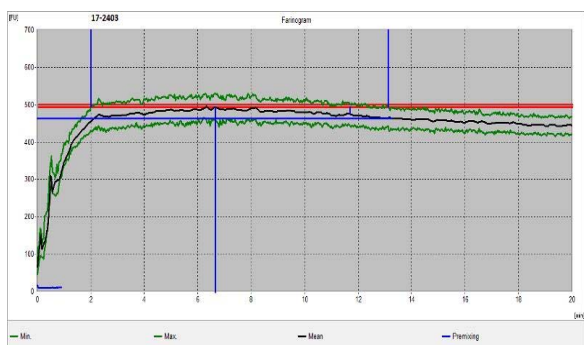
Water abs = 69.8%
Mix time = 5.9 min

17-2402, SY Achieve CL

Physical Dough Tests

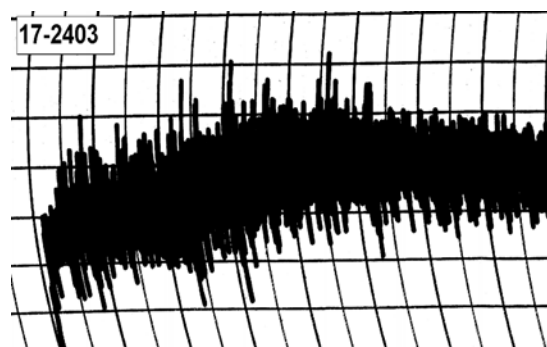
2017 (Small Scale) Samples – Syngenta (continued)

Farinograms



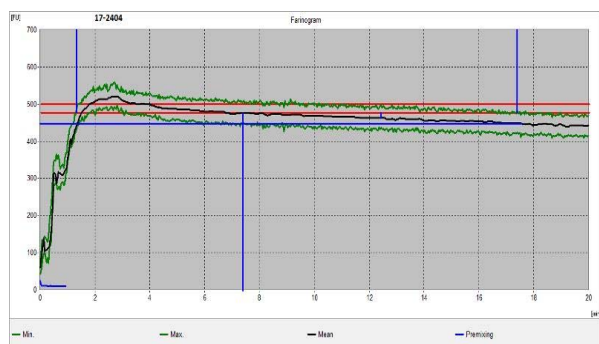
Water abs. = 65.3%, Peak time = 6.7 min,
Mix stab = 11.1 min, MTI = 18 FU

Mixograms

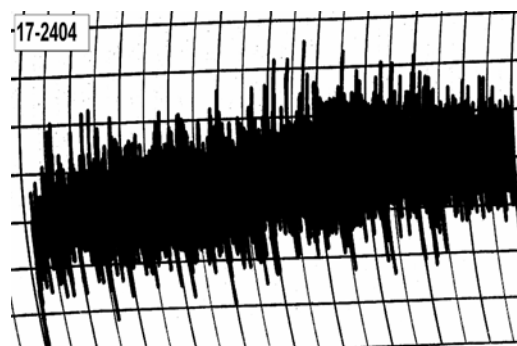


Water abs = 69.6%
Mix time = 3.8 min

17-2403, SY 517 CL2



Water abs. = 68.8%, Peak time = 7.4 min,
Mix stab = 16.1 min, MTI = 15 FU

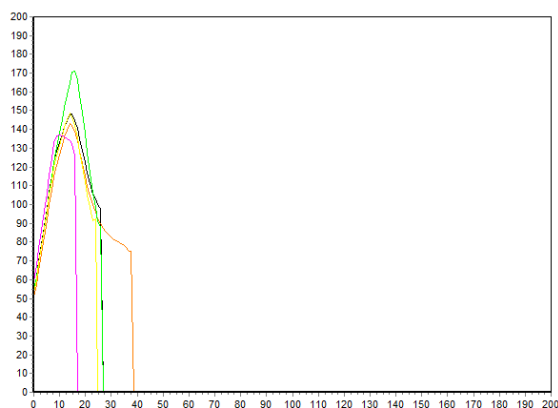


Water abs = 68.6%
Mix time = 6.4 min

17-2404, Jagalene (CC01)

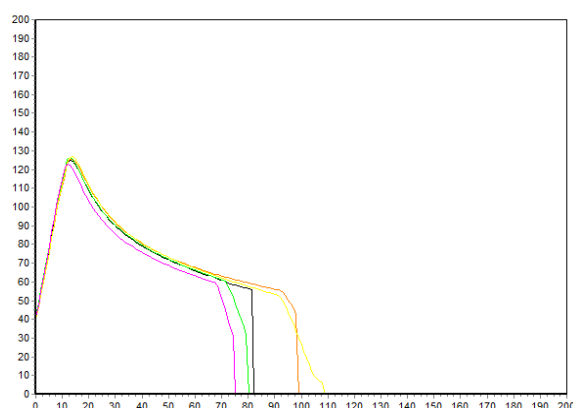
Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Syngenta



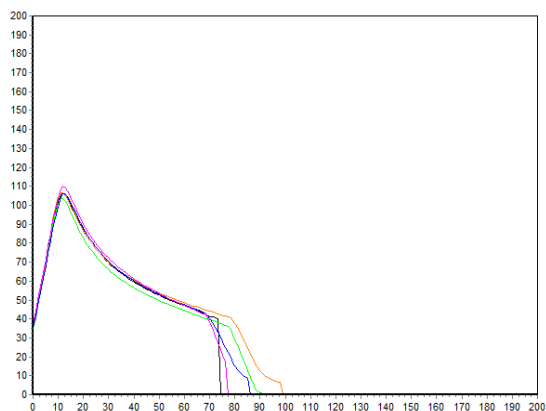
17-2401, SY Monument

P (mm H₂O) = 163, L (mm) = 26, W (10E⁻⁴J) = 195



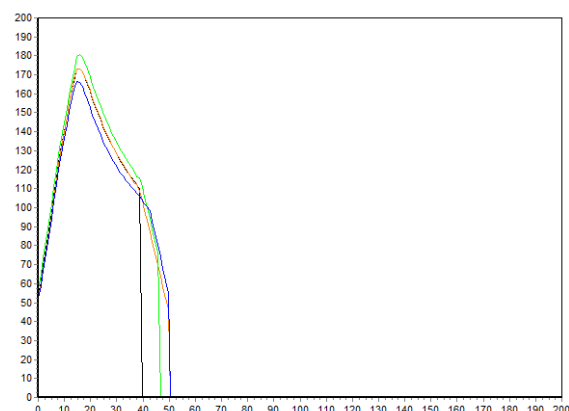
17-2402, SY Achieve CL

P (mm H₂O) = 138, L (mm) = 82, W (10E⁻⁴J) = 427



17-2403, SY 517 CL2

P (mm H₂O) = 117, L (mm) = 74, W (10E⁻⁴J) = 310

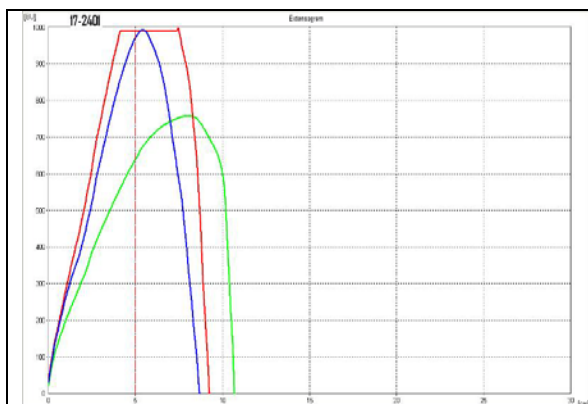


17-2404, Jagalene (CC01)

P (mm H₂O) = 191, L (mm) = 39, W (10E⁻⁴J) = 332

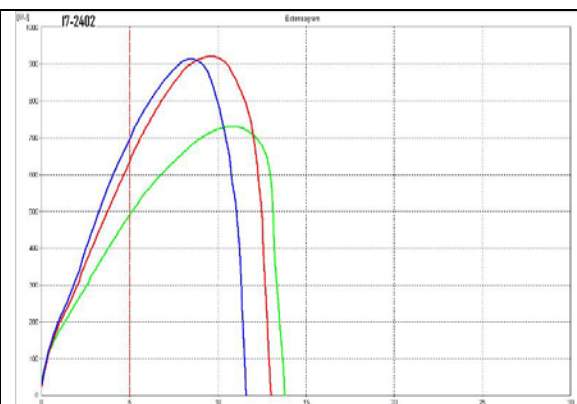
Physical Dough Tests - Extensigraph

2017 (Small Scale) Samples – Syngenta



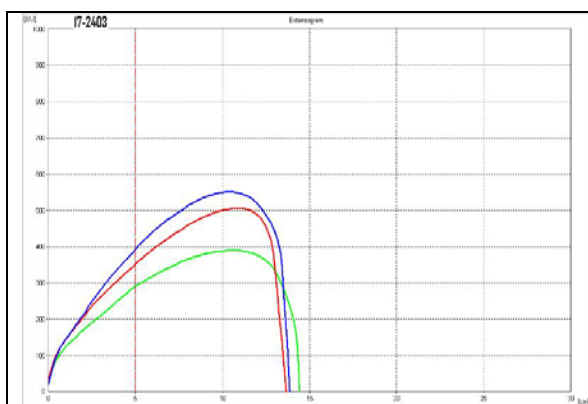
17-2401, SY Monument

R (BU) = 991, E (mm) = 94, W (cm²) = 117
Rmax (BU) = 999, Ratio = 10.6 at 90 min



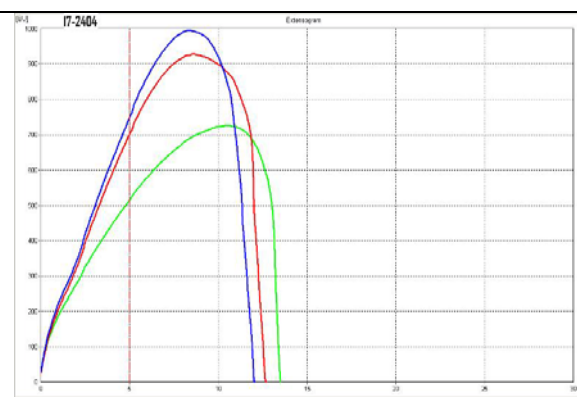
17-2402, SY Achieve CL

R (BU) = 644, E (mm) = 132, W (cm²) = 143
Rmax (BU) = 922, Ratio = 4.9 at 90 min



17-2403, SY 517 CL2

R (BU) = 354, E (mm) = 138, W (cm²) = 87
Rmax (BU) = 506, Ratio = 2.6 at 90 min

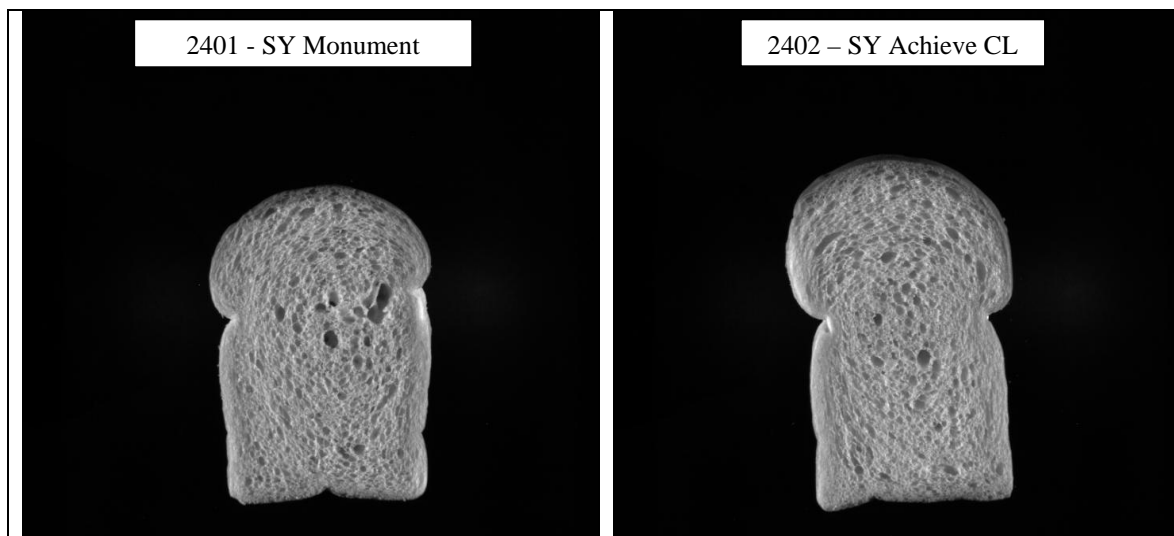


17-2404, Jagalene (CC01)

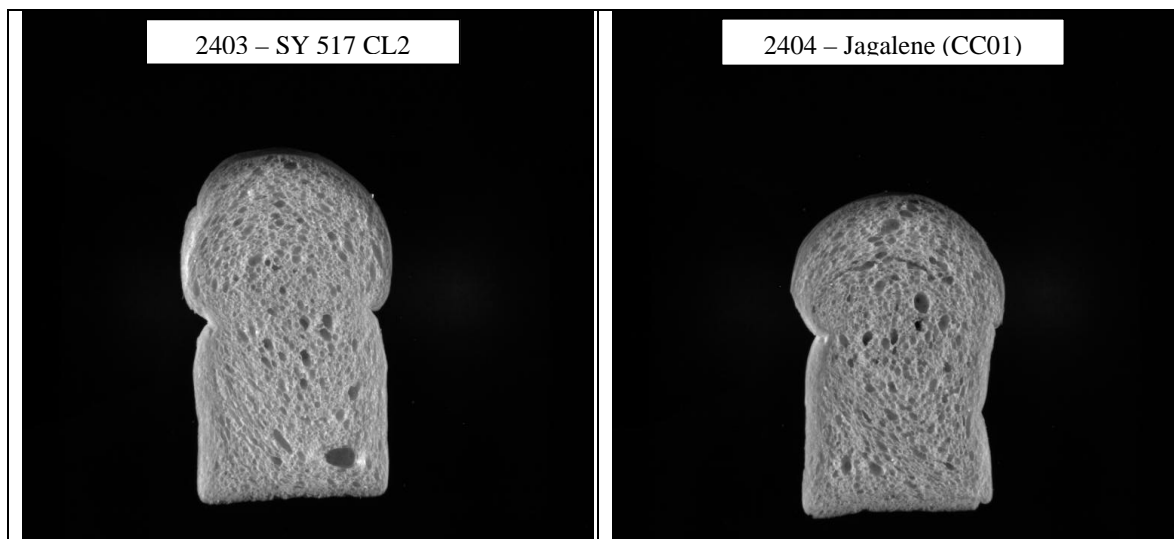
R (BU) = 707, E (mm) = 128, W (cm²) = 144
Rmax (BU) = 928, Ratio = 5.5 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm²) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Syngenta: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2401	4920	130.8	3346	0.439	1.759	4.338	1.670	-2.23
2402	5703	136.7	3808	0.431	1.844	3.311	1.683	-19.78



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2403	5551	141.0	3831	0.427	1.780	1.268	1.638	-26.30
2404	5058	129.2	3530	0.434	1.762	1.526	1.633	-36.63

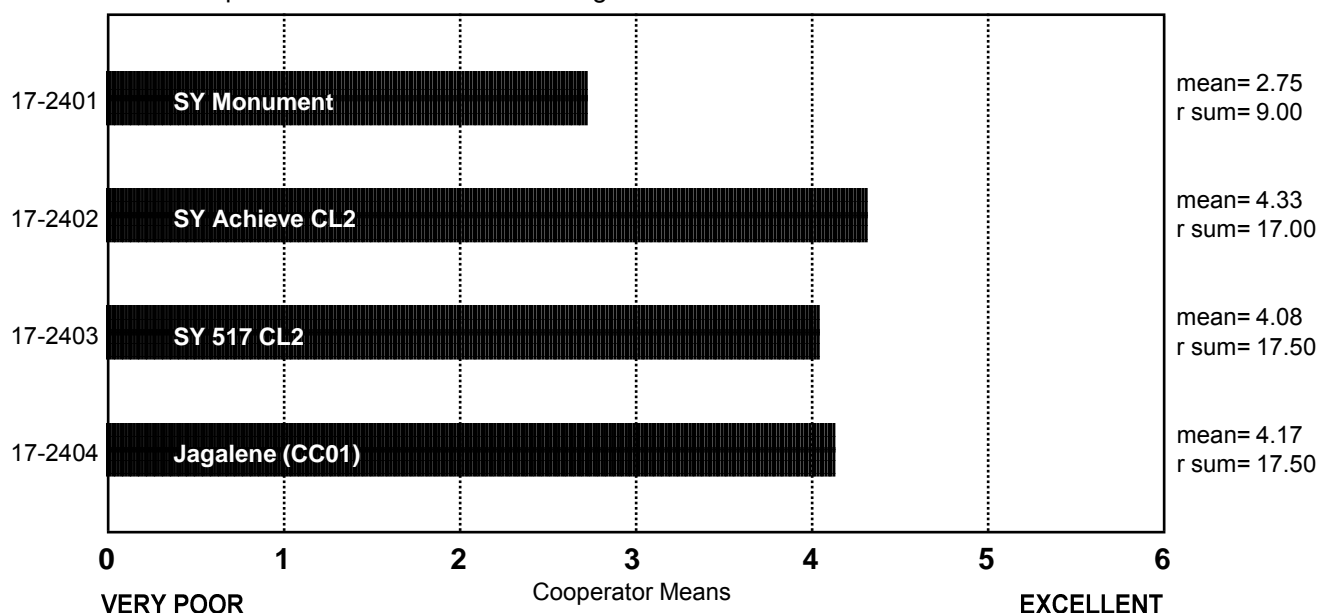
SPONGE CHARACTERISTICS

(Small Scale) Agripro

ncoop= 6
chisq= 8.25
chisqc= -2.49
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



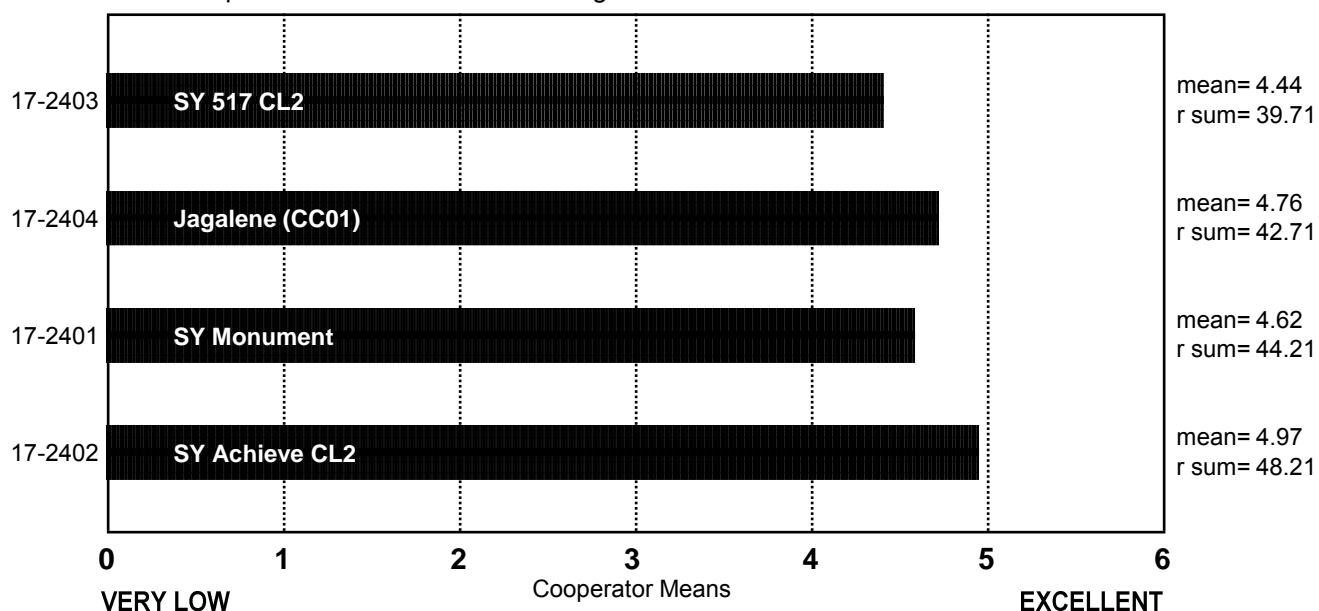
BAKE ABSORPTION

(Small Scale) Agripro

ncoop= 17
chisq= 16.10
chisqc= 6.82
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Agripro

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2401 SY Monument	58.0	65.0	66.6	72.0	68.0	69.3	64.0	70.0	72.3	70.2	62.5	72.7	71.7	70.2	61.2	72.4	65.7
17-2402 SY Achieve CL2	59.0	65.0	65.6	67.5	66.0	65.7	62.0	70.0	68.7	69.8	64.1	67.5	67.2	69.2	63.3	70.2	61.5
17-2403 SY 517 CL2	58.0	65.0	63.8	67.5	64.8	65.3	60.0	70.0	68.3	69.6	63.6	66.5	65.6	65.2	63.3	68.2	59.5
17-2404 Jagalene (CC01)	58.0	65.0	66.7	69.0	68.9	68.8	63.0	70.0	71.8	69.0	63.3	69.3	70.0	69.2	62.1	73.5	64.8

BAKE MIX TIME, ACTUAL

(Small Scale) Agripro

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2401 SY Mounment	20.0	23.0	30.0	5.0	9.0	9.0	25.0	10.0	9.0	5.0	10.5	6.9	6.8	7.4	8.3	14.1	10.0
17-2402 SY Achieve CL2	14.0	18.0	10.0	5.0	5.0	9.0	25.0	5.0	7.0	5.5	6.5	4.3	3.8	5.8	4.9	7.0	6.0
17-2403 SY 517 CL2	6.0	15.0	9.0	5.0	3.5	9.0	16.0	4.0	5.0	4.5	5.3	3.5	3.0	4.4	3.5	4.4	4.0
17-2404 Jagalene (CC01)	20.0	25.0	16.0	4.5	6.0	9.0	25.0	6.3	7.0	6.5	7.3	5.0	4.3	5.4	5.4	9.1	7.0

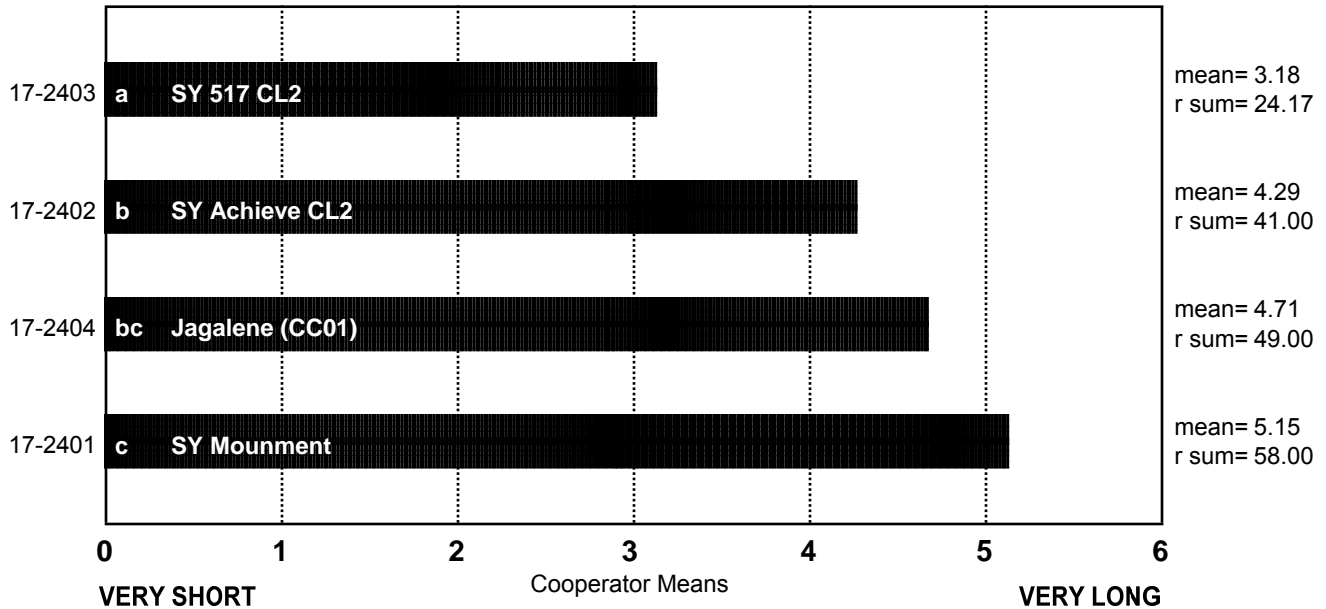
BAKE MIX TIME

(Small Scale) Agripro

ncoop= 17
chisq= 28.41
chisqc= 27.96
cvchisq= 7.82
crdiff= 9.35

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



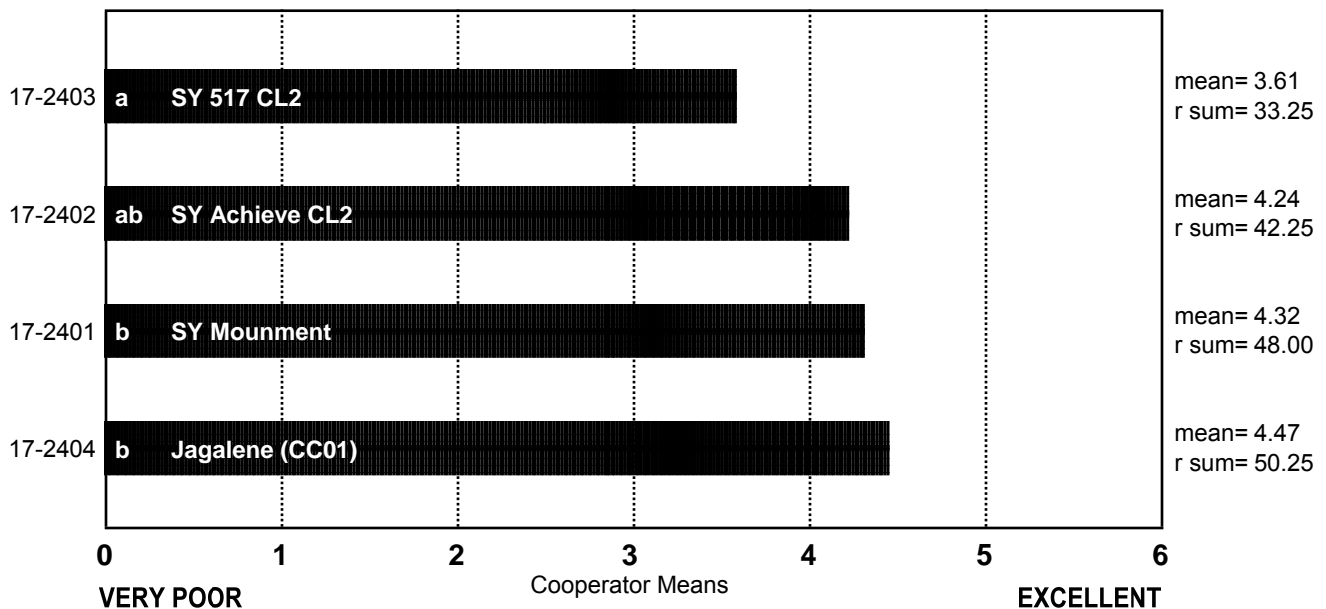
MIXING TOLERANCE

(Small Scale) Agripro

ncoop= 17
chisq= 17.46
chisqc= 9.00
cvchisq= 7.82
crdiff= 12.22

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



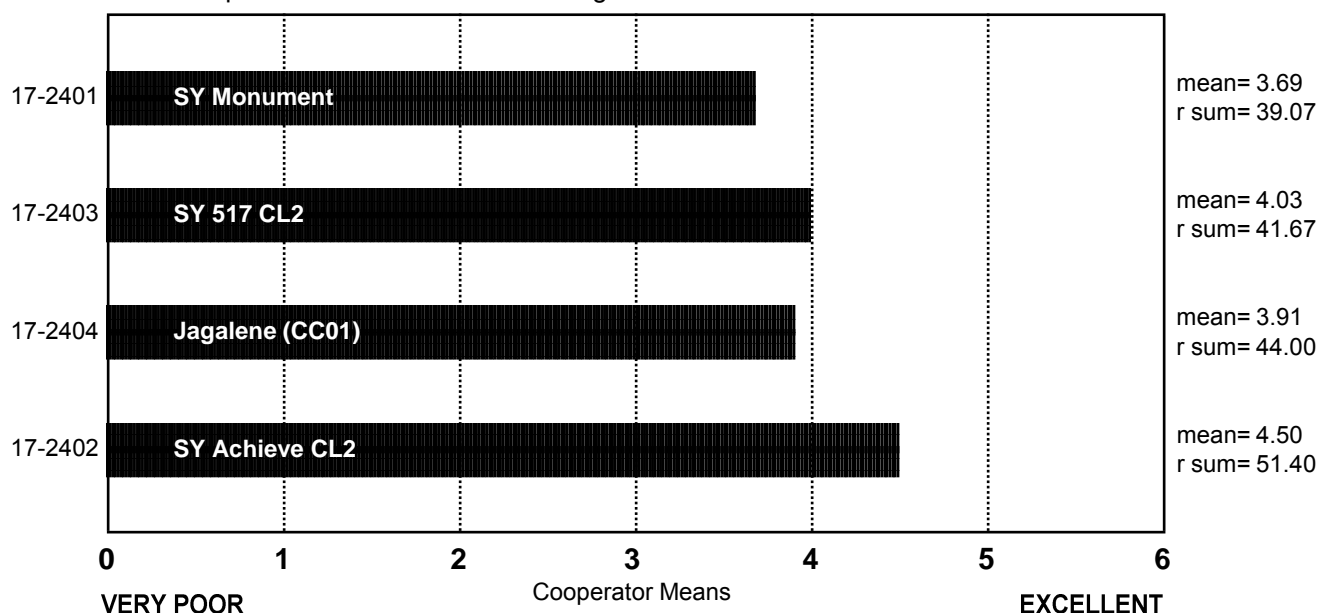
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Agripro

ncoop= 17
chisq= 21.72
chisqc= 5.40
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Agripro

	Sticky	Wet	Tough	Good	Excellent
17-2401 SY Monument	3	1	7	4	2
17-2402 SY Achieve CL2	0	1	4	9	3
17-2403 SY 517 CL2	1	1	4	10	1
17-2404 Jagalene (CC01)	4	1	6	6	0

Frequency Table

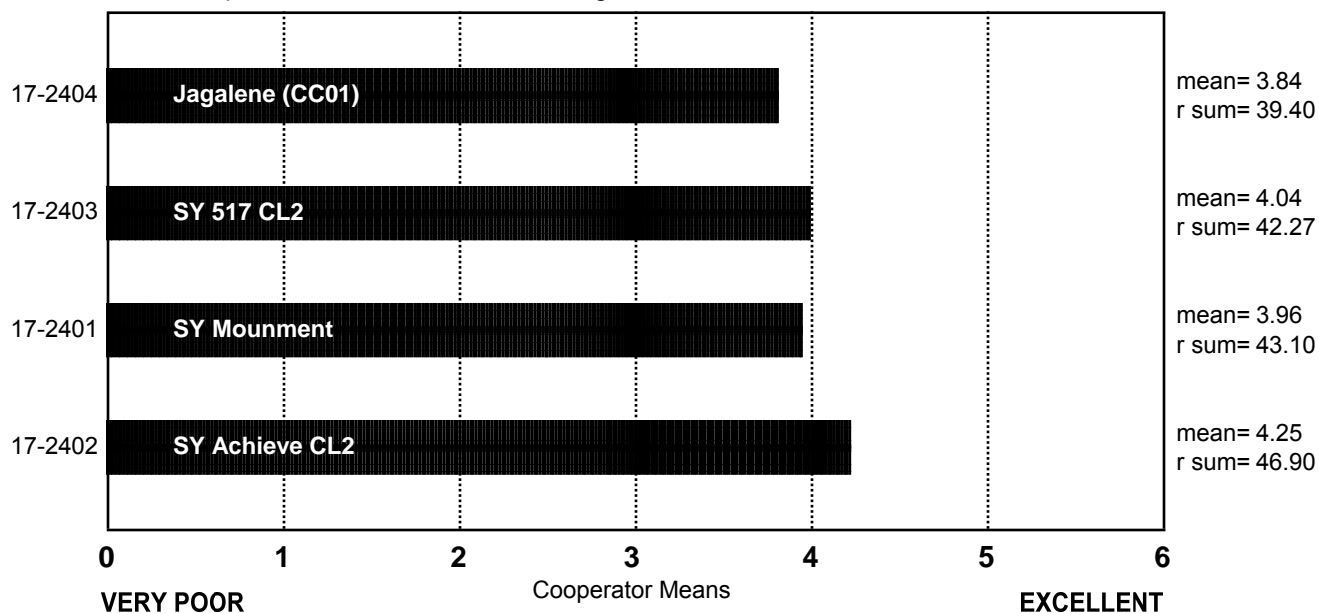
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Agripro

ncoop= 17
chisq= 6.04
chisqc= 3.31
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Agripro

	Sticky	Wet	Tough	Good	Excellent
17-2401 SY Mounment	2	1	6	6	2
17-2402 SY Achieve CL2	2	1	2	11	1
17-2403 SY 517 CL2	3	2	3	8	1
17-2404 Jagalene (CC01)	3	1	6	7	0

Frequency Table

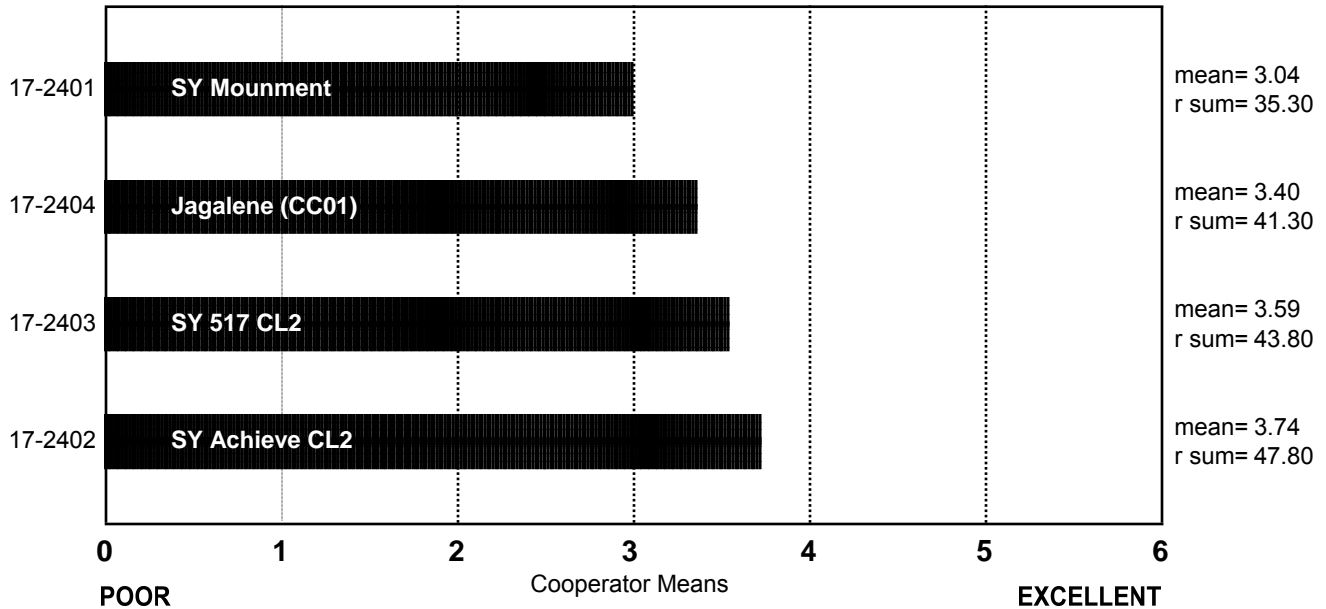
CRUMB GRAIN

(Small Scale) Agripro

ncoop= 17
 chisq= -2.47
 chisqc= 5.81
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Agripro

	Open	Fine	Dense
17-2401 SY Mounment	8	5	4
17-2402 SY Achieve CL2	6	11	0
17-2403 SY 517 CL2	8	7	2
17-2404 Jagalene (CC01)	9	6	2

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Agripro

	Round	Irregular	Elongated
17-2401 SY Mounment	4	7	6
17-2402 SY Achieve CL2	5	5	7
17-2403 SY 517 CL2	4	7	6
17-2404 Jaglene (CC01)	4	7	6

Frequency Table

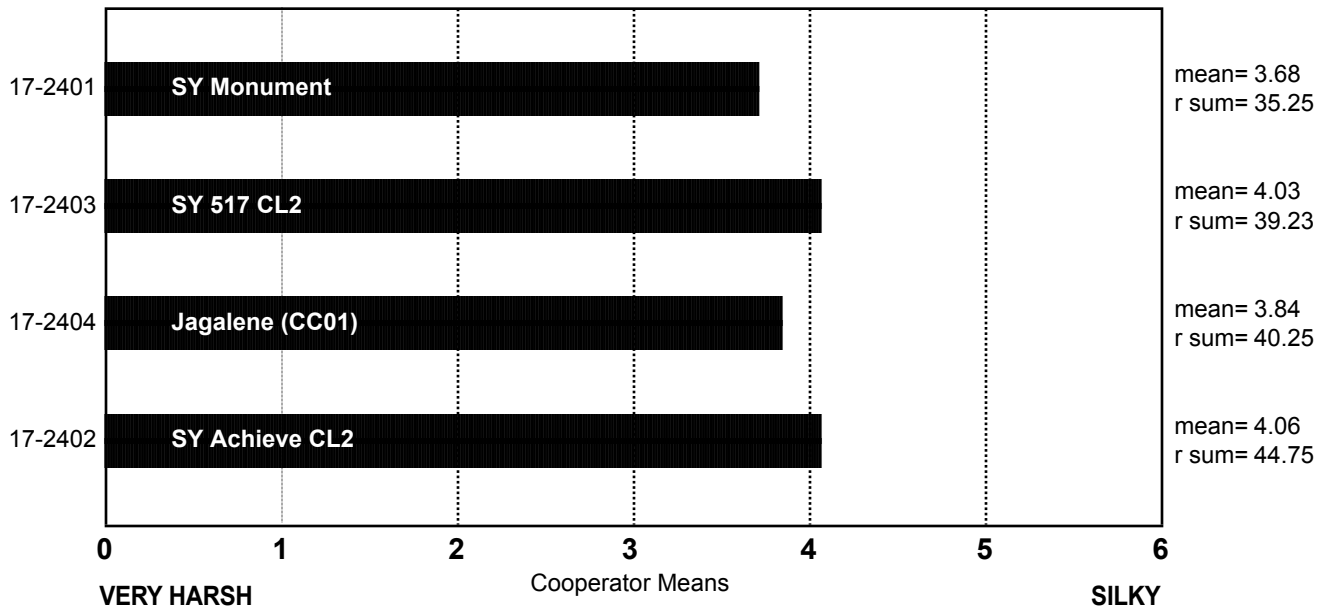
CRUMB TEXTURE

(Small Scale) Agripro

ncoop= 16
 chisq= 0.17
 chisqc= 6.38
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Agripro

	Harsh	Smooth	Silky
17-2401 SY Monument	5	9	3
17-2402 SY Achieve CL2	2	11	4
17-2403 SY 517 CL2	1	14	2
17-2404 Jagalene (CC01)	3	11	3

Frequency Table

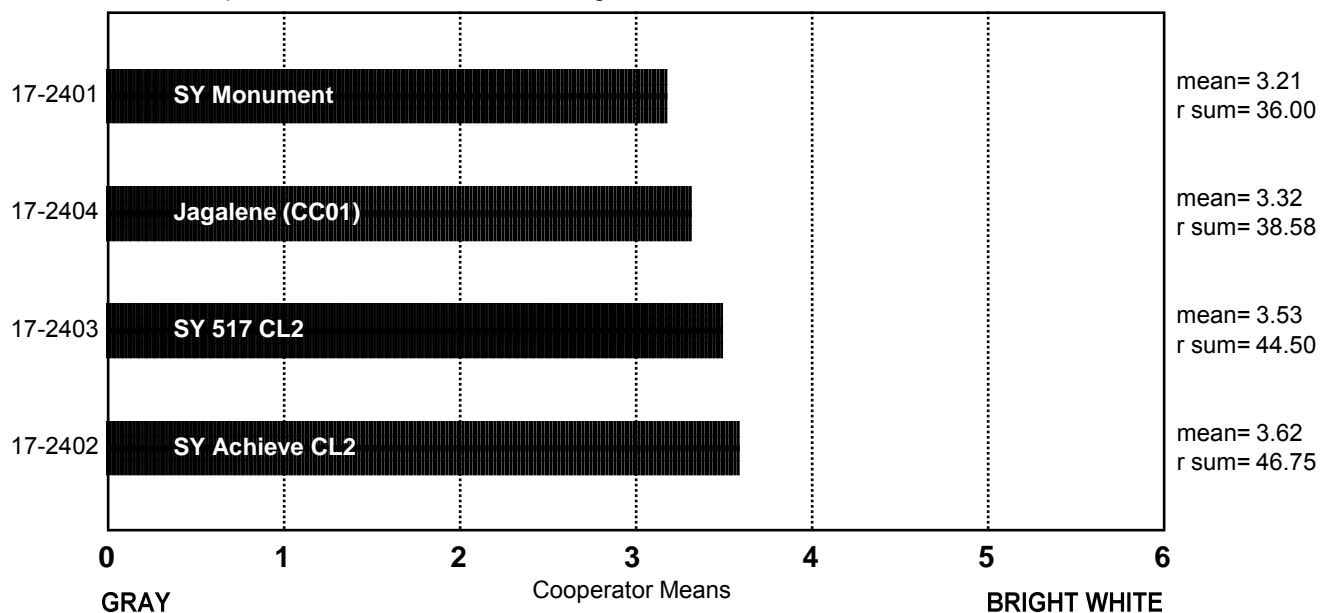
CRUMB COLOR

(Small Scale) Agripro

ncoop= 17
chisq= -9.69
chisqc= 6.95
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Agripro

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2401 SY Monument	2	2	1	4	5	2	1
17-2402 SY Achieve CL2	0	0	2	7	7	1	0
17-2403 SY 517 CL2	0	0	5	6	4	1	1
17-2404 Jagalene (CC01)	0	0	5	5	7	0	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Agripro

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2401 SY Monument	415.0	467.2	425.0	451.0	143.6	453.5		150.7	447.7	136.3	143.2	150.9	138.2	161.6	140.7	156.3	480.2
17-2402 SY Achieve CL2	413.0	465.3	427.0	453.0	144.0	453.9		150.4	448.8	135.1	143.5	146.6	136.3	157.7	139.1	155.2	486.1
17-2403 SY 517 CL2	410.0	465.4	424.0	452.0	146.0	452.6		147.4	445.3	133.5	145.0	148.1	134.9	151.9	139.2	155.1	481.9
17-2404 Jagalene (CC01)	412.0	462.7	429.0	456.0	146.0	454.8		148.9	447.3	132.2	143.1	148.6	136.1	158.1	139.9	160.0	488.6

LOAF VOLUME, ACTUAL

(Small Scale) Agripro

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2401 SY Monument	2650	2175	2550	1925	835	2416	2897	725	2150	760	736	800	862	773	683	670	2250
17-2402 SY Achieve CL2	3025	2150	2750	2100	850	2673	2956	800	2050	900	875	850	872	930	842	835	2275
17-2403 SY 517 CL2	2875	2263	2650	2275	790	2712	2839	780	2125	890	910	795	805	928	809	835	2475
17-2404 Jagalene (CC01)	3100	2363	2800	1800	875	2422	2986	785	1975	805	795	845	962	848	728	700	2138

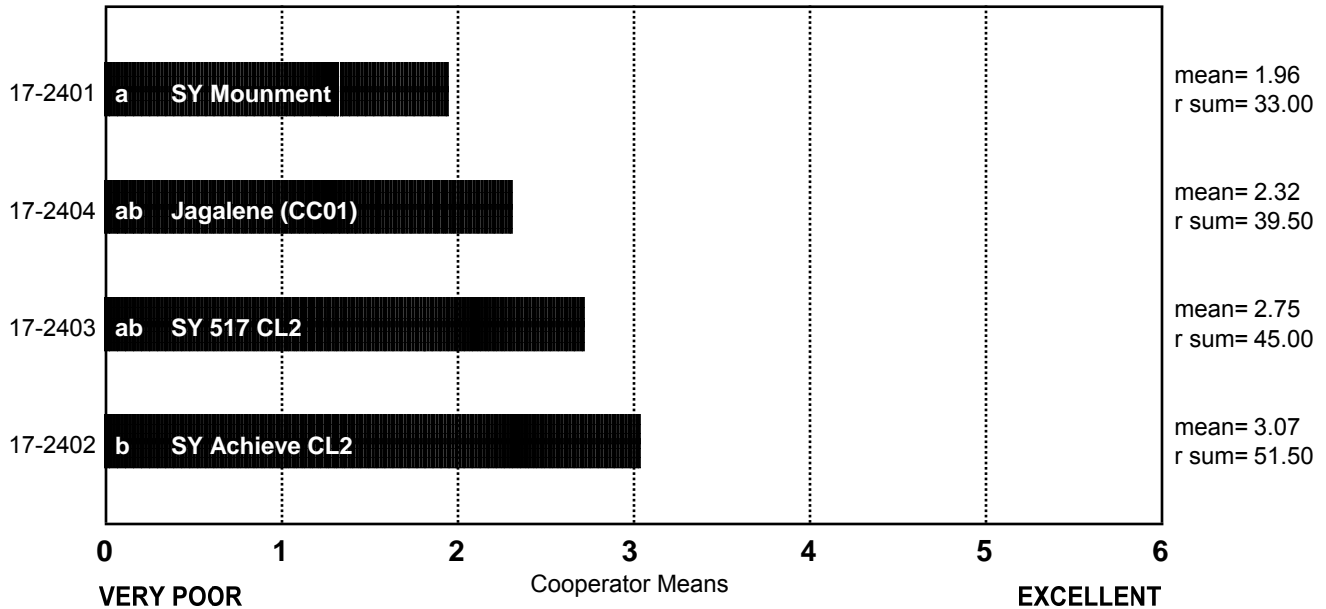
LOAF VOLUME

(Small Scale) Agripro

ncoop= 17
 chisq= 3.58
 chisqc= 8.87
 cvchisq= 7.82
 crdiff= 12.15

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



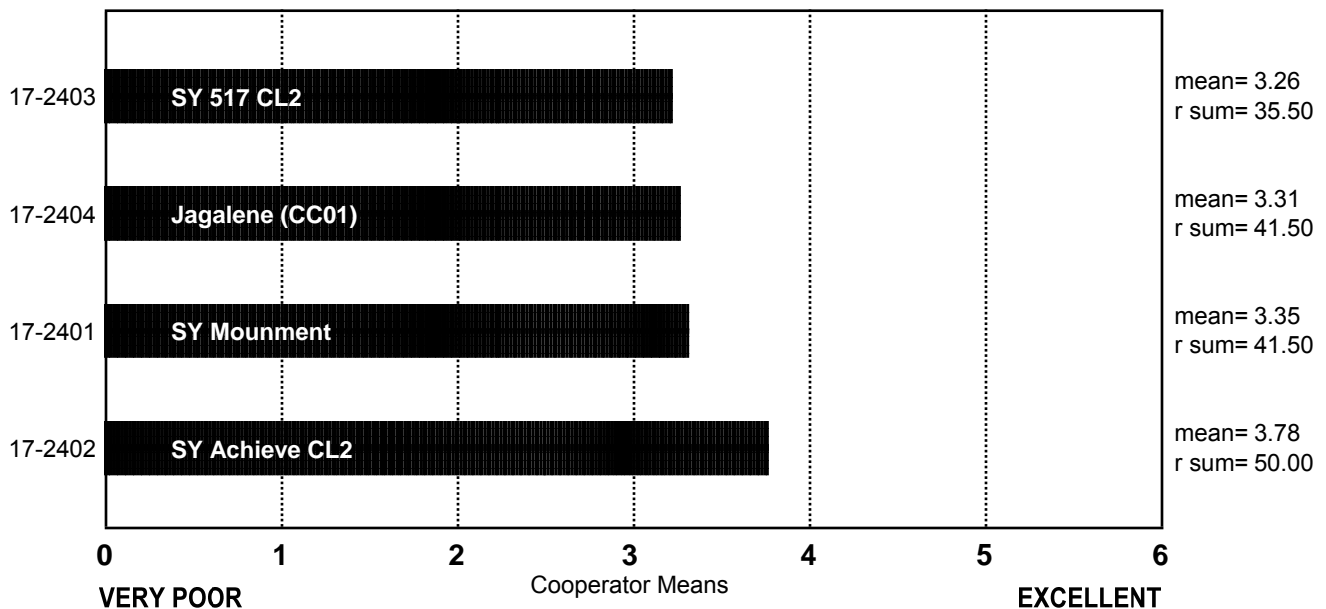
OVERALL BAKING QUALITY

(Small Scale) Agripro

ncoop= 17
 chisq= -0.71
 chisqc= 4.78
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



COOPERATOR'S COMMENTS

(Small Scale) Syngenta

COOP.

17-2401 SY Monument

- A. No comment.
- B. No comment.
- C. Slightly dry sponge, high bake absorption and very long mix time, tough and bucky dough. Good for blending purpose.
- D. Bake absorption did not coincide with farinograph absorption.
- E. Light brown dough, not really gray but more brown bread, dark crust.
- F. No comment.
- G. Very good absorption, mix strength and volume.
- H. Long mix, good absorption.
- I. Had a harder time with this flour, higher absorption, wet and sticky, hard time forming the sponge.
- J. Small poor color.
- K. Normal water absorption, very long mix time, slight sticky & very strong dough, fair volume, dark yellow crumb, dense elongated cells, resilient & tight harsh texture.
- L. Longer mix, very strong, excellent color, took a lot of water to get a nice dough.
- M. No comment.
- N. Poor bake performance especially considering the flour protein.
- O. No comment.
- P. High absorption, extreme long mix time, dough feel unusual, weak, messy, sticky dough, poor crumb grain.
- Q. High absorption, long mix time, good grain, creamy color, and very low volume.

COOP.

17-2402 SY Achieve CL2

- A. No comment.
- B. No comment.
- C. Elastic and good dough feel as well as very good mix time and mix tolerance.
- D. No comment.
- E. Slightly rough break and shred, dark crust.
- F. No comment.
- G. Good absorption, mix strength and volume.
- H. Good absorption.
- I. Best of the set, poor volume but good makeup rating along with a fine/irregular crumb score.
- J. No comment.
- K. Normal water absorption, long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
- L. Good protein.
- M. No comment.
- N. Baked as expected for protein level, good dough strength and good dough feel.
- O. No comment.
- P. High absorption, dry at mix yet sticky at pan, long mix time, Questionable crumb grain.
- Q. Good absorption, tough dough, fine grain, yellow color, very low volume.

COOP.**17-2403 SY 517 CL2**

- A. No comment.
- B. No comment.
- C. Sticky and weak dough after mix.
- D. No comment.
- E. No comment.
- F. No comment.
- G. Average absorption, mix strength and volume.
- H. Good absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, slightly yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Poor loaf volume.
- M. Not as smooth as previous two.
- N. Baked as expected for protein level, good dough strength and good dough feel.
- O. No comment.
- P. Good bake mix time, excellent bake absorption, good at makeup with satisfactory crumb grain, low loaf volume for flour protein.
- Q. Average absorption, good grain, yellow color.

COOP.**17-2404 Jagalene (CC01)**

- A. No comment.
- B. No comment.
- C. Good performance overall.
- D. Bake absorption did not coincide with farinograph absorption.
- E. Long time to pickup, rough break and shred.
- F. No comment.
- G. Good absorption, mix strength and volume.
- H. Good absorption.
- I. Very sticky on the makeup, low volume.
- J. Long mixer and poor color.
- K. Normal water absorption, long mix time, slight sticky & strong dough, OK volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Good strength/color.
- M. No comment.
- N. Dough strength at a reasonable level, loaf volume and crumb grain questionable.
- O. No comment.
- P. Good mixograph, flour did not perform well in the bake, long mix time, sticky at pan, unsatisfactory crumb grain, and low loaf volume.
- Q. High absorption, average grain, yellow color, very low volume.

Notes: **A, C, D, G, I and Q** conducted sponge and dough bake tests

TEXAS

17-2405	Jagalene (CC02)
17-2406	TAM 111
17-2407	TX11A001295
17-2408	TX12M4068

Description of Test Plots and Breeder Entries

Texas – Jackie Rudd and Amir Ibrahim

Texas A&M AgriLife Research

The Wheat Quality Council samples submitted by Texas A&M AgriLife Research were harvested from irrigated strips planted adjacent to the irrigated yield trials at Bushland (near Amarillo in the Texas Panhandle). The field had good moisture at planting on November 11, 2016, and was harvested on June 20, 2017. The strips were fertilized for a yield goal of 100 bu/ac applied as 40 lbs of preplant N fertilizer on September 22, 2016 and were topdressed with 25 lbs of N on March 16, 2017. Stripe rust was present in the area and controlled with foliar fungicide on April 10. Seven inches of water were applied from mid-December until mid-May. The grain yields of Jagalene, TAM 111, TX11A001295, and TX12M4068 were 76, 76, 88, and 74 bu/ac respectively. A heavy snowfall on April 29 flattened the strips, but few stems were broken, and yields were not affected.

JAGALENE (Common Check) Quality check

TAM 111 (Internal Check)

TAM 111 was released in 2003 and licensed to AgriPro Wheat. It has been a dominant variety in the southern High Plains until the past few years. Although it was still the most planted wheat variety in Texas in 2017, acreage is decreasing as newer varieties come along.

TX11A001295

This hard red winter wheat experimental was selected from the TAM Wheat Improvement Program in Amarillo from the cross TAM 112/TX02U2508. It is resistant to greenbugs and wheat curl mites, as well as leaf, stripe, and stem rusts. It has good yield under a wide range of environments across Texas and the Great Plains, but is particularly suited for the High Plains and Rolling Plains of Texas.

TX12M4068

This hard red winter wheat experimental was selected from the TAM Wheat Improvement Program in College Station from the cross AP04TW1318/KS980512-11-9//KS06O3A~49. It is resistant to leaf, stripe, and stem rusts, as well as soil borne mosaic virus. It is tolerant to acid soils. It has good yields in Rolling Plains, Central, and South Texas.

Texas: 2017 (Small-Scale) Samples

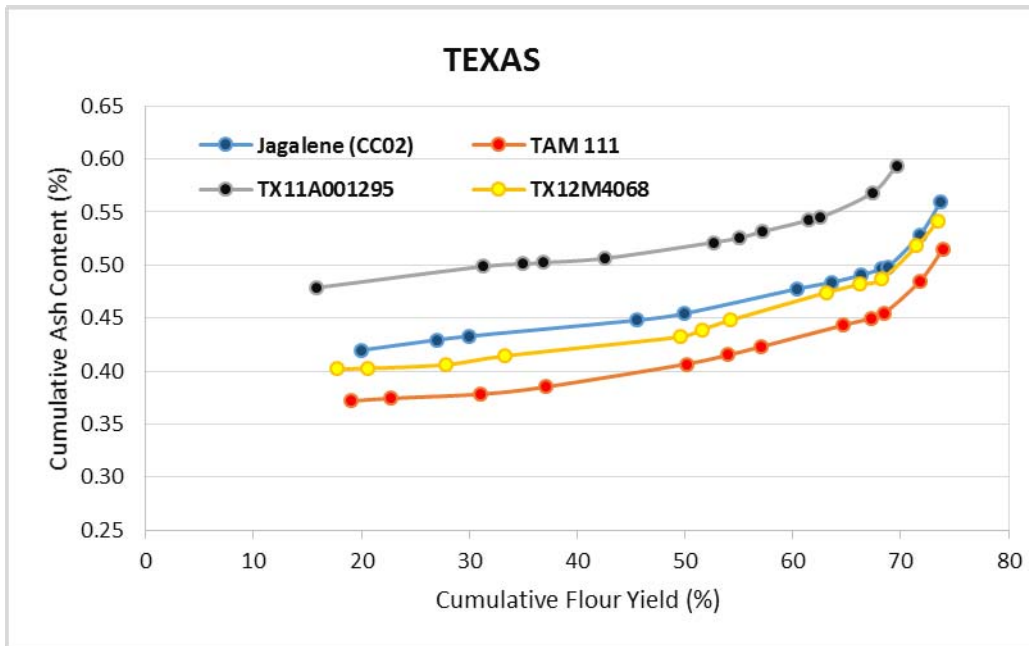
Test entry number	17-2405	17-2406	17-2407	17-2408
Sample identification	Jagalene (CC02)	TAM 111	TX11A001295	TX12M4068
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	63.1	63.4	64.4	63.1
Hectoliter weight (kg/hl)	82.9	83.3	84.6	82.9
1000 kernel weight (gm)	34.4	36.0	34.6	39.5
Wheat kernel size (Rotap)				
Over 7 wire (%)	84.5	82.6	80.8	90.5
Over 9 wire (%)	15.2	17.2	18.7	9.4
Through 9 wire (%)	0.3	0.2	0.5	0.1
Single kernel (skcs) ^a				
Hardness (avg /s.d)	76.5/16.4	72.2/15.7	91.1/15.3	73.9/13.2
Weight (mg) (avg/s.d)	34.4/10.0	36.0/10.2	34.6/11.3	39.5/9.2
Diameter (mm)(avg/s.d)	2.71/0.34	2.71/0.37	2.62/0.38	2.82/0.33
Moisture (%) (avg/s.d)	10.7/0.5	10.9/0.4	10.7/0.3	10.9/0.4
SKCS distribution	01-03-13-83-01	01-04-13-82-01	00-01-02-97-01	01-02-11-86-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	15.6	14.0	14.4	15.7
Wheat ash (12% mb)	1.46	1.45	1.46	1.48
Milling and Flour Quality Data				
Flour yield (% ,str. grade)				
Miag Multomat Mill	73.8	73.9	69.5	73.4
Quadrumat Sr. Mill	67.1	67.7	60.5	66.3
Flour moisture (%)	14.1	14.1	13.4	13.8
Flour protein (14% mb)	13.8	12.5	12.7	13.9
Flour ash (14% mb)	0.53	0.50	0.56	0.50
Rapid Visco-Analyser				
Peak Time (min)	6.1	6.3	6.5	6.4
Peak Viscosity (RVU)	166.8	188.3	196.0	197.6
Breakdown (RVU)	47.6	51.4	49.4	49.3
Final Viscosity at 13 min (RVU)	226.8	250.5	245.5	254.0
Minolta color meter				
L*	91.36	91.54	91.23	91.52
a*	-1.42	-1.41	-1.26	-1.40
b*	9.65	9.36	9.48	9.47
PPO	0.407	0.526	0.366	0.437
Falling number (sec)	448	454	475	431
Damaged Starch				
(AI%)	97.4	97.0	98.6	97.9
(AACC76-31)	7.4	7.1	8.5	7.9

^as.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Texas: Physical Dough Tests and Gluten Analysis 2017 (Small-Scale) Samples

Test Entry Number	17-2405	17-2406	17-2407	17-2408
Sample Identification	Jagalene (CC02)	TAM 111	TX11A001295	TX12M4068
MIXOGRAPH				
Flour Abs (% as-is)	69.6	67.8	69.3	67.0
Flour Abs (14% mb)	69.6	67.7	68.5	66.5
Mix Time (min)	3.1	2.6	3.0	2.3
Mix tolerance (0-6)	2	1	2	0
FARINOGRAPH				
Flour Abs (% as-is)	68.7	66.2	78.5	70.5
Flour Abs (14% mb)	68.7	66.2	77.7	70.0
Peak time (min)	7.5	5.7	5.2	6.2
Mix stability (min)	8.8	7.8	6.4	4.5
Mix Tolerance Index (FU)	24	27	28	70
Breakdown time (min)	14.0	11.6	10.2	8.7
ALVEOGRAPH				
P(mm): Tenacity	134	110	198	130
L(mm): Extensibility	93	95	51	56
G(mm): Swelling index	21.5	21.7	15.9	16.7
W(10 ⁻⁴ J): strength (curve area)	422	303	391	260
P/L: curve configuration ratio	1.44	1.16	3.88	2.32
Ie(P ₂₀₀ /P): elasticity index	58.7	48.6	50.7	46.5
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	293/395/130	214/269/307	261/325/368	255/267/295
Extensibility (mm at 45/90/135 min)	164/170/166	174/165/168	154/167/144	133/132/129
Energy (cm ² at 45/90/135 min)	88/128/130	71/84/98	74/101/94	55/57/62
Resist _{max} (BU at 45/90/135 min)	407/570/609	295/377/435	353/453/491	292/310/344
Ratio (at 45/90/135 min)	1.8/2.3/2.5	1.2/1.6/1.8	1.7/2.0/2.6	1.9/2.0/2.3
PROTEIN ANALYSIS				
HMW-GS Composition	2*,1,5+10,17+18	2*.2+12,7+9	2*,5+10,7+8	2*,1,5+10,7+9
TMP/TPP	0.82	0.79	0.83	0.59
SEDIMENTATION TEST				
Volume (ml)	58.5	43.0	49.6	49.3

Texas: Cumulative Ash Curves

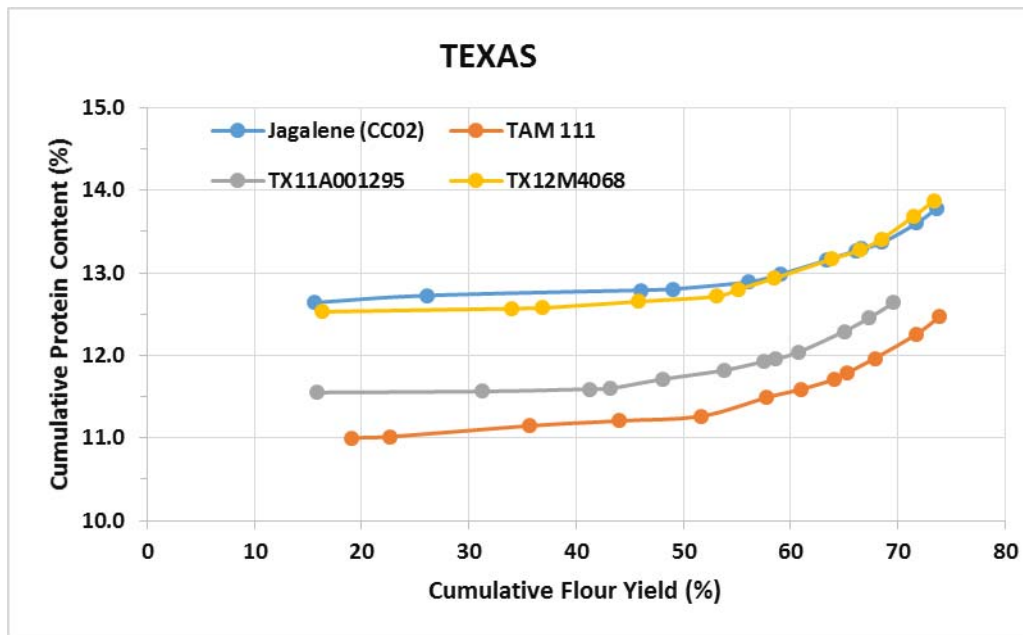


Jagalene (CC02)					TAM 111				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	19.9	0.42	19.9	0.42	2M	19.1	0.37	19.1	0.37
1M	7.1	0.46	27.0	0.43	1M Red	3.6	0.39	22.7	0.37
1M Red	2.9	0.46	30.0	0.43	1M	8.3	0.39	31.0	0.38
3M	15.6	0.48	45.6	0.45	1BK	6.1	0.42	37.1	0.39
1BK	4.3	0.52	49.9	0.45	3M	13.0	0.47	50.1	0.41
4M	10.5	0.59	60.4	0.48	2BK	3.9	0.53	54.0	0.42
2BK	3.2	0.60	63.6	0.48	Grader	3.0	0.56	57.0	0.42
Grader	2.7	0.65	66.3	0.49	4M	7.7	0.59	64.7	0.44
3BK	1.9	0.70	68.2	0.50	3BK	2.6	0.61	67.3	0.45
FILTER FLR	0.6	0.73	68.8	0.50	FILTER FLR	1.2	0.73	68.5	0.46
5M	2.9	1.23	71.8	0.53	5M	3.2	1.11	71.8	0.48
BRAN FLR	1.9	1.73	73.7	0.56	BRAN FLR	2.2	1.52	73.9	0.52
Break Shorts	4.7	2.69	78.4	0.69	Break Shorts	4.2	3.05	78.2	0.65
Red Dog	2.6	2.81	81.0	0.76	Red Dog	3.0	2.58	81.2	0.72
Red Shorts	0.6	3.59	81.6	0.78	Red Shorts	0.7	3.15	81.9	0.74
Filter Bran	0.8	3.35	82.4	0.80	Filter Bran	0.5	3.35	82.4	0.76
Bran	17.6	4.69	100.0	1.49	Bran	17.6	4.88	100.0	1.49

Wheat	1.37	1.35
St. Grd. Fl.	0.53	0.50

TX11A001295					TX12M4068				
Mill Streams	Strm-yld	Ash	Cumul (14%)		Mill Streams	Strm-yld	Ash	Cumul (14%)	
	(14%mb)		Yield	Ash		(14%mb)		Yield	Ash
2M	15.9	0.48	15.9	0.48	2M	17.7	0.40	17.7	0.40
3M	15.4	0.52	31.2	0.50	1M Red	2.9	0.41	20.6	0.40
1BK	3.7	0.52	34.9	0.50	1M	7.3	0.42	27.9	0.41
1M Red	1.9	0.53	36.9	0.50	1BK	5.4	0.46	33.3	0.41
1M	5.7	0.53	42.6	0.51	3M	16.3	0.47	49.6	0.43
4M	10.0	0.58	52.7	0.52	3BK	2.0	0.60	51.6	0.44
2BK	2.3	0.62	55.0	0.53	Grader	2.5	0.63	54.2	0.45
Grader	2.2	0.68	57.2	0.53	4M	9.0	0.63	63.1	0.47
3BK	4.3	0.68	61.4	0.54	2BK	3.0	0.64	66.2	0.48
FILTER FLR	1.1	0.69	62.5	0.54	FILTER FLR	2.0	0.65	68.2	0.49
5M	4.8	0.87	67.4	0.57	5M	3.3	1.17	71.5	0.52
BRAN FLR	2.3	1.35	69.6	0.59	BRAN FLR	1.9	1.39	73.4	0.54
Break Shorts	6.4	1.91	76.0	0.70	Break Shorts	4.6	3.01	78.0	0.69
Red Dog	3.4	2.09	79.4	0.76	Red Dog	2.9	2.19	80.9	0.74
Red Shorts	0.8	3.11	80.2	0.79	Red Shorts	0.6	2.97	81.6	0.76
Filter Bran	0.5	2.16	80.7	0.80	Filter Bran	0.7	2.04	82.3	0.77
Bran	19.3	3.96	100.0	1.40	Bran	17.7	4.90	100.0	1.50
Wheat		1.37					1.38		
St. Grd. Fl.		0.56					0.50		

Texas: Cumulative Protein Curves



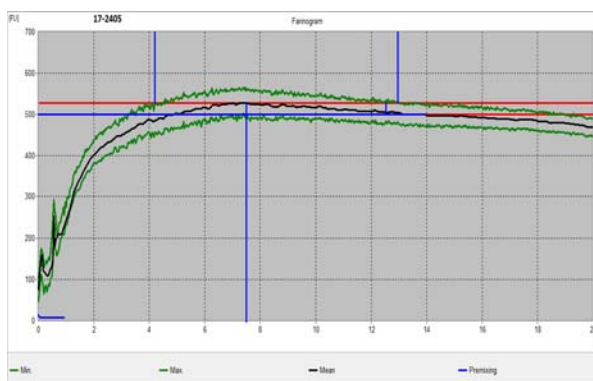
Jagalene (CC02)					TAM 111				
Mill Streams	Strm-yld	Protein	Cumulative (14%)		Mill Streams	Strm-yld	Protein	Cumulative (14%)	
	(14%mb)		Yield	Protein		(14%mb)		Yield	Protein
3M	15.6	12.64	15.6	12.6	2M	19.1	11.00	19.1	11.0
4M	10.5	12.85	26.1	12.7	1M Red	3.6	11.09	22.7	11.0
2M	19.9	12.88	46.1	12.8	3M	13.0	11.38	35.7	11.1
1M Red	2.9	13.00	49.0	12.8	1M	8.3	11.46	44.0	11.2
1M	7.1	13.49	56.1	12.9	4M	7.7	11.59	51.7	11.3
5M	2.9	14.72	59.0	13.0	1BK	6.1	13.39	57.8	11.5
1BK	4.3	15.49	63.3	13.2	5M	3.2	13.41	61.0	11.6
Grader	2.7	15.93	66.1	13.3	Grader	3.0	14.08	64.1	11.7
FILTER FLR	0.6	15.93	66.7	13.3	FILTER FLR	1.2	15.93	65.3	11.8
3BK	1.9	16.03	68.6	13.4	3BK	2.6	16.42	67.9	12.0
2BK	3.2	18.60	71.8	13.6	2BK	3.9	17.38	71.8	12.3
BRAN FLR	1.9	20.68	73.7	13.8	BRAN FLR	2.2	19.53	73.9	12.5
Break Shorts	4.7	14.79	78.4	13.8	Break Shorts	4.2	14.88	78.2	12.6
Red Dog	2.6	16.22	81.0	13.9	Red Dog	3.0	15.50	81.2	12.7
Red Shorts	0.6	13.92	81.6	13.9	Red Shorts	0.7	13.82	81.9	12.7
Filter Bran	0.8	14.84	82.4	13.9	Filter Bran	0.5	14.84	82.4	12.7
Bran	17.6	17.25	100.0	14.5	Bran	17.6	17.33	100.0	13.5
Wheat					13.1				
St. Grd. Fl					12.5				

TC11A001295					TX12M4068				
Mill Streams	Strm-yld	Protein	Cumulative (14%)		Mill Streams	Strm-yld	Protein	Cumulative (14%)	
	(14%mb)		Yield	Protein		(14%mb)		Yield	Protein
2M	15.9	11.55	15.9	11.6	3M	16.3	12.53	16.3	12.5
3M	15.4	11.58	31.2	11.6	2M	17.7	12.60	34.0	12.6
4M	10.0	11.68	41.3	11.6	1M Red	2.9	12.67	36.9	12.6
1M Red	1.9	11.78	43.2	11.6	4M	9.0	12.97	45.8	12.7
5M	4.8	12.70	48.0	11.7	1M	7.3	13.11	53.1	12.7
1M	5.7	12.73	53.8	11.8	FILTER FLR	2.0	15.08	55.2	12.8
1BK	3.7	13.47	57.5	11.9	5M	3.3	15.11	58.5	12.9
FILTER FLR	1.1	13.50	58.6	12.0	1BK	5.4	15.70	63.9	13.2
Grader	2.2	14.32	60.8	12.0	Grader	2.5	15.93	66.4	13.3
3BK	4.3	15.88	65.0	12.3	3BK	2.0	17.75	68.5	13.4
2BK	2.3	17.00	67.4	12.5	2BK	3.0	20.00	71.5	13.7
BRAN FLR	2.3	18.11	69.6	12.6	BRAN FLR	1.9	20.93	73.4	13.9
Break Shorts	6.4	13.58	76.0	12.7	Break Shorts	4.6	15.69	78.0	14.0
Red Dog	3.4	14.64	79.4	12.8	Red Dog	2.9	16.09	80.9	14.1
Red Shorts	0.8	13.81	80.2	12.8	Red Shorts	0.6	14.03	81.6	14.1
Filter Bran	0.5	13.21	80.7	12.8	Filter Bran	0.7	14.14	82.3	14.1
Bran	19.3	16.99	100.0	13.6	Bran	17.7	18.89	100.0	14.9
Wheat		13.5					14.7		
St. Grd. Fl		12.7					13.9		

Physical Dough Tests

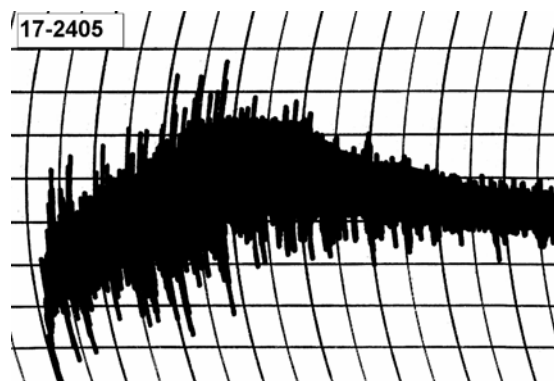
2017 (Small Scale) Samples – Texas

Farinograms



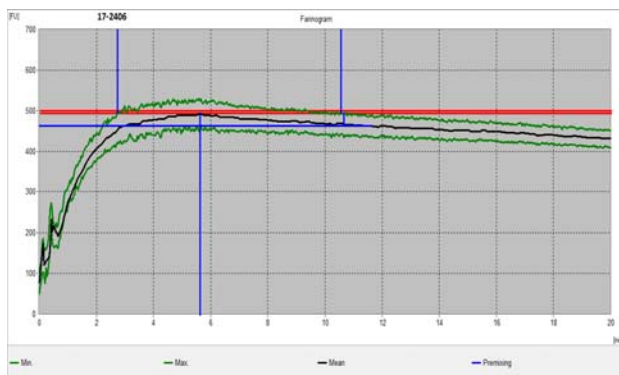
Water abs = 68.7%, Peak time = 7.5 min
Mix stab = 8.8 min, MTI = 24 FU

Mixograms

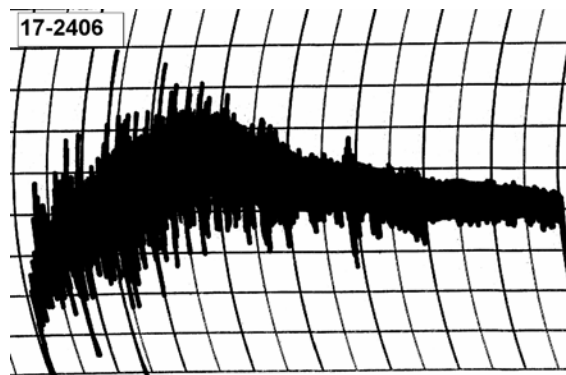


Water abs = 69.6%
Mix time = 3.1 min

17-2405, Jagalene (CC02)



Water abs = 66.2%, Peak time = 5.7 min,
Mix stab = 7.8 min, MTI = 27 FU



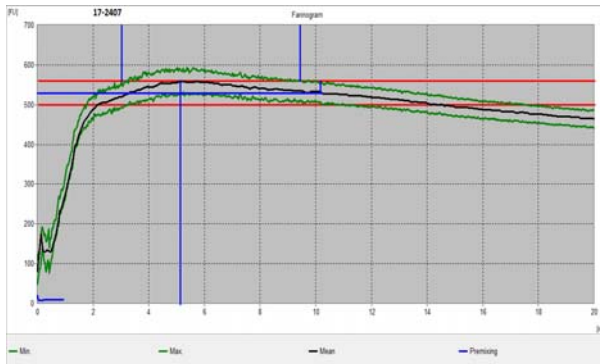
Water abs = 67.7%
Mix time = 2.6 min

17-2406, TAM 111

Physical Dough Tests

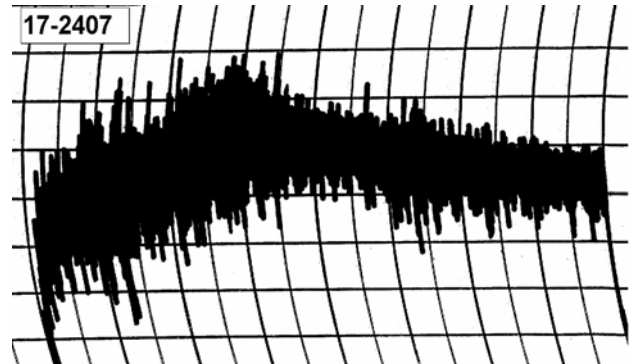
2017 (Small Scale) Samples – Texas (continued)

Farinograms



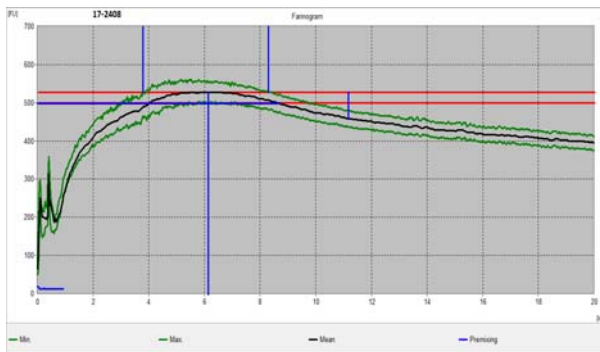
Water abs. = 77.7%, Peak time = 5.2 min,
Mix stab = 6.4 min, MTI = 28 FU

Mixograms

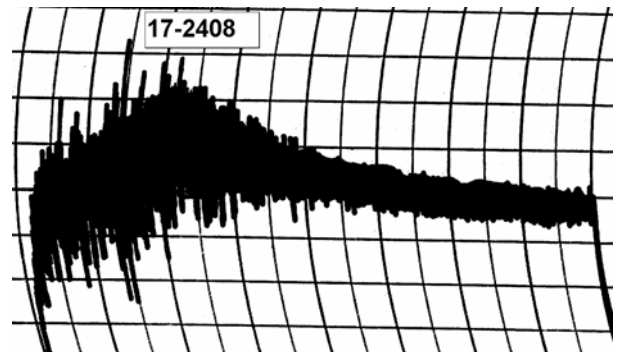


Water abs = 68.5%
Mix time = 3.0 min

17-2407, TX11A001295



Water abs. = 70.0%, Peak time = 6.2 min,
Mix stab = 4.5 min, MTI = 70 FU

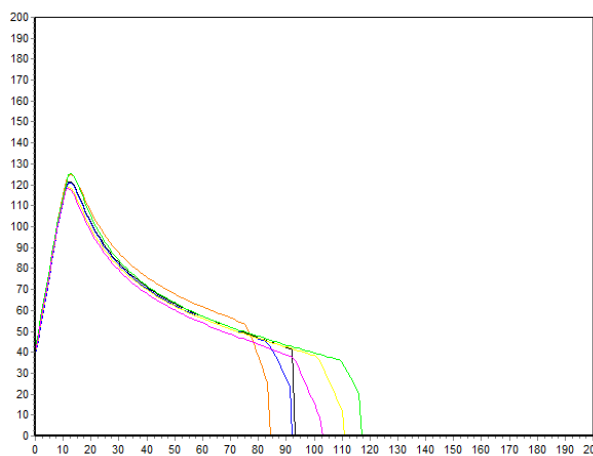


Water abs = 66.5%
Mix time = 2.3 min

17-2408, TX12M4068

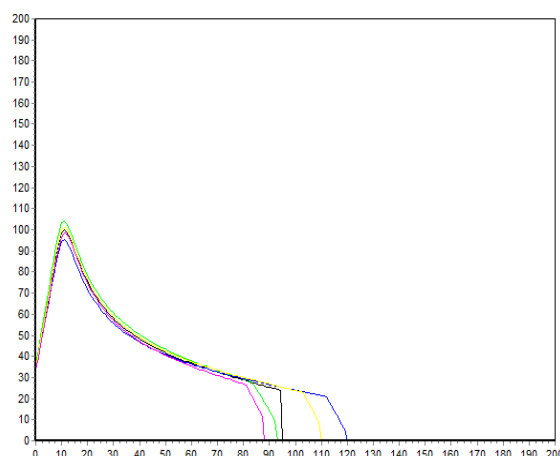
Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Texas



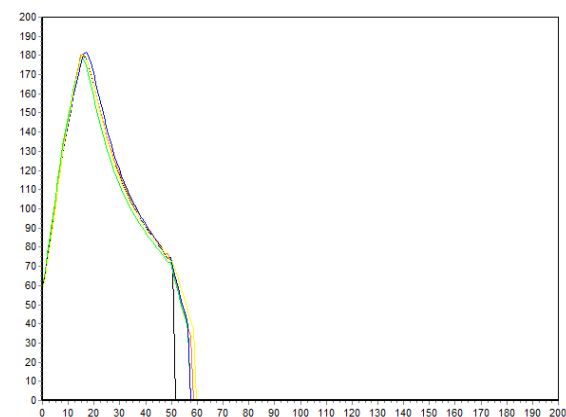
17-2405, Jagalene (CC02)

P (mm H₂O) = 134, L (mm) = 93, W (10E⁻⁴J) = 422



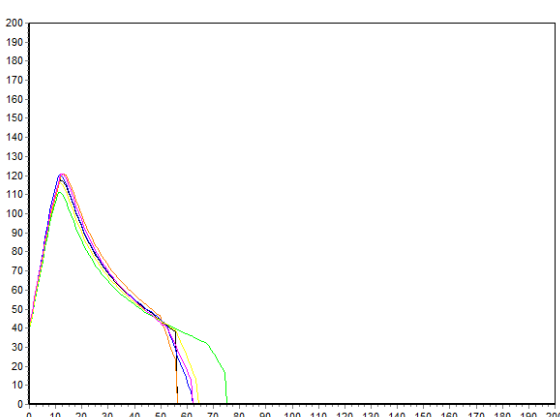
17-2406, TAM 111

P (mm H₂O) = 110, L (mm) = 95, W (10E⁻⁴J) = 303



17-2407, TX11A001295

P (mm H₂O) = 198, L (mm) = 51, W (10E⁻⁴J) = 391

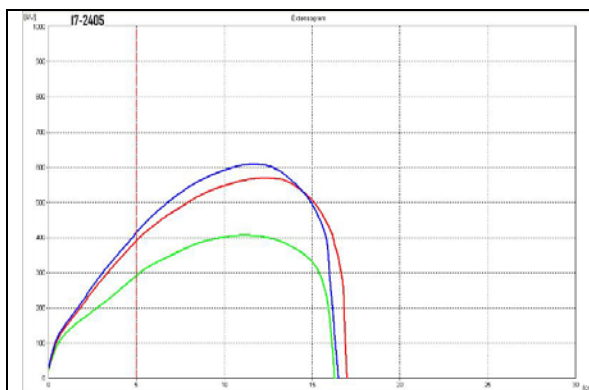


17-2408, TX12M4068

P (mm H₂O) = 130, L (mm) = 56, W (10E⁻⁴J) = 260

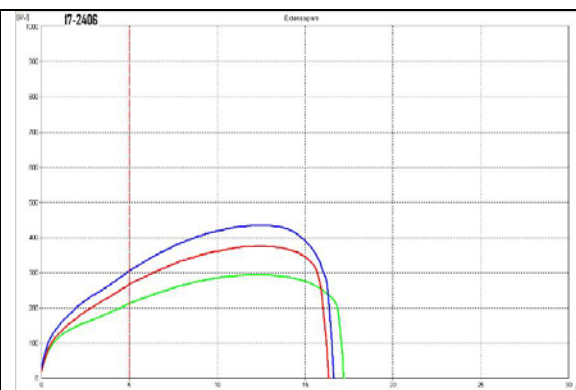
Physical Dough Tests - Extensigraph

2017 (Small Scale) Samples – Texas



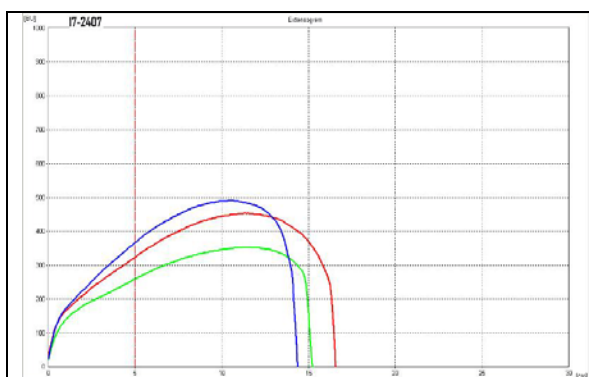
17-2405, Jagalene (CC02)

R (BU) = 395, E (mm) = 170, W (cm²) = 128
Rmax (BU) = 570, Ratio = 2.3 at 90 min



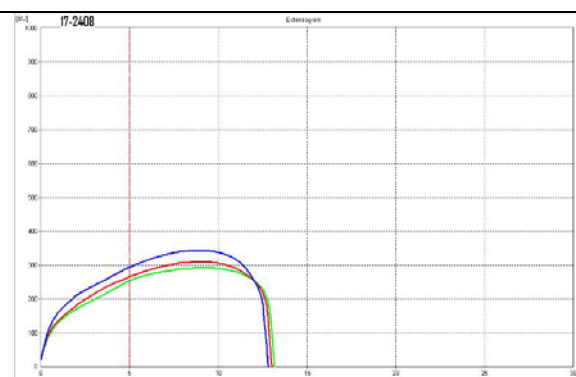
17-2406, TAM 111

R (BU) = 269, E (mm) = 165, W (cm²) = 84
Rmax (BU) = 377, Ratio = 1.6 at 90 min



17-2407, TX11A001295

R (BU) = 325, E (mm) = 167, W (cm²) = 101
Rmax (BU) = 453, Ratio = 2.0 at 90 min

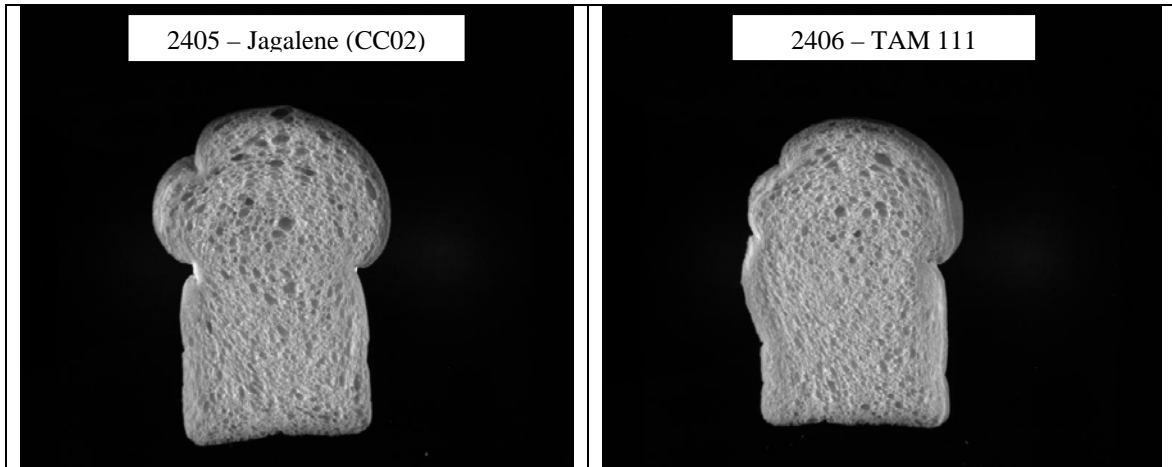


17-2408, TX12M4068

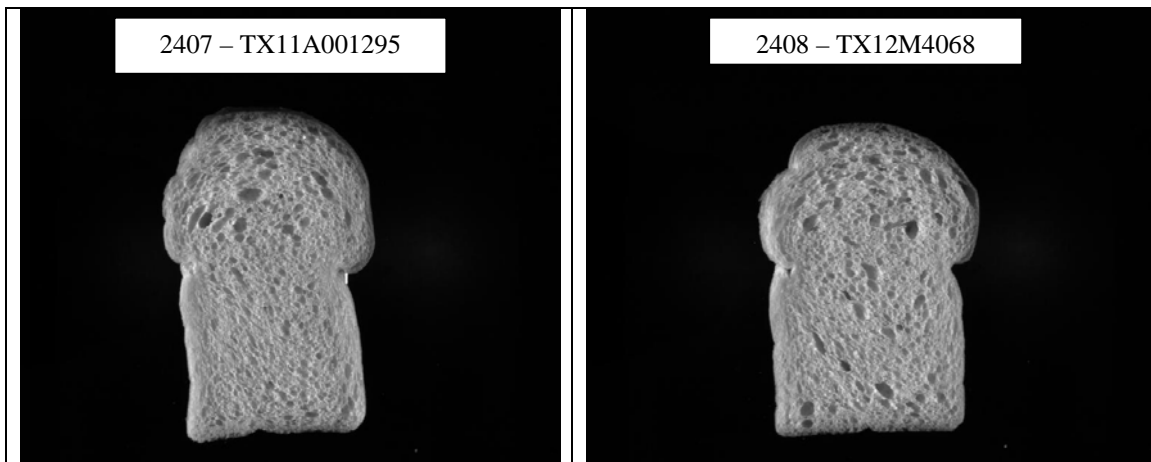
R (BU) = 267, E (mm) = 132, W (cm²) = 57
Rmax (BU) = 310, Ratio = 2.0 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm²) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Texas: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2405	6222	139.4	3887	0.443	2.084	3.856	1.683	-16.18
2406	5685	145.9	3895	0.431	1.868	1.586	1.625	-21.48



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2407	6166	138.4	3949	0.441	2.005	3.050	1.673	-31.73
2408	5963	140.0	3852	0.443	2.010	1.548	1.635	-23.88

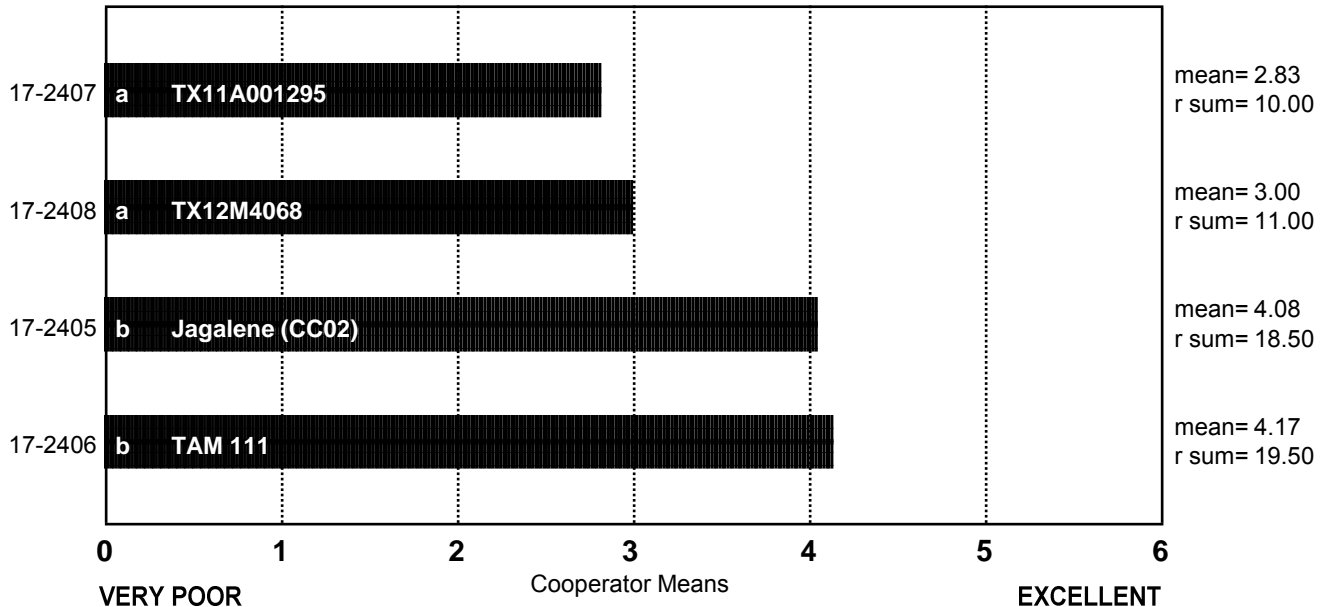
SPONGE CHARACTERISTICS

(Small Scale) Texas

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.

ncoop= 6
chisq= 4.35
chisqc= 724.50
cvchisq= 7.82
crdiff= 6.81



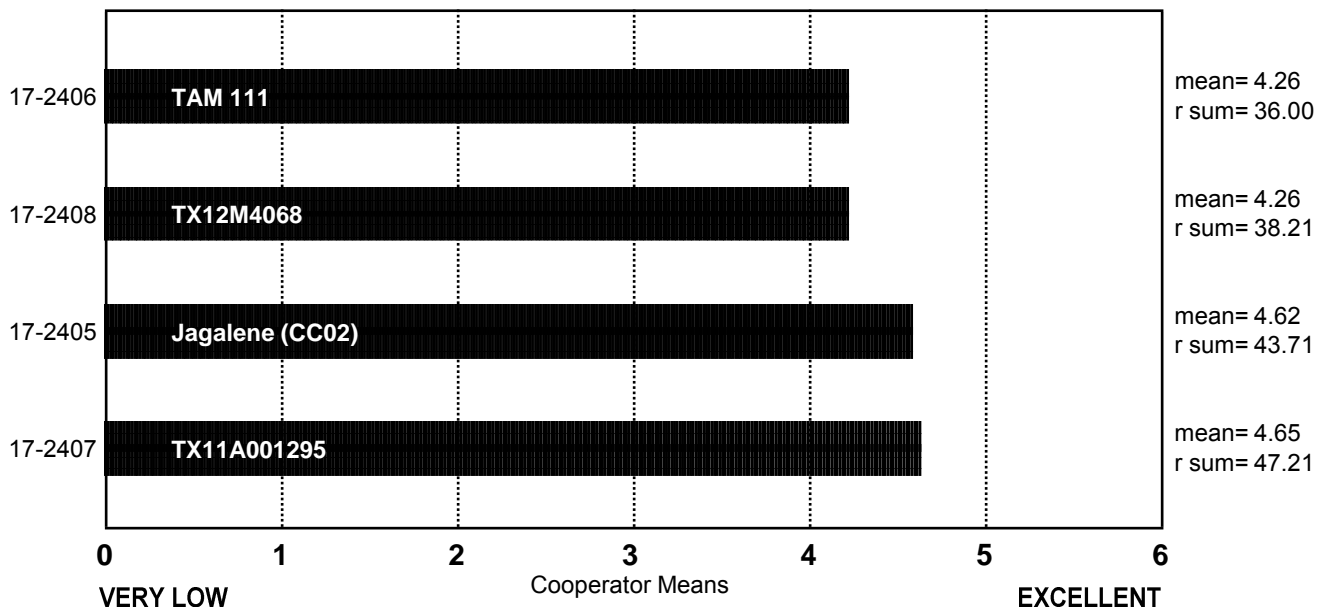
BAKE ABSORPTION

(Small Scale) Texas

Variety order by rank sum.

