Milling and Baking Test Results for Hard Winter Wheat

Harvested in 2016

67th 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.

Ben Handcock
The Wheat Quality Council
5231 Tall Spruce St.
Brighton, CO 80601
Voice: (303) 558-0101
Fax: (303) 558-0100
Email: BhWQC@aol.com
http://www.wheatqualitycouncil.org

2016

Milling and Baking Test Results for

Hard Winter Wheats

Editor: **Richard Y. Chen, Ph.D**
Research Food Technologist, Associate Director
USDA-ARS-CGAHR
Hard Winter Wheat Quality Laboratory
1515 College Ave.
Manhattan, KS 66502

Co-Editor: **Bradford W. Seabourn, Ph.D**
Supervisory Research Chemist, Director
USDA-ARS-CGAHR
Hard Winter Wheat Quality Laboratory
1515 College Ave.
Manhattan, KS 66502

Coordinator: **Ben Handcock**
Executive Vice President
Wheat Quality Council
5231 Tall Spruce St.
Brighton, CO 80601

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 2016 Testing Program

Founded in 1949, this is the **67th** 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 27 entries this year were grown in special locations and submitted for small-scale testing by seven 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 twenty cooperators (16 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.

2016 WQC HWW Entries & Breeding Programs

Breeding Programs	Entry Number	Sample Identification
LIMAGRAIN	16-2401	LCH13-048
	16-2402	LCH13NEDH-12-27
	16-2403	Jagalene (01)
	16-2404	PSB13NEDH-11-26
	16-2405	LCI13-069
	16-2406	PSB13NEDH-14-83
KANSAS-HAYS	16-2407	KS12H56-6-4
	16-2408	Danby
	16-2409	Jagalene (CC02)
NEBRASKA	16-2410	LCH13NEDH-14-53
	16-2411	Jagalene (CC03)
	16-2412	LCH13NEDH-4-16
SYNGENTA	16-2413	Postrock
	16-2414	Jagalene (CC04)
	16-2415	AP11T2409
MONSANTO	16-2416	Jagalene (CC05)
	16-2417	HV9W10_0458
OKLAHOMA	16-2418	Jagalene (CC06)
	16-2419	Ruby Lee
	16-2420	OK10126
	16-2421	OK12D22004-016
	16-2422	OK12912C
	16-2423	OK13209
KANSAS(MANHATTAN)	16-2424	Everest
	16-2425	Jagalene (CC07)
	16-2426	Larry
	16-2427	Zenda

COMMON CHECK	16-2428	Jagalene (CC01)
	16-2429	Jagalene (CC02)
	16-2430	Jagalene (CC03)
	16-2431	Jagalene (CC04)
	16-2432	Jagalene (CC05)
	16-2433	Jagalene (CC06)
	16-2434	Jagalene (CC07)

CC = Common Check

2016 Wheat Classification Results from GIPSA

GIPSA Wheat Market Classification

ID	CL	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	GRADE
16-2401	HRW	0.00	63.6	N/A	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2402	HRW	0.00	62.8	N/A	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2403	HRW	0.11	61.6	N/A	OK	0.0	0.0	0.2	0.2	0.4	0.0	0.0	US NO. 1 HRW DKG 0.1%
16-2404	HRW	0.04	63.7	N/A	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2405	HDWH	0.00	63.2	N/A	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.6	US NO. 1 HDWH DKG 0.0%
16-2406	HDWH	0.01	64.8	N/A	OK	0.0	0.2	0.0	0.0	0.2	0.0	4.2	US NO. 2 HDWH DKG 0.0%
16-2407	HRW	0.00	62.0	N/A	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2408	HDWH	0.00	59.0	N/A	OK	0.0	0.2	0.0	0.6	0.8	0.0	0.0	US NO.2 HDWH DKG 0.0%
16-2409	HRW	0.00	57.1	N/A	OK	0.0	0.2	0.0	1.0	1.2	0.0	0.0	US NO. 3 HRW DKG 0.0%
16-2410	HDWH	0.00	55.6	N/A	OK	0.0	4.1	0.0	0.9	5.0	0.0	2.7	US NO. 4 HDWH DKG 0.0%
16-2411	HRW	0.08	58.2	N/A	OK	0.0	0.3	0.0	0.7	1.0	0.0	0.0	US NO. 2 HRW DKG 0.1%
16-2412	HDWH	0.02	55.9	N/A	OK	0.0	13.4	0.0	0.4	13.8	0.0	3.1	US NO. 5 HDWH DKG 0.0%
16-2413	HRW	0.00	63.2	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2414	HRW	0.00	63.8	N/A	OK	0.0	0.0	0.0	0.1	0.1	0.0	2.3	US NO.1 HRW DKG 0.0%
16-2415	HRW	0.00	62.8	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2416	HRW	0.00	65.7	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2417	HRW	0.00	66.1	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2418	HRW	0.00	62.2	N/A	OK	0.0	0.0	0.0	0.6	0.6	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2419	HRW	0.01	60.7	N/A	OK	0.0	0.1	0.0	0.4	0.5	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2420	HRW	0.01	61.7	N/A	OK	0.0	0.1	0.0	2.9	3.0	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2421	HRW	0.00	62.2	N/A	OK	0.0	0.0	0.0	0.8	0.8	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2422	HRW	0.01	61.6	N/A	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2423	HRW	0.01	61.0	N/A	OK	0.0	0.1	0.0	2.3	2.4	0.0	0.0	US NO. 1 HRW DKG 0.0%
16-2424	HRW	0.00	58.6	N/A	OK	0.0	0.6	0.0	0.1	0.7	0.0	0.0	US NO. 2 HRW DKG 0.0%
16-2425	HRW	0.01	58.7	N/A	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.2	US NO. 2 HRW DKG 0.0%
16-2426	HRW	0.00	57.3	N/A	OK	0.0	0.1	0.0	0.1	0.2	0.0	0.2	US NO. 3 HRW DKG 0.0%
16-2427	HRW	0.00	58.4	N/A	OK	0.0	0.2	0.0	0.1	0.3	0.0	0.0	US 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.

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

LIMAGRAIN

16-2401	LCH13-048
16-2402	LCH13NEDH-12-27
16-2403	Jagalene (CC01)
16-2404	PSB13NEDH-11-26
16-2405	LCI13-069
16-2406	PSB13NEDH-14-83

Description of Test Plots and Breeder Entries

Limagrain - Marla Dale Barnett

Growing Location & Conditions

The hard winter Wheat Quality Council samples from Limagrain Cereal Seeds originated from strip increases grown in Wichita, KS. Growing conditions included timely planting into excellent soil moisture, excellent fall stands and growth. The field was planted October 7, 2015, fertilized with 70 lbs N in February, and harvested on June 23, 2016. Grass and broadleaf herbicide was applied in February. Foliar fungicide and an additional 30 lbs of N was applied in April before head emergence. The increases received adequate spring moisture accompanied by mild temperatures that resulted in yields averaging 67.5 bu/ac in the adjacent LCS Y3 yield trial.

LCH13-048

LCH13-048 is a broadly adapted, early maturing, medium height, hard red winter wheat with high yield potential. It performs well under irrigation and in dryland crop management systems. Excellent leaf rust and stripe rust resistance combined with very good winter-hardiness, straw strength, and yield potential provide LCH13-048 a broad area of adaptation within the Great Plains. Yield data can be attained from the 2016 Kansas State University winter wheat performance trial and the 2016 USDA-ARS Southern Regional Performance Nursery. This line is on increase for potential release in 2017.

Milling and baking quality data from LCS show acceptable overall milling and baking qualities. In 2016 LCS trials across multiple locations, LCH13-048 had an average flour protein of 11.3%, 60.5% water absorption, and a mixograph mid-line peak time of 3.39 minutes. Loaf volume is good to excellent at 865 cc.

PSB13NEDH-11-26

PSB13NEDH-11-26 is a double-haploid line jointly developed by the University of Nebraska and LCS. PSB13NEDH-11-26 is an early maturing, hard red winter wheat adapted to central and southern Kansas and performs exceptionally well under irrigation. This experimental line has moderate resistance to leaf rust and stripe rust and is resistant to prevalent North American stem rust races. PSB13NEDH-11-26 also contains excellent winter-hardiness and very good straw strength. This line is on increase for potential release in 2017. Pedigree is NE06469 / Pronghorn.

Milling and baking quality data from LCS show acceptable overall milling and baking qualities. In 2016 LCS trials across multiple locations, PSB13NEDH-11-26 had an average flour protein of 11.5%, 60.8% water absorption, and a mixograph mid-line peak time of 3.9 minutes. Loaf volume is good to excellent at 890 cc.

LCH13NEDH-12-27

LCH13NEDH-12-27 is a double-haploid line jointly developed by the University of Nebraska and LCS. LCH13NEDH-12-27 is an early maturing, hard red winter wheat adapted to central Kansas. This experimental line is resistant to prevalent North American races of both stripe rust

and stem rust. It is moderately susceptible to leaf rust. LCH13NEDH-12-27 also contains very good winter-hardiness, excellent straw strength, and tolerance to barley yellow dwarf virus. This line is on increase for potential release in 2017. Pedigree is NE04490 / NI06731.

Milling and baking quality data from LCS show acceptable overall milling and baking qualities. In 2016 LCS trials across multiple locations, LCH13NEDH-12-27 had an average flour protein of 12.1%, 61.7% water absorption, and a mixograph mid-line peak time of 2.8 minutes. Loaf volume is good to excellent at 880 cc.

PSB13NEDH-14-83

PSB13NEDH-14-83 is a hard white winter wheat double-haploid line jointly developed by the University of Nebraska and LCS. PSB13NEDH-14-83 has excellent winter-hardiness, tolerance to Fusarium head blight, and very good straw strength. Maturity is full season equal to LCS Chrome. Yield data can be attained from the 2016 USDA Northern Regional Performance Nursery. The experimental line is resistant to stem rust and leaf rust while containing intermediate levels of resistance to stripe rust. A broad area of adaptation includes central Oklahoma to the High-Plains of Nebraska. This line is on increase for potential release in 2017. Pedigree is NW03681 / SD07W084.

Milling and baking quality data from LCS show acceptable overall milling and baking qualities. In 2016 LCS trials across multiple locations, PSB13NEDH-14-83 had an average flour protein of 11.1%, 60.1% water absorption, and a mixograph mid-line peak time of 3.6 minutes. Loaf volume is excellent at 940 cc.

LCI13-069

LCI13-069 is a hard white winter wheat with excellent winter-hardiness, very good straw strength and a broad area of adaptation. Maturity is full-season equal to that of LCS Chrome. The experimental line is susceptible to both leaf rust and stem rust yet contains moderate resistance to stripe rust. This line is on increase for potential release in 2017.

Milling and baking quality data from LCS show acceptable overall milling and baking qualities. In 2016 LCS trials across multiple locations, LCH13-069 had an average flour protein of 11.3%, 60.4% water absorption, and a mixograph mid-line peak time of 5.4 minutes. Loaf volume is superb at 1015 cc.