No samples different at 5.0% level of significance.

ncoop= 17
chisq= 259.51
chisqc= ?
cvchisq= 7.82
crdiff=



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Texas

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2405 Jagalone (CC02)	60.0	65.0	67.0	69.0	64.0	68.7	61.0	68.0	69.2	72.0	64.6	69.0	69.7	67.2	65.0	68.7	65.0
17-2406 TAM 111	59.0	65.0	64.8	67.0	63.8	66.2	61.0	64.0	69.2	73.3	64.6	67.0	66.9	67.2	64.0	67.6	60.9
17-2407 TX11A001295	59.0	65.0	70.1	76.5	65.1	66.0	64.0	65.0	80.7	72.6	64.5	69.2	77.4	68.2	64.5	72.9	64.2
17-2408 TX12M4068	60.0	65.0	68.2	70.0	64.0	66.0	62.0	65.0	73.0	74.2	63.3	67.5	69.8	71.2	65.8	67.2	60.5

BAKE MIX TIME, ACTUAL

(Small Scale) Texas

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2405 Jagalone (CC02)	8.0	12.0	11.0	7.0	3.0	7.0	20.0	3.0	5.0	3.8	4.5	2.6	2.5	4.5	2.9	3.4	4.0
17-2406 TAM 111	7.0	10.0	8.0	6.0	2.5	7.0	13.0	2.5	3.5	3.5	4.1	2.5	1.8	4.0	2.5	2.3	4.0
17-2407 TX11A001295	7.0	13.0	8.0	6.0	3.0	9.0	10.0	2.5	4.0	4.0	4.1	2.7	2.0	4.4	2.8	3.5	4.0
17-2408 TX12M4068	5.0	7.0	8.0	6.0	2.5	7.0	7.0	2.3	4.0	3.3	3.9	2.1	1.8	3.1	2.2	2.8	4.0

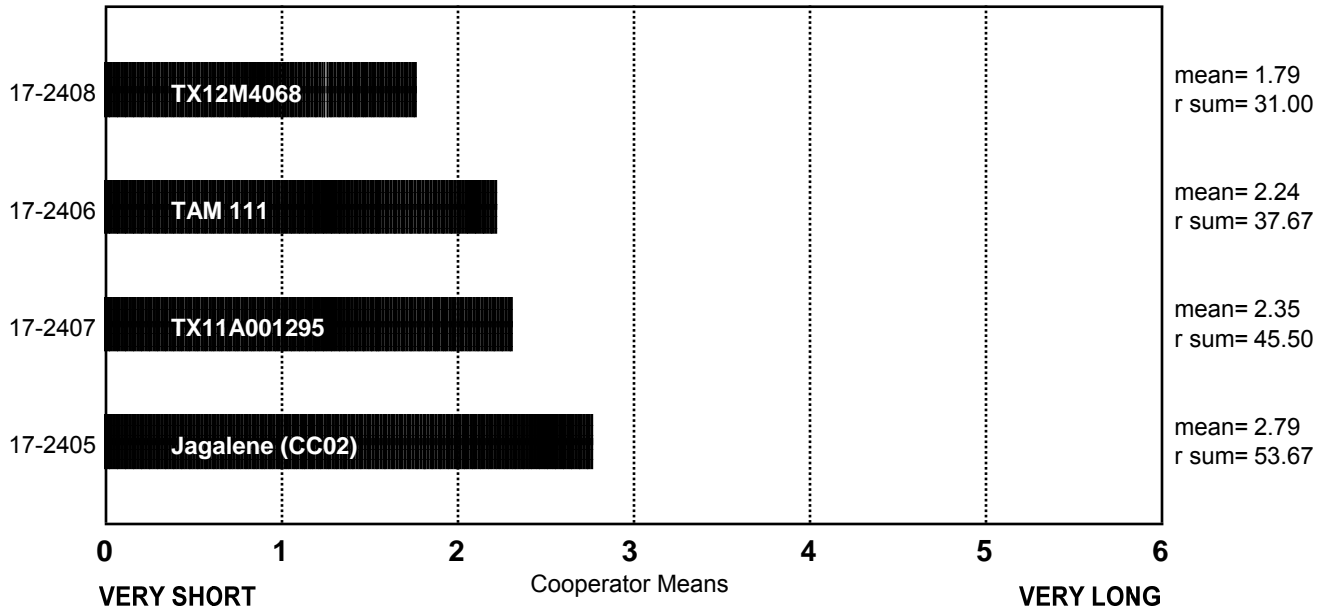
BAKE MIX TIME

(Small Scale) Texas

ncoop= 17
 chisq= 287.12
 chisqc= ?
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



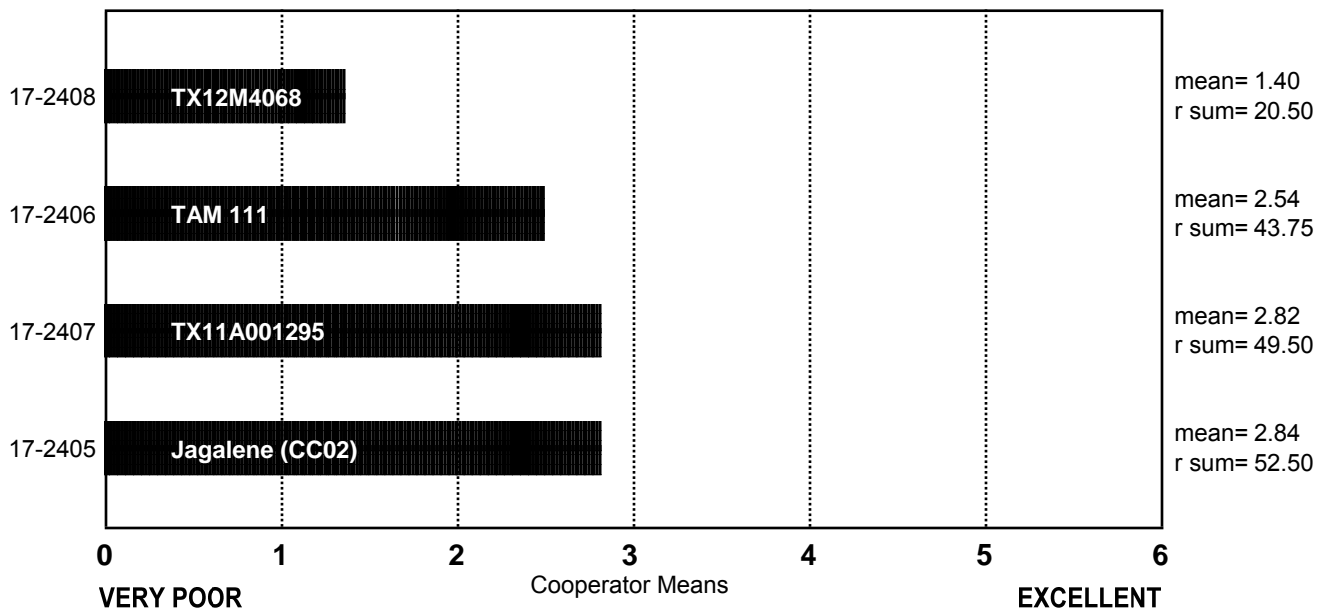
MIXING TOLERANCE

(Small Scale) Texas

ncoop= 17
 chisq= 283.61
 chisqc= ?
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



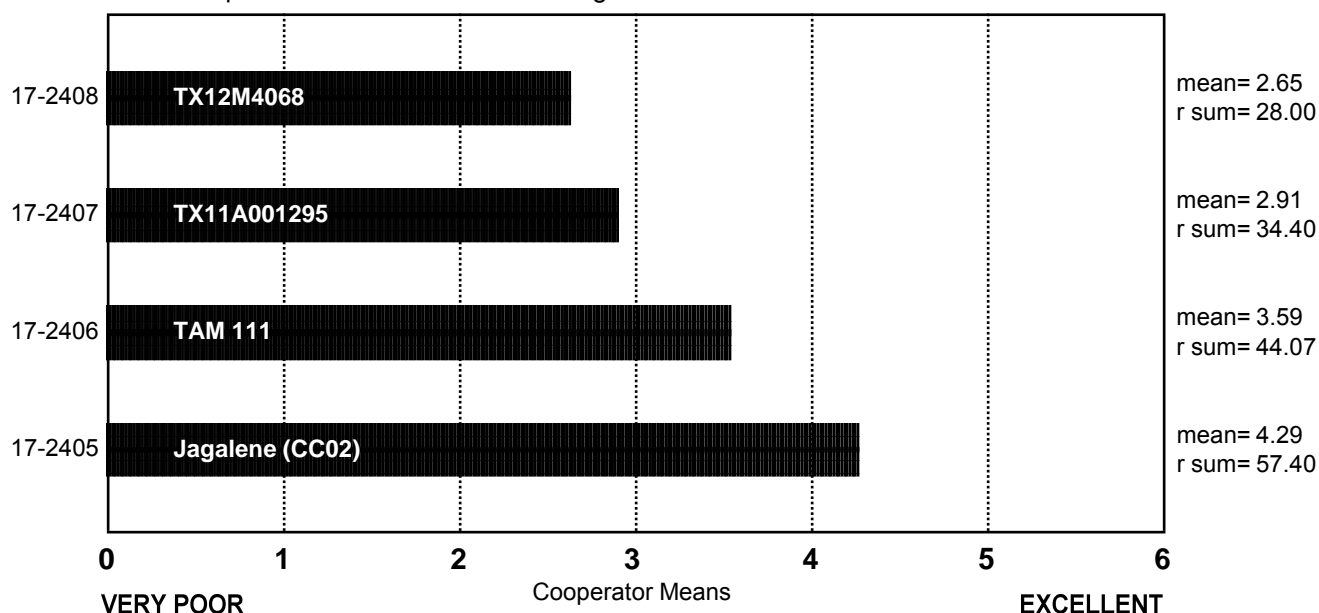
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Texas

ncoop= 17
chisq= 275.97
chisqc= ?
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Texas

	Sticky	Wet	Tough	Good	Excellent
17-2405 Jagalene (CC02)	1	2	2	11	1
17-2406 TAM 111	5	2	3	7	0
17-2407 TX11A001295	6	1	5	5	0
17-2408 TX12M4068	8	0	5	4	0

Frequency Table

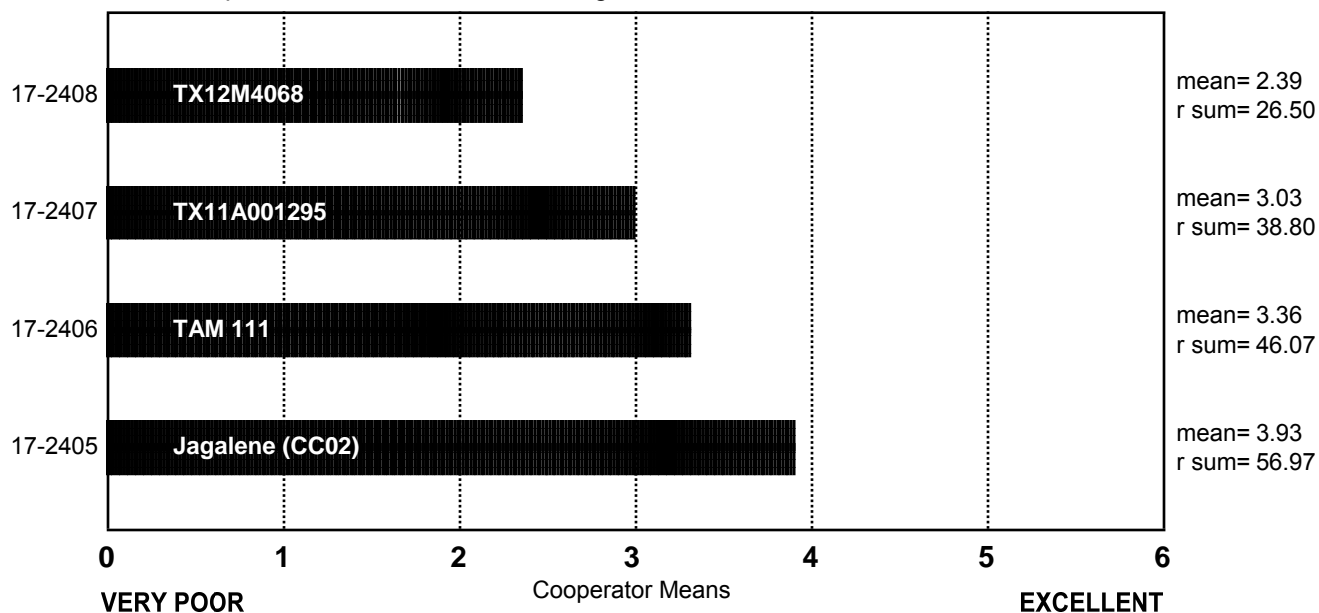
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Texas

ncoop= 17
chisq= 273.39
chisqc= ?
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Texas

	Sticky	Wet	Tough	Good	Excellent
17-2405 Jagalene (CC02)	2	1	2	9	3
17-2406 TAM 111	5	3	1	7	1
17-2407 TX11A001295	3	3	5	6	0
17-2408 TX12M4068	9	0	3	5	0

Frequency Table

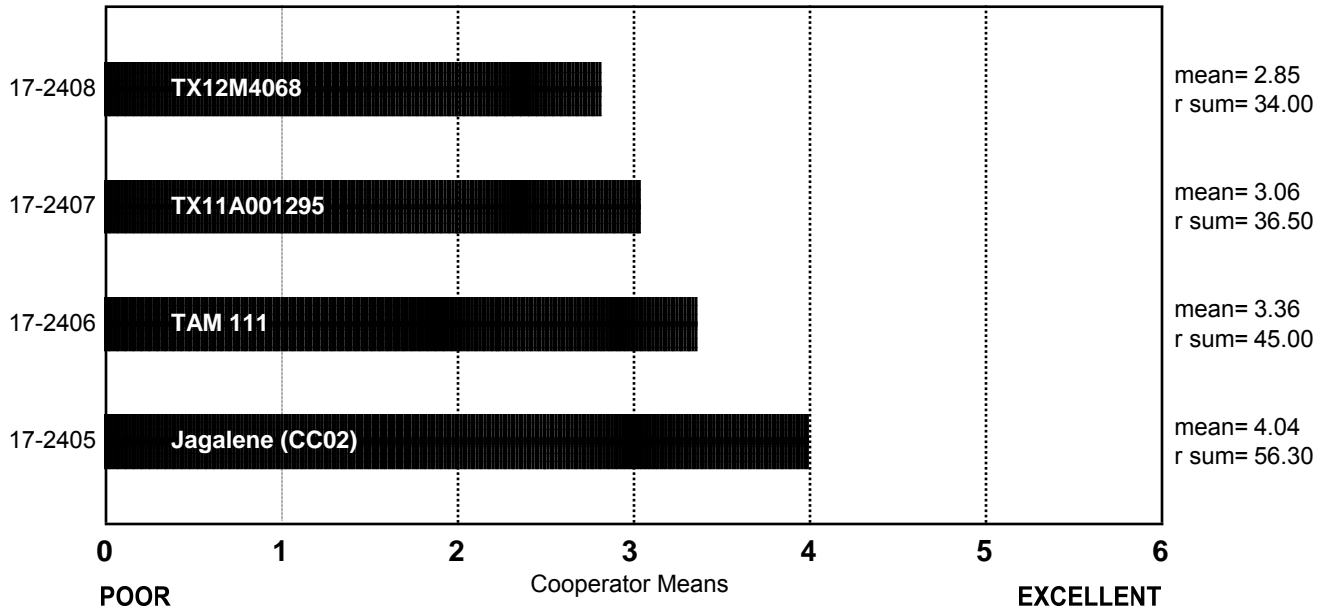
CRUMB GRAIN

(Small Scale) Texas

ncoop= 17
 chisq= 268.69
 chisqc= ?
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Texas

	Open	Fine	Dense
17-2405 Jagalene (CC02)	8	6	3
17-2406 TAM 111	9	4	4
17-2407 TX11A001295	11	2	4
17-2408 TX12M4068	13	3	1

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Texas

	Round	Irregular	Elongated
17-2405 Jaglene (CC02)	1	7	9
17-2406 TAM 111	8	4	5
17-2407 TX11A001295	9	5	3
17-2408 TX12M4068	11	4	2

Frequency Table

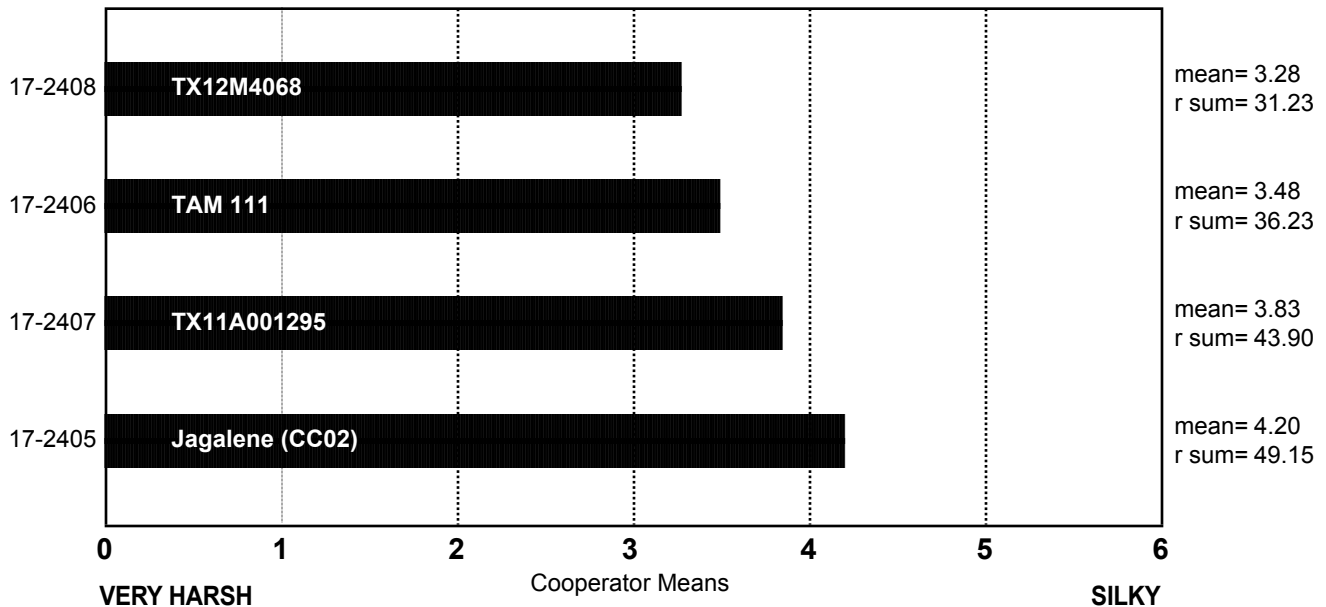
CRUMB TEXTURE

(Small Scale) Texas

ncoop= 16
 chisq= 248.84
 chisqc= ?
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Texas

	Harsh	Smooth	Silky
17-2405 Jagalene (CC02)	0	12	5
17-2406 TAM 111	8	5	4
17-2407 TX11A001295	3	12	2
17-2408 TX12M4068	6	9	2

Frequency Table

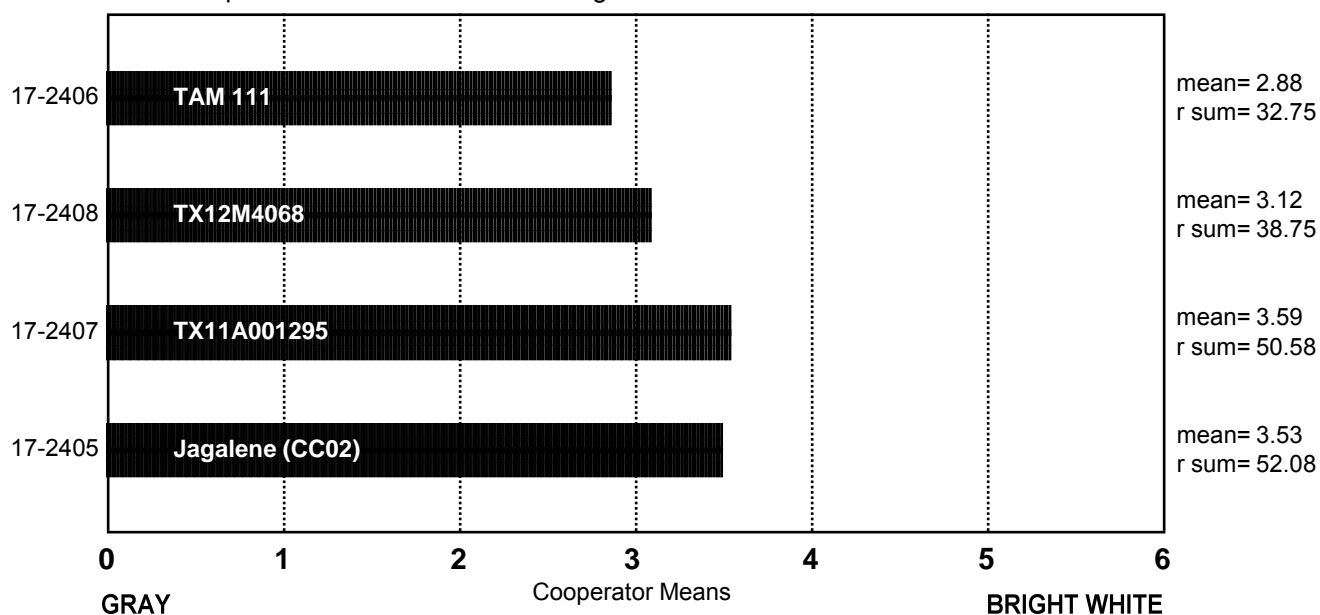
CRUMB COLOR

(Small Scale) Texas

ncoop= 17
 chisq= 267.21
 chisqc= ?
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Texas

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2405 Jagalene (CC02)	0	0	5	3	8	1	0
17-2406 TAM 111	0	1	5	10	0	0	0
17-2407 TX11A001295	0	0	2	5	9	0	1
17-2408 TX12M4068	0	1	7	3	5	0	1

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Texas

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2405 Jagalene (CC02)	410.0	462.7	428.0	447.0	144.2	451.0		147.4	447.1	134.3	142.8	150.3	138.7	154.2	138.1	153.5	476.6
17-2406 TAM 111	410.0	464.8	423.0	444.0	147.2	453.6		144.1	447.7	141.9	143.4	149.9	141.1	155.1	140.7	154.1	484.7
17-2407 TX11A001295	409.0	464.5	434.0	439.0	147.5	453.5		148.9	436.7	141.2	146.3	151.3	144.6	159.4	138.9	160.2	483.3
17-2408 TX12M4068	409.0	465.9	423.0	444.0	144.6	455.0		145.7	443.0	141.1	141.6	151.3	142.1	153.8	138.9	153.6	482.4

LOAF VOLUME, ACTUAL

(Small Scale) Texas

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2405 Jaqalene (CC02)	2925	2238	2650	2500	965	2693	2868	825	2200	1070	1050	880	922	1023	905	955	2525
17-2406 TAM 111	2575	2175	2500	2350	785	2623	2662	715	2350	910	910	785	665	958	758	840	2300
17-2407 TX11A001295	2825	2188	2900	2625	880	2455	2868	615	1950	825	870	750	822	925	794	925	2550
17-2408 TX12M4068	2950	2113	2375	2400	860	2620	2691	750	2100	940	910	740	737	875	842	845	2513

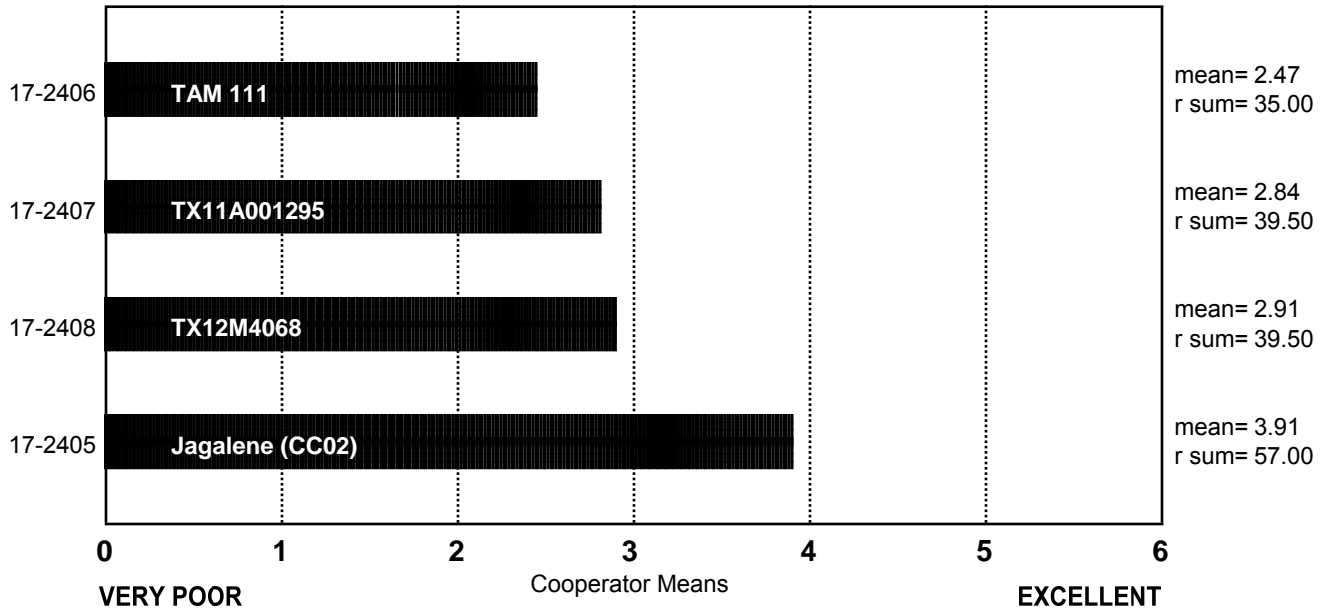
LOAF VOLUME

(Small Scale) Texas

ncoop= 17
chisq= 271.62
chisqc= ?
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



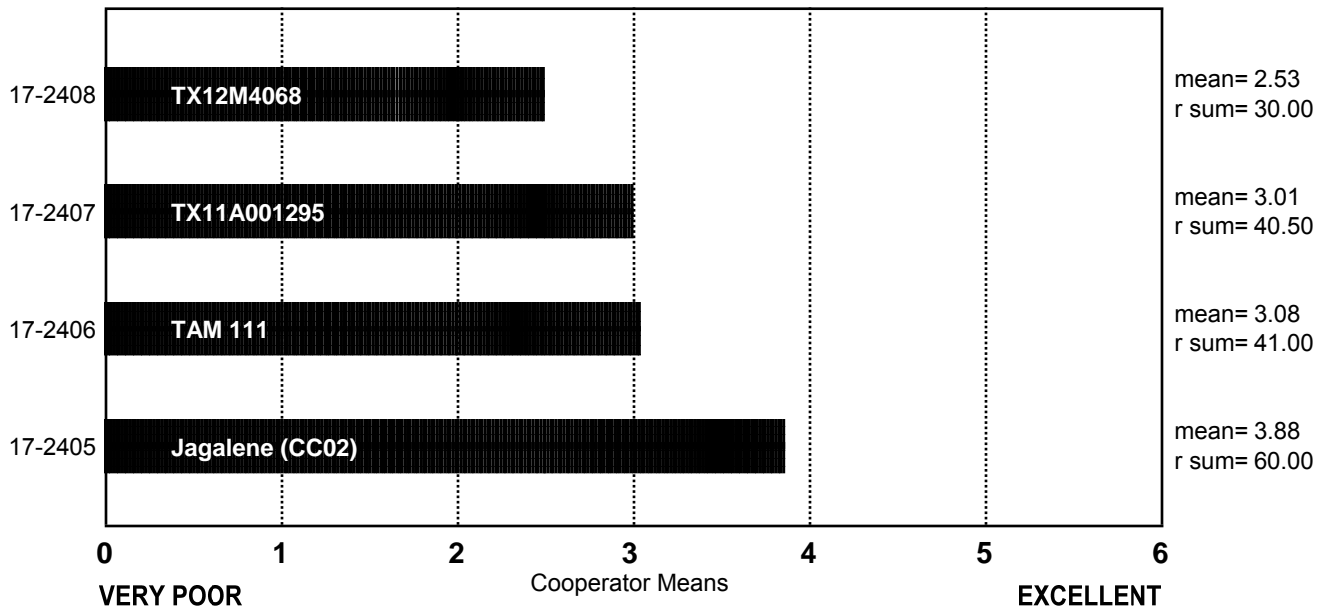
OVERALL BAKING QUALITY

(Small Scale) Texas

ncoop= 17
chisq= 275.33
chisqc= ?
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



COOPERATOR'S COMMENTS

(Small Scale) Texas

COOP.

17-2405 Jagalene (CC02)

- A. No comment.
- B. No comment.
- C. Good recovery during intermediate fermentation time (from mixing to makeup).
- D. Wild break and shred.
- E. Excellent loaf externals, dark crust.
- F. Soft dough.
- G. Good absorption, mix strength and fair volume.
- H. Good absorption.
- I. Crust was darker in color.
- J. Nice loaf, good color.
- K. High water absorption, normal mix time, slight sticky & strong dough, very high volume, slight yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Very good protein, weaker, poor loaf volume.
- M. No comment.
- N. Good volume performance for protein and reasonable crumb grain. Dough strength somewhat questionable.
- O. No comment.
- P. Weak mixograph tolerance but loaf had good absorption and mix time, good dough feel, satisfactory crumb grain.
- Q. High absorption, tough dough, fine grain, yellow color, average volume.

COOP.

17-2406 TAM 111

- A. No comment.
- B. No comment.
- C. Dough handling was good but the bread performance was not.
- D. No comment.
- E. Cap.
- F. No comment.
- G. Fair absorption, mix strength and low volume.
- H. Shorter mix.
- I. Best of the set, good volume.
- J. Nice texture, average volume.
- K. High water absorption, normal mix time, slight sticky & weak dough, high volume, yellow crumb, open elongated cells with keyhole, resilient & slight harsh texture.
- L. Good protein, short mix, weaker, poor loaf volume, poor color.
- M. No comment.
- N. Adequate volume performance but weak dough strength produced weak looking crumb grain.
- O. No comment.
- P. Weak mixograph tolerance, short bake mix time, weak dough but not sticky, Questionable – Satisfactory crumb grain, low loaf volume for flour protein.
- Q. Nice dough, average grain, dark yellow color, very low volume.

COOP.**17-2407 TX11A001295**

- A. No comment.
- B. No comment.
- C. Weak dough & poor performance, partial break down.
- D. Wild break and shred. Open, soft, smooth and bright white crumb. Bake absorption did not coincide with farinograph absorption.
- E. Nice loaf externals, dark crust.
- F. No comment.
- G. Good absorption, low mix strength and fair volume.
- H. Good absorption, shorter mix, poor loaf volume.
- I. Sponge was overflowing, very sticky from beginning to end; sides of the loaf gave in and collapsed some, poor volume.
- J. No comment.
- K. High water absorption, normal mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
- L. Good protein but poor loaf volume.
- M. No comment.
- N. Short mixing dough but relatively tolerant, crumb grain somewhat weak looking, OK volume.
- O. No comment.
- P. Weak mixograph tolerance, high bake absorption, medium mix time, sticky dough at pan, excellent loaf volume, Questionable – Satisfactory crumb grain, good flour protein.
- Q. High absorption, poor mixing tolerance, sticky dough out of mixer, very poor grain, yellow color, good volume.

COOP.**17-2408 TX12M4068**

- A. No comment.
- B. No comment.
- C. Very sticky, partial break down, very poor performance for high protein flour (13.6%).
- D. Wild break and shred. Open, soft, smooth and bright white crumb. Bake absorption did not coincide with farinograph absorption.
- E. Dark crust.
- F. No comment.
- G. Good absorption, very low mix strength and volume.
- H. Good absorption.
- I. Sponge was overflowing, wet and sticky, trouble getting dough through the sheeter.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & weak dough, high volume, yellow crumb, open round cells with keyhole, resilient & slight harsh texture.
- L. Very good protein, short mix, weak, unacceptable loaf volume, rough and poorer color.
- M. Difficult to cut – tough, thick exterior.
- N. Weak dough, very poor loaf volume, weaker looking crumb grain.
- O. No comment.
- P. Weak mixograph, good bake absorption, short bake mix time, weak dough, low loaf volume with dark crust, crumb grain 3.0.
- Q. Poor mixing tolerance with sticky dough, open grain, yellow color, and average volume.

Notes: **A, C, D, G, I and Q** conducted sponge and dough bake tests

COLORADO

17-2409	Byrd
17-2410	CO12D1770
17-2411	Jagalene (CC03)
17-2412	CO13D1783
17-2413	CO12D2011

Description of Test Plots and Breeder Entries

Colorado – Scott Haley

Growing Location & Conditions

The Wheat Quality Council samples from Colorado originated from strip increases grown under dryland conditions at the USDA-ARS Central Great Plains Research Station at Akron, CO. The field with the strip increases, including adjacent breeding and extension trials, was fertilized with a pre-plant application of 50 lbs N (applied as 46-0-0). The planting date was 9/12/16 and the harvest date was 7/7/17.

Growing conditions included: planting into good moisture with rain on the day after planting; average stand establishment; very dry from mid-October through mid-March; consistent and significant rainfall from late March through mid-June; growing degree-day accumulation was 10 days ahead of average by early May; adjacent variety trials and breeding nurseries showed significant infection of stripe and leaf rusts and mite-transmitted viruses (wheat streak mosaic virus, High Plains mosaic virus), and a few Russian wheat aphids; the field was not sprayed with either fungicide or insecticide.

Grain yields of the adjacent state extension variety trial (UVPT) were very high due to the abundant moisture, averaging 92.4 bu/a with an average test weight of 58.9 lb/bu. Average grain protein concentration of the group of 13 strips harvested for potential WQC submission was 11.0% with a range of 10.2% to 12.2% (12% moisture basis).

Jagalene (check) – common check

Byrd (check) – local check

Byrd is a hard red winter wheat (HRW) released by Colorado State University in 2011. Byrd was tested in the 2010 WQC sample set under experimental number CO06424 and has been included as our check since 2012. Byrd has shown good milling and baking quality characteristics, including particularly strong dough mixing properties, high loaf volume, and good crumb grain scores. Byrd is marketed by the Colorado Wheat Research Foundation (CWRF) under the *PlainsGold*[™] brand. In 2017, and for the third straight year, Byrd was the most widely grown wheat cultivar in Colorado (24.7% of total acreage).

CO12D1770

CO12D1770 is a doubled-haploid HRW experimental line from the cross Denali/Antero//Byrd made in 2011. CO12D1770 is medium-short and medium maturing, and has a medium-length coleoptile, good straw strength, and very high test weight. CO12D1770 is resistant to stripe rust, moderately resistant to both leaf rust and stem rust, susceptible to Hessian fly and all biotypes of Russian wheat aphid, moderately resistant to wheat streak mosaic virus, and moderately susceptible to wheat soilborne mosaic virus. The reaction of CO12D1770 to Fusarium head blight is not known.

Across 28 site-years in the CSU Elite Trial (2015-2017), grain yield of CO12D1770 was the highest entry in the trials, about 2% higher than Langin, 4% higher than Byrd, and 5% higher than Antero hard white winter wheat (HWW). In the 2017 CSU Uniform Variety Performance trial, grain yield of CO12D1770 was the fifth highest entry in the trials, about 14% above trial

average. In the 2017 Southern Regional Performance Nursery (SRPN), CO12D1770 was the second highest yielding entry in the trial.

CO12D1770 has shown good overall milling and baking properties in tests conducted in the CSU Wheat Quality Lab. Compared to Byrd, CO12D1770 has similar SKCS kernel weight, higher Brabender quadrumat senior flour yield, similar mixograph peak time and tolerance, similar SRC water absorption, and similar loaf volume and crumb grain scores. CO12D1770 is on foundation seed increase in 2018 with the intent to release as a new cultivar in fall 2018.

CO13D1783

CO13D1783 is a doubled-haploid HRW experimental line from the cross CO08W218/Snowmass//Byrd made in 2012 (CO08W218 = KS01HW152-6/G001011W). CO13D1783 is medium height and later maturing, and has a medium-length coleoptile, fair straw strength, and average test weight. CO13D1783 is moderately resistant to stripe rust and stem rust, moderately susceptible to leaf rust, susceptible to Hessian fly and all biotypes of Russian wheat aphid, moderately resistant to wheat streak mosaic virus, and resistant to wheat soilborne mosaic virus. The reaction of CO13D1783 to Fusarium head blight is not known.

Across 20 site-years in the CSU Elite Trial (2016-2017), grain yield of CO13D1783 was the highest entry in the trials, about 3% higher than Langin, 4% higher than CO12D1770, 5% higher than Byrd, and 7% higher than Antero. In the 2017 CSU Uniform Variety Performance trial, grain yield of CO13D1783 was the highest entry in the trials, about 17% above trial average. In the 2017 Southern Regional Performance Nursery (SRPN), CO13D1783 was the 19th highest yielding entry in the trial.

CO13D1783 has shown good overall milling and baking properties in tests conducted in the CSU Wheat Quality Lab. Compared to Byrd, CO13D1783 has similar SKCS kernel weight, lower Brabender quadrumat senior flour yield, similar mixograph peak time and tolerance, higher SRC water absorption, and similar loaf volume and crumb grain scores. CO13D1783 is on a limited foundation seed increase in 2018 with the intent to release as a new cultivar in fall 2018.

CO12D2011 (released as “Breck”)

CO12D2011 is a doubled-haploid HWW line from the cross Denali/HV9W07-482W//Antero made in 2011 (HV9W07-482W = KS01HW163-4/KS01HW168-4). CO12D2011 was released as “Breck” in fall 2017 and will be marketed by the Colorado Wheat Research Foundation (CWRF) under the *PlainsGold*[™] brand in the CWRF-Ardent Mills Ultragrain[™] Premium Program.

CO12D2011 is medium height and medium-early maturing, and has a medium-length coleoptile, good straw strength, very high test weight, and very good pre-harvest sprouting tolerance. CO12D2011 is resistant to stripe rust and stem rust, moderately susceptible to leaf rust, susceptible to Hessian fly and all biotypes of Russian wheat aphid, intermediate to wheat streak mosaic virus, and susceptible to wheat soilborne mosaic virus. The reaction of CO12D2011 to Fusarium head blight is not known.

Across 28 site-years in the CSU Elite Trial (2015-2017), grain yield of CO12D2011 was 101% of trial average, about 1% lower than Antero HWW, 3% higher than Snowmass HWW, and 4% higher than Sunshine HWW. Across 16 site-years in the CSU Uniform Variety Performance Trial (2016-2017), grain yield of CO12D2011 was 7% above trial average, about 3% lower than Antero HWW, 4% higher than Sunshine HWW, and 6% higher than Snowmass HWW. In the 2017 Southern Regional Performance Nursery (SRPN), CO12D2011 was the 5th highest yielding entry in the trial.

CO12D2011 has shown good overall milling and baking properties in tests conducted in the CSU Wheat Quality Lab. Compared to Sunshine HWW, CO12D2011 has lower SKCS kernel weight, higher Brabender quadrumat senior total and break flour yield, lower mixograph peak time and tolerance, similar SRC water absorption, lower L-Dopa polyphenol oxidase (PPO) activity, and similar loaf volume and crumb grain scores.

Colorado: 2017 (Small-Scale) Samples

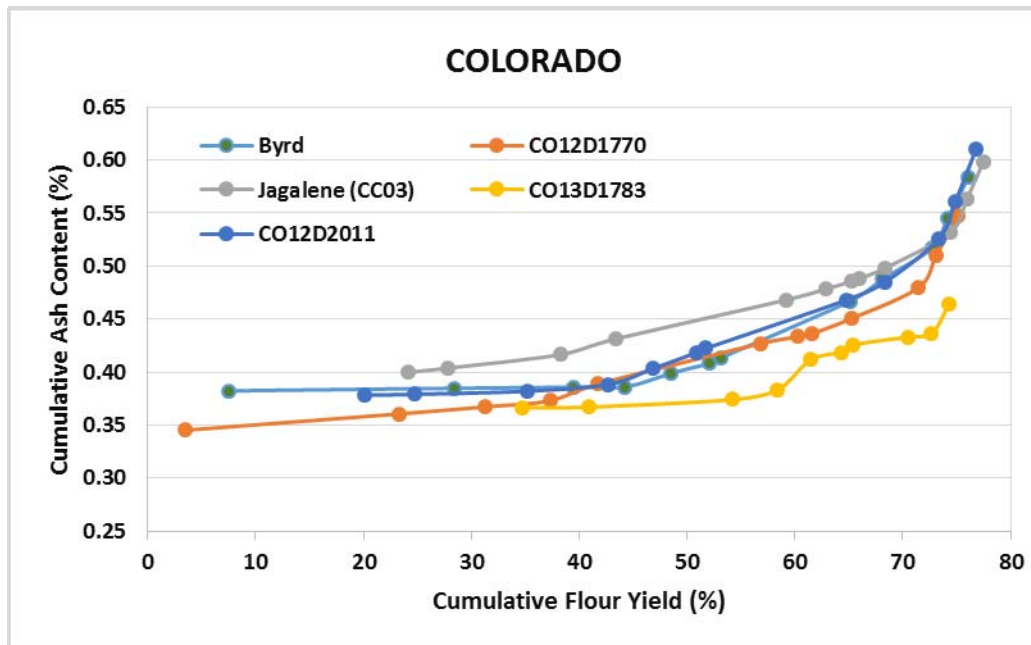
Test entry number	17-2409	17-2410	17-2411	17-2412	17-2413
Sample identification	Byrd	CO12D1770	Jagalene (CC03)	CO13D1783	CO12D2011
Wheat Data					
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW	1 HDWH
Test weight (lb/bu)	62.1	63.8	62.9	60.5	64.6
Hectoliter weight (kg/hl)	81.7	83.8	82.7	79.6	84.9
1000 kernel weight (gm)	29.0	28.9	29.2	27.8	30.5
Wheat kernel size (Rotap)					
Over 7 wire (%)	63.9	55.7	57.6	46.0	57.1
Over 9 wire (%)	35.6	44.1	42.2	53.6	42.7
Through 9 wire (%)	0.5	0.2	0.2	0.4	0.2
Single kernel (skcs) ^a					
Hardness (avg /s.d)	65.8/18.2	71.9/15.4	77.9/15.0	74.6/14.4	73.0/15.8
Weight (mg) (avg/s.d)	29.0/9.4	28.9/7.9	29.2/7.8	27.8/7.6	30.5/10.6
Diameter (mm)(avg/s.d)	2.45/0.36	2.42/0.30	2.58/0.30	2.41/0.28	2.47/0.32
Moisture (%) (avg/s.d)	9.7/0.6	9.4/0.6	9.0/0.6	9.7/0.5	9.4/0.6
SKCS distribution	02-12-18-66-01	02-05-12-81-01	01-02-09-88-01	01-03-11-85-01	01-04-15-80-01
Classification	Hard	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	10.9	11.5	12.5	11.6	13.2
Wheat ash (12% mb)	1.57	1.46	1.51	1.58	1.54
Milling and Flour Quality Data					
Flour yield (% , str. grade)					
Miag Multomat Mill	76.1	75.3	77.6	74.3	76.9
Quadrumat Sr. Mill	69.5	69.4	68.3	65.6	66.8
Flour moisture (%)	13.3	13.3	12.7	12.9	13.1
Flour protein (14% mb)	9.5	10.1	11.0	10.2	11.4
Flour ash (14% mb)	0.56	0.48	0.57	0.49	0.56
Rapid Visco-Analyser					
Peak time (min)	6.2	6.5	6.3	6.4	6.6
Peak viscosity (RVU)	221.7	227.3	182.6	204.8	253.6
Breakdown (RVU)	79.5	58.8	57.5	51.0	59.8
Final viscosity at 13 min (RVU)	259.9	283.0	227.8	269.5	284.8
Minolta color meter					
L*	91.55	92.15	91.10	91.81	91.75
a*	-1.48	-1.51	-1.53	-1.57	-1.24
b*	9.55	8.99	9.85	9.87	8.82
PPO	0.439	0.424	0.377	0.404	0.490
Falling number (sec)	427	421	393	412	450
Damaged Starch					
(AI%)	97.6	97.3	98.3	97.6	96.0
(AACC76-31)	7.6	7.4	8.2	7.6	6.3

^as.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Colorado: Physical Dough Tests and Gluten Analysis 2017 (Small-Scale) Samples

Test Entry Number	17-2409	17-2410	17-2411	17-2412	17-2413
Sample Identification	Byrd	CO12D1770	Jagalene (CC03)	CO13D1783	CO12D2011
MIXOGRAPH					
Flour Abs (% as-is)	61.1	62.6	65.0	62.9	65.5
Flour Abs (14% mb)	60.1	61.7	63.3	61.7	64.5
Mix Time (min)	4.1	4.5	3.4	6.0	4.3
Mix tolerance (0-6)	4	4	1	5	3
FARINOGRAPH					
Flour Abs (% as-is)	58.0	60.4	63.8	62.8	66.4
Flour Abs (14% mb)	57.1	59.5	62.1	61.6	65.5
Peak time (min)	6.1	6.5	6.0	5.8	7.7
Mix stability (min)	12.0	13.0	6.4	15.8	12.1
Mix Tolerance Index (FU)	24	20	39	19	20
Breakdown time (min)	12.8	14.1	9.2	15.1	15.9
ALVEOGRAPH					
P(mm): Tenacity	83	98	97	126	113
L(mm): Extensibility	78	58	71	54	75
G(mm): Swelling index	19.7	17.0	18.8	16.4	19.3
W(10 ⁻⁴ J): strength (curve area)	226	222	241	275	296
P/L: curve configuration ratio	1.06	1.69	1.37	2.33	1.51
le(P ₂₀₀ /P): elasticity index	54.3	57.2	52.0	58.8	54.3
EXTENSIGRAPH					
Resist (BU at 45/90/135 min)	377/432/567	361/512/575	286/378/445	525/773/867	294/374/397
Extensibility (mm at 45/90/135 min)	143/132/117	138/129/115	144/149/143	130/110/95	172/166/155
Energy (cm ² at 45/90/135 min)	96/95/108	88/111/101	70/100/109	115/124/113	96/120/114
Resist _{max} (BU at 45/90/135min)	520/563/732	485/674/700	360/513/580	716/892/997	415/557/567
Ratio (at 45/90/135 min)	2.6/3.3/4.8	2.6/4.0/5.0	2.0/2.5/3.1	4.0/7.1/9.2	1.7/2.3/2.6
PROTEIN ANALYSIS					
HMW-GS Composition	2*,5+10,7+8	1,5+10,7+8	2*,1,5+10,17+18	2*,5+10,7+8	1,5+10,7 ^{oe} +8
TMP/TPP	1.00	0.79	0.97	0.89	0.87
SEDIMENTATION TEST					
Volume (ml)	43.6	47.6	50.6	56.3	50.0

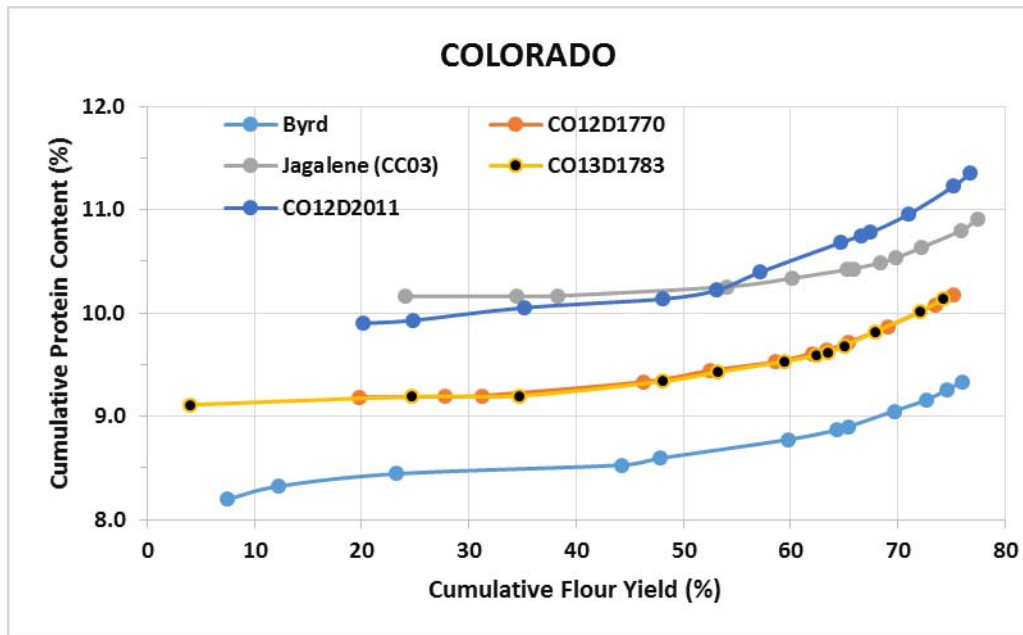
Colorado: Cumulative Ash Curves



Byrd					CO12D1770					Jagalene (CC03)				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
1BK	7.5	0.38	7.5	0.38	1M Red	3.5	0.35	3.5	0.35	2M	24.1	0.40	24.1	0.40
2M	21.0	0.39	28.5	0.38	2M	19.8	0.36	23.3	0.36	1M Red	3.8	0.43	27.9	0.40
1M	11.0	0.39	39.5	0.39	1M	7.9	0.39	31.2	0.37	1M	10.4	0.45	38.3	0.42
1M Red	4.8	0.39	44.3	0.39	1BK	6.1	0.40	37.3	0.37	1BK	5.1	0.54	43.3	0.43
2BK	4.3	0.53	48.6	0.40	2BK	4.4	0.52	41.8	0.39	3M	15.8	0.57	59.2	0.47
Grader	3.6	0.54	52.1	0.41	3M	15.1	0.53	56.9	0.43	2BK	3.7	0.64	62.8	0.48
FILTER FLR	1.1	0.67	53.2	0.41	Grader	3.4	0.54	60.2	0.43	Grader	2.5	0.68	65.3	0.49
3M	11.9	0.70	65.1	0.47	FILTER FLR	1.4	0.58	61.6	0.44	FILTER FLR	0.6	0.73	66.0	0.49
3BK	3.1	0.93	68.2	0.49	3BK	3.7	0.69	65.3	0.45	3BK	2.3	0.77	68.3	0.50
4M	4.6	0.95	72.7	0.52	4M	6.2	0.79	71.4	0.48	4M	6.1	0.91	74.4	0.53
BRAN FLR	1.4	1.96	74.1	0.54	BRAN FLR	1.7	1.82	73.1	0.51	BRAN FLR	1.6	2.07	76.0	0.56
5M	1.9	2.09	76.1	0.58	5M	2.0	1.89	75.2	0.55	5M	1.5	2.34	77.4	0.60
Break Shorts	4.3	4.12	80.3	0.77	Break Shorts	3.6	3.59	78.7	0.69	Break Shorts	3.7	3.43	81.1	0.73
Red Dog	3.3	3.03	83.6	0.86	Red Dog	3.1	2.52	81.9	0.76	Red Dog	2.4	2.88	83.5	0.79
Red Shorts	0.8	3.70	84.4	0.89	Red Shorts	0.7	3.25	82.5	0.78	Red Shorts	0.4	3.45	83.9	0.80
Filter Bran	0.8	3.45	85.2	0.91	Filter Bran	0.6	3.70	83.1	0.80	Filter Bran	1.0	3.55	84.9	0.83
Bran	14.8	5.03	100.0	1.52	Bran	16.9	5.00	100.0	1.51	Bran	15.1	5.22	100.0	1.50
Wheat		1.47					1.37					1.42		
St. Grd. Fl.		0.56					0.48					0.57		

CO13D1783					CO12D2011				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	20.7	0.37	20.7	0.37	2M	20.1	0.38	20.1	0.38
1M Red	4.0	0.37	24.6	0.37	1M Red	4.7	0.38	24.8	0.38
1M	10.1	0.39	34.7	0.37	1M	10.4	0.39	35.2	0.38
1BK	6.1	0.44	40.8	0.38	1BK	7.5	0.42	42.7	0.39
3M	13.4	0.50	54.3	0.41	2BK	4.2	0.56	46.9	0.40
2BK	4.2	0.51	58.4	0.42	Grader	4.0	0.59	50.9	0.42
Grader	3.1	0.56	61.5	0.43	FILTER FLR	0.9	0.65	51.8	0.42
3BK	2.8	0.59	64.3	0.43	3M	13.0	0.65	64.7	0.47
FILTER FLR	1.1	0.63	65.4	0.44	3BK	3.6	0.78	68.3	0.48
4M	5.1	0.81	70.5	0.46	4M	5.0	1.09	73.3	0.53
BRAN FLR	2.2	1.38	72.7	0.49	BRAN FLR	1.6	2.21	74.9	0.56
5M	1.6	2.50	74.3	0.53	5M	1.9	2.54	76.8	0.61
Break Shorts	3.6	3.59	77.8	0.67	Break Shorts	3.9	4.28	80.7	0.79
Red Dog	2.1	2.97	79.9	0.74	Red Dog	2.8	3.10	83.5	0.86
Red Shorts	0.3	3.81	80.2	0.75	Red Shorts	0.5	3.76	84.0	0.88
Filter Bran	0.5	3.15	80.8	0.76	Filter Bran	1.5	3.72	85.4	0.93
Bran	19.2	5.13	100.0	1.60	Bran	14.6	5.61	100.0	1.61
Wheat		1.48					1.45		
St. Grd. Fl.		0.49					0.56		

Colorado: Cumulative Protein Curves



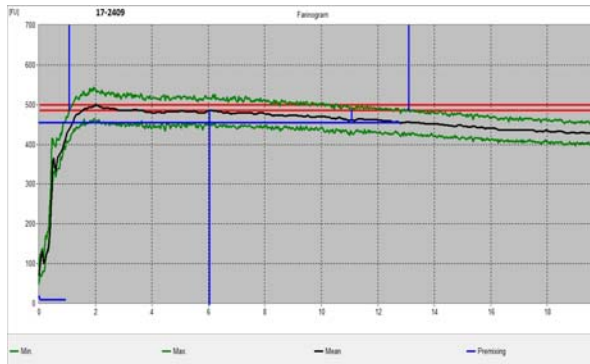
Byrd					CO12D1770					Jagalene (CC03)				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1BK	7.5	8.20	7.5	8.2	2M	19.8	9.19	19.8	9.2	2M	24.1	10.16	24.1	10.2
1M Red	4.8	8.52	12.3	8.3	1M	7.9	9.21	27.8	9.2	1M	10.4	10.17	34.5	10.2
1M	11.0	8.58	23.3	8.4	1M Red	3.5	9.28	31.2	9.2	1M Red	3.8	10.20	38.3	10.2
2M	21.0	8.62	44.3	8.5	3M	15.1	9.61	46.3	9.3	3M	15.8	10.47	54.1	10.3
Grader	3.6	9.41	47.8	8.6	1BK	6.1	10.26	52.4	9.4	4M	6.1	11.07	60.2	10.3
3M	11.9	9.50	59.7	8.8	4M	6.2	10.26	58.6	9.5	1BK	5.1	11.39	65.2	10.4
4M	4.6	10.07	64.3	8.9	Grader	3.4	10.99	62.0	9.6	FILTER FLR	0.6	11.46	65.9	10.4
FILTER FLR	1.1	10.83	65.4	8.9	FILTER FLR	1.4	11.12	63.4	9.6	Grader	2.5	11.95	68.4	10.5
2BK	4.3	11.39	69.6	9.1	5M	2.0	12.08	65.4	9.7	5M	1.5	12.78	69.9	10.5
3BK	3.1	11.66	72.7	9.2	3BK	3.7	12.59	69.1	9.9	3BK	2.3	13.63	72.2	10.6
5M	1.9	13.06	74.6	9.3	2BK	4.4	13.39	73.5	10.1	2BK	3.7	14.01	75.9	10.8
BRAN FLR	1.4	13.28	76.1	9.3	BRAN FLR	1.7	14.29	75.2	10.2	BRAN FLR	1.6	16.15	77.4	10.9
Break Shorts	4.3	13.14	80.3	9.5	Break Shorts	3.6	13.56	78.7	10.3	Break Shorts	3.7	14.40	81.1	11.1
Red Dog	3.3	12.63	83.6	9.7	Red Dog	3.1	12.94	81.9	10.4	Red Dog	2.4	12.99	83.5	11.1
Red Shorts	0.8	12.05	84.4	9.7	Red Shorts	0.7	12.82	82.5	10.4	Red Shorts	0.4	12.19	83.9	11.1
Filter Bran	0.8	11.46	85.2	9.7	Filter Bran	0.6	12.18	83.1	10.5	Filter Bran	1.0	11.15	84.9	11.1
Bran	14.8	14.75	100.0	10.4	Bran	16.9	13.59	100.0	11.0	Bran	15.1	15.33	100.0	11.8
Wheat		10.2					10.8					11.7		
St. Grd. Fl		9.5					10.1					11.0		

CO13D1783					CO12D2011				
Mill Streams	Strm-yld	Protein	Cumulative (14%)		Mill Streams	Strm-yld	Protein	Cumulative (14%)	
	(14%mb)		Yield	Protein		(14%mb)		Yield	Protein
1M Red	4.0	9.11	4.0	9.1	2M	20.1	9.90	20.1	9.9
2M	20.7	9.21	24.6	9.2	1M Red	4.7	10.06	24.8	9.9
1M	10.1	9.22	34.7	9.2	1M	10.4	10.34	35.2	10.1
3M	13.4	9.71	48.1	9.3	3M	13.0	10.37	48.1	10.1
4M	5.1	10.27	53.2	9.4	4M	5.0	11.04	53.2	10.2
1BK	6.1	10.42	59.4	9.5	Grader	4.0	12.70	57.1	10.4
Grader	3.1	10.72	62.4	9.6	1BK	7.5	12.86	64.7	10.7
FILTER FLR	1.1	11.21	63.5	9.6	5M	1.9	12.98	66.6	10.7
5M	1.6	12.45	65.1	9.7	FILTER FLR	0.9	13.14	67.5	10.8
3BK	2.8	12.89	67.9	9.8	3BK	3.6	14.35	71.1	11.0
2BK	4.2	13.21	72.1	10.0	2BK	4.2	15.83	75.2	11.2
BRAN FLR	2.2	13.99	74.3	10.1	BRAN FLR	1.6	17.35	76.8	11.4
Break Shorts	3.6	13.34	77.8	10.3	Break Shorts	3.9	14.56	80.7	11.5
Red Dog	2.1	12.53	79.9	10.3	Red Dog	2.8	13.30	83.5	11.6
Red Shorts	0.3	12.55	80.2	10.3	Red Shorts	0.5	13.05	84.0	11.6
Filter Bran	0.5	11.51	80.8	10.4	Filter Bran	1.5	14.17	85.4	11.6
Bran	19.2	15.27	100.0	11.3	Bran	14.6	15.68	100.0	12.2
Wheat		10.9					12.3		
St. Grd. Fl		10.2					11.4		

Physical Dough Tests

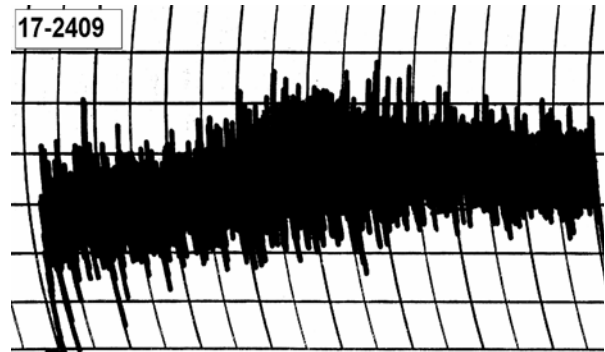
2017 (Small Scale) Samples - Colorado

Farinograms



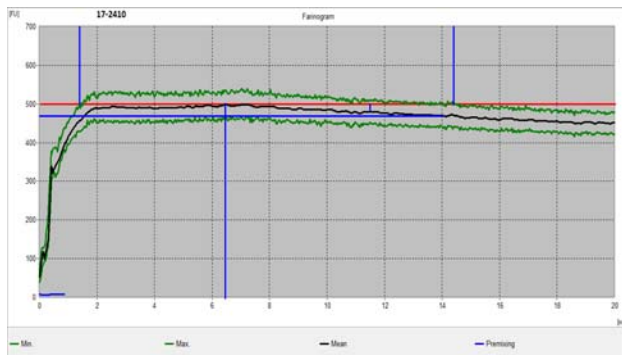
Water abs = 57.1%, Peak time = 6.1 min,
Mix stab = 12.0 min, MTI = 24 FU

Mixograms

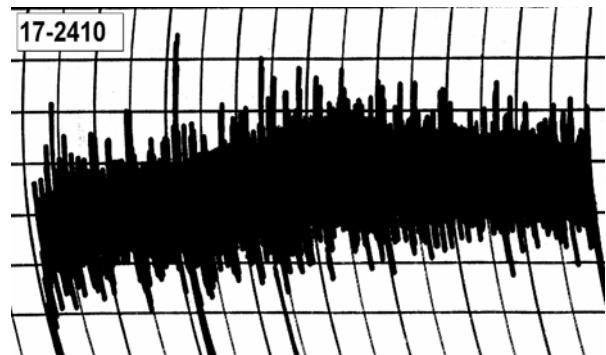


Water abs = 60.1%
Mix time = 4.1 min

17-2409, Byrd



Water abs = 59.5%, Peak time = 6.5 min,
Mix stab = 13.0 min, MTI = 20 FU



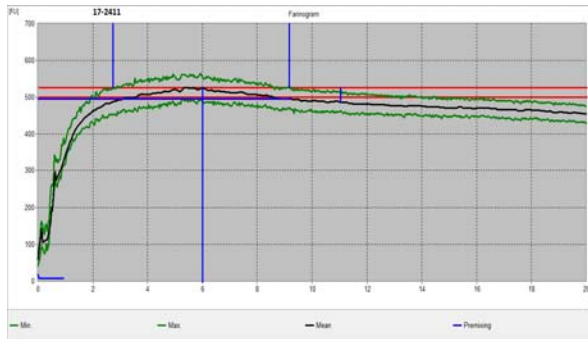
Water abs = 61.7%
Mix time = 4.5 min

17-2410, CO12D1770

Physical Dough Tests

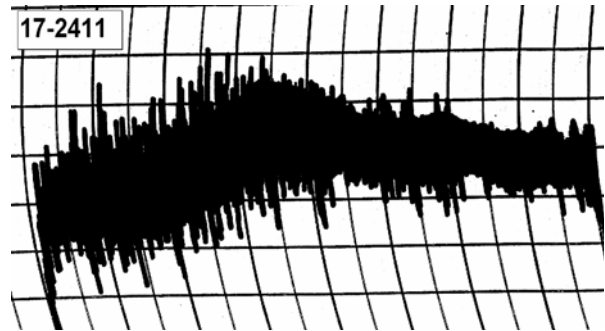
2017 (Small Scale) Samples - Colorado

Farinograms



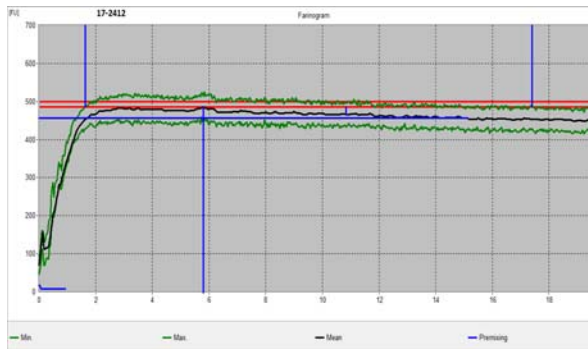
Water abs = 62.1%, Peak time = 6.0 min,
Mix stab = 6.4 min, MTI = 39 FU

Mixograms

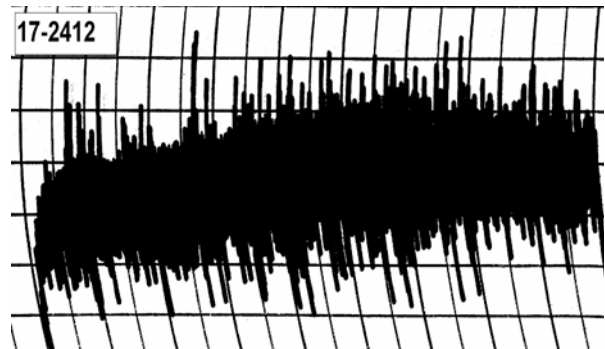


Water abs = 63.3%
Mix time = 3.4 min

17-2411, Jagalene (CC03)



Water abs = 61.6%, Peak time = 5.8 min,
Mix stab = 15.8 min, MTI = 19 FU



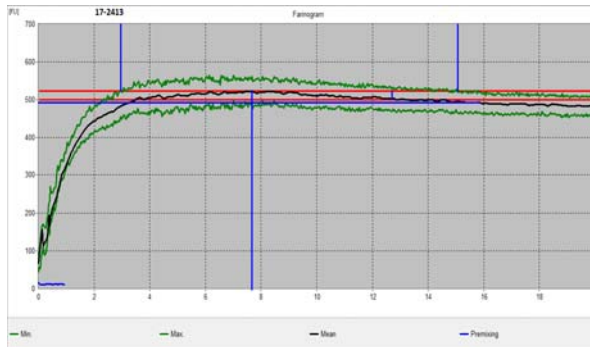
Water abs = 61.7%
Mix time = 6.0 min

17-2412, CO13D1783

Physical Dough Tests

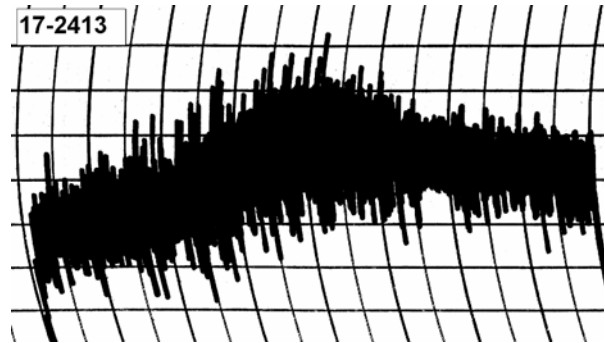
2017 (Small Scale) Samples - Colorado

Farinograms



Water abs = 65.5%, Peak time = 7.7 min,
Mix stab = 12.1 min, MTI = 20 FU

Mixograms

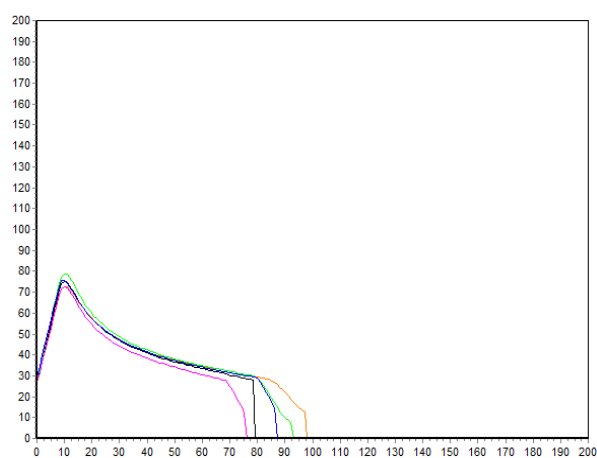


Water abs = 64.5%
Mix time = 4.3 min

17-2413, CO12D2011

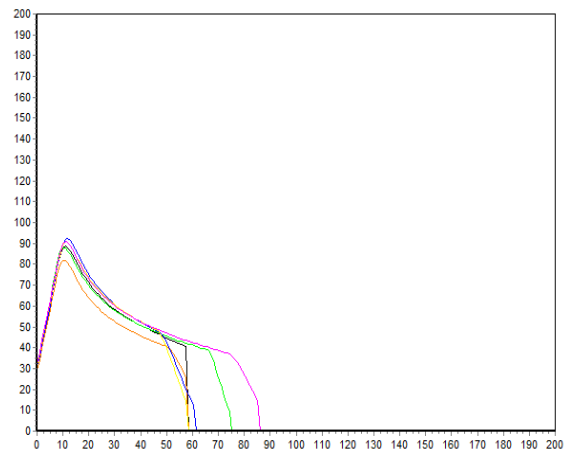
Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Colorado



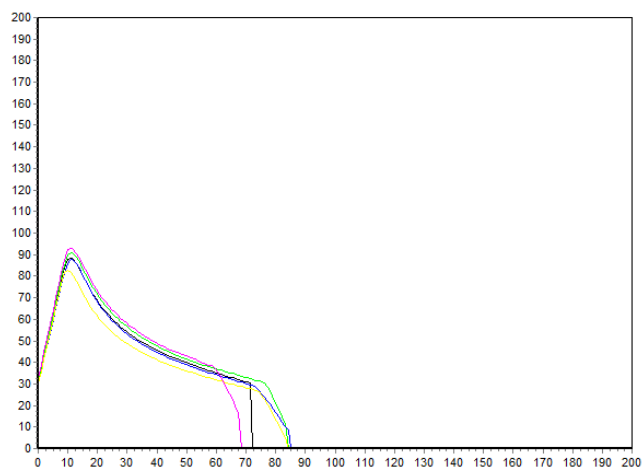
17-2409, BYRD

P(mm H₂O) = 83, L(mm) = 78, W(10E⁻⁴ J) = 226



17-2410, CO12D1770

P(mm H₂O) = 98, L(mm) = 58, W(10E⁻⁴ J) = 222

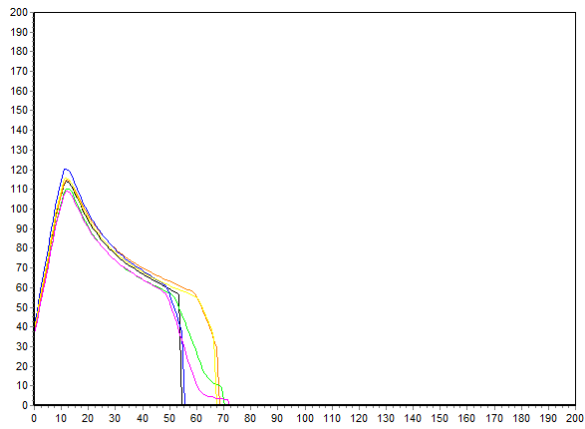


17-2411, Jagalene (CC03)

P(mm H₂O) = 97, L(mm) = 71, W(10E⁻⁴ J) = 241

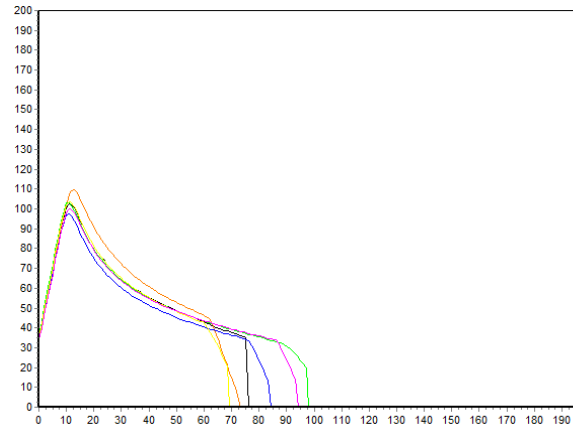
Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Colorado



17-2412, CO13D1783

P(mm H₂O) = 126, L(mm) = 54, W(10E⁻⁴ J) = 275

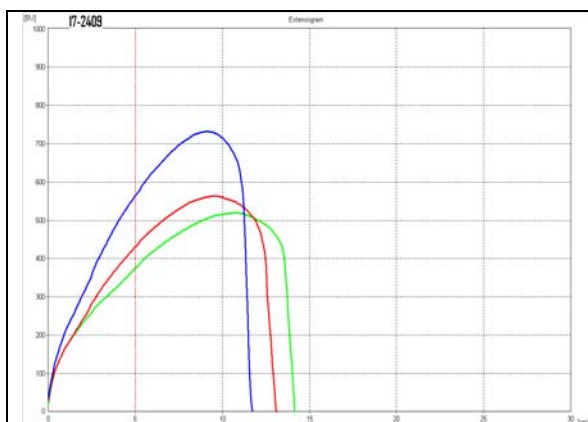


17-2413, CO12D2011

P(mm H₂O) = 113, L(mm) = 75, W(10E⁻⁴ J) = 296

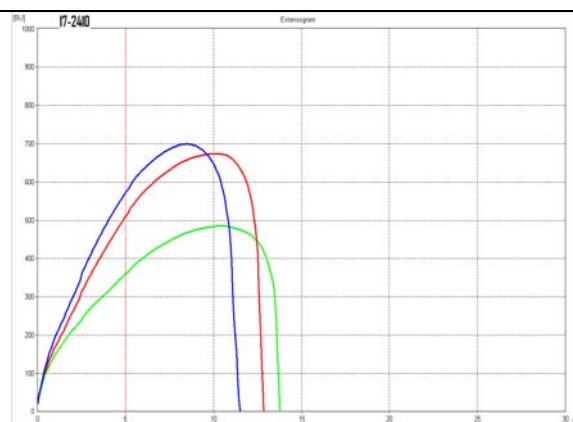
Physical Dough Tests - Extensigraph

2017 (Small Scale) Samples – Colorado



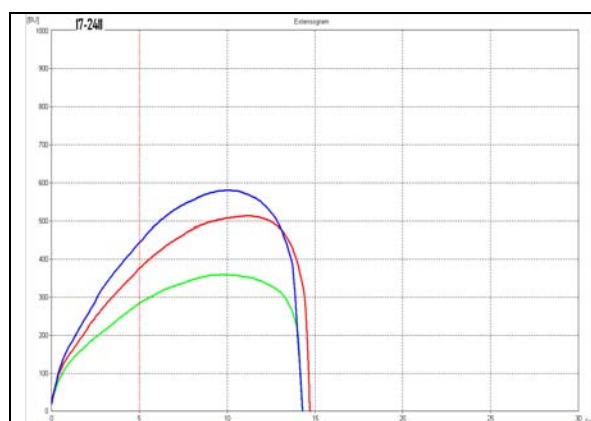
17-2409, BYRD

R (BU) = 432, E (mm) = 132, W (cm²) = 95
Rmax (BU) = 563, Ratio = 3.3 at 90 min



17-2410, CO12D1770

R (BU) = 512, E (mm) = 129, W (cm²) = 111
Rmax (BU) = 674, Ratio = 4.0 at 90 min



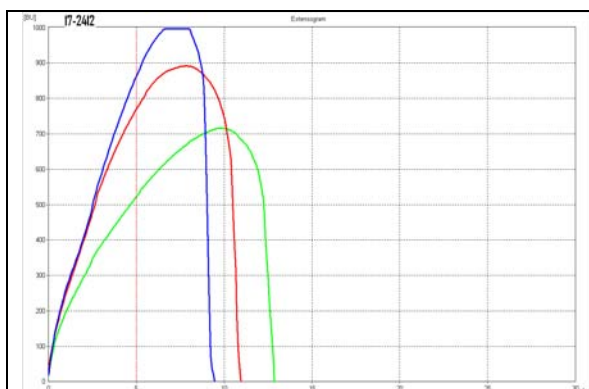
17-2411, Jagalene (CC03)

R (BU) = 378, E (mm) = 149, W (cm²) = 100
Rmax (BU) = 513, Ratio = 2.5 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm²) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

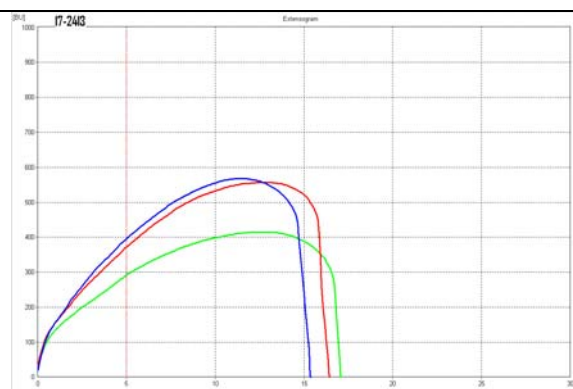
Physical Dough Tests - Extensigraph

2017 (Small Scale) Samples – Colorado



17-2412, CO13D1783

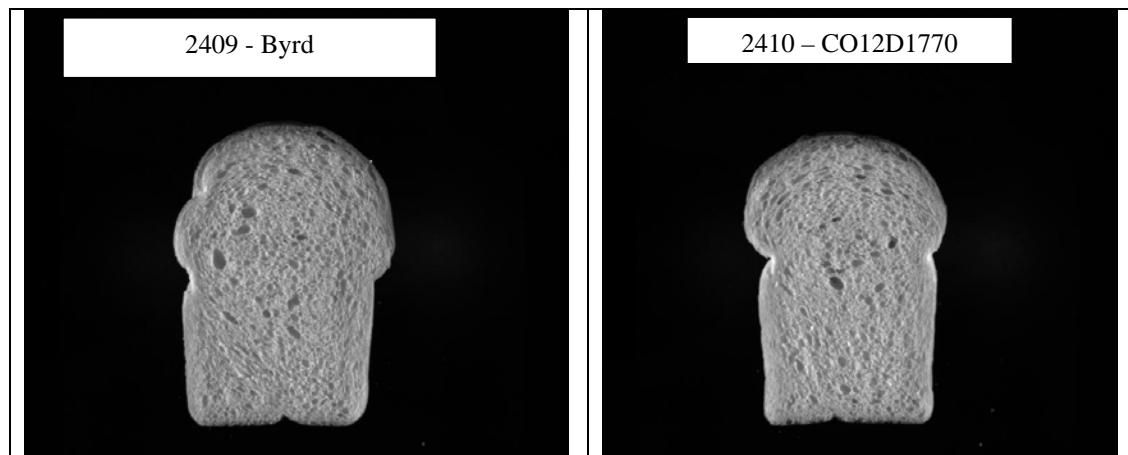
R (BU) = 773, E (mm) = 110, W (cm²) = 124
Rmax (BU) = 892, Ratio = 7.1 at 90 min



17-2413, CO12D2011

R (BU) = 374, E (mm) = 166, W (cm²) = 120
Rmax (BU) = 557, Ratio = 2.3 at 90 min

Colorado: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples

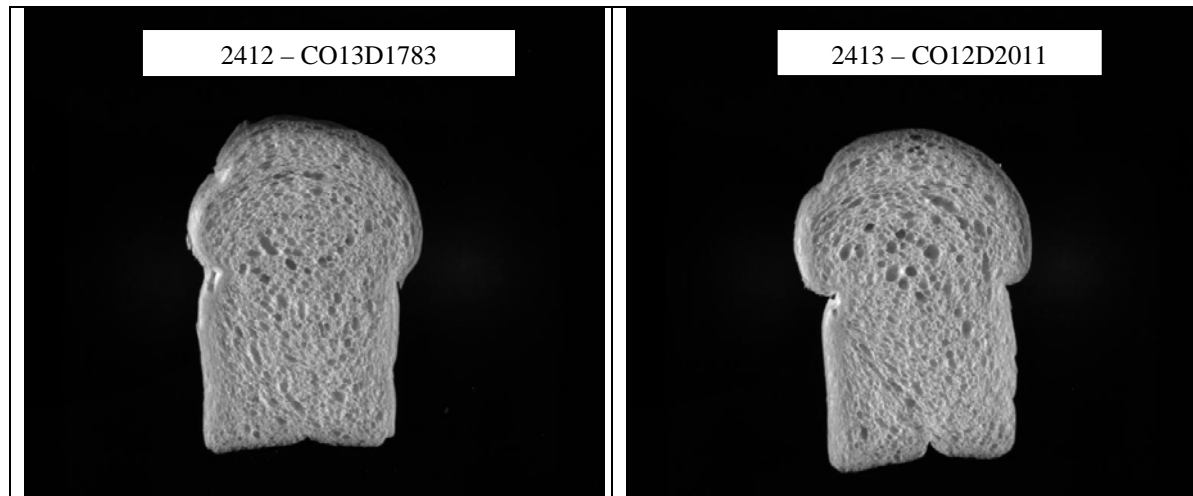


Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2409	5914	139.0	4143	0.426	1.702	2.406	1.693	-13.75
2410	5588	146.4	3994	0.427	1.759	5.118	1.675	-20.73



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2411	5959	138.1	4199	0.426	1.748	1.321	1.643	-10.80

Colorado: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2412	5908	138.2	4008	0.430	1.759	0.810	1.670	-35.75
2413	5749	144.9	3743	0.440	1.923	1.342	1.683	-19.55

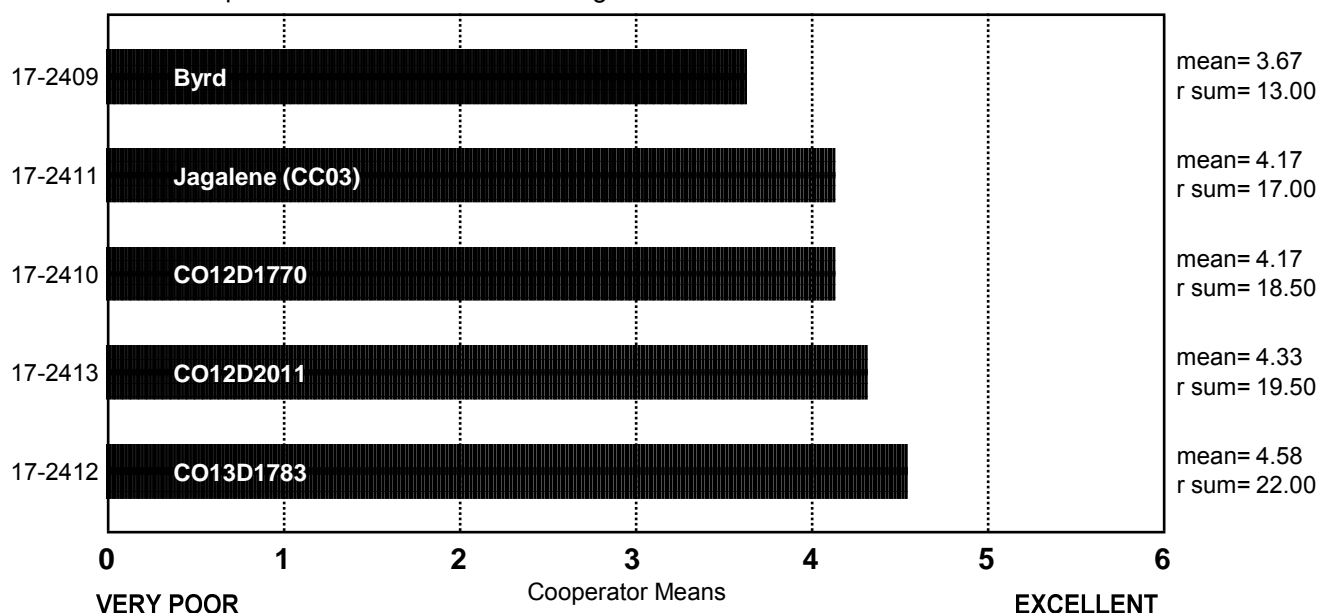
SPONGE CHARACTERISTICS

(Small Scale) Colorado

ncoop= 6
chisq= 2.97
chisqc= -5.56
cvchisq= 9.49
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



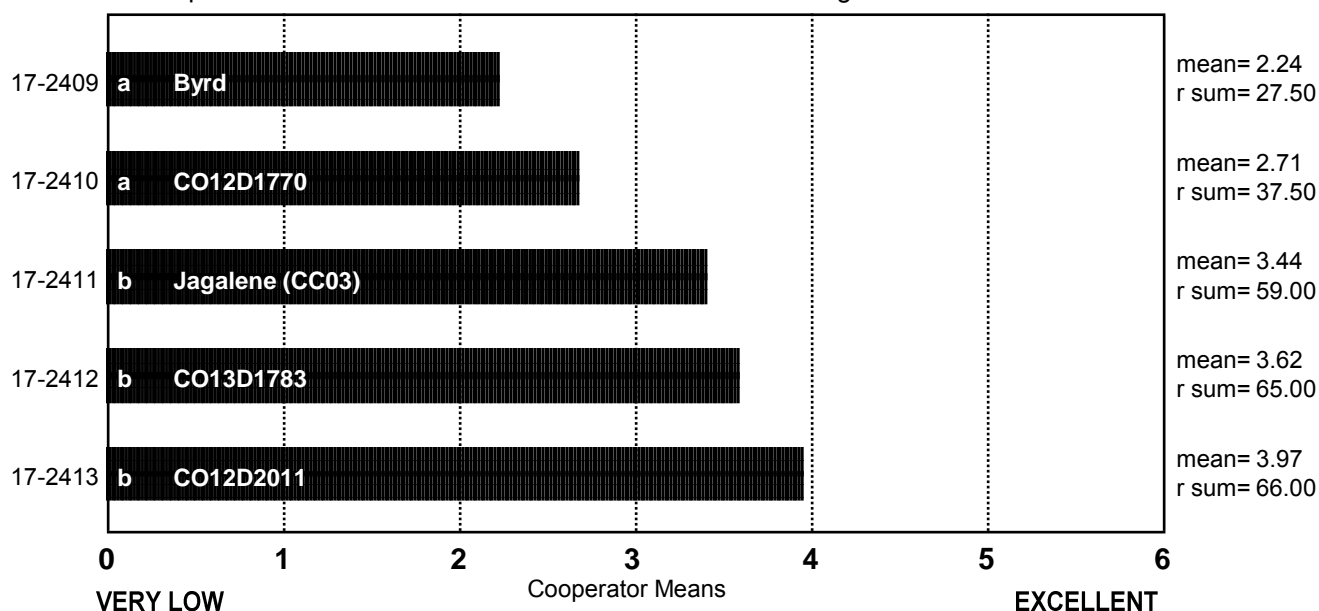
BAKE ABSORPTION

(Small Scale) Colorado

ncoop= 17
chisq= 28.69
chisqc= 35.74
cvchisq= 9.49
crdiff= 11.77

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2409 Byrd	55.0	57.0	58.9	59.5	59.2	57.1	56.0	59.0	60.1	66.3	59.9	59.6	58.9	62.2	59.8	60.7	56.0
17-2410 CO12D1770	56.0	59.5	60.5	61.5	61.0	59.5	57.0	60.0	62.5	64.2	59.6	61.1	60.6	63.2	60.5	62.8	59.1
17-2411 Jagalene (CC03)	57.0	62.0	62.8	66.5	62.0	62.1	57.0	63.0	65.1	69.0	62.1	61.8	62.7	65.2	62.5	64.5	56.3
17-2412 CO13D1783	56.0	61.6	62.4	63.5	61.6	61.6	58.0	61.0	64.6	67.5	60.6	62.9	62.4	66.2	60.7	67.7	60.8
17-2413 CO12D2011	57.0	65.5	62.6	65.0	62.9	65.5	59.0	64.0	68.5	67.3	62.5	63.1	65.2	67.2	63.1	66.7	63.0

BAKE MIX TIME, ACTUAL

(Small Scale) Colorado

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2409 Byrd	6.0	15.0	9.0	7.0	4.5	7.0	10.0	4.3	4.5	3.5	7.9	4.2	3.5	4.5	5.9	6.5	5.0
17-2410 CO12D1770	6.0	15.0	15.0	6.0	4.3	7.0	10.0	4.2	3.5	4.5	6.2	3.9	3.3	4.7	4.4	6.6	5.0
17-2411 Jagalene (CC03)	7.0	10.0	8.0	6.0	3.3	7.0	11.0	3.0	3.5	4.0	4.5	2.7	2.8	5.1	3.2	4.1	4.0
17-2412 CO13D1783	13.0	15.0	17.0	7.0	5.5	9.0	25.0	5.3	5.5	6.0	9.2	4.4	4.3	4.6	4.8	8.6	6.0
17-2413 CO12D2011	8.0	15.0	17.0	6.0	3.5	9.0	14.0	3.3	4.5	4.5	5.2	3.2	2.5	4.1	3.4	4.4	4.0

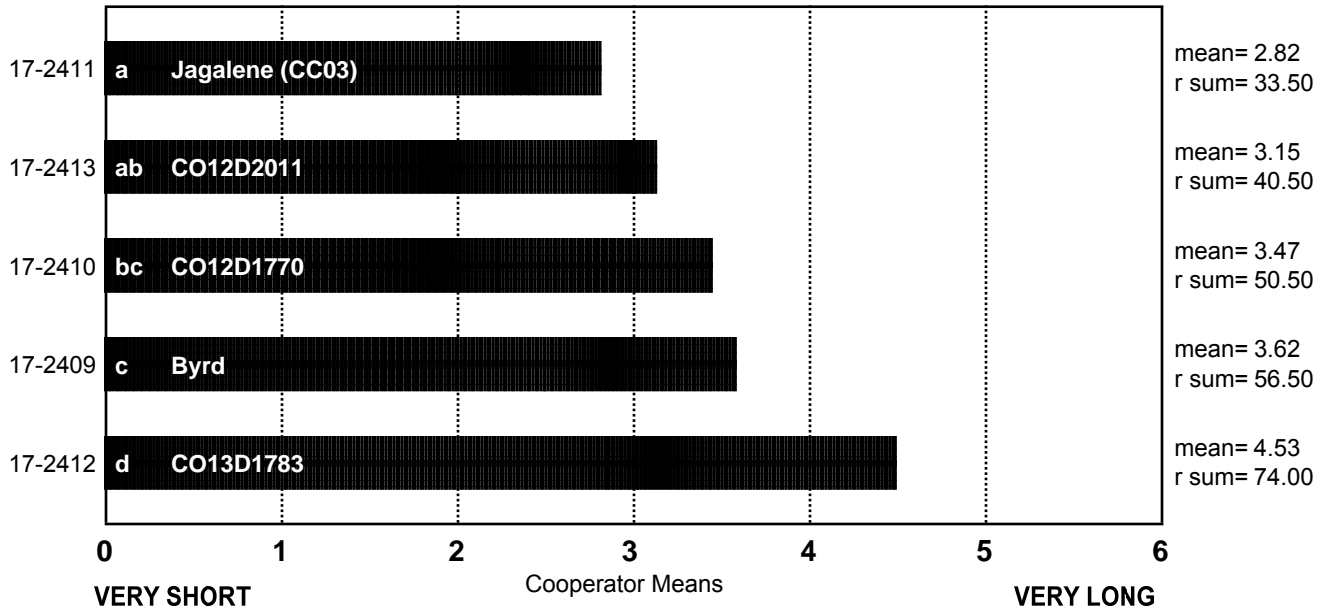
BAKE MIX TIME

(Small Scale) Colorado

ncoop= 17
chisq= 22.96
chisqc= 29.92
cvchisq= 9.49
crdiff= 12.51

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



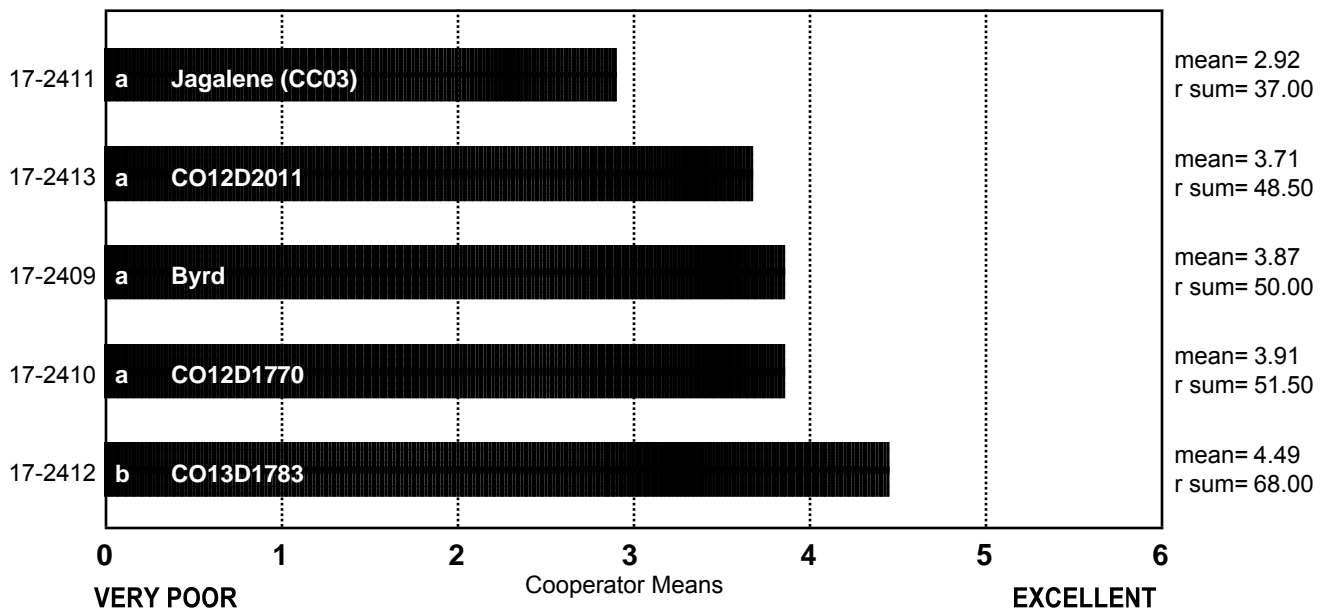
MIXING TOLERANCE

(Small Scale) Colorado

ncoop= 17
chisq= 11.59
chisqc= 15.39
cvchisq= 9.49
crdiff= 14.56

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



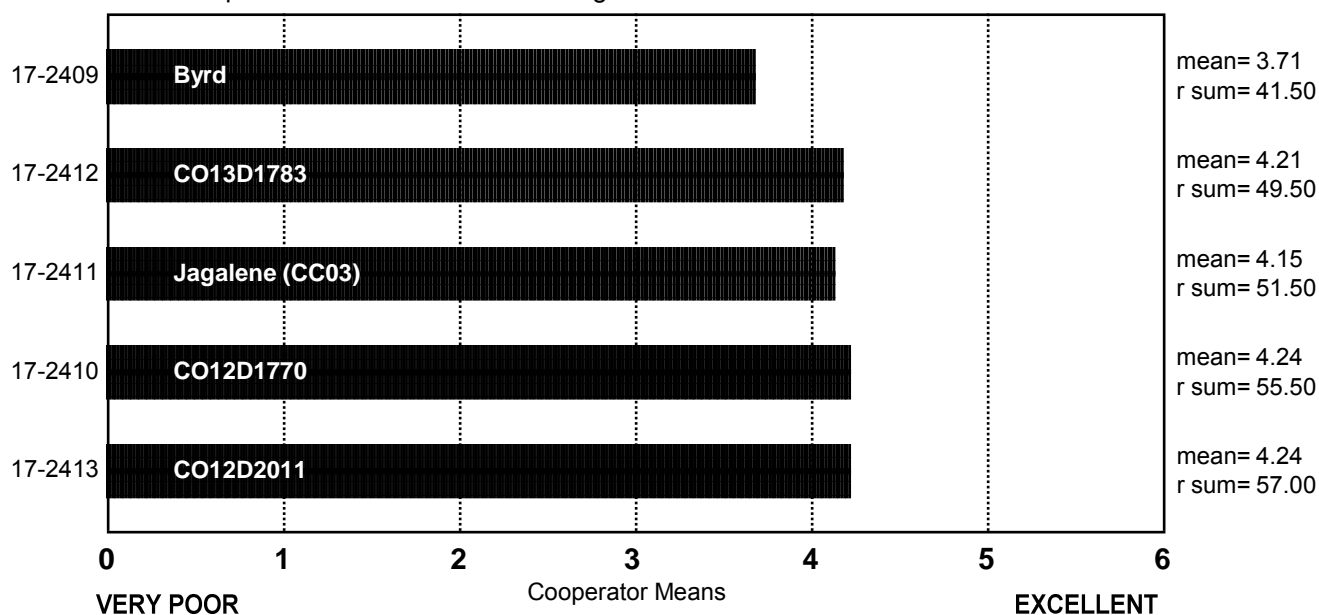
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Colorado

ncoop= 17
chisq= 3.51
chisqc= 5.03
cvchisq= 9.49
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Colorado

	Sticky	Wet	Tough	Good	Excellent
17-2409 Byrd	2	1	3	10	1
17-2410 CO12D1770	2	0	2	12	1
17-2411 Jagalene (CC03)	2	0	3	12	0
17-2412 CO13D1783	2	1	6	7	1
17-2413 CO12D2011	2	0	3	10	2

Frequency Table

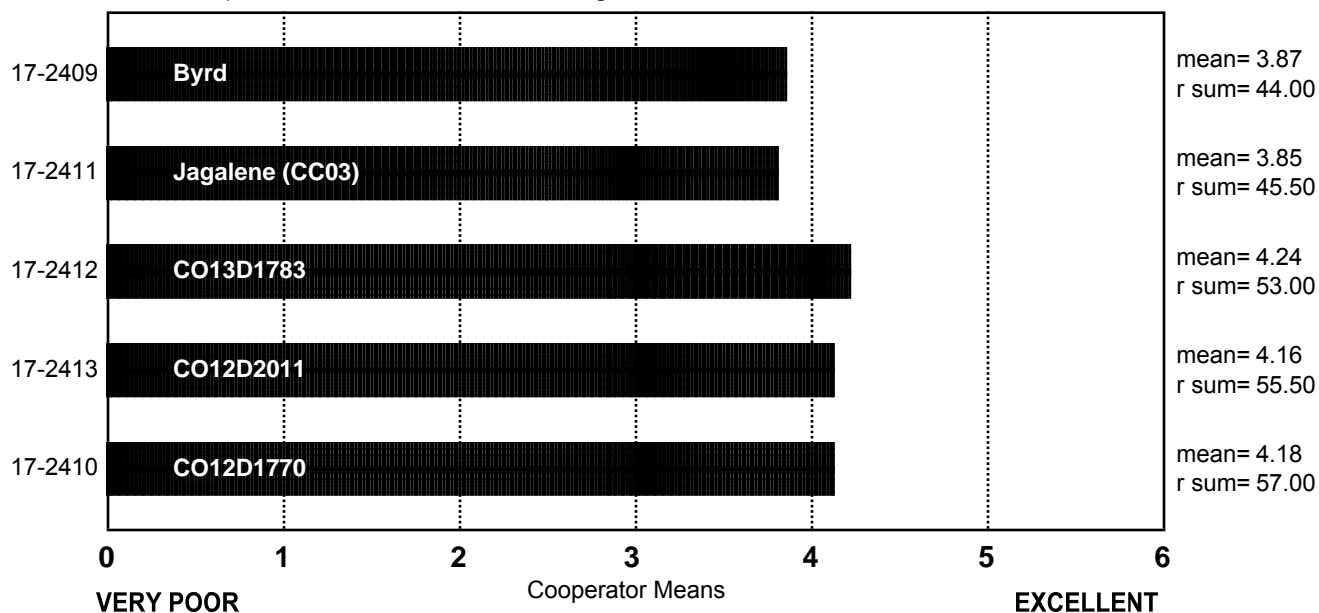
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Colorado

ncoop= 17
chisq= 3.28
chisqc= 4.38
cvchisq= 9.49
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Colorado

	Sticky	Wet	Tough	Good	Excellent
17-2409 Byrd	2	2	4	8	1
17-2410 CO12D1770	2	1	1	12	1
17-2411 Jagalene (CC03)	2	1	2	12	0
17-2412 CO13D1783	1	1	7	6	2
17-2413 CO12D2011	1	0	3	11	2

Frequency Table

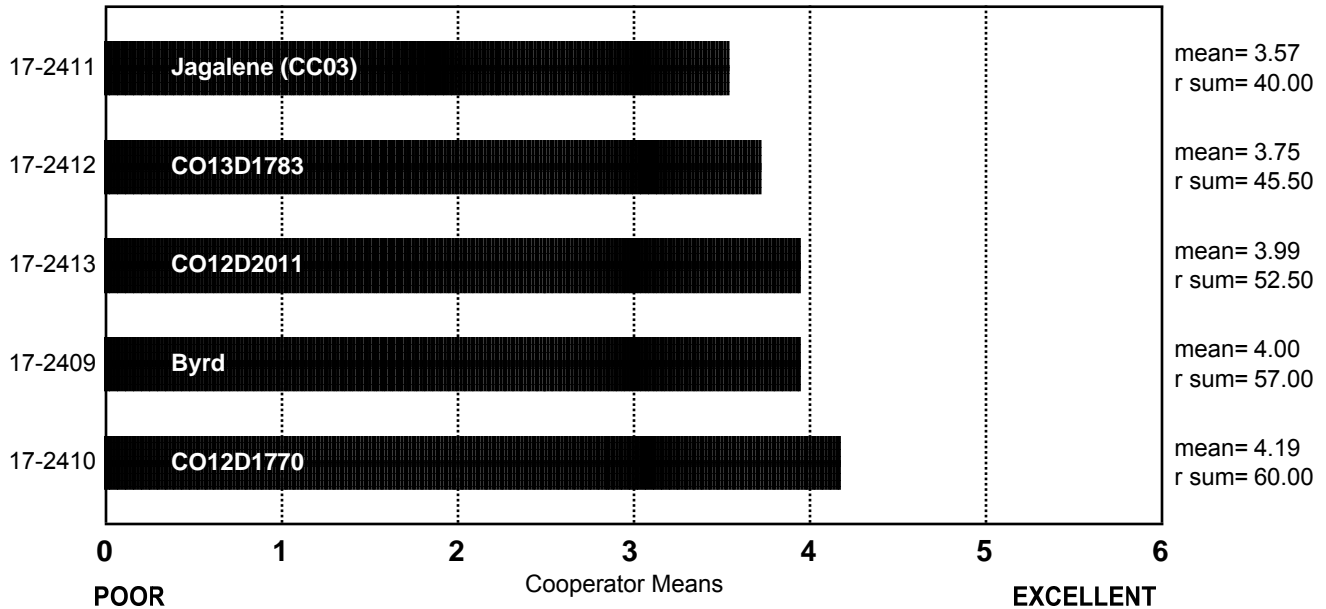
CRUMB GRAIN

(Small Scale) Colorado

ncoop= 17
chisq= 6.36
chisqc= 8.91
cvchisq= 9.49
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Colorado

	Open	Fine	Dense
17-2409 Byrd	6	10	1
17-2410 CO12D1770	2	12	3
17-2411 Jagalene (CC03)	5	10	2
17-2412 CO13D1783	10	5	2
17-2413 CO12D2011	7	10	0

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Colorado

	Round	Irregular	Elongated
17-2409 Byrd	5	5	7
17-2410 CO12D1770	4	6	7
17-2411 Jaqueline (CC03)	5	5	7
17-2412 CO13D1783	3	8	6
17-2413 CO12D2011	5	5	7

Frequency Table

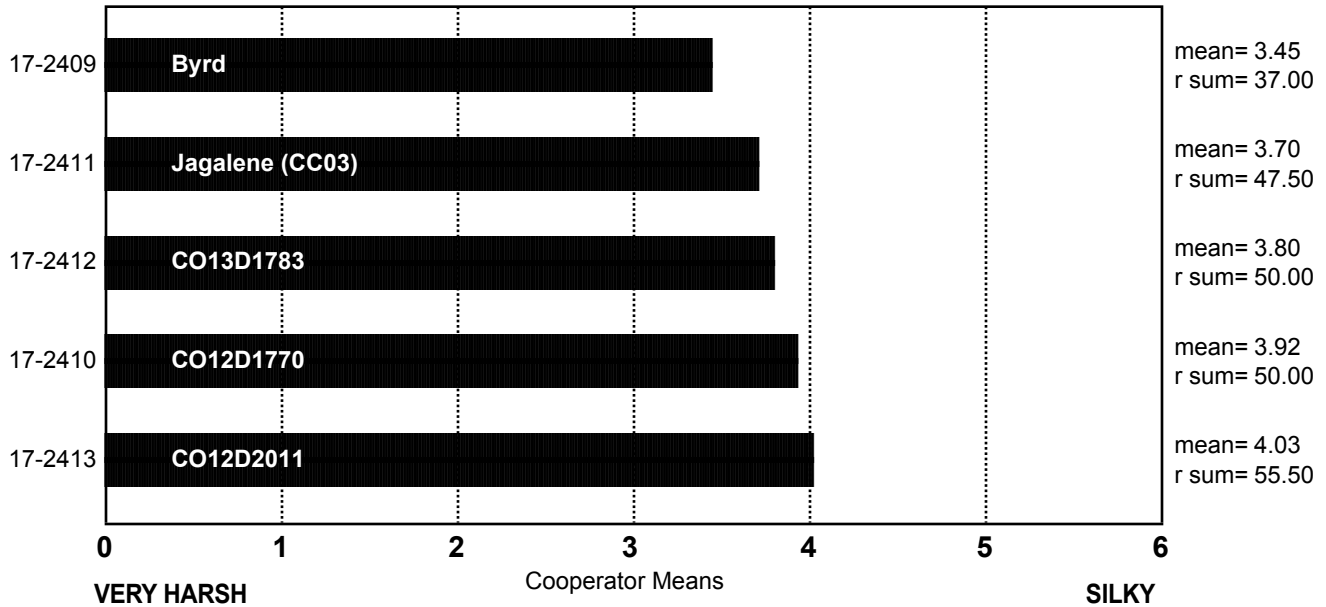
CRUMB TEXTURE

(Small Scale) Colorado

ncoop= 16
 chisq= 4.64
 chisqc= 6.65
 cvchisq= 9.49
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Colorado

	Harsh	Smooth	Silky
17-2409 Byrd	7	10	0
17-2410 CO12D1770	6	7	4
17-2411 Jagalene (CC03)	5	7	5
17-2412 CO13D1783	5	8	4
17-2413 CO12D2011	2	10	5

Frequency Table

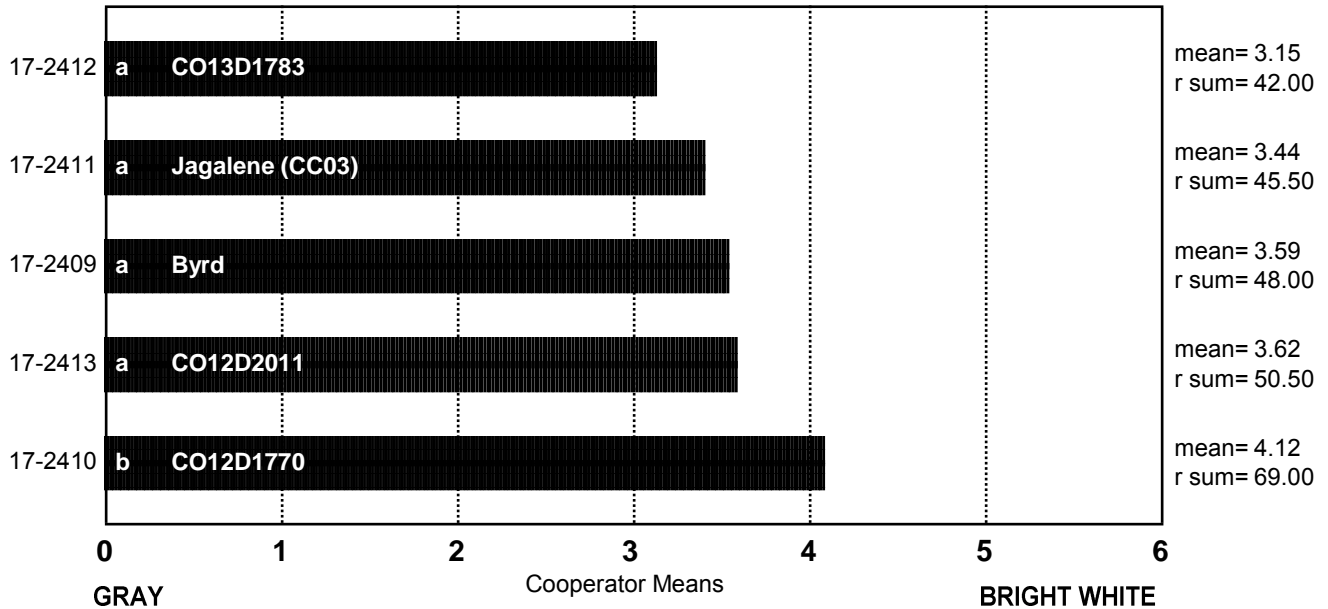
CRUMB COLOR

(Small Scale) Colorado

ncoop= 17
 chisq= 10.46
 chisqc= 16.85
 cvchisq= 9.49
 crdiff= 13.03

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Colorado

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2409 Byrd	0	0	4	6	5	1	1
17-2410 CO12D1770	0	0	2	1	9	5	0
17-2411 Jagalene (CC03)	0	0	6	6	3	2	0
17-2412 CO13D1783	0	0	7	3	5	1	0
17-2413 CO12D2011	0	0	3	5	7	2	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2409 Byrd	417.0	464.4	425.0	453.0	143.1	460.5		141.6	450.8	135.0	137.1	141.7	127.9	146.2	139.3	147.2	486.9
17-2410 CO12D1770	409.0	465.3	424.0	450.0	141.8	458.2		141.8	449.8	135.9	139.7	141.8	130.6	149.1	139.4	150.6	489.0
17-2411 Jagalene (CC03)	413.0	463.4	429.0	451.0	144.7	458.4		142.7	445.1	134.7	140.0	145.6	134.3	150.4	138.6	151.9	491.2
17-2412 CO13D1783	414.0	464.9	426.0	452.0	141.7	460.2		143.1	443.8	132.3	137.2	145.3	131.1	147.2	137.7	151.3	483.0
17-2413 CO12D2011	413.0	462.6	426.0	449.0	143.6	460.9		144.2	444.4	133.6	144.8	142.9	132.8	148.6	140.7	152.2	488.1

LOAF VOLUME, ACTUAL

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2409 Byrd	2925	2600	2600	2375	815	2600	2986	710	2375	870	891	850	770	935	855	805	2400
17-2410 CO12D1770	2775	2475	2600	2350	845	2763	2927	725	2350	885	865	840	717	943	790	750	2400
17-2411 Jagalene (CC03)	2875	2463	2650	2275	835	2709	2868	690	2375	850	930	745	735	900	833	850	2238
17-2412 CO13D1783	2825	2463	2650	2250	925	2769	2986	710	2500	870	895	850	832	923	890	840	2450
17-2413 CO12D2011	2825	2275	2525	2400	765	2557	2839	770	2200	900	953	800	780	908	819	840	2300

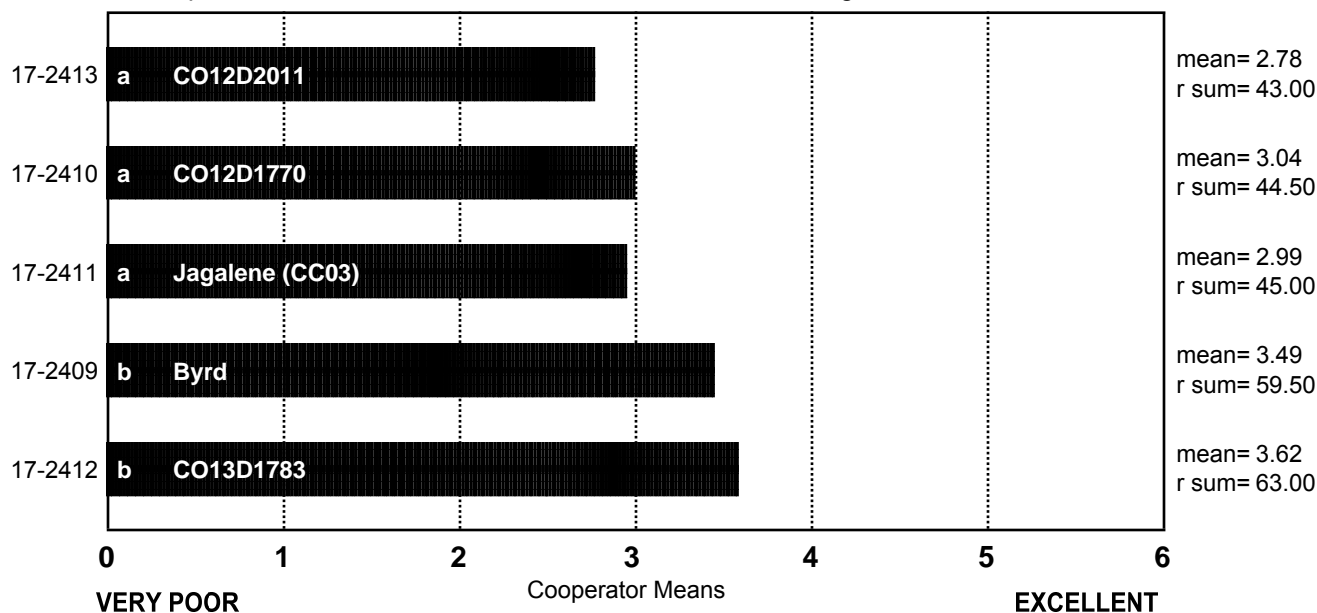
LOAF VOLUME

(Small Scale) Colorado

ncoop= 17
chisq= 8.44
chisqc= 12.05
cvchisq= 9.49
crdiff= 14.47

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



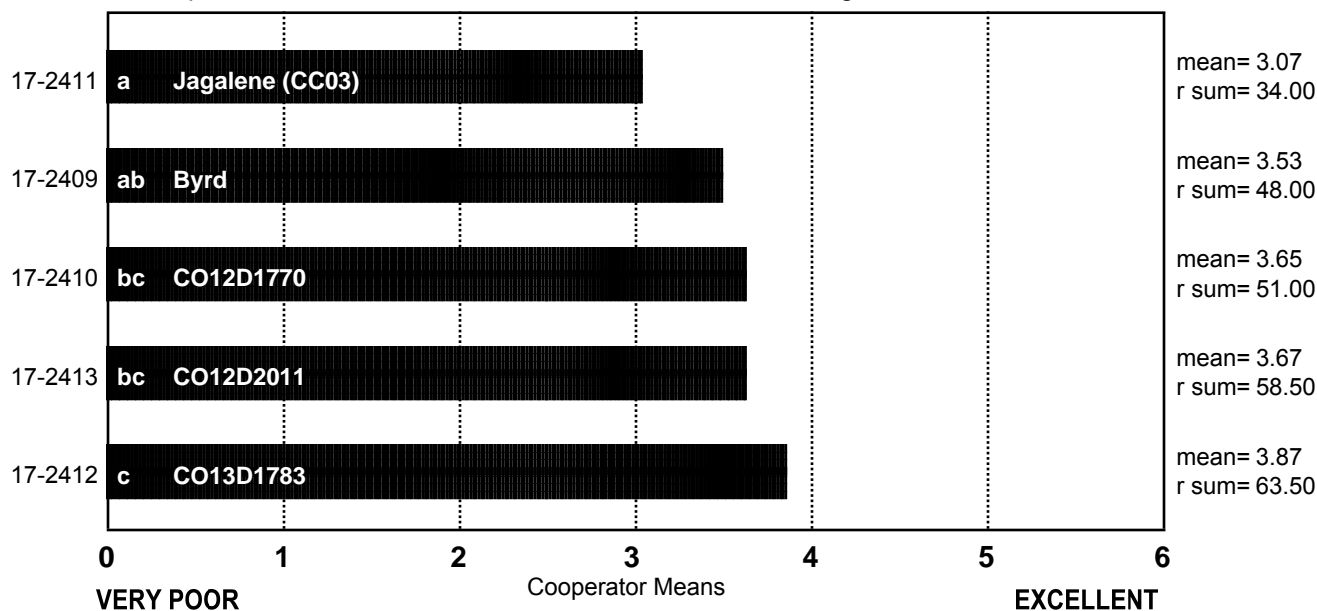
OVERALL BAKING QUALITY

(Small Scale) Colorado

ncoop= 17
chisq= 12.01
chisqc= 14.53
cvchisq= 9.49
crdiff= 15.38

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS

(Small Scale) Colorado

COOP.

17-2409 Byrd

- A. No comment.
- B. No comment.
- C. Very good overall performance for low protein (9.5%).
- D. No comment.
- E. No comment.
- F. No comment.
- G. Low absorption, mix strength and good volume.
- H. Absorption less than target.
- I. No comment.
- J. Poor color, low protein.
- K. Low water absorption, long mix time, slight sticky & weak dough, high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Unacceptable protein but good loaf volume/grain.
- M. No comment.
- N. Excellent performance for the low protein level. It made a reasonable loaf of bread at 9.4% protein.
- O. No comment.
- P. Nice mixograph, low bake absorption, long mix time, good dough at pan, fine & elongated crumb grain, low loaf volume.
- Q. Very low absorption, average grain, yellow color.

COOP.

17-2410 CO12D1770

- A. No comment.
- B. No comment.
- C. Good dough feel but poor bread performance.
- D. No comment.
- E. Rough break and shred.
- F. No comment.
- G. Low absorption, mix strength and good volume.
- H. Absorption less than target.
- I. No comment.
- J. No comment.
- K. Low water absorption, long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
- L. Unacceptable protein but performed well.
- M. No comment.
- N. Reasonable dough strength and volume performance, crumb grain somewhat weak looking, good performance for 10% protein.
- O. No comment.
- P. Good mixograph, medium absorption, long mix time, dough good at pan, satisfactory crumb grain, very low loaf volume.
- Q. Nice dough, fine grain, yellow color.

COOP.**17-2411 Jagalene (CC03)**

- A. No comment.
- B. No comment.
- C. Very weak mix tolerance, stressed dough to partial break down.
- D. No comment.
- E. No comment.
- F. No comment.
- G. Low absorption, mix strength and fair volume.
- H. Average absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, slight yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Low protein and loaf volume.
- M. No comment.
- N. Good volume performance for protein, weaker dough.
- O. No comment.
- P. Weak mixograph tolerance, nice bake absorption and mix time, good dough at pan, disappointed with crumb grain and loaf volume.
- Q. Low absorption, tough dough, poor open grain, yellow color, very low volume.

COOP.**17-2412 CO13D1783**

- A. No comment.
- B. No comment.
- C. Good performance overall.
- D. No comment.
- E. Nice loaf externals.
- F. No comment.
- G. Slightly low absorption, good mix strength and volume.
- H. Average absorption.
- I. Best of the set, good mix time, crumb was dense and elongated, good volume.
- J. Poor color.
- K. Low water absorption, long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
- L. Unacceptable protein but good grain, white color.
- M. No comment.
- N. Good performance for low protein flour, nice volume and crumb grain with that consideration.
- O. No comment.
- P. Nice mixograph, high bake absorption, long mix time, good dough at pan, good crumb grain.
- Q. Good absorption, good grain, dark yellow color.

COOP.**17-2413 CO12D2011**

- A. No comment.
- B. No comment.
- C. Good performance overall, slightly low loaf volume.
- D. No comment.
- E. No comment.
- F. No comment.
- G. Fair absorption, mix strength and low volume.
- H. Good absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
- L. Excellent color.
- M. No comment.
- N. Performed as expected for protein level.
- O. No comment.
- P. Good bake absorption, medium bake mix time, nice dough at pan, good crumb grain, and low loaf volume.
- Q. High absorption, good grain, yellow color, very low volume.

Notes: **A, C, D, G, I and Q** conducted sponge and dough bake tests

KANSAS-HAYS

17-2414	Jagalene (CC04)
17-2415	KS13HW92-3
17-2416	Danby
17-2417	KS14HW106-6-6

Description of Test Plots and Breeder Entries

Kansas-Hays – Guorong Zhang

The samples submitted were grown at Hays experimental station in 2017. Jagalene, Danby and KS13HW92-3 were grown in a field with sandy-loam soil. KS14HW106-6-6 was grown in another field with silty-loam soil. Test plots were fertilized with 60 lb/a N before planting. Plots were not irrigated, and were not treated with fungicide. 2017 had a warm winter and above normal precipitation in its late spring (April to June). Plots had good stands and grew well. 2017 crop had severe leaf rust infestation. The common check Jagalene was moderately susceptible to leaf rust. Local check Danby had intermediate reaction to leaf rust. The experimental entries KS13HW92-3 and KS14HW106-6-6 showed moderate resistance to leaf rust. At maturity, plots were hailed and had severe grain shattering.

Jagalene (common check)

Danby (local check)

KS13HW92-3

KS14HW106-6-6

KS13HW92-3 is a hard white winter wheat line with medium late maturity and medium tall stature. It has moderate tolerance to pre-harvest sprouting. KS13HW92-3 has good resistances to stripe rust, leaf rust, and soilborne mosaic virus. It has intermediate to moderate resistance to *Fusarium* head blight and barley yellow dwarf virus. KS13HW92-3 has intermediate reaction to acid soil and is susceptible to wheat streak mosaic virus and Hessian fly. KS13HW92-3 has good yield potential. It has good test weight and good baking quality.

KS14HW106-6-6 is a hard white winter wheat line. This line is medium early and medium short. It has pre-harvest sprouting tolerance. KS14HW106-6-6 has a good disease resistance package, including resistance to wheat streak mosaic virus, stripe rust, leaf rust, soilborne mosaic virus, and Hessian fly. KS14HW106-6-6 is moderately susceptible to *Fusarium* head blight and barley yellow dwarf virus. KS14HW106-6-6 has good yield potential. It has good test weight and good baking quality.

Kansas-Hays: 2017 (Small-Scale) Samples

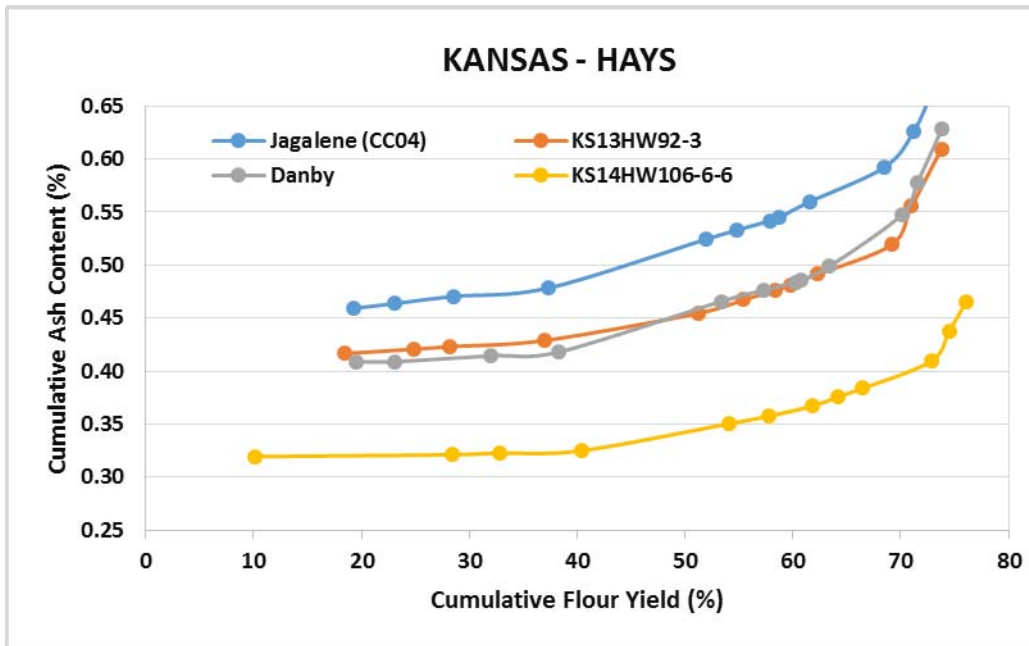
Test entry number	17-2414	17-2415	17-2416	17-2417
Sample identification	Jagalene (CC04)	KS13HW92-3	Danby	KS14HW106-6-6
Wheat Data				
GIPSA classification	3 HRW	2 HDWH	1 HDWH	1 HDWH
Test weight (lb/bu)	56.0	59.0	60.4	60.3
Hectoliter weight (kg/hl)	73.8	77.6	79.5	79.3
1000 kernel weight (gm)	28.3	31.1	30.9	37.0
Wheat kernel size (Rotap)				
Over 7 wire (%)	47.2	53.3	55.8	84.7
Over 9 wire (%)	50.7	45.5	43.2	15.3
Through 9 wire (%)	2.1	1.2	1.0	0.0
Single kernel (skcs)^a				
Hardness (avg /s.d)	72.3/21.1	74.1/16.4	70.9/17.6	50.0/14.3
Weight (mg) (avg/s.d)	28.3/10.9	31.1/11.4	30.0/11.7	37.0/11.4
Diameter (mm)(avg/s.d)	2.45/0.42	2.52/0.34	2.51/0.35	2.76/0.36
Moisture (%) (avg/s.d)	11.0/0.5	11.1/0.4	11.0/0.4	11.3/0.3
SKCS distribution	02-08-15-75-01	02-04-12-82-01	02-08-16-74-01	09-31-37-23-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	13.2	14.2	13.6	13.7
Wheat ash (12% mb)	1.59	1.56	1.54	1.32
Milling and Flour Quality Data				
Flour yield (% , str. grade)				
Miag Multomat Mill	73.1	73.9	73.9	76.1
Quadrumat Sr. Mill	63.9	64.1	64.4	70.7
Flour moisture (%)	12.9	12.9	13.0	12.7
Flour protein (14% mb)	11.6	12.7	11.9	12.1
Flour ash (14% mb)	0.65	0.57	0.58	0.44
Rapid Visco-Analyser				
Peak Time (min)	6.1	6.1	6.2	6.0
Peak Viscosity (RVU)	181.7	205.3	238.9	209.2
Breakdown (RVU)	60.8	83.8	99.9	98.5
Final Viscosity at 13 min (RVU)	238.8	219.7	241.0	202.1
Minolta color meter				
L*	90.37	91.37	91.66	91.67
a*	-1.31	-1.26	-1.36	-1.07
b*	10.36	9.25	8.63	7.51
PPO	0.423	0.233	0.567	0.635
Falling number (sec)	432	425	464	354
Damaged Starch				
(AI%)	97.8	97.2	96.8	96.4
(AACC76-31)	7.8	7.2	6.9	6.6

^as.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Kansas-Hays: Physical Dough Tests and Gluten Analysis 2017 (Small-Scale) Samples

Test Entry Number	17-2414	17-2415	17-2416	17-2417
Sample Identification	Jagalene (CC04)	KS13HW92-3	Danby	KS14HW106-6-6
MIXOGRAPH				
Flour Abs (% as-is)	65.9	72.1	65.5	69.0
Flour Abs (14% mb)	64.7	70.9	64.3	67.4
Mix Time (min)	3.9	3.6	2.6	5.9
Mix tolerance (0-6)	4	3	2	4
FARINOGRAPH				
Flour Abs (% as-is)	65.1	69.5	66.5	63.2
Flour Abs (14% mb)	63.9	68.3	65.2	61.6
Peak time (min)	5.0	8.8	5.7	8.2
Mix stability (min)	13.6	14.4	9.6	21.9
Mix Tolerance Index (FU)	17	18	23	9
Breakdown time (min)	14.6	18.1	13.3	24.0
ALVEOGRAPH				
P(mm): Tenacity	116	132	91	89
L(mm): Extensibility	74	92	117	112
G(mm): Swelling index	19.1	21.4	24.1	23.6
W(10 ⁻⁴ J): strength (curve area)	305	407	282	345
P/L: curve configuration ratio	1.57	1.43	0.78	0.79
Ie(P ₂₀₀ /P): elasticity index	55.0	57.3	48.1	61.4
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	350/396/457	307/439/477	223/228/245	324/643/771
Extensibility (mm at 45/90/135 min)	151/140/163	159/161/159	167/173/175	142/123/103
Energy (cm ² at 45/90/135 min)	97/97/137	89/134/139	68/74/80	82/122/113
Resist _{max} (BU at 45/90/135 min)	484/542/650	420/645/684	293/302/321	448/799/895
Ratio (at 45/90/135 min)	2.3/2.8/2.8	1.9/2.7/3.0	1.3/1.3/1.4	2.3/5.2/7.5
PROTEIN ANALYSIS				
HMW-GS Composition	2*,1,5+10,17+18	2*,5+10,7 ^{oe} +8	2*,5+10,7+9	2*,5+10,7+9
TMP/TPP	1.04	0.97	0.96	0.93
SEDIMENTATION TEST				
Volume (ml)	49.4	61.8	49.4	63.5

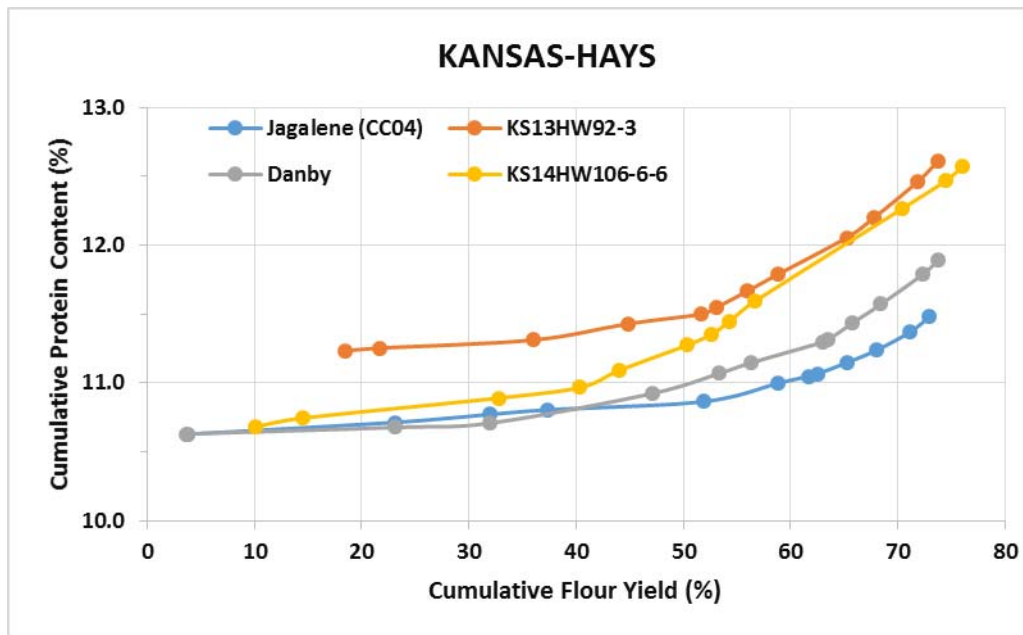
Kansas-Hays: Cumulative Ash Curves



Jagalene (CC04)					KS13HW92-3				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	19.3	0.46	19.3	0.46	2M	18.4	0.42	18.4	0.42
1M Red	3.8	0.49	23.1	0.46	1BK	6.5	0.43	24.9	0.42
1BK	5.4	0.50	28.5	0.47	1M Red	3.3	0.44	28.2	0.42
1M	8.9	0.50	37.4	0.48	1M	8.8	0.45	37.0	0.43
3M	14.6	0.64	51.9	0.52	3M	14.3	0.52	51.3	0.45
Grader	2.9	0.69	54.8	0.53	2BK	4.1	0.62	55.4	0.47
2BK	3.1	0.70	57.9	0.54	Grader	2.9	0.64	58.3	0.48
FILTER FLR	0.8	0.76	58.7	0.54	FILTER FLR	1.4	0.69	59.8	0.48
3BK	2.9	0.87	61.6	0.56	3BK	2.5	0.73	62.3	0.49
4M	6.9	0.88	68.5	0.59	4M	6.9	0.77	69.2	0.52
5M	2.7	1.47	71.2	0.63	BRAN FLR	1.9	1.91	71.0	0.56
BRAN FLR	1.8	2.25	73.0	0.67	5M	2.8	1.99	73.8	0.61
Break Shorts	4.2	3.81	77.1	0.84	Break Shorts	4.0	3.55	77.8	0.76
Red Dog	4.1	2.68	81.2	0.93	Red Dog	3.7	2.68	81.5	0.85
Red Shorts	0.8	3.43	82.0	0.95	Red Shorts	0.6	3.26	82.1	0.87
Filter Bran	1.0	3.09	83.0	0.98	Filter Bran	0.8	2.61	82.9	0.88
Bran	17.0	4.90	100.0	1.64	Bran	17.1	5.12	100.0	1.61
Wheat		1.59					1.56		
St. Grd. Fl.		0.65					0.57		

Danby					KS14HW106-6-6				
Mill Streams	Strm-yld	Ash	Cumul (14%)		Mill Streams	Strm-yld	Ash	Cumul (14%)	
	(14%mb)		Yield	Ash		(14%mb)		Yield	Ash
2M	19.5	0.41	19.5	0.41	1M	10.1	0.32	10.1	0.32
1M Red	3.6	0.41	23.1	0.41	2M	18.3	0.32	28.5	0.32
1M	8.9	0.43	32.0	0.41	1M Red	4.3	0.33	32.8	0.32
18K	6.3	0.44	38.3	0.42	18K	7.6	0.33	40.4	0.32
3M	15.1	0.59	53.4	0.47	3M	13.7	0.43	54.1	0.35
2BK	3.9	0.62	57.3	0.48	Grader	3.6	0.46	57.8	0.36
Grader	2.9	0.63	60.2	0.48	2BK	4.0	0.50	61.8	0.37
FILTER FLR	0.5	0.68	60.8	0.49	3BK	2.4	0.60	64.2	0.38
3BK	2.7	0.81	63.4	0.50	FILTER FLR	2.3	0.61	66.5	0.38
4M	6.7	1.01	70.1	0.55	4M	6.3	0.68	72.8	0.41
BRAN FLR	1.4	2.05	71.6	0.58	5M	1.7	1.67	74.5	0.44
5M	2.3	2.23	73.8	0.63	BRAN FLR	1.6	1.79	76.1	0.47
Break Shorts	3.9	3.87	77.7	0.79	Break Shorts	2.8	3.15	78.9	0.56
Red Dog	3.3	2.71	81.0	0.87	Red Dog	2.1	1.99	81.0	0.60
Red Shorts	0.5	3.35	81.5	0.89	Red Shorts	0.2	3.09	81.2	0.61
Filter Bran	0.7	3.92	82.3	0.91	Filter Bran	1.1	2.65	82.3	0.63
Bran	17.7	4.94	100.0	1.63	Bran	17.7	4.90	100.0	1.39
Wheat		1.54					1.32		
St. Grd. Fl.		0.58					0.44		

Kansas-Hays: Cumulative Protein Curves



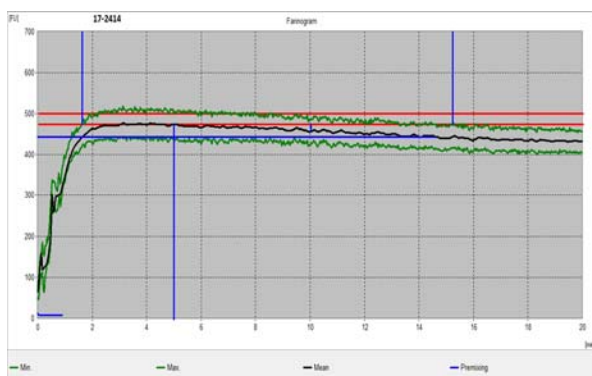
Jagalene (CC04)					KS13HW92-3				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1M Red	3.8	10.63	3.8	10.6	2M	18.4	11.23	18.4	11.2
2M	19.3	10.73	23.1	10.7	1M Red	3.3	11.36	21.7	11.3
1M	8.9	10.92	31.9	10.8	3M	14.3	11.40	36.0	11.3
1BK	5.4	11.00	37.4	10.8	1M	8.8	11.91	44.8	11.4
3M	14.6	11.02	51.9	10.9	4M	6.9	11.96	51.7	11.5
4M	6.9	11.99	58.8	11.0	FILTER FLR	1.4	13.33	53.1	11.5
Grader	2.9	12.11	61.7	11.0	Grader	2.9	13.85	56.0	11.7
FILTER FLR	0.8	12.34	62.5	11.1	5M	2.8	14.18	58.8	11.8
5M	2.7	13.00	65.2	11.1	1BK	6.5	14.50	65.3	12.1
3BK	2.9	13.36	68.1	11.2	3BK	2.5	15.90	67.8	12.2
2BK	3.1	14.27	71.2	11.4	2BK	4.1	16.82	71.9	12.5
BRAN FLR	1.8	15.84	73.0	11.5	BRAN FLR	1.9	18.35	73.8	12.6
Break Shorts	4.2	15.34	77.1	11.7	Break Shorts	4.0	15.68	77.8	12.8
Red Dog	4.1	14.54	81.2	11.8	Red Dog	3.7	14.39	81.5	12.8
Red Shorts	0.8	13.83	82.0	11.9	Red Shorts	0.6	13.76	82.1	12.9
Filter Bran	1.0	13.01	83.0	11.9	Filter Bran	0.8	13.23	82.9	12.9
Bran	17.0	16.21	100.0	12.6	Bran	17.1	17.87	100.0	13.7
Wheat		12.5					13.4		
St. Grd. Fl		11.6					12.7		

Danby					KS14HW106-6-6				
Mill Streams	Strm-yld	Protein	Cumulative (14%)		Mill Streams	Strm-yld	Protein	Cumulative (14%)	
	(14%mb)		Yield	Protein		(14%mb)		Yield	Protein
1M Red	3.6	10.63	3.6	10.6	1M	10.1	10.68	10.1	10.7
2M	19.5	10.69	23.1	10.7	1M Red	4.3	10.89	14.5	10.7
1M	8.9	10.79	32.0	10.7	2M	18.3	11.01	32.8	10.9
3M	15.1	11.38	47.1	10.9	1BK	7.6	11.30	40.4	11.0
1BK	6.3	12.17	53.4	11.1	Grader	3.6	12.46	44.0	11.1
Grader	2.9	12.52	56.3	11.1	4M	6.3	12.56	50.3	11.3
4M	6.7	12.56	63.0	11.3	FILTER FLR	2.3	13.06	52.6	11.4
FILTER FLR	0.5	13.49	63.5	11.3	5M	1.7	14.41	54.3	11.4
5M	2.3	14.83	65.8	11.4	3BK	2.4	14.92	56.7	11.6
3BK	2.7	14.97	68.4	11.6	3M	13.7	15.05	70.5	12.3
2BK	3.9	15.61	72.4	11.8	2BK	4.0	15.97	74.5	12.5
BRAN FLR	1.4	17.09	73.8	11.9	BRAN FLR	1.6	17.61	76.1	12.6
Break Shorts	3.9	16.01	77.7	12.1	Break Shorts	2.8	15.74	78.9	12.7
Red Dog	3.3	15.28	81.0	12.2	Red Dog	2.1	14.90	81.0	12.7
Red Shorts	0.5	14.41	81.5	12.2	Red Shorts	0.2	14.59	81.2	12.8
Filter Bran	0.7	14.53	82.3	12.3	Filter Bran	1.1	13.87	82.3	12.8
Bran	17.7	16.92	100.0	13.1	Bran	17.7	17.32	100.0	13.6
Wheat		12.8					13.1		
St. Grd. Fl		11.9					12.1		

Physical Dough Tests

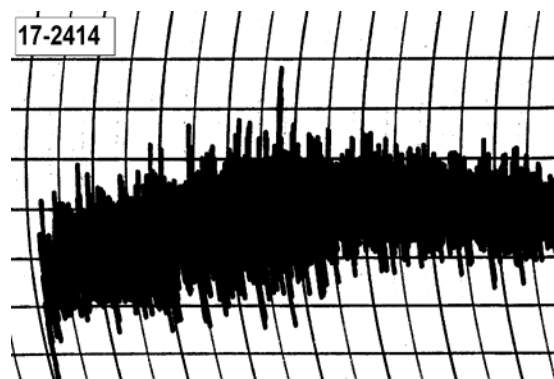
2017 (Small Scale) Samples – Kansas-Hays

Farinograms



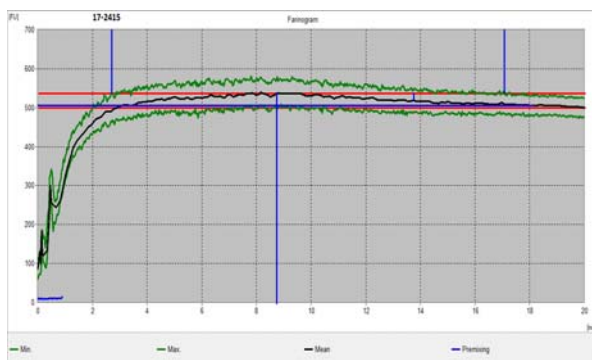
Water abs = 63.9%, Peak time = 5.0 min
Mix stab = 13.6 min, MTI = 17 FU

Mixograms

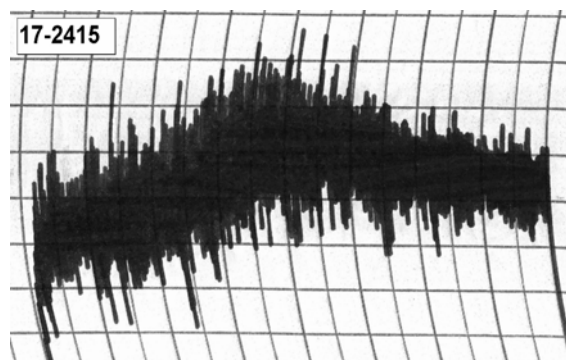


Water abs = 64.7%
Mix time = 3.9 min

17-2414, Jagalene (CC04)



Water abs = 68.3%, Peak time = 8.8 min,
Mix stab = 14.4 min, MTI = 18 FU



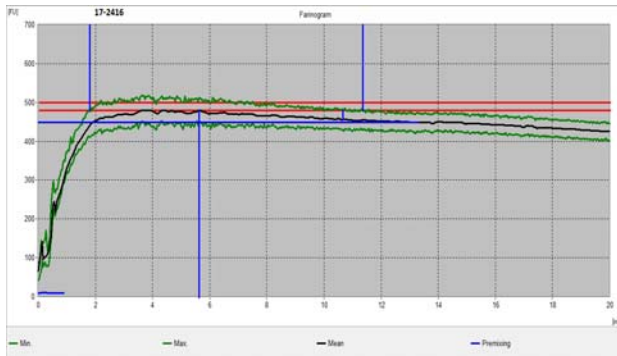
Water abs = 70.9%
Mix time = 3.6 min

17-2415, KS13HW92-3

Physical Dough Tests

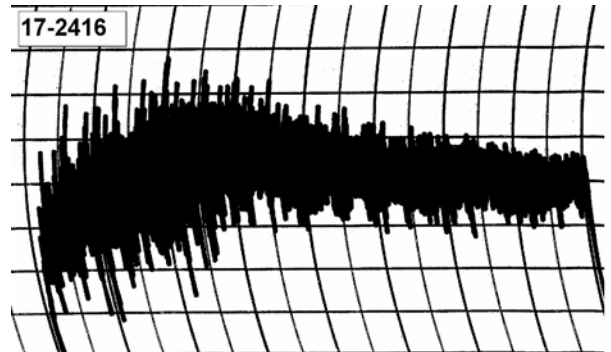
2017 (Small Scale) Samples – Kansas-Hays (continued)

Farinograms



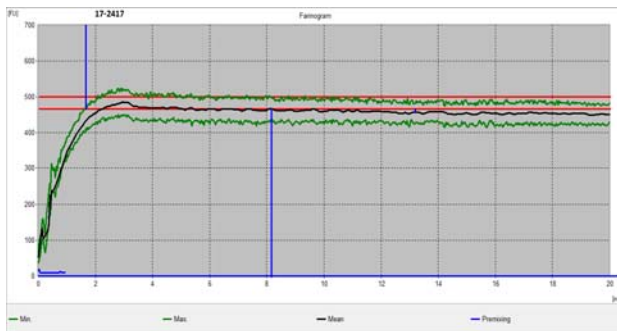
Water abs. = 65.2%, Peak time = 5.7 min,
Mix stab = 9.6 min, MTI = 23 FU

Mixograms

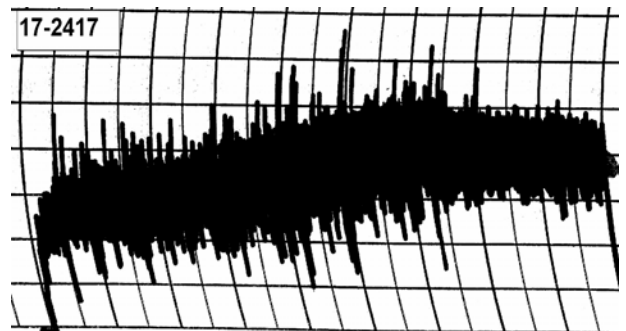


Water abs = 64.3%
Mix time = 2.6 min

17-2416, Danby



Water abs. = 61.6%, Peak time = 8.2 min,
Mix stab = 21.9 min, MTI = 9 FU

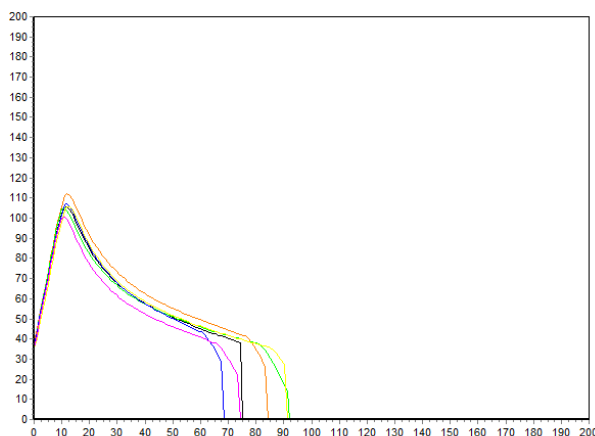


Water abs = 67.4%
Mix time = 5.9 min

17-2417, KS14HW106-6-6

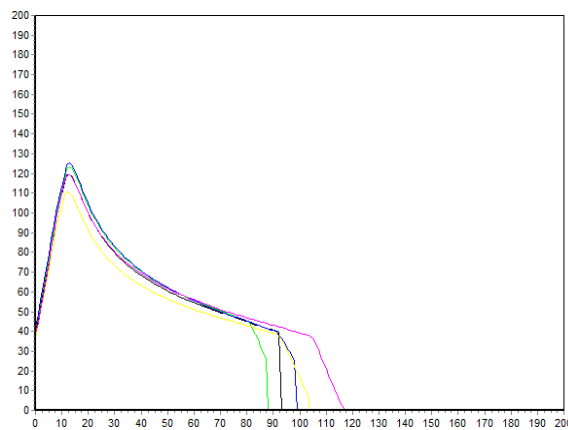
Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Kansas-Hays



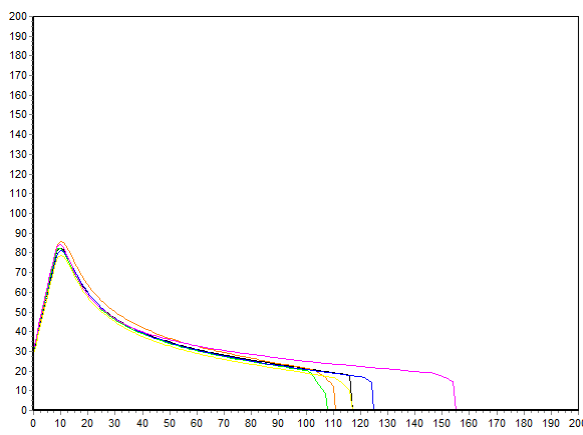
17-2414, Jagalene (CC04)

P (mm H₂O) = 116, L (mm) = 74, W (10E⁻⁴J) = 305



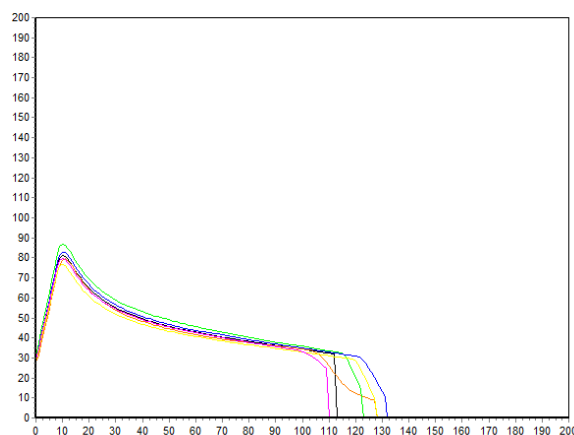
17-2415, KS13HW92-3

P (mm H₂O) = 132, L (mm) = 92, W (10E⁻⁴J) = 407



17-2416, Danby

P (mm H₂O) = 91, L (mm) = 117, W (10E⁻⁴J) = 282

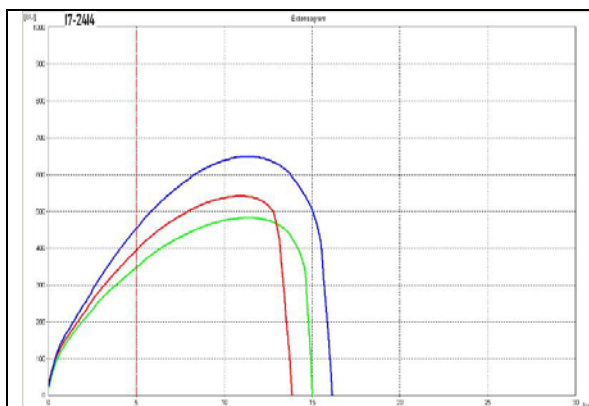


17-2417, KS14HW106-6-6

P (mm H₂O) = 89, L (mm) = 112, W (10E⁻⁴J) = 345

Physical Dough Tests - Extensigraph

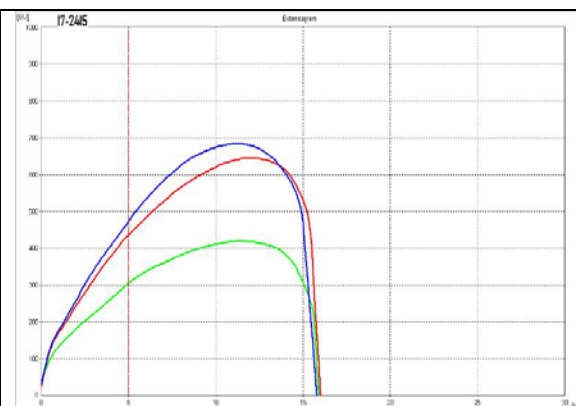
2017 (Small Scale) Samples – Kansas-Hays



17-2414, Jagalene (CC04)

R (BU) = 396, E (mm) = 140, W (cm²) = 97

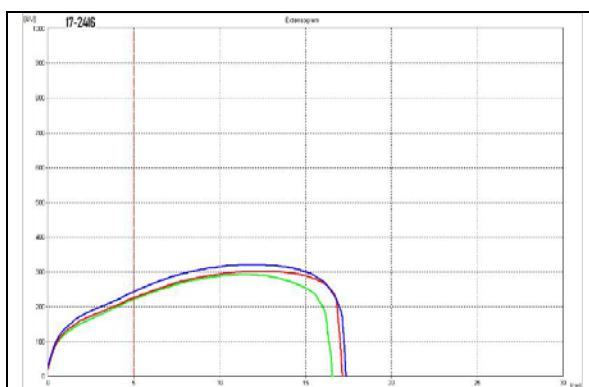
Rmax (BU) = 542, Ratio = 2.8 at 90 min



17-2415, KS13HW92-3

R (BU) = 439, E (mm) = 161, W (cm²) = 134

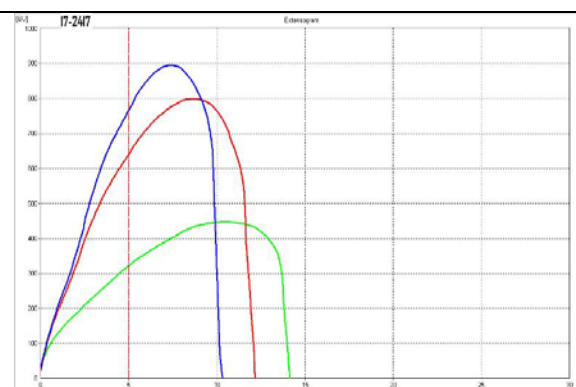
Rmax (BU) = 645, Ratio = 2.7 at 90 min



17-2416, Danby

R (BU) = 228, E (mm) = 173, W (cm²) = 74

Rmax (BU) = 302, Ratio = 1.3 at 90 min



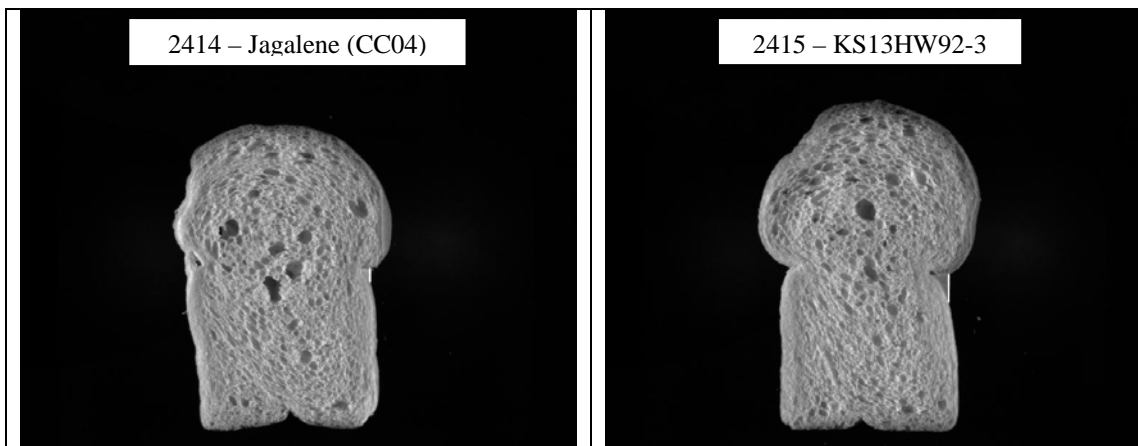
17-2417, KS14HW106-6-6

R (BU) = 643, E (mm) = 123, W (cm²) = 122

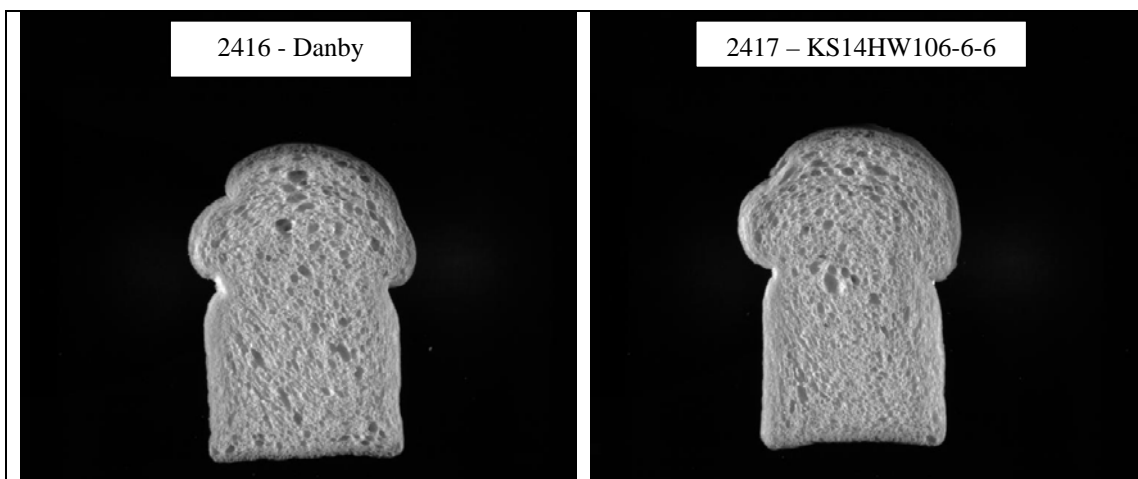
Rmax (BU) = 799, Ratio = 5.2 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm²) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Kansas-Hays: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2414	5692	137	3812	0.432	1.820	2.863	1.708	-20.98
2415	6062	138	3804	0.448	2.048	2.173	1.713	-23.90



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2416	5636	144	3671	0.449	2.010	4.129	1.670	-20.80
2417	5570	145	3752	0.440	1.909	3.583	1.670	-14.48

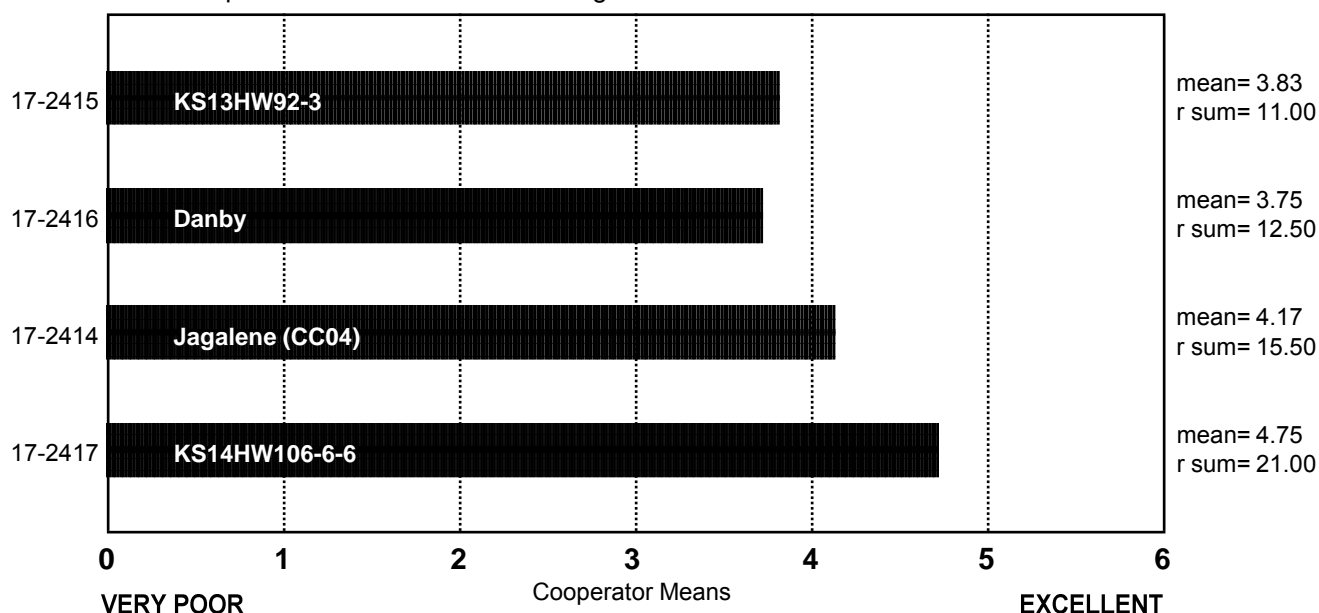
SPONGE CHARACTERISTICS

(Small Scale) Kansas-Hays

Variety order by rank sum.

No samples different at 5.0% level of significance.

ncoop= 6
chisq= 5.85
chisqc= -19.50
cvchisq= 7.82
crdiff=



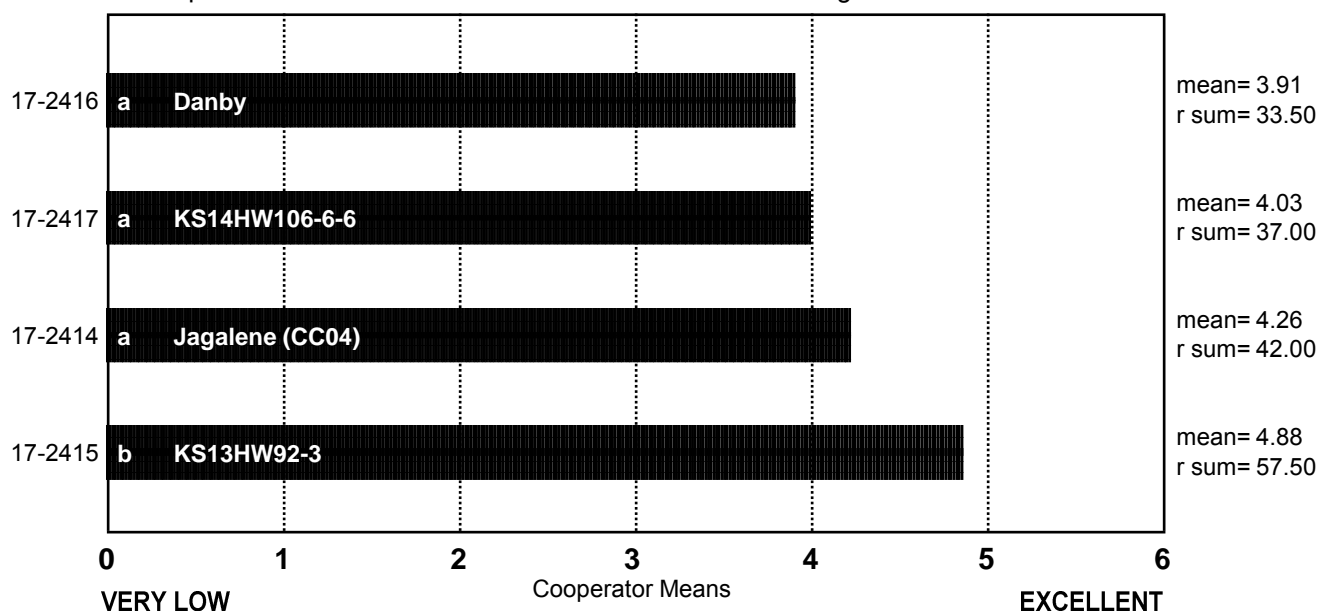
BAKE ABSORPTION

(Small Scale) Kansas-Hays

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.

ncoop= 17
chisq= 11.88
chisqc= 14.74
cvchisq= 7.82
crdiff= 11.81



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Kansas-Hays

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2414 Jaglene (CC04)	58.0	64.0	63.1	65.0	63.0	63.9	60.0	64.0	66.9	67.6	63.5	62.9	64.5	68.2	63.3	70.2	62.8
17-2415 KS13HW92-3	59.0	65.0	64.7	69.5	66.0	68.3	62.0	66.0	71.3	71.3	64.6	67.9	69.2	69.7	65.3	73.7	64.8
17-2416 Danby	58.0	65.0	60.6	65.5	61.6	65.2	61.0	63.0	68.2	67.3	64.0	63.2	65.8	68.2	63.8	66.2	61.8
17-2417 KS14HW106-6-6	58.0	61.6	60.8	63.0	62.5	61.6	57.0	64.0	64.6	68.7	64.0	63.9	62.5	68.2	64.5	68.7	60.4

BAKE MIX TIME, ACTUAL

(Small Scale) Kansas-Hays

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2414 Jaglene (CC04)	8.0	15.0	11.0	5.0	4.3	10.0	14.0	4.0	4.0	4.5	5.8	3.5	3.3	4.7	4.9	6.1	5.0
17-2415 KS13HW92-3	9.0	15.0	14.0	7.0	3.5	8.0	20.0	3.2	4.0	4.3	4.8	2.9	2.5	3.4	3.2	4.3	5.0
17-2416 Danby	5.0	10.0	8.0	5.0	3.0	8.0	7.0	2.5	3.0	3.5	4.5	2.4	2.3	4.3	2.6	3.1	4.0
17-2417 KS14HW106-6-6	8.0	23.0	20.0	7.0	4.3	8.0	23.0	4.0	4.0	5.0	6.8	3.8	3.3	5.1	4.7	5.9	6.0

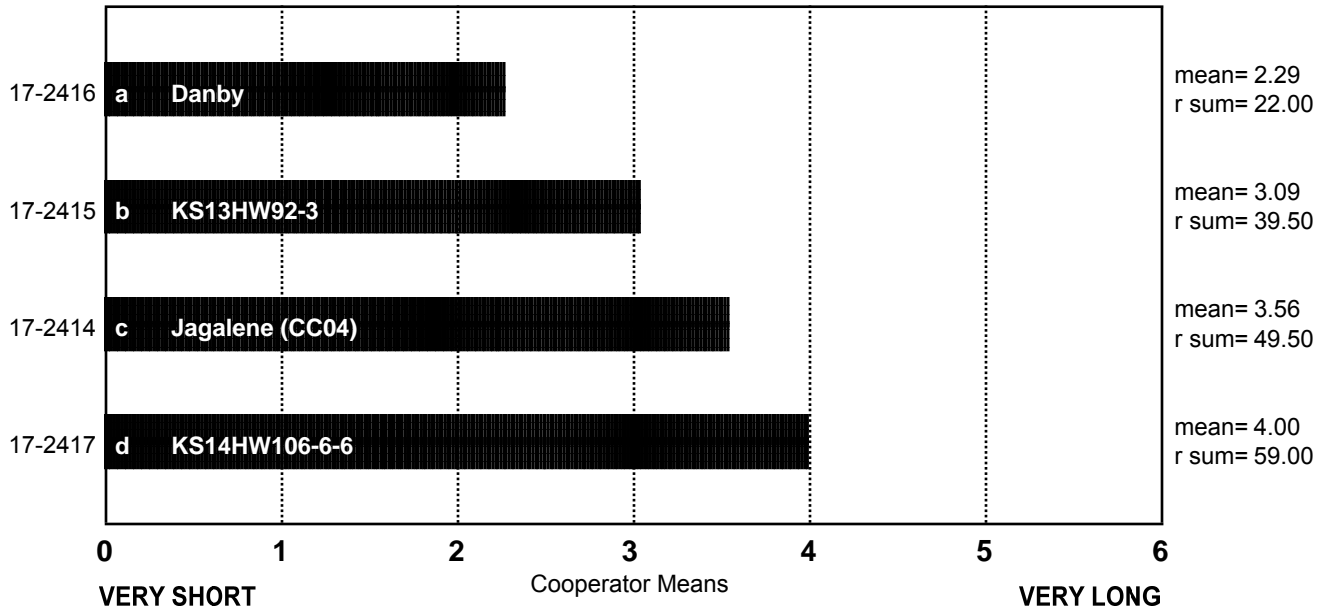
BAKE MIX TIME

(Small Scale) Kansas-Hays

ncoop= 17
 chisq= 26.49
 chisqc= 31.27
 cvchisq= 7.82
 crdiff= 8.93

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



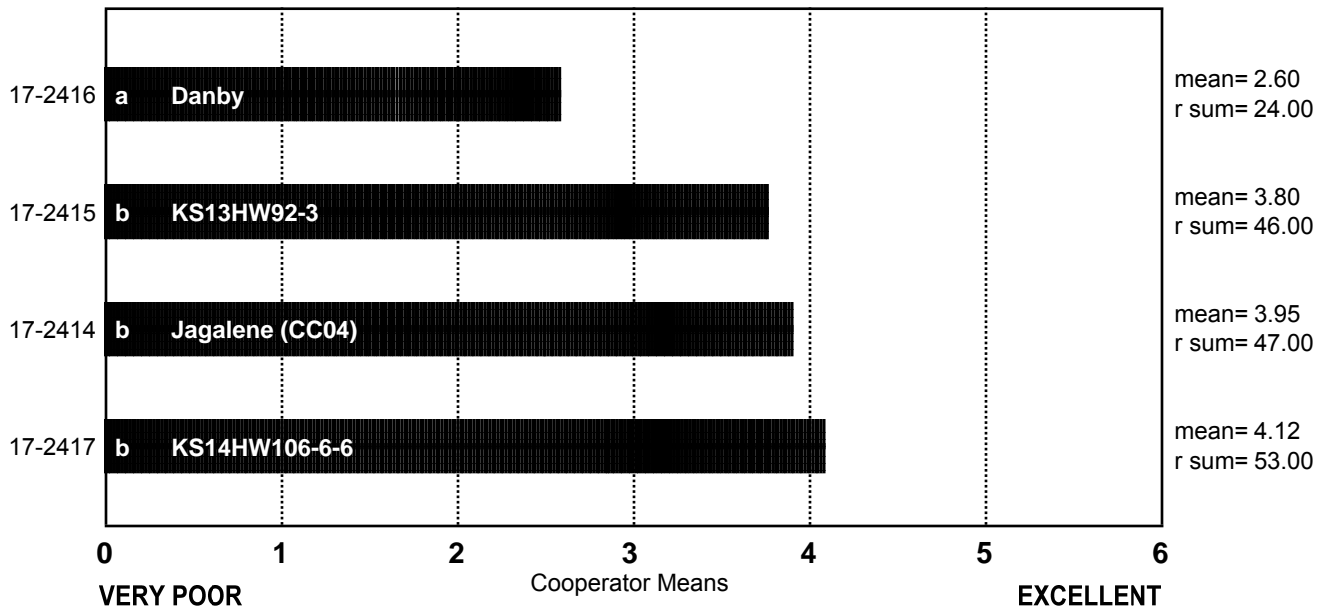
MIXING TOLERANCE

(Small Scale) Kansas-Hays

ncoop= 17
 chisq= 17.12
 chisqc= 22.73
 cvchisq= 7.82
 crdiff= 10.08

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



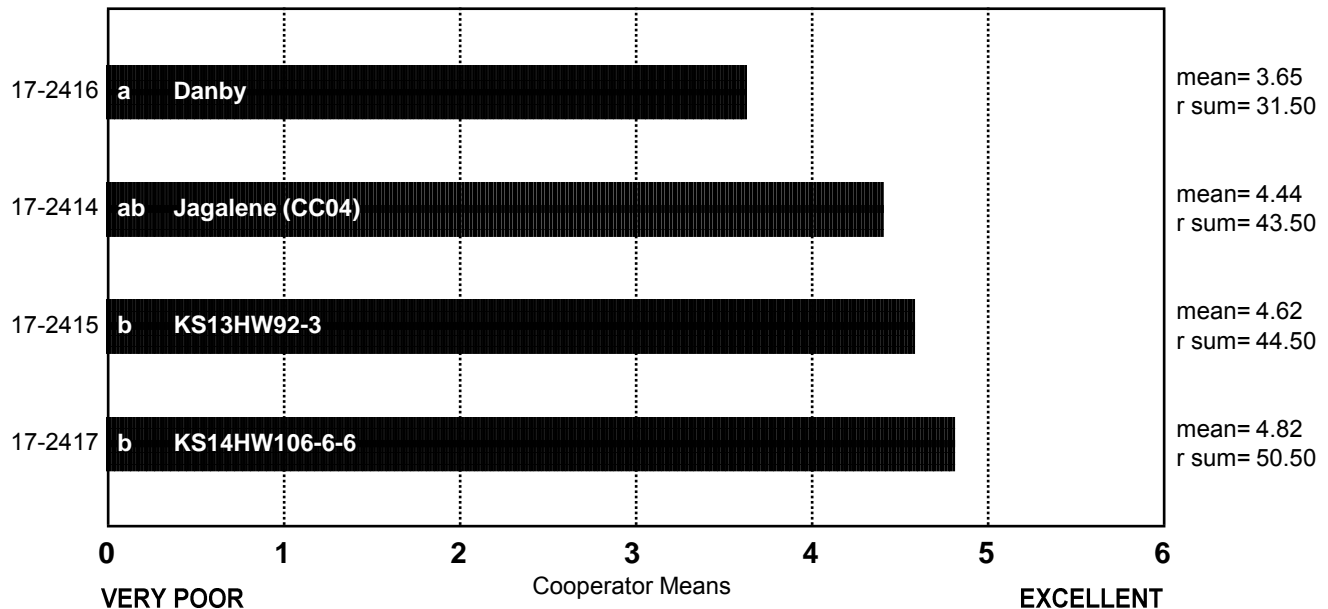
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 6.71
chisqc= 8.77
cvchisq= 7.82
crdiff= 12.42

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
17-2414 Jagalene (CC04)	2	0	3	8	4
17-2415 KS13HW92-3	0	0	3	11	3
17-2416 Danby	5	1	3	6	2
17-2417 KS14HW106-6-6	0	1	3	9	4

Frequency Table

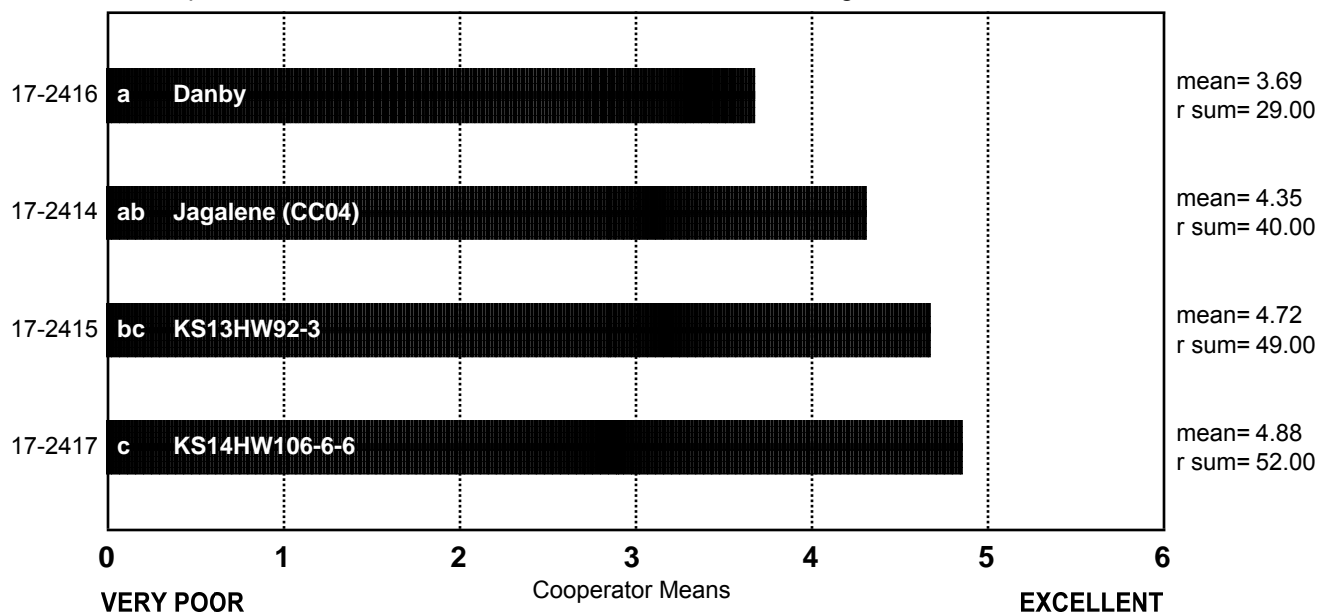
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 11.33
chisqc= 15.66
cvchisq= 7.82
crdiff= 11.05

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
17-2414 Jagalene (CC04)	1	0	2	9	5
17-2415 KS13HW92-3	0	0	4	7	6
17-2416 Danby	3	0	2	10	2
17-2417 KS14HW106-6-6	0	0	2	10	5

Frequency Table

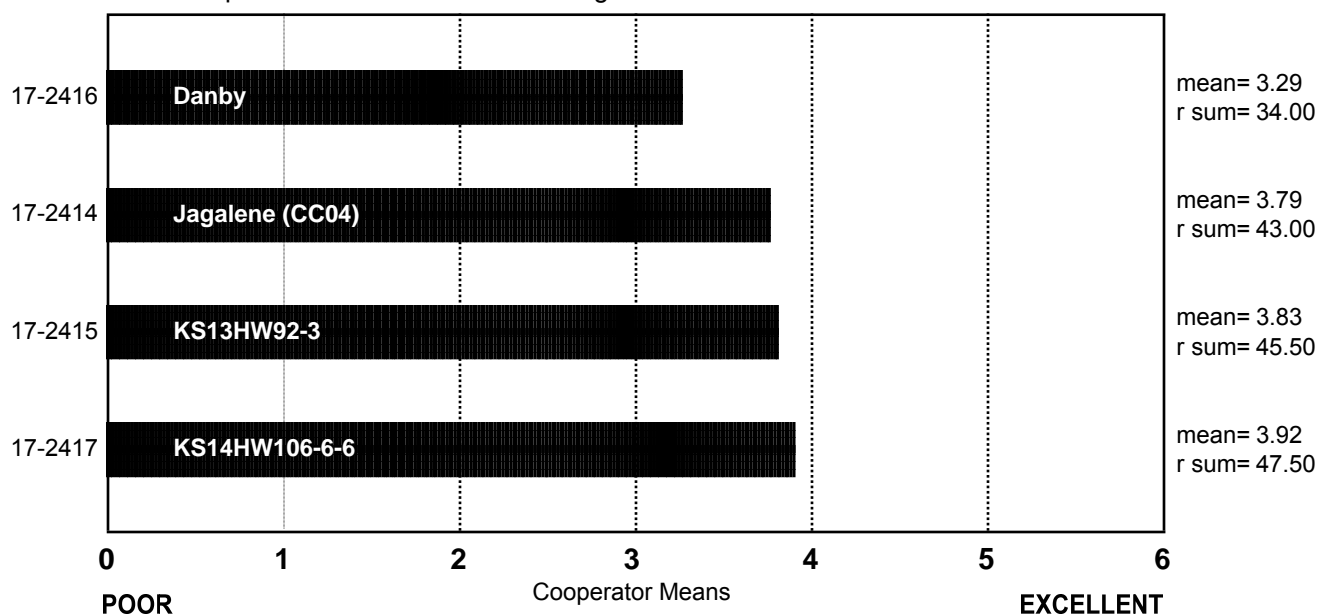
CRUMB GRAIN

(Small Scale) Kansas-Hays

ncoop= 17
 chisq= 3.76
 chisqc= 4.95
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Kansas-Hays

	Open	Fine	Dense
17-2414 Jagalene (CC04)	7	9	1
17-2415 KS13HW92-3	6	10	1
17-2416 Danby	8	8	1
17-2417 KS14HW106-6-6	9	8	0

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Kansas-Hays

	Round	Irregular	Elongated
17-2414 Jagalone (CC04)	5	8	4
17-2415 KS13HW92-3	5	7	5
17-2416 Danby	10	4	3
17-2417 KS14HW106-6-6	3	6	8

Frequency Table

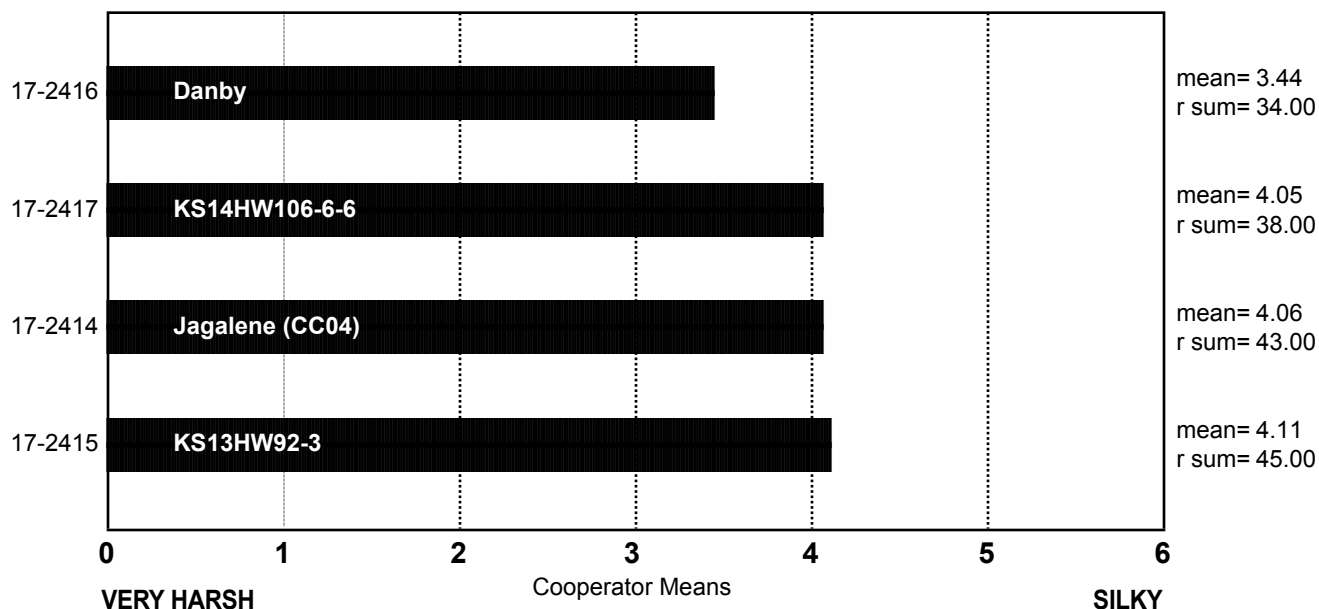
CRUMB TEXTURE

(Small Scale) Kansas-Hays

ncoop= 16
 chisq= 2.78
 chisqc= 3.96
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Kansas-Hays

	Harsh	Smooth	Silky
17-2414 Jagalene (CC04)	2	10	5
17-2415 KS13HW92-3	4	6	7
17-2416 Danby	6	8	3
17-2417 KS14HW106-6-6	2	13	2

Frequency Table

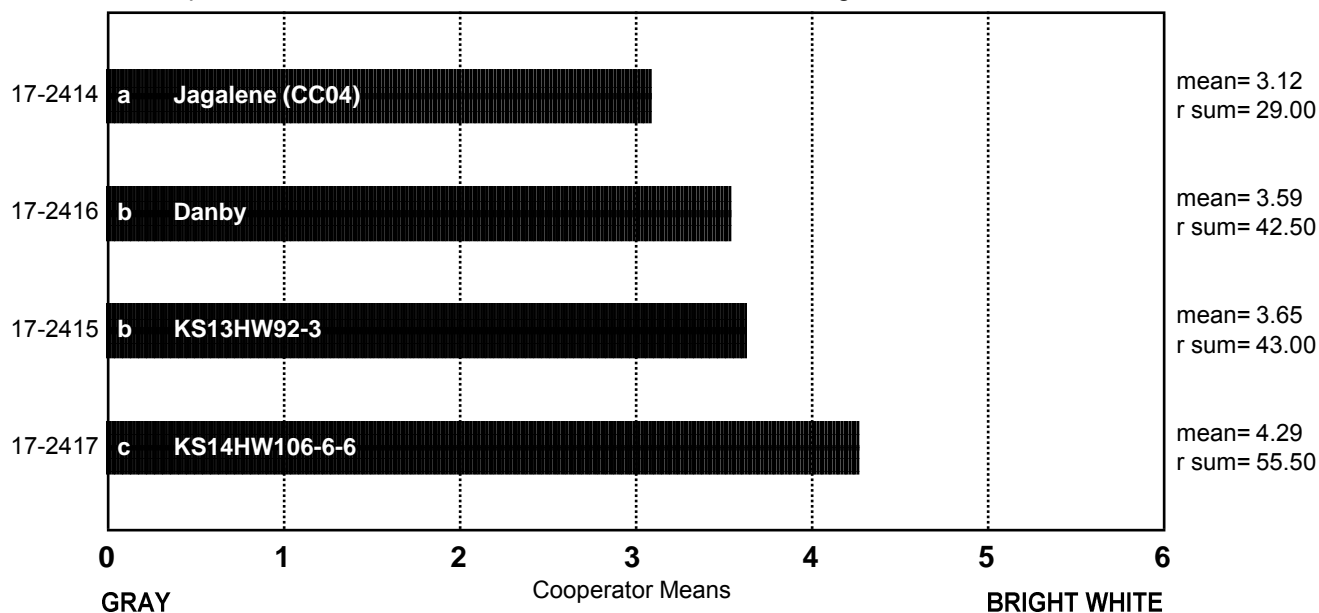
CRUMB COLOR

(Small Scale) Kansas-Hays

ncoop= 17
 chisq= 12.41
 chisqc= 18.34
 cvchisq= 7.82
 crdiff= 10.27

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Kansas-Hays

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2414 Jagalene (CC04)	1	0	6	5	3	1	0
17-2415 KS13HW92-3	0	0	4	3	7	2	1
17-2416 Danby	0	0	5	2	8	1	1
17-2417 KS14HW106-6-6	0	0	1	1	9	5	1

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Kansas-Hays

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2414 Jaqalene (CC04)	412.0	464.0	430.0	448.0	144.6	453.5		144.0	445.1	134.8	141.5	145.8	134.7	159.3	139.1	154.6	486.8
17-2415 KS13HW92-3	410.0	463.1	424.0	451.0	144.0	449.4		146.4	443.0	135.7	144.2	147.7	137.4	158.1	138.7	155.6	478.6
17-2416 Danby	412.0	464.6	427.0	447.0	145.2	450.7		142.6	442.6	134.1	140.8	148.5	137.1	153.7	139.6	151.5	494.2
17-2417 KS14HW106-6-6	415.0	464.3	425.0	455.0	141.0	450.3		142.8	448.2	134.4	138.3	145.0	130.6	153.5	140.3	152.6	488.8

LOAF VOLUME, ACTUAL

(Small Scale) Kansas-Hays

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2414 Jaqualene (CC04)	3025	2525	2775	2350	895	2808	2986	750	2400	860	940	875	827	913	863	845	2500
17-2415 KS13HW92-3	3025	2288	2400	2225	905	2708	2809	845	2125	1010	1050	915	902	1015	880	955	2413
17-2416 Danby	2675	2363	2500	2400	725	2580	2721	700	2350	955	970	725	770	950	808	825	2263
17-2417 KS14HW106-6-6	2800	2450	2650	2575	930	2926	2897	880	2350	1025	1018	960	910	1063	888	890	2388

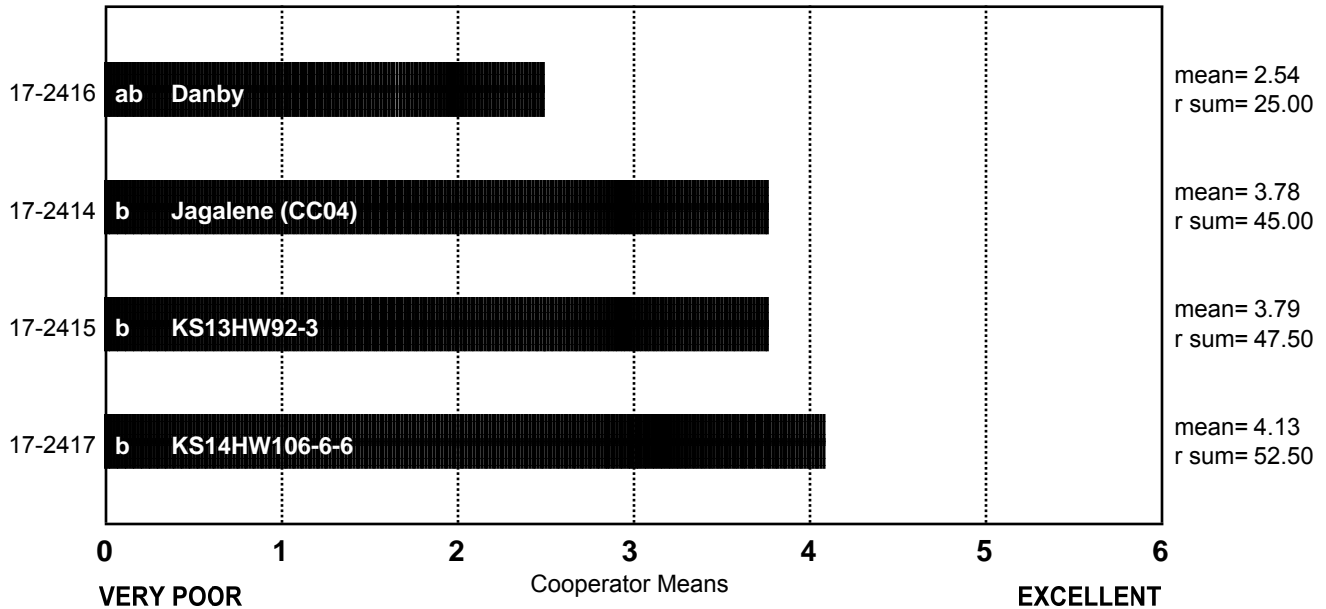
LOAF VOLUME

(Small Scale) Kansas-Hays

ncoop= 17
 chisq= 15.44
 chisqc= 17.62
 cvchisq= 7.82
 crdiff= 11.82

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



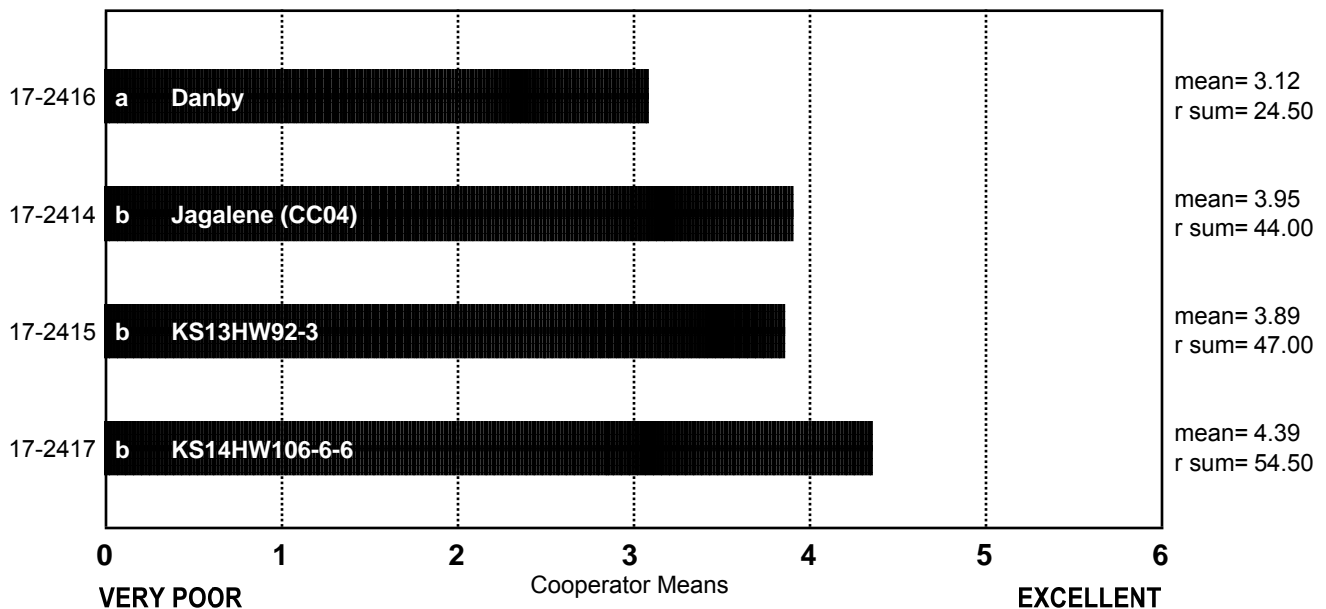
OVERALL BAKING QUALITY

(Small Scale) Kansas-Hays

ncoop= 17
 chisq= 17.31
 chisqc= 19.24
 cvchisq= 7.82
 crdiff= 11.68

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS

(Small Scale) Kansas-Hays

COOP.