Check - Jagalene

Limagrain: 2016 (Small-Scale) Samples

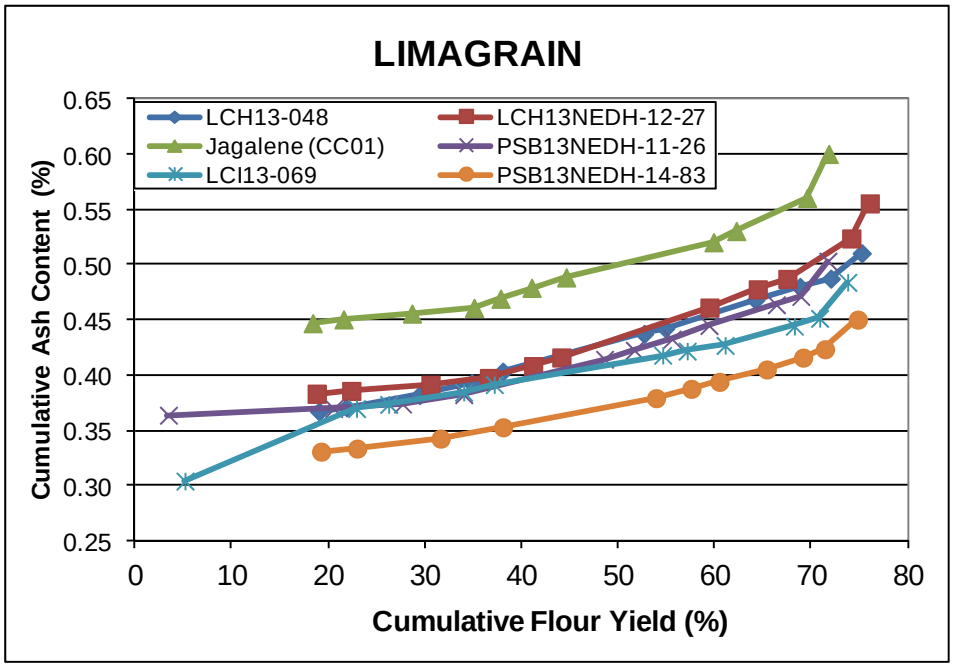
Test entry number	16-2401	16-2402	16-2403	16-2404	16-2405	16-2406
Sample identification	**LCH13-048**	**LCH13NEDH-12-27**	**Jagalene (CC01)**	**PSB13NEDH-11-26**	**LCI13-069**	**PSB13NEDH-14-83**
Wheat Data						
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW	1 HDWH	2 HDWH
Test weight (lb/bu)	63.6	62.8	61.6	63.7	63.2	64.8
Hectoliter weight (kg/hl)	83.6	82.6	81.0	83.7	83.1	85.1
1000 kernel weight (gm)	34.1	34.0	32.6	34.4	34.2	38.2
Wheat kernel size (Rotap)						
Over 7 wire (%)	81.5	83.5	69.7	73.8	83.9	90.6
Over 9 wire (%)	18.5	16.4	29.5	26.0	16.0	9.4
Through 9 wire (%)	0.0	0.1	0.8	0.2	0.1	0.0
Single kernel (skcs)[a]						
Hardness (avg /s.d)	86.2/16.3	77.6/14.9	80.0/18.1	80.1/11.6	90.0/15.5	79.4/13.6
Weight (mg) (avg/s.d)	34.1/8.9	34.0/7.8	32.6/8.7	34.4/7.9	34.2/8.7	38.2/7.5
Diameter (mm)(avg/s.d)	2.77/0.34	2.82/0.31	2.76/0.33	2.75/0.30	2.71/0.37	2.94/0.29
Moisture (%) (avg/s.d)	11.5/0.4	11.2/0.4	13.8/0.4	12.1/0.3	11.7/0.3	12.4/0.3
SKCS distribution	00-01-04-95-01	01-01-09-89-01	01-03-10-86-01	00-01-02-97-01	00-00-04-96-01	00-01-05-94-01
Classification	Hard	Hard	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	11.8	12.1	10.2	13.1	9.6	10.7
Wheat ash (12% mb)	1.46	1.60	1.63	1.57	1.44	1.47
Milling and Flour Quality Data						
Flour yield (%, str. grade)						
Miag Multomat Mill	75.2	75.9	71.7	71.5	73.5	74.6
Quadrumat Sr. Mill	66.1	64.9	65.0	67.0	66.3	70.1
Flour moisture (%)	13.6	13.5	13.8	13.9	13.4	13.5
Flour protein (14% mb)	10.6	10.7	9.3	11.7	8.4	9.6
Flour ash (14% mb)	0.50	0.54	0.60	0.49	0.50	0.46
Rapid Visco-Analyser						
Peak time (min)	6.1	6.3	6.1	6.3	6.1	6.1
Peak viscosity (RVU)	190.8	180.9	175.6	203.2	178.3	227.3
Breakdown (RVU)	69.1	52.2	62.2	57.2	59.1	89.1
Final viscosity at 13 min (RVU)	228.3	229.8	218.8	267.5	229.3	240.0
Minolta color meter						
L*	91.41	91.40	91.26	91.65	92.22	92.51
a*	-1.54	-1.30	-1.64	-1.40	-1.44	-1.69
b*	9.23	8.53	9.76	8.73	8.16	8.45
PPO	0.361	0.423	0.366	0.426	0.395	0.322
Falling number (sec)	454	416	397	507	427	421
Damaged Starch						
(AI%)	98.2	97.7	98.3	98.3	98.9	97.4
(AACC76-31)	8.1	7.7	8.2	8.2	8.7	7.4

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Limagrain: Physical Dough Tests and Gluten Analysis
2016 (Small-Scale) Samples

Test Entry Number	16-2401	16-2402	16-2403	16-2404	16-2405	16-2406
Sample Identification	LCH13-048	LCH13NEDH-12-27	Jagalene (CC01)	PSB13NEDH-11-26	LCI13-069	PSB13NEDH-14-83
MIXOGRAPH						
Flour Abs (% as-is)	65.1	64.4	63.2	68.7	65.7	63.6
Flour Abs (14% mb)	64.7	63.8	63.0	68.4	65.0	63.0
Mix Time (min)	3.1	3.6	5.4	5.6	7.5	4.4
Mix tolerance (0-6)	3	3	3	5	4	4
FARINOGRAPH						
Flour Abs (% as-is)	64.9	64.8	62.4	64.8	66.6	62.0
Flour Abs (14% mb)	64.4	64.2	62.2	64.6	65.9	61.4
Development time (min)	4.0	4.7	1.9	7.0	2.0	8.0
Mix stability (min)	8.6	8.7	2.1	16.2	1.7	16.9
Mix Tolerance Index (FU)	26	22	42	16	76	14
Breakdown time (min)	11.0	10.9	3.6	15.7	3.1	19.4
ALVEOGRAPH						
P(mm): Tenacity	128	132	125	139	141	108
L(mm): Extensibility	73	63	49	78	31	71
G(mm): Swelling index	19.0	17.7	15.6	19.7	12.4	18.8
W(10^{-4} J): strength (curve area)	313	298	245	411	167	283
P/L: curve configuration ratio	1.75	2.10	2.55	1.78	4.55	1.52
Ie(P_{200}/P): elasticity index	50.5	50.5	53.4	61.6	0.0	56.5
EXTENSIGRAPH						
Resist (BU at 45/90/135 min)	294/379/386	344/399/445	457/609/681	455/713/852	509/696/806	369/548/630
Extensibility (mm at 45/90/135 min)	144/139/142	128/133/126	128/110/112	145/135/120	119/101/92	136/138/121
Energy (cm^2 at 45/90/135 min)	75/91/98	72/86/89	98/96/108	121/168/150	97/97/95	87/127/118
Resist $_{max}$ (BU at 45/90/135min)	370/486/526	414/491/545	592/696/797	663/998/995	642/795/841	483/736/779
Ratio (at 45/90/135 min)	2.05/2.72/2.71	2.69/3.00/3.54	3.57/5.53/6.10	3.14/5.30/7.09	4.26/6.89/8.72	2.72/3.97/5.21
PROTEIN ANALYSIS						
HMW-GS Composition	2*,1, 7+8,2+12	2*,7+8,5+10	2*,1,17+18,5+10	2*,7+9,5+10	2*,7+9,5+10	2*,7+8,5+10
%IPP	51.4	53.8	57.4	49.7	51.5	48.8
SEDIMENTATION TEST						
Volume (ml)	50.8	44.7	42.4	57.8	38.7	39.8

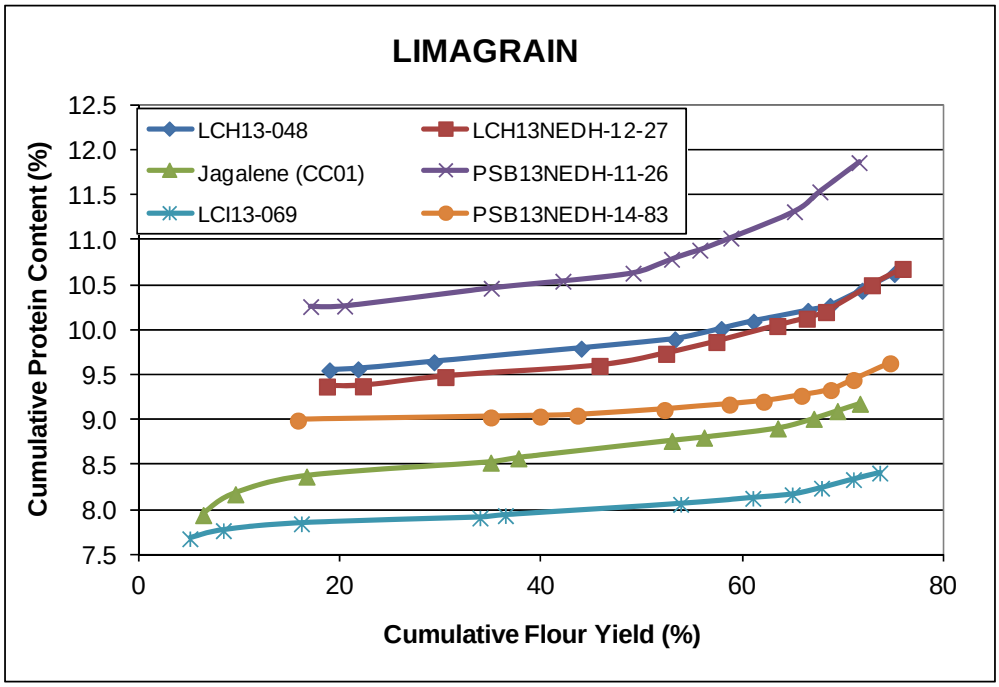
Limagrain: Cumulative Ash Curves



LCH13-048					LCH13NEDH-12-27					Jagalene (CC01)				
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	19.0	0.37	19.0	0.37	2M	18.7	0.38	18.7	0.38	2M	18.3	0.45	18.3	0.45
1M Red	2.8	0.40	21.8	0.37	1M Red	3.6	0.40	22.3	0.39	1M Red	3.2	0.47	21.5	0.45
1M	7.6	0.41	29.4	0.38	1M	8.2	0.41	30.5	0.39	1M	7.1	0.47	28.6	0.46
1BK	5.4	0.45	34.8	0.39	1BK	6.1	0.43	36.6	0.40	1BK	6.4	0.48	35.0	0.46
2BK	3.2	0.52	38.0	0.40	2BK	4.6	0.49	41.1	0.41	Grader	2.8	0.57	37.7	0.47
3M	14.6	0.53	52.6	0.44	Grader	2.9	0.53	44.0	0.42	FILTER FLR	3.2	0.60	41.0	0.48
Grader	2.2	0.56	54.8	0.44	3M	15.3	0.59	59.4	0.46	2BK	3.6	0.60	44.5	0.49
4M	9.3	0.62	64.1	0.47	FILTER FLR	5.0	0.67	64.4	0.48	3M	15.3	0.61	59.8	0.52
FILTER FLR	4.6	0.65	68.7	0.48	3BK	3.1	0.69	67.4	0.49	3BK	2.4	0.79	62.1	0.53
3BK	3.2	0.65	71.9	0.49	4M	6.6	0.90	74.0	0.52	4M	7.3	0.82	69.5	0.56
5M	3.2	1.03	75.1	0.51	5M	1.9	1.78	76.0	0.56	5M	2.2	1.84	71.7	0.60
Break Shorts	3.8	3.79	78.9	0.67	Break Shorts	3.5	4.06	79.5	0.71	Break Shorts	3.6	3.48	75.3	0.74
Red Dog	2.8	2.09	81.7	0.72	Red Dog	2.0	2.59	81.5	0.76	Red Dog	2.6	2.59	77.9	0.80
Red Shorts	0.5	3.40	82.1	0.73	Red Shorts	0.4	3.22	81.9	0.77	Red Shorts	0.5	3.27	78.4	0.81
Filter Bran	1.8	2.59	83.9	0.77	Filter Bran	1.7	2.71	83.5	0.81	Filter Bran	2.3	2.67	80.7	0.87
Bran	16.1	4.82	100.0	1.42	Bran	16.5	5.12	100.0	1.52	Bran	19.3	4.88	100.0	1.64
Wheat		1.43					1.57					1.59		
St. Grd. Fl.		0.50					0.53					0.60		

PSB13NEDH-11-26					LCI13-069					PSB13NEDH-14-83				
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	3.4	0.36	3.4	0.36	1BK	5.1	0.30	5.1	0.30	2M	19.2	0.33	19.2	0.33
2M	17.1	0.37	20.5	0.37	2M	17.7	0.39	22.8	0.37	1M Red	3.7	0.35	22.9	0.33
1M	7.1	0.39	27.6	0.37	1M Red	3.3	0.40	26.2	0.37	1M	8.6	0.37	31.5	0.34
1BK	6.3	0.42	33.9	0.38	1M	7.8	0.42	33.9	0.38	1BK	6.5	0.40	38.0	0.35
3M	14.6	0.49	48.5	0.41	2BK	3.2	0.46	37.1	0.39	3M	15.8	0.44	53.8	0.38
Grader	3.1	0.55	51.6	0.42	3M	17.4	0.47	54.5	0.42	2BK	3.6	0.51	57.5	0.39
2BK	3.9	0.57	55.5	0.43	Grader	2.5	0.50	57.1	0.42	Grader	2.9	0.52	60.4	0.39
FILTER FLR	3.8	0.62	59.3	0.44	FILTER FLR	3.9	0.50	61.0	0.43	4M	4.9	0.54	65.3	0.40
4M	7.0	0.62	66.3	0.46	4M	7.2	0.59	68.1	0.44	FILTER FLR	3.8	0.60	69.1	0.42
3BK	2.5	0.67	68.8	0.47	3BK	2.6	0.64	70.8	0.45	3BK	2.3	0.66	71.3	0.42
5M	2.8	1.29	71.6	0.50	5M	2.9	1.28	73.7	0.48	5M	3.4	1.01	74.7	0.45
Break Shorts	3.3	3.74	74.9	0.64	Break Shorts	2.8	2.82	76.5	0.57	Break Shorts	2.7	3.08	77.4	0.54
Red Dog	2.7	2.14	77.6	0.70	Red Dog	1.8	2.49	78.3	0.61	Red Dog	2.1	2.46	79.5	0.59
Red Shorts	0.5	3.08	78.1	0.71	Red Shorts	0.6	3.28	78.9	0.63	Red Shorts	0.4	3.35	79.9	0.61
Filter Bran	1.6	3.55	79.7	0.77	Filter Bran	1.7	3.16	80.6	0.69	Filter Bran	2.5	3.33	82.4	0.69
Bran	20.3	4.96	100.0	1.62	Bran	19.4	4.73	100.0	1.47	Bran	17.6	5.13	100.0	1.47
Wheat		1.53					1.41					1.44		
St. Grd. Fl.		0.49					0.50					0.46		

Limagrain: Cumulative Protein Curves



LCH13-048				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
2M	19.0	9.6	19.0	9.6
1M Red	2.8	9.6	21.8	9.6
1M	7.6	9.9	29.4	9.6
3M	14.6	10.1	44.0	9.8
4M	9.3	10.4	53.3	9.9
FILTER FLR	4.6	11.4	57.9	10.0
5M	3.2	11.6	61.1	10.1
1BK	5.4	11.6	66.5	10.2
Grader	2.2	12.0	68.7	10.3
3BK	3.2	14.1	71.9	10.4
2BK	3.2	14.8	75.1	10.6
Break Shorts	3.8	15.4	78.9	10.9
Red Dog	2.8	13.7	81.7	11.0
Red Shorts	0.5	13.2	82.1	11.0
Filter Bran	1.8	13.2	83.9	11.0
Bran	16.1	15.6	100.0	11.7
Wheat		11.9		
St. Grd. Fl		10.6		

LCH13NEDH-12-27				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
2M	18.7	9.4	18.7	9.4
1M Red	3.6	9.4	22.3	9.4
1M	8.2	9.8	30.5	9.5
3M	15.3	9.9	45.8	9.6
4M	6.6	10.7	52.4	9.7
FILTER FLR	5.0	11.2	57.4	9.9
1BK	6.1	11.7	63.5	10.0
Grader	2.9	11.9	66.4	10.1
5M	1.9	12.7	68.3	10.2
2BK	4.6	15.0	72.9	10.5
3BK	3.1	15.0	76.0	10.7
Break Shorts	3.5	15.6	79.5	10.9
Red Dog	2.0	13.4	81.5	11.0
Red Shorts	0.4	12.1	81.9	11.0
Filter Bran	1.7	12.7	83.5	11.0
Bran	16.5	16.3	100.0	11.9
		12.3		
		10.7		

Jagalene (CC01)				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
1BK	6.4	7.9	6.4	7.9
1M Red	3.2	8.6	9.6	8.2
1M	7.1	8.6	16.7	8.4
2M	18.3	8.7	35.0	8.5
Grader	2.8	9.2	37.7	8.6
3M	15.3	9.2	53.0	8.8
FILTER FLR	3.2	9.4	56.2	8.8
4M	7.3	9.7	63.5	8.9
2BK	3.6	10.9	67.1	9.0
3BK	2.4	11.6	69.5	9.1
5M	2.2	11.7	71.7	9.2
Break Shorts	3.6	13.2	75.3	9.4
Red Dog	2.6	12.3	77.9	9.5
Red Shorts	0.5	11.9	78.4	9.5
Filter Bran	2.3	10.7	80.7	9.5
Bran	19.3	13.1	100.0	10.2
		10.3		
		9.3		

PSB13NEDH-11-26				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
2M	17.1	10.3	17.1	10.3
1M Red	3.4	10.3	20.5	10.3
3M	14.6	10.7	35.1	10.5
1M	7.1	10.9	42.2	10.5
4M	7.0	11.2	49.1	10.6
FILTER FLR	3.8	12.8	53.0	10.8
5M	2.8	12.8	55.8	10.9
Grader	3.1	13.5	58.9	11.0
1BK	6.3	14.0	65.2	11.3
3BK	2.5	17.3	67.7	11.5
2BK	3.9	17.5	71.6	11.9
Break Shorts	3.3	15.2	74.9	12.0
Red Dog	2.7	14.1	77.6	12.1
Red Shorts	0.5	12.5	78.1	12.1
Filter Bran	1.6	14.0	79.7	12.1
Bran	20.3	16.9	100.0	13.1
Wheat		13.3		
St. Grd. Fl		11.7		

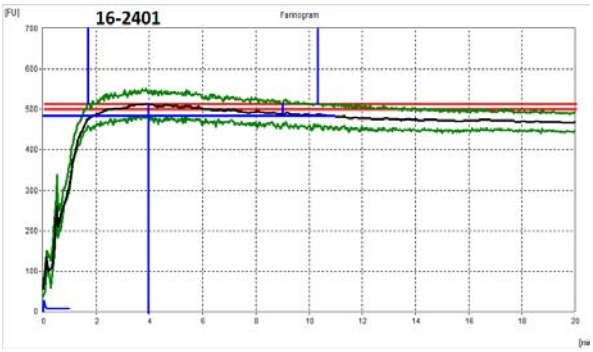
LCI13-069				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
1BK	5.1	7.7	5.1	7.7
1M Red	3.3	7.9	8.4	7.8
1M	7.8	7.9	16.2	7.9
2M	17.7	8.0	33.9	7.9
Grader	2.5	8.3	36.5	7.9
3M	17.4	8.3	53.9	8.1
4M	7.2	8.6	61.1	8.1
FILTER FLR	3.9	8.8	65.0	8.2
5M	2.9	9.9	67.9	8.2
2BK	3.2	10.4	71.1	8.3
3BK	2.6	10.4	73.7	8.4
Break Shorts	2.8	11.5	76.5	8.5
Red Dog	1.8	11.6	78.3	8.6
Red Shorts	0.6	11.5	78.9	8.6
Filter Bran	1.7	11.5	80.6	8.7
Bran	19.4	14.0	100.0	9.7
		9.7		
		8.4		

PSB13NEDH-14-83				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
3M	15.8	9.0	15.8	9.0
2M	19.2	9.1	35.0	9.0
4M	4.9	9.1	39.9	9.0
1M Red	3.7	9.2	43.6	9.1
1M	8.6	9.4	52.3	9.1
1BK	6.5	9.7	58.7	9.2
5M	3.4	9.8	62.1	9.2
FILTER FLR	3.8	10.4	65.9	9.3
Grader	2.9	10.8	68.8	9.3
3BK	2.3	12.9	71.1	9.4
2BK	3.6	13.3	74.7	9.6
Break Shorts	2.7	13.0	77.4	9.7
Red Dog	2.1	12.0	79.5	9.8
Red Shorts	0.4	11.9	79.9	9.8
Filter Bran	2.5	12.8	82.4	9.9
Bran	17.6	14.9	100.0	10.8
		10.8		
		9.6		