17-2414 Jagalene (CC04)

- A. No comment.
- B. No comment.
- C. All good.
- D. No comment.
- E. Yellow dough, excellent loaf externals.
- F. Gummy crumb texture.
- G. Fair absorption, mix strength and good volume, high ash.
- H. Good absorption.
- I. Best of set, good volume and crumb rating is what put this one above the others in the set.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, fine elongated cells, resilient & very smooth texture.
- L. Good mix time/strength/grain.
- M. No comment.
- N. Performed as expected for protein level.
- O. No comment.
- P. High bake absorption, long bake mix time, excellent out of mixer and good at pan, crumb grain Questionable – Satisfactory, loaf volume ok for flour protein.
- Q. High absorption, dark yellow color, average volume.

COOP.

17-2415 KS13HW92-3

- A. No comment.
- B. No comment.
- C. Poor bread performance, very low loaf volume.
- D. No comment.
- E. White dough, excellent loaf externals.
- F. No comment.
- G. Good absorption, mix strength and slightly low volume.
- H. Good absorption.
- I. No comment.
- J. No comment.
- K. High water absorption, normal mix time, slight sticky & strong dough, very high volume, slightly yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Good protein/color.
- M. No comment.
- N. Good volume performance.
- O. No comment.
- P. Strong mixograph, beautiful exterior loaf, good medium mix time, high bake absorption, excellent dough, loaf volume and crumb grain.
- Q. High absorption, nice dough out of mixer, yellow color.

COOP.**17-2416 Danby**

- A. No comment.
- B. No comment.
- C. Poor bread performance, low loaf volume.
- D. No comment.
- E. Slight cap.
- F. Gummy crumb texture.
- G. Good absorption, very low mix strength and volume.
- H. Average absorption.
- I. Overall good, had an open crumb rating.
- J. Average texture, tough out of mixer and slack after fermentation.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
- L. Short mix, weaker, unacceptable loaf volume.
- M. No comment.
- N. Good volume, weaker dough type.
- O. No comment.
- P. Weak mixograph tolerance, good bake absorption & dough feel, short bake mix time, Questionable – Satisfactory crumb grain, low loaf volume.
- Q. Good absorption, poor mixing tolerance, sticky dough, open grain, yellow color, very low volume.

COOP.**17-2417 KS14HW106-6-6**

- A. No comment.
- B. No comment.
- C. Average performance.
- D. No comment.
- E. Rough break and shred.
- F. No comment.
- G. Low absorption, good mix strength and volume, high ash.
- H. Good absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption, long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
- L. Excellent color, acceptable-low protein but performed very well.
- M. No comment.
- N. Excellent dough and loaf volume, good crumb grain character.
- O. No comment.
- P. Nice flour protein, excellent bake absorption and dough feel, crumb grain excellent.
- Q. Good absorption, nice dough, yellow color, low volume.

Notes: **A, C, D, G, I and Q** conducted sponge and dough bake tests

MONTANA

17-2418	Yellowstone
17-2419	MT1465
17-2420	Jagalene (CC05)
17-2421	MTW1491

Description of Test Plots and Breeder Entries

Montana – Phil Bruckner/Jim Berg

Growing Location & Conditions

The samples submitted were grown at the Post Agronomy Farm, west of Bozeman. Strips were planted in silt-loam on September 20, 2016 into above average fall moisture. There was normal snow cover during winter months and no winterkill was observed. Heading (June 9) was earlier than the 65year average by 11 days. Temperatures from March to August were above average with above average moisture recorded in March and April, and below average moisture in June and July. Harvest, on August 21st, was during the solar eclipse. Stripe rust was evident in mid-May and was a major factor in yield and test weight reduction for replicated field tests (which were not sprayed with fungicide). The WQC strips (Jagalene is susceptible) were sprayed with fungicide (Quilt) on May 15th.

The Montana Intrastate Winter Wheat Test (varieties and elite lines, planted nearby), which includes lines grown in the WQC drill strips, had yields (average = 89 bu/a, range 24 – 125 bu/a) and test weights (average = 59.7 lb/bu, range 55.0 - 63.1 lb/bu) which were comparable to recent averages. Proteins were average at 13.1% (range 11.6 to 15.1%). Stripe rust infection averaged 27% on July 2nd (range 2 – 94% flag leaf involvement).

Yellowstone (local check)

MT1465 – a hollow stemmed hard red winter wheat line derived from a diverse composite cross comprised of 5 experimental lines all crossed to Yellowstone. MT1465 has above average yield and test weight and average protein. Over 25 location-years, yield of MT1465 was 2 bu/a higher than Yellowstone. MT1465 has average winter hardiness in limited testing in eastern Montana and western North Dakota. MT1465 has medium heading date (0.4d earlier than Yellowstone) and is 2 in. shorter than Yellowstone. MT1465 is moderately susceptible to stem rust (Yellowstone is susceptible) and resistant to stripe rust.

MT1465 is a medium PPO line with above average flour yield and flour protein in MSU tests. Ash is good and lower than Yellowstone. Mix times are medium-long, similar to most Montana varieties. Mixing tolerance is average. Mix and bake absorption is above average (similar to Yellowstone). Loaf volume is above average and exceeds Yellowstone.

Jagalene (common check)

MTW1491 – a hollow stemmed hard white winter wheat line derived from a low PPO Yellowstone plant selection crossed to a 'Colter' sib line then backcrossed to a different low PPO Yellowstone plant selection. MTW1491 has above average yield and test weight and below average protein. Over 25 location-years, yield of MTW1491 was 4 bu/a higher than Yellowstone. MT1465 has average winter hardiness in limited testing in

eastern Montana and western North Dakota. MTW1491 has medium-late heading date (1 d later than Yellowstone) and is 1.5 in. taller than Yellowstone. MTW1465 is susceptible to stem rust and resistant to stripe rust.

MTW1491 is a low PPO line with high flour yield and below average flour protein in MSU tests. Ash is good and lower than Yellowstone. Mix times are long, similar to most Montana varieties. Mixing tolerance is good. Mix and bake absorption is average. Loaf volume is acceptable. Noodles prepared with MTW1491 show good 24 hour L* stability with a high composite noodle score.

Montana: 2017 (Small-Scale) Samples

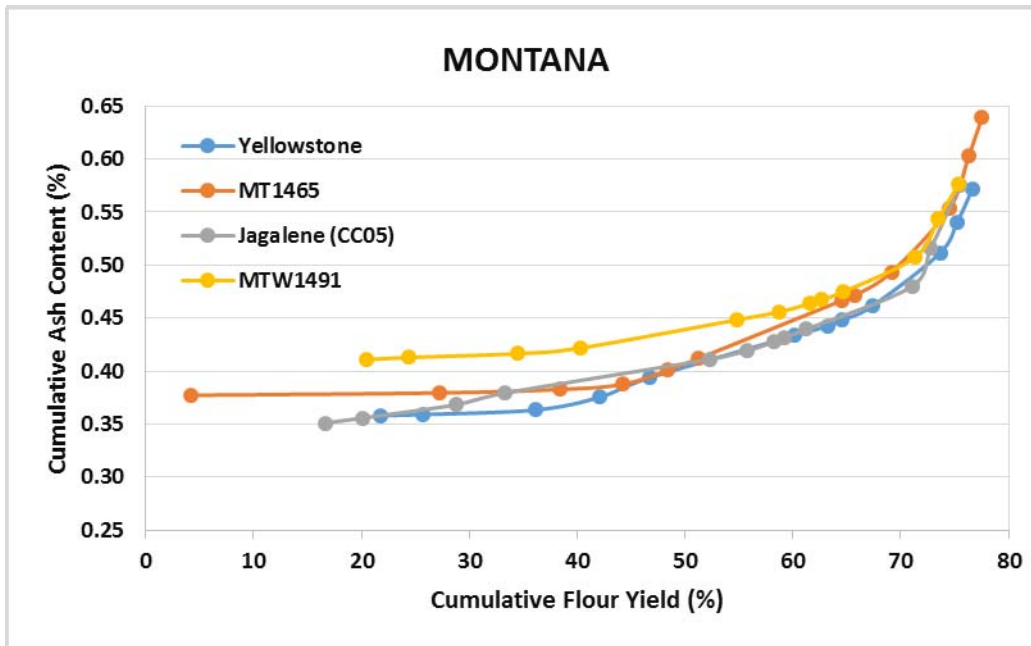
Test entry number	17-2418	17-2419	17-2420	17-2421
Sample identification	Yellowstone	MT1465	Jagalene (CC05)	MTW1491
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HDWH
Test weight (lb/bu)	61.7	62.4	64.1	61.9
Hectoliter weight (kg/hl)	81.1	82.0	84.2	81.4
1000 kernel weight (gm)	33.4	30.6	32.2	35.1
Wheat kernel size (Rotap)				
Over 7 wire (%)	73.4	61.9	62.8	69.0
Over 9 wire (%)	26.6	38.0	37.1	30.9
Through 9 wire (%)	0.0	0.1	0.1	0.1
Single kernel (skcs) ^a				
Hardness (avg /s.d)	69.8/14.4	69.1/14.8	70.6/16.2	71.8/13.7
Weight (mg) (avg/s.d)	33.4/7.2	30.6/8.8	32.2/9.8	35.1/9.8
Diameter (mm)(avg/s.d)	2.58/0.30	2.54/0.34	2.63/0.31	2.57/0.32
Moisture (%) (avg/s.d)	8.2/0.7	8.0/0.7	8.0/0.7	8.5/0.7
SKCS distribution	01-04-19-76-01	01-06-19-74-01	03-05-13-79-01	00-04-15-81-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	13.6	13.7	13.4	14.2
Wheat ash (12% mb)	1.62	1.54	1.46	1.48
Milling and Flour Quality Data				
Flour yield (% ,str. grade)				
Miag Multomat Mill	76.7	77.7	75.5	75.3
Quadrumat Sr. Mill	70.0	70.5	70.5	70.6
Flour moisture (%)	13.4	13.0	13.0	12.9
Flour protein (14% mb)	12.0	12.2	11.7	12.5
Flour ash (14% mb)	0.54	0.59	0.51	0.50
Rapid Visco-Analyser				
Peak Time (min)	6.5	6.5	6.3	6.5
Peak Viscosity (RVU)	198.3	189.3	161.8	192.5
Breakdown (RVU)	43.3	38.0	35.0	36.2
Final Viscosity at 13 min (RVU)	260.0	248.8	222.5	257.6
Minolta color meter				
L*	91.19	91.03	91.66	91.83
a*	-1.24	-1.17	-1.49	-1.39
b*	9.47	9.52	9.75	9.38
PPO	0.357	0.476	0.450	0.218
Falling number (sec)	461	441	387	440
Damaged Starch				
(AI%)	97.3	96.9	98.7	97.4
(AACC76-31)	7.3	7.0	8.5	7.4

^as.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Montana: Physical Dough Tests and Gluten Analysis 2017 (Small-Scale) Samples

Test Entry Number	17-2418	17-2419	17-2420	17-2421
Sample Identification	Yellowstone	MT1465	Jagalene (CC05)	MTW1491
MIXOGRAPH				
Flour Abs (% as-is)	67.3	67.3	67.9	67.5
Flour Abs (14% mb)	66.5	66.1	66.5	66.5
Mix Time (min)	6.5	4.1	4.1	7.8
Mix tolerance (0-6)	5	4	4	4
FARINOGRAPH				
Flour Abs (% as-is)	63.5	64.0	66.1	65.8
Flour Abs (14% mb)	62.7	62.8	64.7	64.8
Peak time (min)	5.0	7.5	7.5	3.7
Mix stability (min)	10.7	11.4	10.1	10.7
Mix Tolerance Index (FU)	24	29	30	24
Breakdown time (min)	11.1	12.0	12.2	11.2
ALVEOGRAPH				
P(mm): Tenacity	112	116	136	136
L(mm): Extensibility	85	75	54	77
G(mm): Swelling index	20.5	19.3	16.4	19.5
W(10 ⁻⁴ J): strength (curve area)	375	336	296	439
P/L: curve configuration ratio	1.32	1.55	2.52	1.77
Ie(P ₂₀₀ /P): elasticity index	66.3	62.3	58.4	70.9
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	580/781/950	415/543/694	383/557/601	646/994/995
Extensibility (mm at 45/90/135 min)	134/119/93	144/130/139	129/120/115	121/112/98
Energy (cm ² at 45/90/135 min)	128/135/112	104/112/144	81/103/104	124/150/119
Resist _{max} (BU at 45/90/135 min)	759/938/998	553/678/840	479/714/767	831/99/996
Ratio (at 45/90/135 min)	4.3/6.6/10.3	2.9/4.2/4.4	3.0/4.6/5.2	5.3/8.8/10.1
PROTEIN ANALYSIS				
HMW-GS Composition	1,5+10,7+8	2*,5+10,7+8	2*,1,5+10,17+18	1,5+10,7+8
TMP/TPP	0.84	0.85	0.95	0.83
SEDIMENTATION TEST				
Volume (ml)	56.1	53.8	54.3	64.8

Montana: Cumulative Ash Curves

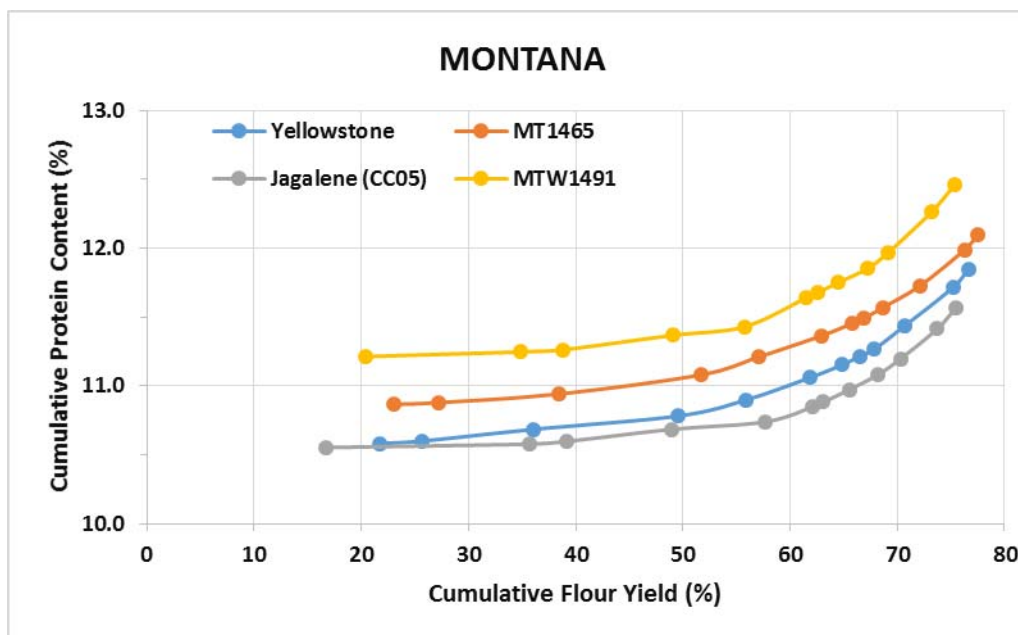


Yellowstone					MT1465				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	21.8	0.36	21.8	0.36	1M Red	4.2	0.38	4.2	0.38
1M Red	3.9	0.36	25.7	0.36	2M	23.1	0.38	27.3	0.38
1M	10.4	0.37	36.1	0.36	1M	11.2	0.39	38.4	0.38
1BK	6.0	0.45	42.1	0.38	1BK	5.8	0.42	44.3	0.39
2BK	4.6	0.56	46.7	0.39	2BK	4.1	0.54	48.4	0.40
3M	13.5	0.57	60.2	0.43	Grader	2.9	0.60	51.3	0.41
Grader	3.0	0.61	63.2	0.44	3M	13.3	0.68	64.6	0.47
FILTER FLR	1.4	0.71	64.6	0.45	FILTER FLR	1.1	0.73	65.7	0.47
3BK	2.8	0.77	67.4	0.46	3BK	3.5	0.92	69.1	0.49
4M	6.3	1.05	73.6	0.51	4M	5.3	1.32	74.5	0.55
5M	1.6	1.87	75.2	0.54	5M	1.8	2.65	76.3	0.60
BRAN FLR	1.4	2.27	76.6	0.57	BRAN FLR	1.3	2.89	77.5	0.64
Break Shorts	3.2	4.32	79.9	0.72	Break Shorts	4.1	4.68	81.7	0.84
Red Dog	2.0	2.88	81.9	0.78	Red Dog	2.9	3.13	84.6	0.92
Red Shorts	0.3	3.54	82.2	0.79	Red Shorts	0.5	3.65	85.1	0.94
Filter Bran	2.5	3.37	84.7	0.86	Filter Bran	1.1	3.49	86.2	0.97
Bran	15.3	5.66	100.0	1.60	Bran	13.8	5.42	100.0	1.59

Wheat	1.50	1.44
St. Grd. Fl.	0.54	0.59

Jagalene (CC05)					MTW1491				
Mill Streams	Strm-yld	Ash	Cumul (14%)		Mill Streams	Strm-yld	Ash	Cumul (14%)	
	(14%mb)		Yield	Ash		(14%mb)		Yield	Ash
2M	16.7	0.35	16.7	0.35	2M	20.4	0.41	20.4	0.41
1M Red	3.5	0.38	20.1	0.36	1M Red	3.9	0.42	24.3	0.41
1M	8.7	0.40	28.8	0.37	1M	10.2	0.43	34.5	0.42
1BK	4.4	0.45	33.3	0.38	1BK	5.7	0.45	40.3	0.42
3M	19.1	0.47	52.3	0.41	3M	14.5	0.52	54.8	0.45
2BK	3.4	0.55	55.8	0.42	2BK	4.0	0.56	58.8	0.46
Grader	2.4	0.61	58.2	0.43	Grader	2.8	0.63	61.5	0.46
FILTER FLR	1.0	0.67	59.2	0.43	FILTER FLR	1.1	0.66	62.7	0.47
3BK	2.1	0.67	61.3	0.44	3BK	1.9	0.71	64.6	0.47
4M	9.8	0.73	71.0	0.48	4M	6.7	0.82	71.3	0.51
BRAN FLR	1.8	1.97	72.8	0.52	BRAN FLR	2.2	1.74	73.5	0.54
5M	2.7	2.19	75.5	0.58	5M	1.9	1.87	75.4	0.58
Break Shorts	4.0	2.89	79.5	0.69	Break Shorts	3.6	3.01	79.0	0.69
Red Dog	2.1	2.83	81.5	0.75	Red Dog	1.7	2.67	80.7	0.73
Red Shorts	0.4	3.40	82.0	0.76	Red Shorts	0.2	3.46	80.9	0.74
Filter Bran	0.9	2.96	82.9	0.78	Filter Bran	0.7	3.04	81.7	0.76
Bran	17.1	5.08	100.0	1.52	Bran	18.3	5.42	100.0	1.61
Wheat		1.36					1.39		
St. Grd. Fl.		0.51					0.50		

Montana: Cumulative Protein Curves



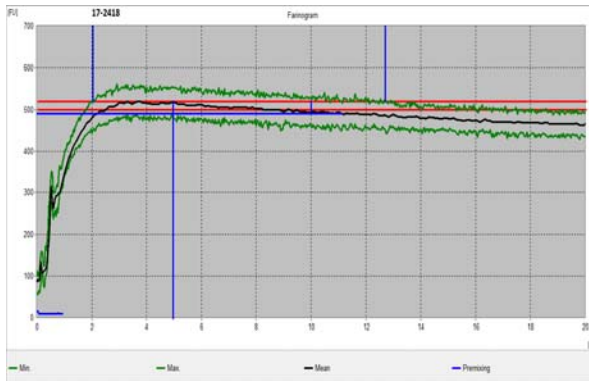
Yellowstone					MT1465				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
2M	21.8	10.58	21.8	10.6	2M	23.1	10.86	23.1	10.9
1M Red	3.9	10.70	25.7	10.6	1M Red	4.2	10.95	27.3	10.9
1M	10.4	10.89	36.1	10.7	1M	11.2	11.09	38.4	10.9
3M	13.5	11.04	49.6	10.8	3M	13.3	11.48	51.7	11.1
4M	6.3	11.81	55.9	10.9	4M	5.3	12.46	57.1	11.2
1BK	6.0	12.58	61.9	11.1	1BK	5.8	12.86	62.9	11.4
Grader	3.0	13.06	64.9	11.2	Grader	2.9	13.44	65.8	11.5
5M	1.6	13.71	66.5	11.2	FILTER FLR	1.1	13.68	66.9	11.5
FILTER FLR	1.4	13.76	67.8	11.3	5M	1.8	14.53	68.7	11.6
3BK	2.8	15.49	70.6	11.4	3BK	3.5	14.87	72.1	11.7
2BK	4.6	16.09	75.2	11.7	2BK	4.1	16.53	76.3	12.0
BRAN FLR	1.4	18.95	76.6	11.8	BRAN FLR	1.3	18.81	77.5	12.1
Break Shorts	3.2	15.72	79.9	12.0	Break Shorts	4.1	15.30	81.7	12.3
Red Dog	2.0	13.62	81.9	12.0	Red Dog	2.9	14.06	84.6	12.3
Red Shorts	0.3	11.83	82.2	12.0	Red Shorts	0.5	12.76	85.1	12.3
Filter Bran	2.5	13.25	84.7	12.1	Filter Bran	1.1	12.36	86.2	12.3
Bran	15.3	17.23	100.0	12.9	Bran	13.8	16.85	100.0	13.0
Wheat		12.6					12.7		
St. Grd. Fl		12.0					12.2		

Jagalene (CC05)					MTW1491				
Mill Streams	Strm-yld	Protein	Cumulative (14%)		Mill Streams	Strm-yld	Protein	Cumulative (14%)	
	(14%mb)		Yield	Protein		(14%mb)		Yield	Protein
2M	16.7	10.55	16.7	10.6	2M	20.4	11.21	20.4	11.2
3M	19.1	10.60	35.7	10.6	3M	14.5	11.29	34.9	11.2
1M Red	3.5	10.81	39.2	10.6	1M Red	3.9	11.40	38.8	11.3
4M	9.8	11.03	49.0	10.7	1M	10.2	11.77	49.0	11.4
1M	8.7	11.04	57.7	10.7	4M	6.7	11.88	55.7	11.4
1BK	4.4	12.28	62.1	10.8	1BK	5.7	13.67	61.5	11.6
FILTER FLR	1.0	13.01	63.1	10.9	FILTER FLR	1.1	13.85	62.6	11.7
Grader	2.4	13.30	65.5	11.0	5M	1.9	14.13	64.5	11.7
5M	2.7	13.77	68.2	11.1	Grader	2.8	14.27	67.2	11.9
3BK	2.1	14.91	70.3	11.2	3BK	1.9	16.04	69.2	12.0
2BK	3.4	15.88	73.7	11.4	2BK	4.0	17.32	73.2	12.3
BRAN FLR	1.8	18.06	75.5	11.6	BRAN FLR	2.2	19.12	75.4	12.5
Break Shorts	4.0	14.01	79.5	11.7	Break Shorts	3.6	14.30	79.0	12.5
Red Dog	2.1	13.83	81.5	11.7	Red Dog	1.7	13.72	80.7	12.6
Red Shorts	0.4	12.80	82.0	11.8	Red Shorts	0.2	13.67	80.9	12.6
Filter Bran	0.9	12.00	82.9	11.8	Filter Bran	0.7	11.16	81.7	12.6
Bran	17.1	17.01	100.0	12.7	Bran	18.3	17.79	100.0	13.5
Wheat		12.5					13.3		
St. Grd. Fl		11.7					12.5		

Physical Dough Tests

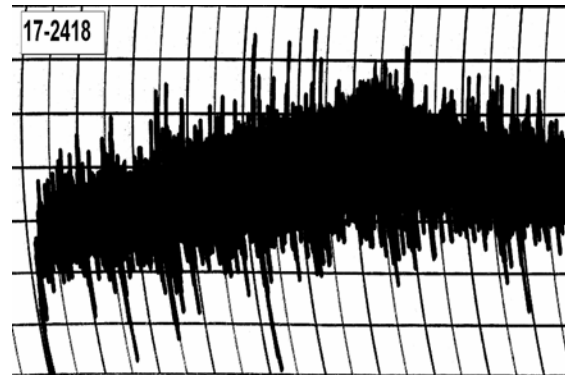
2017 (Small Scale) Samples – Montana

Farinograms



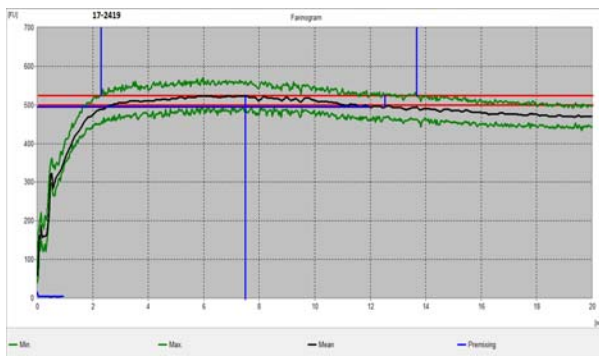
Water abs = 62.7%, Peak time = 5.0 min
Mix stab = 10.7 min, MTI = 24 FU

Mixograms

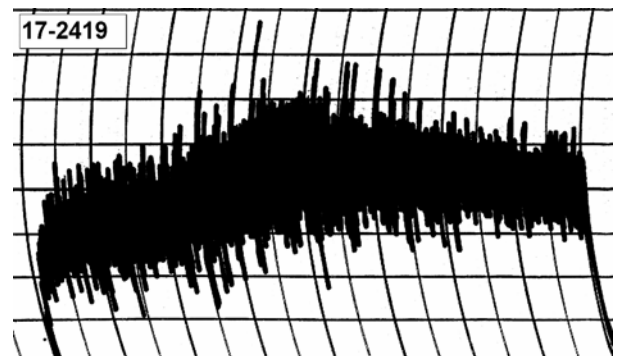


Water abs = 6.5%
Mix time = 6.5 min

17-2418, Yellowstone



Water abs = 62.8%, Peak time = 7.5 min,
Mix stab = 11.4 min, MTI = 29 FU



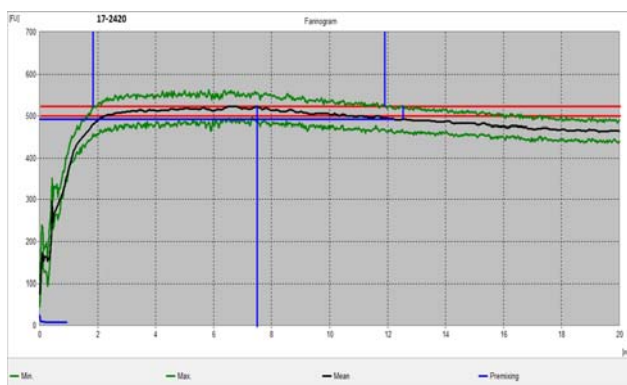
Water abs = 66.1%
Mix time = 4.1 min

17-2419, MT1465

Physical Dough Tests

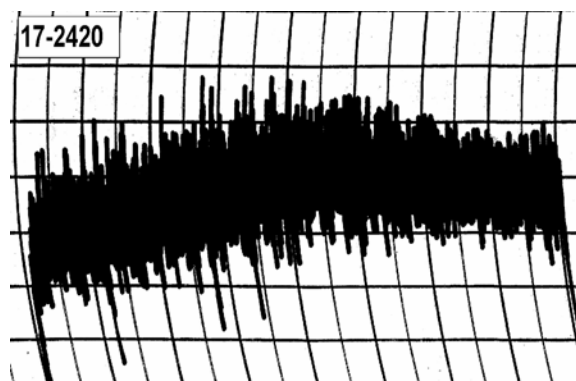
2017 (Small Scale) Samples – Montana (continued)

Farinograms



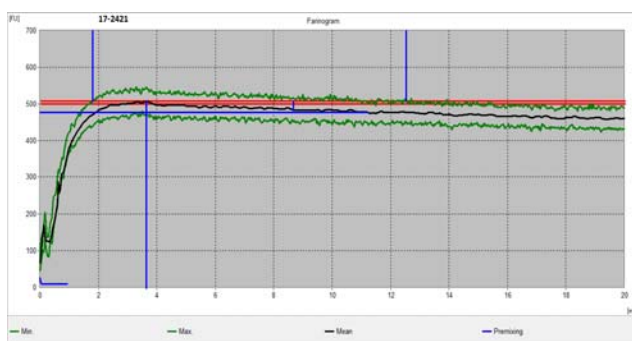
Water abs. = 64.7%, Peak time = 7.5 min,
Mix stab = 10.1 min, MTI = 30 FU

Mixograms

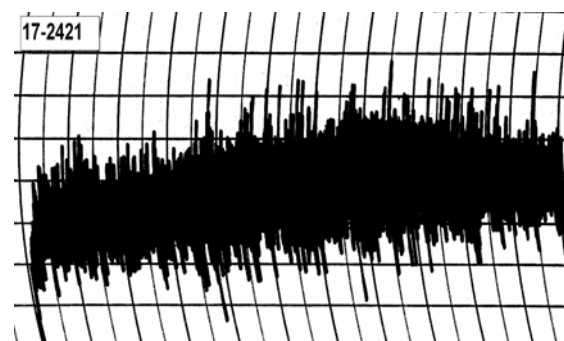


Water abs = 66.5%
Mix time = 4.1 min

17-2420, Jagalene (CC05)



Water abs. = 64.8%, Peak time = 3.7 min,
Mix stab = 10.7 min, MTI = 24 FU

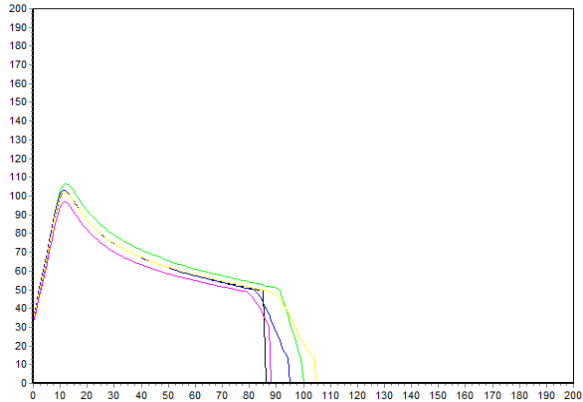


Water abs = 66.5%
Mix time = 7.8 min

17-2421, MTW1491

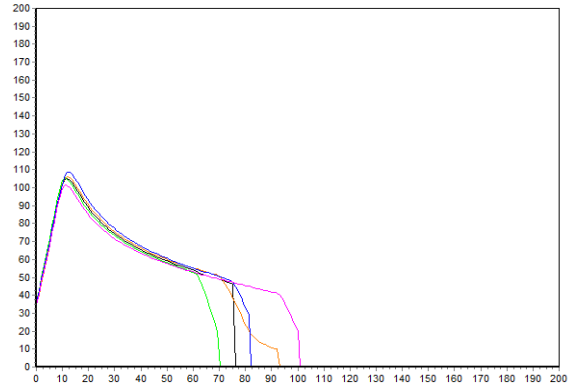
Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Montana



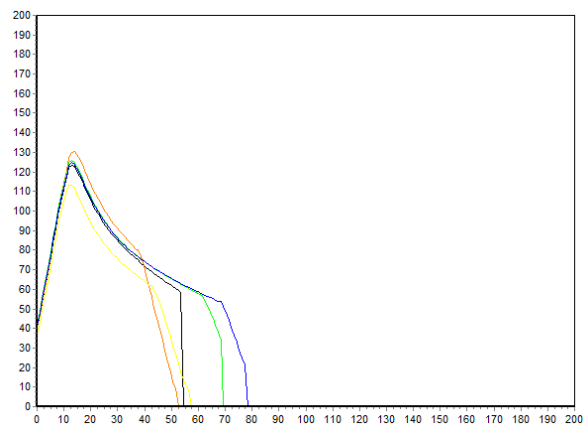
17-2418, Yellowstone

P (mm H₂O) = 112, L (mm) = 85, W (10E⁻⁴J) = 375



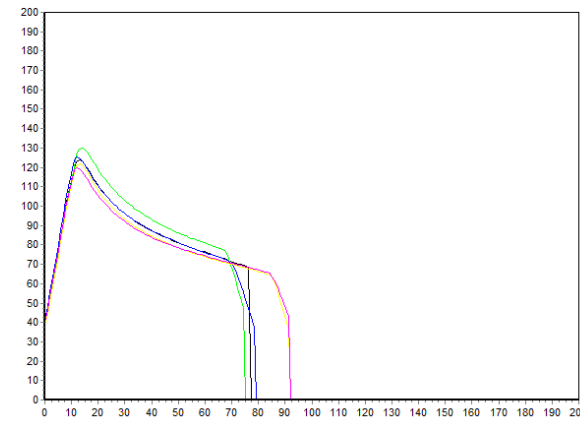
17-2419, MT1465

P (mm H₂O) = 116, L (mm) = 75, W (10E⁻⁴J) = 336



17-2420, Jagalene (CC05)

P (mm H₂O) = 136, L (mm) = 54, W (10E⁻⁴J) = 296

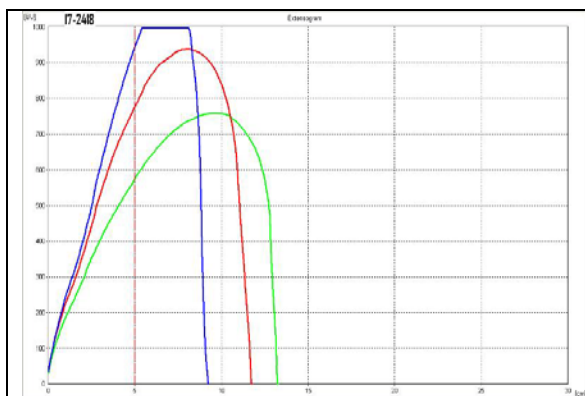


17-2421, MTW1491

P (mm H₂O) = 136, L (mm) = 77, W (10E⁻⁴J) = 439

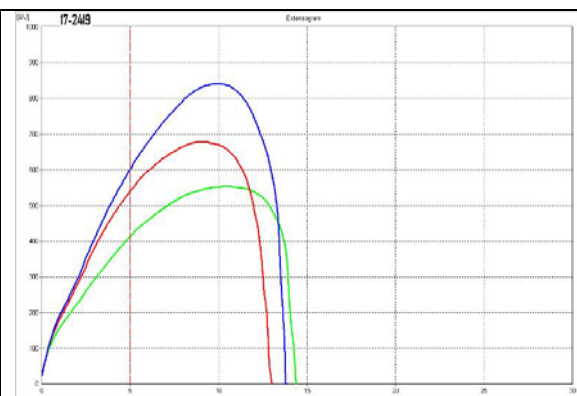
Physical Dough Tests - Extensigraph

2017 (Small Scale) Samples – Montana



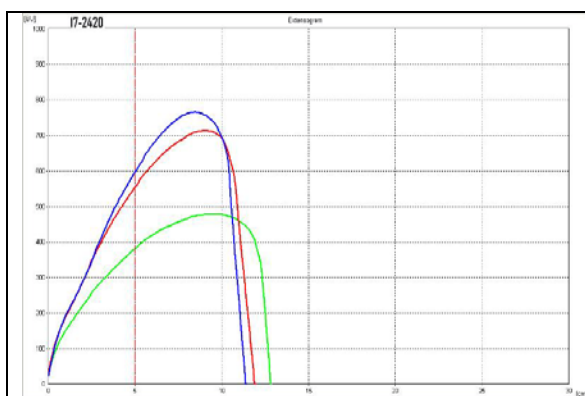
17-2418, Yellowstone

R (BU) = 781, E (mm) = 119, W (cm²) = 135
Rmax (BU) = 938, Ratio = 6.6 at 90 min



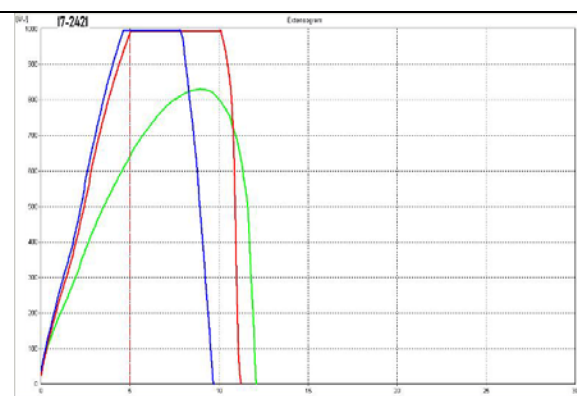
17-2419, MT1465

R (BU) = 543, E (mm) = 130, W (cm²) = 112
Rmax (BU) = 678, Ratio = 4.2 at 90 min



17-2420, Jagalene (CC05)

R (BU) = 557, E (mm) = 120, W (cm²) = 103
Rmax (BU) = 714, Ratio = 4.6 at 90 min

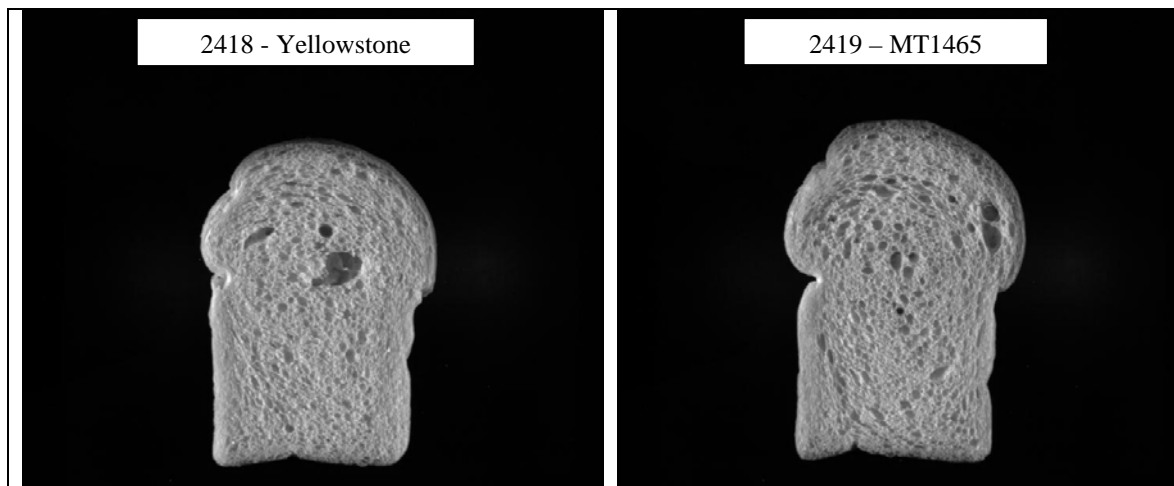


17-2421, MTW1491

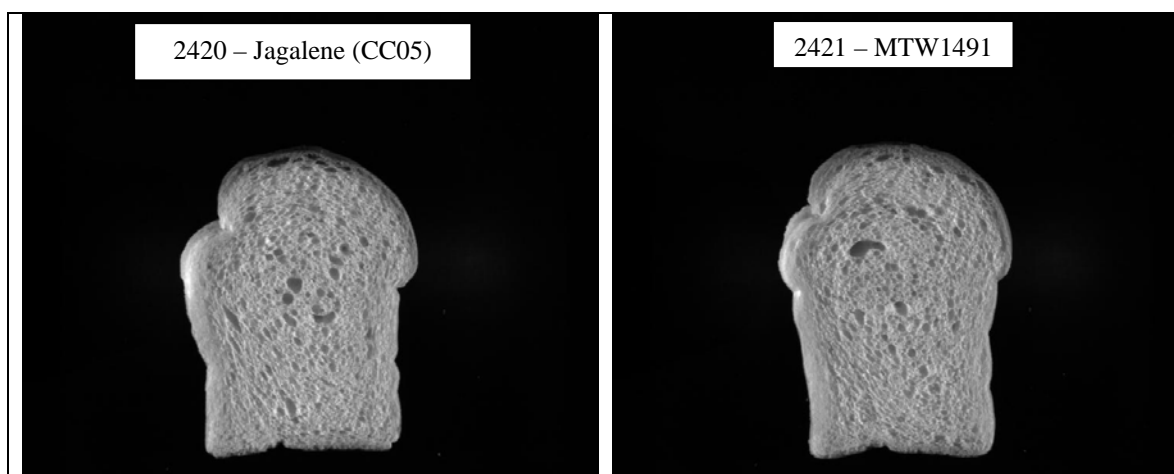
R (BU) = 994, E (mm) = 112, W (cm²) = 150
Rmax (BU) = 995, Ratio = 8.8 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm²) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Montana: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2418	5751	144	3997	0.430	1.766	7.587	1.675	-20.35
2419	6137	134	4065	0.433	1.886	2.791	1.705	-17.10



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2420	5593	143	3941	0.426	1.752	1.606	1.670	-18.55
2421	5772	142	3971	0.430	1.794	2.575	1.670	-26.55

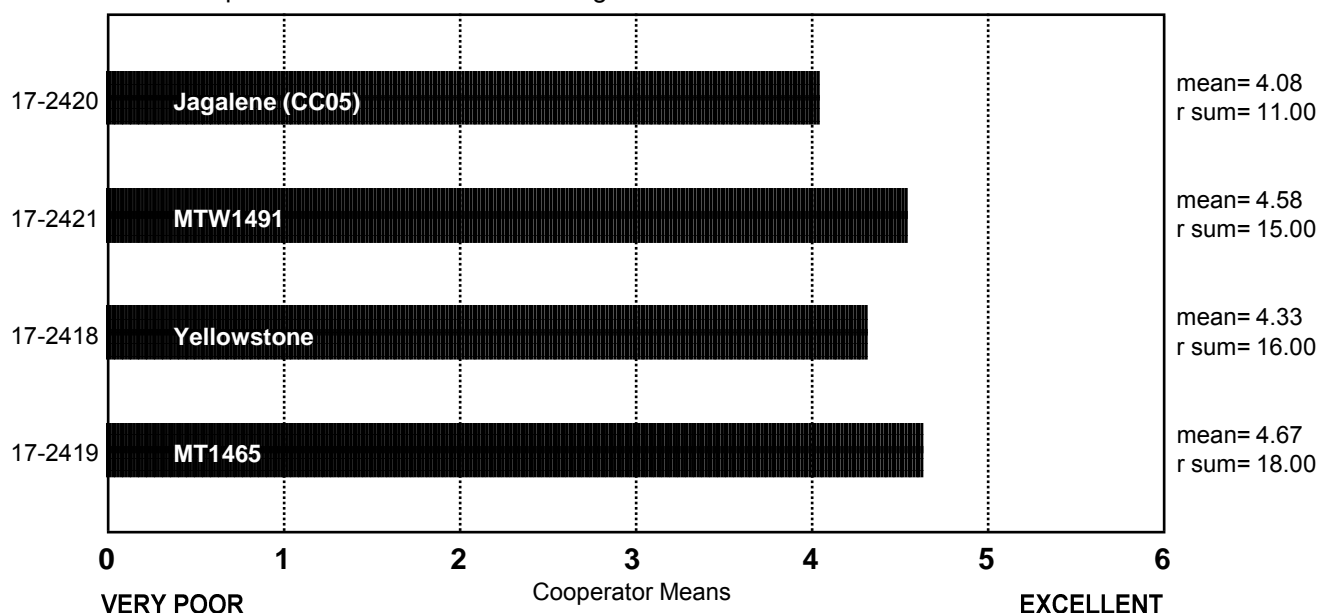
SPONGE CHARACTERISTICS

(Small Scale) Montana

Variety order by rank sum.

No samples different at 5.0% level of significance.

ncoop= 6
chisq= 2.60
chisqc= -3.71
cvchisq= 7.82
crdiff=



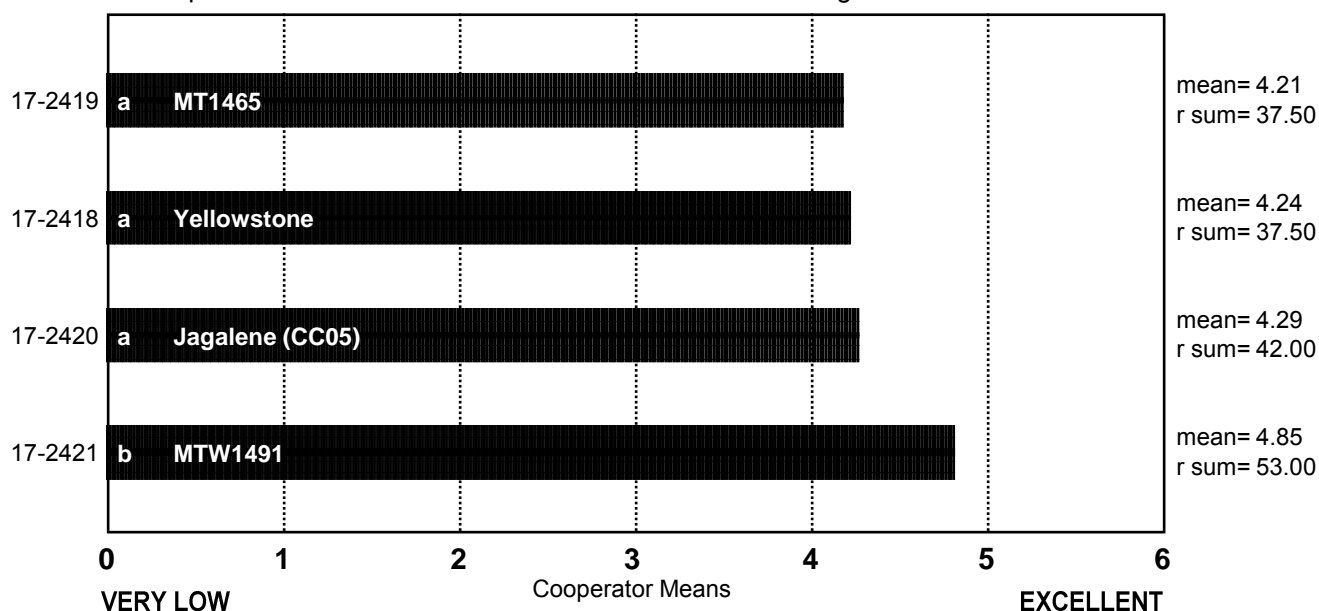
BAKE ABSORPTION

(Small Scale) Montana

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.

ncoop= 17
chisq= 5.66
chisqc= 9.63
cvchisq= 7.82
crdiff= 10.78



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2418 Yellowstone	58.0	62.7	63.0	65.0	65.0	62.7	59.0	64.0	65.7	69.9	63.3	64.2	63.5	65.2	63.5	68.7	61.2
17-2419 MT1465	58.0	62.8	63.4	65.0	62.8	62.8	58.0	65.0	65.8	70.6	63.3	63.9	63.3	66.2	64.3	67.7	60.8
17-2420 Jagalene (CC05)	57.0	64.7	64.9	67.5	63.0	64.7	59.0	64.0	67.7	69.7	63.6	62.6	65.0	67.2	63.4	68.7	61.6
17-2421 MTW1491	58.0	64.8	64.8	65.5	66.8	64.8	58.0	65.0	67.8	70.8	63.7	66.0	65.0	68.2	64.6	70.7	62.0

BAKE MIX TIME, ACTUAL

(Small Scale) Montana

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2418 Yellowstone	13.0	18.0	35.0	7.0	5.0	8.0	25.0	5.0	5.5	5.0	7.8	4.6	4.3	5.6	5.4	7.3	10.0
17-2419 MT1465	9.0	20.0	18.0	8.0	4.0	8.0	25.0	4.0	4.0	4.5	5.6	3.6	3.0	4.0	3.8	5.4	6.0
17-2420 Jagalene (CC05)	6.0	15.0	10.0	6.0	3.8	8.0	14.0	4.0	4.0	4.5	5.3	2.8	3.0	4.0	3.2	4.9	6.0
17-2421 MTW1491	14.0	40.0	35.0	7.0	6.0	8.0	25.0	6.0	8.0	6.5	8.3	5.0	4.8	5.9	5.6	9.3	15.0

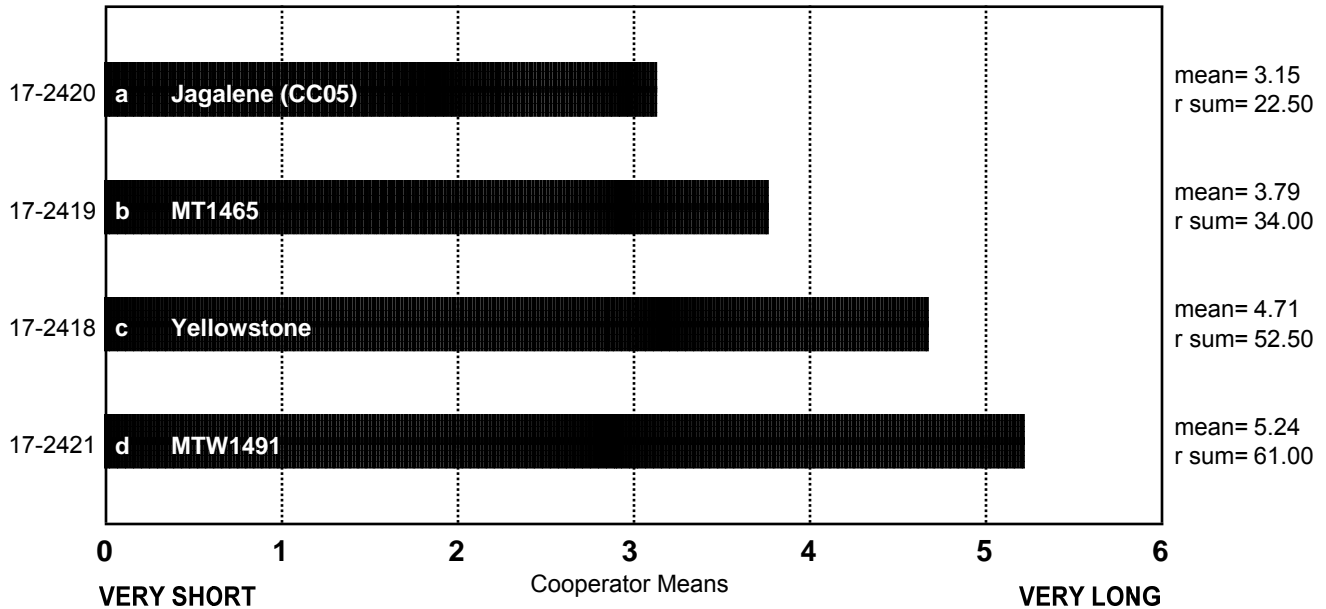
BAKE MIX TIME

(Small Scale) Montana

ncoop= 17
 chisq= 32.28
 chisqc= 40.95
 cvchisq= 7.82
 crdiff= 6.15

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



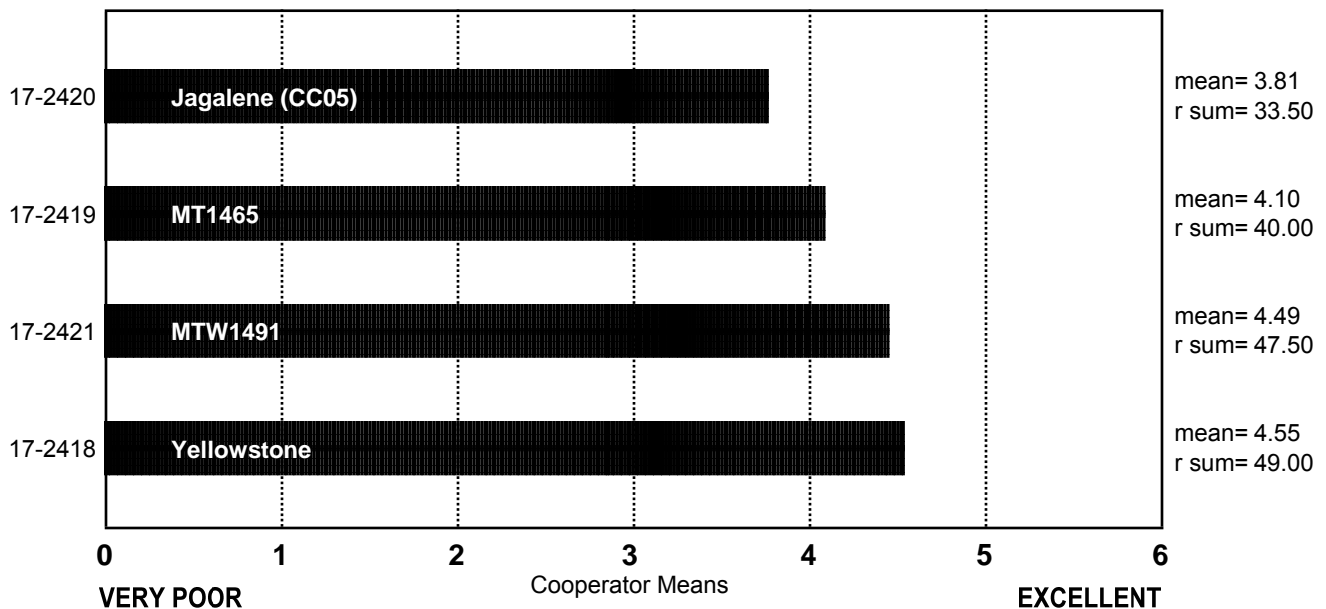
MIXING TOLERANCE

(Small Scale) Montana

ncoop= 17
 chisq= 5.45
 chisqc= 7.54
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



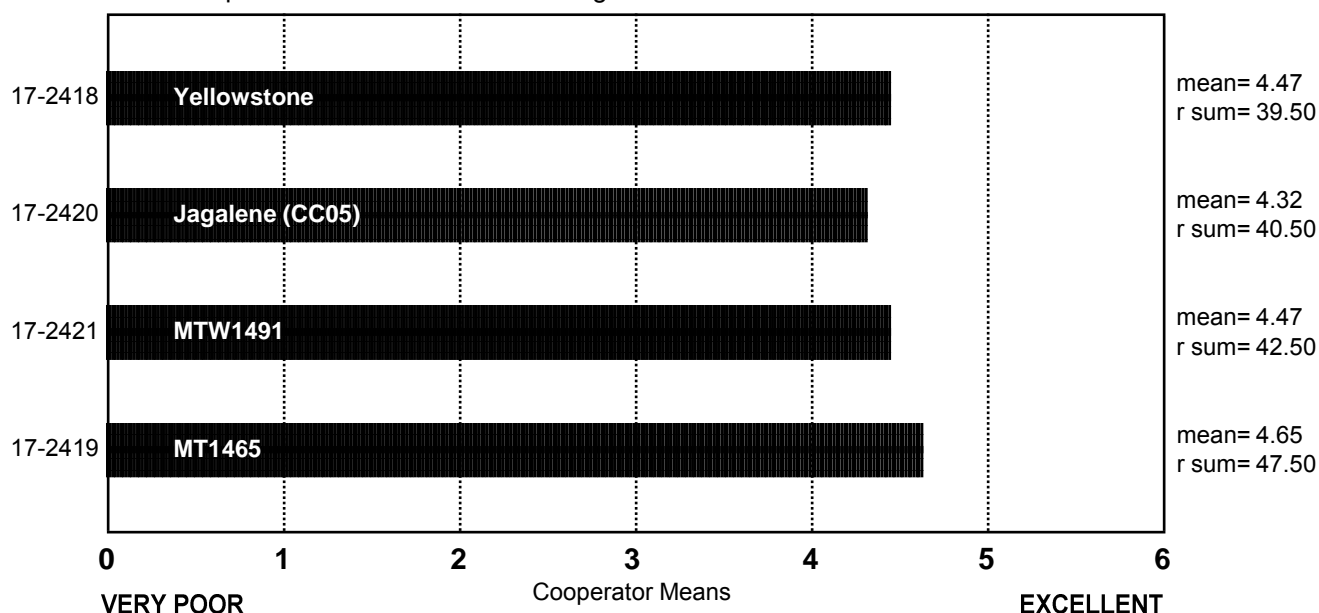
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Montana

ncoop= 17
chisq= 1.34
chisqc= 1.85
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Montana

	Sticky	Wet	Tough	Good	Excellent
17-2418 Yellowstone	1	1	5	7	3
17-2419 MT1465	2	0	2	11	2
17-2420 Jagalene (CC05)	0	0	2	14	1
17-2421 MTW1491	3	0	8	4	2

Frequency Table

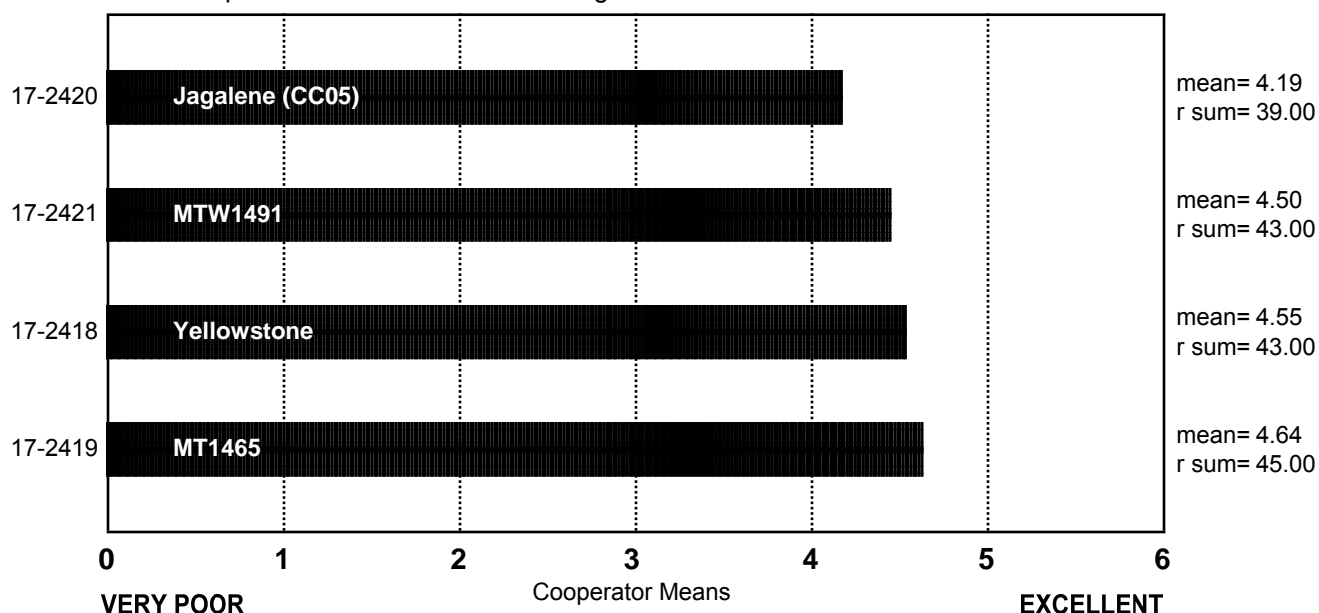
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Montana

ncoop= 17
chisq= 0.67
chisqc= 1.00
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Montana

	Sticky	Wet	Tough	Good	Excellent
17-2418 Yellowstone	0	0	4	11	2
17-2419 MT1465	0	0	2	14	1
17-2420 Jagalene (CC05)	1	1	3	10	2
17-2421 MTW1491	1	0	6	7	3

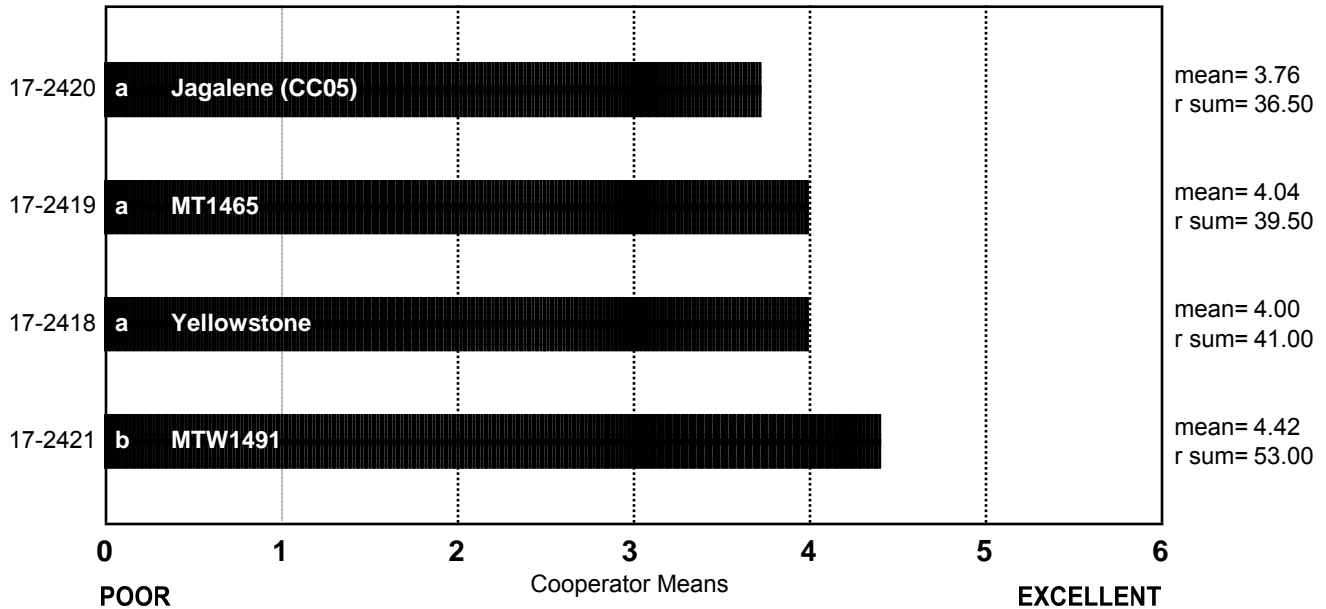
Frequency Table

CRUMB GRAIN (Small Scale) Montana

ncoop= 17
chisq= 5.56
chisqc= 8.59
cvchisq= 7.82
crdiff= 11.45

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED (Small Scale) Montana

	Open	Fine	Dense
17-2418 Yellowstone	8	8	1
17-2419 MT1465	5	11	1
17-2420 Jagalene (CC05)	5	8	4
17-2421 MTW1491	3	13	1

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Montana

	Round	Irregular	Elongated
17-2418 Yellowstone	3	6	8
17-2419 MT1465	2	11	4
17-2420 Jaglene (CC05)	4	7	6
17-2421 MTW1491	1	4	12

Frequency Table

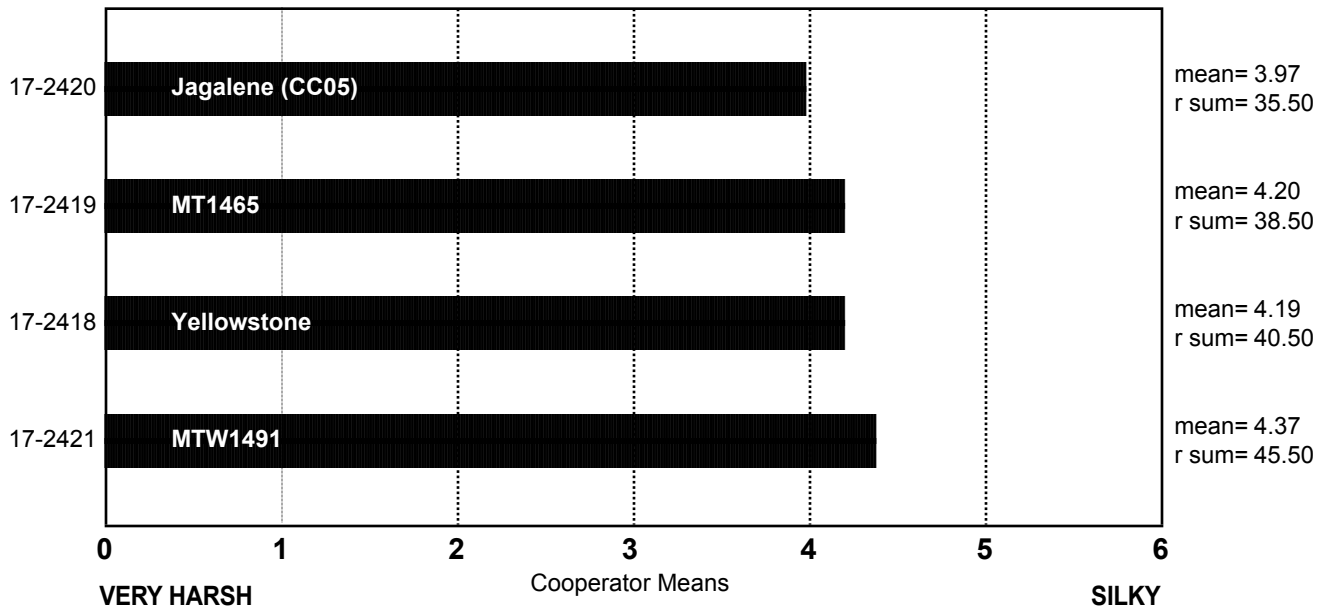
CRUMB TEXTURE

(Small Scale) Montana

ncoop= 16
 chisq= 1.99
 chisqc= 3.88
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Montana

	Harsh	Smooth	Silky
17-2418 Yellowstone	1	10	6
17-2419 MT1465	0	13	4
17-2420 Jagalene (CC05)	4	8	5
17-2421 MTW1491	0	11	6

Frequency Table

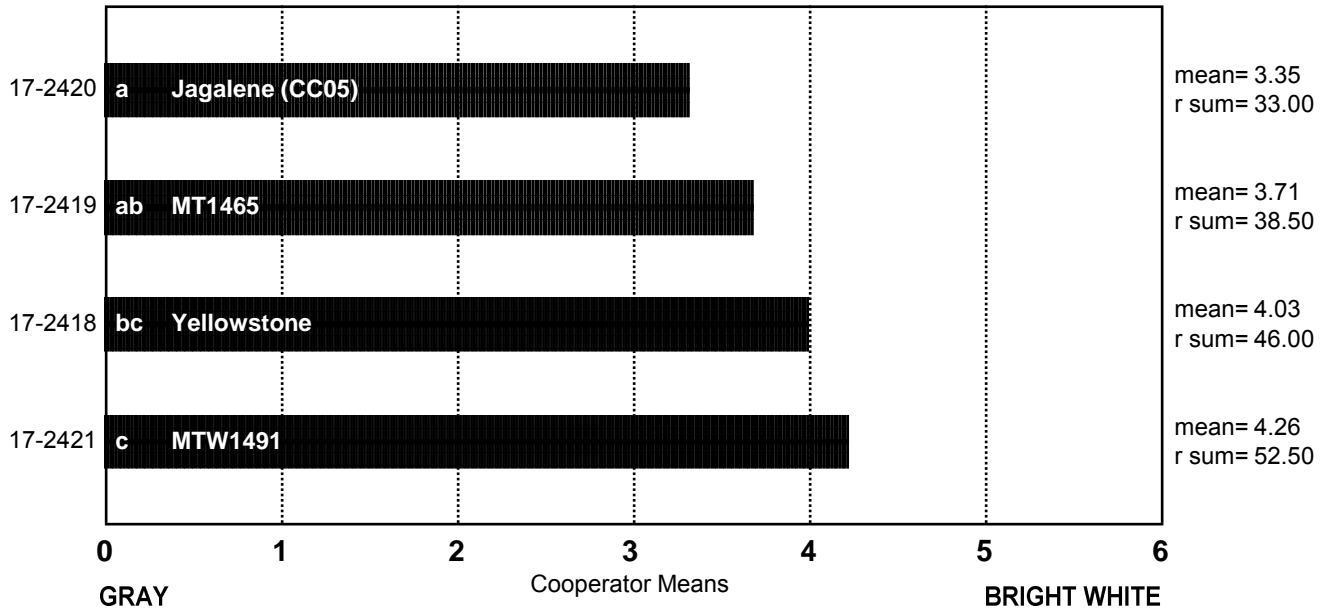
CRUMB COLOR

(Small Scale) Montana

ncoop= 17
 chisq= 7.71
 chisqc= 12.03
 cvchisq= 7.82
 crdiff= 10.92

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Montana

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2418 Yellowstone	1	0	0	3	9	4	0
17-2419 MT1465	0	0	2	5	9	0	1
17-2420 Jagalene (CC05)	0	0	8	2	6	0	1
17-2421 MTW1491	0	0	1	1	11	3	1

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2418 Yellowstone	411.0	463.9	430.0	454.0	142.7	452.6		141.9	447.2	132.8	138.5	145.6	132.1	151.7	138.6	156.0	479.7
17-2419 MT1465	410.0	461.0	432.0	454.0	143.0	452.4		143.3	444.0	132.1	139.7	147.3	133.2	153.1	139.2	150.8	477.8
17-2420 Jagalene (CC05)	412.0	462.5	433.0	454.0	143.8	452.5		142.6	445.0	131.1	144.4	146.9	133.9	154.5	140.5	153.2	483.6
17-2421 MTW1491	412.0	463.0	434.0	456.0	145.9	452.6		144.1	445.6	130.9	139.0	145.7	132.7	154.5	138.8	156.4	487.4

LOAF VOLUME, ACTUAL

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2418 Yellowstone	2925	2488	2700	2400	875	2819	3015	855	2325	930	965	915	905	975	865	815	2438
17-2419 MT1465	2925	2600	2850	2450	905	2755	2986	815	2325	990	998	825	817	973	911	875	2488
17-2420 Jaglene (CC05)	2925	2488	2900	2250	915	2589	2927	740	2350	885	923	765	805	938	802	810	2538
17-2421 MTW1491	2875	2625	2800	2275	980	2853	3045	835	2200	1000	895	930	885	1008	861	850	2400

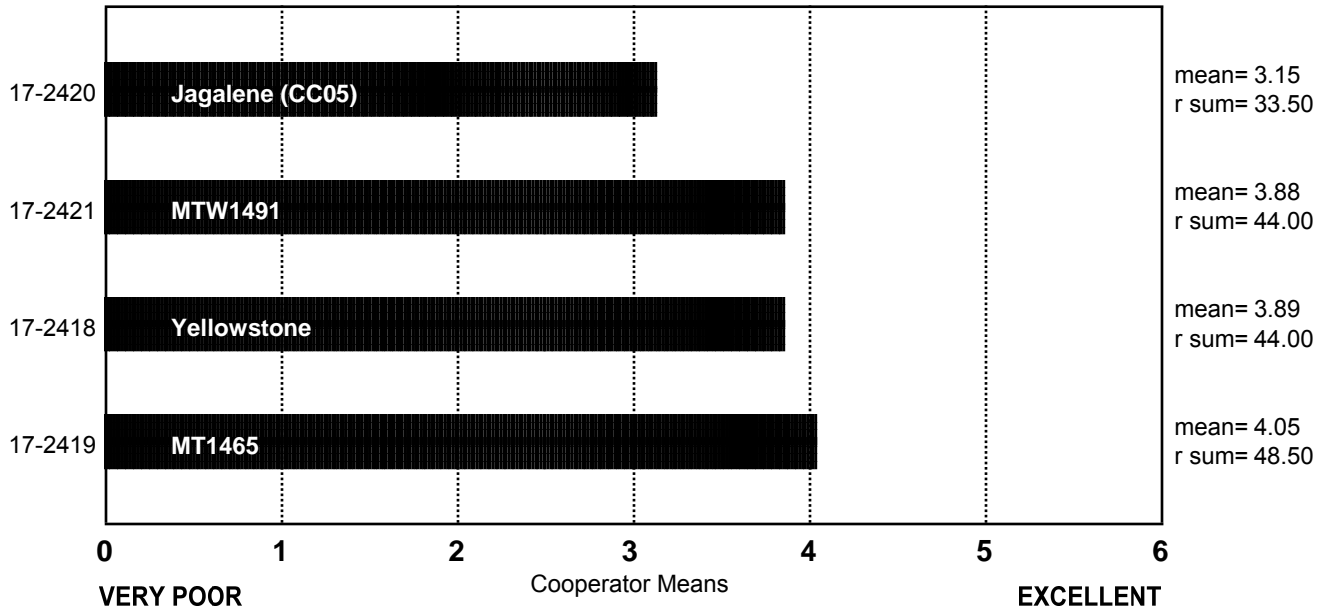
LOAF VOLUME

(Small Scale) Montana

ncoop= 17
 chisq= 4.29
 chisqc= 5.17
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



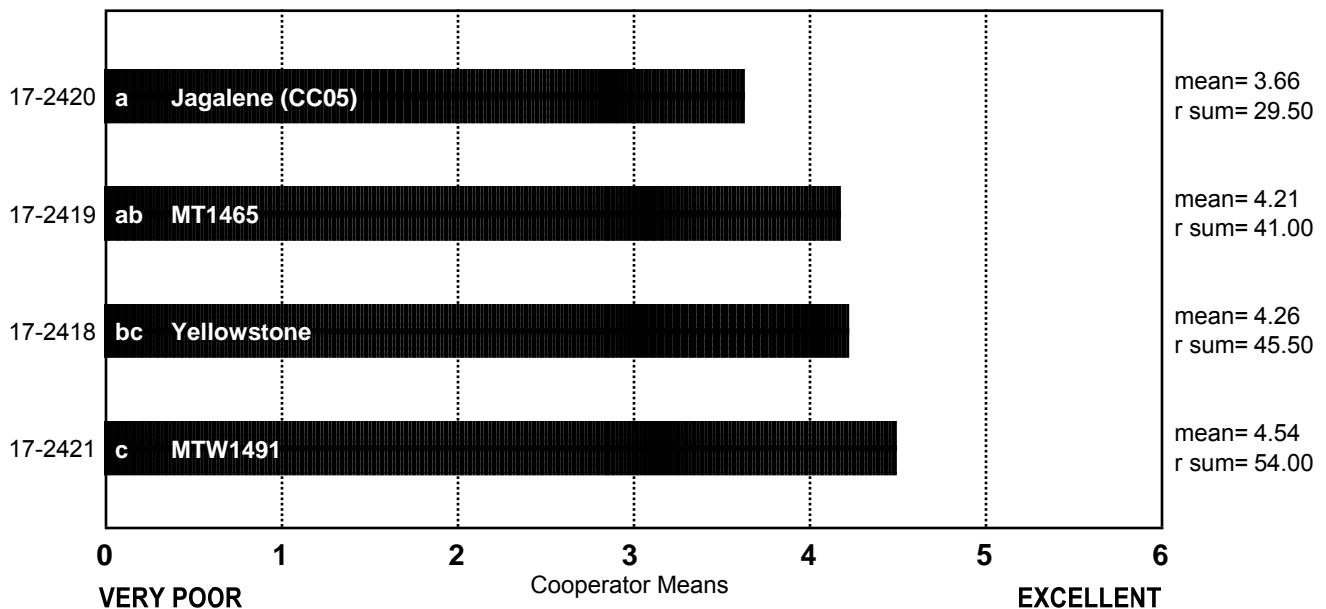
OVERALL BAKING QUALITY

(Small Scale) Montana

ncoop= 17
 chisq= 11.03
 chisqc= 12.42
 cvchisq= 7.82
 crdiff= 12.79

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS

(Small Scale) Montana

COOP.

17-2418 Yellowstone

- A. No comment.
- B. No comment.
- C. Good bread performance but very long mix time, good for blending purpose.
- D. No comment.
- E. No comment.
- F. No comment.
- G. Good absorption, mix strength and volume.
- H. Good absorption.
- I. Best of set but set was very similar, great mix time and makeup rating.
- J. Longer mixer, tough dough.
- K. Normal water absorption, long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
- L. Good strength/color.
- M. No comment.
- N. Excellent dough and loaf volume performance.
- O. No comment.
- P. High absorption, long mix time, excellent dough feel, Questionable – Satisfactory crumb grain, low loaf volume.
- Q. Good absorption, long mix time, tough dough, good grain, and creamy color.

COOP.

17-2419 MT1465

- A. No comment.
- B. No comment.
- C. Good bread performance.
- D. No comment.
- E. Excellent loaf externals.
- F. Gummy crumb texture.
- G. Slightly low absorption, very good mix strength and volume.
- H. Good absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, very high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Poor loaf volume.
- M. No comment.
- N. Excellent dough and loaf volume, good crumb grain character.
- O. No comment.
- P. Nice flour protein, good bake absorption, medium long mix time, excellent dough feel, satisfactory crumb grain, good loaf volume.
- Q. Good absorption, good grain, yellow color.

COOP.**17-2420 Jagalene (CC05)**

- A. No comment.
- B. No comment.
- C. Good performance overall.
- D. No comment.
- E. Excellent loaf externals.
- F. No comment.
- G. Fair absorption, mix strength and good volume.
- H. Good absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Poor loaf volume.
- M. No comment.
- N. Good volume performance.
- O. No comment.
- P. Good bake absorption, mix time and dough feel, nice loaf, but disappointing crumb grain and loaf volume.
- Q. Good absorption, tough dough at makeup, fine grain, yellow color.

COOP.**17-2421 MTW1491**

- A. No comment.
- B. No comment.
- C. Excellent bread performance but very long mix time, excellent for blending purpose.
- D. No comment.
- E. Long time to pickup, excellent loaf externals.
- F. No comment.
- G. Slightly low absorption, very good mix strength and volume.
- H. Good absorption.
- I. Fairly sticky out of the mixer and also on the makeup.
- J. Long mixer.
- K. Normal water absorption, long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
- L. Good protein/strength, very good grain/color.
- M. No comment.
- N. Excellent dough and loaf volume, good crumb grain character.
- O. No comment.
- P. Excellent bake absorption, long mix time, excellent dough feel, above satisfactory crumb grain, best of set.
- Q. Good absorption, very long mix time, very tough dough at makeup, fine grain, yellow color.

Notes: **A, C, D, G, I and Q** conducted sponge and dough bake tests

NEBRASKA

17-2422

NI13706

17-2423

NE12561

17-2424

Jagalene (CC06)

Description of Test Plots and Breeder Entries

Nebraska - Stephen Baenziger

Growing Conditions:

When these samples were milled, they surely went to heaven because they had already been through Hell. The samples were to be a composite of wheat from Sidney, North Platte, and Lincoln as we had done in the past in an attempt to provide an “average” sample representative of Nebraska produced wheat. The plots at Sidney were harvested mistakenly by a custom combiner. The plots at North Platte provided very little grain (not sure why) but with very sound grain visually (basically we got our seed back with a little to spare ~ 10 lbs), and the bulk of the seed came from increases at Lincoln, Nebraska. Lincoln had good growing conditions until grain filling and harvest when we had above average rain. The increase strips were not sprayed with fungicides so we had stripe rust and some leaf rust. The grain was weathered due to late harvest. Our testweights were lower than we wanted but the falling number was above 300 in our tests, so rather than lose a year, we decided to have the sample evaluated. Of the lines, Jagalane was the most affected by disease and being relative early in our conditions, it was also most affected by weathering. Needless to say, we were happy to institute a multi-state grow out system this year for Wheat Quality Council Samples for 2018.

Yield at the grow out site in Lincoln, NE (Lancaster Country) from the State Variety Trial.

Lancaster County Winter Wheat Variety Test - 2017							
Brand	Variety	Grain Yield (bu/a)	Moisture (%)	Bushel Weight (lb/bu)	Plant Height (inches)	Lodging	Protein
WestBred	WB-Grainfield	121.1	11.5	56.2	41	0.2	12.4
Limagrain Cereal Seeds	LCS Chrome	112.1	11.1	55.2	40	0.0	14.5
-----	NE12561	110.5	11.0	57.2	41	0.4	14.1
AgriPro Syngenta	SY Wolf	107.9	11.0	55.0	38	0.0	14.2
-----	NI13706	107.0	11.4	58.4	39	0.0	14.2
Kansas Wheat Alliance	Zenda	103.5	11.2	56.9	39	0.3	13.4
-----	Ruth	100.9	11.2	56.0	42	0.0	13.0
WestBred	WB-Cedar	98.1	11.2	56.7	37	0.0	14.2
Husker Genetics	Freeman	96.1	10.6	52.6	41	1.0	13.5
Average of all entries		92.7	11.0	54.5	41	9.6	14.0
Difference required for significance at 5%		7.8	0.5	2.3	1	13.9	1.6

NE12561: NI04420/NE00403. Based on the data that we have collected so far, NE12561 is a semi-dwarf wheat experimental line with above average straw strength that is moderately resistant to Hessian fly; leaf, stripe, and stem rust, and wheat soilborne mosaic virus. It is moderately susceptible to wheat streak mosaic virus. It is moderately susceptible to Fusarium head blight (FHB, scab) and moderately susceptible to DON. It has good test weight and good protein. It has acceptable end-use quality. It is adapted to Southeast and Southcentral Nebraska, however, wheat acreage is declining in those areas,

so its release may depend more on acreage than on merits. The interest in this line is that its level of stripe rust resistance is high enough that a later, single application of fungicide to control FHB (which will also control stripe rust) should be possible, thus reducing input costs to the grower. In Southeast and Southcentral Nebraska, fungicide applications are common.

NI13706: NI02425/HV9W99-558//Robidoux. Based on the data that we have collected so far, NI13706 is a semi-dwarf wheat experimental line with above average straw strength that is moderately resistant to stem rust and wheat soilborne mosaic virus. It is moderately resistant/moderately susceptible to leaf and stripe rust. It is moderately susceptible to Hessian fly and wheat streak mosaic virus. It is also moderately susceptible to Fusarium head blight (FHB, scab) and moderately susceptible to DON. It has average test weight and good protein. It has acceptable end-use quality. It is broadly adapted to the wheat producing areas of Nebraska. The interest in this line is when grown in the drier (western parts of Nebraska), FHB is rare so only a single fungicide application would be necessary if stripe rust were present. In Southeast and Southcentral Nebraska, if stripe rust is prevalent, it may be necessary to spray to control stripe rust and if conditions are right for FHB to spray again for FHB which will control later infections of stripe rust. Stripe rust infections usually precede FHB infections by 7 to 10 days.

Both **NE12561** and **NI13706** are superior to very susceptible FHB lines such as Overley, but inferior to moderately resistant FHB lines such as Overland.

Jagalene was the quality control line.

Nebraska: 2017 (Small-Scale) Samples

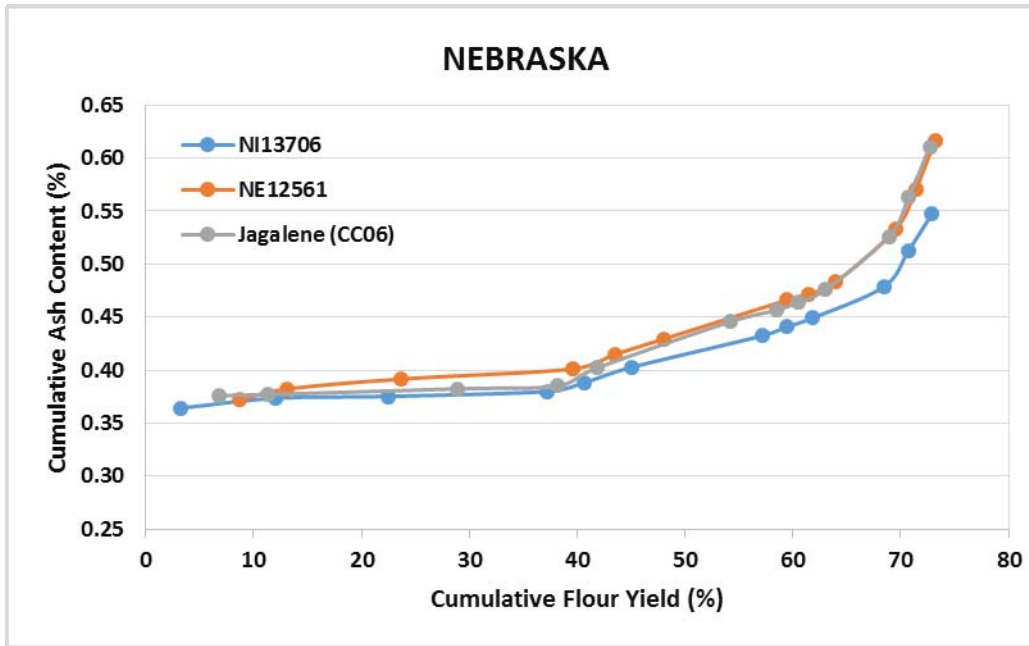
Test entry number	17-2422	17-2423	17-2424
Sample identification	NI13706	NE12561	Jagalene (CC06)
Wheat Data			
GIPSA classification	3 HRW	2 HRW	4 HRW
Test weight (lb/bu)	56.8	58.5	55.5
Hectoliter weight (kg/hl)	74.8	77.0	73.1
1000 kernel weight (gm)	28.8	32.5	28.4
Wheat kernel size (Rotap)			
Over 7 wire (%)	60.6	72.8	48.9
Over 9 wire (%)	37.7	26.6	46.8
Through 9 wire (%)	1.7	0.6	4.3
Single kernel (skcs)^a			
Hardness (avg /s.d)	53.5/15.8	45.7/15.0	53.2/19.6
Weight (mg) (avg/s.d)	28.8/9.7	32.5/10.1	28.4/12.4
Diameter (mm)(avg/s.d)	2.53/0.38	2.67/0.37	2.44/0.43
Moisture (%) (avg/s.d)	10.9/0.5	10.4/0.5	10.3/0.6
SKCS distribution	10-23-33-34-01	17-36-29-18-03	16-21-29-34-03
Classification	Hard	Mixed	Mixed
Wheat protein (12% mb)	13.5	13.5	13.1
Wheat ash (12% mb)	1.69	1.72	1.68
Milling and Flour Quality Data			
Flour yield (% , str. grade)			
Miag Multomat Mill	73.0	73.1	72.7
Quadrumat Sr. Mill	66.2	69.4	67.7
Flour moisture (%)	13.3	13.2	12.8
Flour protein (14% mb)	12.0	11.7	11.3
Flour ash (14% mb)	0.51	0.53	0.57
Rapid Visco-Analyser			
Peak Time (min)	6.3	6.3	6.1
Peak Viscosity (RVU)	189.0	183.8	189.9
Breakdown (RVU)	60.5	58.6	74.8
Final Viscosity at 13 min (RVU)	239.3	228.2	226.3
Minolta color meter			
L*	91.30	91.27	90.52
a*	-1.45	-1.19	-1.45
b*	8.42	7.86	9.26
PPO	0.613	0.594	0.542
Falling number (sec)	387	405	395
Damaged Starch			
(AI%)	95.3	95.6	96.6
(AACC76-31)	5.7	6.0	6.7

^as.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Nebraska: Physical Dough Tests and Gluten Analysis For 2017 (Small-Scale) Samples

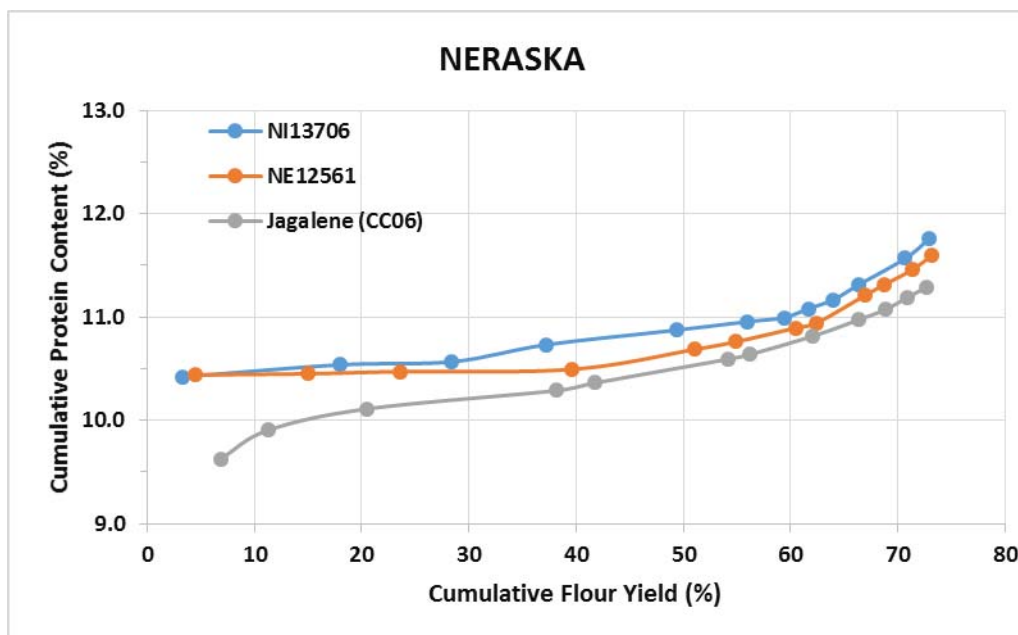
Test Entry Number	17-2422	17-2423	17-2424
Sample Identification	NI13706	NE12561	Jagalene (CC06)
MIXOGRAPH			
Flour Abs (% as-is)	65.1	64.4	64.2
Flour Abs (14% mb)	64.6	63.4	62.9
Mix Time (min)	2.9	3.6	4.4
Mix tolerance (0-6)	2	2	3
FARINOGRAPH			
Flour Abs (% as-is)	60.7	59.3	60.0
Flour Abs (14% mb)	60.2	58.3	58.6
Peak time (min)	5.2	4.3	3.0
Mix stability (min)	10.0	8.0	7.3
Mix Tolerance Index (FU)	20	30	32
Breakdown time (min)	12.5	9.5	8.0
ALVEOGRAPH			
P(mm): Tenacity	67	64	78
L(mm): Extensibility	121	91	87
G(mm): Swelling index	24.5	21.2	20.8
W(10 ⁻⁴ J): strength (curve area)	246	200	245
P/L: curve configuration ratio	0.55	0.70	0.90
Ie(P ₂₀₀ /P): elasticity index	56.1	57.2	59.8
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	247/289/287	256/352/400	400/469/475
Extensibility (mm at 45/90/135 min)	157/168/163	161/159/162	152/139/143
Energy (cm ² at 45/90/135 min)	71/96/90	76/108/122	111/116/122
Resist _{max} (BU at 45/90/135 min)	337/430/426	356/518/584	560/659/577
Ratio (at 45/90/135 min)	1.6/1.7/1.8	1.6/2.2/2.5	2.6/3.4/3.3
PROTEIN ANALYSIS			
HMW-GS Composition	2*,2+12,7+9	2*,5+10,17+18/7+9	2*,1,5+10,17+18
TMP/TPP	0.85	0.94	1.09
SEDIMENTATION TEST			
Volume (ml)	46.3	43.1	45.4

Nebraska: Cumulative Ash Curves



NI13706					NE12561					Jagalene (CC06)				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
1M Red	3.2	0.36	3.2	0.36	1BK	8.6	0.37	8.6	0.37	1BK	6.9	0.38	6.9	0.38
1BK	8.8	0.38	12.1	0.37	1M Red	4.4	0.40	13.1	0.38	1M Red	4.4	0.38	11.3	0.38
1M	10.4	0.38	22.5	0.38	1M	10.6	0.40	23.6	0.39	2M	17.7	0.39	28.9	0.38
2M	14.8	0.39	37.2	0.38	2M	16.0	0.42	39.6	0.40	1M	9.3	0.39	38.2	0.39
Grader	3.4	0.48	40.6	0.39	Grader	3.9	0.56	43.5	0.41	Grader	3.6	0.58	41.8	0.40
2BK	4.4	0.54	45.0	0.40	2BK	4.5	0.57	48.0	0.43	3M	12.4	0.59	54.2	0.45
3M	12.1	0.54	57.1	0.43	3M	11.4	0.62	59.4	0.47	2BK	4.2	0.59	58.4	0.46
3BK	2.4	0.65	59.5	0.44	FILTER FLR	2.0	0.64	61.4	0.47	FILTER FLR	2.0	0.68	60.5	0.46
FILTER FLR	2.3	0.66	61.8	0.45	3BK	2.6	0.76	64.0	0.48	3BK	2.6	0.76	63.0	0.48
4M	6.6	0.76	68.4	0.48	4M	5.6	1.11	69.5	0.53	4M	5.9	1.06	68.9	0.53
5M	2.3	1.53	70.7	0.51	BRAN FLR	1.8	1.97	71.4	0.57	BRAN FLR	1.8	1.95	70.7	0.56
BRAN FLR	2.2	1.68	72.9	0.55	5M	1.8	2.45	73.2	0.62	5M	2.0	2.34	72.7	0.61
Break Shorts	3.2	3.52	76.1	0.67	Break Shorts	3.2	4.20	76.3	0.76	Break Shorts	3.6	3.95	76.2	0.77
Red Dog	2.1	2.46	78.2	0.72	Red Dog	1.8	3.43	78.1	0.83	Red Dog	2.1	3.20	78.3	0.83
Red Shorts	0.5	3.18	78.7	0.74	Red Shorts	0.4	3.53	78.5	0.84	Red Shorts	0.6	3.56	78.9	0.85
Filter Bran	2.3	3.00	81.0	0.80	Filter Bran	1.7	4.33	80.2	0.91	Filter Bran	2.2	3.93	81.1	0.94
Bran	19.0	5.39	100.0	1.67	Bran	19.8	5.84	100.0	1.89	Bran	18.9	5.45	100.0	1.79
Wheat		1.59					1.62					1.59		
St. Grd. Fl.		0.51					0.53					0.57		

Nebraska: Cumulative Protein Curves

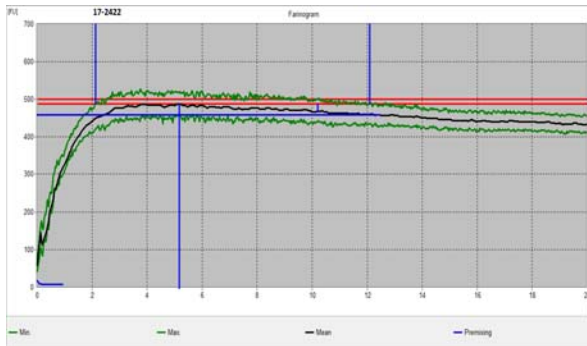


NI13706					NE12561					Jagalene (CC06)				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
1M Red	3.2	0.36	3.2	0.36	1BK	8.6	0.37	8.6	0.37	1BK	6.9	0.38	6.9	0.38
1BK	8.8	0.38	12.1	0.37	1M Red	4.4	0.40	13.1	0.38	1M Red	4.4	0.38	11.3	0.38
1M	10.4	0.38	22.5	0.38	1M	10.6	0.40	23.6	0.39	2M	17.7	0.39	28.9	0.38
2M	14.8	0.39	37.2	0.38	2M	16.0	0.42	39.6	0.40	1M	9.3	0.39	38.2	0.39
Grader	3.4	0.48	40.6	0.39	Grader	3.9	0.56	43.5	0.41	Grader	3.6	0.58	41.8	0.40
2BK	4.4	0.54	45.0	0.40	2BK	4.5	0.57	48.0	0.43	3M	12.4	0.59	54.2	0.45
3M	12.1	0.54	57.1	0.43	3M	11.4	0.62	59.4	0.47	2BK	4.2	0.59	58.4	0.46
3BK	2.4	0.65	59.5	0.44	FILTER FLR	2.0	0.64	61.4	0.47	FILTER FLR	2.0	0.68	60.5	0.46
FILTER FLR	2.3	0.66	61.8	0.45	3BK	2.6	0.76	64.0	0.48	3BK	2.6	0.76	63.0	0.48
4M	6.6	0.76	68.4	0.48	4M	5.6	1.11	69.5	0.53	4M	5.9	1.06	68.9	0.53
5M	2.3	1.53	70.7	0.51	BRAN FLR	1.8	1.97	71.4	0.57	BRAN FLR	1.8	1.95	70.7	0.56
BRAN FLR	2.2	1.68	72.9	0.55	5M	1.8	2.45	73.2	0.62	5M	2.0	2.34	72.7	0.61
Break Shorts	3.2	3.52	76.1	0.67	Break Shorts	3.2	4.20	76.3	0.76	Break Shorts	3.6	3.95	76.2	0.77
Red Dog	2.1	2.46	78.2	0.72	Red Dog	1.8	3.43	78.1	0.83	Red Dog	2.1	3.20	78.3	0.83
Red Shorts	0.5	3.18	78.7	0.74	Red Shorts	0.4	3.53	78.5	0.84	Red Shorts	0.6	3.56	78.9	0.85
Filter Bran	2.3	3.00	81.0	0.80	Filter Bran	1.7	4.33	80.2	0.91	Filter Bran	2.2	3.93	81.1	0.94
Bran	19.0	5.39	100.0	1.67	Bran	19.8	5.84	100.0	1.89	Bran	18.9	5.45	100.0	1.79
Wheat		1.59					1.62					1.59		
St. Grd. Fl.		0.51					0.53					0.57		

Physical Dough Tests

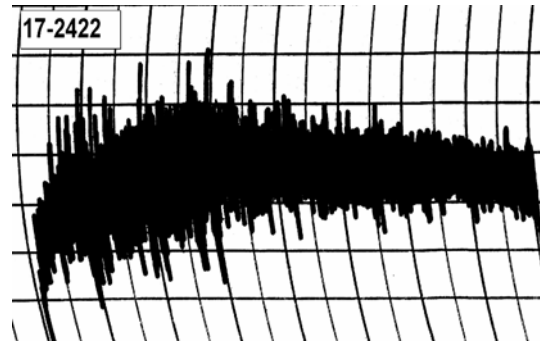
2017 (Small Scale) Samples – Nebraska

Farinograms



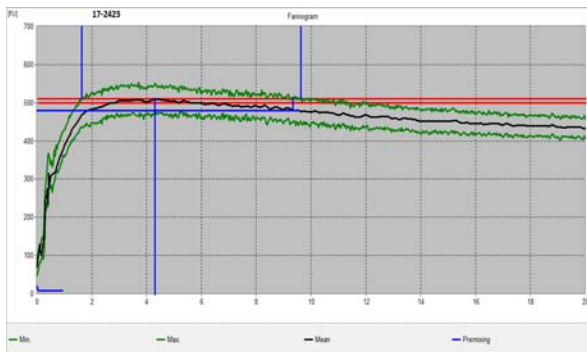
Water abs = 60.2%, Peak time = 5.2 min,
Mix stab = 10.0 min, MTI = 20 FU

Mixograms

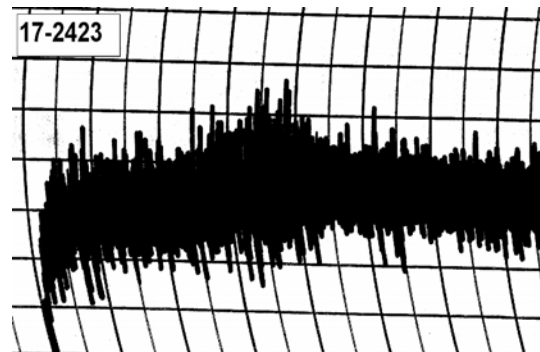


Water abs = 64.6%
Mix time = 2.9 min

17-2422, NI13706



Water abs = 58.3%, Peak time = 4.3 min,
Mix stab = 8.0 min, MTI = 30 FU



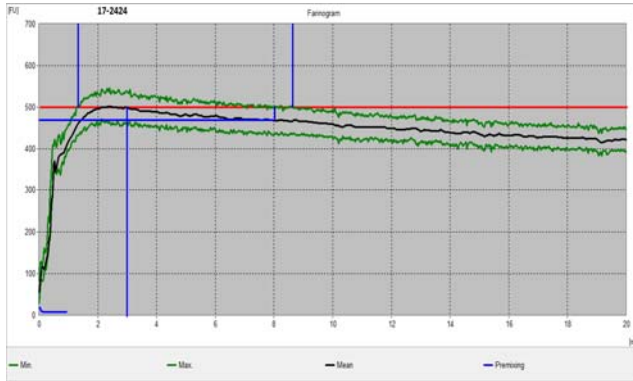
Water abs = 63.4%
Mix time = 3.6 min

17-2423, NE12561

Physical Dough Tests

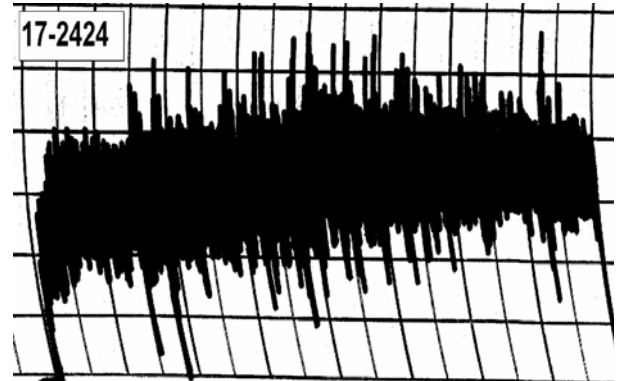
2017 (Small Scale) Samples – Nebraska

Farinograms



Water abs = 58.6%, Peak time = 3.0 min,
Mix stab = 7.3 min, MTI = 32 FU

Mixograms

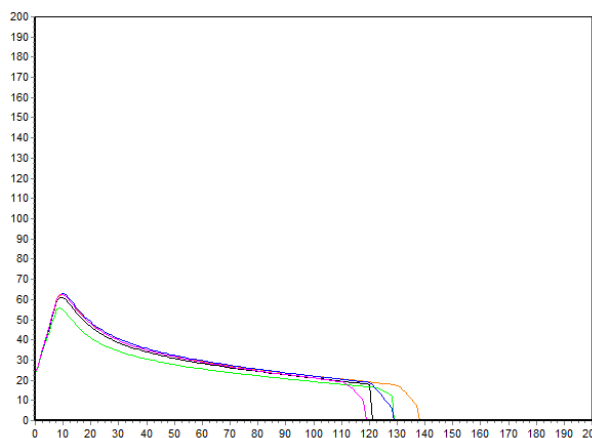


Water abs = 62.9%
Mix time = 4.4 min

17-2424, Jagalene (CC06)

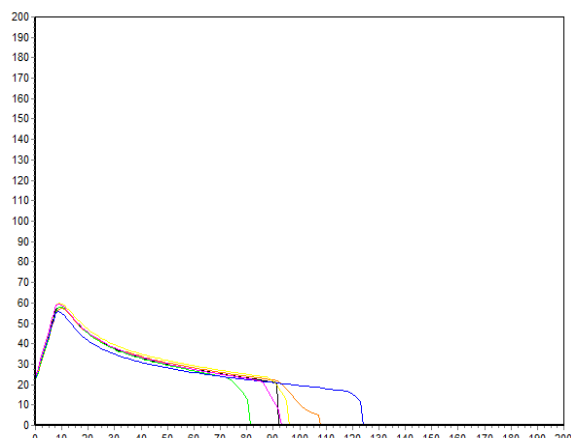
Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Nebraska



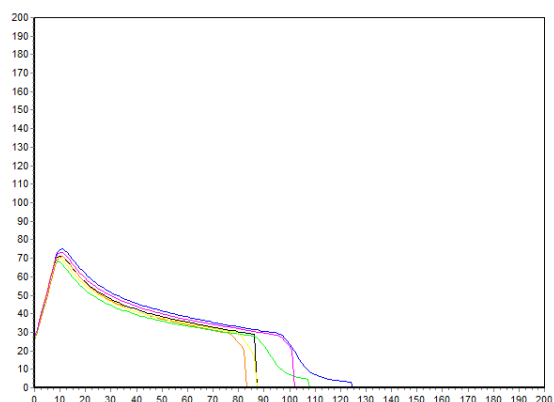
17-2422, NI13706

P (mm H₂O) = 67, L (mm) = 121, W (10E⁻⁴J) = 246



17-2423, NE12561

P (mm H₂O) = 64, L (mm) = 91, W (10E⁻⁴J) = 200

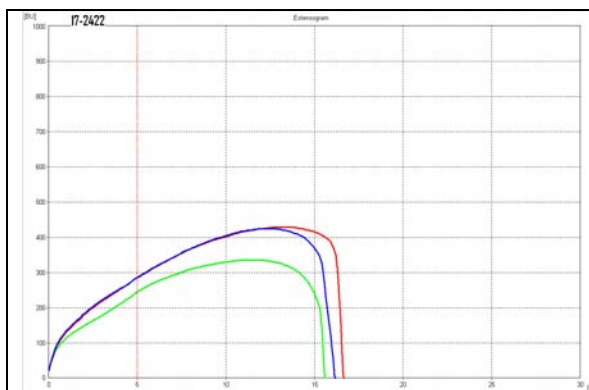


17-2424, Jagalene (CC06)

P (mm H₂O) = 78, L (mm) = 87, W (10E⁻⁴J) = 245

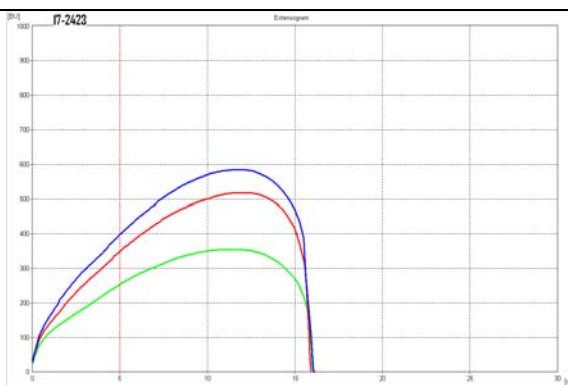
Physical Dough Tests - Extensigraph

2017 (Small Scale) Samples – Nebraska



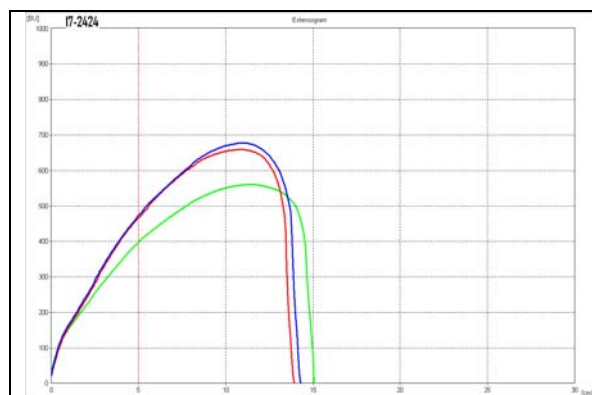
17-2422, NI13706

R (BU) = 289, E (mm) = 168, W (cm²) = 96
Rmax (BU) = 430, Ratio = 1.9 at 90 min



17-2423, NE12561

R (BU) = 352, E (mm) = 159, W (cm²) = 108
Rmax (BU) = 518, Ratio = 2.2 at 90 min

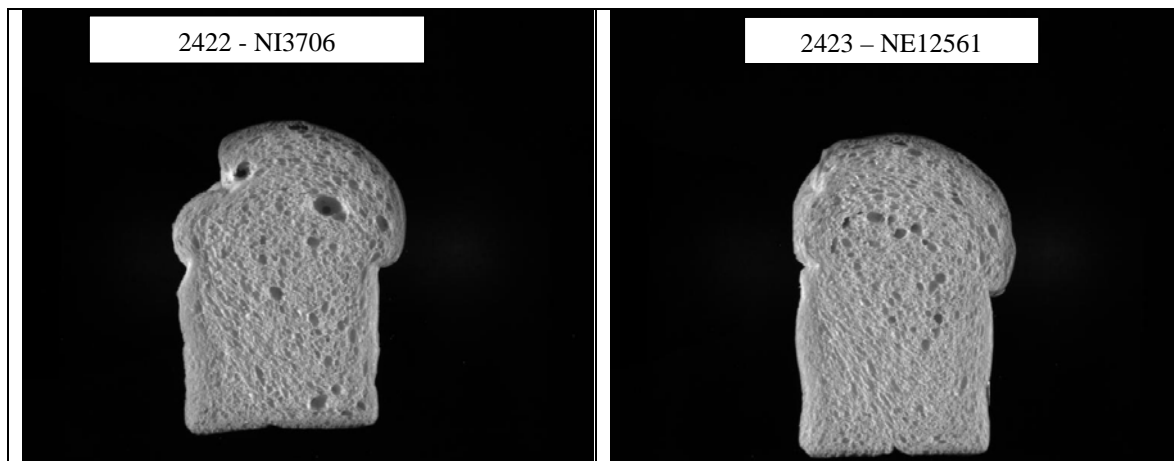


17-2424, Jagalene (CC06)

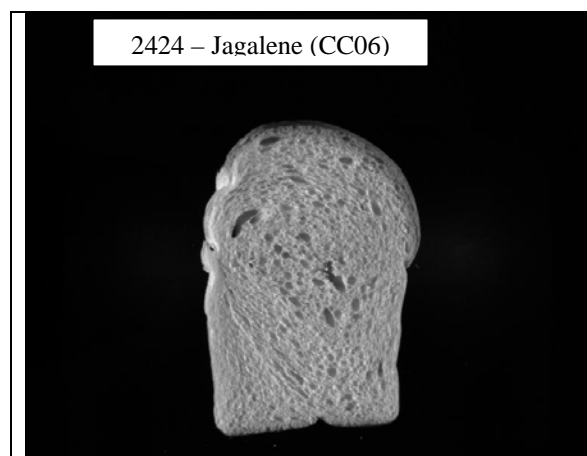
R (BU) = 469, E (mm) = 139, W (cm²) = 116
Rmax (BU) = 659, Ratio = 3.4 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm²) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Nebraska: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2422	5880	141	4106	0.433	1.831	1.009	1.640	-20.83
2423	6174	145	4454	0.422	1.710	2.430	1.680	-21.70



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2424	5877	140	4387	0.418	1.668	2.695	1.695	-21.25

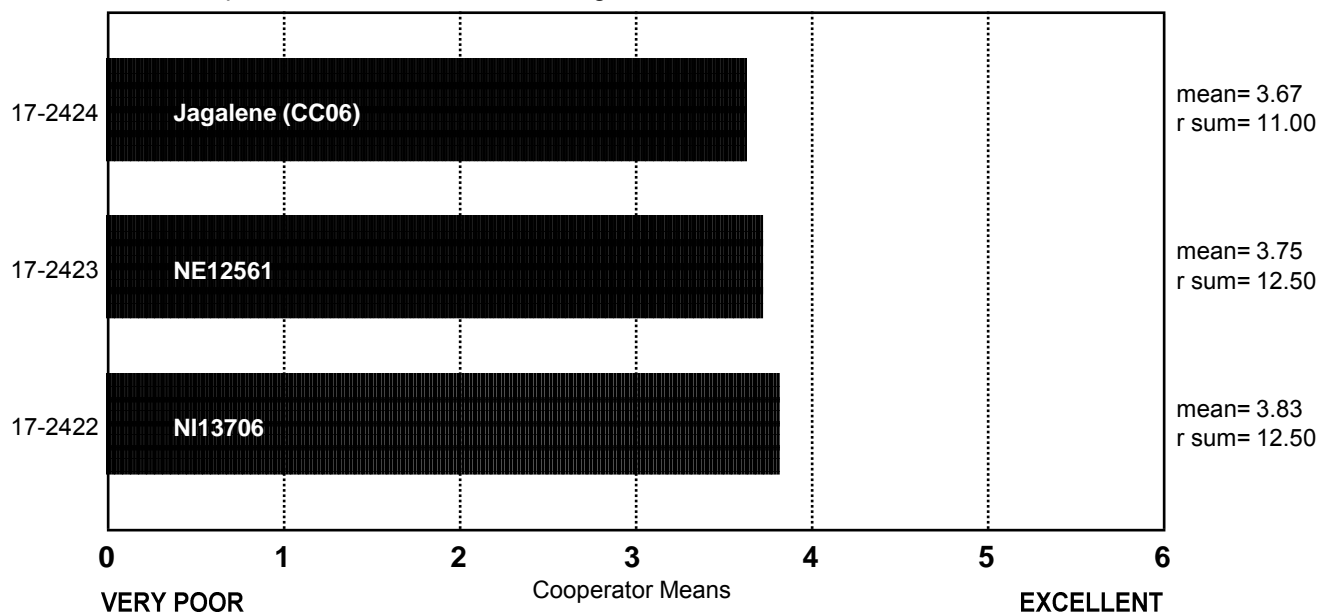
SPONGE CHARACTERISTICS

(Small Scale) Nebraska

ncoop= 6
chisq= 0.25
chisqc= -0.35
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



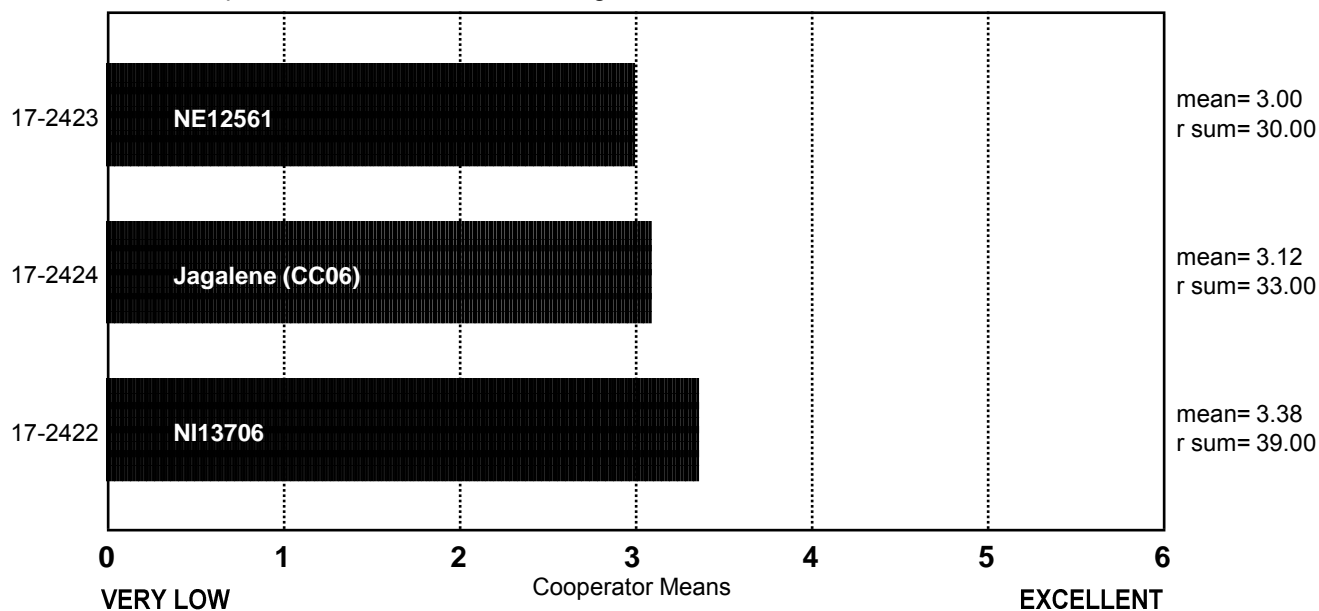
BAKE ABSORPTION

(Small Scale) Nebraska

ncoop= 17
chisq= 2.47
chisqc= 5.09
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Nebraska

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2422 NI13706	58.0	60.2	60.5	62.0	60.0	60.2	57.0	63.0	63.2	67.6	63.1	61.5	60.9	65.2	63.3	63.7	59.5
17-2423 NE12561	57.0	58.3	60.2	60.0	61.8	58.3	56.0	63.0	61.3	61.3	62.8	60.5	58.8	64.2	63.1	63.7	57.0
17-2424 Jagalene (CC06)	57.0	58.6	59.0	61.0	60.7	58.6	58.0	62.0	61.6	65.1	62.6	60.6	59.0	64.7	62.8	63.4	56.7

BAKE MIX TIME, ACTUAL

(Small Scale) Nebraska

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2422 NI13706	5.0	15.0	7.0	6.0	2.8	7.0	10.0	2.3	4.5	3.0	4.5	2.5	2.3	3.8	2.8	3.3	4.0
17-2423 NE12561	5.0	10.0	8.0	6.0	3.3	7.0	8.0	5.0	4.0	3.3	5.1	3.2	2.0	4.2	4.0	4.1	4.0
17-2424 Jagalone (CC06)	5.0	15.0	9.0	5.0	4.8	7.0	9.0	5.2	4.0	4.5	6.8	3.9	3.3	5.2	4.3	6.3	4.0

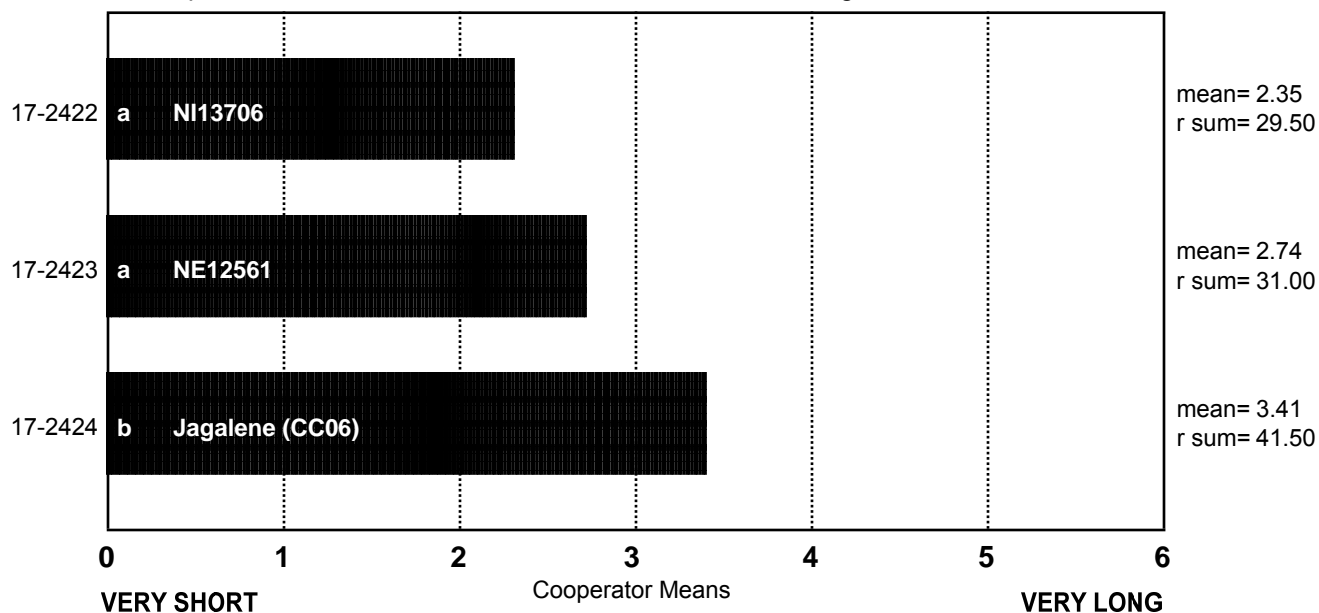
BAKE MIX TIME

(Small Scale) Nebraska

ncoop= 17
chisq= 5.03
chisqc= 7.60
cvchisq= 5.99
crdiff= 8.78

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



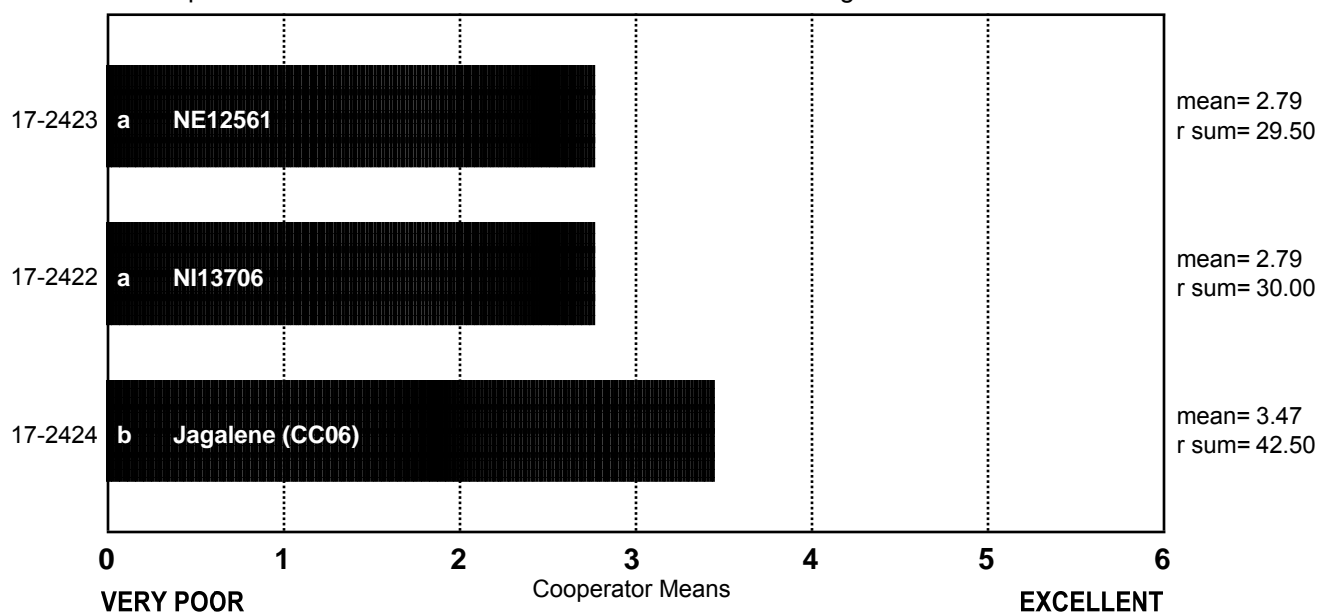
MIXING TOLERANCE

(Small Scale) Nebraska

ncoop= 17
chisq= 6.38
chisqc= 8.86
cvchisq= 5.99
crdiff= 8.94

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



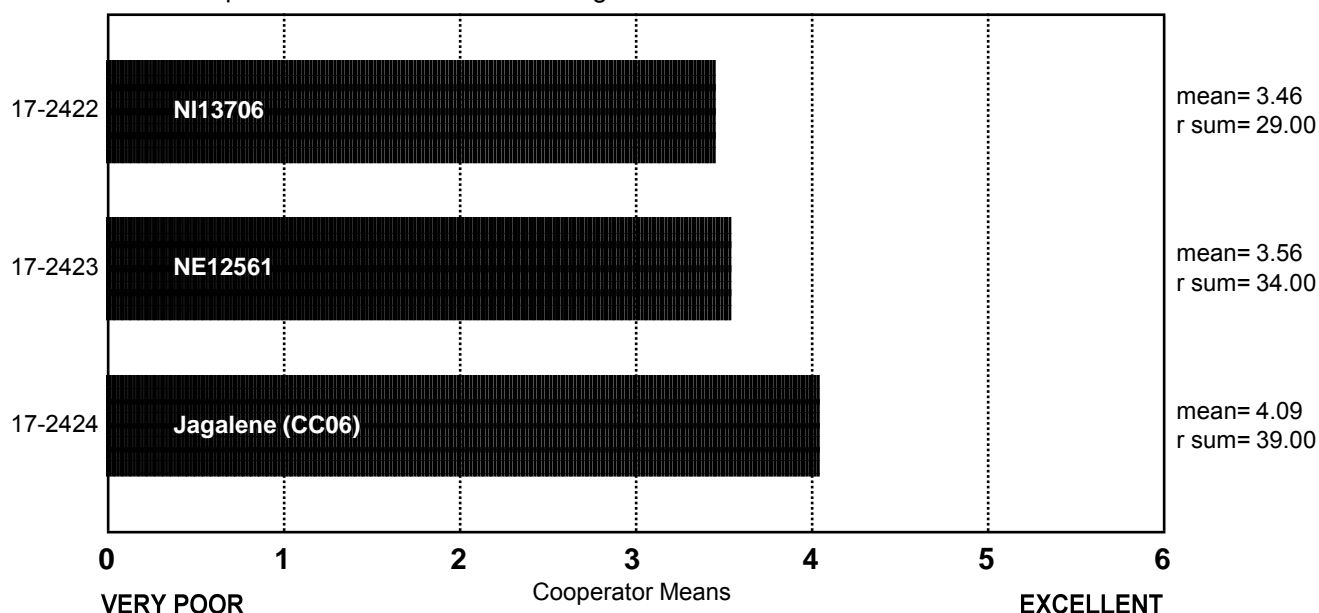
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Nebraska

ncoop= 17
chisq= 2.94
chisqc= 4.35
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
17-2422 NI13706	7	2	1	6	1
17-2423 NE12561	6	3	2	5	1
17-2424 Jagalene (CC06)	3	2	0	11	1

Frequency Table

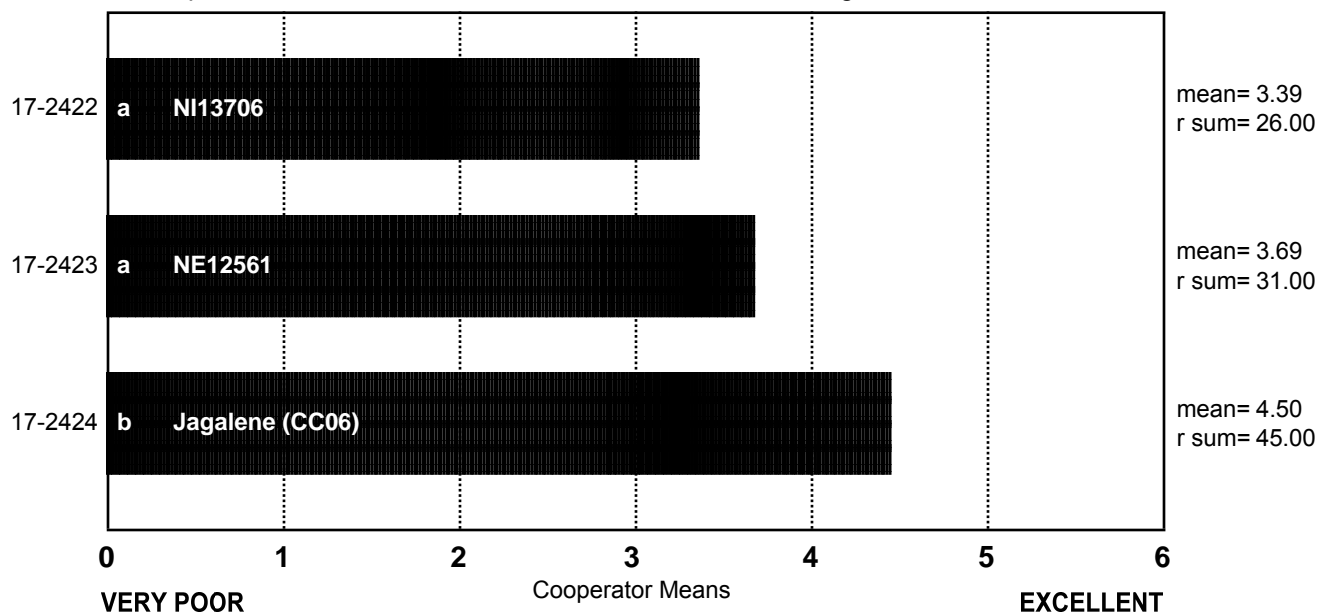
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Nebraska

ncoop= 17
chisq= 11.41
chisqc= 16.51
cvchisq= 5.99
crdiff= 7.30

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
17-2422 NI13706	3	3	2	8	1
17-2423 NE12561	1	3	2	9	2
17-2424 Jagalene (CC06)	0	0	1	14	2

Frequency Table

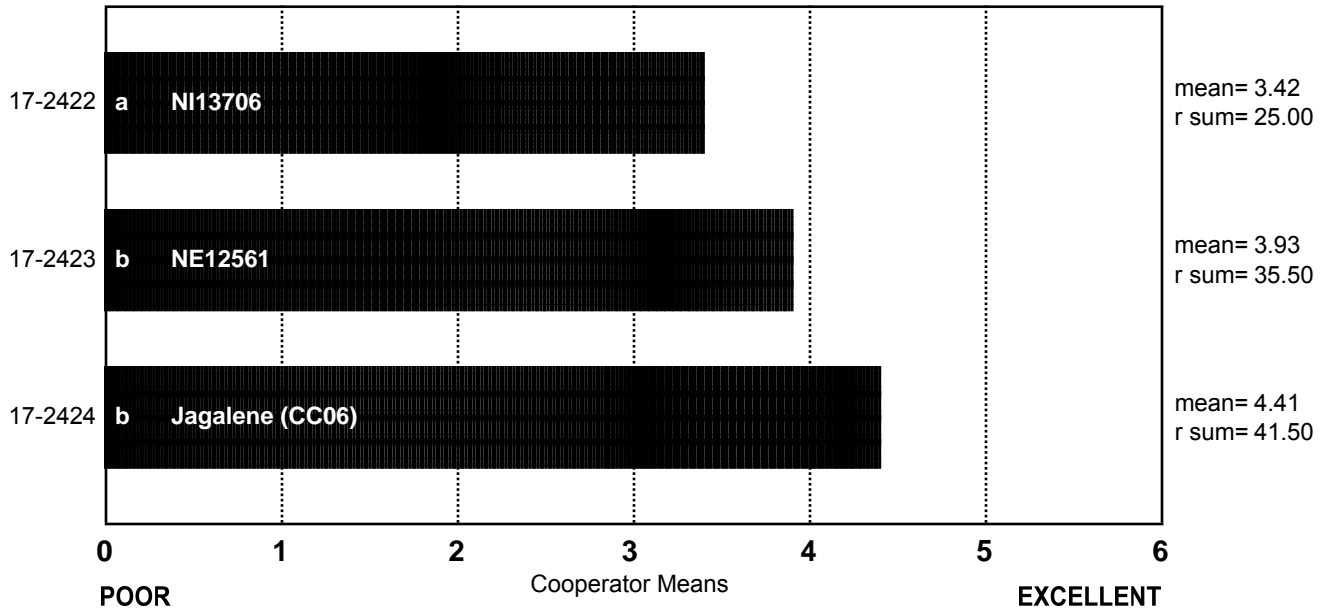
CRUMB GRAIN

(Small Scale) Nebraska

ncoop= 17
 chisq= 8.21
 chisqc= 11.87
 cvchisq= 5.99
 crdiff= 8.21

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Nebraska

	Open	Fine	Dense
17-2422 NI13706	10	5	2
17-2423 NE12561	8	7	2
17-2424 Jagalene (CC06)	4	11	2

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Nebraska

	Round	Irregular	Elongated
17-2422 NI13706	5	9	3
17-2423 NE12561	6	5	6
17-2424 Jagalone (CC06)	2	4	11

Frequency Table

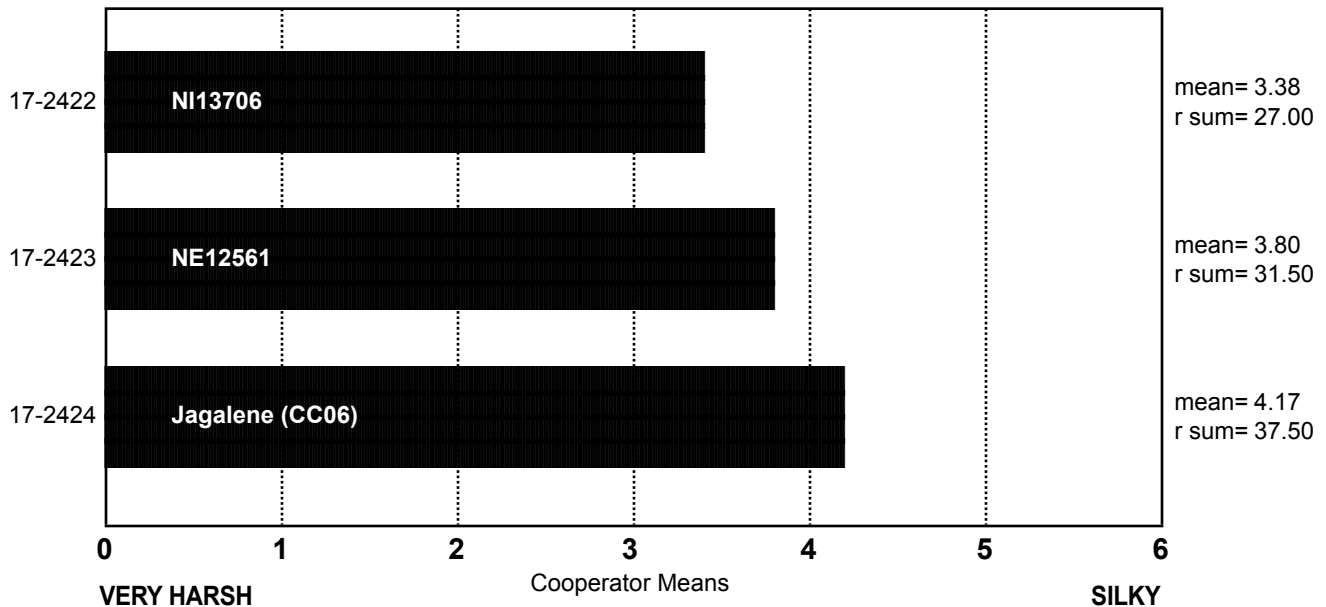
CRUMB TEXTURE

(Small Scale) Nebraska

ncoop= 16
 chisq= 3.47
 chisqc= 4.63
 cvchisq= 5.99
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Nebraska

	Harsh	Smooth	Silky
17-2422 NI13706	9	6	2
17-2423 NE12561	6	8	3
17-2424 Jagalene (CC06)	3	10	4

Frequency Table

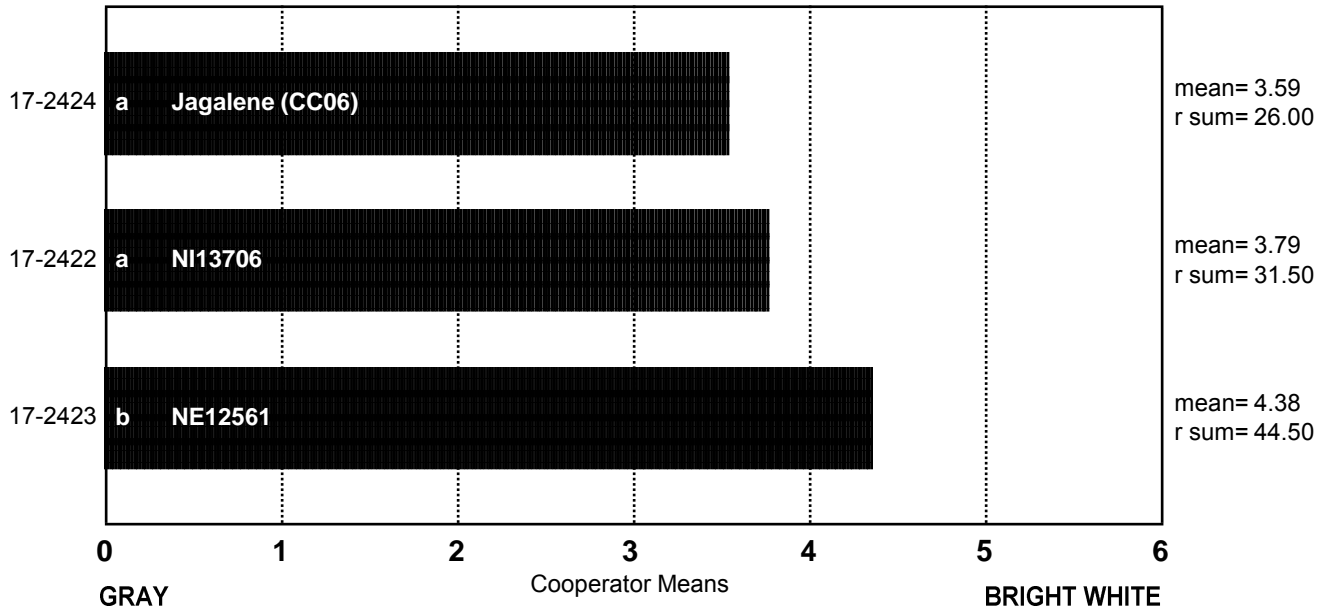
CRUMB COLOR

(Small Scale) Nebraska

ncoop= 17
 chisq= 10.62
 chisqc= 16.79
 cvchisq= 5.99
 crdiff= 6.93

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Nebraska

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2422 NI13706	0	0	1	8	5	2	1
17-2423 NE12561	0	0	1	2	7	5	2
17-2424 Jagalene (CC06)	0	0	2	7	8	0	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Nebraska

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2422 NI13706	411.0	470.8	431.0	453.0	143.7	460.6		141.3	448.3	135.2	140.3	144.5	132.4	149.8	139.5	151.3	485.8
17-2423 NE12561	411.0	466.1	435.0	460.0	143.2	462.7		140.6	449.5	125.6	139.1	143.0	133.3	150.7	140.9	150.8	485.7
17-2424 Jagalone (CC06)	413.0	468.5	436.0	455.0	141.2	465.0		140.9	447.6	133.3	138.0	143.6	130.5	150.9	139.5	149.3	486.1

LOAF VOLUME, ACTUAL

(Small Scale) Nebraska

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2422 NI13706	2875	2375	3000	2625	810	2749	2986	835	2525	1010	1031	880	720	1038	878	855	2488
17-2423 NE12561	3100	2525	2950	2425	925	2861	2986	885	2475	980	980	970	687	1003	888	880	2500
17-2424 Jagalene (CC06)	3025	2763	3000	2375	980	2930	3074	830	2475	1010	965	955	802	968	923	845	2663

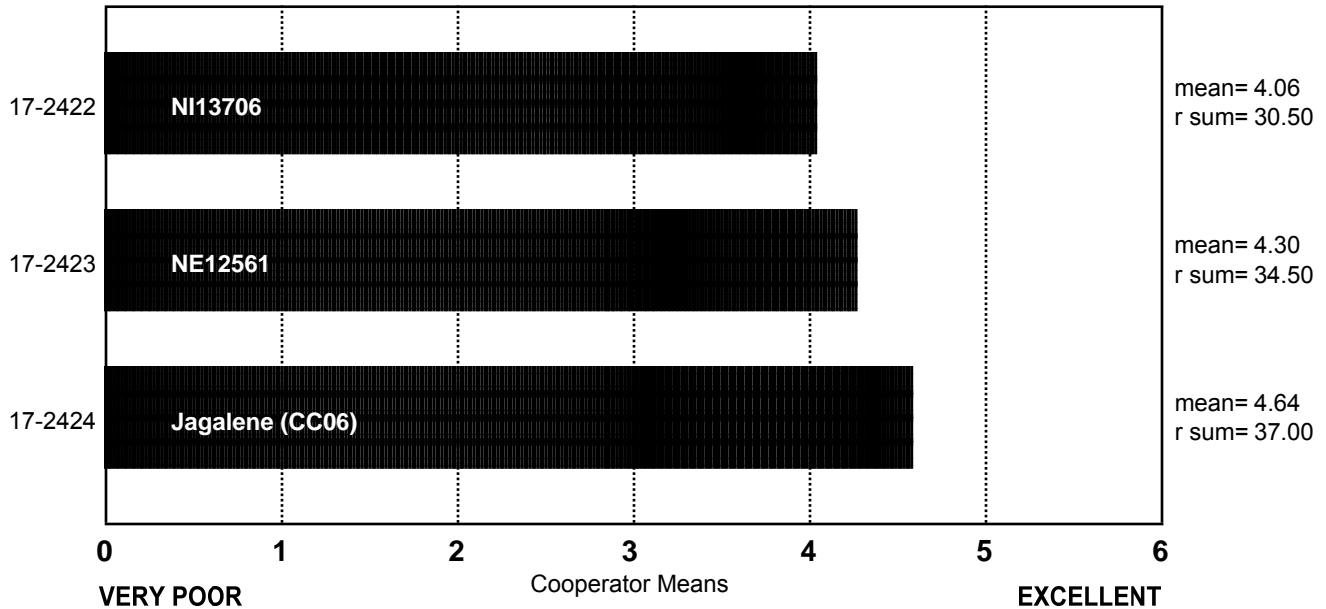
LOAF VOLUME

(Small Scale) Nebraska

ncoop= 17
chisq= 1.26
chisqc= 1.72
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



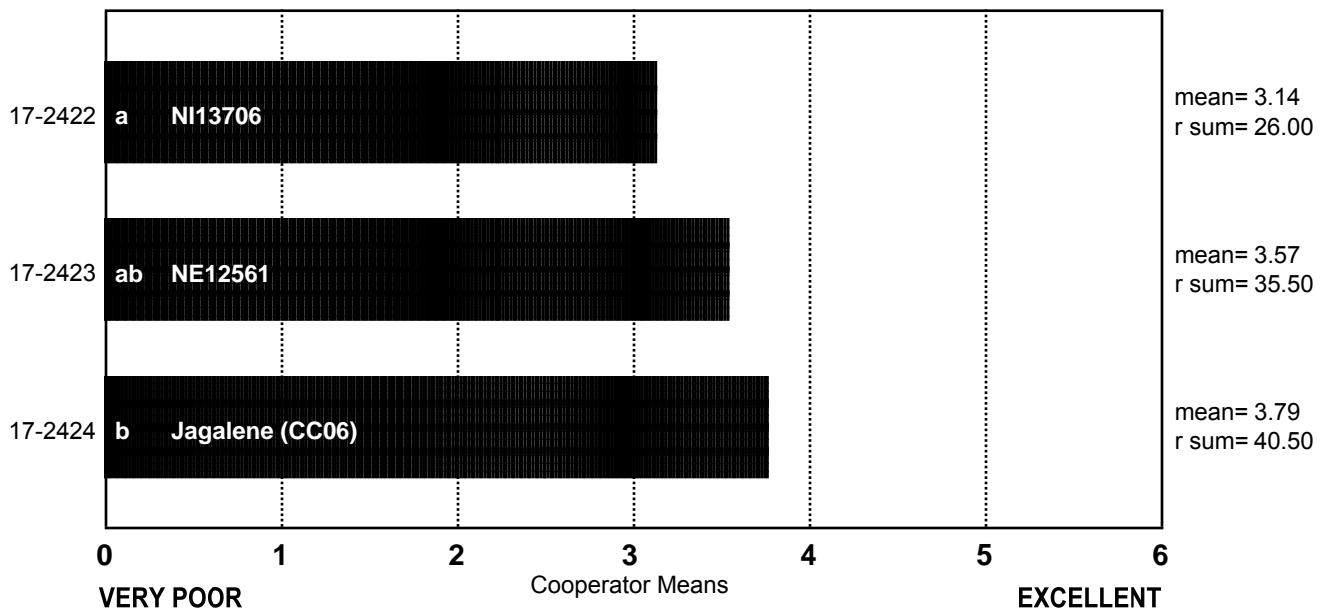
OVERALL BAKING QUALITY

(Small Scale) Nebraska

ncoop= 17
chisq= 6.38
chisqc= 7.48
cvchisq= 5.99
crdiff= 9.99

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS

(Small Scale) Nebraska

COOP.

17-2422 NI13706

- A. No comment.
- B. No comment.
- C. Weak dough & capping on loaves.
- D. No comment.
- E. Grayish dough.
- F. Gummy crumb texture.
- G. Low absorption, mix strength and good volume.
- H. Shorter mix, average absorption.
- I. No comment.
- J. Short mixing time but good loaf volume.
- K. Normal water absorption and mix time, slight sticky & weak dough, very high volume, yellow crumb, open irregular cells with keyhole, resilient & harsh texture.
- L. Short mix, weaker.
- M. Crumb is dull with grayish tint.
- N. Good volume performance but somewhat weaker dough character.
- O. No comment.
- P. Weak mixograph, low bake absorption, short mix time, good dough at pan, Questionable – Satisfactory crumb grain.
- Q. Nice dough, open grain.

COOP.

17-2423 NE12561

- A. No comment.
- B. No comment.
- C. Capping & open grain structure.
- D. No comment.
- E. Excellent loaf externals.
- F. Tough.
- G. Very low absorption, low mix strength and good volume.
- H. Average absorption.
- I. 2422, 2423 and 2424 are the best rated breads and are all very similar. Overall this was by far the best set.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, slight crumb, open round cells, resilient & slight harsh texture.
- L. Good bake for protein, excellent color.
- M. No comment.
- N. Good volume performance but somewhat weaker dough character.
- O. No comment.
- P. Nice break & shred, good absorption and mix time, excellent dough feel, satisfactory crumb grain.
- Q. Low absorption, average grain and volume.

COOP.**17-2424 Jagalene (CC06)**

- A. No comment.
- B. No comment.
- C. Excellent performance.
- D. No comment.
- E. Very nice, excellent loaf externals.
- F. No comment.
- G. Low absorption, mix strength and good volume.
- H. Average absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Good bake for protein.
- M. No comment.
- N. Good volume performance but somewhat weaker dough character.
- O. No comment.
- P. Lower absorption, long mix time, weak dough feel out of mixer but good at pan, above satisfactory crumb grain.
- Q. Low absorption, nice dough, good grain, yellow color, excellent volume.

Notes: **A, C, D, G, I and Q** conducted sponge and dough bake tests

MONSANTO (WESTBRED)

17-2425	Jagalene (CC07)
17-2426	WB4623CLP
17-2427	WB4721

Description of Test Plots and Breeder Entries

Monsanto – Sid Perry

The test samples were grown in Filer, Idaho. The plots were planted on October 15, 2016. Pre-plant N was applied via manure application targeting 125 bushel per acre yields. Liquid 32 was applied at a rate of 100 units/acre. The growth regulator Palisade was applied at jointing. Caramba was applied at flowering to reduce stripe rust and head scab infections. Full irrigation was provided and produced a yield level of 170 bushels per acre.

Jagalene (Common Check)

WB4721

A hard red winter wheat adapted to the Southern and Central Plains and portions of the Northern Plains. Medium-late maturity. Medium height. Excellent straw strength. Very good test weight. Good leaf and stripe rust resistance. Susceptible to soil borne mosaic virus and Fusarium head blight.

WB4623CLP

A hard red winter Clearfield wheat adapted to the Pacific Northwest, Northern Plains and Montana. Medium-late maturity, medium height. Very good test weight. Good winterhardiness and standability. Good resistance to stripe rust. Susceptible to Wheat Stem Sawfly.

Monsanto: 2017 (Small-Scale) Samples

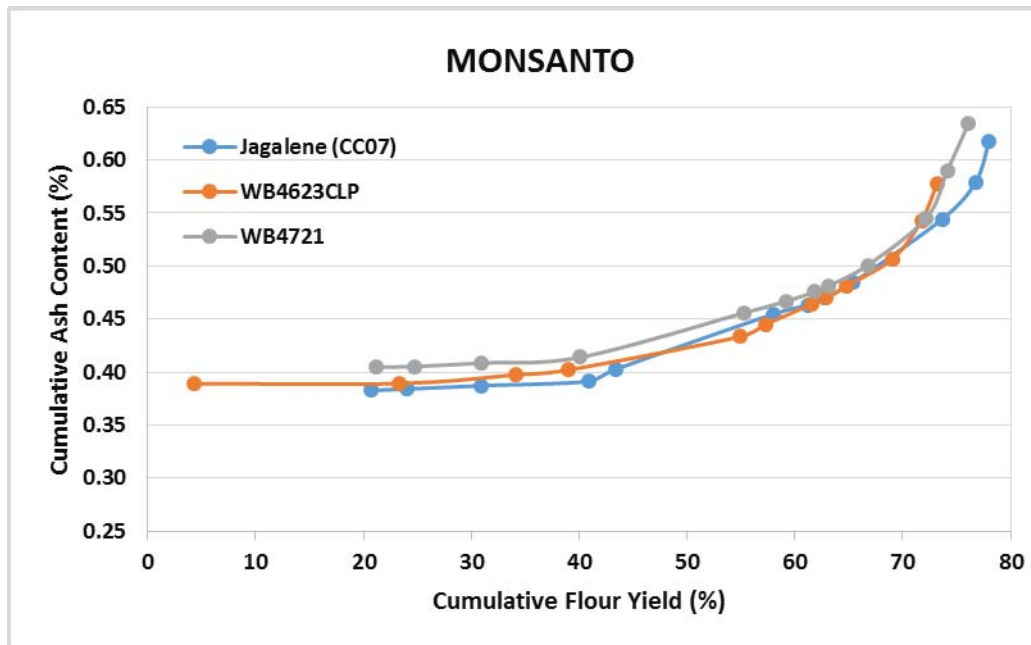
Test entry number	17-2425	17-2426	17-2427
Sample identification	Jagalene (CC07)	WB4623CLP	WB4721
Wheat Data			
GIPSA classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	65.2	64.4	65.4
Hectoliter weight (kg/hl)	85.7	84.6	85.9
1000 kernel weight (gm)	45.0	36.7	40.9
Wheat kernel size (Rotap)			
Over 7 wire (%)	94.8	78.2	91.8
Over 9 wire (%)	5.2	21.8	8.1
Through 9 wire (%)	0.0	0.0	0.1
Single kernel (skcs)^a			
Hardness (avg /s.d)	62.4/14.9	76.2/15.2	64.5/14.4
Weight (mg) (avg/s.d)	45.0/11.2	36.7/10.7	40.9/10.5
Diameter (mm)(avg/s.d)	3.06/0.42	2.74/0.35	2.95/0.42
Moisture (%) (avg/s.d)	9.3/0.5	9.0/0.6	9.5/0.5
SKCS distribution	01-12-32-55-01	01-03-09-87-01	02-08-27-63-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	11.4	12.8	12.9
Wheat ash (12% mb)	1.62	1.61	1.69
Milling and Flour Quality Data			
Flour yield (% , str. grade)			
Miag Multomat Mill	78.1	73.2	76.0
Quadrumat Sr. Mill	70.8	66.7	69.6
Flour moisture (%)	13.2	13.2	12.7
Flour protein (14% mb)	9.8	11.1	11.2
Flour ash (14% mb)	0.57	0.57	0.57
Rapid Visco-Analyser			
Peak Time (min)	6.1	6.3	6.3
Peak Viscosity (RVU)	166.4	192.6	149.0
Breakdown (RVU)	52.8	68.1	41.0
Final Viscosity at 13 min (RVU)	209.5	227.5	191.4
Minolta color meter			
L*	91.71	91.50	91.63
a*	-1.45	-1.24	-1.13
b*	8.87	7.84	7.89
PPO	0.325	0.446	0.342
Falling number (sec)	371	377	351
Damaged Starch			
(AI%)	98.2	98.7	98.8
(AACC76-31)	8.1	8.5	8.6

^as.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Monsanto: Physical Dough Tests and Gluten Analysis For 2017 (Small-Scale) Samples

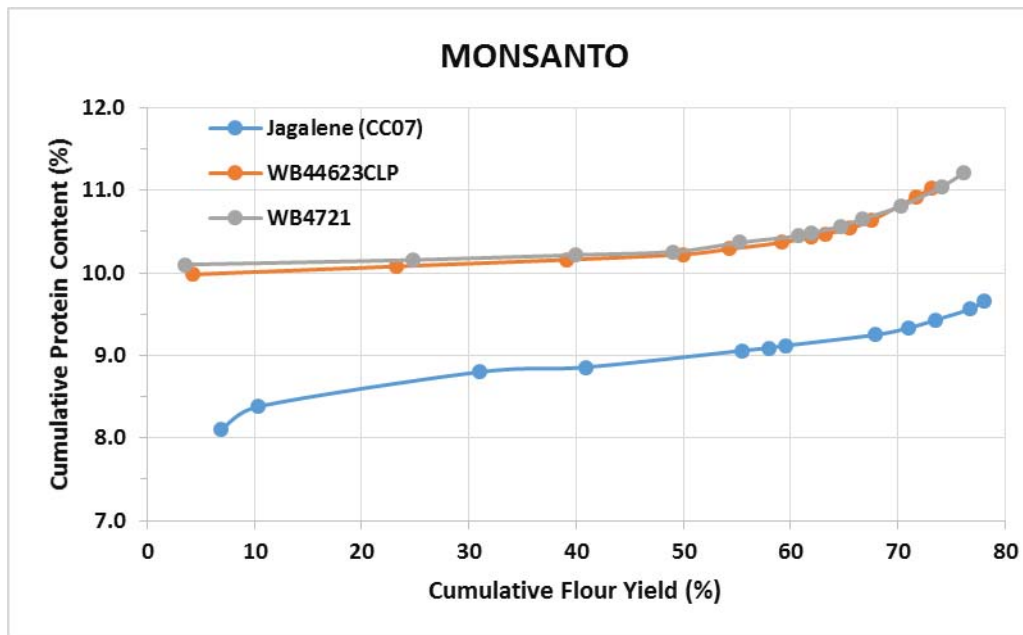
Test Entry Number	17-2425	17-2426	17-2427
Sample Identification	Jagalene (CC07)	WB4623CLP	WB4721
MIXOGRAPH			
Flour Abs (% as-is)	62.8	66.0	67.1
Flour Abs (14% mb)	61.7	64.7	65.7
Mix Time (min)	2.8	2.9	2.3
Mix tolerance (0-6)	1	2	0
FARINOGRAPH			
Flour Abs (% as-is)	65.3	68.4	71.8
Flour Abs (14% mb)	64.3	67.1	70.4
Peak time (min)	3.9	4.1	4.2
Mix stability (min)	5.1	6.7	4.8
Mix Tolerance Index (FU)	42	27	54
Breakdown time (min)	6.6	9.6	7.6
ALVEOGRAPH			
P(mm): Tenacity	97	159	128
L(mm): Extensibility	59	40	40
G(mm): Swelling index	17.1	14.1	14.1
W(10 ⁻⁴ J): strength (curve area)	194	256	195
P/L: curve configuration ratio	1.64	3.97	3.20
Ie(P ₂₀₀ /P): elasticity index	44.1	42.6	34.6
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	220/310/361	261/363/354	170/227/222
Extensibility (mm at 45/90/135 min)	139/137/132	127/127/125	143/132/145
Energy (cm ² at 45/90/135 min)	54/70/77	54/74/70	40/49/55
Resist _{max} (BU at 45/90/135 min)	281/380/455	309/422/434	189/260/272
Ratio (at 45/90/135 min)	1.6/2.3/2.7	2.1/2.9/2.8	1.2/1.7/1.5
PROTEIN ANALYSIS			
HMW-GS Composition	2*,1,5+10,17+18	Null,5+10,7+8	2*,5+10,7+8
TMP/TTP	1.00	0.85	0.79
SEDIMENTATION TEST			
Volume (ml)	36.6	45.4	37.5

Monsanto: Cumulative Ash Curves



Jagalene (CC07)					WB4623CLP					WB4721				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	20.6	0.38	20.6	0.38	1M Red	4.3	0.39	4.3	0.39	2M	21.2	0.40	21.2	0.40
1M Red	3.4	0.39	24.0	0.38	2M	19.0	0.39	23.3	0.39	1M Red	3.5	0.41	24.8	0.41
1BK	6.9	0.40	31.0	0.39	1M	10.8	0.41	34.1	0.40	1BK	6.2	0.42	30.9	0.41
1M	9.9	0.40	40.9	0.39	1BK	4.9	0.44	39.0	0.40	1M	9.2	0.43	40.1	0.41
Grader	2.5	0.59	43.4	0.40	3M	15.9	0.51	54.9	0.43	3M	15.1	0.57	55.3	0.46
3M	14.6	0.61	58.0	0.45	Grader	2.4	0.71	57.3	0.45	2BK	3.9	0.62	59.2	0.47
2BK	3.2	0.61	61.2	0.46	2BK	4.3	0.72	61.5	0.46	Grader	2.7	0.68	61.9	0.48
FILTER FLR	1.6	0.73	62.8	0.47	FILTER FLR	1.3	0.73	62.9	0.47	FILTER FLR	1.3	0.75	63.1	0.48
3BK	2.5	0.84	65.3	0.48	3BK	1.9	0.87	64.8	0.48	3BK	3.6	0.84	66.8	0.50
4M	8.3	1.02	73.7	0.54	4M	4.3	0.89	69.1	0.51	4M	5.5	1.09	72.2	0.55
5M	3.1	1.40	76.7	0.58	5M	2.7	1.48	71.8	0.54	BRAN FLR	1.9	2.26	74.1	0.59
BRAN FLR	1.3	2.95	78.0	0.62	BRAN FLR	1.4	2.32	73.2	0.58	5M	2.0	2.30	76.1	0.63
Break Shorts	3.1	4.24	81.1	0.76	Break Shorts	4.0	3.01	77.2	0.70	Break Shorts	4.1	3.38	80.2	0.78
Red Dog	2.3	3.00	83.5	0.82	Red Dog	3.7	2.09	80.9	0.77	Red Dog	1.6	2.92	81.8	0.82
Red Shorts	0.4	3.76	83.8	0.83	Red Shorts	0.5	1.93	81.4	0.77	Red Shorts	0.2	3.18	82.0	0.82
Filter Bran	1.9	4.13	85.8	0.91	Filter Bran	0.9	3.17	82.3	0.80	Filter Bran	1.0	4.43	83.0	0.86
Bran	14.2	5.92	100.0	1.62	Bran	17.7	4.86	100.0	1.52	Bran	17.0	5.71	100.0	1.69
Wheat		1.52					1.50					1.60		
St. Grd. Fl.		0.57					0.57					0.57		

Monsanto: Cumulative Protein Curves

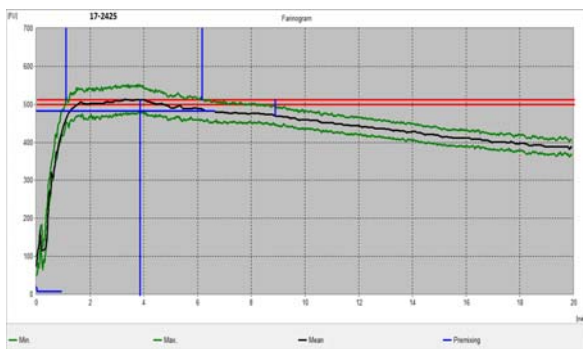


Jagalene (CC07)					WB4623CLP					WB4721				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
18K	6.9	8.10	6.9	8.1	1M Red	4.3	9.98	4.3	10.0	1M Red	3.5	10.10	3.5	10.1
1M Red	3.4	8.95	10.3	8.4	2M	19.0	10.10	23.3	10.1	2M	21.2	10.17	24.8	10.2
2M	20.6	9.01	31.0	8.8	3M	15.9	10.28	39.2	10.2	3M	15.1	10.31	39.9	10.2
1M	9.9	9.04	40.9	8.9	1M	10.8	10.46	50.0	10.2	1M	9.2	10.43	49.1	10.3
3M	14.6	9.62	55.5	9.1	4M	4.3	11.04	54.3	10.3	18K	6.2	11.25	55.3	10.4
Grader	2.5	9.81	58.0	9.1	18K	4.9	11.25	59.2	10.4	4M	5.5	11.25	60.7	10.4
FILTER FLR	1.6	10.18	59.6	9.1	5M	2.7	11.95	61.9	10.4	FILTER FLR	1.3	12.27	62.0	10.5
4M	8.3	10.18	67.9	9.2	FILTER FLR	1.3	12.01	63.2	10.5	Grader	2.7	12.36	64.7	10.6
5M	3.1	11.12	71.0	9.3	Grader	2.4	12.44	65.6	10.5	5M	2.0	13.56	66.7	10.7
3BK	2.5	12.17	73.5	9.4	3BK	1.9	13.74	67.5	10.6	3BK	3.6	13.63	70.3	10.8
2BK	3.2	12.58	76.7	9.6	2BK	4.3	15.52	71.8	10.9	2BK	3.9	15.46	74.2	11.0
BRAN FLR	1.3	15.40	78.0	9.7	BRAN FLR	1.4	16.28	73.2	11.0	BRAN FLR	1.9	17.21	76.1	11.2
Break Shorts	3.1	14.18	81.1	9.8	Break Shorts	4.0	13.53	77.2	11.2	Break Shorts	4.1	13.87	80.2	11.3
Red Dog	2.3	12.67	83.5	9.9	Red Dog	3.7	12.81	80.9	11.2	Red Dog	1.6	13.39	81.8	11.4
Red Shorts	0.4	12.67	83.8	9.9	Red Shorts	0.5	11.64	81.4	11.2	Red Shorts	0.2	13.28	82.0	11.4
Filter Bran	1.9	12.33	85.8	10.0	Filter Bran	0.9	13.10	82.3	11.3	Filter Bran	1.0	14.50	83.0	11.4
Bran	14.2	15.90	100.0	10.8	Bran	17.7	16.14	100.0	12.1	Bran	17.0	17.18	100.0	12.4
Wheat		10.7					12.0					12.2		
St. Grd. Fl		9.8					11.1					11.2		

Physical Dough Tests

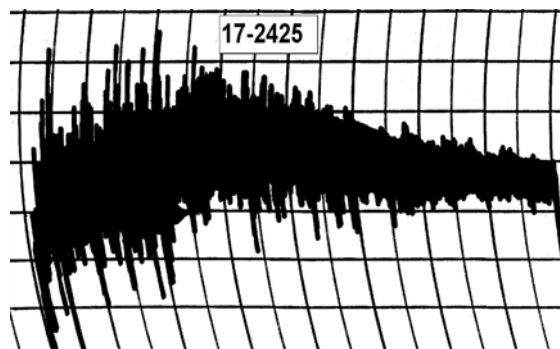
2017 (Small Scale) Samples – Monsanto

Farinograms



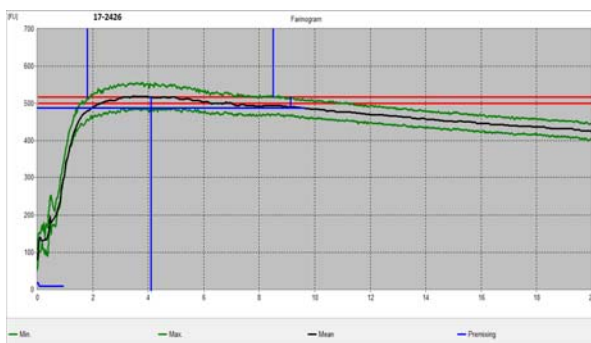
Water abs = 64.3%, Peak time = 3.9 min,
Mix stab = 5.1min, MTI = 42 FU

Mixograms

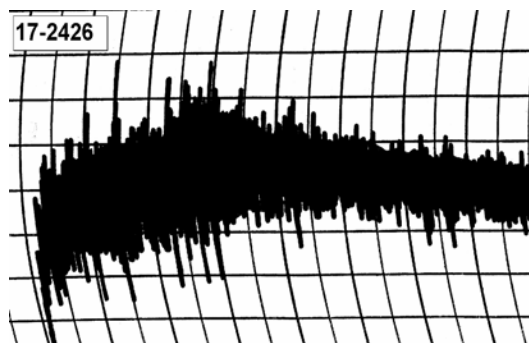


Water abs = 61.7%
Mix time = 2.8 min

17-2425, Jagalene (CC07)



Water abs = 67.1%, Peak time = 4.1 min,
Mix stab = 6.7 min, MTI = 27 FU



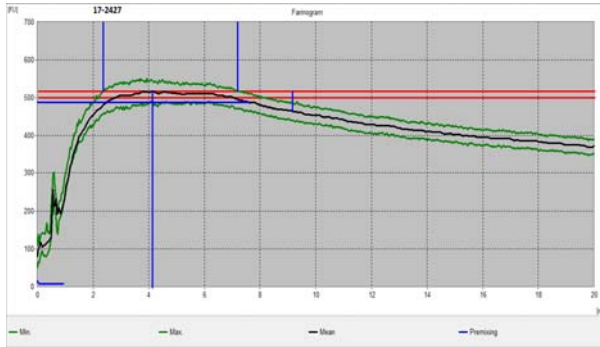
Water abs = 64.7%
Mix time = 2.9 min

17-2426, WB4623CLP

Physical Dough Tests

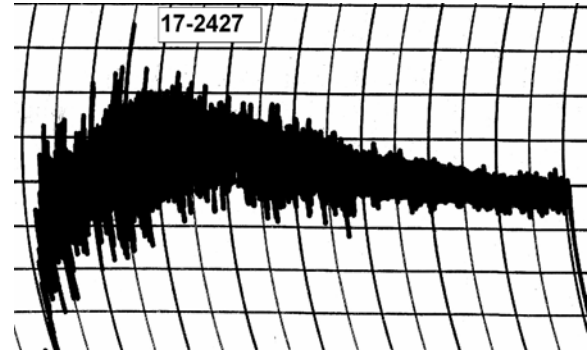
2017 (Small Scale) Samples – Monsanto

Farinograms



Water abs = 70.4%, Peak time = 4.2 min,
Mix stab = 4.8 min, MTI = 54 FU

Mixograms

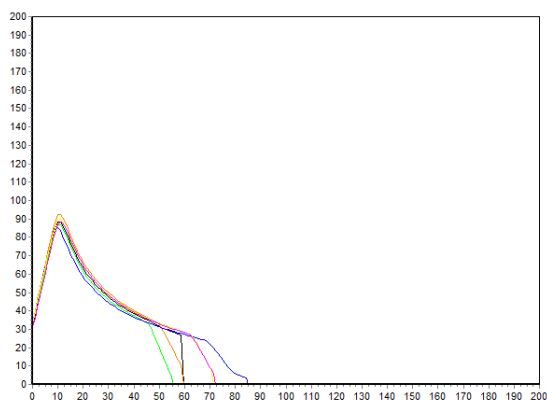


Water abs = 65.7%
Mix time = 2.3 min

17-2427, WB4721

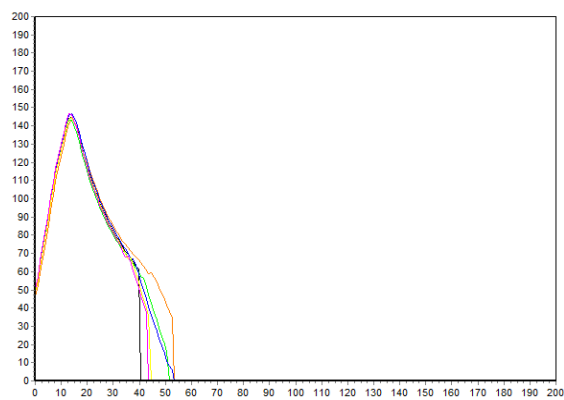
Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Monsanto



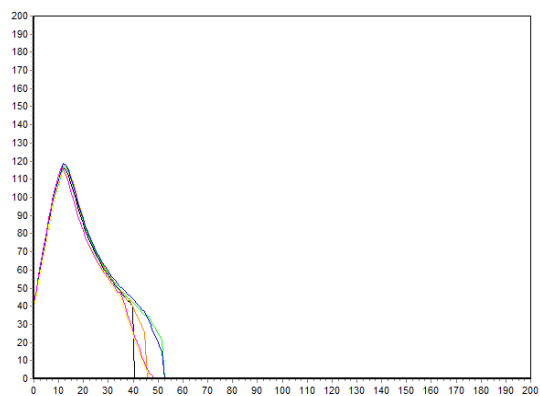
17-2425, Jagalene (CC07)

P (mm H₂O) = 97, L (mm) = 59, W (10E⁻⁴J) = 194



17-2426, WB4623CLP

P (mm H₂O) = 159, L (mm) = 40, W (10E⁻⁴J) = 256

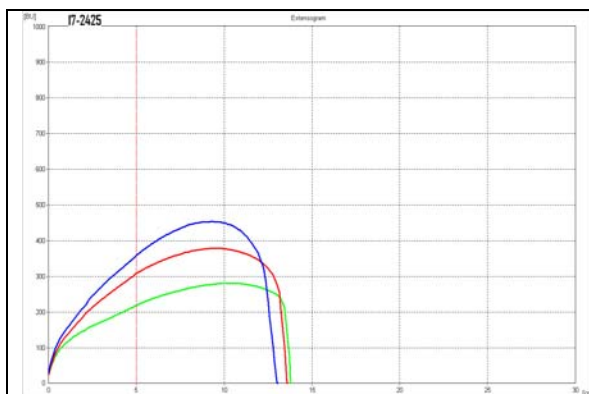


17-2427, WB4721

P (mm H₂O) = 128, L (mm) = 40, W (10E⁻⁴J) = 195

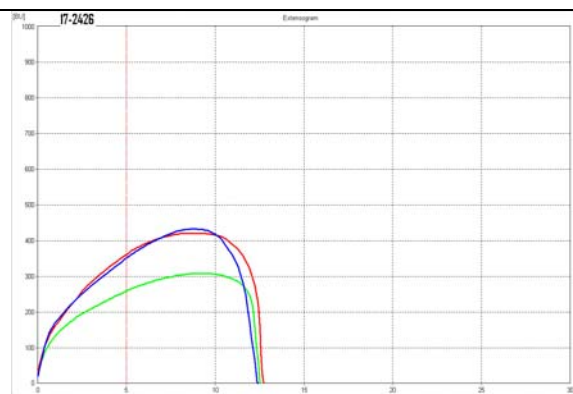
Physical Dough Tests - Extensigraph

2017 (Small Scale) Samples – Monsanto



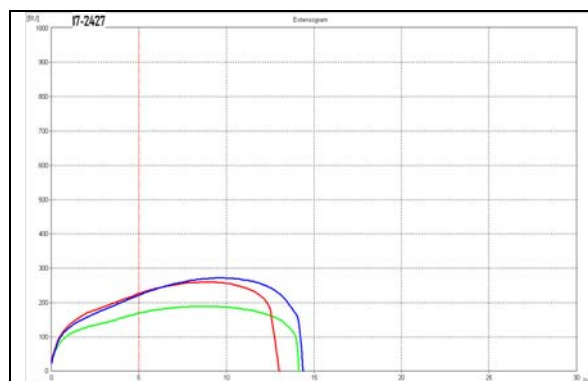
17-2425, Jagalene (CC07)

R (BU) = 310, E (mm) = 137, W (cm²) = 70
Rmax (BU) = 380, Ratio = 2.3 at 90 min



17-2426, WB46233CLP

R (BU) = 363, E (mm) = 127, W (cm²) = 74
Rmax (BU) = 422, Ratio = 2.9 at 90 min

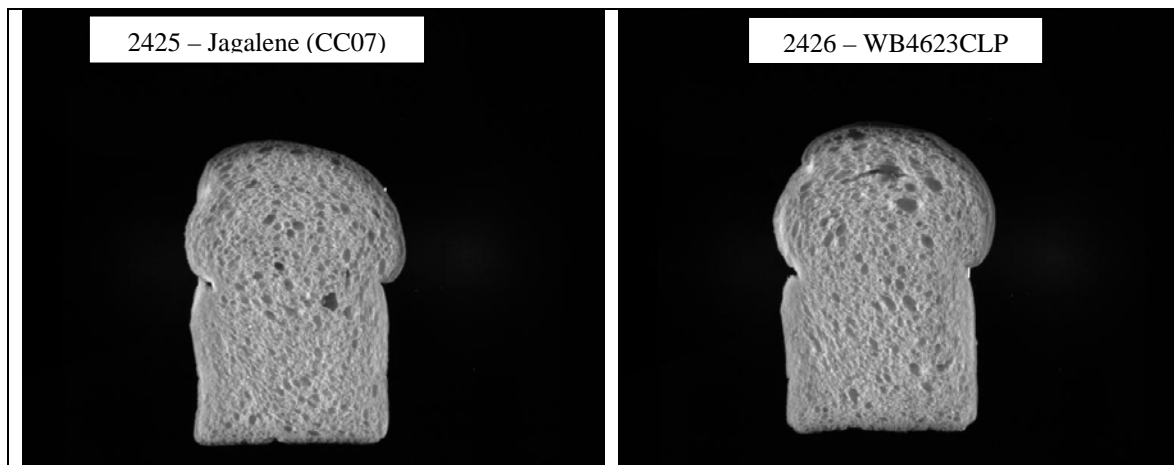


17-2427, WB4721

R (BU) = 227, E (mm) = 132, W (cm²) = 49
Rmax (BU) = 260, Ratio = 1.7 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm²) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Monsanto: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2425	5459	144	3716	0.432	1.770	2.257	1.645	-19.45
2426	5729	141	3693	0.441	1.929	1.708	1.655	-22.05



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2427	5303	139	3476	0.442	1.868	1.452	1.603	-26.45