Physical Dough Tests

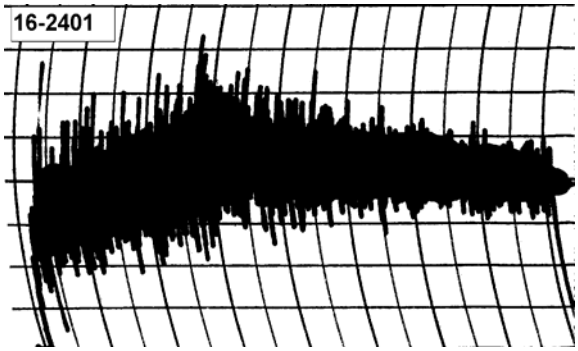
2016 (Small Scale) Samples - Limagrain

Farinograms



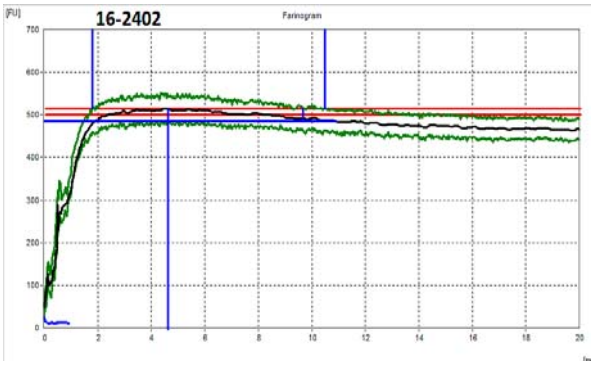
Water abs = 64.4%, Peak time = 4.0 min,
Mix stab = 8.6 min, MTI = 26 FU

Mixograms

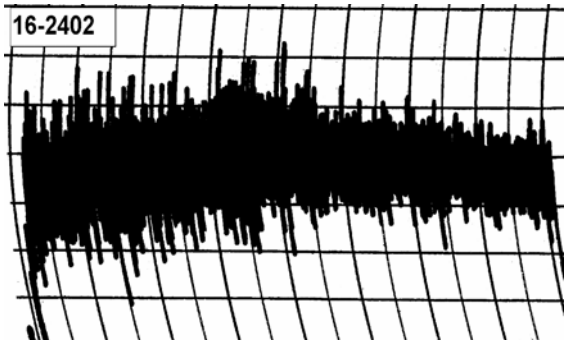


Water abs = 64.7%
Mix time = 3.1 min

16-2401, LCH13-048



Water abs = 64.2%, Peak time = 4.7 min,
Mix stab = 8.7 min, MTI = 22 FU



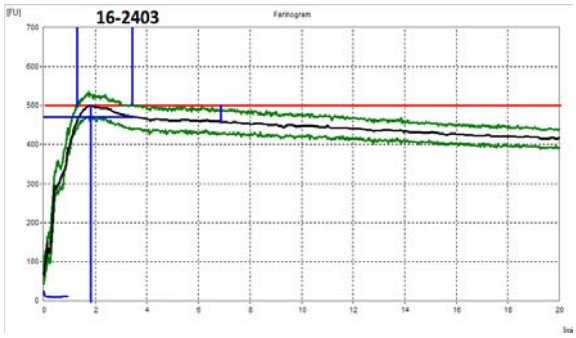
Water abs = 63.8%
Mix time = 3.6 min

16-2402, LCH13NEDH-12-27

Physical Dough Tests

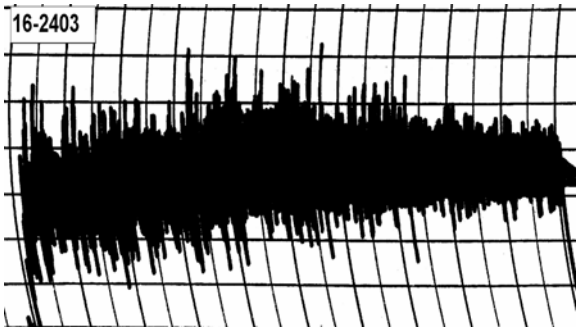
2016 (Small Scale) Samples - Limagrain

Farinograms



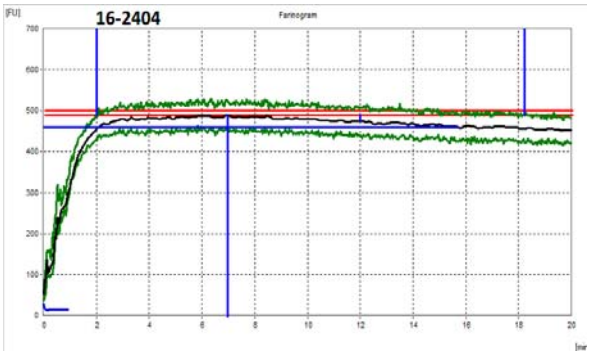
Water abs = 62.2%, Peak time = 1.9 min,
Mix stab = 2.1 min, MTI = 42 FU

Mixograms

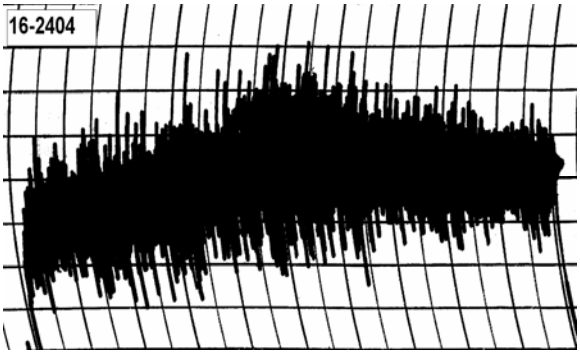


Water abs = 63.0%
Mix time = 5.4 min

16-2403, Jagalene (CC01)



Water abs = 64.6%, Peak time = 7.0 min,
Mix stab = 16.2 min, MTI = 16 FU



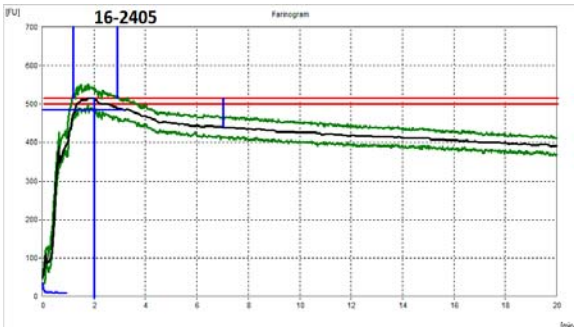
Water abs = 68.4%
Mix time = 5.5 min

16-2404, PSB13NEDH-11-26

Physical Dough Tests

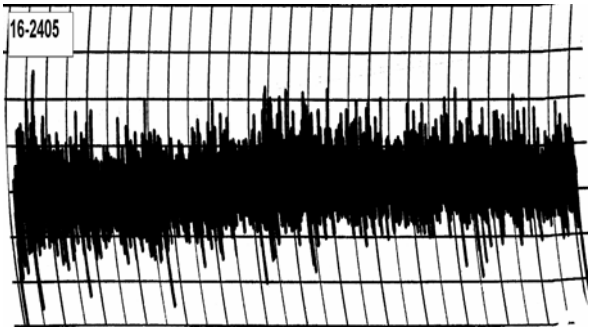
2016 (Small Scale) Samples - Limagrain

Farinograms



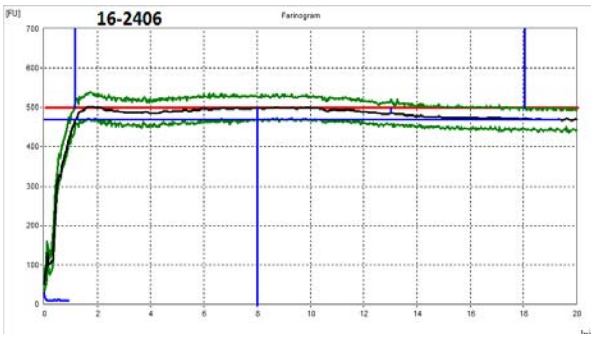
Water abs = 65.9%, Peak time = 2.0 min,
Mix stab = 1.7 min, MTI = 76 FU

Mixograms

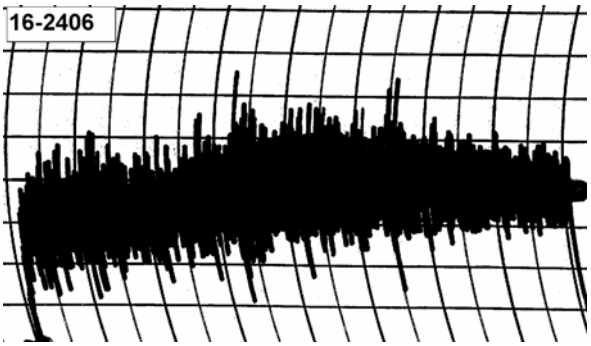


Water abs = 65.0%
Mix time = 7.5 min

16-2405, LCI13-069



Water abs = 61.4%, Peak time = 8.0 min,
Mix stab = 16.9 min, MTI = 14 FU

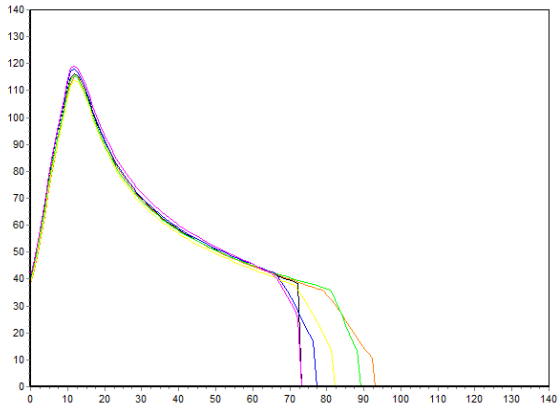


Water abs = 63.0%
Mix time = 4.4 min

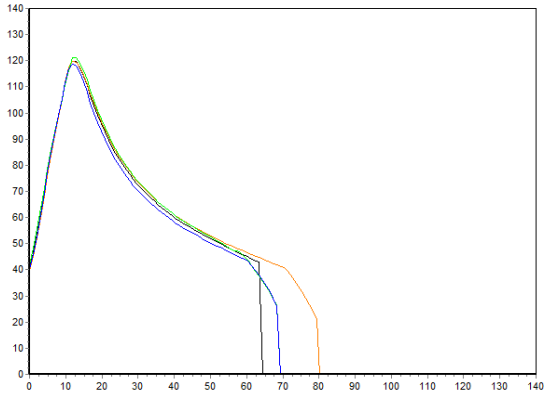
16-2406, PSB13NEDH-14-83

Physical Dough Tests - Alveograph

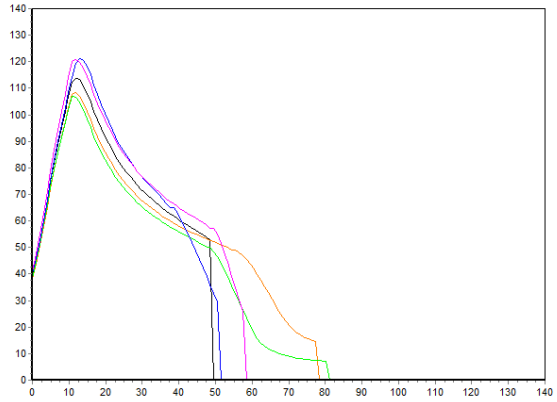
2016 (Small Scale) Samples – Limagrain



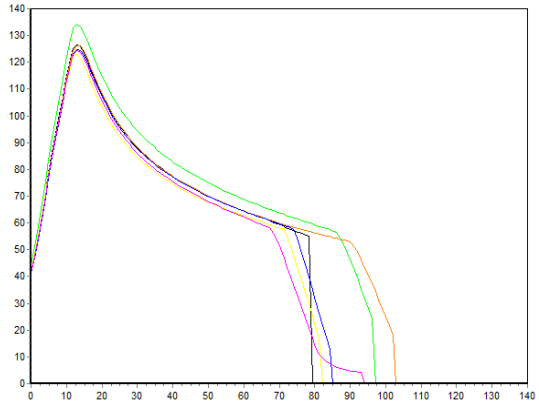
16-2401, LCH13-048
P(mm H_20) =128, L(mm) = 73, W($10E^{-4}$ J) = 313



16-2402, LCH13NEDH-12-27
P(mm H_20) = 132, L(mm) = 63, W($10E^{-4}$ J) = 298



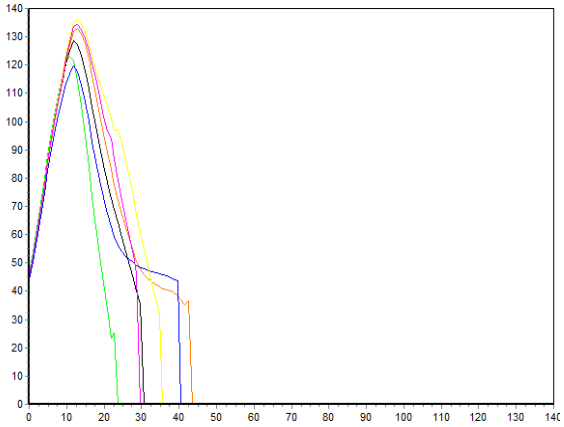
16-2403, Jagalene (CC01)
P(mm H_20) =125, L(mm) = 49, W($10E^{-4}$ J) = 245



16-2404, PSB13NEDH-11-26
P(mm H_20) = 139, L(mm) = 78, W($10E^{-4}$ J) = 411

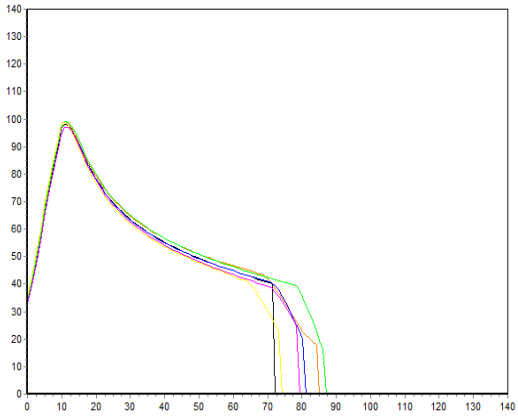
Physical Dough Tests - Alveograph

2016 (Small Scale) Samples – Limagrain



16-2405, LCI13-069

P(mm H_20) =141, L(mm) = 31, W($10E^{-4}$ J) = 167

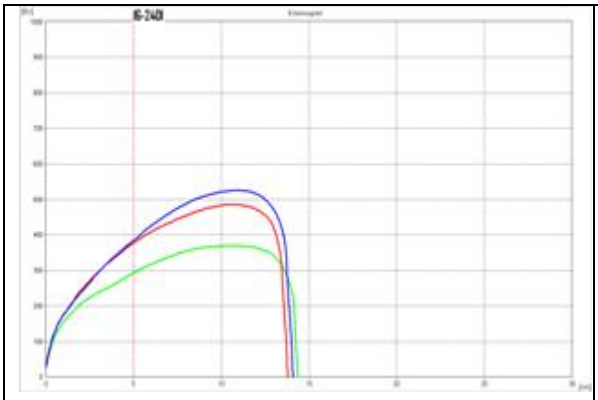


16-2406, PSB13NEDH-14-83

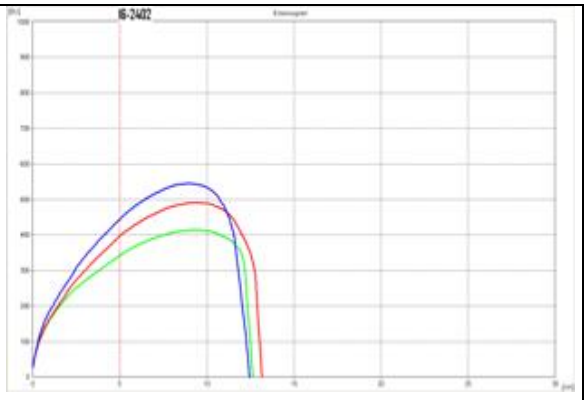
P(mm H_20) = 108, L(mm) = 71, W($10E^{-4}$ J) = 283

Physical Dough Tests - Extensigraph

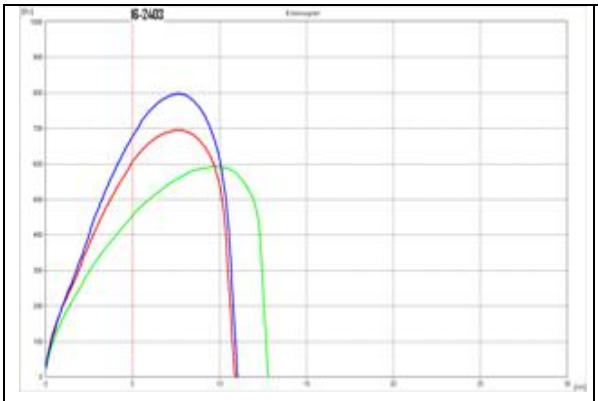
2016 (Small Scale) Samples – Limagrain



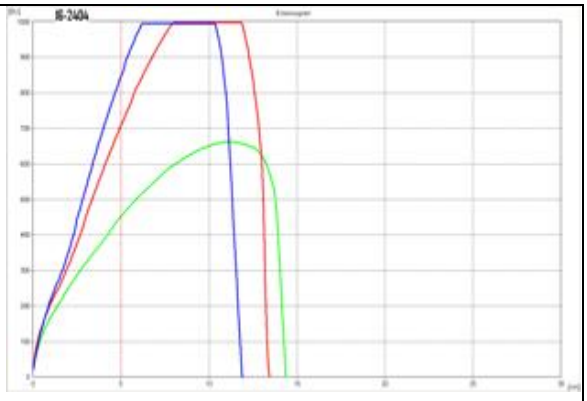
16-2401, LCH13-048
R (BU) = 379, E (mm) = 139, W (cm^2) = 91
Rmax (BU) = 486, Ratio = 2.72 at 90 min



16-2402, LCH13NEDH-12-27
R (BU) = 399, E (mm) = 133, W (cm^2) = 86
Rmax (BU) = 491, Ratio = 3.00 at 90 min



16-2403, Jagalene (CC01)
R (BU) = 609, E (mm) = 110, W (cm^2) = 96
Rmax (BU) = 696, Ratio = 5.53 at 90 min

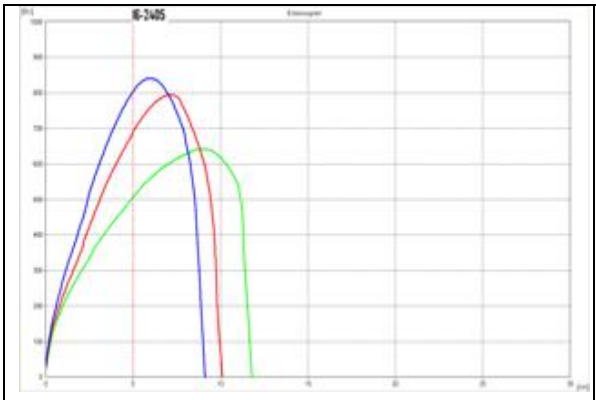


16-2404, PSB13NEDH-11-26
R (BU) = 713, E (mm) = 135, W (cm^2) = 168
Rmax (BU) = 998, Ratio = 5.30 at 90 min

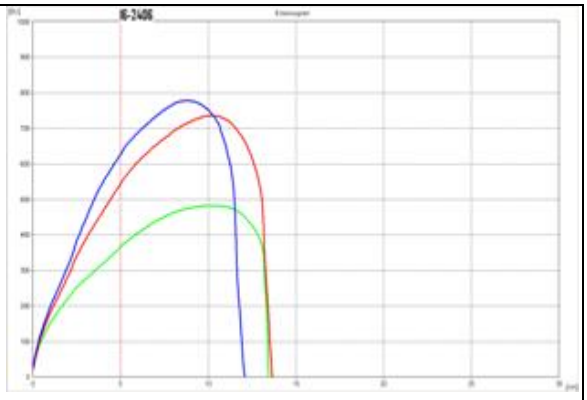
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigraph

2016 (Small Scale) Samples – Limagrain



16-2405, LCI13-069
R (BU) = 696, E (mm) = 101, W (cm^2) = 97
Rmax (BU) = 797, Ratio = 6.89 at 90 min



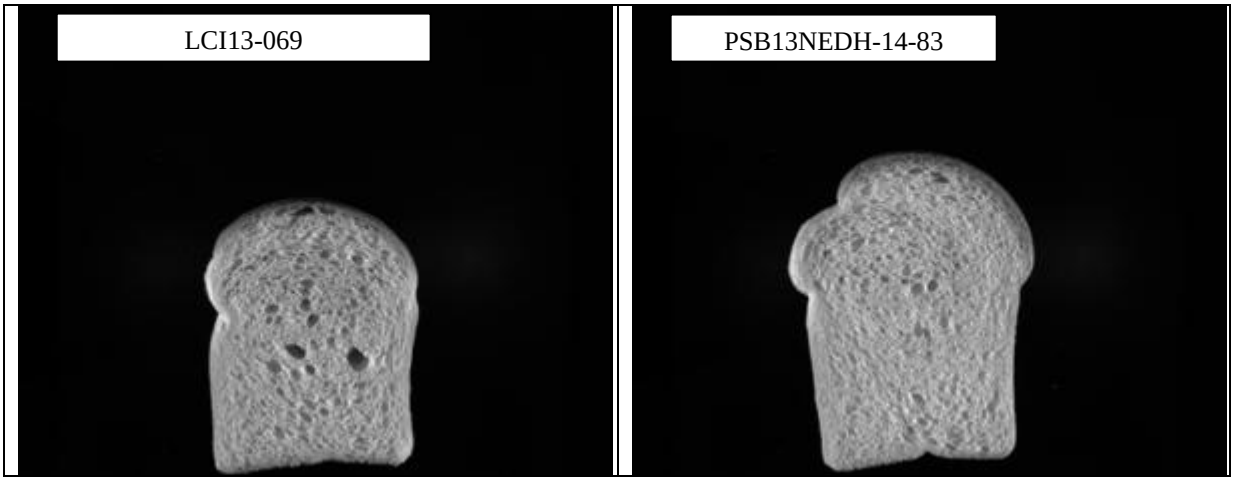
16-2406, PSB13NEDH-14-83
R (BU) = 548, E (mm) = 138, W (cm^2) = 127
Rmax (BU) = 736, Ratio = 3.97 at 90 min

Limagrain: C-Cell Bread Images and Analysis
2016 (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 (^{0})
2401	5725	142.1	3874	0.438	1.692	2.924	1.678	-17.10
2402	5750	139.9	4021	0.428	1.734	0.795	1.700	-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 (^{0})
2403	5257	138.6	3683	0.431	1.723	3.303	1.685	-23.30
2404	5872	141.9	3969	0.437	1.856	8.747	1.695	-21.15