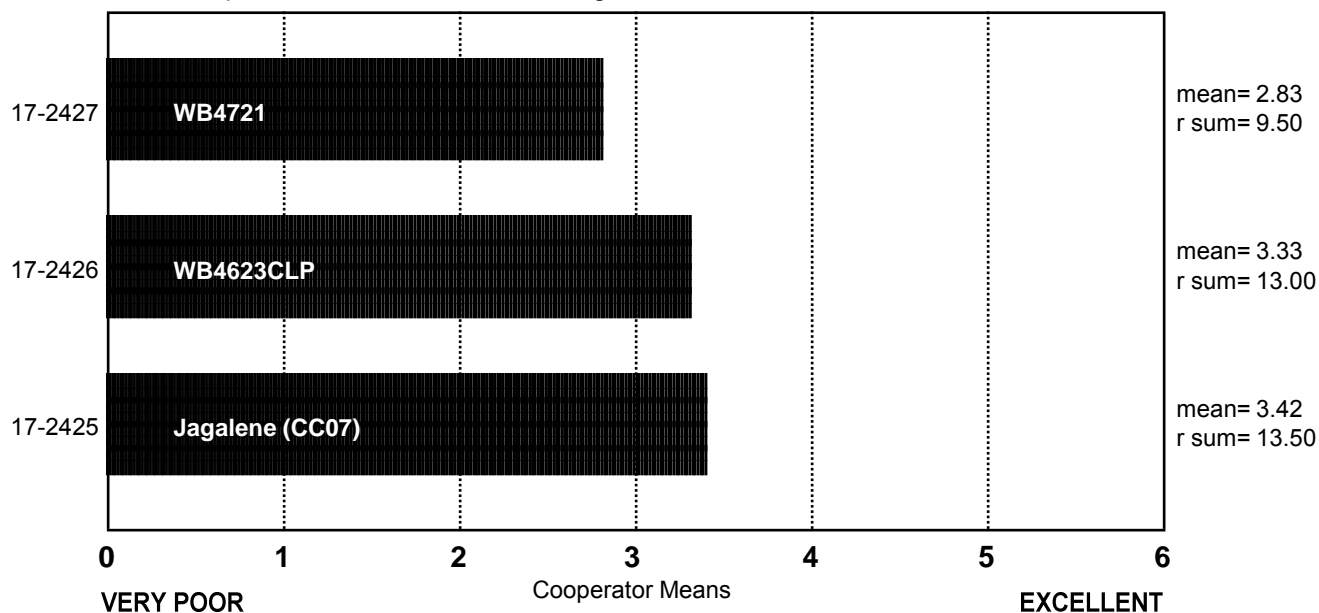
SPONGE CHARACTERISTICS

(Small Scale) Westbred

ncoop= 6
chisq= 1.58
chisqc= -2.38
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



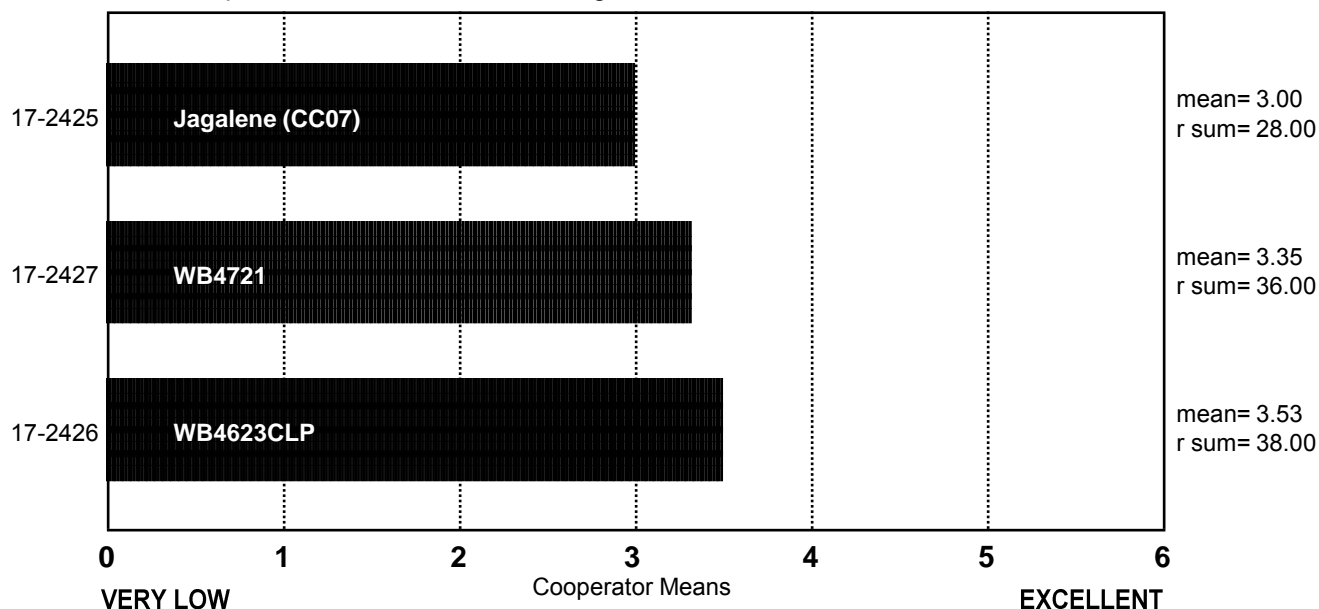
BAKE ABSORPTION

(Small Scale) Westbred

ncoop= 17
chisq= 3.29
chisqc= 4.57
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Westbred

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2425 Jagalene (CC07)	55.0	64.3	61.9	62.0	58.2	64.3	59.0	59.0	67.3	66.5	59.6	60.0	64.8	61.2	59.9	62.6	58.9
17-2426 WB4623CLP	57.0	67.1	62.4	67.5	61.9	67.1	63.0	63.0	70.1	66.9	62.5	62.2	67.3	66.2	62.3	64.4	57.7
17-2427 WB4721	58.0	67.1	64.3	70.5	59.6	66.0	64.0	61.0	73.4	67.0	63.4	62.6	70.4	64.2	62.4	65.3	61.6

BAKE MIX TIME, ACTUAL

(Small Scale) Westbred

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2425 Jaqalene (CC07)	5.0	6.0	6.0	4.0	3.0	8.0	6.0	2.5	4.0	3.8	3.8	2.5	2.3	5.1	2.7	3.1	4.0
17-2426 WB4623CLP	5.0	6.0	6.0	6.0	3.0	8.0	6.0	2.5	4.0	3.8	4.0	2.7	2.3	3.6	2.9	3.6	4.0
17-2427 WB4721	5.0	5.0	6.0	4.0	2.5	7.0	6.0	2.3	5.5	3.5	3.5	1.9	1.8	3.7	2.4	2.5	4.0

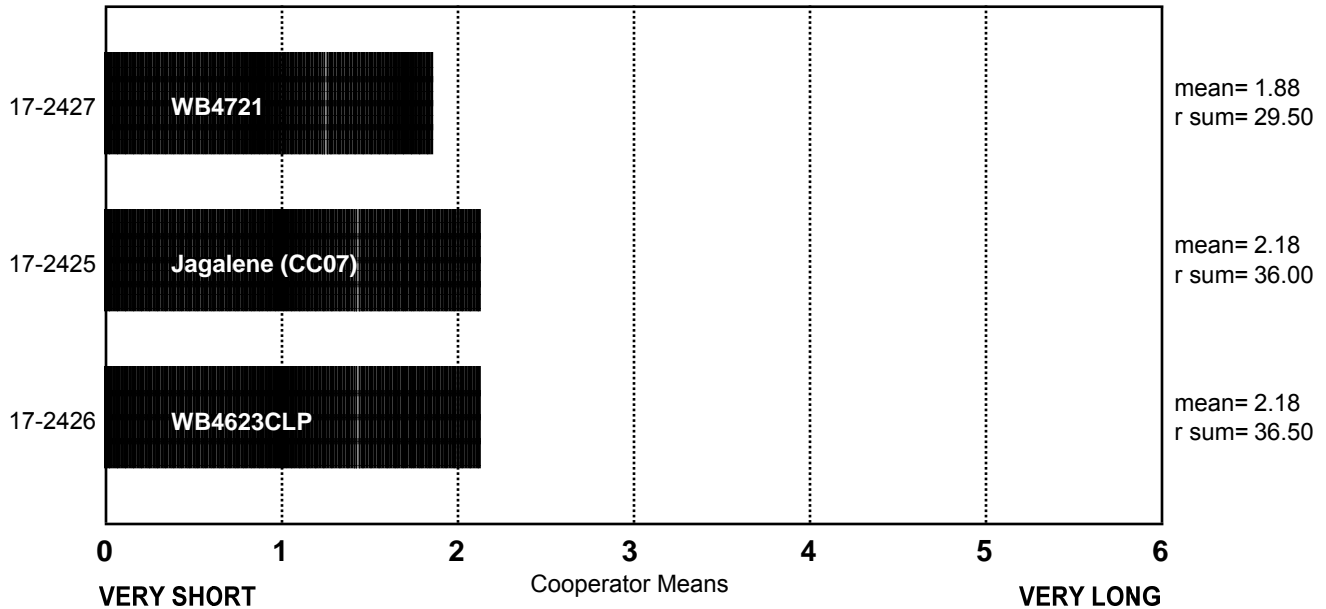
BAKE MIX TIME

(Small Scale) Westbred

ncoop= 17
 chisq= 1.79
 chisqc= 4.52
 cvchisq= 5.99
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



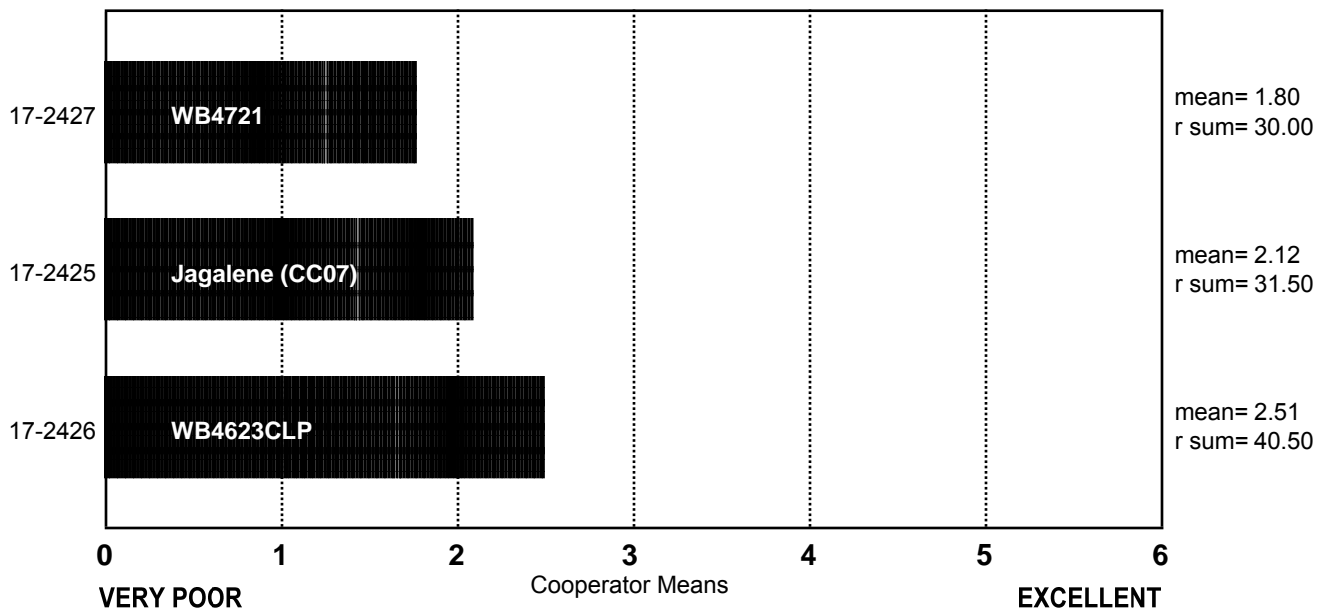
MIXING TOLERANCE

(Small Scale) Westbred

ncoop= 17
 chisq= 3.79
 chisqc= 5.73
 cvchisq= 5.99
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



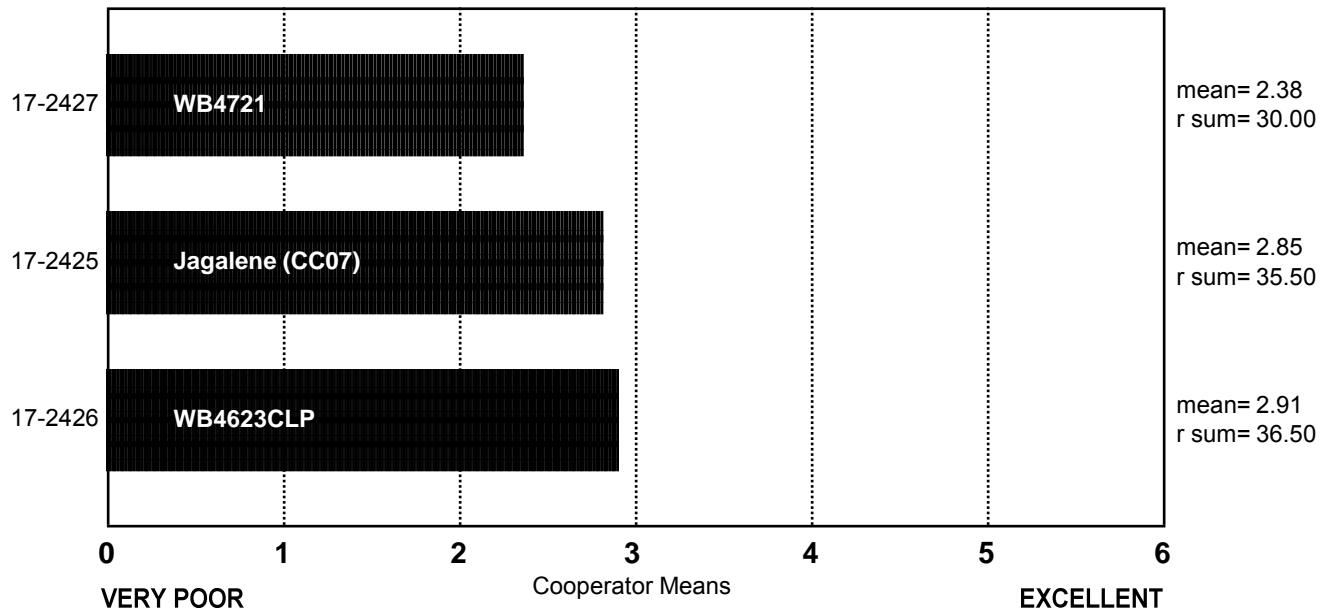
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Westbred

ncoop= 17
chisq= 1.44
chisqc= 2.65
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
17-2425 Jagalene (CC07)	7	1	2	7	0
17-2426 WB4623CLP	4	1	5	7	0
17-2427 WB4721	4	2	6	5	0

Frequency Table

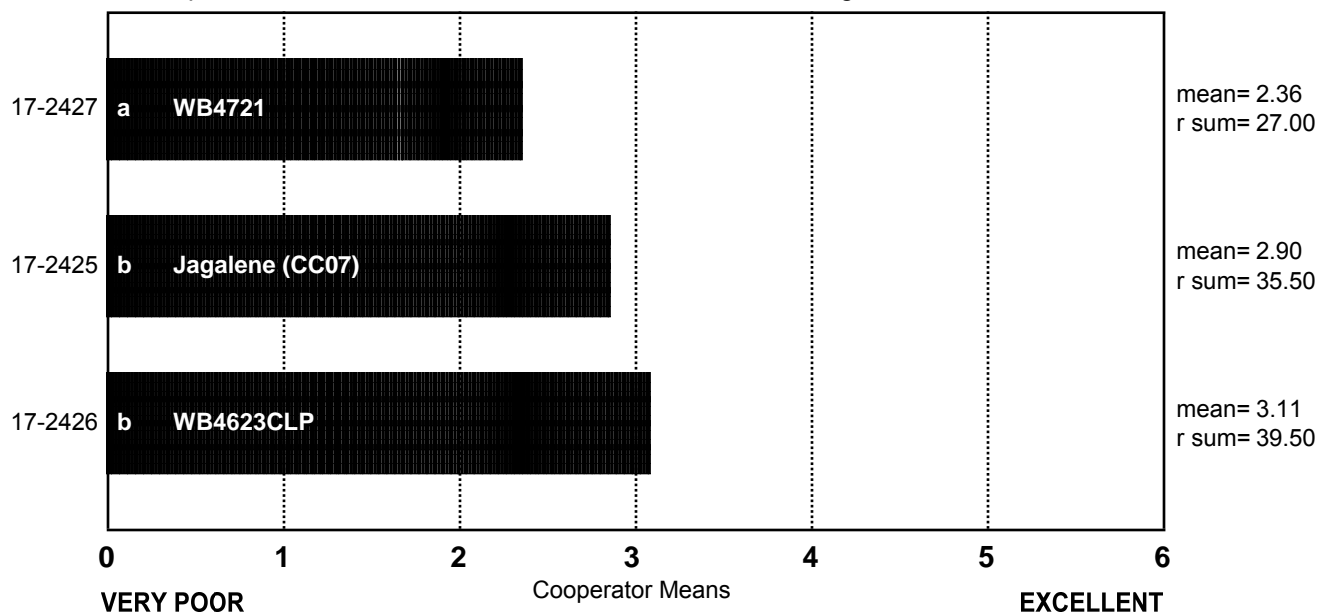
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Westbred

ncoop= 17
chisq= 4.79
chisqc= 7.24
cvchisq= 5.99
crdiff= 8.32

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
17-2425 Jagalene (CC07)	5	2	2	8	0
17-2426 WB4623CLP	2	1	4	10	0
17-2427 WB4721	6	2	4	5	0

Frequency Table

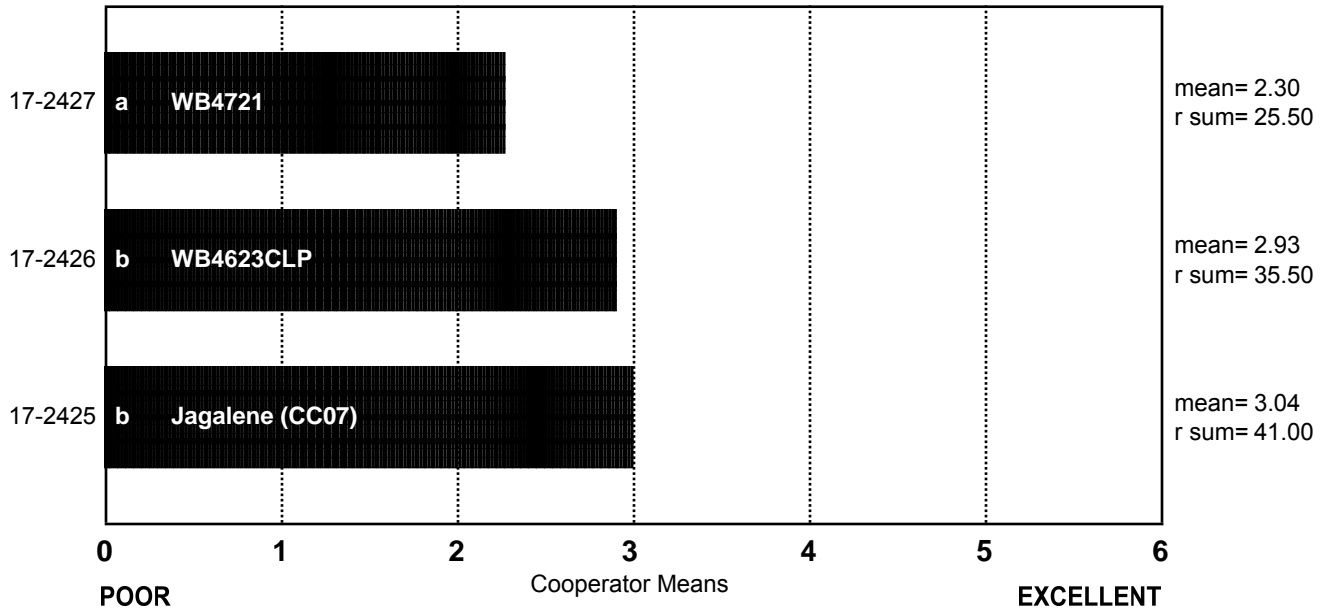
CRUMB GRAIN

(Small Scale) Westbred

ncoop= 17
 chisq= 7.26
 chisqc= 10.74
 cvchisq= 5.99
 crdiff= 8.33

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Westbred

	Open	Fine	Dense
17-2425 Jagalene (CC07)	11	4	2
17-2426 WB4623CLP	13	1	3
17-2427 WB4721	15	0	2

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Westbred

	Round	Irregular	Elongated
17-2425 Jagalene (CC07)	5	9	3
17-2426 WB4623CLP	5	9	3
17-2427 WB4721	9	8	0

Frequency Table

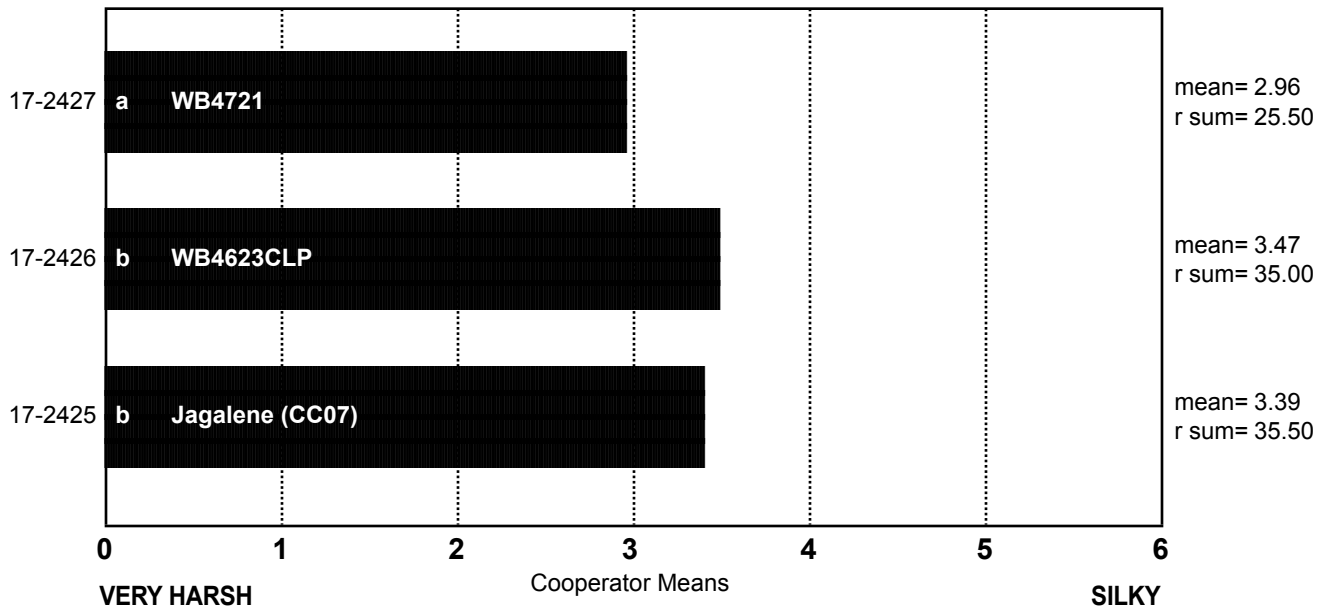
CRUMB TEXTURE

(Small Scale) Westbred

ncoop= 16
chisq= 3.97
chisqc= 6.35
cvchisq= 5.99
crdiff= 8.44

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Westbred

	Harsh	Smooth	Silky
17-2425 Jagalene (CC07)	7	7	3
17-2426 WB4623CLP	7	8	2
17-2427 WB4721	11	4	2

Frequency Table

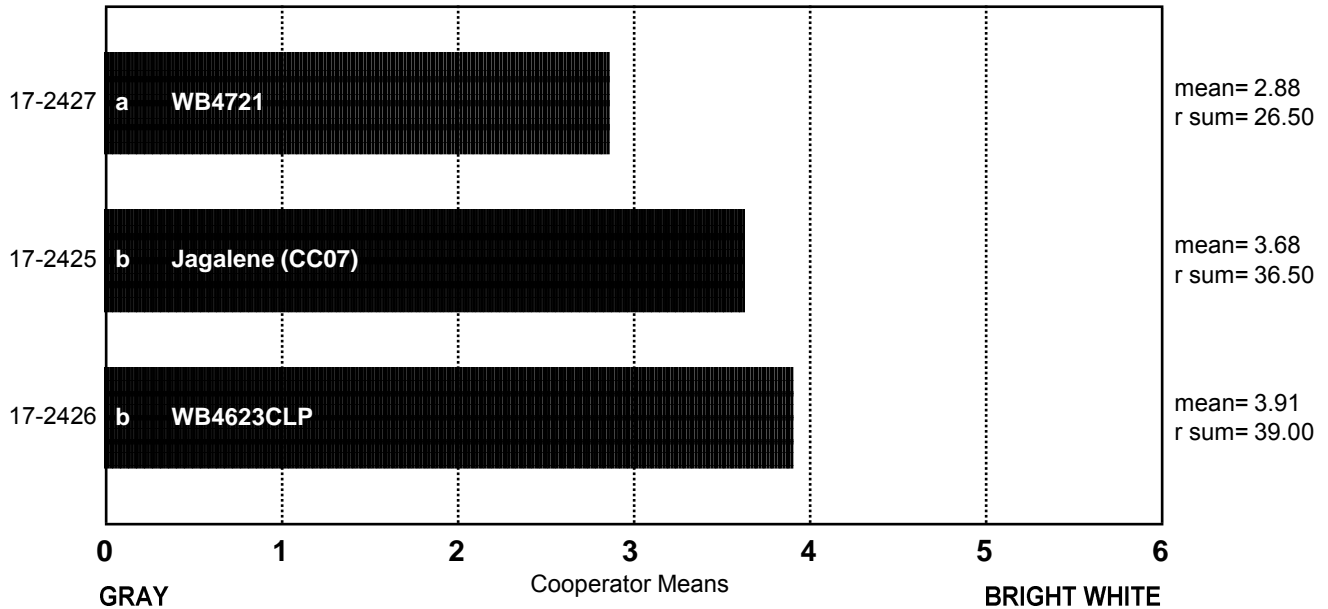
CRUMB COLOR

(Small Scale) Westbred

ncoop= 17
 chisq= 5.15
 chisqc= 7.45
 cvchisq= 5.99
 crdiff= 9.00

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Westbred

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2425 Jagalene (CC07)	0	0	4	4	6	3	0
17-2426 WB4623CLP	1	0	1	5	6	3	1
17-2427 WB4721	3	0	4	6	4	0	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Westbred

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2425 Jagalene (CC07)	411.0	460.6	432.0	436.0	141.1	449.6		141.7	446.7	136.7	137.5	143.9	136.0	151.1	141.5	151.4	483.4
17-2426 WB4623CLP	410.0	460.7	429.0	440.0	138.3	449.0		144.0	441.2	134.9	141.9	145.5	136.9	152.5	138.9	151.2	480.0
17-2427 WB4721	412.0	464.5	429.0	446.0	142.4	455.0		145.0	445.3	139.0	140.4	148.4	142.8	158.0	139.5	152.8	486.6

LOAF VOLUME, ACTUAL

(Small Scale) Westbred

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2425 Jaqalene (CC07)	2675	2375	2800	2200	800	2575	2809	650	2200	800	878	630	777	823	803	785	2513
17-2426 WB4623CLP	2625	2200	2800	2450	855	2604	2927	690	2225	760	888	675	845	863	805	845	2663
17-2427 WB4721	2300	2175	2400	2275	745	2391	2603	520	2125	650	851	575	722	745	748	755	2263

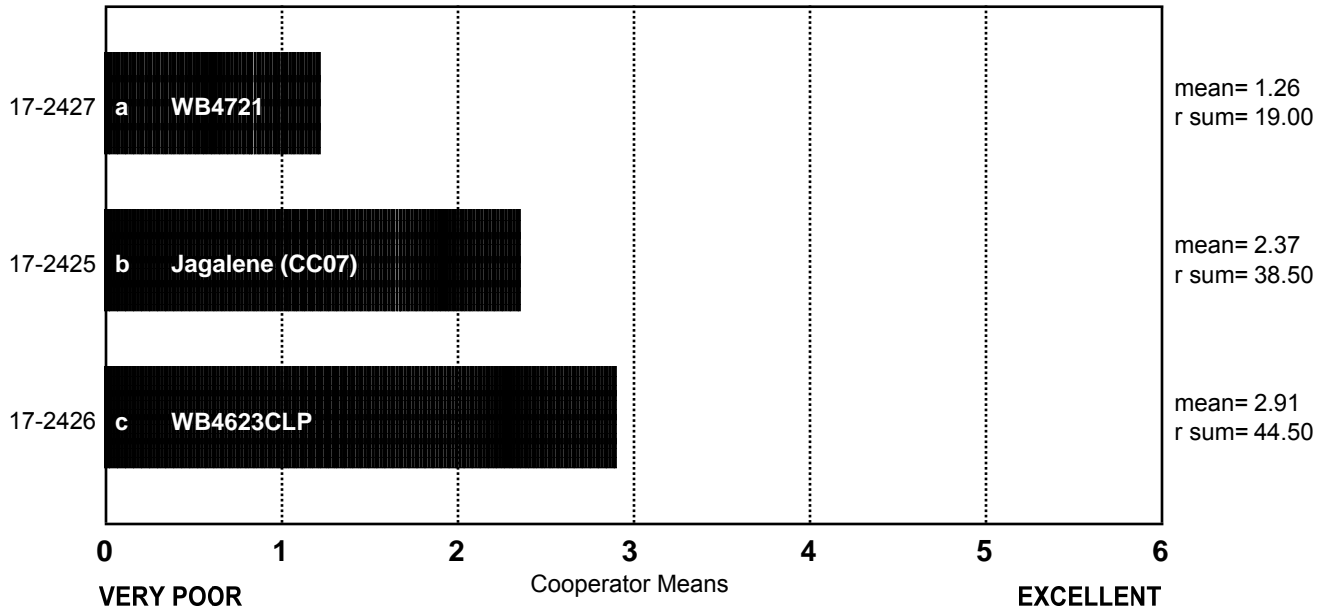
LOAF VOLUME

(Small Scale) Westbred

ncoop= 17
 chisq= 20.91
 chisqc= 24.52
 cvchisq= 5.99
 crdiff= 5.97

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



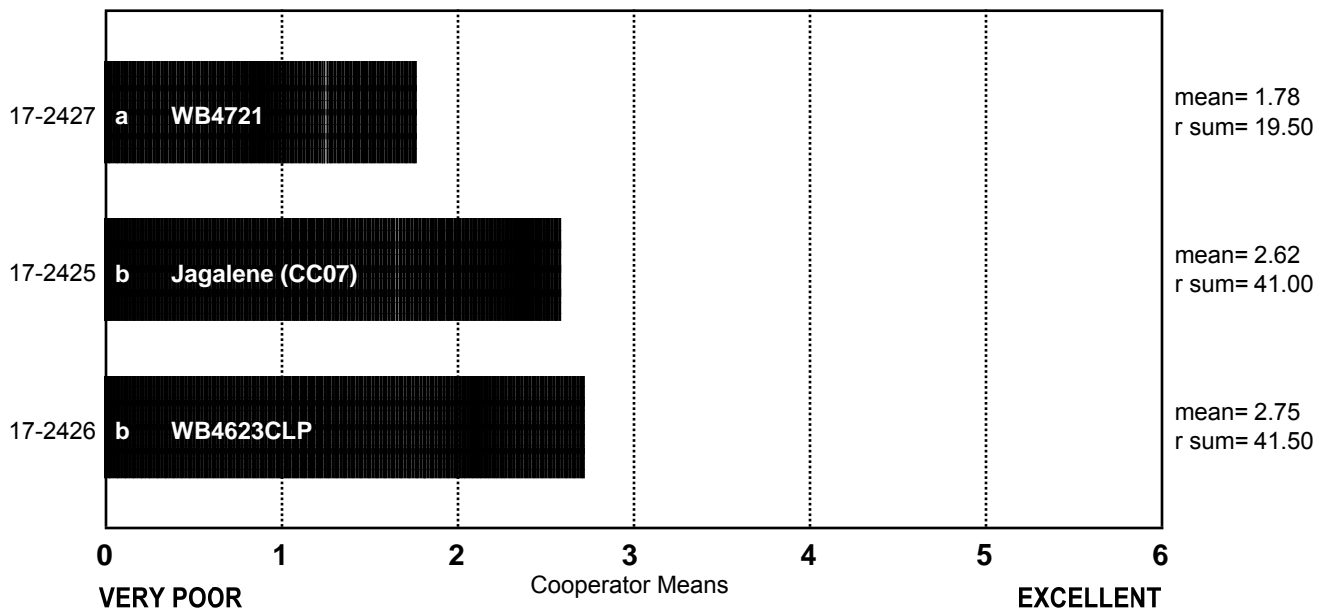
OVERALL BAKING QUALITY

(Small Scale) Westbred

ncoop= 17
 chisq= 18.56
 chisqc= 21.76
 cvchisq= 5.99
 crdiff= 6.78

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS

(Small Scale) Westbred

COOP.

17-2425 Jagalene (CC07)

- A. No comment.
- B. No comment.
- C. Very short mix time & sticky dough, capping.
- D. No comment.
- E. Dark crust, rough break and shred.
- F. Very sticky dough, needed lots of dusting flour for rounding & moulding, off flavor from the crumb.
- G. Fair absorption, very low mix strength and slightly low volume.
- H. Shorter mix, absorption less than target.
- I. No comment.
- J. Low protein and low loaf volume.
- K. Low water absorption, normal mix time, slight sticky & strong dough, high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Unacceptable protein, short mix, weaker, poor loaf volume/crumb.
- M. No comment.
- N. Low protein, weak dough, expected poor crumb but produced bread with good volume for protein level.
- O. No comment.
- P. Low flour protein, low bake absorption, short mix time, good dough feel at pan, Questionable – Satisfactory crumb grain with low loaf volume.
- Q. Sticky dough, poor mixing tolerance, open grain, yellow color.

COOP.

17-2426 WB4623CLP

- A. No comment.
- B. No comment.
- C. Very short mix time, wet dough handling but good bread performance.
- D. No comment.
- E. Very rough break, cap, dark crust.
- F. Very sticky dough, needed lots of dusting flour for rounding & moulding.
- G. Good absorption, but very low mix strength and good volume.
- H. Average absorption, shorter mix.
- I. Best of set, all 3 very similar, 2426 had the best volume.
- J. Small loaf.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, slight yellow crumb, open elongated cells, resilient & smooth texture.
- L. Low protein/loaf volume but good color.
- M. No comment.
- N. Weak dough and crumb grain, volume reasonable for protein level.
- O. No comment.
- P. Good bake absorption and mix time, weak dough feel out of mixer & at pan, good crumb grain.
- Q. Sticky dough out of mixer, poor mixing tolerance, open grain, but nice creamy color and excellent volume.

COOP.

17-2427 WB4721

- A. No comment.
- B. No comment.
- C. Poor overall performance, capping & open cell structure.
- D. No comment.
- E. No comment.
- F. Very sticky dough, needed lots of dusting flour for rounding & moulding.
- G. Farinograph absorption was high, but the dough felt wet & sticky. Very low mix strength and volume, high ash.
- H. Average absorption, shorter mix, poor loaf volume.
- I. No comment.
- J. Not suitable for bread.
- K. Normal water absorption, short mix time, slight sticky & strong dough, medium volume, yellow crumb, open irregular cells, resilient & slight harsh texture.
- L. Low protein, short mix, weak, unacceptable loaf volume, poor grain/color. Overall unacceptable flour.
- M. Crumb is dull with grayish tint.
- N. No redeeming value.
- O. No comment.
- P. Weak mixograph, poor exterior loaf with dark crust, good bake absorption, short mix time, weak at pan, poor crumb grain, low loaf volume.
- Q. Good absorption, sticky dough, poor mixing tolerance, open grain, very low volume, but creamy color.

Notes: **A, C, D, G, I and Q** conducted sponge and dough bake tests

OKLAHOMA

17-2428	Ruby Lee
17-2429	OK13621
17-2430	OK12D22004-016
17-2431	OCW04S7171T-6W
17-2432	Jagalene (CC08)

Description of Test Plots and Breeder Entries

Oklahoma – Brett Carver

The North Central Agronomy Research Station at Lahoma, OK (12 miles west of Enid) once again played host to the 2017 WQC evaluation program. This site receives no supplemental irrigation, and grain yields typically exceed 50 bu/ac. Grain yield of the submitted WQC entries and checks averaged 58 bu/ac and varied from 30 bu/ac (Jagalene) to 73 bu/ac (OK12D22004-016). Though leaf rust was present beginning at anthesis and at a severe level throughout grain filling, it could not claim to be the sole source of yield tribulations. One of the experimental entries, OK13621, showed a susceptible reaction, yet at 69 bu/ac was only four bushels off the top.

The plot area was fertilized for a yield goal of 60 bu/ac, but the entire field in which these and other entries were evaluated only averaged 11.0% wheat protein. The entire Lahoma station struggled to average in the 11.5-12.0% wheat protein range. Even Gallagher and Bentley, two additional check entries not evaluated in the WQC, averaged only 10% wheat protein. However, just like 2016, sedimentation volumes, adjusted to a constant flour protein level, came in well above-average (8.5 mL) compared with expectation (7.0 mL), and pup loaf volume was highly variable, from 745 to 918 cc. Kernel size was small, averaging 29 mg, indicative of late-season cumulative effects of leaf rust.

Entries included in the Oklahoma set were the standard check, Jagalene, and the local check, Ruby Lee. All experimental entries have been tested or are currently being tested in the USDA-ARS Southern Regional Performance Nursery.



2017 Wheat Quality Council growout, Lahoma, OK, 14 April 2017, shown in back right corner,

looking south from Highway 412, west of Enid. OSU wheat breeding nurseries consume the three fields directly south of the station building, totaling 6,783 quality-yield plots. Photography by Brian Arnall, OSU WIT.

Ruby Lee (local check)

This 2011 release with pedigree KS94U275/Endurance is a proven winner in milling and baking performance; not to mention but will be mentioned is its very high yield potential is often realized when protected against stripe rust with a fungicide. Planted acres in 2016 were concentrated in western and north central Oklahoma, which amounted to the third most widely planted variety in Oklahoma, behind Gallagher and Duster. 2017 acreage dropped to fifth place, thanks to the stripe rust epidemic of 2016. Ruby Lee is known to have excellent grazeability and grazing tolerance, cold tolerance, and resilience to April freeze events, temperature-sensitive Hessian fly resistance, and wheat show quality.

OK13621

Next to Ruby Lee, this *could* be OSU's best dough quality. Mixograms almost always scream strength. Thanks to the USDA-ARS HWWQL, 2016 farinograph statistics from statewide flour samples further caught our attention: 2 minute peak time with 13 min stability. Extensibility appears, as best as we can tell, to be in good balance. PPO is low, for what that is worth in a HRW wheat. Since 2013 OK13621 has been a top-five yielding experimental in the replicated trial it was tested, except in 2017, when susceptibility to leaf rust without fungicide held it back. Such was its fate in the 2017 SRPN, placing in the middle of the pack region-wide, and performing better in the Texas and Oklahoma panhandles. As for stripe rust, OK13621 has shown a high level of adult-plant resistance from Oklahoma to Washington. Maturity is very early. A release recommendation is forthcoming in 2018, and will hinge on a satisfactory answer to the question of not how to distribute the seed but how to manage the grain. TX00D1390 and Billings are the proud parents of OK13621.

OK12D22004-016

Previously tested as sample 16-2421 in the 2016 WQC where its worst comment was no comment, and given a high probability for release in early 2018, a second WQC look at OK12D22004-016 seemed justified for a candidate that will likely be the focus of producing high-quality product. OK12D22004-016's yield house has a very high ceiling with short walls that do not buckle in the face of wind or quake. It performed well in the 2017 SRPN from Texas to central Kansas, ranking 8th across the entire region. It shows moderately good adult-plant resistance to leaf rust and stripe rust. Resistance to Hessian fly and acidic soils, and very early maturity make it even more attractive. Its best showing in the 2017 OSU wheat variety trials was at Lahoma and Goodwell, OK. This doubled haploid from Everest/OK08328//OK09634 will be paired with OK13621 for a pending release recommendation in 2018. OK12D22004-016 shares a similar (strong) dough profile with OK13621 but with a full percentage point (or more) lower in protein content and unexplainably higher P/L ratio.

OCW04S7171T-6W

Now that hard white wheat is off to a blood-rushing, rip-roaring start in the 2010s, and

grain handlers are doing everything in their power to keep the supply of white wheat steady and on pace with demand, wheat breeders should do their part, too, to ensure a vast and high-performing pipeline of genetics. OSU has developed two HW candidates potentially worthy of replacing Stardust in central Oklahoma. One of those is featured in this year's WQC evaluation; the second will follow next year. Sprout tolerance of OCW04S7171T-6W has been very good to average – not as consistent as Stardust but better in some environments. Its disease package has very few superiors on the HRW side of the breeding program, and includes effective resistance to leaf rust, stripe rust, powdery mildew, wheat soil-borne mosaic/wheat spindle streak mosaic complex, tan spot, and septoria tritici blotch. Even tolerance to nitrogen stress is exceptional. Its only notable weakness is an apparent lack of fitness in the Oklahoma panhandle. Protein content typically runs moderately high though perhaps not in this particular sample. Gluten strength is above-average. The original cross for OCW04S7171T-6W was made by Art Klatt and included parents of CIMMYT and K-State origin, with the last parent in the complex cross being KS91W047.

Oklahoma: 2017 (Small-Scale) Samples

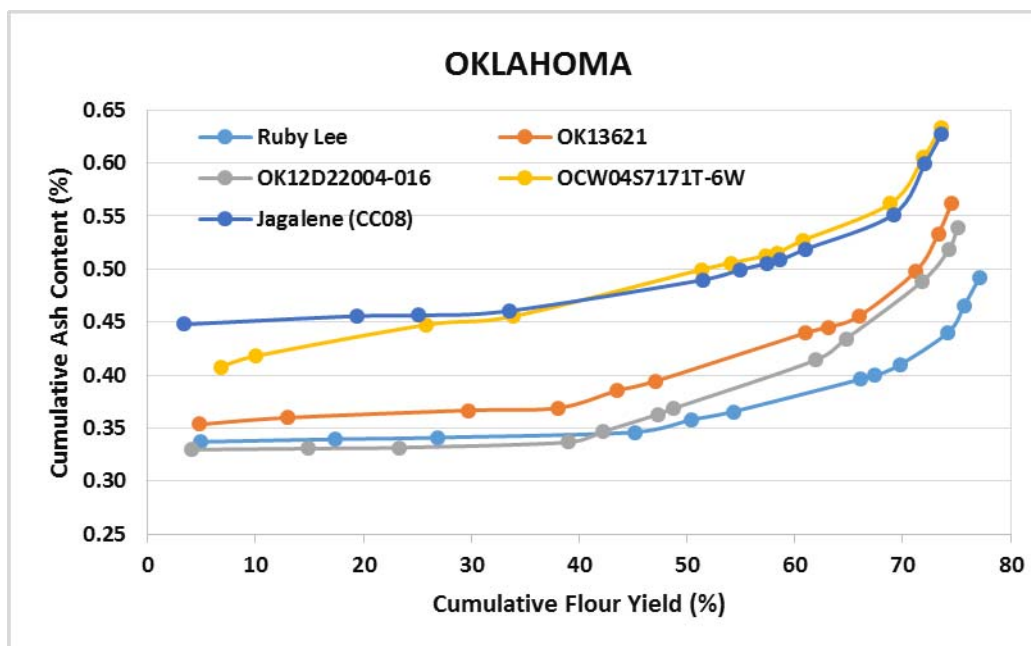
Test entry number	17-2428	17-2429	17-2430	17-2431	17-2432
Sample identification	Ruby Lee	OK13621	OK12D22004-016	OCW04S7171T-6W	Jagalene (CC08)
Wheat Data					
GIPSA classification	2 HRW	2 HRW	2 HRW	2 HDWH	2 HRW
Test weight (lb/bu)	58.8	58.4	59.5	59.1	58.2
Hectoliter weight (kg/hl)	77.4	76.9	78.3	77.8	76.6
1000 kernel weight (gm)	33.1	29.5	30.8	33.6	28.2
Wheat kernel size (Rotap)					
Over 7 wire (%)	78.8	60.3	69.7	78.1	46.9
Over 9 wire (%)	21.0	38.7	29.6	21.5	51.2
Through 9 wire (%)	0.2	1.0	0.7	0.4	1.9
Single kernel (skcs) ^a					
Hardness (avg /s.d)	49.3/15.8	56.8/18.5	52.9/19.6	67.6/21.7	66.2/20.6
Weight (mg) (avg/s.d)	33.1/9.6	29.5/10.5	30.8/10.4	33.6/10.2	28.2/12.3
Diameter (mm)(avg/s.d)	2.75/0.40	2.51/0.37	2.64/0.40	2.67/0.39	2.43/0.43
Moisture (%) (avg/s.d)	11.9/0.4	11.6/0.4	11.9/0.3	11.8/0.4	11.2/0.4
SKCS distribution	12-32-33-23-03	09-21-27-43-01	16-24-28-32-03	05-12-23-60-01	06-09-24-61-01
Classification	Mixed	Hard	Mixed	Hard	Hard
Wheat protein (12% mb)	11.0	12.2	10.6	12.3	13.8
Wheat ash (12% mb)	1.40	1.59	1.47	1.50	1.61
Milling and Flour Quality Data					
Flour yield (% str. grade)					
Miag Multomat Mill	77.1	74.7	75.2	73.6	73.7
Quadrumat Sr. Mill	70.9	68.3	68.1	65.6	67.0
Flour moisture (%)	12.8	13.4	13.1	13.3	12.7
Flour protein (14% mb)	9.8	10.8	9.5	10.9	12.3
Flour ash (14% mb)	0.46	0.54	0.51	0.57	0.60
Rapid Visco-Analyser					
Peak time (min)	6.1	6.1	6.3	6.3	6.1
Peak viscosity (RVU)	207.2	203.4	213.8	180.8	181.1
Breakdown (RVU)	75.1	75.1	67.1	53.8	61.6
Final viscosity at 13 min (RVU)	242.8	240.3	259.0	228.2	228.7
Minolta color meter					
L*	91.57	91.18	91.52	91.28	90.62
a*	-1.29	-1.41	-1.41	-1.42	-1.39
b*	7.97	9.17	8.50	9.28	10.03
PPO	0.549	0.238	0.203	0.524	0.460
Falling number (sec)	437	441	465	495	458
Damaged Starch					
(AI%)	97.9	97.0	97.4	98.1	98.0
(AACC76-31)	7.9	7.1	7.4	8.0	8.0

^as.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Oklahoma: Physical Dough Tests and Gluten Analysis 2017 (Small-Scale) Samples

Test Entry Number	17-2428	17-2429	17-2430	17-2431	17-2432
Sample Identification	Ruby Lee	OK13621	OK12D22004-016	OCW04S7171T-6W	Jagalene (CC08)
MIXOGRAPH					
Flour Abs (% as-is)	66.4	65.6	65.5	67.3	69.2
Flour Abs (14% mb)	65.0	64.5	64.4	66.2	67.7
Mix Time (min)	6.0	6.9	4.3	4.5	4.0
Mix tolerance (0-6)	5	5	4	4	2
FARINOGRAPH					
Flour Abs (% as-is)	63.0	60.0	63.4	64.9	65.9
Flour Abs (14% mb)	61.6	59.0	62.4	63.9	64.4
Peak time (min)	8.4	7.0	6.7	5.7	8.0
Mix stability (min)	24.2	16.1	13.0	11.5	13.2
Mix Tolerance Index (FU)	19	17	21	22	24
Breakdown time (min)	23.0	16.8	14.2	11.3	15.6
ALVEOGRAPH					
P(mm): Tenacity	119	95	118	123	109
L(mm): Extensibility	68	73	57	79	82
G(mm): Swelling index	18.4	19.0	16.8	19.8	20.2
W(10 ⁻⁴ J): strength (curve area)	298	259	245	336	309
P/L: curve configuration ratio	1.75	1.30	2.07	1.56	1.33
Ie(P ₂₀₀ /P): elasticity index	56.0	58.4	49.8	54.8	55.9
EXTENSIGRAPH					
Resist (BU at 45/90/135 min)	497/786/946	579/847/926	336/490/494	425/541/514	386/422/439
Extensibility (mm at 45/90/135 min)	133/104/101	135/120/112	142/123/114	132/123/114	154/156/142
Energy (cm ² at 45/90/135 min)	110/119/130	136/155/149	84/95/87	94/120/109	106/125/109
Resist _{max} (BU at 45/90/135min)	632/922/997	793/996/996	435/589/593	542/747/653	522/628/592
Ratio (at 45/90/135 min)	3.7/7.6/9.4	4.3/7.0/8.2	2.4/4.0/4.3	3.2/4.2/3.9	2.5/2.7/3.1
PROTEIN ANALYSIS					
HMW-GS Composition	2*,2+12,7+8	2*,5+10,7+8	2*,5+10,17+18	2*,5+10,7+9	2*,1,5+10,17+18
TMP/TPP	1.15	1.17	1.07	0.98	0.99
SEDIMENTATION TEST					
Volume (ml)	50.3	48.5	40.6	42.1	50.3

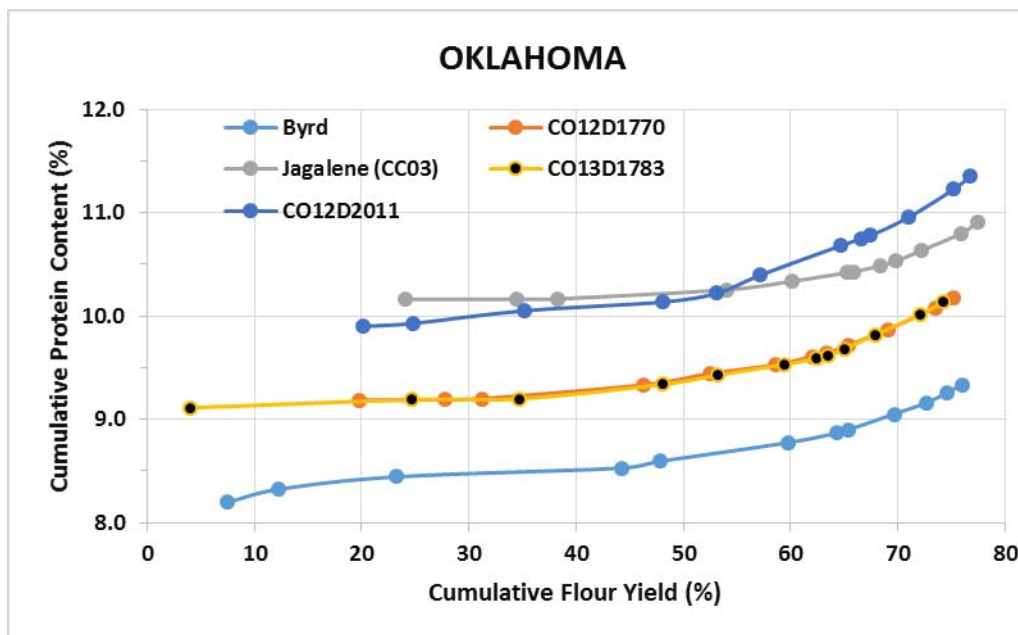
Oklahoma: Cumulative Ash Curves



Ruby Lee					OK13621					OK12D22004-016				
Mill	Stm-yld	Ash	Cumul (14%)		Mill	Stm-yld	Ash	Cumul (14%)		Mill	Stm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
1M Red	4.9	0.34	4.9	0.34	1M Red	4.8	0.35	4.8	0.35	1M Red	4.1	0.33	4.1	0.33
1M	12.5	0.34	17.3	0.34	1M	8.2	0.36	13.0	0.36	1M	10.7	0.33	14.8	0.33
1BK	9.6	0.34	26.9	0.34	2M	16.7	0.37	29.7	0.37	1BK	8.5	0.33	23.3	0.33
2M	18.2	0.35	45.1	0.35	1BK	8.3	0.38	38.0	0.37	2M	15.7	0.34	39.0	0.34
2BK	5.2	0.46	50.4	0.36	2BK	5.5	0.50	43.5	0.39	Grader	3.2	0.47	42.3	0.35
Grader	3.9	0.47	54.3	0.37	Grader	3.6	0.50	47.1	0.39	2BK	5.0	0.50	47.3	0.36
3M	11.8	0.54	66.0	0.40	3M	13.9	0.59	61.0	0.44	FILTER FLR	1.5	0.55	48.8	0.37
FILTER FLR	1.3	0.57	67.4	0.40	FILTER FLR	2.1	0.61	63.1	0.45	3M	13.2	0.58	62.0	0.41
3BK	2.3	0.70	69.7	0.41	3BK	2.9	0.69	66.0	0.46	3BK	2.8	0.88	64.8	0.43
4M	4.5	0.92	74.2	0.44	4M	5.3	1.03	71.2	0.50	4M	7.0	0.98	71.8	0.49
BRAN FLR	1.5	1.72	75.7	0.47	5M	2.1	1.75	73.3	0.53	5M	2.5	1.39	74.3	0.52
5M	1.4	1.92	77.1	0.49	BRAN FLR	1.3	2.24	74.6	0.56	BRAN FLR	0.8	2.47	75.1	0.54
Break Shorts	2.7	3.57	79.8	0.60	Break Shorts	3.9	4.11	78.4	0.74	Break Shorts	4.3	4.32	79.4	0.74
Red Dog	1.2	2.23	81.0	0.62	Red Dog	2.3	2.54	80.7	0.79	Red Dog	4.2	2.32	83.6	0.82
Red Shorts	0.2	3.09	81.2	0.63	Red Shorts	0.5	3.15	81.2	0.80	Red Shorts	0.5	3.18	84.1	0.84
Filter Bran	1.2	3.25	82.4	0.66	Filter Bran	2.3	2.55	83.5	0.85	Filter Bran	0.7	2.73	84.8	0.85
Bran	17.6	5.21	100.0	1.46	Bran	16.5	5.61	100.0	1.64	Bran	15.2	5.39	100.0	1.54
Wheat		1.33					1.51					1.40		
St. Grd. Fl.		0.46					0.54					0.51		

OCW04S717T-6W					Jagalene (CC08)				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
1BK	6.8	0.41	6.8	0.41	1M Red	3.3	0.45	3.3	0.45
1M Red	3.2	0.44	10.0	0.42	2M	16.0	0.46	19.4	0.46
2M	15.8	0.47	25.8	0.45	1BK	5.7	0.46	25.0	0.46
1M	8.1	0.48	33.9	0.46	1M	8.4	0.47	33.5	0.46
3M	17.5	0.59	51.4	0.50	3M	18.0	0.54	51.4	0.49
Grader	2.7	0.62	54.1	0.51	2BK	3.5	0.64	54.9	0.50
2BK	3.2	0.62	57.3	0.51	Grader	2.5	0.64	57.4	0.51
FILTER FLR	1.0	0.66	58.3	0.52	FILTER FLR	1.2	0.65	58.6	0.51
3BK	2.4	0.82	60.7	0.53	3BK	2.4	0.77	61.0	0.52
4M	8.2	0.82	68.9	0.56	4M	8.2	0.80	69.2	0.55
5M	3.1	1.58	71.9	0.61	5M	2.9	1.73	72.1	0.60
BRAN FLR	1.6	1.90	73.5	0.63	BRAN FLR	1.5	1.97	73.6	0.63
Break Shorts	3.8	3.32	77.3	0.76	Break Shorts	3.7	3.43	77.3	0.76
Red Dog	3.0	2.78	80.3	0.84	Red Dog	2.5	2.68	79.8	0.82
Red Shorts	0.5	3.53	80.7	0.85	Red Shorts	0.4	3.18	80.3	0.84
Filter Bran	0.7	1.85	81.5	0.86	Filter Bran	0.9	2.10	81.2	0.85
Bran	18.5	4.73	100.0	1.58	Bran	18.8	5.13	100.0	1.65
Wheat		1.42					1.53		
St. Grd. Fl.		0.57					0.60		

Oklahoma: Cumulative Protein Curves



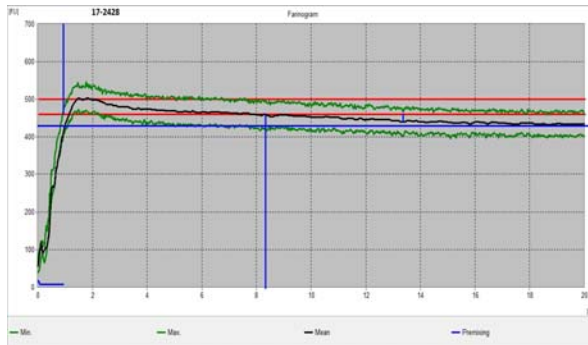
Ruby Lee					OK13621					OK12D22004-016				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1BK	9.6	8.68	9.6	8.7	1BK	8.3	9.39	8.3	9.4	1BK	8.5	7.75	8.5	7.8
1M Red	4.9	8.86	14.5	8.7	1M Red	4.8	9.85	13.1	9.6	1M	10.7	8.74	19.2	8.3
1M	12.5	8.94	26.9	8.8	1M	8.2	9.92	21.3	9.7	1M Red	4.1	8.77	23.3	8.4
2M	18.2	8.99	45.1	8.9	2M	16.7	10.10	38.0	9.9	2M	15.7	8.84	39.0	8.6
3M	11.8	9.69	56.9	9.1	Grader	3.6	10.65	41.6	9.9	Grader	3.2	9.30	42.3	8.6
Grader	3.9	9.99	60.8	9.1	3M	13.9	10.66	55.5	10.1	3M	13.2	9.49	55.4	8.8
FILTER FLR	1.3	10.20	62.1	9.1	FILTER FLR	2.1	10.96	57.6	10.2	FILTER FLR	1.5	9.55	57.0	8.8
4M	4.5	10.95	66.6	9.3	4M	5.3	11.88	62.9	10.3	4M	7.0	10.27	64.0	9.0
3BK	2.3	12.58	69.0	9.4	5M	2.1	12.70	65.0	10.4	5M	2.5	10.84	66.5	9.1
5M	1.4	12.70	70.4	9.4	2BK	5.5	13.10	70.4	10.6	2BK	5.0	11.77	71.5	9.3
2BK	5.2	13.04	75.6	9.7	3BK	2.9	13.66	73.3	10.7	3BK	2.8	11.86	74.3	9.4
BRAN FLR	1.5	14.66	77.1	9.8	BRAN FLR	1.3	15.43	74.6	10.8	BRAN FLR	0.8	13.46	75.1	9.4
Break Shorts	2.7	13.34	79.8	9.9	Break Shorts	3.9	15.18	78.4	11.0	Break Shorts	4.3	12.72	79.4	9.6
Red Dog	1.2	11.29	81.0	9.9	Red Dog	2.3	12.71	80.7	11.1	Red Dog	4.2	10.99	83.6	9.7
Red Shorts	0.2	12.62	81.2	9.9	Red Shorts	0.5	12.46	81.2	11.1	Red Shorts	0.5	11.46	84.1	9.7
Filter Bran	1.2	11.76	82.4	10.0	Filter Bran	2.3	12.90	83.5	11.1	Filter Bran	0.7	11.26	84.8	9.7
Bran	17.6	14.29	100.0	10.7	Bran	16.5	16.33	100.0	12.0	Bran	15.2	13.04	100.0	10.2
Wheat		10.5					11.6					10.0		
St. Grd. Fl		9.8					10.8					9.5		

OCW04S7171T-6W					Jagalene (CC08)				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1BK	6.8	9.21	6.8	9.2	1BK	5.7	11.48	5.7	11.5
1M Red	3.2	9.87	10.0	9.4	1M Red	3.3	11.54	9.0	11.5
2M	15.8	10.26	25.8	9.9	2M	16.0	11.70	25.0	11.6
1M	8.1	10.28	33.9	10.0	1M	8.4	11.82	33.5	11.7
Grader	2.7	10.58	36.6	10.1	3M	18.0	11.98	51.4	11.8
3M	17.5	10.64	54.1	10.2	FILTER FLR	1.2	12.21	52.6	11.8
FILTER FLR	1.0	10.73	55.1	10.3	4M	8.2	12.33	60.8	11.9
4M	8.2	11.43	63.3	10.4	Grader	2.5	12.72	63.3	11.9
5M	3.1	13.29	66.3	10.5	5M	2.9	14.45	66.2	12.0
2BK	3.2	13.52	69.6	10.7	3BK	2.4	15.06	68.6	12.1
3BK	2.4	13.60	71.9	10.8	2BK	3.5	15.22	72.1	12.3
BRAN FLR	1.6	15.59	73.5	10.9	BRAN FLR	1.5	16.94	73.6	12.4
Break Shorts	3.8	14.64	77.3	11.1	Break Shorts	3.7	15.21	77.3	12.5
Red Dog	3.0	13.82	80.3	11.2	Red Dog	2.5	14.54	79.8	12.6
Red Shorts	0.5	13.18	80.7	11.2	Red Shorts	0.4	13.51	80.3	12.6
Filter Bran	0.7	11.03	81.5	11.2	Filter Bran	0.9	12.71	81.2	12.6
Bran	18.5	16.29	100.0	12.1	Bran	18.8	15.33	100.0	13.1
Wheat		11.6					13.1		
St. Grd. Fl		10.9					12.3		

Physical Dough Tests

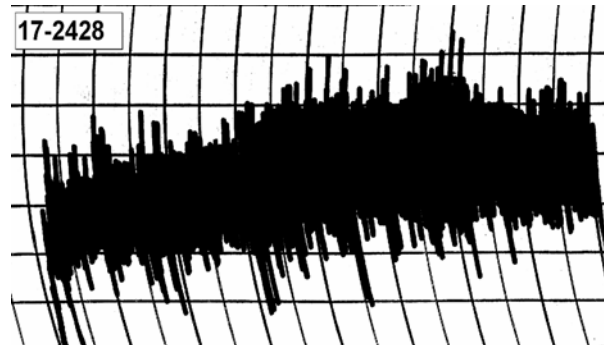
2017 (Small Scale) Samples - Oklahoma

Farinograms



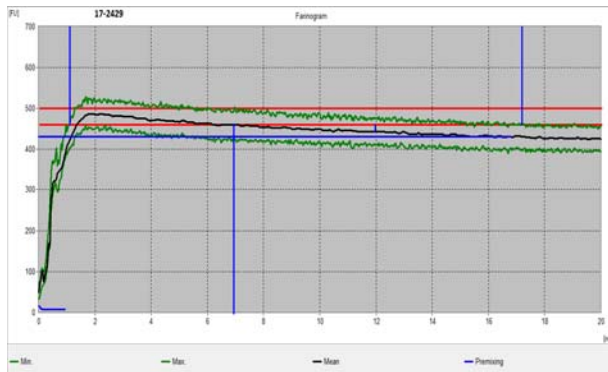
Water abs = 61.6%, Peak time = 8.4 min,
Mix stab = 24.2 min, MTI = 19 FU

Mixograms

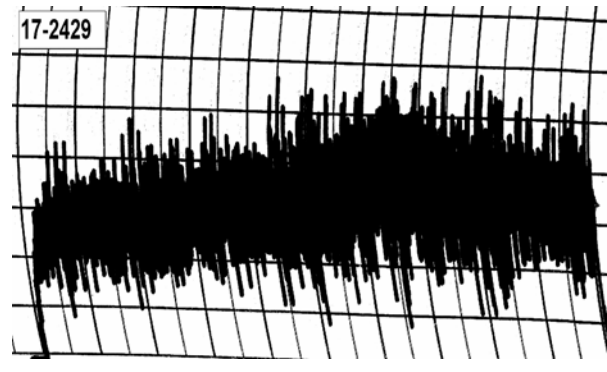


Water abs = 65.0%
Mix time = 6.0 min

17-2428, Ruby Lee



Water abs = 59.0%, Peak time = 7.0 min,
Mix stab = 16.1 min, MTI = 17 FU



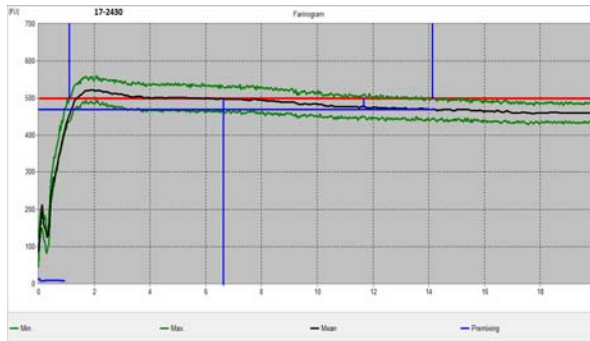
Water abs = 64.5%
Mix time = 6.9 min

17-2429, OK13621

Physical Dough Tests

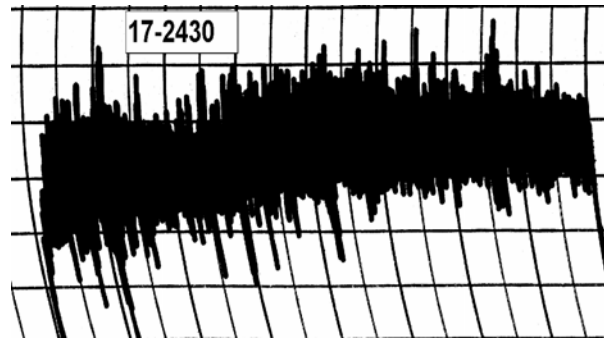
2017 (Small Scale) Samples - Oklahoma

Farinograms



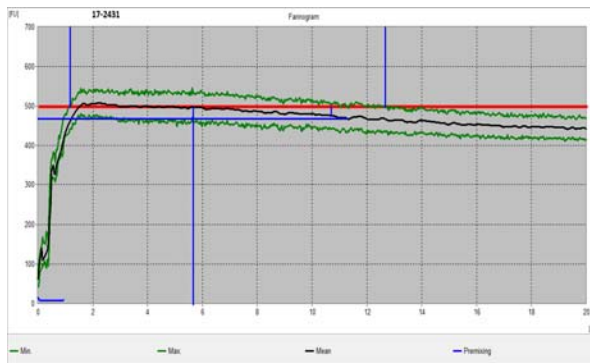
Water abs = 62.4%, Peak time = 6.7 min,
Mix stab = 13.0 min, MTI = 21 FU

Mixograms

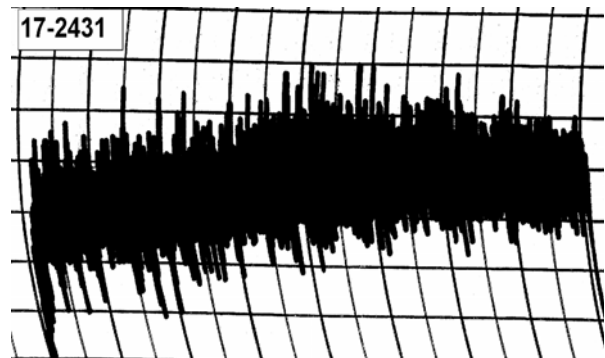


Water abs = 64.4%
Mix time = 4.3 min

17-2430, OK12D22004-016



Water abs = 63.9%, Peak time = 5.7 min,
Mix stab = 11.5 min, MTI = 22 FU



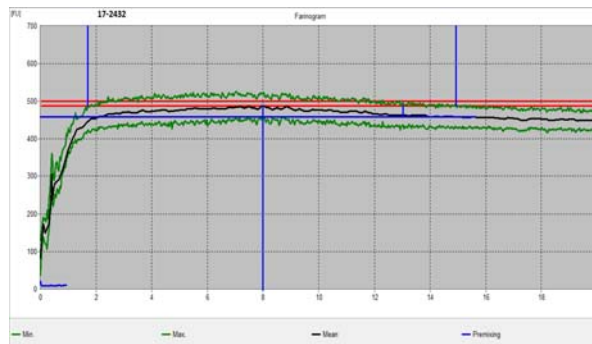
Water abs = 66.2%
Mix time = 4.5 min

17-2431, OCW04S7171T-6W

Physical Dough Tests

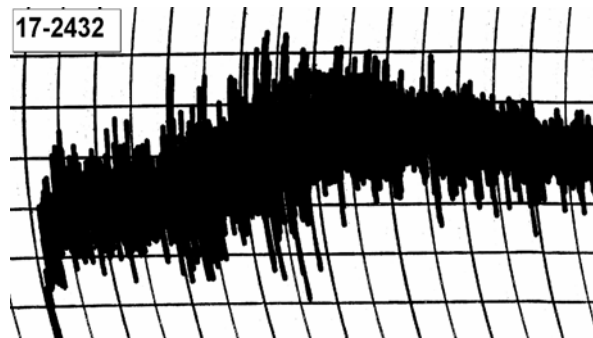
2017 (Small Scale) Samples - Oklahoma

Farinograms



Water abs = 64.4%, Peak time = 8.0 min,
Mix stab = 13.2 min, MTI = 24 FU

Mixograms

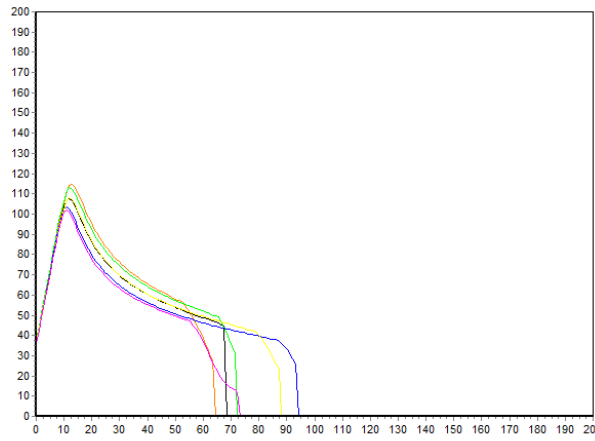


Water abs = 67.7%
Mix time = 4.0 min

17-2432, Jagalene (CC08)

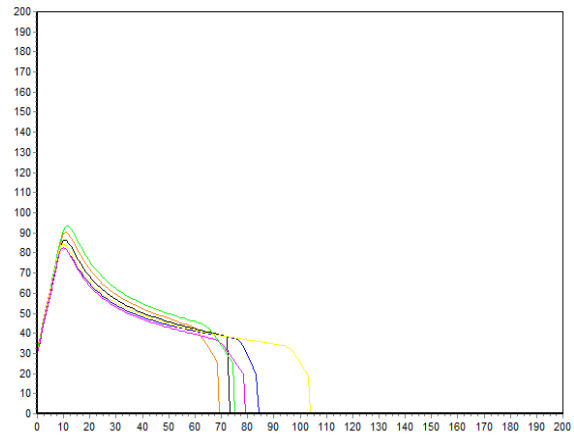
Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Oklahoma



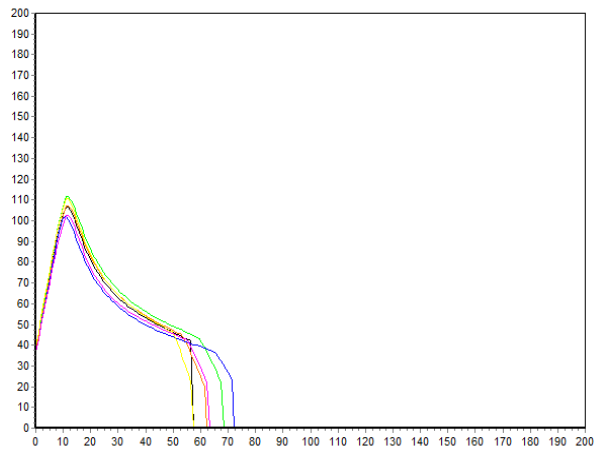
17-2428, Ruby Lee

P(mm H₂O) = 119, L(mm) = 68, W(10E⁻⁴ J) = 298



17-2429, OK13621

P(mm H₂O) = 95, L(mm) = 73, W(10E⁻⁴ J) = 259

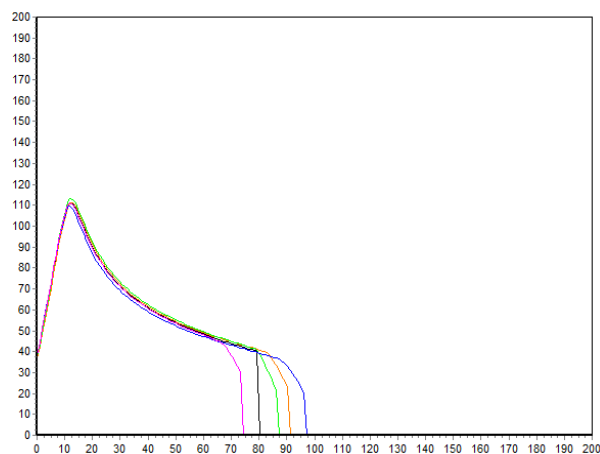


17-2430, OK12D22004-016

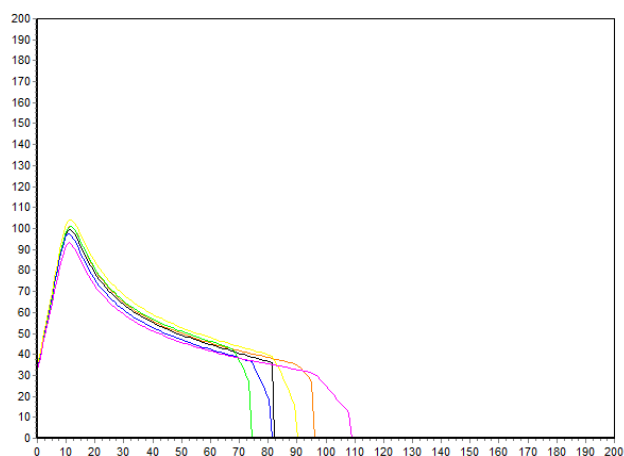
P(mm H₂O) = 118, L(mm) = 57, W(10E⁻⁴ J) = 245

Physical Dough Tests - Alveograph

2017 (Small Scale) Samples – Oklahoma



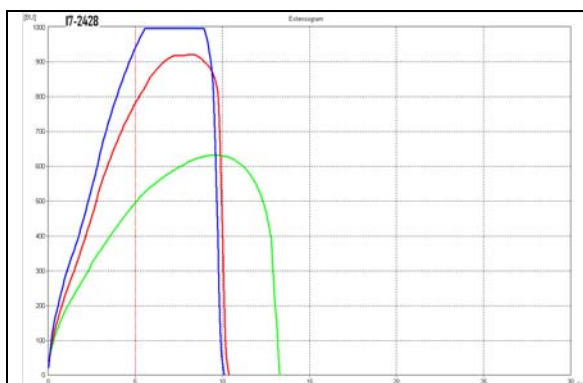
17-2431, OCW04S7171T-6W
 $P(\text{mm H}_2\text{O}) = 123$, $L(\text{mm}) = 79$, $W(10\text{E}^{-4} \text{ J}) = 336$



17-2432, Jagalene (CC08)
 $P(\text{mm H}_2\text{O}) = 109$, $L(\text{mm}) = 82$, $W(10\text{E}^{-4} \text{ J}) = 309$

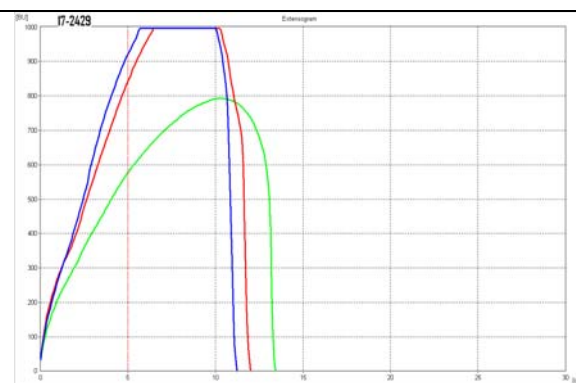
Physical Dough Tests - Extensigraph

2017 (Small Scale) Samples – Oklahoma



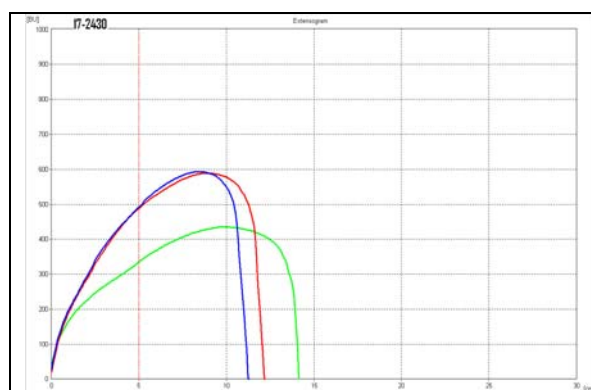
17-2428, Ruby Lee

R (BU) = 786, E (mm) = 104, W (cm²) = 119
Rmax (BU) = 922, Ratio = 7.6 at 90 min



17-2429, OK13621

R (BU) = 847, E (mm) = 120, W (cm²) = 155
Rmax (BU) = 996, Ratio = 7.0 at 90 min



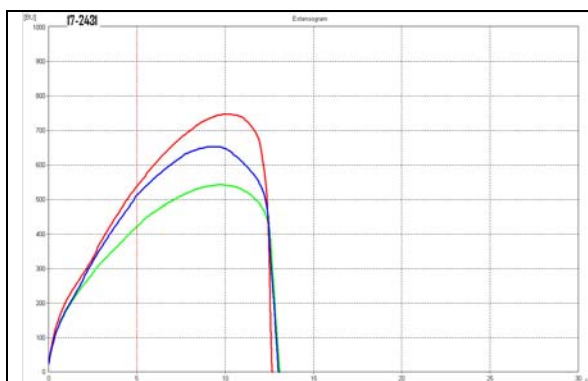
17-2430, OK12D22004-016

R (BU) = 490, E (mm) = 123, W (cm²) = 95
Rmax (BU) = 589, Ratio = 4.0 at 90 min

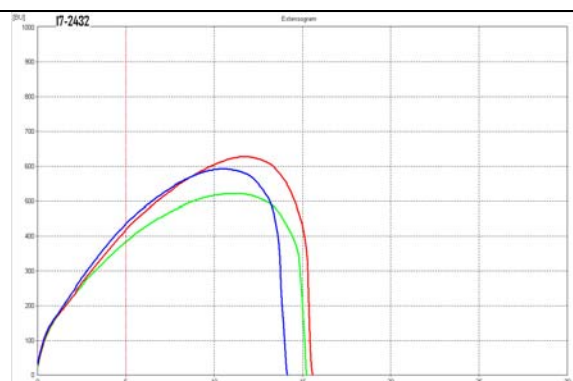
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm²) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigraph

2017 (Small Scale) Samples – Oklahoma

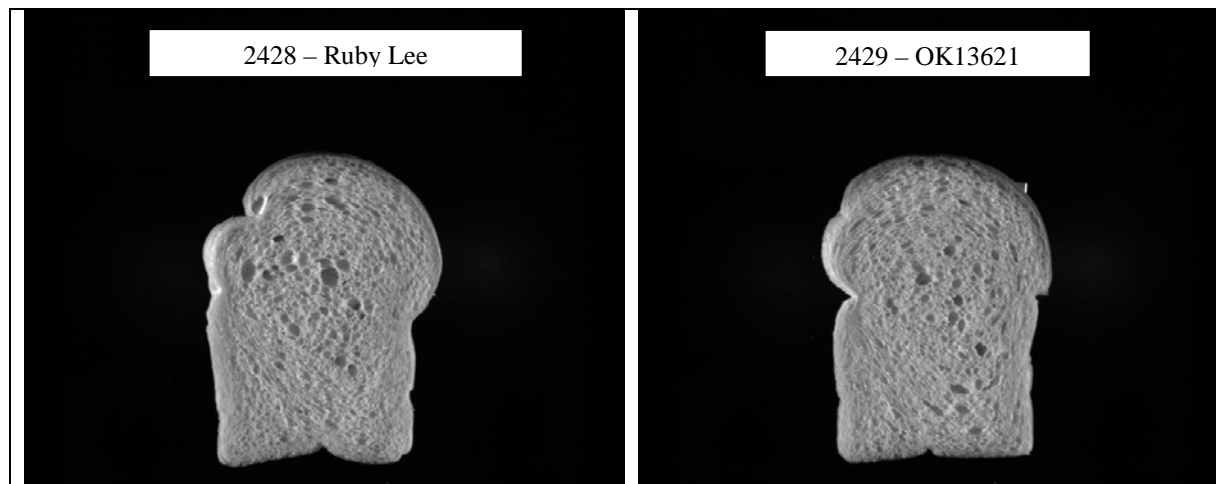


17-2431, OCW04S7171T-6W
R (BU) = 541, E (mm) = 128, W (cm²) = 120
Rmax (BU) = 747, Ratio = 4.2 at 90 min

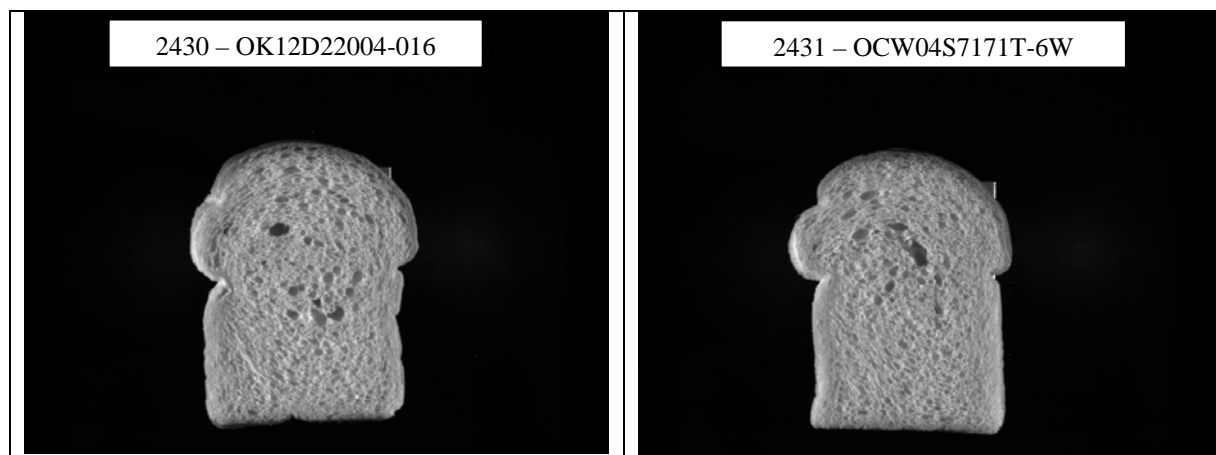


17-2432, Jagalene (CC08)
R (BU) = 422, E (mm) = 156, W (cm²) = 125
Rmax (BU) = 628, Ratio = 2.7 at 90 min

Oklahoma: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples

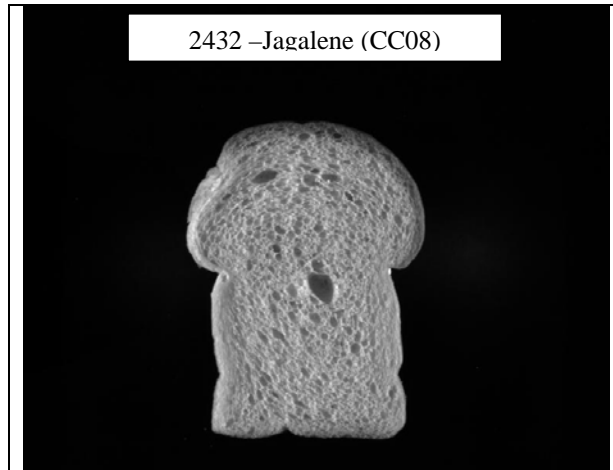


Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2428	5419	138	3756	0.432	1.780	8.182	1.690	-20.05
2429	5462	137	3983	0.419	1.672	1.423	1.720	-19.40



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2430	5489	141	3912	0.425	1.719	2.015	1.665	-28.90
2431	5129	143	3474	0.433	1.784	3.417	1.670	-16.85

Oklahoma: C-Cell Bread Images and Analysis 2017 (Small-Scale) Samples



Entry #	Slice Area (mm ²)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (°)
2432	5806	137	3820	0.434	1.856	1.138	1.675	-24.80

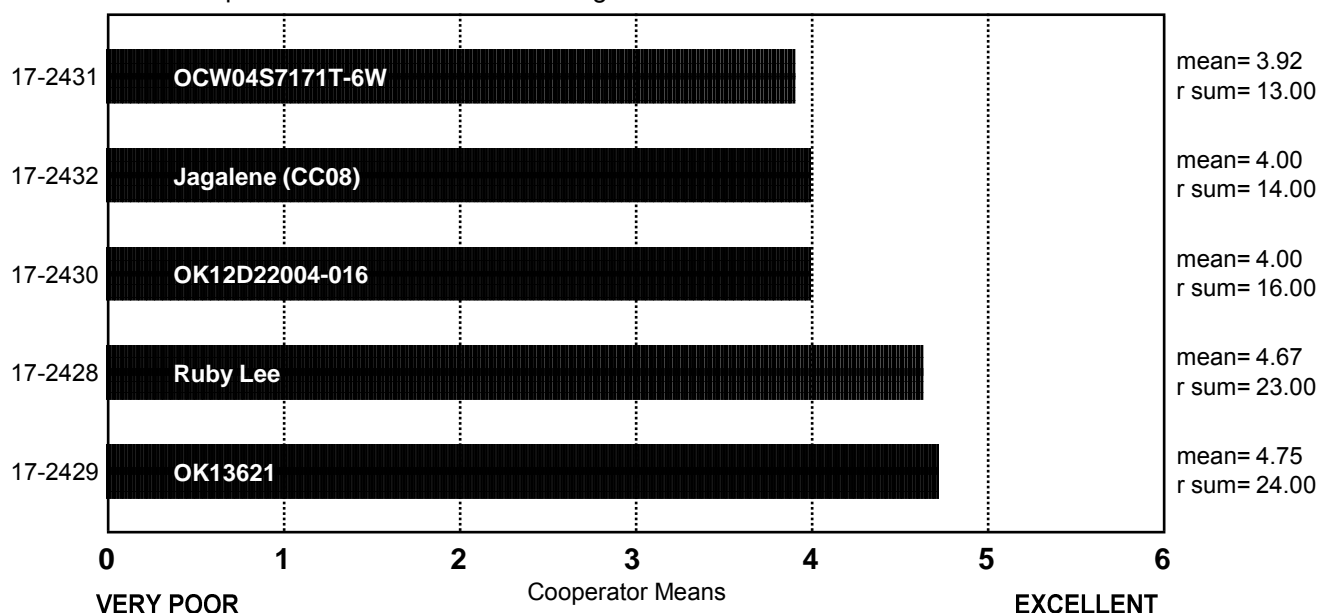
SPONGE CHARACTERISTICS

(Small Scale) Oklahoma

ncoop= 6
chisq= 7.07
chisqc= -24.94
cvchisq= 9.49
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



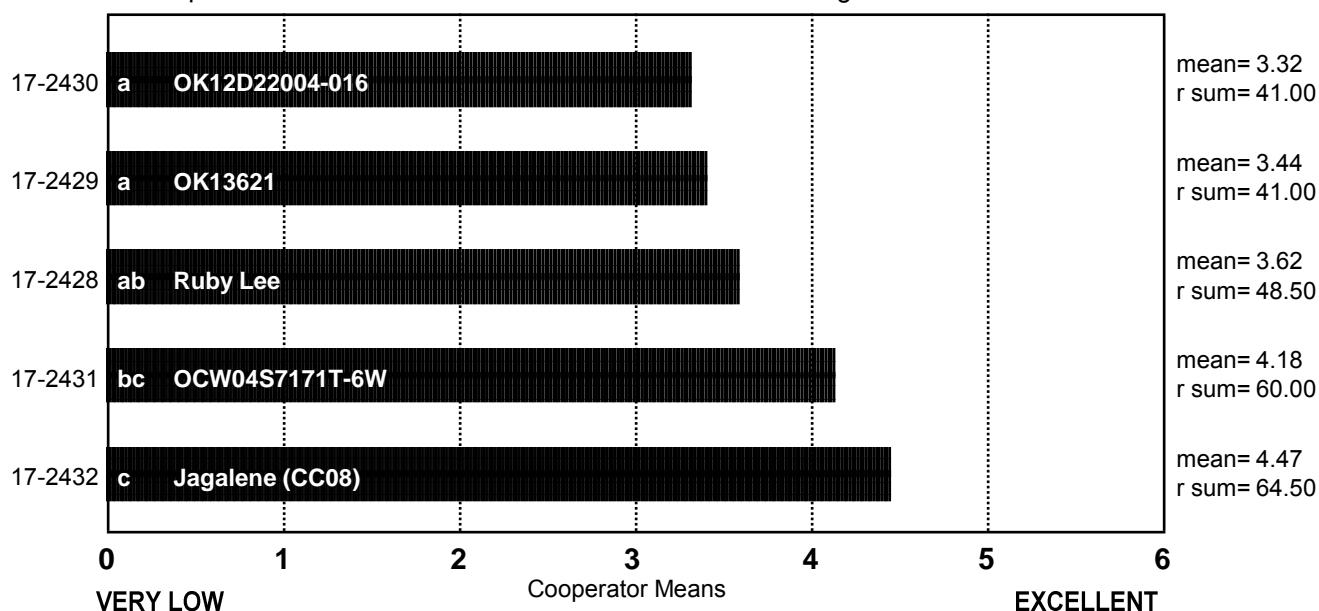
BAKE ABSORPTION

(Small Scale) Oklahoma

ncoop= 17
chisq= 11.05
chisqc= 14.23
cvchisq= 9.49
crdiff= 14.95

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2428 Ruby Lee	55.0	61.6	60.9	62.5	61.6	61.6	59.0	60.0	64.6	64.9	59.6	62.6	63.1	64.7	60.3	68.3	62.6
17-2429 OK13621	56.0	59.0	60.8	58.5	63.0	59.0	57.0	61.0	62.0	66.2	61.1	63.0	61.1	65.2	61.6	64.6	57.9
17-2430 OK12D22004-016	55.0	62.4	61.3	62.5	61.1	62.4	62.0	59.0	65.4	64.2	59.6	63.0	64.6	62.7	59.6	65.6	59.9
17-2431 OCW04S7171T-6W	57.0	63.9	64.7	63.0	64.0	63.9	61.0	63.0	66.9	66.3	61.5	66.0	65.5	68.2	61.6	67.6	61.9
17-2432 Jagalene (CC08)	58.0	64.4	65.2	64.0	64.7	64.4	61.0	65.0	67.4	68.9	62.5	65.5	64.4	66.2	64.9	68.5	62.5

BAKE MIX TIME, ACTUAL

(Small Scale) Oklahoma

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2428 Ruby Lee	6.0	25.0	35.0	8.0	5.3	10.0	25.0	4.3	4.5	4.0	6.3	3.8	4.0	5.7	5.5	6.5	5.0
17-2429 OK13621	12.0	50.0	35.0	6.0	6.0	10.0	25.0	5.2	6.0	4.5	8.8	5.0	5.3	4.3	5.7	9.3	6.0
17-2430 OK12D22004-016	5.0	15.0	12.0	5.0	4.0	9.0	6.0	4.0	5.0	5.0	5.1	3.7	3.5	5.0	3.9	5.9	4.0
17-2431 OCW04S7171T-6W	9.0	12.0	16.0	4.0	4.8	8.0	11.0	4.0	5.0	3.8	5.1	3.6	3.5	4.2	4.3	6.5	4.0
17-2432 Jagalene (CC08)	5.0	15.0	12.0	8.0	4.0	8.0	13.0	3.5	4.5	4.5	4.8	3.1	3.3	5.3	3.4	5.1	4.0

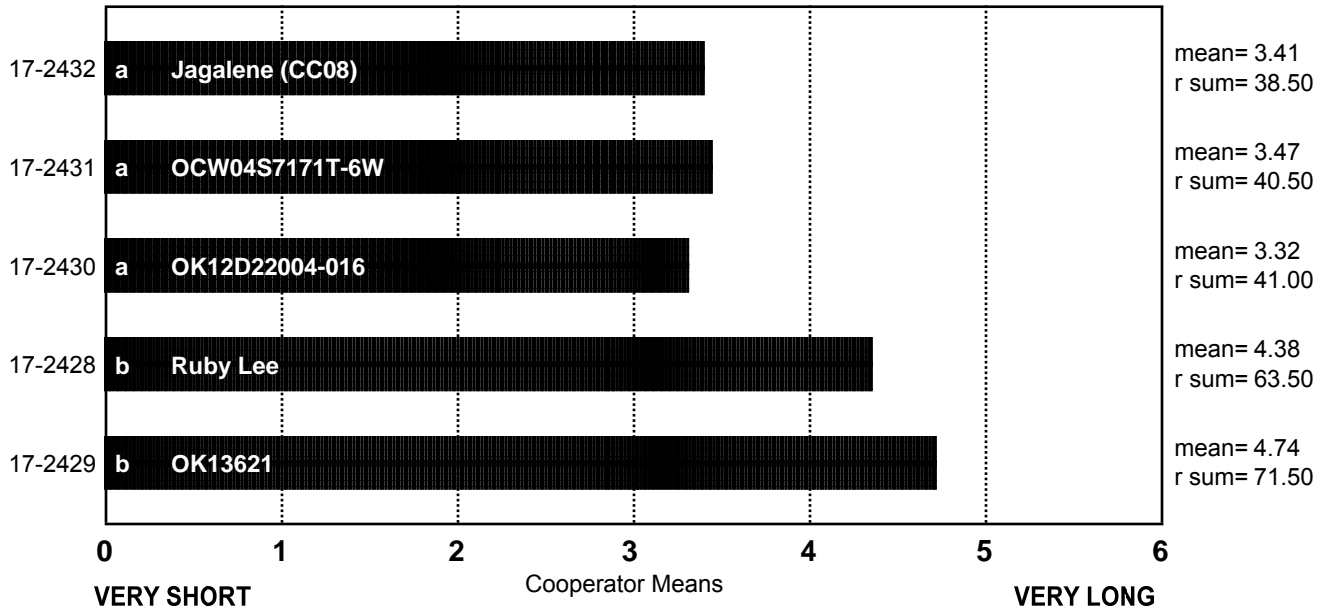
BAKE MIX TIME

(Small Scale) Oklahoma

ncoop= 17
 chisq= 22.19
 chisqc= 27.23
 cvchisq= 9.49
 crdiff= 13.33

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



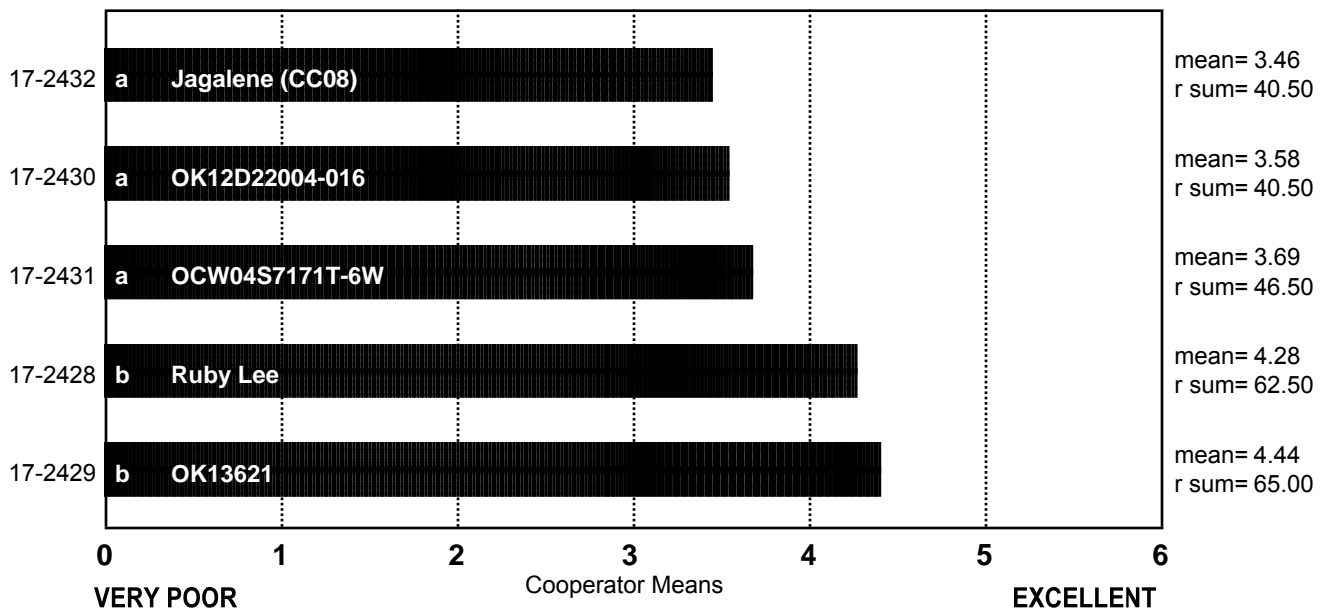
MIXING TOLERANCE

(Small Scale) Oklahoma

ncoop= 17
 chisq= 13.39
 chisqc= 15.92
 cvchisq= 9.49
 crdiff= 15.31

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



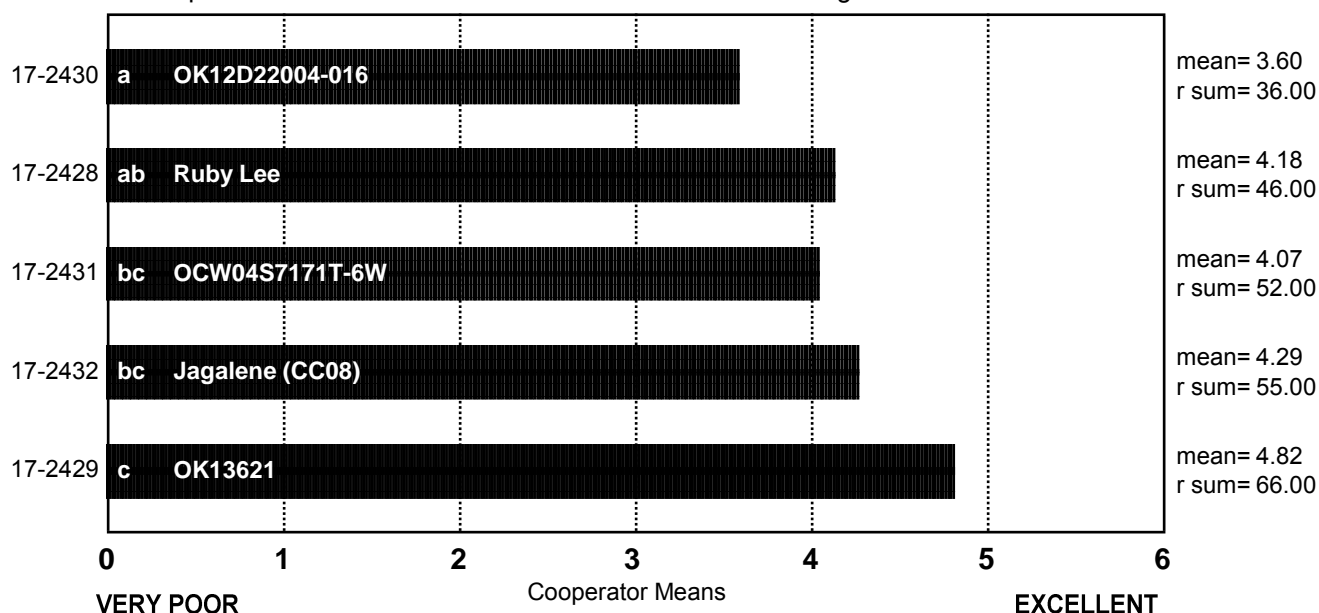
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Oklahoma

ncoop= 17
chisq= 11.58
chisqc= 15.26
cvchisq= 9.49
crdiff= 14.63

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
17-2428 Ruby Lee	2	0	6	8	1
17-2429 OK13621	0	1	3	10	3
17-2430 OK12D22004-016	3	1	5	7	1
17-2431 OCW04S7171T-6W	0	3	2	11	1
17-2432 Jagalene (CC08)	2	1	1	11	2

Frequency Table

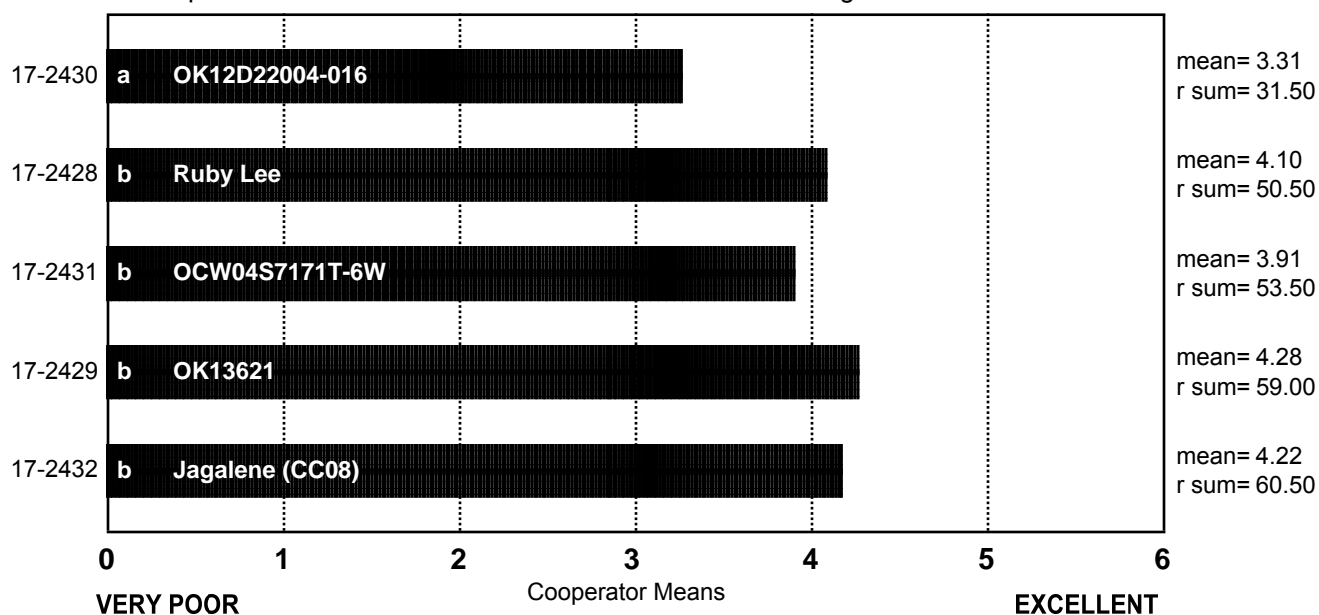
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Oklahoma

ncoop= 17
chisq= 12.73
chisqc= 15.80
cvchisq= 9.49
crdiff= 15.00

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
17-2428 Ruby Lee	2	1	5	8	1
17-2429 OK13621	0	0	7	7	3
17-2430 OK12D22004-016	2	2	5	8	0
17-2431 OCW04S7171T-6W	2	1	2	12	0
17-2432 Jagalene (CC08)	0	1	2	11	3

Frequency Table

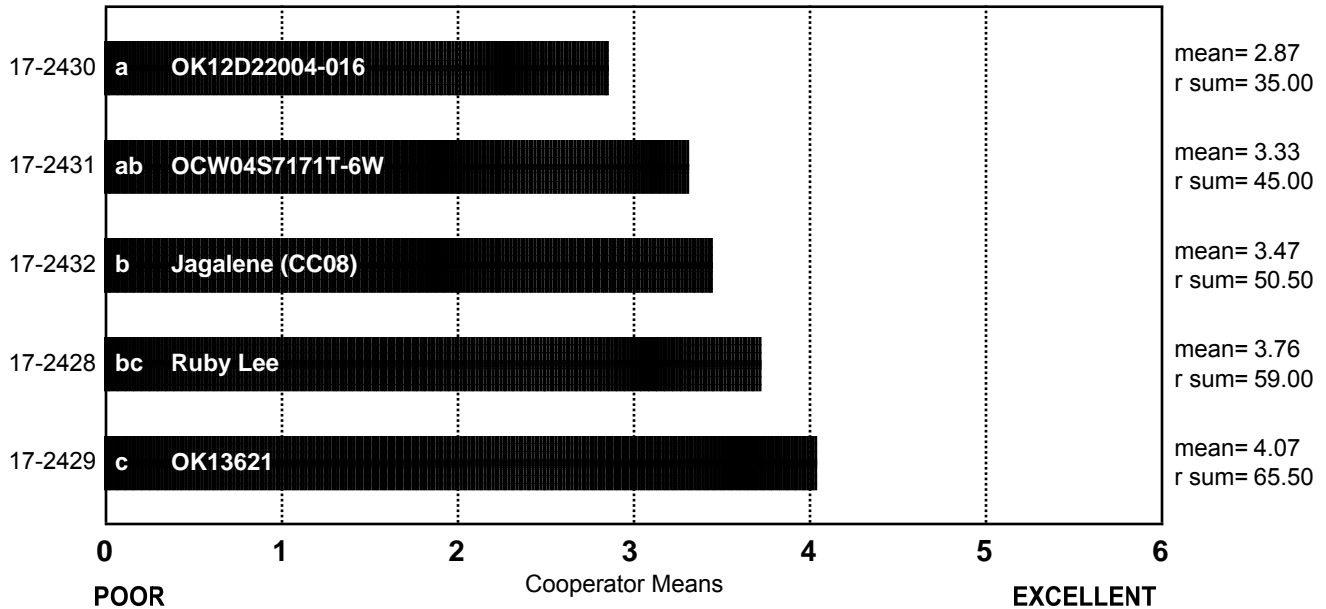
CRUMB GRAIN

(Small Scale) Oklahoma

ncoop= 17
 chisq= 13.33
 chisqc= 16.48
 cvchisq= 9.49
 crdiff= 14.93

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Oklahoma

	Open	Fine	Dense
17-2428 Ruby Lee	8	6	3
17-2429 OK13621	6	10	1
17-2430 OK12D22004-016	12	3	2
17-2431 OCW04S7171T-6W	9	5	3
17-2432 Jagalene (CC08)	9	7	1

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Oklahoma

	Round	Irregular	Elongated
17-2428 Ruby Lee	3	6	8
17-2429 OK13621	2	5	10
17-2430 OK12D22004-016	2	11	4
17-2431 OCW04S7171T-6W	5	7	5
17-2432 Jagalene (CC08)	4	7	6

Frequency Table

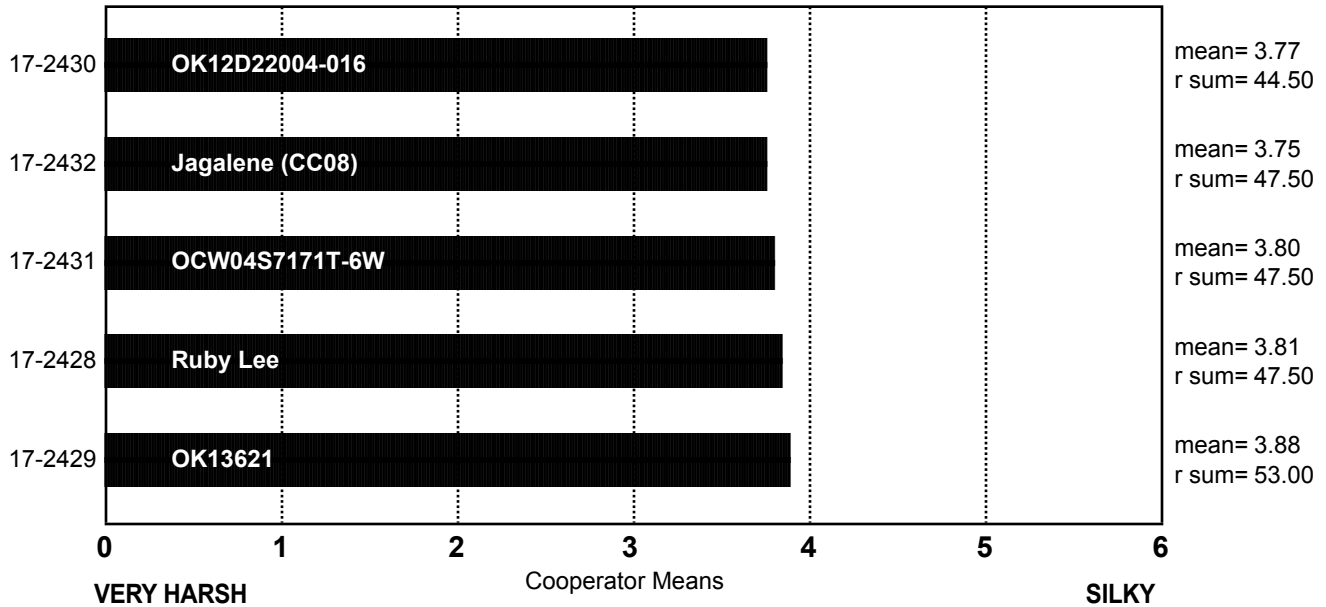
CRUMB TEXTURE

(Small Scale) Oklahoma

ncoop= 16
 chisq= 0.95
 chisqc= 1.42
 cvchisq= 9.49
 crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Oklahoma

	Harsh	Smooth	Silky
17-2428 Ruby Lee	5	9	3
17-2429 OK13621	5	9	3
17-2430 OK12D22004-016	3	10	4
17-2431 OCW04S7171T-6W	6	7	4
17-2432 Jagalene (CC08)	4	9	4

Frequency Table

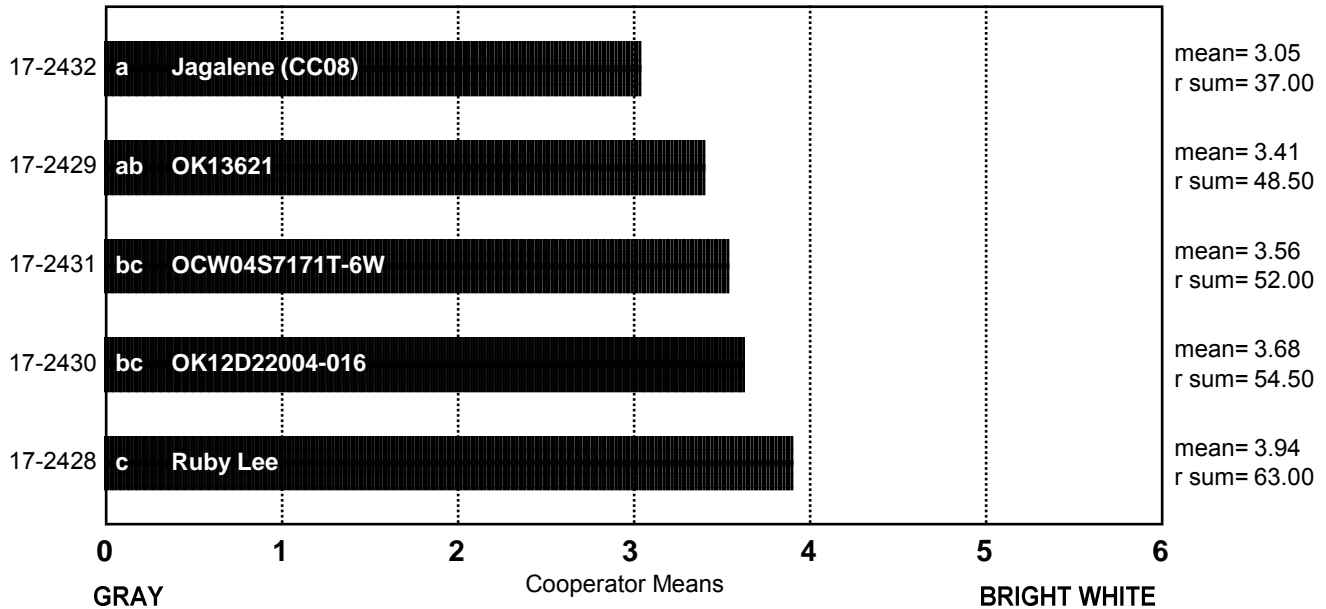
CRUMB COLOR

(Small Scale) Oklahoma

ncoop= 17
 chisq= 8.46
 chisqc= 14.17
 cvchisq= 9.49
 crdiff= 13.11

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Oklahoma

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2428 Ruby Lee	0	0	0	5	10	2	0
17-2429 OK13621	1	0	4	5	7	0	0
17-2430 OK12D22004-016	1	0	3	2	10	1	0
17-2431 OCW04S7171T-6W	0	0	3	6	6	2	0
17-2432 Jagalene (CC08)	2	1	2	7	4	0	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2428 Ruby Lee	413.0	464.8	427.0	447.0	142.3	457.5		140.9	451.1	135.0	138.2	144.0	133.3	148.9	?	155.3	481.3
17-2429 OK13621	410.0	471.7	426.0	450.0	142.6	460.2		140.8	449.7	133.7	140.0	142.4	129.9	152.2	139.8	151.6	485.3
17-2430 OK12D22004-016	410.0	467.3	428.0	452.0	144.0	456.6		142.3	449.7	133.2	137.1	146.3	134.4	149.3	140.6	152.4	483.4
17-2431 OCW04S7171T-6W	409.0	462.3	426.0	450.0	144.5	456.8		144.0	443.1	134.0	142.9	149.0	134.9	154.3	140.6	160.9	483.3
17-2432 Jagalene (CC08)	412.0	462.6	423.0	457.0	143.4	460.0		143.5	439.4	128.8	147.4	147.9	133.9	152.1	138.1	154.6	482.8

LOAF VOLUME, ACTUAL

(Small Scale) Oklahoma

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2428 Ruby Lee	2550	2663	2750	2375	885	2697	3074	735	2225	825	890	825	897	873	845	755	2525
17-2429 OK13621	2900	2575	2650	2375	950	2786	3074	805	2300	870	870	940	907	915	862	785	2550
17-2430 OK12D22004-016	2475	2350	2650	2250	880	2554	2956	575	2300	675	783	795	815	873	779	750	2438
17-2431 OCW04S7171T-6W	2725	2250	2500	2275	840	2661	2839	680	2300	815	843	780	815	898	769	740	2400
17-2432 Jagalene (CC08)	2725	2388	2500	2350	965	2735	2868	810	2350	890	1035	875	905	940	912	905	2513

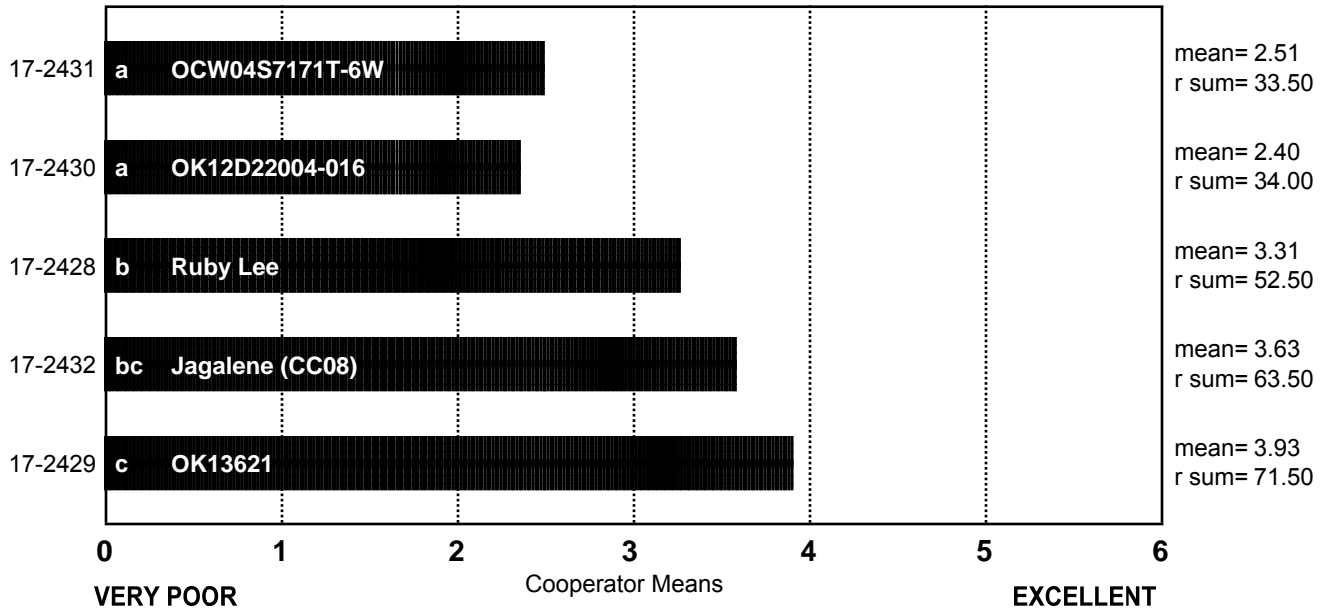
LOAF VOLUME

(Small Scale) Oklahoma

ncoop= 17
chisq= 27.62
chisqc= 32.39
cvchisq= 9.49
crdiff= 12.75

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



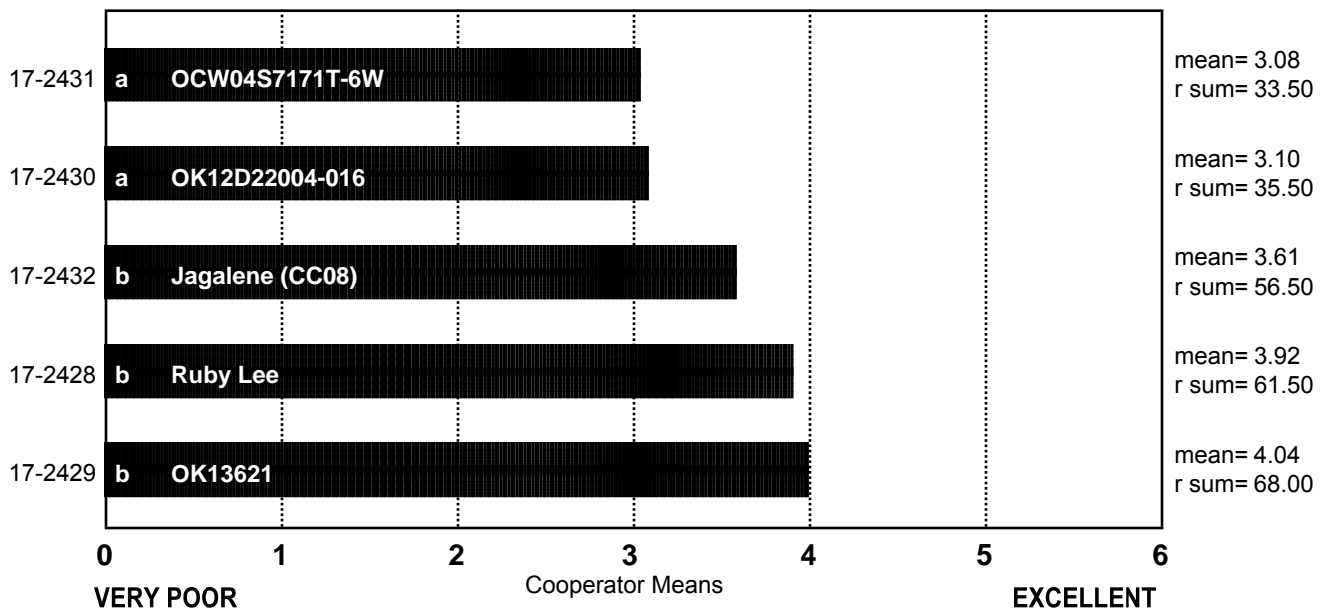
OVERALL BAKING QUALITY

(Small Scale) Oklahoma

ncoop= 17
chisq= 22.96
chisqc= 26.20
cvchisq= 9.49
crdiff= 14.00

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS

(Small Scale) Oklahoma

COOP.

17-2428 Ruby Lee

- A. No comment.
- B. No comment.
- C. Strong dough & very long mix time, but excellent bread performance. Good for blending purpose.
- D. Wild break and shred.
- E. Very rough break.
- F. No comment.
- G. Fair absorption, good mix strength and low volume.
- H. Absorption less than target.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & silky smooth texture.
- L. Unacceptable protein but very good absorption.
- M. Best in the set in terms of color and texture.
- N. Weak dough but surprisingly good bread for protein level.
- O. No comment.
- P. High absorption, long mix time, excellent dough feel, Questionable – Satisfactory crumb grain, low loaf volume.
- Q. High absorption, fine grain, creamy color.

COOP.

17-2429 OK13621

- A. No comment.
- B. No comment.
- C. Strong dough & very long mix time, but excellent bread performance. Good for blending purpose.
- D. No comment.
- E. No comment.
- F. No comment.
- G. Low absorption, very good mix strength and volume.
- H. Average absorption.
- I. Best of set, lack of volume hurt the overall score; makeup on this flour was excellent.
- J. No comment.
- K. Low water absorption, long mix time, slight sticky & strong dough, high volume, slight yellow crumb, fine elongated cells, resilient & very smooth texture.
- L. Low protein, very good loaf volume, but good absorption.
- M. No comment.
- N. Somewhat weak dough but reasonable bread performance.
- O. No comment.
- P. Good bake absorption, very long mix time, good out of mix, Questionable – Satisfactory crumb grain and low loaf volume; better than 2428.
- Q. Tough dough at makeup, good grain, yellow color, good volume.

COOP.**17-2430 OK12D22004-016**

- A. No comment.
- B. No comment.
- C. Dough partial break down but recovered, good performance for low protein (9.6%).
- D. No comment.
- E. Rough break and shred.
- F. No comment.
- G. Good absorption, but very low mix strength and good volume.
- H. Absorption less than target.
- I. No comment.
- J. Low protein not well suited for bread.
- K. Low water absorption, normal mix time, slight sticky & strong dough, fair volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Unacceptable protein, but had acceptable loaf volume for protein, good absorption.
- M. No comment.
- N. Weak dough but surprisingly good bread for protein level.
- O. No comment.
- P. Low flour protein, good bake absorption, long mix time, sticky out of mixer, satisfactory crumb grain, low loaf volume.
- Q. Sticky dough, poor mixing tolerance, open grain, but nice creamy color.

COOP.**17-2431 OCW04S7171T-6W**

- A. No comment.
- B. No comment.
- C. Low volume but good cell structure, good performance overall.
- D. No comment.
- E. Rough break and shred.
- F. Tough.
- G. Fair absorption, slightly low mix strength and volume.
- H. Average absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, medium volume, creamy crumb, fine elongated cells, resilient & smooth texture.
- L. Low protein but very good absorption.
- M. No comment.
- N. Good volume performance for protein level.
- O. No comment.
- P. Poor quality exterior with dark crust, good bake absorption, long mix time, weak out of mixer & pan, Questionable – Satisfactory crumb grain, low loaf volume.
- Q. Good absorption, fine grain, yellow color.

COOP.**17-2432 Jagalene (CC08)**

- A. No comment.
- B. No comment.
- C. Capping & open grain structure.
- D. Shell top, wild break and shred.
- E. Excellent loaf externals.
- F. No comment.
- G. Fair absorption, mix strength and volume.
- H. Good absorption.
- I. 2430, 2431 and 2432 were all very similar. Lack of volume and crumb score hurt these flours.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, very high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
- L. Questionable color, very good absorption.
- M. Slightly yellow crumb.
- N. Performed as expected for protein level.
- O. No comment.
- P. Good flour protein, excellent bake absorption, good mix time, good out of mixer & pan, Questionable – Satisfactory crumb grain, terrific loaf volume.
- Q. High absorption, tough dough at makeup, good grain, dark yellow color.

Notes: **A, C, D, G, I and Q** conducted sponge and dough bake tests

COMMOM CHECK

17-2433 = 17-2404	Jagalene (CC01)
17-2434 = 17-2405	Jagalene (CC02)
17-2435 = 17-2411	Jagalene (CC03)
17-2436 = 17-2414	Jagalene (CC04)
17-2437 = 17-2420	Jagalene (CC05)
17-2438 = 17-2424	Jagalene (CC06)
17-2439 = 17-2425	Jagalene (CC07)
17-2440 = 17-2432	Jagalene (CC08)

End-use Quality of the Common Check

Common Check – Jagalene

General Information

A Hard Red Winter Wheat variety, Jagalene, was used as a common check for each of breeding programs in 2017. Eight breeding programs submitted their common checks with their breeding lines for WQC baking evaluation. They were:

17-2404	Jagalene (CC01)	Syngenta (Agripro)
17-2405	Jagalene (CC02)	Texas
17-2411	Jagalene (CC03)	Colorado
17-2414	Jagalene (CC04)	Kansas-Hays
17-2420	Jagalene (CC05)	Montana
17-2424	Jagalene (CC06)	Nebraska
17-2425	Jagalene (CC07)	Monsanto (Westbred)
17-2432	Jagalene (CC08)	Oklahoma

In order to facilitate relational database output of statistical data in the same manner as breeding lines contained with the WQC annual report, the common checks were treated as a breeding program for baking data analysis and their comparisons in order to see how different they are in terms of baking performance quality characteristics.

Wheat and Flour Quality Characteristics of the Common Checks

Entry No.	17-2404	17-2405	17-2411	17-2414	17-2420	17-2424	17-2425	17-2432
ID for CC comparison	17-2433	17-2434	17-2435	17-2436	17-2437	17-2438	17-2439	17-2440
Breeding Programs	Syngenta	Texas	Colorado	Kansas-Hays	Montana	Nebraska	Monsanto	Oklahoma
Wheat Protein (14%mb)	12.7	14.5	11.7	12.5	12.5	12.4	10.7	13.1
Flour Protein (14%mb)	11.7	13.8	11.0	11.6	11.7	11.3	9.8	12.3
Flour Ash (14%mb)	0.55	0.53	0.57	0.65	0.51	0.57	0.57	0.60
TPP/TMP*	0.88	0.82	0.97	1.04	0.95	1.09	1.00	0.99
Sedimentation (ml 14%mc)								
Mixograph Abs (14%mb)	68.6	69.6	63.3	64.7	66.5	62.9	61.7	67.7
Mix Time (min)	6.4	3.1	3.4	3.9	4.1	4.4	2.8	4.0
Tolerance	5	2	1	4	4	3	1	2
Farinograph Abs (14%mb)	68.8	68.7	62.1	63.9	64.7	58.6	64.3	64.4
Peak time (min)	7.4	7.5	6.0	5.0	7.5	3.0	3.9	8.0
Stability (min)	16.1	8.8	6.4	13.6	10.1	7.3	5.1	13.2
MTI (FU)	15	24	39	17	30	32	42	24
Bake Abs (14%mb)	69.1	68.0	63.6	65.1	65.2	61.9	61.5	65.6
Bake Mix Time (min)	6.3	3.2	3.5	4.5	4.0	4.9	3.0	4.0
Loaf Volume (cc)	824	952	805	856	835	912	760	912
Crumb Color Rating (0-5)	3.1	3.1	2.9	2.7	2.9	3.3	3.4	3.1
Crumb Grain Rating (0-5)	3.5	3.8	3.2	3.8	3.3	4.2	3.1	3.8
Crumb Texture Rating (0-5)	3.4	3.6	2.6	3.4	3.0	3.6	2.9	3.3

Bake data average based on 7 cooperators' pop loaf straight grade dough method

¹ CC = Common Check.

* TPP/TMP= total polymeric protein/total monomeric protein.

+ The bake data is an average on 7 cooperators who conducted pup-loaf straight dough bake tests.

Brief Conclusions

Six of 16 cooperators conducted the sponge-and-dough baking test and didn't find any statistically significant differences in the sponge dough characteristics of the common checks at the 5% level of significance. However, other baking performance quality characteristics evaluated by the 17 cooperators were found to be significantly different (at the 0.5% level) among the common checks. These characteristics included bake absorption, bake mix time, mixing tolerance, dough properties (out of mixer and at make-up), crumb color, crumb grain, loaf volume, and overall baking quality.

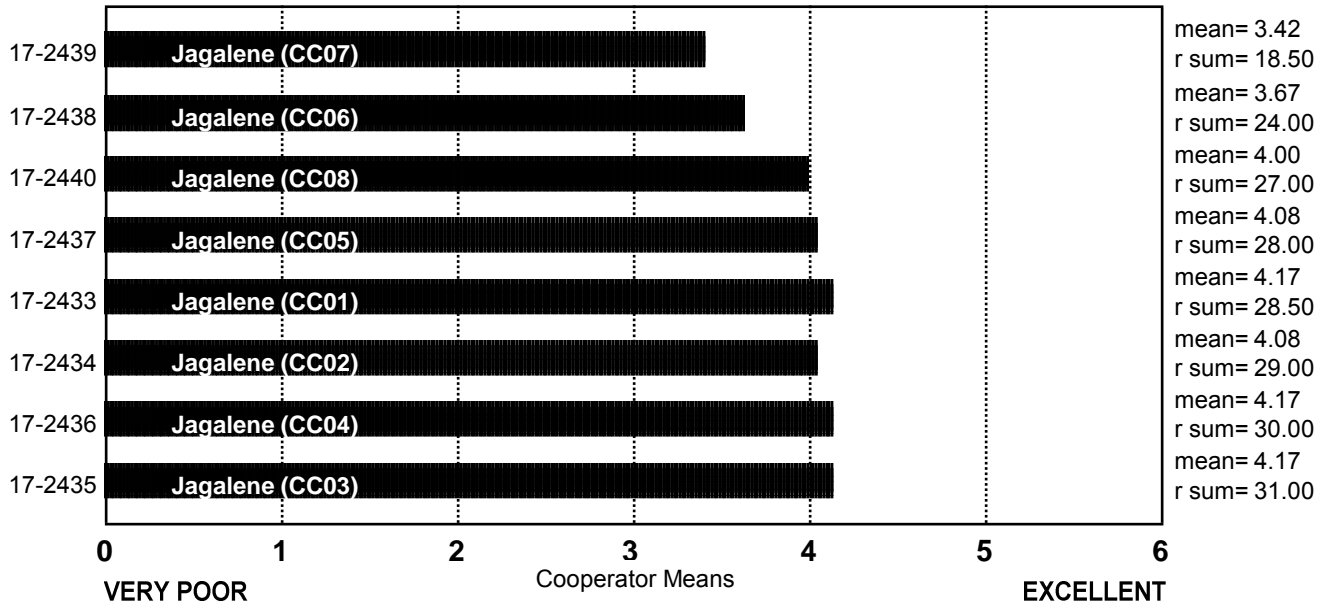
SPONGE CHARACTERISTICS

(Small Scale) Common Check

ncoop= 6
chisq= 3.15
chisqc= -13.24
cvchisq= 14.07
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



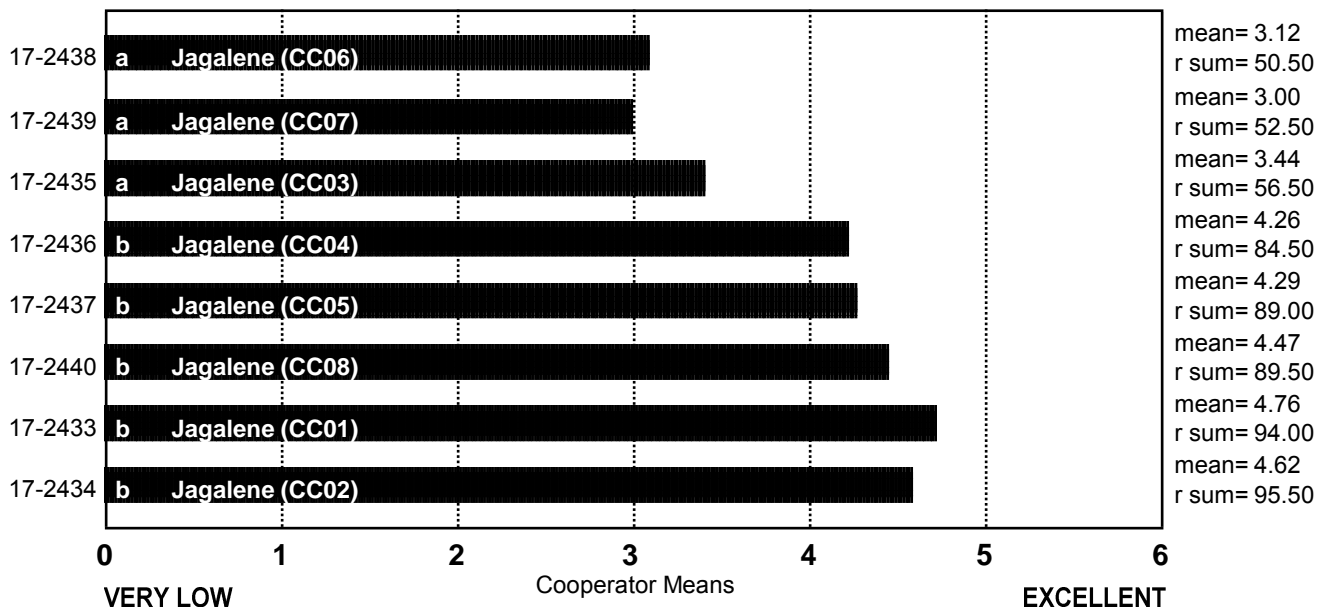
BAKE ABSORPTION

(Small Scale) Common Check

ncoop= 17
chisq= 26.55
chisqc= 30.83
cvchisq= 14.07
crdiff= 23.61

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Common Check

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2433 Jagalene (CC01)	58.0	65.0	66.7	69.0	68.9	68.8	63.0	70.0	71.8	69.0	63.3	69.3	70.0	69.2	62.1	73.5	64.8
17-2434 Jagalene (CC02)	60.0	65.0	67.0	69.0	64.0	68.7	61.0	68.0	69.2	72.0	64.6	69.0	69.7	67.2	65.0	68.7	65.0
17-2435 Jagalene (CC03)	57.0	62.0	62.8	66.5	62.0	62.1	57.0	63.0	65.1	69.0	62.1	61.8	62.7	65.2	62.5	64.5	56.3
17-2436 Jagalene (CC04)	58.0	64.0	63.1	65.0	63.0	63.9	60.0	64.0	66.9	67.6	63.5	62.9	64.5	68.2	63.3	70.2	62.8
17-2437 Jagalene (CC05)	57.0	64.7	64.9	67.5	63.0	64.7	59.0	64.0	67.7	69.7	63.6	62.6	65.0	67.2	63.4	68.7	61.6
17-2438 Jagalene (CC06)	57.0	58.6	59.0	61.0	60.7	58.6	58.0	62.0	61.6	65.1	62.6	60.6	59.0	64.7	62.8	63.4	56.7
17-2439 Jagalene (CC07)	55.0	64.3	61.9	62.0	58.2	64.3	59.0	59.0	67.3	66.5	59.6	60.0	64.8	61.2	59.9	62.6	58.9
17-2440 Jagalene (CC08)	58.0	64.4	65.2	64.0	64.7	64.4	61.0	65.0	67.4	68.9	62.5	65.5	64.4	66.2	64.9	68.5	62.5

BAKE MIX TIME, ACTUAL

(Small Scale) Common Check

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2433 Jagalene (CC01)	20.0	25.0	16.0	4.5	6.0	9.0	25.0	6.3	7.0	6.5	7.3	5.0	4.3	5.4	5.4	9.1	7.0
17-2434 Jagalene (CC02)	8.0	12.0	11.0	7.0	3.0	7.0	20.0	3.0	5.0	3.8	4.5	2.6	2.5	4.5	2.9	3.4	4.0
17-2435 Jagalene (CC03)	7.0	10.0	8.0	6.0	3.3	7.0	11.0	3.0	3.5	4.0	4.5	2.7	2.8	5.1	3.2	4.1	4.0
17-2436 Jagalene (CC04)	8.0	15.0	11.0	5.0	4.3	10.0	14.0	4.0	4.0	4.5	5.8	3.5	3.3	4.7	4.9	6.1	5.0
17-2437 Jagalene (CC05)	6.0	15.0	10.0	6.0	3.8	8.0	14.0	4.0	4.0	4.5	5.3	2.8	3.0	4.0	3.2	4.9	6.0
17-2438 Jagalene (CC06)	5.0	15.0	9.0	5.0	4.8	7.0	9.0	5.2	4.0	4.5	6.8	3.9	3.3	5.2	4.3	6.3	4.0
17-2439 Jagalene (CC07)	5.0	6.0	6.0	4.0	3.0	8.0	6.0	2.5	4.0	3.8	3.8	2.5	2.3	5.1	2.7	3.1	4.0
17-2440 Jagalene (CC08)	5.0	15.0	12.0	8.0	4.0	8.0	13.0	3.5	4.5	4.5	4.8	3.1	3.3	5.3	3.4	5.1	4.0

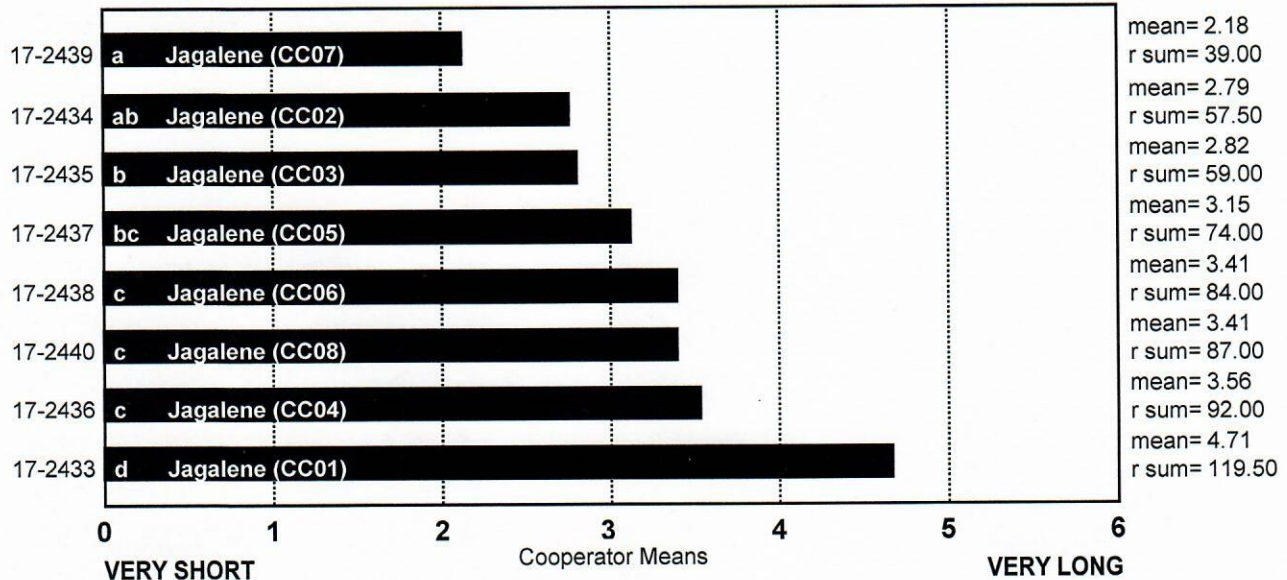
BAKE MIX TIME

(Small Scale) Common Check

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.

ncoop= 17
chisq= 42.50
chisqc= 53.15
cvchisq= 14.07
crdiff= 19.66



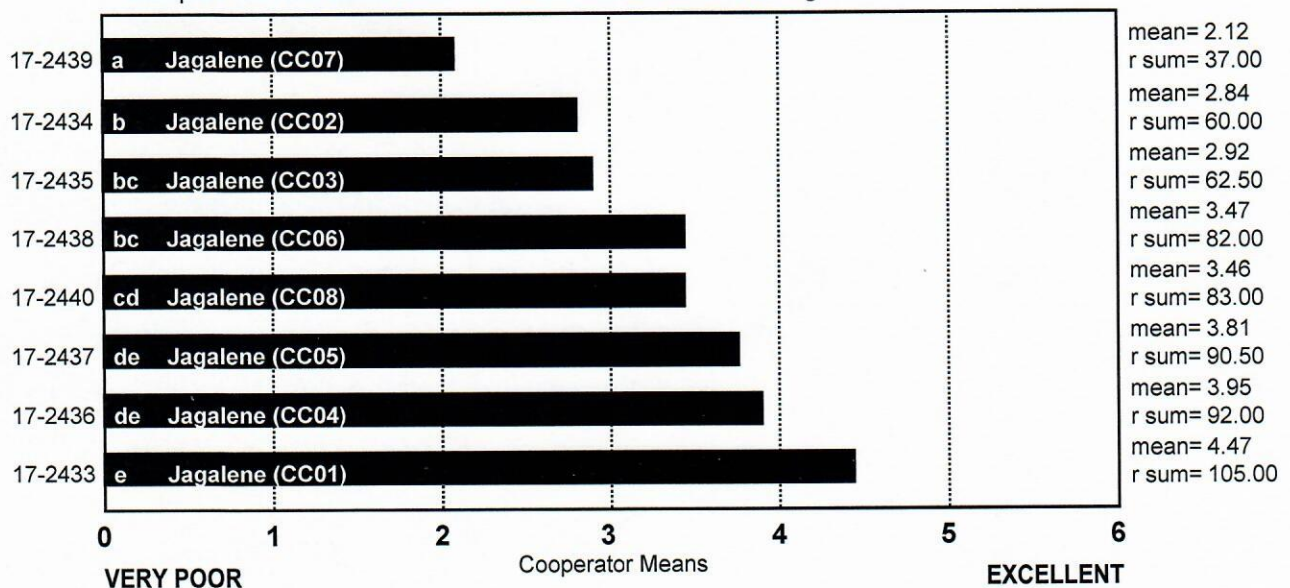
MIXING TOLERANCE

(Small Scale) Common Check

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.

ncoop= 17
chisq= 32.84
chisqc= 37.97
cvchisq= 14.07
crdiff= 22.67



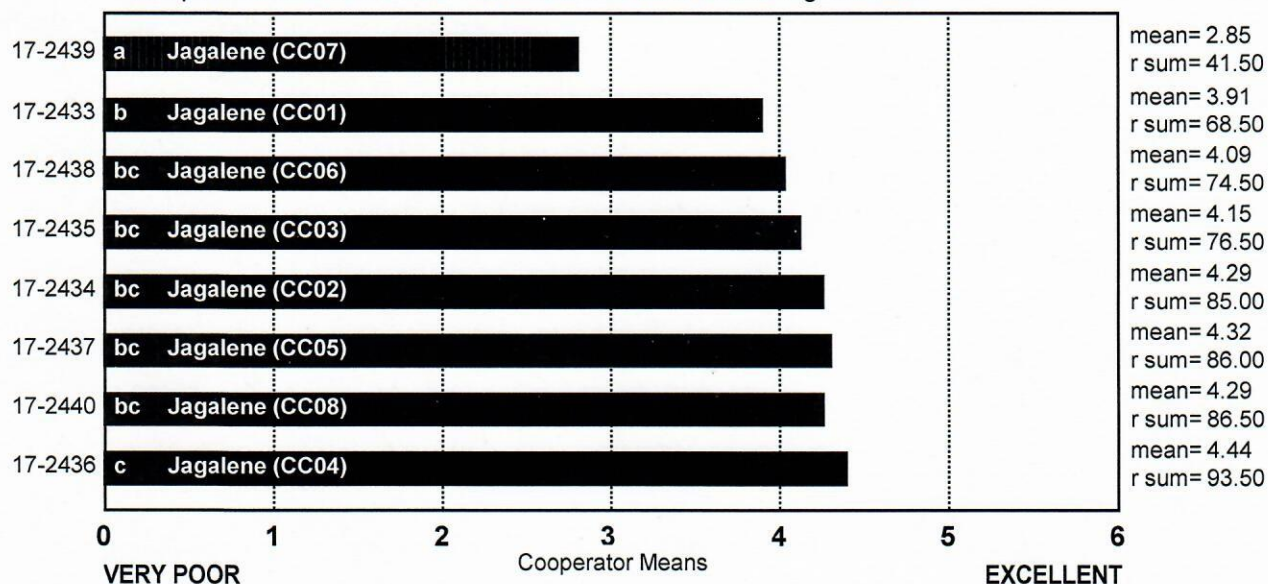
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Common Check

ncoop= 17
chisq= 18.08
chisqc= 22.32
cvchisq= 14.07
crdiff= 23.97

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Common Check

	Sticky	Wet	Tough	Good	Excellent
17-2433 Jagalene (CC01)	4	1	6	6	0
17-2434 Jagalene (CC02)	1	2	2	11	1
17-2435 Jagalene (CC03)	2	0	3	12	0
17-2436 Jagalene (CC04)	2	0	3	8	4
17-2437 Jagalene (CC05)	0	0	2	14	1
17-2438 Jagalene (CC06)	3	2	0	11	1
17-2439 Jagalene (CC07)	7	1	2	7	0
17-2440 Jagalene (CC08)	2	1	1	11	2

Frequency Table

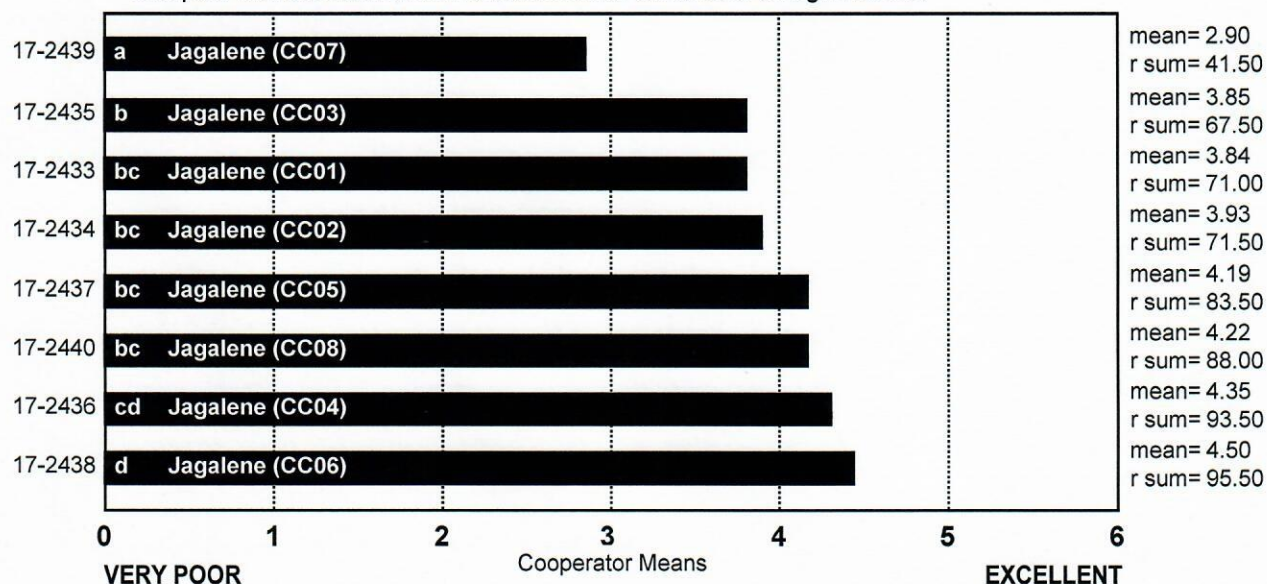
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Common Check

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.

ncoop= 17
chisq= 21.50
chisqc= 26.35
cvchisq= 14.07
crdiff= 23.55



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Common Check

	Sticky	Wet	Tough	Good	Excellent
17-2433 Jagalene (CC01)	3	1	6	7	0
17-2434 Jagalene (CC02)	2	1	2	9	3
17-2435 Jagalene (CC03)	2	1	2	12	0
17-2436 Jagalene (CC04)	1	0	2	9	5
17-2437 Jagalene (CC05)	1	1	3	10	2
17-2438 Jagalene (CC06)	0	0	1	14	2
17-2439 Jagalene (CC07)	5	2	2	8	0
17-2440 Jagalene (CC08)	0	1	2	11	3

Frequency Table

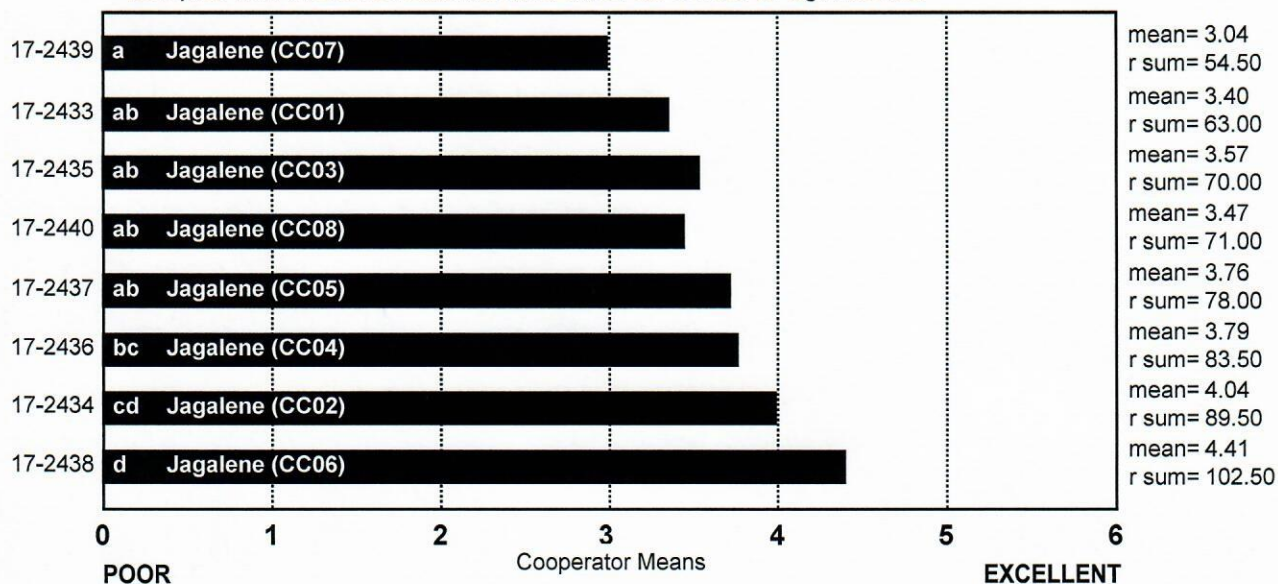
CRUMB GRAIN

(Small Scale) Common Check

ncoop= 17
chisq= 16.03
chisqc= 18.95
cvchisq= 14.07
crdiff= 24.92

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Common Check

	Open	Fine	Dense
17-2433 Jagalene (CC01)	9	6	2
17-2434 Jagalene (CC02)	8	6	3
17-2435 Jagalene (CC03)	5	10	2
17-2436 Jagalene (CC04)	7	9	1
17-2437 Jagalene (CC05)	5	8	4
17-2438 Jagalene (CC06)	4	11	2
17-2439 Jagalene (CC07)	11	4	2
17-2440 Jagalene (CC08)	9	7	1

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Common Check

	Round	Irregular	Elongated
17-2433 Jagalene (CC01)	4	7	6
17-2434 Jagalene (CC02)	1	7	9
17-2435 Jagalene (CC03)	5	5	7
17-2436 Jagalene (CC04)	5	8	4
17-2437 Jagalene (CC05)	4	7	6
17-2438 Jagalene (CC06)	2	4	11
17-2439 Jagalene (CC07)	5	9	3
17-2440 Jagalene (CC08)	4	7	6

Frequency Table

CRUMB TEXTURE

(Small Scale) Common Check

ID	Average	SD	Max	Min
Jagalene (CC01)	3.9	1.0	6	2
Jagalene (CC02)	4.3	1.0	5	1
Jagalene (CC03)	3.6	1.7	6	0
Jagalene (CC04)	4.0	1.2	6	1
Jagalene (CC05)	4.0	1.4	6	1
Jagalene (CC06)	4.1	1.0	6	3
Jagalene (CC07)	3.4	1.6	5	0
Jagalene (CC08)	3.8	1.3	6	1

Crumb Texture Average Rating from 17 Cooperators based on 0 – 6 scale

CRUMB TEXTURE, DESCRIBED

(Small Scale) Common Check

ID	Harsh	Smooth	Silky
Jagalene (CC01)	3	11	3
Jagalene (CC02)	0	12	5
Jagalene (CC03)	5	7	5
Jagalene (CC04)	2	10	5
Jagalene (CC05)	4	8	5
Jagalene (CC06)	3	10	4
Jagalene (CC07)	7	7	3
Jagalene (CC08)	4	9	4

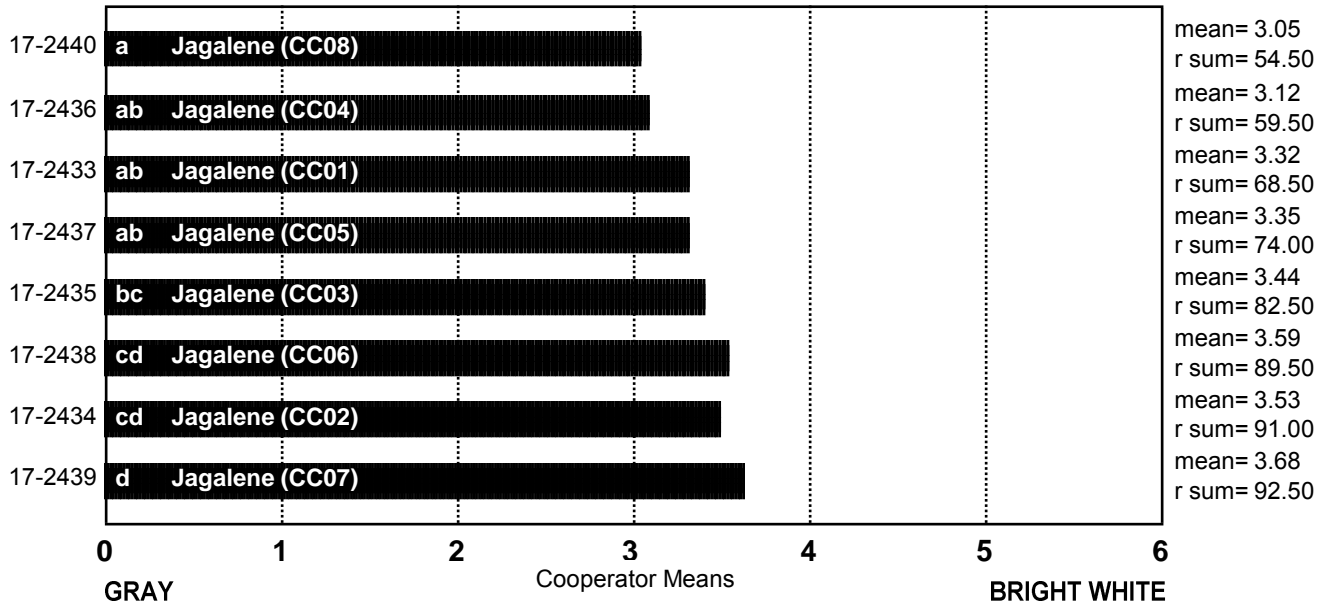
CRUMB COLOR

(Small Scale) Common Check

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.

ncoop= 17
chisq= 14.85
chisqc= 19.65
cvchisq= 14.07
crdiff= 23.47



CRUMB COLOR, DESCRIBED

(Small Scale) Common Check

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2433 Jagalene (CC01)	0	0	5	5	7	0	0
17-2434 Jagalene (CC02)	0	0	5	3	8	1	0
17-2435 Jagalene (CC03)	0	0	6	6	3	2	0
17-2436 Jagalene (CC04)	1	0	6	5	3	1	0
17-2437 Jagalene (CC05)	0	0	8	2	6	0	0
17-2438 Jagalene (CC06)	0	0	2	7	8	0	
17-2439 Jagalene (CC07)	0	0	4	4	6	3	0
17-2440 Jagalene (CC08)	2	1	2	7	4	0	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Common Check

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
17-2433 Jagalene (CC01)	412.0	462.7	429.0	456.0	146.0	454.8		148.9	447.3	132.2	143.1	148.6	136.1	158.1	139.9	160.0	488.6
17-2434 Jagalene (CC02)	410.0	462.7	428.0	447.0	144.2	451.0		147.4	447.1	134.3	142.8	150.3	138.7	154.2	138.1	153.5	476.6
17-2435 Jagalene (CC03)	413.0	463.4	429.0	451.0	144.7	458.4		142.7	445.1	134.7	140.0	145.6	134.3	150.4	138.6	151.9	491.2
17-2436 Jagalene (CC04)	412.0	464.0	430.0	448.0	144.6	453.5		144.0	445.1	134.8	141.5	145.8	134.7	159.3	139.1	154.6	486.8
17-2437 Jagalene (CC05)	412.0	462.5	433.0	454.0	143.8	452.5		142.6	445.0	131.1	144.4	146.9	133.9	154.5	140.5	153.2	483.6
17-2438 Jagalene (CC06)	413.0	468.5	436.0	455.0	141.2	465.0		140.9	447.6	133.3	138.0	143.6	130.5	150.9	139.5	149.3	486.1
17-2439 Jagalene (CC07)	411.0	460.6	432.0	436.0	141.1	449.6		141.7	446.7	136.7	137.5	143.9	136.0	151.1	141.5	151.4	483.4
17-2440 Jagalene (CC08)	412.0	462.6	423.0	457.0	143.4	460.0		143.5	439.4	128.8	147.4	147.9	133.9	152.1	138.1	154.6	482.8

LOAF VOLUME, ACTUAL

(Small Scale)Common Check

	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.	Coop.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
17-2433 Jagalene (CC01)	3100	2363	2800	1800	875	2422	2986	785	1975	805	795	845	962	848	728	700	2138
17-2434 Jagalene (CC02)	2925	2238	2650	2500	965	2693	2868	825	2200	1070	1050	880	922	1023	905	955	2525
17-2435 Jagalene (CC03)	2875	2463	2650	2275	835	2709	2868	690	2375	850	930	745	735	900	833	850	2238
17-2436 Jagalene (CC04)	3025	2525	2775	2350	895	2808	2986	750	2400	860	940	875	827	913	863	845	2500
17-2437 Jagalene (CC05)	2925	2488	2900	2250	915	2589	2927	740	2350	885	923	765	805	938	802	810	2538
17-2438 Jagalene (CC06)	3025	2763	3000	2375	980	2930	3074	830	2475	1010	965	955	802	968	923	845	2663
17-2439 Jagalene (CC07)	2675	2375	2800	2200	800	2575	2809	650	2200	800	878	630	777	823	803	785	2513
17-2440 Jagalene (CC08)	2725	2388	2500	2350	965	2735	2868	810	2350	890	1035	875	905	940	912	905	2513

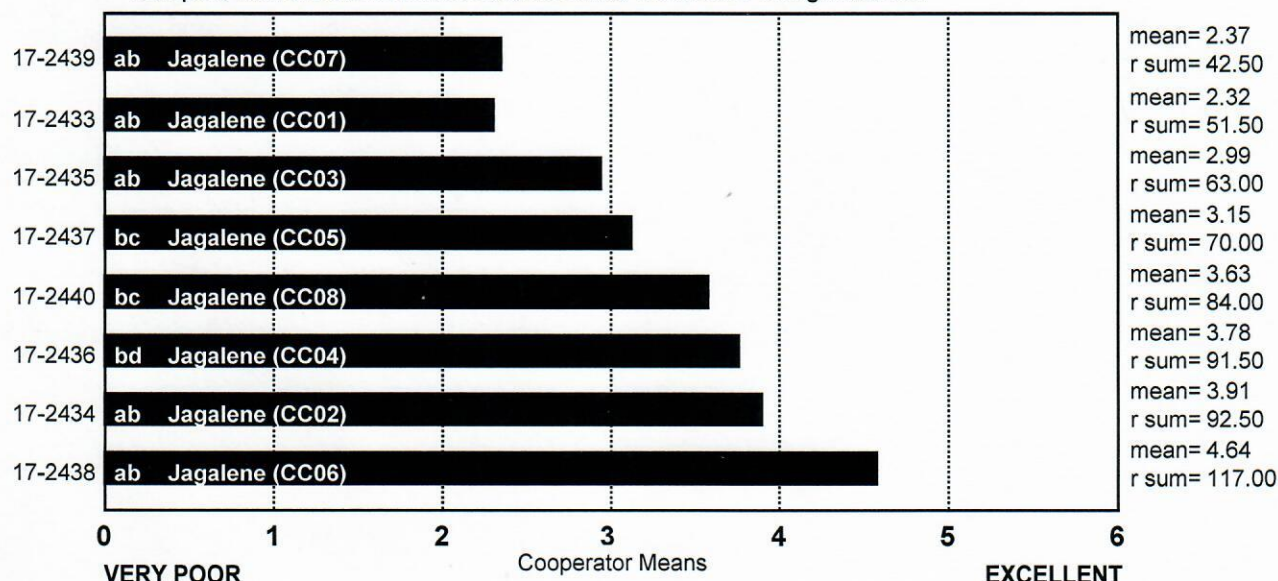
LOAF VOLUME

(Small Scale) Common Check

ncoop= 17
chisq= 41.01
chisqc= 46.55
cvchisq= 14.07
crdiff= 21.64

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



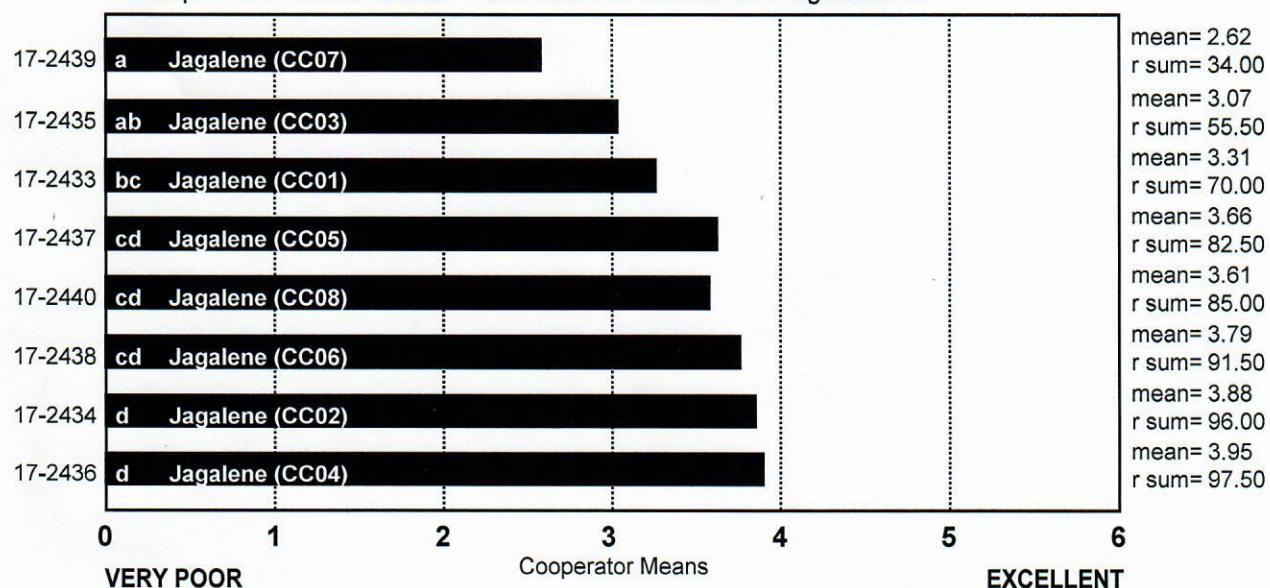
OVERALL BAKING QUALITY

(Small Scale) Common Check

ncoop= 17
chisq= 33.76
chisqc= 37.76
cvchisq= 14.07
crdiff= 23.09

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS

(Small Scale) Common Check

COOP.

17-2433 Jagalene (CC01)

- A. No comment.
- B. No comment.
- C. Good performance overall.
- D. Bake absorption did not coincide with farinograph absorption.
- E. Long time to pickup, rough break and shred.
- F. No comment.
- G. Good absorption, mix strength and volume.
- H. Good absorption.
- I. Very sticky on the makeup, low volume.
- J. Long mixer and poor color.
- K. Normal water absorption, long mix time, slight sticky & strong dough, OK volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Good strength/color.
- M. No comment.
- N. Dough strength at a reasonable level, loaf volume and crumb grain questionable.
- O. No comment.
- P. Good mixograph, flour did not perform well in the bake, long mix time, sticky at pan, unsatisfactory crumb grain, and low loaf volume.
- Q. High absorption, average grain, yellow color, very low volume.

COOP.

17-2434 Jagalene (CC02)

- A. No comment.
- B. No comment.
- C. Good recovery during intermediate fermentation time (from mixing to makeup).
- D. Wild break and shred.
- E. Excellent loaf externals, dark crust.
- F. Soft dough.
- G. Good absorption, mix strength and fair volume.
- H. Good absorption.
- I. Crust was darker in color.
- J. Nice loaf, good color.
- K. High water absorption, normal mix time, slight sticky & strong dough, very high volume, slight yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Very good protein, weaker, poor loaf volume.
- M. No comment.
- N. Good volume performance for protein and reasonable crumb grain. Dough strength somewhat questionable.
- O. No comment.
- P. Weak mixograph tolerance but loaf had good absorption and mix time, good dough feel, satisfactory crumb grain.
- Q. High absorption, tough dough, fine grain, yellow color, average volume.

COOP.**17-2435 Jagalene (CC03)**

- A. No comment.
- B. No comment.
- C. Very weak mix tolerance, stressed dough to partial break down.
- D. No comment.
- E. No comment.
- F. No comment.
- G. Low absorption, mix strength and fair volume.
- H. Average absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, slight yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Low protein and loaf volume.
- M. No comment.
- N. Good volume performance for protein, weaker dough.
- O. No comment.
- P. Mixograph weak tolerance, nice bake absorption and mix time, good dough at pan, disappointed with crumb grain and loaf volume.
- Q. Low absorption, tough dough, poor open grain, yellow color, very low volume.

COOP.**17-2436 Jagalene (CC04)**

- A. No comment.
- B. No comment.
- C. All good.
- D. No comment.
- E. Yellow dough, excellent loaf externals.
- F. Gummy crumb texture.
- G. Fair absorption, mix strength and good volume, high ash.
- H. Good absorption.
- I. Best of set, good volume and crumb rating is what put this one above the others in the set.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, fine elongated cells, resilient & very smooth texture.
- L. Good mix time/strength/grain.
- M. No comment.
- N. Performed as expected for protein level.
- O. No comment.
- P. High bake absorption, long bake mix time, excellent out of mixer and good at pan, crumb grain Questionable – Satisfactory, loaf volume ok for flour protein.
- Q. High absorption, dark yellow color, average volume.

COOP.**17-2437 Jagalene (CC05)**

- A. No comment.
- B. No comment.
- C. Good performance overall.
- D. No comment.
- E. Excellent loaf externals.
- F. No comment.
- G. Fair absorption, mix strength and good volume.
- H. Good absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Poor loaf volume.
- M. No comment.
- N. Good volume performance.
- O. No comment.
- P. Good bake absorption, mix time and dough feel, nice loaf, but disappointing crumb grain and loaf volume.
- Q. Good absorption, tough dough at makeup, fine grain, yellow color.

COOP.**17-2438 Jagalene (CC06)**

- A. No comment.
- B. No comment.
- C. Excellent performance.
- D. No comment.
- E. Very nice, excellent loaf externals.
- F. No comment.
- G. Low absorption, mix strength and good volume.
- H. Average absorption.
- I. No comment.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Good bake for protein.
- M. No comment.
- N. Good volume performance but somewhat weaker dough character.
- O. No comment.
- P. Lower absorption, long mix time, weak dough feel out of mixer but good at pan, above satisfactory crumb grain.
- Q. Low absorption, nice dough, good grain, yellow color, excellent volume.

COOP.**17-2439 Jagalene (CC07)**

- A. No comment.
- B. No comment.
- C. Very short mix time & sticky dough, capping.
- D. No comment.
- E. Dark crust, rough break and shred.
- F. Very sticky dough, needed lots of dusting flour for rounding & moulding, off flavor from the crumb.
- G. Fair absorption, very low mix strength and slightly low volume.
- H. Shorter mix, absorption less than target.
- I. No comment.
- J. Low protein and low loaf volume.
- K. Low water absorption, normal mix time, slight sticky & strong dough, high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
- L. Unacceptable protein, short mix, weaker, poor loaf volume/crumb.
- M. No comment.
- N. Low protein, weak dough, expected poor crumb but produced bread with good volume for protein level.
- O. No comment.
- P. Low flour protein, low bake absorption, short mix time, good dough feel at pan, Questionable – Satisfactory crumb grain with low loaf volume.
- Q. Sticky dough, poor mixing tolerance, open grain, yellow color.

COOP.**17-2440 Jagalene (CC08)**

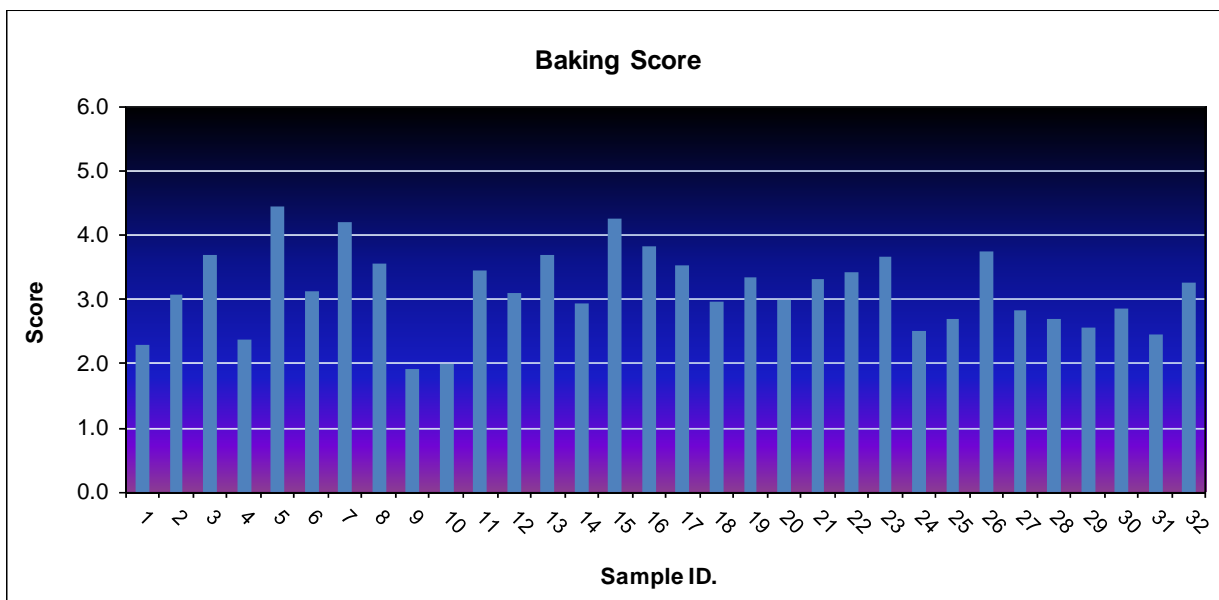
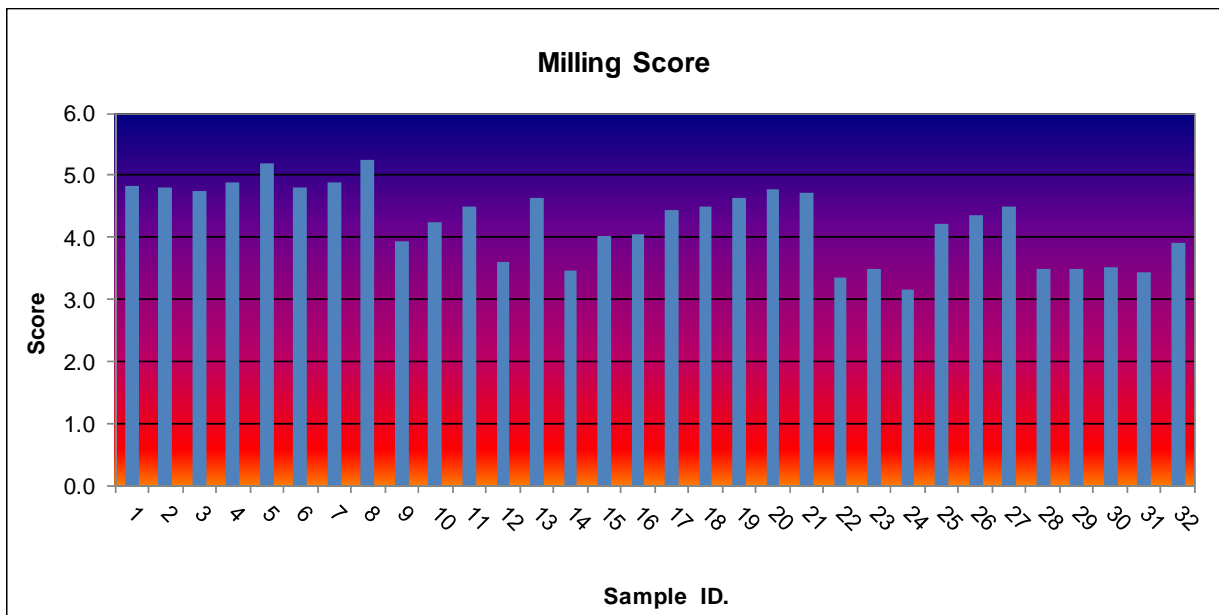
- A. No comment.
- B. No comment.
- C. Capping & open grain structure.
- D. Shell top, wild break and shred.
- E. Excellent loaf externals.
- F. No comment.
- G. Fair absorption, mix strength and volume.
- H. Good absorption.
- I. 2430, 2431 and 2432 were all very similar. Lack of volume and crumb score hurt these flours.
- J. No comment.
- K. Normal water absorption and mix time, slight sticky & strong dough, very high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
- L. Questionable color, very good absorption.
- M. Slightly yellow crumb.
- N. Performed as expected for protein level.
- O. No comment.
- P. Good flour protein, excellent bake absorption, good mix time, good out of mixer & pan, Questionable – Satisfactory crumb grain, terrific loaf volume.
- Q. High absorption, tough dough at makeup, good grain, dark yellow color.

Notes: **A, C, D, G, I and Q** conducted sponge and dough bake tests

*2017 WQC Milling and Baking
Marketing Scores*

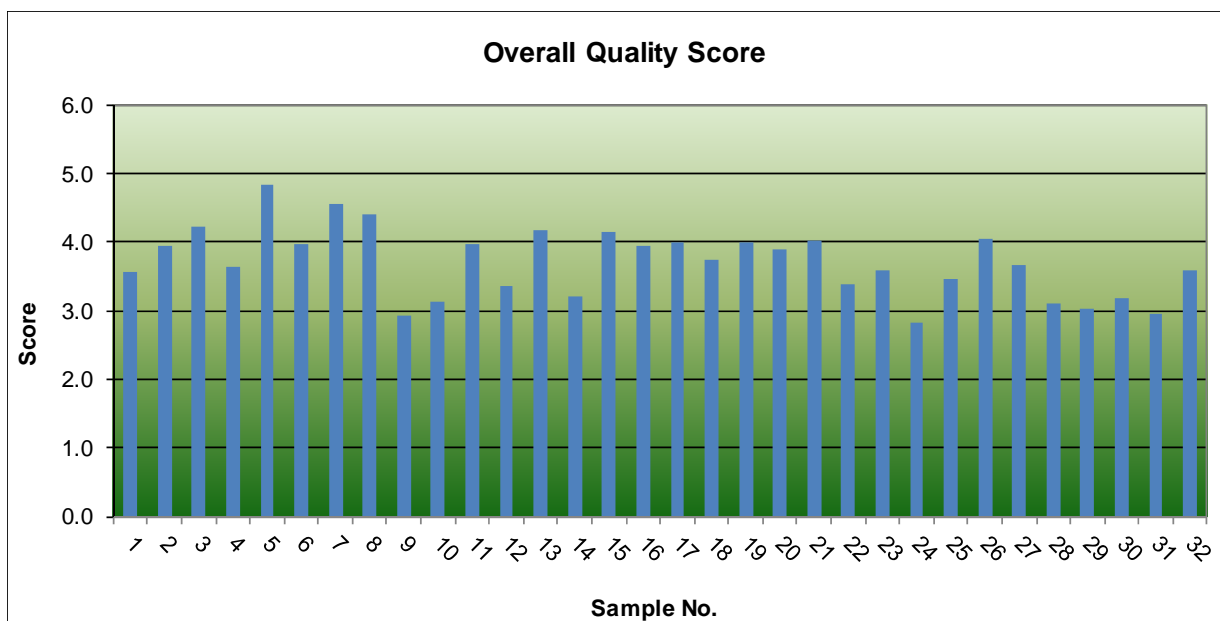
2017 WQC Milling & Baking Marketing Scores

(Based upon HWWQL Quality Data and KSU Milling Data)



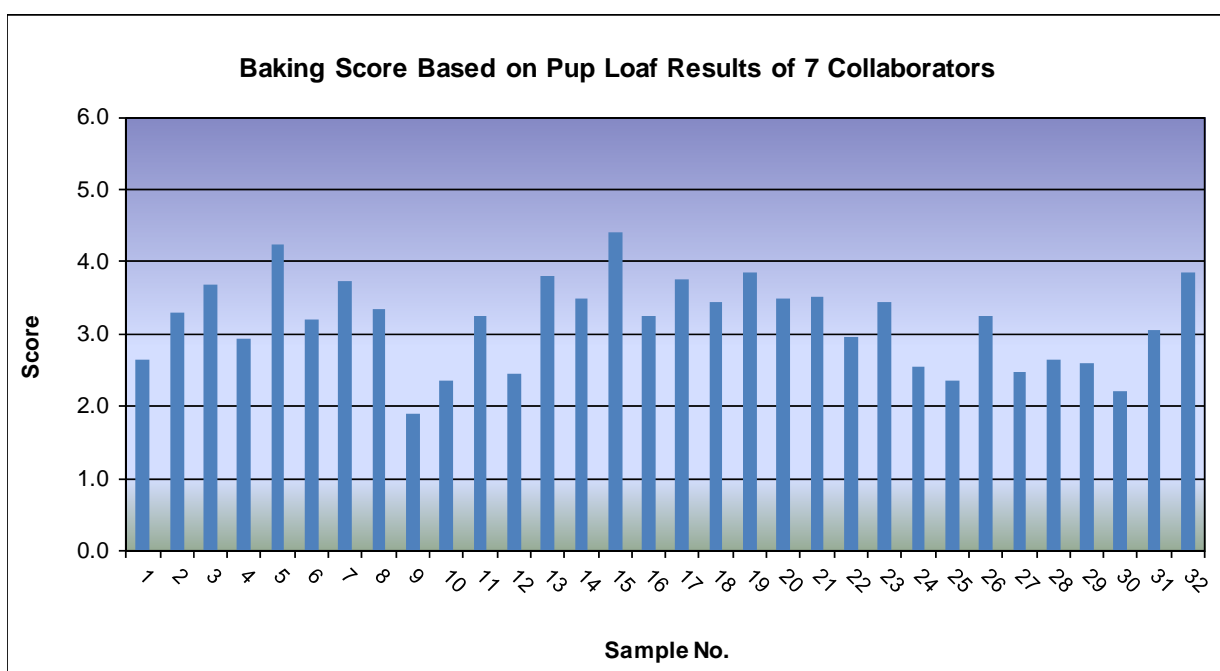
2017 WQC Milling & Baking Marketing Scores

(Based upon HWWQL Quality Data and KSU Milling Data)



2017 WQC Baking Marketing Scores

(Based upon Average Baking Data of Collaborators Pup-Loaf Straight Dough)



Marketing Scores

Achieving acceptable end-use (milling and baking) quality is a fundamental objective of wheat breeding programs throughout the U.S. hard winter wheat region. Numerous statistical methods have been developed to measure quality. Several years ago, Dr. Scott Haley (Colorado State University), in conjunction with the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL), developed a relational database for summarization and interpretation of regional performance nursery wheat end-use quality data generated annually by the HWWQL (Scott D. Haley, Rod D. May, Bradford W. Seabourn, and Okkyung K. Chung. 1999. *Relational database system for summarization and interpretation of Hard Winter Wheat regional quality data*. Crop Sci. 39:309–315). Until that time, few tools were available to assist in the decision-making process when faced with a large number of parameters from comprehensive milling and baking tests. The database system uses a graphical interface that requires input from the user. The database system provides simultaneous assessment of multiple quality traits on a standardized scale, *user-specified prioritization* of end-use quality traits for numerical and qualitative ratings of genotypes, tabulation of major quality deficiencies of genotypes, and summarization of quality ratings for a genotype across multiple nurseries.

As an extension of this relational database, and in keeping with the precedent set by Dr. Gary Hareland and the Hard Spring wheat region with the introduction of a ‘marketing score’ into their 2004 annual crop report to the Wheat Quality Council, the HWWQL developed (using the HRS system as a guide) a similar marketing score for both milling and baking for the Hard Winter Wheat Region, as shown below.

Variation(+/-) from Target Value:	SCORE	Kernel TW	Kernel Size	Kernel Weight	Wheat Protein	Kernel Hardness	Str Grd Flour Yield	Wheat Ash	Wheat Falling Number
		lbs/bu	% Large	g/1000	12%mb	NIR	%	14%mb	Seconds
	6	63	39	45	15.0	100	76	1.30	375
	5	62	36	40	14.0	90	74	1.40	350
	4	61	33	35	13.0	80	72	1.50	325
TARGET VALUE:	3	60	30	30	12.0	70	70	1.60	300
	2	59	26	25	11.0	60	68	1.70	275
	1	58	22	20	10.0	50	66	1.80	250
	0	57	18	15	9.0	40	64	1.90	225

Milling Marketing Score = (TW*1.5) + (largeK*1) + (1000KWT*0.5) + (protein*2.5) + (NIRHS*1) + (YLD*1.5) + (ash*1) + (FN*1)/10 (where TW = test weight, largeK = large kernel size %, 1000KWT = thousand kernel weight, protein = protein content %, NIRHS = NIR hardness score, YLD = flour yield, ash = wheat ash content %, and FN = falling number value).

Variation(+/-) from Target Value:		Absorption Actual (%)	Volume Actual (cc)	Color Rating Score	Grain Rating Score	Texture Rating Score	SCORE	Mix Time Actual (min)
	6	65	1050	6.0	6.0	6.0	0	5.00
	5	64	1000	5.4	5.4	5.4	2	4.50
	4	63	950	4.7	4.7	4.7	4	4.00
TARGET VALUE:	3	62	900	4.0	4.0	4.0	6	3.50
	2	61	850	3.3	3.3	3.3	4	3.00
	1	60	800	1.6	1.6	1.6	2	2.50
	0	59	750	1.0	1.0	1.0	0	2.00

Bake Marketing Score = (Abs*3) + (Lvol*2) + (color*1) + (grain*1.5) + (texture*1) + (MT*1.5)/10 (where Abs = mixograph water absorption %, Lvol = loaf volume [cc], color = crumb color [0-6 scale], grain = crumb grain [0-6 scale], texture = crumb texture [0-6 scale], and MT = mixograph mix time).

Alkaline Noodle Quality Tests of 2017 WQC Hard Winter Wheat Entries



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Alkaline Noodle Quality Report

Objectives: Evaluate alkaline noodle color and cooking characteristics.

Materials: 32 WQC hard winter wheat samples harvested in 2017.

Methods:

PPO (Polyphenol Oxidase) Test:

The PPO level in wheat meal was determined using a method modified from AACCI Approved Method 22-85.