Limagrain: C-Cell Bread Images and Analysis
2016 (Small-Scale) Samples



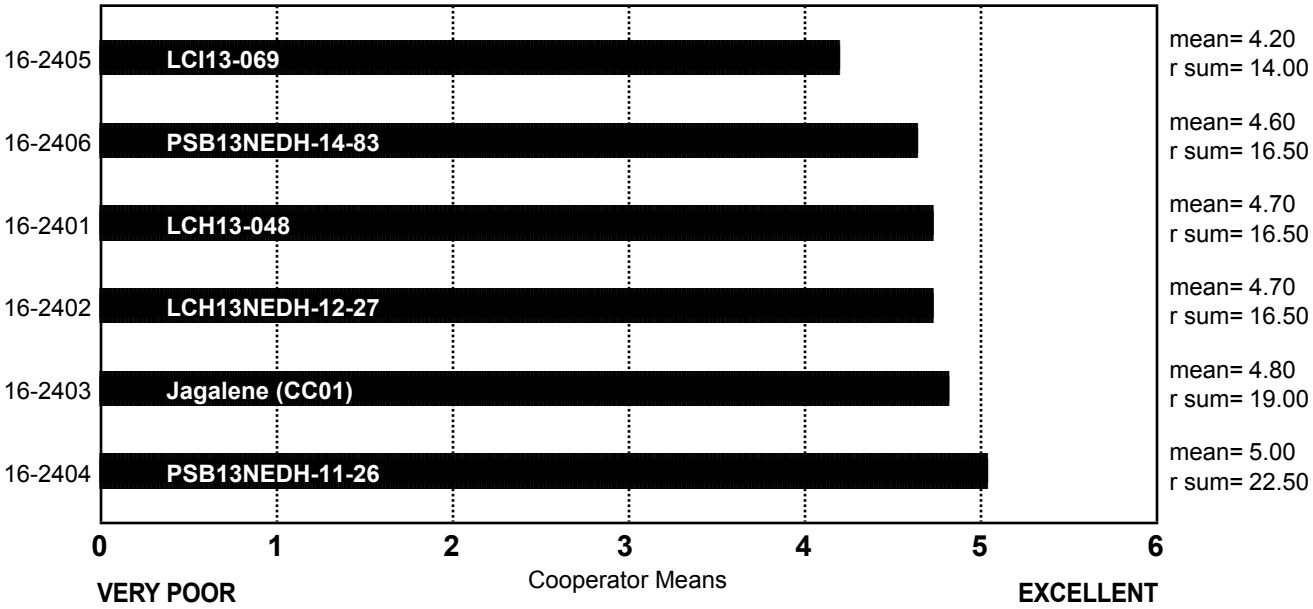
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2405	4790	138.2	3158	0.444	1.780	1.295	1.625	-28.90
2406	5788	149.0	3940	0.430	1.782	2.682	1.665	-17.80

SPONGE CHARACTERISTICS

(Small Scale) Limagrain

ncoop= 5
chisq= 2.43
chisqc= 4.47
cvchisq= 11.07
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

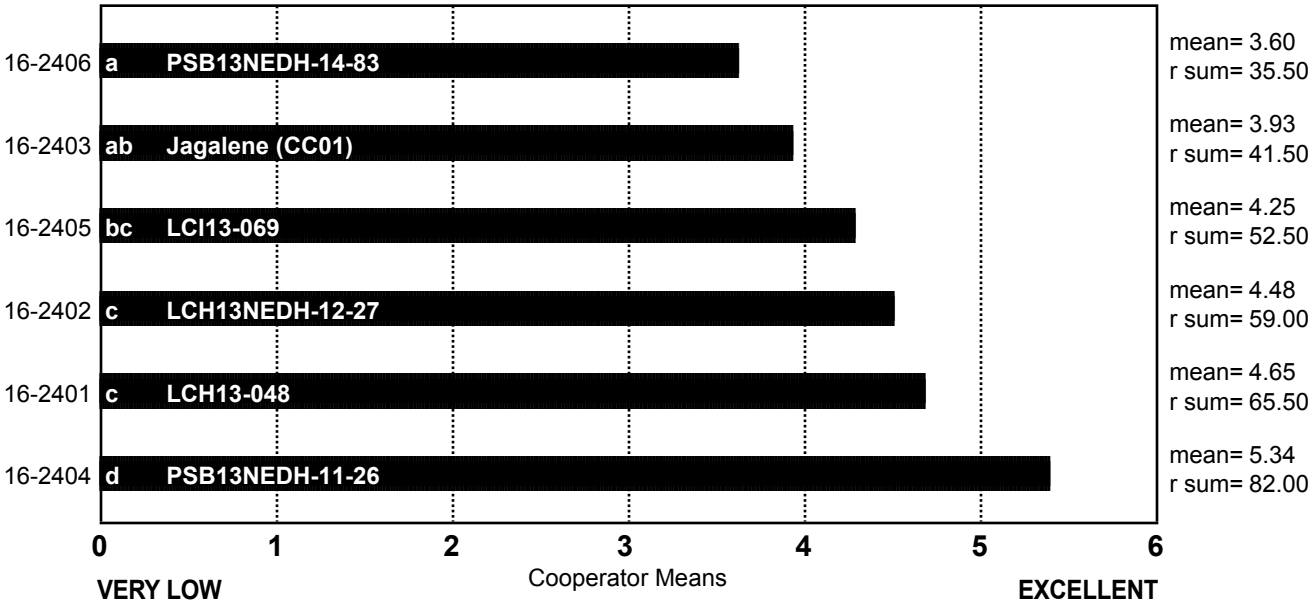


BAKE ABSORPTION

(Small Scale) Limagrain

ncoop= 16
chisq= 25.32
chisqc= 32.82
cvchisq= 11.07
crdiff= 14.80

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) Limagrain

	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
16-2401 LCH13-048	**62.9**	**64.4**	**64.4**	**67.0**	**62.5**	**70.1**	**57.0**	**60.0**	**67.8**	**60.8**	**63.6**	**65.8**	**64.4**	**60.0**	**64.0**	**64.7**
16-2402 LCH13NEDH-12-27	**63.9**	**64.2**	**64.2**	**65.2**	**64.0**	**68.1**	**57.0**	**60.1**	**67.6**	**59.5**	**62.4**	**64.1**	**64.2**	**60.0**	**64.0**	**63.8**
16-2403 Jagalene (CC01)	**63.1**	**62.2**	**62.2**	**65.2**	**60.5**	**66.4**	**55.0**	**57.7**	**66.6**	**58.0**	**61.8**	**64.0**	**62.2**	**60.0**	**62.0**	**63.0**
16-2404 PSB13NEDH-11-26	**66.2**	**64.6**	**64.6**	**69.8**	**65.5**	**67.7**	**58.0**	**61.4**	**69.0**	**62.1**	**66.7**	**68.9**	**64.6**	**60.0**	**64.0**	**68.4**
16-2405 LCI13-069	**62.5**	**65.9**	**65.9**	**65.6**	**60.0**	**69.0**	**54.0**	**56.9**	**69.9**	**59.4**	**63.3**	**66.0**	**65.9**	**60.0**	**65.0**	**63.4**
16-2406 PSB13NEDH-14-83	**61.4**	**61.4**	**61.4**	**64.7**	**61.8**	**62.3**	**55.0**	**58.4**	**65.1**	**58.5**	**61.4**	**63.6**	**61.4**	**60.0**	**61.0**	**62.8**

BAKE MIX TIME, ACTUAL

(Small Scale) Limagrain

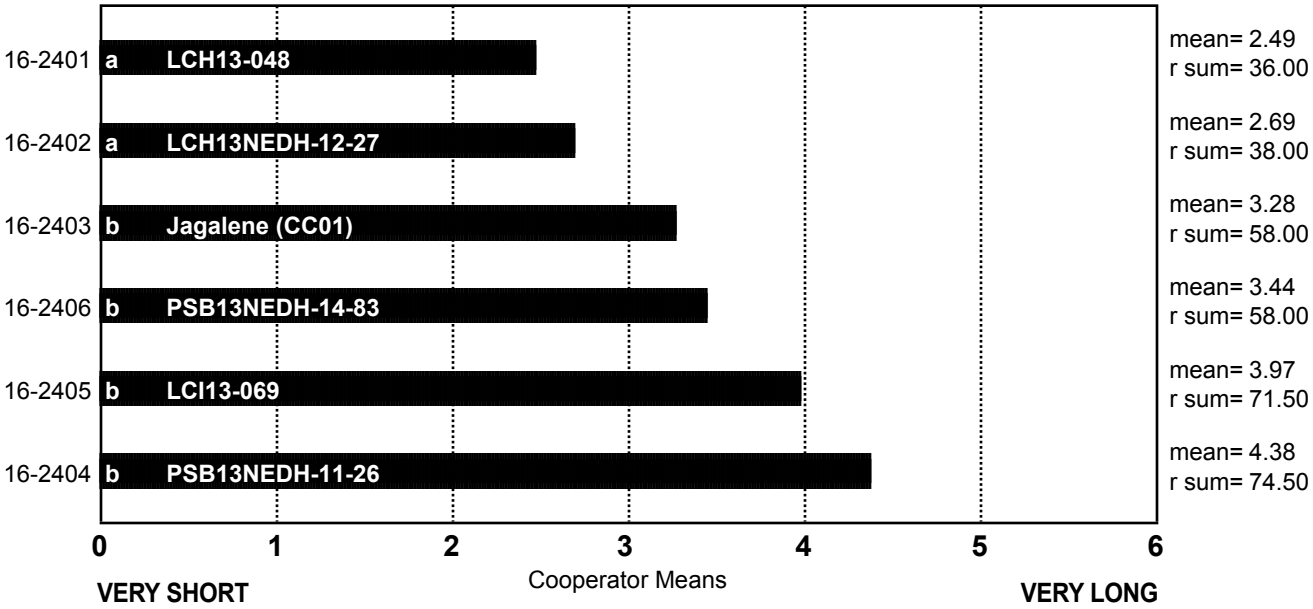
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2401 LCH13-048	**3.3**	**4.0**	**7.0**	**2.8**	**5.1**	**4.0**	**6.0**	**3.3**	**2.8**	**4.0**	**2.8**	**3.6**	**4.5**	**4.0**	**8.0**	**3.1**
16-2402 LCH13NEDH-12-27	**3.3**	**4.0**	**7.0**	**3.6**	**5.8**	**3.5**	**8.0**	**4.0**	**2.0**	**4.0**	**2.9**	**4.1**	**4.0**	**4.0**	**10.0**	**3.6**
16-2403 Jagalene (CC01)	**5.0**	**3.0**	**4.3**	**4.6**	**8.1**	**4.5**	**7.0**	**5.0**	**3.8**	**4.0**	**4.0**	**6.0**	**3.0**	**4.0**	**10.0**	**4.9**
16-2404 PSB13NEDH-11-26	**5.0**	**11.0**	**10.0**	**4.7**	**7.2**	**5.0**	**11.0**	**4.3**	**3.5**	**8.0**	**3.8**	**6.0**	**6.0**	**16.0**	**25.0**	**5.0**
16-2405 LCI13-069	**7.5**	**6.0**	**3.0**	**7.4**	**12.6**	**4.0**	**9.0**	**6.0**	**6.0**	**8.0**	**5.6**	**10.0**	**2.0**	**8.0**	**10.0**	**7.5**
16-2406 PSB13NEDH-14-83	**4.5**	**8.0**	**8.0**	**4.6**	**6.6**	**4.0**	**9.0**	**4.2**	**2.8**	**4.0**	**3.7**	**5.1**	**4.0**	**4.0**	**12.0**	**4.4**