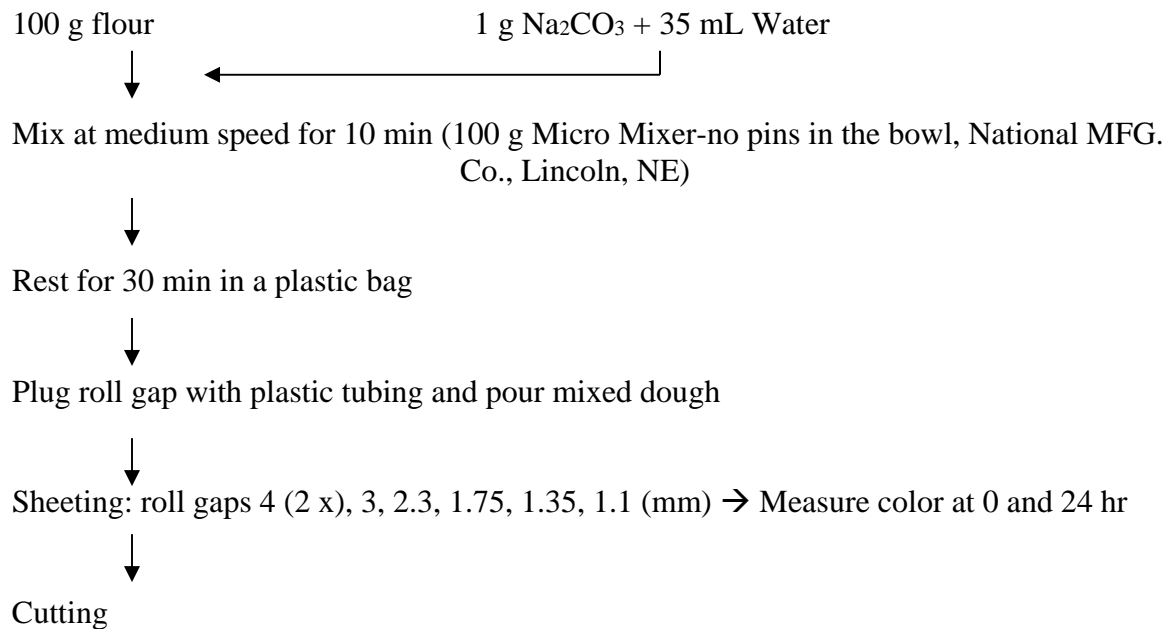
1. Grind wheat using a Udy Mill and blend the sample thoroughly on tumbling equipment.
2. Weigh 75 mg of wheat meal in a 2 mL microfuge tube.
3. Dispense 1.5 mL of 5 mM L-DOPA in 50 mM MOPS (pH 6.5) solution.
4. Vortex 10 min.
5. Centrifuge 4 min at 10,000 rpm.
6. Read absorbance at 475 nm.

Noodle Making:

Formulation:

Alkaline Noodle was made with 100 g flour, 1 g Na₂CO₃, and 35 mL of water (fixed).

Procedure:



Measurement of Noodle Dough Color:

Noodle dough color (L^* , lightness; a^* , redness-greenness; b^* , yellowness-blueness) was measured by Minolta Colorimeter (Model CR-300) at 0 and 24 hr.

Cooking Noodles:

1. After cutting noodles, rest noodles in plastic bags for 2 hr at 21°C.
2. Put the noodles (25 g) in the boiling distilled water (300 mL).
3. Cook continuously with gentle stirring for 4 min 30 sec or until the core of noodle disappears.
4. Pour noodles and hot water through colander and collect the cooking water for calculation of cooking loss.
5. Immerse the cooked noodles in a bowl with distilled water (100 mL) for 1 min.
6. Drain water by shaking the colander 10 times.
Measure the cooked noodle weight for calculation of water uptake.
7. Test noodle texture immediately.

Measurement of Cooking Loss and Water Uptake:

Cooking Loss:

1. Pre-weigh 500 mL beaker to 0.01 g.
2. Quantitatively transfer cooking/rinse water to beaker.
3. Evaporate to dryness (constant weight) in air oven at $95 \pm 5^\circ\text{C}$.
Drying time is about 20 hr.
4. Cool beakers and weigh to 0.01 g.
For 25 g sample, multiply by 4 \rightarrow % cooking loss.

Water Uptake:

Water Uptake (%) = (Cooked noodle weight - Raw noodle weight) / Raw noodle weight \times 100

Texture Profile Analysis (TPA) of Noodle:

Immediately after cooking, noodle TPA was conducted using a TA-XTplus (Texture Technologies, NY) on 3 strings of noodle with 1-mm flat Perspex Knife Blade (A/LKB-F). TPA provides objective sensory results on various parameters as follows:

- **Hardness (N):** maximum peak force during the first compression cycle (first bite) and often substituted by the term “firmness”.
- **Springiness (elasticity, ratio):** ratio related to the height that the food recovers during the time that elapses between the end of the first bite and the start of the second bite.
- **Chewiness:** hardness \times cohesiveness \times springiness.

- **Resilience (ratio):** measurement of how the sample recovers from deformation both in terms of speed and forces derived.
- **Cohesiveness (ratio):** ratio of the positive force area during the second compression to that during the first compression.

Results:

Top 3 samples showing desirable properties were selected in each category.

Table I shows the following:

Noodle Color (*L* value, Higher is better.) **at 0 hr:** 2425 (81.34), 2430(80.32), 2428 (79.92)

Noodle Color (*L* value, Higher is better.) **at 24 hr:** 2430 (68.12), 2431 (67.67), 2425 (66.75)

Delta L (Change of *L* value, Lower absolute value is better.)
2414 (-10.93), 2422 (-11.23), 2419 (-11.56)

PPO (Lower is better.): 2430 (0.203), 2421 (0.218), 2429 (0.238)

Table II shows the following:

Hardness: 2423(2.827), 2422 (2.735), 2424 (2.731)

Springiness: 2405 (0.909), 2412 (0.909), 2402 (0.900)

Chewiness: 2423 (1.615), 2409 (1.539), 2416 (1.526)

Resilience: 2405 (0.447), 2402 (0.438), 2407 (0.429)

Cohesiveness: 2405 (0.703), 2402 (0.696), 2418 (0.689)

Water Uptake: 2405 (88.92), 2407 (88.92), 2431 (87.32)

Cooking Loss: 2407 (6.40), 2432 (6.44), 2429 (6.92)

Discussion

Sample 2430 had the highest *L*-value (brightness) at 24 hrs and the second highest *L*-value (brightness) at 0 hrs, and had the lowest PPO value. This sample also had the lowest hardness and chewiness after cooking. Therefore, sample 2430 would be considered the most favorable

variety overall for white salted noodles quality (Japanese Udon-type), which are preferred to have a bright, creamy white color, and smooth, soft texture.

Sample 2425 had the highest L-value (brightness) at 0 hrs and had third highest L-value (brightness) at 24 hrs.

Sample 2405 had highest springiness, resilience and cohesiveness after cooking, also had highest water uptake.

Table I. Noodle Color and PPO Level

Sample ID	L* @ 0	L* @ 24	a* @ 0	a* @ 24	b* @ 0	b* @ 24	delta L*	delta a*	delta b*	PPO
2401	78.40	66.53	-0.64	1.50	20.21	24.08	-11.87	2.14	3.87	0.244
2402	77.80	64.38	-0.42	1.98	20.61	25.13	-13.42	2.40	4.52	0.399
2403	76.67	64.32	-1.15	1.45	24.46	27.62	-12.35	2.60	3.16	0.406
2404	79.12	66.76	-0.89	1.38	20.81	25.11	-12.36	2.26	4.30	0.411
2405	75.75	60.99	-1.03	1.24	25.21	25.31	-14.76	2.26	0.09	0.407
2406	76.68	62.68	-1.02	1.70	23.88	27.01	-14.00	2.72	3.13	0.526
2407	78.09	61.60	-1.39	1.08	22.77	23.64	-16.49	2.47	0.86	0.366
2408	74.64	58.87	-0.99	1.82	25.16	24.52	-15.78	2.81	-0.64	0.437
2409	76.10	61.73	-0.92	2.30	23.07	25.94	-14.37	3.22	2.87	0.439
2410	79.36	65.52	-1.36	1.43	22.45	27.18	-13.84	2.79	4.73	0.424
2411	76.36	61.28	-1.09	2.28	25.30	26.80	-15.08	3.37	1.50	0.377
2412	77.75	62.08	-1.11	1.63	22.20	24.52	-15.68	2.73	2.32	0.404
2413	76.57	62.60	-1.19	2.14	26.55	27.23	-13.97	3.32	0.68	0.490
2414	76.83	62.60	-0.74	2.01	23.12	26.65	-14.24	2.75	3.54	0.423
2415	76.47	65.54	-0.85	1.63	27.11	29.70	-10.93	2.48	2.59	0.233
2416	75.80	63.02	-1.11	1.62	25.99	27.70	-12.79	2.72	1.72	0.567
2417	77.12	64.05	-0.91	1.65	23.43	25.95	-13.07	2.55	2.53	0.635
2418	77.66	63.86	-0.94	1.81	21.90	26.10	-13.80	2.75	4.21	0.357
2419	75.66	64.11	-0.24	2.43	26.08	27.32	-11.56	2.66	1.24	0.476
2420	72.98	58.23	-0.09	3.36	24.19	24.90	-14.76	3.44	0.71	0.450
2421	77.24	64.38	-1.03	1.74	25.01	27.50	-12.86	2.77	2.49	0.218
2422	74.95	63.72	-0.83	1.08	22.16	24.30	-11.23	1.91	2.15	0.613
2423	74.36	62.79	-0.53	1.79	21.94	23.54	-11.58	2.32	1.60	0.594
2424	76.17	62.03	-0.93	1.59	21.49	24.69	-14.14	2.51	3.20	0.542
2425	81.34	66.75	-1.83	0.33	20.15	22.12	-14.59	2.16	1.97	0.325
2426	77.55	58.84	-1.72	1.45	20.88	22.74	-18.71	3.16	1.86	0.446
2427	79.17	62.61	-1.05	1.76	19.45	22.38	-16.56	2.80	2.94	0.342
2428	79.92	65.22	-0.90	1.59	18.74	23.85	-14.71	2.49	5.11	0.549
2429	77.39	64.73	-1.00	1.43	23.41	28.72	-12.67	2.43	5.31	0.238
2430	80.32	68.12	-1.26	0.85	19.60	26.22	-12.20	2.11	6.62	0.203
2431	79.88	67.67	-1.63	0.67	23.22	27.75	-12.21	2.29	4.53	0.524
2432	75.62	59.88	-0.94	1.76	24.73	26.08	-15.74	2.69	1.35	0.460
Avg	77.18	63.36	-0.99	1.64	22.98	25.69	-13.82	2.62	2.72	0.422

Table II. Texture Profile Analysis of Cooked Noodle and Water Uptake and Cooking Loss

Sample ID	Springiness	Hardness	Chewiness	Resilience	Cohesiveness	Water Uptake (%)	cooking loss(%)
2401	0.888	2.285	1.340	0.418	0.674	75.48	9.32
2402	0.900	2.403	1.507	0.438	0.696	81.32	7.40
2403	0.886	2.409	1.425	0.419	0.668	86.64	7.12
2404	0.892	2.442	1.430	0.416	0.672	80.40	8.48
2405	0.909	2.317	1.480	0.447	0.703	88.92	7.24
2406	0.888	2.467	1.459	0.400	0.666	84.04	7.64
2407	0.880	2.514	1.505	0.429	0.680	88.92	6.40
2408	0.884	2.395	1.425	0.416	0.673	82.84	7.64
2409	0.894	2.661	1.539	0.377	0.647	86.60	7.76
2410	0.882	2.579	1.467	0.374	0.645	84.68	7.84
2411	0.869	2.630	1.457	0.384	0.637	85.92	8.12
2412	0.909	2.519	1.523	0.387	0.666	81.80	8.32
2413	0.882	2.543	1.480	0.390	0.660	86.92	7.64
2414	0.863	2.458	1.391	0.385	0.656	82.64	7.28
2415	0.865	2.321	1.351	0.416	0.673	80.32	7.04
2416	0.880	2.648	1.526	0.387	0.655	85.12	7.12
2417	0.876	2.459	1.472	0.399	0.684	79.68	7.60
2418	0.869	2.398	1.435	0.424	0.689	76.64	8.24
2419	0.876	2.590	1.521	0.406	0.671	77.80	7.72
2420	0.888	2.454	1.463	0.402	0.671	79.96	7.04
2421	0.881	2.401	1.401	0.403	0.662	81.48	8.68
2422	0.805	2.735	1.367	0.356	0.621	76.64	8.20
2423	0.898	2.827	1.615	0.357	0.636	79.36	7.76
2424	0.867	2.731	1.476	0.356	0.622	85.84	7.28
2425	0.888	2.407	1.368	0.368	0.640	86.36	8.04
2426	0.892	2.398	1.453	0.410	0.679	83.04	8.04
2427	0.876	2.310	1.350	0.402	0.668	84.56	7.52
2428	0.892	2.533	1.501	0.410	0.665	86.48	7.36
2429	0.855	2.620	1.434	0.379	0.640	86.68	6.92
2430	0.867	2.284	1.291	0.394	0.652	85.48	7.88
2431	0.890	2.378	1.392	0.396	0.658	87.32	7.40
2432	0.884	2.512	1.508	0.413	0.679	86.64	6.44
Avg	0.880	2.487	1.450	0.399	0.663	83.33	7.64

TORTILLA BAKING TEST RESULTS of 2017 WQC SAMPLES

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(December 2017)

SUMMARY

This report includes the methods for production and evaluation of wheat flour tortillas and data of the 2017 WQC samples. The data was collected over 17 days, including baking and shelf stability.

Samples 2403 and 2406 created tortillas that were ranked as “good”, based on their final diameter (≥ 160 mm) and subjective rollability (v. little cracking when rolled 16 days after baking) as seen in Table 2. These samples also had good dough handling properties (Table 1). Higher diameter and rollability scores suggest flour that is moderately strong with good extensibility characteristics. Sample 2405 was ranked as “fair-good” because it had a diameter that just missed the cutoff for good (158 mm) and had great rollability (4.25 = signs of cracking, but no breaking) over 16 days of storage.

Samples 2408, 2411, 2413, and 2416 ranked as “fair”, based on their diameter (150-160 mm), though they had good rollability. This suggests these flours were strong and caused shrinkage to the tortilla dough when hot-pressed. Samples 2402, 2407, 2414, and 2419 were ranked as “poor-fair” because they had good rollability but slightly inferior diameter. These samples also had slightly reduced dough handling properties as compared to fair samples.

Sample 2401 and 2428 created hard and rough doughs evidenced by their extreme ratings in all subjective dough parameters (Table 1). This resulted in a tortillas with inferior diameter (131 and 136 mm, respectively) that had reduced rollability over 16 days of storage; they were ranked as “v. poor”. This is indicative of very strong gluten proteins, which often increase shrinkage after hot-press, an undesirable dough trait in tortillas. Samples 2412, 2427, and 2430 also created stiff doughs, which were not highly extensible, and led to poor quality tortillas.

Samples 2422, 2423, and 2426 had good diameters (160-166 mm) but low rollability scores (<3), indicative of weak flours.

RESULTS

Table 1 – Subjectively evaluated dough properties.

Test #	Abs [%]	Mix Time [min]	Smoothness	Softness	Extensibility	Force to Extend	Press Rating
2401	50.0	13	4	4	2	5	5
2402	51.5	14	2	3	1	3	3
2403	51.3	12	2	2	3	2	2
2404	50.9	14	3	3	2	3	3
2405	54.0	13	2	2	3	2	2
2406	52.4	10	3	3	2	2	2
2407	52.1	11	3	3	3	3	3
2408	53.9	11	2	2	3	2	2
2409	47.7	12	2	3	2	3	3
2410	48.6	10	2	2	3	3	3
2411	49.8	10	3	3	2	3	3
2412	48.8	12	3	4	2	4	4
2413	50.7	10	2	2	3	2	2
2414	50.9	13	2	2	2	3	3
2415	52.5	11	2	3	2	3	3
2416	51.5	11	2	2	3	2	2
2417	51.6	12	3	2	2	3	2
2418	51.3	12	3	2	2	2	2
2419	51.8	11	3	3	2	3	3
2420	50.7	10	3	3	3	2	3
2421	52.1	12	2	3	4	3	3
2422	51.3	12	2	2	3	2	2
2423	50.7	9	2	2	4	2	1
2424	50.3	10	2	2	4	2	2
2425	47.9	9	2	3	2	3	3
2426	50.1	10	2	3	3	3	2
2427	50.1	11	3	4	2	4	4
2428	48.0	12	3	4	1	5	5
2429	49.5	13	3	3	3	3	4
2430	47.6	12	3	4	2	5	4
2431	49.7	13	2	3	4	4	3
2432	51.9	12	2	3	3	3	3

Smoothness: 1 = satin smooth, **2 = preferred**, 5 = very rough

Softness: 1 = very soft, **2 = preferred**, 5 = very hard

Extensibility: 1 = breaks immediately, **3 = preferred**, 5 = extends readily

Force to extend: 1 = less force, **2 = preferred**, 5 = extreme force

Press rating: 1 = less force, **2 = preferred**, 5 = extreme force

Methodology listed on subsequent pages.

Table 2 – Physical and textural properties of tortillas.

Test #	Finished Tortilla Physical Properties						Finished Tortilla Texture						Rating*
	Moisture [%]	Weight [g]	Thickness [mm]	Diameter [mm]	Sp. Vol [cm ³ /g]	Lightness* [L-value]	Force Day 8 [N]	Distance Day 8 [mm]	Force Day 16 [N]	Distance Day 16 [mm]	Rollability Day 8	Rollability Day 16	
2401	24.3	41.2	3.5	131	1.1	76.9	1577	17.4	1341	14.0	4.00	2.75	V. Poor
2402	28.2	40.0	2.6	148	1.1	80.3	1455	20.5	1238	16.0	5.00	3.75	Poor-Fair
2403	27.6	40.6	2.5	160	1.2	82.6	1099	16.6	862	13.8	5.00	4.00	Good
2404	27.5	42.8	2.9	142	1.1	79.2	1472	17.3	1351	14.8	5.00	4.25	Poor
2405	28.4	40.1	2.4	158	1.2	81.6	1391	19.0	1117	16.9	5.00	4.25	Fair-Good
2406	27.6	39.4	2.4	166	1.3	82.0	932	16.3	796	13.9	5.00	3.50	Good
2407	28.0	40.2	2.6	149	1.1	80.4	1325	17.2	1362	17.0	5.00	3.75	Poor-Fair
2408	28.6	40.1	2.2	157	1.0	80.6	1270	22.7	1201	19.3	5.00	5.00	Fair
2409	26.6	40.5	2.7	153	1.2	75.7	1132	15.9	1081	13.9	3.00	2.25	Poor
2410	26.5	40.2	2.4	159	1.2	82.9	1035	15.5	871	13.6	4.00	2.00	Poor
2411	25.7	41.1	3.0	153	1.3	82.0	1019	16.2	1042	14.0	5.00	3.75	Fair
2412	26.7	40.4	2.9	144	1.2	80.9	1208	17.0	1365	16.2	4.50	2.50	Poor
2413	26.6	40.7	2.5	150	1.1	80.9	1285	22.0	1041	17.5	4.00	3.75	Fair
2414	28.1	40.2	2.7	148	1.1	78.1	1653	19.5	1293	15.8	4.00	3.25	Poor-Fair
2415	28.2	41.2	2.8	140	1.0	78.7	1562	20.2	1481	18.3	4.50	4.50	Poor
2416	28.1	40.5	2.6	155	1.2	81.9	1203	17.9	962	15.3	5.00	3.75	Fair
2417	28.2	40.4	2.6	146	1.1	79.6	1274	17.7	1332	16.0	5.00	4.50	Poor
2418	28.1	40.7	2.5	150	1.1	79.7	1261	18.4	1168	16.1	4.00	2.75	Poor
2419	28.2	40.5	2.6	149	1.1	80.1	1212	18.3	1428	19.0	4.50	3.50	Poor-Fair
2420	26.8	40.7	2.4	147	1.0	80.8	1426	19.3	1476	19.4	4.50	3.25	Poor
2421	28.4	40.6	2.7	142	1.0	82.0	1492	19.6	1513	18.8	5.00	4.75	Poor
2422	28.1	40.7	2.3	166	1.2	80.6	963	15.8	1033	16.1	3.50	2.75	Poor
2423	27.5	39.9	2.5	165	1.3	81.7	1084	15.9	1059	14.9	5.00	2.75	Poor
2424	26.2	41.1	2.8	153	1.3	78.8	1186	14.6	1286	15.2	5.00	2.50	Poor
2425	26.8	39.8	2.5	159	1.2	83.1	816	12.5	915	11.7	4.50	1.50	Poor
2426	28.8	40.7	2.2	160	1.1	81.1	959	15.9	983	15.4	5.00	2.75	Poor
2427	27.9	40.1	2.7	156	1.3	82.0	840	14.0	1035	13.8	3.50	1.75	Poor
2428	27.1	40.9	2.7	136	0.9	79.7	1616	24.1	1007	15.5	4.00	3.00	V. Poor
2429	27.1	40.7	3.0	143	1.2	79.7	1622	18.6	1654	17.7	4.00	3.50	Poor
2430	25.7	40.6	2.6	147	1.1	81.0	1053	14.2	979	12.9	4.00	2.50	Poor
2431	27.5	40.4	2.6	145	1.1	82.3	1384	17.8	1437	16.6	4.50	3.00	Poor
2432	27.9	40.1	2.5	144	1.0	78.7	1435	19.2	1612	20.5	5.00	2.75	Poor

*Subjective rating based primarily on diameter and rollability. Good: rollability score >3.0 on day 16, ≥ 160 mm diameter. Fair: rollability score >3.0 on day 16, 150-160 mm diameter. Poor: rollability score <3.0 on day 16, any diameter.

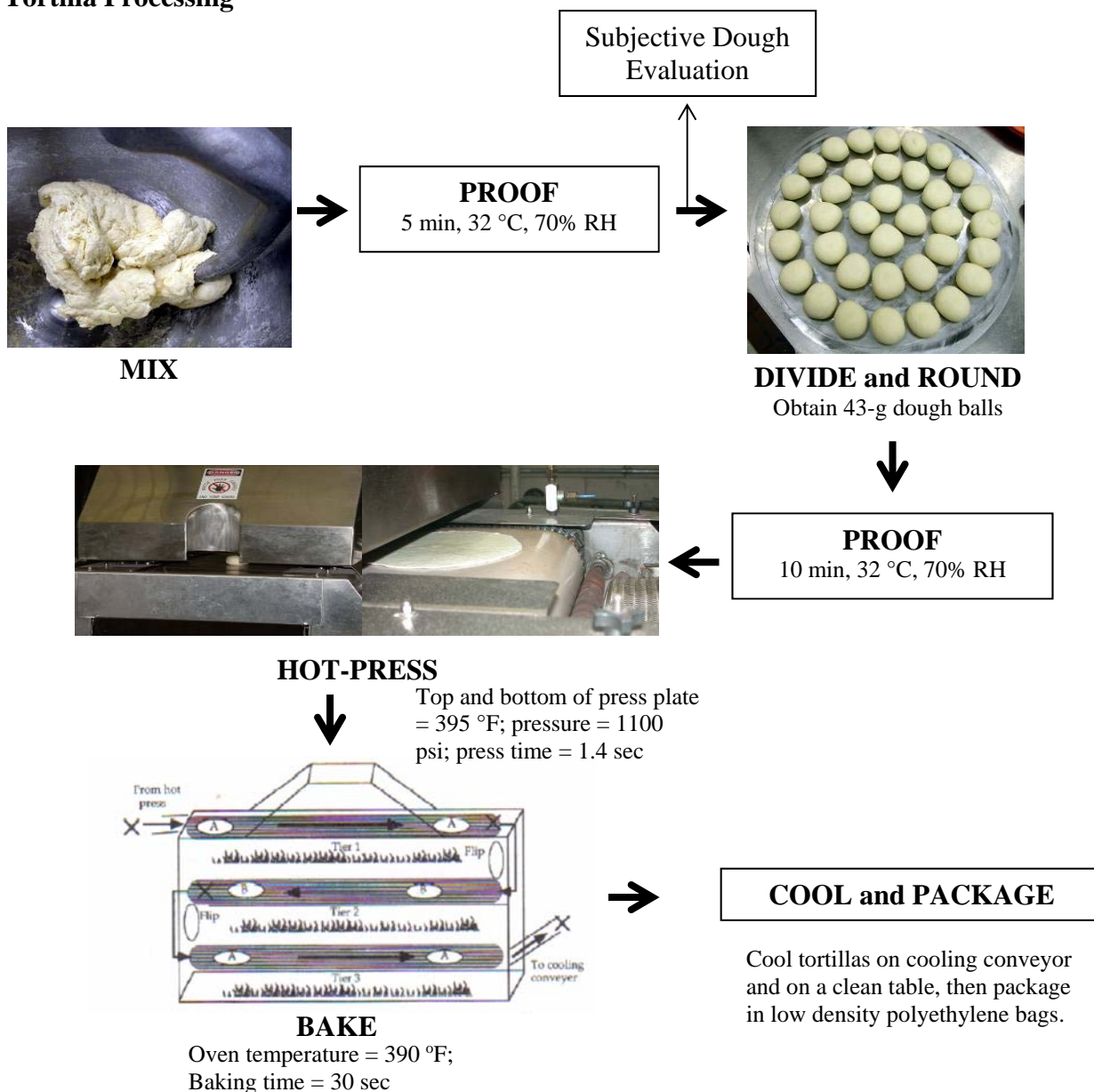
**Descriptors or scales for other parameters listed on subsequent pages.

PRODUCTION AND EVALUATION OF WHEAT FLOUR TORTILLAS

Tortilla Formulation

Ingredients	Amount
Wheat flour	100%
Salt	1.5%
Sodium Propionate	0.8%
Potassium Sorbate	0.4%
All-purpose Shortening	6.0%
Sodium Bicarbonate	0.6%
Fumaric Acid - encapsulated	0.5%
Sodium Aluminum Phosphate	0.82%

Tortilla Processing



Subjective Dough Evaluation

The dough properties were evaluated subjectively for smoothness, softness, toughness, and press rating after the first proofing. These parameters were evaluated primarily to determine the machinability of the dough.

Smoothness refers to the appearance and texture of the dough surface; suggests how cohesive the dough is.

Softness refers to the firmness of the dough when compressed.

Force to extend refers to the elasticity of the dough when pulled apart.

Extensibility refers to the length the dough extends when pulled apart.

Press rating refers to the force required to press the dough on the stainless steel round plate before dividing and rounding.

Scale	Smoothness	Softness	Force to Extend	Extensibility	Press Rating
1	very smooth	very soft	less force	breaks immed.	less force
2	smooth	soft	slight force	some extension	slight force
3	slightly smooth	slightly hard	some force	extension	some force
4	rough	hard	more force	more extension	more force
5	very rough	very hard	extreme force	extends readily	extreme force

BOLD values = desired dough properties.

Evaluation of Tortilla Properties

Tortillas were evaluated one day after processing for weight, diameter, thickness, moisture, and color. Texture tests (rollability and puncture) were performed 8 and 16 days after processing.

1. Weight

Average of 10 tortillas weighed on an analytical balance.

2. Diameter

Average diameter of 10 tortillas, which was measured by using a ruler at two points across the tortilla. This varied widely among wheat samples depending on flour quality; desired values are > 160 mm.

3. Thickness

Average height of 10 tortillas, which were measured using a digital calipers.

4. Moisture

Moisture was determined using a two-stage procedure (AACC, Method 44-15A, 2000).

5. Color Values

The color values of lightness (L^*), $+a^*$ (redness and greenness) and $+b^*$ (yellowness and blueness) of tortillas were determined using a handheld colorimeter (model CR-300, Minolta Camera Co., Ltd., Chuo-Ku, Osaka, Japan). L^* -values correlate with opacity and are usually greater than 80.

6. Specific Volume

$$\text{Specific volume } \left[\frac{\text{cm}^3}{\text{g}} \right] = \frac{\pi * \left(\frac{\text{Diameter}}{2} \right)^2 * \text{Height}}{1000 * \text{Weight}}$$

This corresponds to fluffiness of the tortilla; desired value is $> 1.0 \text{ cm}^3/\text{g}$.

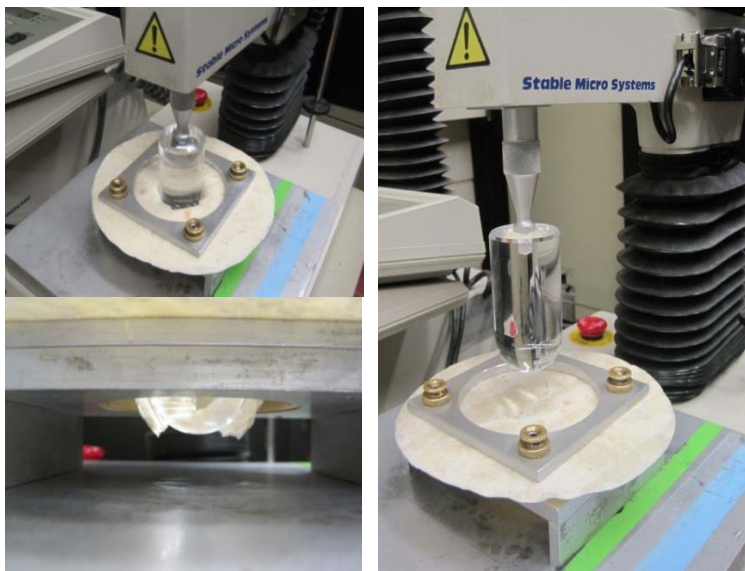
7. Tortilla Rollability Score

Two tortillas were evaluated on days 8 and 16 of storage by wrapping a tortilla around a dowel (1.0 cm diameter). The cracking and breakage of the tortilla was rated using a continuous scale of 1-5 (5 = no cracking, 4 = signs of cracking, but no breaking, 3 = cracking and breaking beginning on the surface, 2 = cracking and breaking imminent on both sides, 1 = unrollable, breaks easily). This measured shelf stability, and the desired value was >3 on the 16th day.



8. Objective rheological test

Extensibility of two tortillas was measured on days 8 and 16 of storage using a texture analyzer (model TA XT2, Texture Technologies Corp., Scarsdale, NY/Stable Micro Systems, Godalming, Surrey, UK). The tortilla was mounted on the circular frame and a rounded nose probe (The TA-33: 1.5 inch diameter, 3 inch tall rounded end acrylic probe) pushed into the tortilla during the test. Force and distance required to rupture were measured.



2017 WQC HARD WINTER WHEAT FLOUR PROTEIN ANALYSIS

Michael Tilley, Ph.D.

USDA, CGAHR, Manhattan, KS

Procedures

1. Determination of polymeric to monomeric protein ratio

- Protein extraction (Gupta et al, 1993): 20 mg flour + 1 ml 50 mM sodium phosphate buffer, pH 6.9, containing 0.5% SDS, sonicated for 15 sec. Collect the supernatant (contains total protein).
- Filter the supernatant in a 0.45 µm filter and analyze by size-exclusion HPLC (SE-HPLC).
- SE-HPLC using a 300.0 x 7.8 mm BioSep S4000 column at 50°C, with a constant gradient of 50 mM sodium phosphate buffer, pH 7.0, containing 1% SDS, flow rate of 1.0 ml/min for 20 min.
- The chromatograms were manually integrated and the ratio was determined using the areas of the specific peaks.

2. Determination of the Percentage of Insoluble Polymeric Protein (%IPP)

- Protein extraction (Bean et al, 1998): 10 mg flour + 1 ml 50% 1-propanol- vortex for 5 min, centrifuge for 5 min at 12,000 x g. Discard supernatant. Repeat two times.
- Lyophilize the pellet, which contains the insoluble polymeric proteins.
- Determine pellet protein content by Nitrogen combustion (LECO analysis).
- Insoluble polymeric protein percentage (%IPP) is calculated by multiplying nitrogen values by a conversion factor of 5.7 and dividing by total flour protein.

3. Determination of High Molecular Weight Glutenin Subunit (HMW-GS) composition

Sequential protein extraction:

- 10 mg flour + 1 ml 50 mM Tris-HCl buffer, pH 7.8, containing 100 mM KCl and 5 mM EDTA- vortex for 5 min, centrifuge for 5 min at 12,000 x g. Discard the supernatant.
- Repeat the procedure one more time to ensure complete removal of those proteins.
- Repeat the procedure two more times using water, to remove salt from the pellet. Discard the supernatants.
- Add 1 ml 50% 1-propanol to the pellet and vortex for 5 min, centrifuge for 5 min at 12,000 x g. Discard the supernatant.
- Repeat the extraction with 50% 1-propanol one more time. Discard the supernatant.
- Add 1 ml 50% 1-propanol containing 2% tris(2-carboxyethyl)phosphine (TCEP reducing agent) to the pellet and vortex for 30 min, centrifuge for 5 min at 12,000 x g. Collect the supernatant (contains HMW-GS and LMW-GS).
- Analyze protein in the supernatant using the Agilent 2100 Bioanalyzer (lab-on-a-chip).

References

Bean, S.R.; Lyne, R.K.; Tilley, K.A.; Chung, O.K.; Lookhart, G.L. 1998. A rapid method for quantitation of insoluble polymeric proteins in flour. *Cereal Chemistry* 75:374-379.

Gupta, R.B.; Khan, K.; MacRitchie, F. 1993. Biochemical basis of flour properties in bread wheats. I. Effects of variation in the quantity and size distribution of polymeric protein. *Journal of Cereal Science* 18:23-41.

Results of Flour Protein Analysis

	HMW GLUTENIN SUBUNITS			
SAMPLE	GLU-A1	GLU- D1	GLU- B1	TMP/TPP
17-2401	2*	5+10	7+9	0.82
17-2402	2*	5+10	17+18	0.76
17-2403	2*	5+10	17+18/7+9	0.77
17-2404	2*,1	5+10	17+18	0.88
17-2405	2*,1	5+10	17+18	0.82
17-2406	2*	2+12	7+9	0.79
17-2407	2*	5+10	7+8	0.83
17-2408	2*,1	5+10	7+9	0.59
17-2409	2*	5+10	7+8	1.00
17-2410	1	5+10	7+8	0.79
17-2411	2*,1	5+10	17+18	0.97
17-2412	2*	5+10	7+8	0.89
17-2413	1	5+10	7 ^{oe} +8	0.87
17-2414	2*,1	5+10	17+18	1.04
17-2415	2*	5+10	7 ^{oe} +8	0.97
17-2416	2*	5+10	7+9	0.96
17-2417	2*	5+10	7+9	0.93
17-2418	1	5+10	7+8	0.84
17-2419	2*	5+10	7+8	0.85
17-2420	2*,1	5+10	17+18	0.95
17-2421	1	5+10	7+8	0.83
17-2422	2*	2+12	7+9	0.85
17-2423	2*	5+10	17+18/7+9	0.94
17-2424	2*,1	5+10	17+18	1.09
17-2425	2*,1	5+10	17+18	1.00
17-2426	neg	5+10	7+8	0.85
17-2427	2*	5+10	7+8	0.79
17-2428	2*	2+12	7+8	1.15
17-2429	2*	5+10	7+8	1.17
17-2430	2*	5+10	17+18	1.07
17-2431	2*	5+10	7+9	0.98
17-2432	2*,1	5+10	17+18	0.99

APPENDIX A

Credits and Methods

CREDITS

Milling, Sample Analysis, Ingredients and Report Preparation

Single Kernel Analysis, Kernel Size Distribution, and Test Weight	USDA/ARS/HWWQL Manhattan, KS
Flour Milling (Miag Multomat)	KSU Dept. Grain Science & Ind. Manhattan, KS
Wheat Grading	GIPSA Kansas City, MO
Moisture, Ash, Protein, and Minolta Flour Color	USDA/ARS/HWWQL Manhattan, KS
Mixograph, Farinograph Tests, Extensigraph, and Alveograph Tests	USDA/ARS/HWWQL Manhattan, KS
Rapid Visco-Analyzer, and Sedimentation Tests	USDA/ARS/HWWQL Manhattan, KS
Marketing Scores Sedimentation Tests	USDA/ARS/HWWQL Manhattan, KS
Flour Protein Analysis	USDA/ARS/GQSRU Manhattan, KS
Falling Number Test and Starch Damage	USDA/ARS/HWWQL Manhattan, KS
Doh-Tone 2 as Fungi α -amylase	Corbion 3947 Broadway Kansas City, MO 64111
Tortilla Evaluation	TAMU, Cereal Quality Lab College Station, TX
Alkaline Noodle Evaluation	USDA/ARS/HWWQL Manhattan, KS
Data Compilation and Final Report	USDA/ARS/HWWQL Manhattan, KS

CREDITS

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Baking Collaborators

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METHODS

Test Weight – AACC Approved Method 55-10. Test weight is the weight per Winchester bushel expressed to the nearest tenth of a pound. This method determines the weight of dockage-free grain.

Weight per Hectoliter - Weight per Winchester Bu x 1.292 + 1.419 (all wheats except Durum) expressed to the nearest tenth of a kilogram. Example: 60.5 lb/bu x 1.292 + 1.419 = 79.6 kg/hl.

1000 Kernel Weight - The weight in grams of 300 kernels of wheat, determined by SKCS, and converted to 1000.

Wheat Kernel Size Test - 200g of wheat are placed on the top sieve of a stack of 3 (8inch diameter) Tyler No. 7, 9 & 12 sieves (2.79, 1.98, & 1.40 mm openings; US Equiv. No. 7, 10 & 12) and sifted for 60 seconds on a Ro-Tap sifter. The percentage remaining on each sieve is reported.

Wheat and Flour Moisture - AACC Approved Method 44-15A. Wheat (ground in Falling Number 3303 burr-type mill to prevent drying before grinding) or flour is dried in a forced air oven at 130⁰ C for one hour.

Wheat and Flour Protein - AACC Approved Method 46-30 wheat meal and flour. Combustion nitrogen method.

Ash - AACC Approved Method 08-01. Sample remaining after ignition is expressed as percent.

Experimental Milling Test - Brabender Quadrumat Sr. is used to mill wheat samples with 15% of tempering moisture for more than 16 hours and feed rate is 150 g/min.

Miag Multomat (Small Scale) Milling - Each coded variety is cleaned with a Carter dockage tester, placed in drums, and sampled for physical wheat tests and analysis. Each variety is then tempered using a double cone blender with enough added water to bring the wheat moisture to 16%. The tempered wheat is held in drums for approximately 20 hours before milling. Milling is performed on the Miag Multomat, which consists of 3 breaks, 5 reductions, and a bran duster. Feed rate is set at 850 to 900 grams per minute. The mill is warmed up and adjusted using KSU mill mix, after which 2-3 bushels of each coded experimental sample are milled.

Break rollers are adjusted to the following releases through a U.S. 20 S.S. sieve:

First Break	50%
Second Break	50%
Third Break	clean-up

Flour yields are calculated from scale weights and expressed as percentage of total products recovered from the mill.

Flour Color – Evaluated using Minolta Chroma Meter. The flour color results are reported in terms of 3-dimensional color values based on L*, a*, and b*.

Wet Gluten - AACC Approved Method (38-12). 10 g. of flour and 5.2 ml. of 2% salt solution are mixed in a Glutomatic test chamber for 20 seconds and then washed for 5 minutes to separate the gluten and the soluble starch products. The gluten ball is divided and placed in a centrifuge for one minute to remove excess water. Percent Wet Gluten is calculated as weight of the centrifuged gluten x 10.

Dry Gluten - Gluten from the wet gluten test is dried between two heated, Teflon coated plates for approximately 4 minutes. Percent Dry Gluten is calculated as weight of the dry gluten x 10.

Falling Number - AACC Approved Method 56-18A. Determination is made by the method of Hagberg (Cereal Chemistry 38:202, 1961) using 7g of flour.

Wheat Hardness - AACC Approved Methods 39-70A (NIR hardness) and 55-31 (using Perten 4100 Single Kernel Characterization System).

Damaged Starch - AACC Approved Method 76-33 using SDmatic. Results are given in an iodine absorption index percentage (AI%) and AACC 76-31 results converted from the testing.

Flour Treatment - Fungal alpha-amylase is added to the flour by each baking cooperator.

Mixograph and Farinograph - AACC Approved Methods (54-40A and 54-21) respectively. These instruments measure and record the resistance to mixing of a flour-and-water dough. The recorded curve rises to a “peak” as the gluten is developed and then falls as the gluten is broken down by continued mixing. Curves made by the two instruments are not directly comparable.

The time required for a Mixograph or Farinograph curve to reach the “peak” is an estimate of the amount of mixing required to properly develop the dough for handling and baking. The rate at which a curve falls and narrows after the peak and stability of peak height on either side of the peak are indicators of mixing tolerance. Terms used to describe the Farinograph curve or “farinogram” include:

Absorption - Reported on a 14% moisture basis. Percentage of water required to center the curve on the 500 Farinograph Unit (FU) line at maximum dough consistency (peak). This may not be optimum absorption in a bakery, because baking ingredients influence absorption and flours vary in “slacking-out” during fermentation.

Peak Time - Also called Mixing Time or Dough Development Time. Time (minutes) required for the curve to reach its full development or maximum consistency. High peak values are usually associated with strong wheats that have long mixing requirements.

Stability - Also called Tolerance. This is the time (minutes) that the top of the curve remains above the 500 FU line. Greater stability indicates that the flour can stand more mixing abuse and longer fermentation.

Rapid Visco-Analyzer Test – AACC Approved Methods (61-02).

Sedimentation Test - AACC Approved Methods (56-60).

Alveograph – AACC Approved Methods (54-30A). The instrument measures resistance of dough extension, extensibility, and dough strength. A sheet of dough of definite thickness prepared is expanded by air pressure into a bubble until it is ruptured. The internal pressure in bubble is recorded on automated integrator. P = Tenacity (resistance to extension), L = extensibility, W = baking strength (curve area), P/L = curve configuration ratio, G = swelling index (the square root of the volume of air needed to rupture the bubble), $I_e = P_{200}/P$, elasticity index (P200: pressure 4 cm from the start of the curve, I_e will be 0 if the extensibility is shorter than 4 cm).

Extensigraph – AACC Approved Method (54-10). The Extensograph® -E stretches the dough prepared by a modified method published in AACC International’s Cereal Chemistry (86(5):582-589). The instrument measures resistance of dough extension (R), extensibility (E), maximum resistance (Rmax), and energy (W).

Cumulative Ash and Protein Curves

Ideally, the miller would like to separate wheat bran from endosperm, and reduce endosperm particle size, without producing any bran powder at any stage of the milling process. Unfortunately, current milling technology does not allow this “ideal” situation to occur, and once bran powder is produced it goes into the flour and can never be removed. Ash determination has traditionally been used as an analytical tool in managing the extraction rate of wheat during the milling process. Ash determination consists of burning a known mass of the material to be analyzed and then measuring the residue. Since burning destroys everything but the mineral components, the mass of the residue provides an indication of the contribution that minerals made to the original material. The application of this method to determining bran content of flour has been justified by the fact that endosperm has a lower mineral content than bran. Ash content is lowest in the

center of the kernel and increases toward the outer parts because the bran layer contains several times more minerals than pure endosperm.

Many millers have flour refinement specifications (ash content or flour color) that must be met. Therefore, the overall milling value of a wheat sample is determined not only by flour yield, but also flour refinement. A commonly used index of wheat milling value is the cumulative ash curve (Lillard and Hertsgaard 1983). Cumulative ash curves are determined by arranging millstreams in ascending order of ash content, and tabulating the ash content of the total flour produced with the addition of successive millstreams. Wheat that gives low ash content at low extraction, and a slow rate of ash content increase with increasing extraction rate, has a high milling value because of the potential to produce a high percentage of patent flour, which usually sells for a premium in many markets. It should be noted that several authors have indicated that ash curves can be influenced by hardness, variety, whole grain ash, and milling system (Seibel 1974; Posner and Deyoe 1986; Li and Posner 1987, 1989). Natural endosperm ash is typically regarded to be 0.30%; anything above that is generally considered to be due to the milling process.

Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein content increase with increasing extraction rate, has a high milling value because high protein flour typically sells for a premium in many markets.

LI, Y. Z., and POSNER, E. S. 1987. The influence of kernel size on wheatmillability. Bull. Assoc. Operative Millers November: 5089-5098.

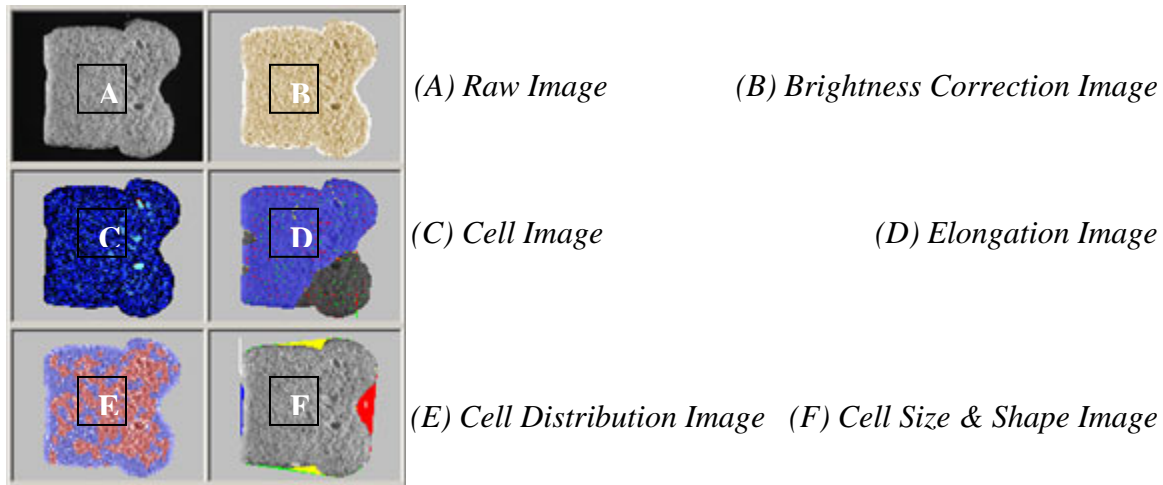
LI, Y. Z., and POSNER, E. S. 1989. An experimental milling techniquefor various flour extraction levels. Cereal Chem. 66:324-328.

LILLARD, D.W. and HERTSGAARD, D.M. 1983. Computer analysis and plotting of milling data: HRS wheat cumulative ash curves. Cereal Chem. 60:42-46.

C-Cell Image Analysis

Pup loaves were baked in duplicate and evaluated with the C-Cell system and its image analysis software (Campden & Chorleywood Food Research Association (CCFRA) and Calibre Control International[®]) at the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL) in Manhattan, KS. Two slices from each loaf were scanned: with the break facing the observer, slice 4 and 5 from the right end of the loaf were selected and evaluated with the break side of the slice oriented on the left. Images of the internal grain and crumb structure of each slice represent only the fourth slice of replicate 1, and are shown in the report. Selected numerical data from the image analysis of slice 4 represent the average of slice 4 from replicates 1 and 2, and are shown in the report. General capabilities of the instrument and image analysis are shown below:

Images:



Data:

Forty-eight (48) individual measurements are presented in the data display screens and are saved to the database.

Cell Size: Numbers and dimensions of cells and holes are measured. Wall thickness & coarse/fine clustering.

Cell Elongation and Orientation: Cell alignment and elongation, circulation and curvature

Dimensions: Sample area, height, breadth, ratios and wrapper length.

Brightness: Sample brightness and cell contrast.

Shape: Various physical features including, break, concavity and roundness.

Slice Area: The total area of a product slice (mm²).

Slice Brightness: The mean grey level (0-255) of pixels within the slice. The value is lower for products with a darker crumb and for products with larger or deeper cells that contribute to greater shadows. The measurement provides a useful indication of product reflectance.

Number of Cells: The number of discrete cells detected within the slice. Higher values may be due to a finer structure or a larger total slice area. The cells are shown in the Cell image. When interpreting this image, cells only touching diagonally are considered to be discrete.

Wall Thickness: The average thickness of cell walls (mm). for bright slices, saturation of some regions may be interpreted as thick walls. Walls close to the edge of the slice are given a reduced weighting in the calculation.

Cell Diameter: The average diameter of cells (mm), based on measurements of the average cell area. This is a good general purpose indicator of the coarseness of the texture, but does not take the depth of cells into account.

Non-Uniformity: A measure of the lack of uniformity between fine and coarse texture (including holes) across the slice. High values indicate less uniformity of texture. The value is useful for comparing slices of similar types of product, but comparisons between products of differing type tend to be less easily interpreted.

Average Cell Elongation: The average length to breadth ratio of cells, independent of their relative orientation. Lower weighting is given to cells close to the edge of the slice. Values close to 1 indicate rounded cells. Higher values indicate greater elongation.

Cell Angle to Vertical ($^{\circ}$): The angle (degrees) of the direction of Net Cell Elongation, measured clockwise from the slice vertical. Lower weighting is given to cells close to the edge of the slice. Values are given in the range of -90 to +90 degrees. Values close to 0 represent a vertical orientation. Values close to + or - 90 represent a horizontal orientation.

Collaborators' Baking Test Profiles and Other Information

2017 WQC COLLABORATORS' BAKING TEST PROFILES AND OTHER INFORMATION

Coop	No.	Test Methods	Est. Flour and Dough Wt (g)	Mixing Tolerance	Fermentation time (min)	Oven Temp	Baking Time
A	1	Sponge and dough	600 g flour, 480 g dough	Other	240 min (sponge time) and 45 min (fermentation)	420	20
B	2	No time dough	700 g flour, 524 g dough	Farinograph	10 min floor time, proof to height, no sponge time	420	20
C	3	Sponge and dough	600 g flour, 160 g dough	Mixing series	240 min	425	16
D	4	Sponge and dough	700 g flour, 19 oz	Farinograph	180 min (sponge) and 70 min (fermentation)	420	20
E	5	Pup-loaf straight dough	100 g, approx 170 g	Mixograph	90 min	400	25
F	6	Straight dough	700 g flour, 525 g dough	Mixing series	120 min	400	25
G	7	Sponge and dough	540 g dough	Mixing series	210 min	430	23
H	8	Pup-loaf straight dough	100 g	Mixograph	90 min	400	25
I	9	Sponge and dough	1000 g flour, 500 g dough	Farinograph	240 min	425	20
J	10	Pup-loaf straight dough	100 g flour, approx 160 g dough	Farinograph	120 min	425	20
K	11	Straight dough	100 g flour, approx. 175 g dough	Farinograph and Mixograph	180 fermentation and 60 min proof time	400	25
L	12	Pop loaf straight	100 g	Mixograph	90 min	400	25
M	13	Pup-loaf straight dough	100 g flour	Farinograph	120 min	390	25
N	14	Pup-loaf straight dough	100 g flour, approx 175 g dough	Mixograph	90 min	425	21
O	15	Pup-loaf straight dough	200g, 170 g dough	Mixograph	180 min	419	24
P	16	Pup-loaf straight dough	100 g flour, approx 170 g dough	Mixograph	120 min	420	18
Q	17	Sponge and dough	700 g flour, 524 g dough	Farinograph with mixing evalu	240 min (sponge time) and 60 min (fermentation)	420	20

APPENDIX B
HWWQC Technical Board and Goals
for HWW Breeders

Hard Winter Wheat Quality Council

2017 Technical Board Officers

CHAIR: **Sid Perry**, Monsanto/WestBred

VICE CHAIR: **Scott Baker**, Ardent Mills

SECRETARY: **Charlie Moon**, Flowers Food

MEMBER: **Mike Wolt**, Bimbo Bakeries USA

MEMBER: **Stephen Baenziger**, University of Nebraska

2017 Quality Evaluation & Advisory Committee

Brad Seabourn, USDA/ARS/HWWQL

Terry Selleck, Bay State Milling

Jon Rich, Syngenta/AgriPro

Craig Warner, BIMBO Bakeries USA

Richard Chen, USDA/ARS/HWWQL

Hard Winter Wheat Quality Council (HWWQC)

Charter

Revised and Approved (February 20, 2003)

Mission, Policy, and Operating Procedure

The mission of the HWWQC is to provide a forum for leadership and communication in promoting continuous quality improvement among the various elements of the community of hard winter wheat interests. The HWWQC will provide an organization structure to evaluate the quality of hard winter wheat experimental lines and cultivars that may be grown in the traditional growing regions of the United States. The HWWQC also will establish other activities as requested by the membership. The HWWQC operates under the direction and supervision of the Wheat Quality Council (WQC).

Objectives

- Encourage wide participation by all members of the hard winter wheat industry.
- Determine, through professional consulting expertise, the parameters and ranges that adequately describe the performance characteristics that members seek in new and existing cultivars.
- Promote the enhancement of hard winter wheat quality in new cultivars.
- Emphasize the importance of communication across all sectors and provide resources for education on the continuous quality improvement and utilization of hard winter wheat.
- Encourage the organizations vital to hard winter wheat quality enhancement to continue to make positive contributions through research and communications.
- Offer advice and support for the U.S.D.A. - A.R.S. Hard Winter Wheat Quality Laboratory in Manhattan, KS.

Membership

- The membership of the HWWQC will consist of members of the WQC.

HWWQC Technical Board

- The Technical Board shall be the administrative unit responsible for managing the functions of the HWWQC.
- The Technical Board shall consist of five members, elected from the membership, to serve three-year terms.
- Officers of the technical board shall consist of a chair, vice-chair, and secretary.
- Each officer serves three years in his or her office.
- Terms start the day after the annual meeting of the HWWQC.
- The vice-chair generally replaces the chair at the conclusion of the chair's term and the secretary generally replaces the vice-chair at the conclusion of the vice-chair's term.
- Officers (normally only the secretary) shall be elected annually at the annual meeting of the HWWQC by nomination and majority vote.
- Any eligible member may be reelected after being out of office for one year.
- Vacancies that occur during the term of office of the members of the technical board shall be filled by nomination and majority vote of the remaining members of the technical board and the WQC Executive Vice President. The appointee will serve the remaining term of the vacancy (up to three years).
- Exceptions to the above may be granted if voted on by the Technical Board or by majority vote of the HWWQC at the annual meeting.

Duties of the Technical Board

- The chair shall be responsible to establish a meeting place and preside at all meetings of the technical board and Wheat Quality Council (selected elements of the General Meeting).
- The vice-chair shall preside at meetings in absence of the chair and assume such duties as may be assigned by the chair of the technical board.
- The secretary shall be responsible for taking minutes of the technical board meetings.
- The Technical Board will direct the Executive Vice President of the WQC on disbursement of allocated funds.
- The chair shall be responsible for communicating budget needs to the Executive Vice President.
- The Technical Board is responsible for presenting budget updates to the general membership at the annual meeting.

Compensation

- Technical Board members shall serve without compensation.

Expenses

- The WQC Executive Vice President for some technical board functions may authorize certain paid expenses.

Hard Winter Wheat Quality Evaluation and Advisory Committee

Committee Purpose

A technical committee entitled “Hard Winter Wheat Quality Evaluation and Advisory Committee” shall be established and consist of the five technical board members and key WQC members working on hard winter wheat. Those members should include, but are not limited to:

- The director of the USDA Hard Winter Wheat Quality Laboratory, Manhattan, KS.
- At least one hard winter wheat breeder from the Great Plains area.
- At least one cooperator from hard winter wheat milling or baking laboratories.
- The senior scientist/editor responsible for the hard winter wheat quality annual report.

Evaluation and Responsibilities

- Establish procedures and requirements for the annual grow out (if applicable), handling, evaluation and reporting of the experimental test line quality evaluation program.
- Annual approval of the samples submitted by hard winter wheat breeders.
- The collection milling and reporting of the experimental and check samples.
- Distribution of samples to cooperators (member companies willing to conduct testing and baking evaluations on the samples prepared)
- Preparation of an annual quality report.

Sample/Locations

- Each breeder entity shall have the privilege of submitting two experimental test lines and one check cultivar each year for evaluation. If slots are available by some breeders not submitting the full allotment, other breeders may submit more than two up to a maximum of 30 samples annually.

Annual Meeting

- The annual meeting of the HWWQC shall coincide with the annual meeting of the WQC. If for some reason the WQC annual meeting is not held, it shall be the duty of the technical board chair to establish an annual meeting time and place.
- The purpose of the meeting shall be to discuss the results of the cooperators quality testing program, elect board members and carry on other business as required by the HWWQC.
- The Technical Board may establish other meetings determined to be necessary.

Finances and Budget

- The executive board of the WQC shall designate the finances required to meet the operating expenses of the HWWQC.
- The budget shall be presented for membership approval at the annual meeting.

Amendments

- Amendments to the policy and operation procedure of the HWWQC can be made by majority vote of the HWWQC members.
- The proposed changes must be submitted in writing and must be in the hands of the membership two weeks prior to voting on the change.

Outlined Goals for Hard Winter Wheat Breeders

**Developed by the
Grain Trade, Operative Millers, and Mill Chemists Subcommittees
of the
Wheat Quality Council Hard Winter Wheat Technical Committee**

1. Adaptability. Varieties should be adaptable and retain their quality integrity over a large geographic area.
2. Varieties should be resistant to diseases, to insect infestation (including stored grain insects), and to sprouting.
3. Emphasize quality evaluation in earlier generations. Obtain milling and baking data before F7. Grain and Texture should be considered along with loaf volume, absorption, mixing, and dough properties when evaluating baking quality.
4. Kernel Characteristics:
 - A. Visual Appearance typical of class.
 - B. Hardness significantly greater than soft wheat, but not so hard that milling or flour properties are negatively influenced.
 - C. Uniformly large, plump, vitreous.

	<u>Objective</u>	<u>Minimum Acceptable</u>
Bushel Weight (lb.)	60+	58
Thousand Kernel Wt. (g)	30+	24
Over 7 Wire (%)	60+	50

5. Milling Performance. Should mill easily to produce a high extraction (yield) of quality flour. Reduction, sifting, and stock-handling consistent with class history.

Performance on KSU Pilot Mill

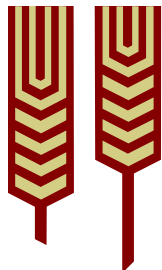
	<u>Objective</u>	<u>Acceptable</u>
Straight Grade Extraction		
% at .48% ash	76	74 (minimum)
Str.-Gr. Agron Color	50	40 (minimum)
Str.-Gr. Flour Ash (%)	0.46	0.50 (maximum)

6. Gluten Strength-Mixing Time. About 60% strong and 40% mellow should be acceptable in the seeded acreage. A reasonably broad range of gluten strength

is needed to meet current demands of various flour users. One variety or gluten type is undesirable.

7. Improved Mixing Tolerance with 'extensible gluten', not bucky or tough.

<p>APPENDIX C</p> <p>Hard Red Winter Wheat Quality Targets</p>



RECOMMENDED* QUALITY TARGETS FOR HARD RED WINTER WHEAT

HWW Quality Targets Committee
Approved February, 2006



* "The purpose of Recommended Quality Targets (RQT) for Hard Red Winter Wheat (HRW) is to provide specific quality 'goals' for the breeding community, wheat producers, and marketing programs in order to assist and guide the decisions needed to maintain the consistency and end-use quality of the U.S. HRW market class. The RQT will be dynamic over time in direct response to the primary needs of the marketplace (domestic and foreign), and the needs of the U.S. industry to breed, produce and market wheats to meet market needs. The RQT should NOT be used as essential criteria for variety release decisions in breeding programs, or as marketing/grading standards for private companies or federal/state agencies. This **Statement of Purpose** must accompany all published forms of the RQT."
HWWQT Committee, 2006

Quality Parameter (End-Use: Pan Bread)	Recommended Target Value
<u>Wheat</u>	
Test Weight (lb/bu)	> 60
SKCS-Hardness Index (SK-HI)	60 – 80
SK-HI Standard Deviation	< 17.0
SKCS-Weight (SK-WT, mg)	> 30.0
SK-WT Standard Deviation	< 8.0
SKCS-Diameter (SK-SZ, mm)	> 2.40
SK-SZ Standard Deviation	< 0.40
Protein Content (%; 12% mb)	> 12.0
Ash Content (%; 12% mb)	< 1.60
Falling Number (sec)	> 300
Straight Grade Flour Yield (%)	> 68
<u>Flour</u>	
Flour Color L-Value (Minolta Colorimeter)	> 90
Gluten Index	> 95
Sedimentation Volume (cc)	> 40
<u>Farinograph:</u>	
Water Absorption (%; 14% mb)	62+
Peak Time (min)	4.00 – 8.00
Stability (min)	10.00-16.00
<u>Mixograph:</u>	
Water Absorption (%; 14% mb)	62+
Peak Time (min)	3.00 – 6.00
Mixing Tolerance (HWWQL Score, 0-6)	3.0
<u>Straight Dough Pup Method:</u>	
Water Absorption (%; 14% mb)	62+
Mix Time (min)	3.00 – 5.00
Loaf Volume (cc)	> 850
Crumb Score (HWWQL Score, 0-6)	> 3.0

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Hard Winter Wheat Quality Laboratory
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APPENDIX D

Hard White Wheat Quality Targets
Adopted from PNW for Great Plains

Hard White Wheat Quality Targets
Dual Purpose -- Chinese Noodles and Western Pan Bread
Updated on March 1, 2002 at Hard White Wheat Quality Targets Meeting
Wheat Marketing Center, Portland, Oregon

	Chinese Hard-Bite Noodles (1)	Pan Bread
Wheat Quality Parameter		
Test Weight (lb/bu)	60 Minimum	60 Minimum
Kernel Hardness (SKCS 4100)	65 - 90	65 Minimum
Kernel Diameter (mm) (SKCS 4100)	2.5 Minimum	2.5 Minimum
Falling Number (seconds)	300 Minimum	300 Minimum
Protein (%; 12% mb)	11-15.0	11.5-14.0
Ash (%; 14% mb)	1.4 Maximum	1.6 Maximum
PPO Level by L-DOPA (WWQL Method)	0	N/A
Flour Quality Parameter		
Protein (%; 14% mb)	10-13.5	10.2-13
Ash (14% mb)	0.38-0.45	N/A
Patent Flour Yield at 0.4% Ash (%)	60 (by Buhler)	N/A
Straight-Grade Flour Yield at 0.45% Ash (%)	70 (by Buhler)	N/A
L* (Minolta Colorimeter CR 310)	91 Minimum	N/A
Wet Gluten (%; 14% mb)	30 Minimum (2)	28
Farinograph Absorption (%; 14% mb)	60 Minimum (2)	60
Farinograph Stability (minutes)	12 Minimum (2)	12
Amylograph Peak Viscosity (Bu) (3)	500-850	500 minimum
Mixograph Peak Time (minutes)	N/A	3-7 @ 5.5 mm peak ht.
Mixograph Absorption (%)	N/A	60
Chinese Raw Noodle Quality Parameter (Refer to WMC Protocol) (4)		
Chinese Raw Noodle Dough Sheet L*24 h	72 Minimum	N/A
Chinese Raw Noodle Dough Sheet L*0-L*24	10 Maximum	N/A
Chinese Raw Noodle Dough Sheet b* 24 h	25 Maximum	N/A
Cooked Noodle Hardness (g)	1250 Minimum (2)	N/A
Pan Bread Quality Parameter		
Pup Loaf Volume (cc)	N/A	900 @11% flour protein

Notes:

- (1) Chinese raw, Chinese wet, Chinese instant fried, Philippine instant fried, Malaysia hokkien and Thai bamee noodles.
- (2) Straight-grade flour of 12% protein wheat.
- (3) Method: 65 g untreated flour + 450 ml deionized water.
- (4) Noodle formula: straight-grade flour, 100%; water, 28%; and sodium chloride, 1.2%.
Noodle sizes: 2.5 mm (width) x 1.2 mm (thickness).
Noodle textural measurement: cook 100 g noodles in 1000 ml deionized water for 5 min, rinse in 27°C water and drain. Measure noodle texture on five noodle strands by compressing to 70% of noodle thickness with a 5-mm flat probe attached to TA.XT2 Texture Analyzer.

**These end-use quality targets emphasize
the broadest possible utilization of hard white wheats.**

Wheat Marketing Center, Portland, Oregon

	Korean Instant Noodles	Chinese Northern-Type Steamed Bread	Hamburger/Hotdog Buns
Wheat Quality Parameter			
Test Weight (lb/bu)	60 Minimum	60 Minimum	60 Minimum
Kernel Hardness (SKCS 4100)	65 Minimum	65 Minimum	65 Minimum
Kernel Diameter (mm) (SKCS 4100)	2.5 Minimum	2.5 Minimum	2.5 Minimum
Falling Number (seconds)	300 Minimum	350-400	300 Minimum
Protein (% , 12% mb)	10-11.0	10-11.5	13-15.0
Ash (% , 14% mb)	1.4 Maximum	1.4 Maximum	1.6 Maximum
PPO Level by L-DOPA (WWQL Method)	0-0.2	0-0.2	N/A
Flour Quality Parameter			
Protein (% , 14% mb)	8.5-9.5	8.5-10.0	12.2-13.0
Ash (14% mb)	0.38-0.40	0.38-0.45	N/A
Patent Flour Yield at 0.4% Ash (%)	60 (by Buhler)	60 (by Buhler)	N/A
Straight-Grade Flour Yield at 0.45% Ash (%)	70 (by Buhler)	70 (by Buhler)	N/A
L* (Minolta Colorimeter CR 310)	91 Minimum	91 Minimum	N/A
Wet Gluten (% , 14% mb)	N/A	28-30	34.5
Farinograph Absorption (% , 14% mb)	58-60	60-62	64
Farinograph Stability (minutes)	7.5-8.5	4-6.0	15-18.0
Amylograph Peak Viscosity (Bu) (1)	800 Minimum	500 Minimum	500 Minimum
Amylograph Breakdown (Bu)	200 Minimum	N/A	N/A
Mixograph Peak Time (minutes)	N/A	N/A	4-7 @ 5.8 mm peak ht.
Mixograph Absorption (%)	N/A	N/A	64
Pan Bread Quality Parameter			
Pup Loaf Volume (cc)	N/A	N/A	980 @ 13% flour protein

Notes:

(1) Method: 65 g untreated flour + 450 ml deionized water.

APPENDIX E
WQC Business Meeting Minutes
by Scott Baker
Feb. 22, 2017

Hard Winter Wheat Quality Council Meeting Minutes Annual Meeting February 22, 2017

Ben Handcock opened this year's meeting

Review of 2016 Minutes – Vance Lamb, HWWQC Board

Minutes approved as-is

Nominations for 1 new member:

Stephen Baenziger, University of Nebraska, nominated and elected

Board for 2017:

Chair – Sid Perry, Monsanto/WestBred

Vice Chair – Scott Baker, Ardent Mills

Secretary – Charlie Moon, Flowers Foods

Member – Mike Wolt, Bimbo

Member – Stephen Baenziger, University of Nebraska

Richard Chen, WQC Report for 2016

- 27 entries, 7 programs, 16 cooperators
- Jagalene was used as a common check

Shawn Thiele, KSU Mill Operations Manager, Overview of Milling and Sampling

- Still completing repairs on Miag
 - Re-built sifter drive motor
 - New starter relay fuses for the sifter motor
 - New air locks
 - For 2017 - ~ \$22,000 for repairs including cyclone sight glasses and air handling system to eliminate filter stock flour
- Sample Milling
 - Started milling samples 10/14/16 – later than planned due to air compressor failure. WQC donated an air compressor
 - Break Extractions – 1st and 2nd Break = 48%, 3 Break = 43-48%
 - Bran duster failed after the 1st sample so no bran duster flour was included
 - Samples finished by 10/23

Allan Fritz, Proposal to Modify HWW WQC Growouts

- Purpose
 - Facilitate a more direct comparison of varieties
 - Provide better sense of environmental stability of lines tested
- HWW Region would be divided into 3 sub regions, with each region having 5 locations (allows for 2 locations to fail)

- South Central Plains
 - High Plains (TX, OK, NE Panhandle)
 - Northern Plains (NE, SD, MT)
 - Size of sub region tried to mirror regional nursery plan to account for variation within a region
- Location selected by breeder input
- Target of 70 lbs grain / entry / location
 - 10 lbs of each individual location will be milled on the USDA tandem Buhler and baked at USDA to get environmental effect
 - 60 lbs used to composite for Miag milling
- Breeders will be given an allotment of entries and can choose sub region
- 2 Checks will be grown (High Quality, Average / Acceptable Quality)
- Number of cooperator samples should decrease due to fewer check samples
- Challenges
 - More coordination
 - Lack of replication within location for GxE interaction (could be added later)
- Other Considerations
 - Fungicide treatments at all locations
 - Coding of lines and development of MTA to allow grow outs
 - Need a subcommittee within USDA lab to determine criterion as to whether a location will be excluded
- Motion was made and accepted to adopt the proposal to be implemented with the 2018 growing season

Ben Handcock

- Financially in good shape with one year's budget in reserve
- Dave Green to begin travelling and meeting with other potential members.

Mark Hodges, Review of 2016 Crop

- Crop was challenging in lots of respects
 - Abnormally low protein, even in fertilized fields and normal areas of higher protein.
 - Wheat got planted timely and in good condition but had limited rain in the fall
 - Crop was starting to head down hill in April / May before it starting raining

Meeting adjourned at 9:30 am.

APPENDIX F

Historical WQC Hard Winter
Wheat Entries
from 2001 to 2017

A History of WQC Hard Winter Wheat Entries

2017						
Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
SY Monument	17-2401	HRW				Syngenta
SY Achieve CL2	17-2402	XWHT				Syngenta
SY 517 CL2	17-2403	HRW				Syngenta
Jagalene (CC01)	17-2404	HRW				Syngenta
Jagalene (CC02)	17-2405	HRW				Texas
TAM 111	17-2406	HRW				Texas
TX11A001295	17-2407	HRW				Texas
TX12M4068	17-2408	HRW				Texas
Byrd	17-2409	HRW				Colorado
CO12D1770	17-2410	HRW				Colorado
Jagalene (CC03)	17-2411	HRW				Colorado
CO13D1783	17-2412	HRW				Colorado
CO12D2011	17-2413	HDWH	2017	Breck		Colorado
Jagalene (CC04)	17-2414	HRW				Kansas-Hays
KS13HW92-3	17-2415	HDWH				Kansas-Hays
Danby	17-2416	HDWH				Kansas-Hays
KS14HW106-6-6	17-2417	HDWH				Kansas-Hays
Yellowstone	17-2418	HRW				Montana
MT1465	17-2419	HRW				Montana
Jagalene (CC05)	17-2420	HRW				Montana
MTW1491	17-2421	HDWH				Montana
NI13706	17-2422	HRW				Nebraska
NE12561	17-2423	HRW				Nebraska
Jagalene (CC06)	17-2424	HRW				Nebraska
Jagalene (CC07)	17-2425	HRW				Monsanto
WB4623CLP	17-2426	HRW				Monsanto
WB4721	17-2427	HRW				Monsanto
Ruby Lee	17-2428	HRW				Oklahoma
OK13621	17-2429	HRW				Oklahoma
OK12D22004-016	17-2430	HRW				Oklahoma
OCW04S7171T-6W	17-2431	HDWH				Oklahoma
Jagalene (CC08)	17-2432	HRW				Oklahoma

2016						
LCH13-048	16-2401	HRW				Limagrain
LCH13NEDH-12-27	16-2402	HRW				Limagrain
Jagalene (CC01)	16-2403	HRW				Limagrain
PSB13NEDH-11-26	16-2404	HRW				Limagrain
LCI13-069	16-2405	HWW				Limagrain
PSB13NEDH-14-83	16-2406	HWW				Limagrain
KS1256-6-4	16-2407	HRW	yes	Tatanka	2016	Kansas-Hays
Danby	16-2408	HWW				Kansas-Hays
Jagalene (CC02)	16-2409	HRW				Kansas-Hays
LCH13NEDH-14-53	16-2410	HWW				Nebraska

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Jagalene (CC03)	16-2411	HRW				Nebraska
LCHNEDH-4-16	16-2412	HWW				Nebraska
Postrock	16-2413	HRW				Syngenta
Jagalene (CC04)	16-2414	HRW				Syngenta
AP11T2409	16-2415	HRW				Syngenta
Jagalene (CC05)	16-2416	HRW				Monsanto
HV9W10-0458	16-2417	HRW				Monsanto
Jagalene (CC06)	16-2418	HRW				Oklahoma
Ruby Lee	16-2419	HRW				Oklahoma
OK10126	16-2420	HRW				Oklahoma
OK12D22004-016	16-2421	HRW				Oklahoma
OK12912C	16-2422	HRW				Oklahoma
OK13209	16-2423	HRW				Oklahoma
Everest	16-2424	HRW				Kansas-Manhattan
Jagalene (CC07)	16-2425	HRW				Kansas-Manhattan
Larry	16-2426	HRW				Kansas-Manhattan
Zenda	16-2427	HRW				Kansas-Manhattan

2015

Jagalene (CC01)	15-2401	HRW				Kansas-Hays
Danby (IC)	15-2402	HRW				Kansas-Hays
KS11HW39-5	15-2403	HRW	yes	Joe	2015	Kansas-Hays
Jagalene (CC04)	15-2404	HRW				Nebraska
NE1059	15-2405	HRW	yes	Ruth	2016	Nebraska
Jagalene (CC06)	15-2406	HRW				Monsanto
BZ9W09-2075	15-2407	HWW				Monsanto
HV9W10-1002	15-2408	HWW	yes	WB4303	2015	Monsanto
Jagalene (CC09)	15-2409	HRW				Colorado
Byrd (IC)	15-2410	HRW				Colorado
CO11D1397	15-2411	HRW				Colorado
CO11D1539	15-2412	HRW				Colorado
CO11D1767	15-2413	HRW				Colorado
Jagalene (CC14)	15-2414	HRW				Oklahoma
Gallagher (IC)	15-2415	HRW				Oklahoma
OK11D25056	15-2416	HRW				Oklahoma
OK13625	15-2417	HRW				Oklahoma
OK10728W	15-2418	HWW				Oklahoma
Jagalene (CC19)	15-2419	HRW				Montana
Yellowstone (IC)	15-2420	HRW				Montana
MTS1224	15-2421	HRW				Montana
MT1265	15-2422	HRW				Montana
Ideal (IC)	15-2423	HRW				South Dakota
SD10257-2	15-2424	HRW				South Dakota
LCH13DH-20-87	15-2425	HRW	Yes	LCS Chrome	2015	Limagrain

2014

Jagalene (CC01)	14-2401	HRW				Kansas_Hays
Danby (IC)	14-2402	HWW				Kansas_Hays
KS11HW15-4	14-2403	HWW				Kansas_Hays

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
KS11W39-5	14-2404	HWW				Kansas_Hays
Jagalene (CC05)	14-2405	HRW				Texas_Amarillo
TAM 111 (IC)	14-2406	HRW				Texas_Amarillo
TX08A001249	14-2407	HRW				Texas_Amarillo
TX09A001194	14-2408	HRW				Texas_Amarillo
TX09D1172	14-2409	HRW				Texas_Amarillo
Jagalene (CC10)	14-2410	HRW				Colorado
Byrd (IC)	14-2411	HRW				Colorado
CO11D174	14-2412	HRW	yes	Avery	2014	Colorado
CO11D446	14-2413	HRW				Colorado
Jagalene (CC)	14-2414	HRW				Nebraska
Camelot (IC)	14-2415	HRW				Nebraska
NE07531	14-2416	HRW				Nebraska
NE09521	14-2417	HRW				Nebraska
Jagalene (CC18)	14-2418	HRW				Montana
Yellowstone (IC)	14-2419	HRW				Montana
MT1078	14-2420	HRW				Montana
MT1138	14-2421	HRW				Montana
Jagalene (CC22)	14-2422	HRW				Oklahoma
Ruby Lee (IC)	14-2423	HRW				Oklahoma
OK09125	14-2424	HRW	yes	Bentley	2015	Oklahoma
OK10126	14-2425	HRW				Oklahoma
Jagalene (CC26)	14-2426	HRW				Kansas_Manhattan
KanMark	14-2427	HRW				Kansas_Manhattan
06BC722#25	14-2428	HRW	yes	SY Flint	2015	Agripro
06BC796#68	14-2429	HRW	yes	SY Sunrise	2015	Agripro

2013

Check Blend (check)	13-2401	HRW				Limagrain
LCH08-80	13-2402	HRW				Limagrain
ICS Mint	13-2403	HRW				Limagrain
Danby (check)	13-2404	HWW				Kansas-Hays
Oakley CL	13-2405	HRW	yes	Oakley CL	2013	Kansas-Hays
KS10HW78-1	13-2406	HWW				Kansas-Hays
Lyman (check)	13-2407	HRW				South Dakota
SD08200	13-2408	HRW				South Dakota
SD09192	13-2409	HRW				South Dakota
Postorock (check)	13-2410	HRW				Agripro
04BC574-2	13-2411	HRW	yes	SY Monument	2014	Agripro
Millennium (check)	13-2412	HRW				Nebraska
NE09521	13-2413	HRW				Nebraska
NE08499	13-2414	HRW				Nebraska
Yellowstone (check)	13-2415	HRW				Montana
MT1090	13-2416	HRW				Montana
MTW08168	13-2417	HWW	yes	WB3768	2013	Montana
Ruby Lee (check)	13-2418	HRW				Oklahoma
Doublestop CL+	13-2419	HRW	yes	Doublestop CL+	2013	Oklahoma
OK09125	13-2420	HRW				Oklahoma

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2012						
WB-Stout (check)	12-2401	HRW				Westbred
HV9W07-1028	12-2402	HRW				Westbred
Millennium (check)	12-2403	HRW				Nebraska
NW07505	12-2404	HWW				Nebraska
NE06545	12-2405	HRW	yes	Freeman	2012	Nebraska
NE06607	12-2406	HRW				Nebraska
Byrd (check)	12-2407	HRW				Colorado
Snowmass (check)	12-2408	HWW				Colorado
CO07W245	12-2409	HWW	Yes	Antero	2012	Colorado
CO07W722-F5	12-2410	HWW				Colorado
Billings (check)	12-2411	HRW				Oklahoma
Ruby Lee	12-2412	HRW				Oklahoma
Gallagher (OK07214)	12-2413	HRW				Oklahoma
Iba (OK07209)	12-2414	HRW				Oklahoma
OK09634	12-2415	HRW				Oklahoma
Lyman (check)	12-2416	HRW				South Dakota
SD08080	12-2417	HRW				South Dakota
SD06158	12-2418	HRW	yes	Redfield	2013	South Dakota
Yellowstone (check)	12-2419	HRW				Montana
MT08172	12-2420	HRW	yes	Colter	2012	Montana
MT0978	12-2421	HRW	yes	Northern	2015	Montana
TAM 111 (check)	12-2422	HRW				Texas
TX07A001505	12-2423	HRW				Texas
TX03A0563-07	12-2424	HRW				Texas
2011						
Danby (check)	11-2401	HWW				Kansas-Hays
Tiger	11-2402	HWW	yes			Kansas-Hays
KS08HW35-1	11-2403	HWW	yes	Clara CL	2011	Kansas-Hays
PostRock (check)	11-2404	HRW				AgriPro
SY Wolf	11-2405	HRW	yes			AgriPro
Syngenta Exp 138-45	11-2406	HRW	yes	SY Southwind	2012	AgriPro
Fuller (check)	11-2407	HRW				Kansas-Manhattan
KS020319-7-3	11-2408	HRW	yes	1863	2012	Kansas-Manhattan
KS020633M-13	11-2409	HRW	no			Kansas-Manhattan
McGill (check)	11-2410	HRW				Nebraska
NE05496	11-2411	HRW	no			Nebraska
NE05548	11-2412	HRW	no			Nebraska
NI08708	11-2413	HRW	no			Nebraska
Jagalene (check)	11-2414	HRW				Westbred
HV9W06-509	11-2415	HWW	yes	WB-Grainfield	2012	Westbred
Yellowstone (check)	11-2416	HRW				Montana
MTS0808	11-2417	HRW	yes	Warhorse	2013	Montana
MT0871	11-2418	HRW	no			Montana
Lyman (check)	11-2419	HRW				South Dakota
SD06158	11-2420	HRW	no			South Dakota
SD07184	11-2421	HRW	no			South Dakota

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2010						
Lyman (check)	10-2401	HRW				SDSU
SD05118-1	10-2402	HRW	yes	Ideal	2011	SDSU
SD06158	10-2403	HRW	no			SDSU
Hatcher (check)	10-2404	HRW				CSU
CO050303-2	10-2405	HRW	yes	Denali	2011	CSU
CO06052	10-2406	HRW	yes	Brawl CL Plus	2011	CSU
CO06424	10-2407	HRW	yes	Byrd	2011	CSU
Millennium (check)	10-2408	HRW				NU
NE03490	10-2409	HRW	no			NU
NE04490	10-2410	HRW	no			NU
Billings (check)	10-2411	HRW				OSU
OK05526	10-2412	HRW	no			OSU
OK05212	10-2413	HRW	yes	Garrison	2011	OSU
OK07231	10-2414	HRW	no			OSU
Smoky Hill (check)	10-2415	HRW				Westbred
HV9W06-262R	10-2416	HRW	no			Westbred
HV9W06-218W	10-2417	HWW	no			Westbred
Yellowstone (check)	10-2418	HRW				MSU
MTS0721	10-2419	HRW	yes	Bearpaw	2011	MSU
TAM 111 (check)	10-2420	HRW				TAMU
TX05A001822	10-2421	HRW	no			TAMU
TX06A001263	10-2422	HRW	no			TAMU
2009						
Smoky Hill (check)	09-2401	HRW				Westbred
Stout (HV9W03-539R)	09-2402	HRW	yes	WB-Stout	2009	Westbred
RonL (check)	09-2403	HWW				KSU-Hays
Tiger	09-2404	HWW	yes			KSU-Hays
Hatcher (check)	09-2405	HRW				CSU
CO04393	09-2406	HRW	no			CSU
CO04499	09-2407	HRW	no			CSU
OK Bullet (check)	09-2408	HRW				OSU
Billings	09-2409	HRW	yes			OSU
OK05526	09-2410	HRW	no			OSU
PostRock (check)	09-2411	HRW				AgriPro
CJ	09-2412	HRW	yes			AgriPro
SY Gold (AP00x0100-51)	09-2413	HRW	yes	SY Gold	2010	AgriPro
Yellowstone (check)	09-2414	HRW				MSU
MT06103	09-2415	HRW	no			MSU
MTS0713	09-2416	HRW	yes	Judee	2011	MSU
TAM 111 (check)	09-2417	HRW				TAMU
TX02A0252	09-2418	HRW	yes	TAM 113	2010	TAMU
Millennium (check)	09-2419	HRW				NU
NE01481	09-2420	HRW	yes	McGill	2010	NU
NI04421	09-2421	HRW	yes	Robidoux	2010	NU

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2008						
Jagalene (check)	08-2401	HRW				AgriPro
Art	08-2402	HRW	yes			AgriPro
Hawken	08-2403	HRW	yes			AgriPro
NuDakota	08-2404	HRW	yes			AgriPro
Hatcher (check)	08-2405	HRW				CSU
Thunder CL	08-2406	HWW	yes			CSU
CO03W054	08-2407	HWW	yes	Snowmass		CSU
CO03064	08-2408	HRW	no			CSU
Danby (check)	08-2409	HWW				KSU-Hays
Tiger	08-2410	HWW	yes			KSU-Hays
Karl 92 (check)	08-2411	HRW				KSU-Manhattan
KS970093-8-9-#1	08-2412	HRW	yes	Everest	2009	KSU-Manhattan
OK Bullet (check)	08-2413	HRW				OSU
OK03305	08-2414	HRW	yes	Pete	2009	OSU
OK03522	08-2415	HRW	yes	Billings	2009	OSU
OK03825-5403-6	08-2416	HRW				OSU
Tandem (check)	08-2417	HRW	yes	STARS0601W	2006	SDSU
SD05W030	08-2418	HWW	no			SDSU
2007						
Hatcher (check)	07-2401	HRW				CSU
CO03W239	07-2402	HWW	yes	Thunder CL	2008	CSU
CO03W054	07-2403	HWW	yes	Snowmass		CSU
CO02W237	07-2404	HWW	no			CSU
Millennium (check)	07-2405	HRW				NU
NH03614	07-2406	HRW	yes	Settler CL	2008	NU
OK Bullet (check)	07-2407	HRW				OSU
OK00514-05806	07-2408	HRW	no			OSU
OK05737W	07-2409	HWW	no			OSU
OK03522	07-2410	HRW	yes	Billings	2009	OSU
OK02405	07-2411	HRW	no			OSU
Tandem (check)	07-2412	HRW				SDSU
SD98W175-1	07-2413	HRW	no			SDSU
SD01058	07-2414	HRW	no			SDSU
SD0111-9	07-2415	HRW	yes	Lyman	2008	SDSU
SD01273	07-2416	HRW	no			SDSU
Genou (check)	07-2417	HRW				MSU
MT0495	07-2418	HRW	no			MSU
MTS04114	07-2419	HRW	no			MSU
2006						
Overlay (check)	06-2401	HRW				KSU-Manhattan
Fuller	06-2402	HRW	yes			KSU-Manhattan
KS990498-3-&~2	06-2403	HRW	no			KSU-Manhattan
KS970274-14*9	06-2404	HRW	no			KSU-Manhattan
Overlay (check)	06-2405	HRW				Westbred
Smoky Hill	06-2406	HRW	yes			Westbred
Aspen	06-2407	HRW	yes			Westbred

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Millennium (check)	06-2408	HRW				NU
NW98S097	06-2409	HRW	yes	Anton	2008	NU
N02Y5117	06-2410	HRW	yes	Mace	2007	NU
NE01643	06-2411	HRW	yes	Overland	2007	NU
NE02584	06-2412	HRW	no			NU
OK Bullet (check)	06-2413	HRW				OSU
Duster	06-2414	HRW	yes			OSU
OK01420	06-2415	HRW	no			OSU
OK02405	06-2416	HRW	no			OSU
OK02522W	06-2417	HWW	yes	OK Rising	2008	OSU
Tandem (check)	06-2418	HRW				SDSU
SD96240-3-1	06-2419	HRW	no			SDSU
SD01122	06-2420	HRW	no			SDSU
SD01W065	06-2421	HWW	no			SDSU
TAM 111 (check)	06-2422	HRW				TAMU
TAM 112	06-2423	HRW	yes			TAMU
TX01A5936	06-2424	HRW	no			TAMU
TX01D3232	06-2425	HRW	yes	TAM 304	2006	TAMU
TX01V5314	06-2426	HRW	yes	TAM 203	2007	TAMU

2005

Akron (check)	05-2401	HRW				CSU
CO00016	05-2402	HRW	yes	Ripper	2006	CSU
Jagger (check)	05-2403	HRW				KSU-Hays
2137	05-2404	HRW	yes			KSU-Hays
KS03HW6-6	05-2405	HWW	no			KSU-Hays
KS03HW158-1	05-2406	HWW	yes	RonL		KSU-Hays
Jagger (check)	05-2407	HRW				AgriPro
Neosho	05-2408	HRW	yes			AgriPro
W03-20	05-2409	HRW	yes	Postrock	2005	AgriPro
Goodstreak (check)	05-2410	HRW				NU
Infinity CL	05-2411	HRW	yes			NU
OK Bullet (check)	05-2412	HRW				OSU
OK93p656H3299-2c04	05-2413	HRW	yes	Duster	2006	OSU
OK01307	05-2414	HRW	no			OSU
OK03918C	05-2415	HRW	yes	Centerfield	2006	OSU
OK00611W	05-2416	HWW	no			OSU
Tandem (check)	05-2417	HRW				SDSU
Crimson	05-2418	HRW	yes			SDSU
SD97059-2	05-2419	HRW	no			SDSU
SD01W064	05-2420	HWW	no			SDSU

2004

Jagger (check)	04-2401	HRW				KSU-Hays
2137	04-2402	HRW	yes			KSU-Hays
KS02HW34	04-2403	HWW	yes	Danby	2005	KSU-Hays
KS02HW35-5	04-2404	HWW	no			KSU-Hays
KS03HW158	04-2405	HWW	yes	RonL	2006	KSU-Hays
Antelope (check)	04-2406	HRW				NE-USDA-ARS

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Arrowsmith	04-2407	HRW	yes			NE-USDA-ARS
NW99L7068	04-2408	HRW	no			NE-USDA-ARS
Millennium (check)	04-2409	HRW				NU
NE99495	04-2410	HRW	yes	NE99495	2005	NU
OK102 (check)	04-2411	HRW				OSU
OK00618W	04-2412	HWW	yes	Guymon	2005	OSU
OK99212	04-2413	HRW	no			OSU
OK00514	04-2414	HRW	yes	OK Bullet	2005	OSU
OK02909C	04-2415	HRW	yes	Okfield	2005	OSU
Tandem (check)	04-2416	HRW				SDSU
SD97W609	04-2417	HWW	yes	Alice	2006	SDSU
SD97538	04-2418	HRW	no			SDSU
SD98102	04-2419	HRW	yes	Darrell	2006	SDSU

2003

Akron (check)	03-2401	HRW				CSU
CO980607	03-2402	HRW	yes	Hatcher	2004	CSU
CO00D007	03-2403	HRW	yes	Bond CL	2004	CSU
Jagger (check)	03-2404	HRW				KSU-Hays
2137	03-2405	HRW	yes			KSU-Hays
KS01HW152-6	03-2406	HWW	no			KSU-Hays
KS01HW163-4	03-2407	HWW	no			KSU-Hays
KS02HW34	03-2408	HWW	yes	Danby	2005	KSU-Hays
Jagger (check)	03-2409	HRW				KSU-Manhattan
2137	03-2410	HRW	yes			KSU-Manhattan
Overley	03-2411	HRW	yes			KSU-Manhattan
KS940786-6-9	03-2412	HRW	no			KSU-Manhattan
OK 102 (check)	03-2413	HRW				OSU
OK94P549-11	03-2414	HRW	yes	Endurance	2004	OSU
OK98690	03-2415	HRW	yes	Deliver	2004	OSU
Crimson (check)	03-2416	HRW				SDSU
SD97W604	03-2417	HWW	yes	Wendy	2004	SDSU
SD92107-5	03-2418	HRW	no			SDSU

2002

Jagger (check)	02-2401	HRW				AgriPro
Cutter	02-2402	HRW	yes			AgriPro
Dumas	02-2403	HRW	yes			AgriPro
Jagalene	02-2404	HRW	yes			AgriPro
G1878 (check)	02-2405	HRW				Cargill
G980723	02-2406	HRW	no			Cargill
G970252W	02-2407	HWW	no			Cargill
Prowers (check)	02-2408	HRW				CSU
CO980376	02-2409	HRW	no			CSU
CO980607	02-2410	HRW	yes	Hatcher	2004	CSU
CO980630	02-2411	HRW	no			CSU
Jagger (check)	02-2412	HRW				KSU-Manhattan
KS940748-2-2	02-2413	HRW	no			KSU-Manhattan
KS940786-6-7	02-2414	HRW	yes	Overley	2003	KSU-Manhattan

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
KS940786-6-9	02-2415	HRW	no			KSU-Manhattan
Millennium (check)	02-2416	HRW				NU
NE97V121	02-2417	HRW	no			NU
NE98466	02-2418	HRW	no			NU
NE98471	02-2419	HRW	yes	Hallam	2004	NU
NI98439	02-2420	HRW	no			NU
2174 (check)	02-2421	HRW				OSU
OK102	02-2422	HRW	yes			OSU
OK95548-54	02-2423	HRW	no			OSU
OK95616-56	02-2424	HRW	no			OSU
OK96705-38	02-2425	HRW	no			OSU
OK98699	02-2426	HRW	no			OSU
2001						
Jagger (check)	01-2401	HRW				Cargill
G970380A	01-2402	HRW	no			Cargill
G970209W	01-2403	HWW	no			Cargill
Prowers 99 (check)	01-2404	HRW				CSU
CO970547	01-2405	HRW	no			CSU
Millennium (check)	01-2406	HRW				NU
NE97426	01-2407	HRW	no			NU
NE97465	01-2408	HRW	yes	Goodstreak	2002	NU
NE97638	01-2409	HRW	yes	Empire	2002	NU
NE97669	01-2410	HRW	no			NU
NE97689	01-2411	HRW	yes	Harry	2002	NU
2174 (check)	01-2412	HRW				OSU
OK96717-99-6756	01-2413	HRW	no			OSU
OK97508	01-2414	HRW	yes	Ok102	2002	OSU



Thank you for reviewing this report of 2017 WQC Hard Winter Wheat milling and baking. Please let me know if you have any comments on this report. I can be reached at (785)776-2750 or by email, Richard.chen@ars.usda.gov