BAKE MIX TIME

(Small Scale) Limagrain

ncoop= 16
chisq= 23.47
chisqc= 27.22
cvchisq= 11.07
crdiff= 16.55

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

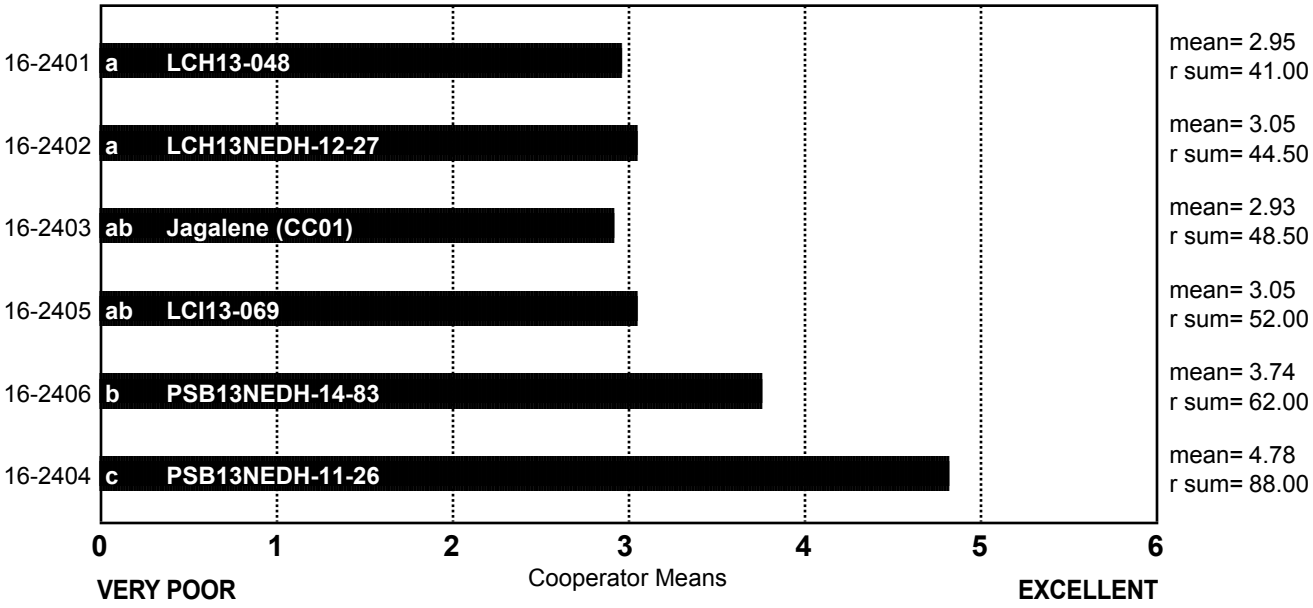


MIXING TOLERANCE

(Small Scale) Limagrain

ncoop= 16
chisq= 26.60
chisqc= 31.56
cvchisq= 11.07
crdiff= 15.67

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

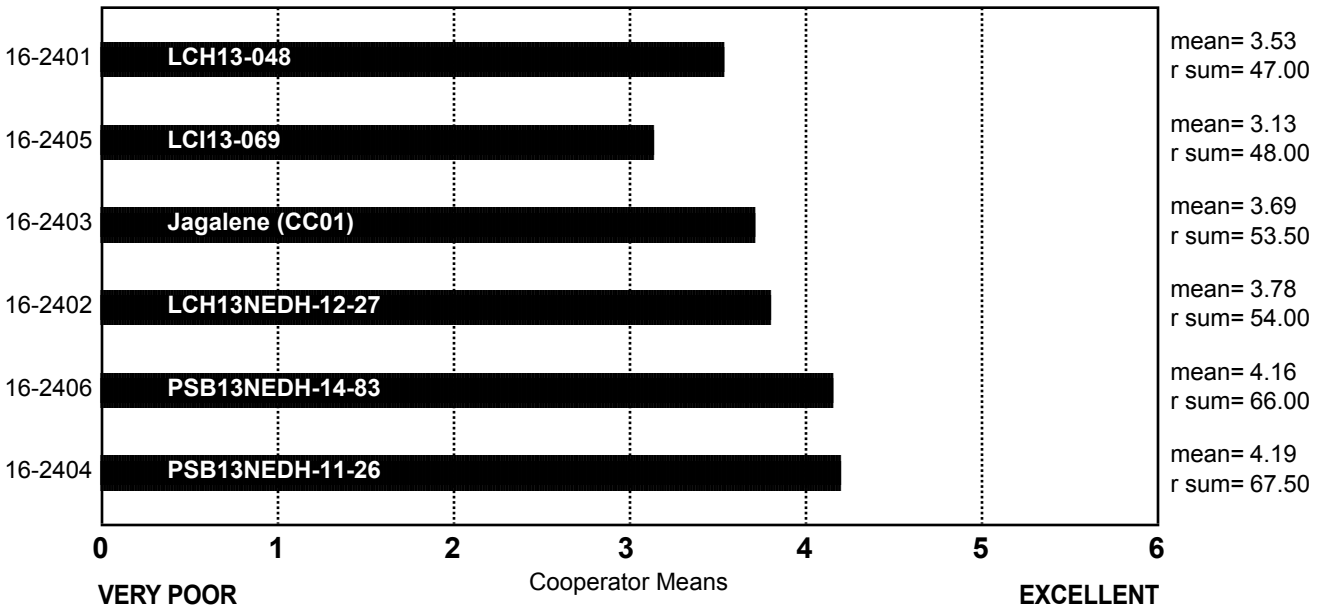


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Limagrain

ncoop= 16
chisq= 6.92
chisqc= 9.23
cvchisq= 11.07
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Limagrain

	Sticky	Wet	Tough	Good	Excellent
16-2401 LCH13-048	**4**	**1**	**2**	**8**	**1**
16-2402 LCH13NEDH-12-27	**0**	**4**	**2**	**10**	**0**
16-2403 Jagalene (CC01)	**0**	**1**	**6**	**8**	**1**
16-2404 PSB13NEDH-11-26	**0**	**1**	**5**	**6**	**4**
16-2405 LCI13-069	**1**	**3**	**4**	**7**	**1**
16-2406 PSB13NEDH-14-83	**2**	**2**	**1**	**9**	**2**

Frequency Table

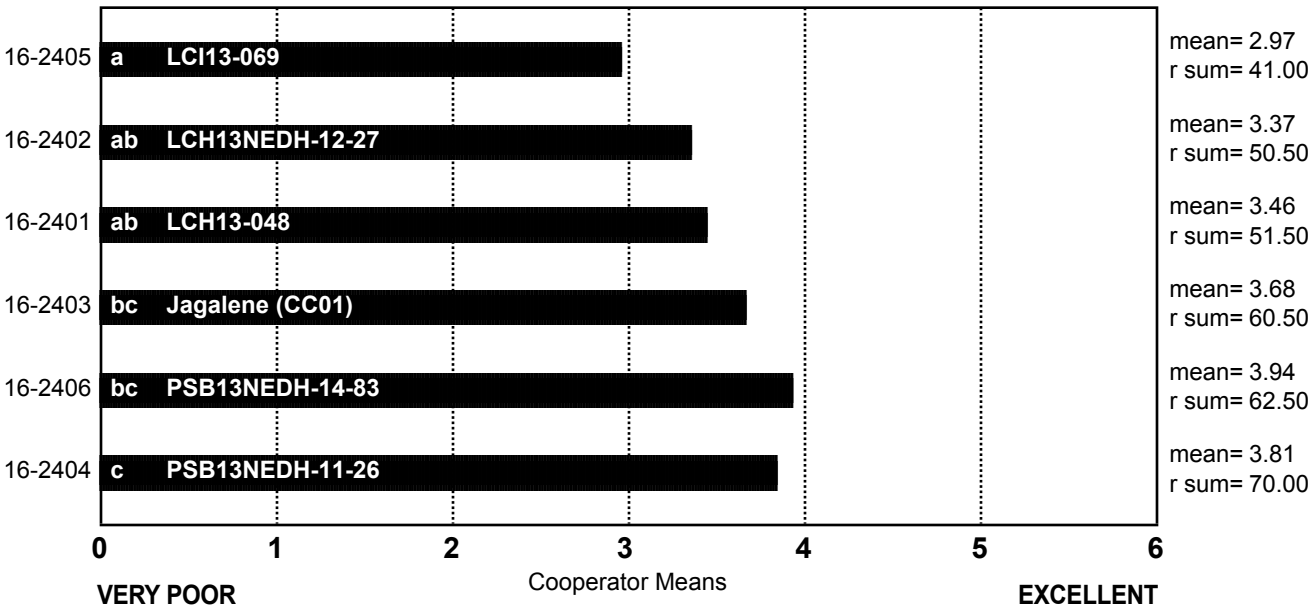
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Limagrain

ncoop= 16
chisq= 9.54
chisqc= 13.59
cvchisq= 11.07
crdiff= 16.74

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) Limagrain

	Sticky	Wet	Tough	Good	Excellent
16-2401 LCH13-048	**2**	**3**	**1**	**9**	**1**
16-2402 LCH13NEDH-12-27	**2**	**4**	**1**	**8**	**1**
16-2403 Jagalene (CC01)	**1**	**0**	**4**	**10**	**1**
16-2404 PSB13NEDH-11-26	**0**	**0**	**5**	**9**	**2**
16-2405 LCI13-069	**2**	**2**	**4**	**7**	**1**
16-2406 PSB13NEDH-14-83	**3**	**2**	**0**	**10**	**1**

Frequency Table

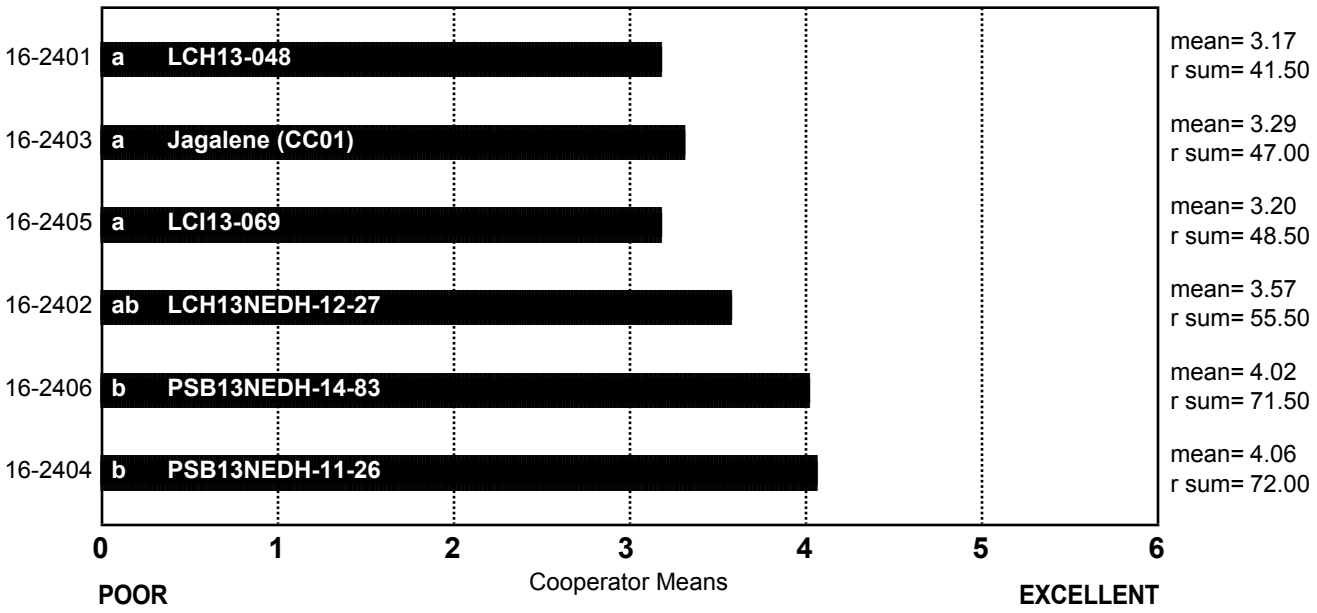
CRUMB GRAIN

(Small Scale) Limagrain

ncoop= 16
chisq= 15.07
chisqc= 19.01
cvchisq= 11.07
crdiff= 17.06

Variety order by rank sum.

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Limagrain

	Open	Fine	Dense
16-2401 LCH13-048	**11**	**4**	**1**
16-2402 LCH13NEDH-12-27	**5**	**7**	**4**
16-2403 Jagalene (CC01)	**7**	**6**	**3**
16-2404 PSB13NEDH-11-26	**6**	**9**	**1**
16-2405 LCI13-069	**6**	**5**	**5**
16-2406 PSB13NEDH-14-83	**4**	**11**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Limagrain

	Round	Irregular	Elongated
16-2401 LCH13-048	**10**	**2**	**4**
16-2402 LCH13NEDH-12-27	**6**	**4**	**6**
16-2403 Jagalene (CC01)	**2**	**8**	**6**
16-2404 PSB13NEDH-11-26	**3**	**6**	**7**
16-2405 LCI13-069	**7**	**7**	**2**
16-2406 PSB13NEDH-14-83	**4**	**4**	**8**

Frequency Table

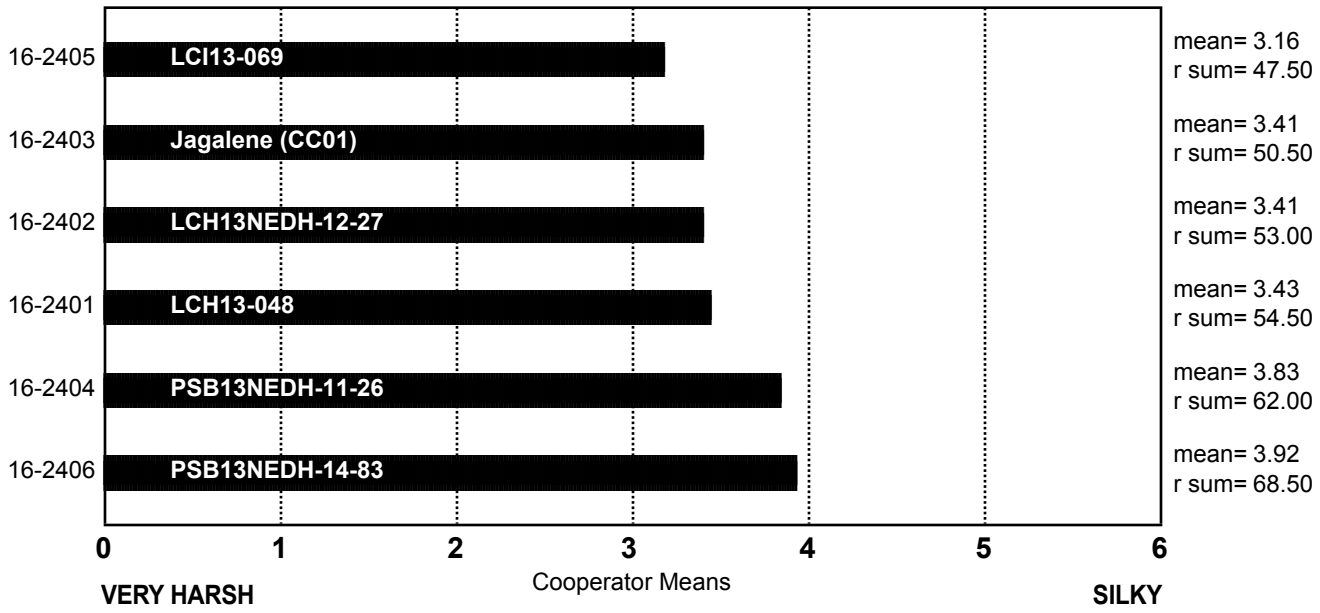
CRUMB TEXTURE

(Small Scale) Limagrain

ncoop= 16
chisq= 5.46
chisqc= 7.48
cvchisq= 11.07
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Limagrain

	Harsh	Smooth	Silky
16-2401 LCH13-048	**6**	**7**	**3**
16-2402 LCH13NEDH-12-27	**5**	**10**	**1**
16-2403 Jagalene (CC01)	**9**	**5**	**2**
16-2404 PSB13NEDH-11-26	**4**	**10**	**2**
16-2405 LCI13-069	**7**	**9**	**0**
16-2406 PSB13NEDH-14-83	**1**	**13**	**2**

Frequency Table

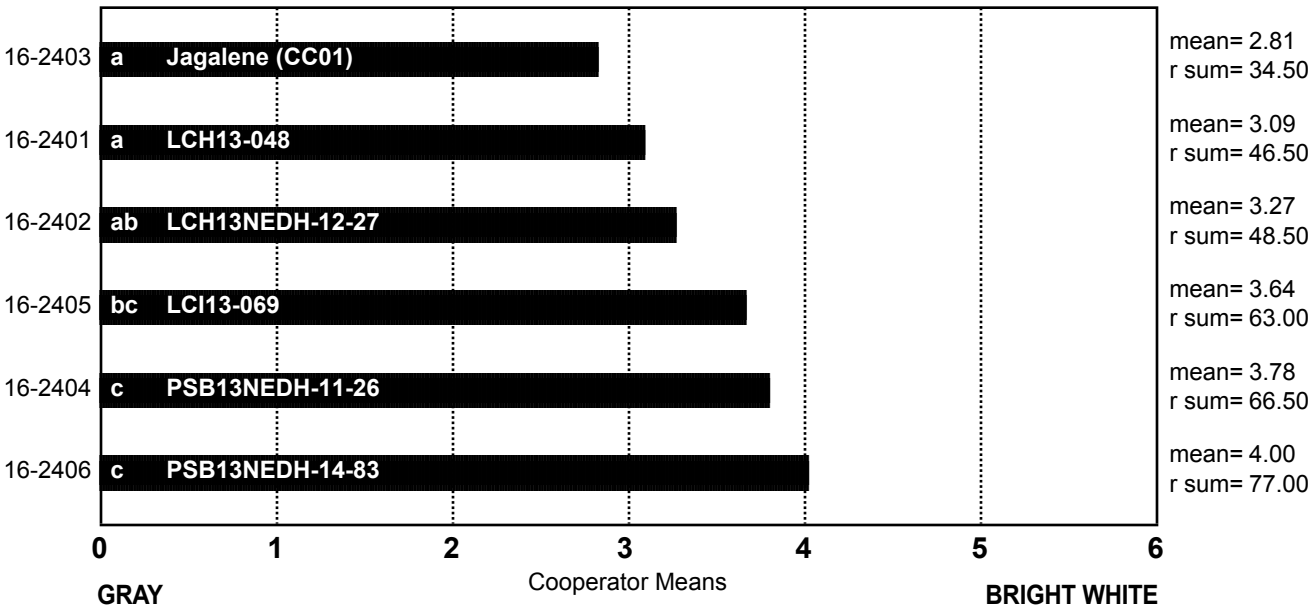
CRUMB COLOR

(Small Scale) Limagrain

ncoop= 16
chisq= 21.59
chisqc= 28.72
cvchisq= 11.07
crdiff= 15.23

Variety order by rank sum.

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



CRUMB COLOR, DESCRIBED

(Small Scale) Limagrain

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
16-2401 LCH13-048	**0**	**0**	**7**	**5**	**3**	**1**	**0**
16-2402 LCH13NEDH-12-27	**0**	**0**	**3**	**7**	**6**	**0**	**0**
16-2403 Jagalene (CC01)	**1**	**2**	**4**	**4**	**4**	**1**	**0**
16-2404 PSB13NEDH-11-26	**0**	**0**	**1**	**3**	**11**	**0**	**1**
16-2405 LCI13-069	**0**	**0**	**4**	**2**	**6**	**4**	**4**
16-2406 PSB13NEDH-14-83	**0**	**0**	**2**	**1**	**8**	**3**	**2**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Limagrain

	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
16-2401 LCH13-048	**143.7**	**458.7**	**453.2**	**158.3**	**138.2**	**131.9**	**415.0**	**141.1**	**136.1**	**475.8**	**142.9**	**152.2**	**442.9**	**148.6**		**137.9**
16-2402 LCH13NEDH-12-27	**142.9**	**463.8**	**458.6**	**155.8**	**139.3**	**131.9**	**414.0**	**141.6**	**136.2**	**478.9**	**142.8**	**152.0**	**441.1**	**147.0**		**138.4**
16-2403 Jagalene (CC01)	**142.5**	**467.7**	**461.5**	**153.7**	**137.8**	**134.6**	**413.0**	**142.0**	**135.8**	**480.2**	**141.4**	**153.0**	**440.0**	**144.7**		**138.6**
16-2404 PSB13NEDH-11-26	**145.6**	**464.1**	**460.0**	**159.9**	**147.4**	**131.9**	**413.0**	**142.5**	**136.2**	**482.9**	**142.9**	**156.4**	**442.7**	**150.2**		**138.0**
16-2405 LCI13-069	**142.7**	**463.4**	**461.4**	**157.9**	**137.8**	**140.1**	**415.0**	**142.4**	**135.9**	**486.3**	**143.0**	**155.9**	**444.1**	**146.9**		**141.4**
16-2406 PSB13NEDH-14-83	**144.4**	**463.1**	**442.6**	**154.9**	**139.4**	**129.7**	**415.0**	**139.4**	**132.6**	**473.6**	**140.3**	**151.2**	**445.8**	**146.8**		**139.1**

LOAF VOLUME, ACTUAL

(Small Scale) Limagrain

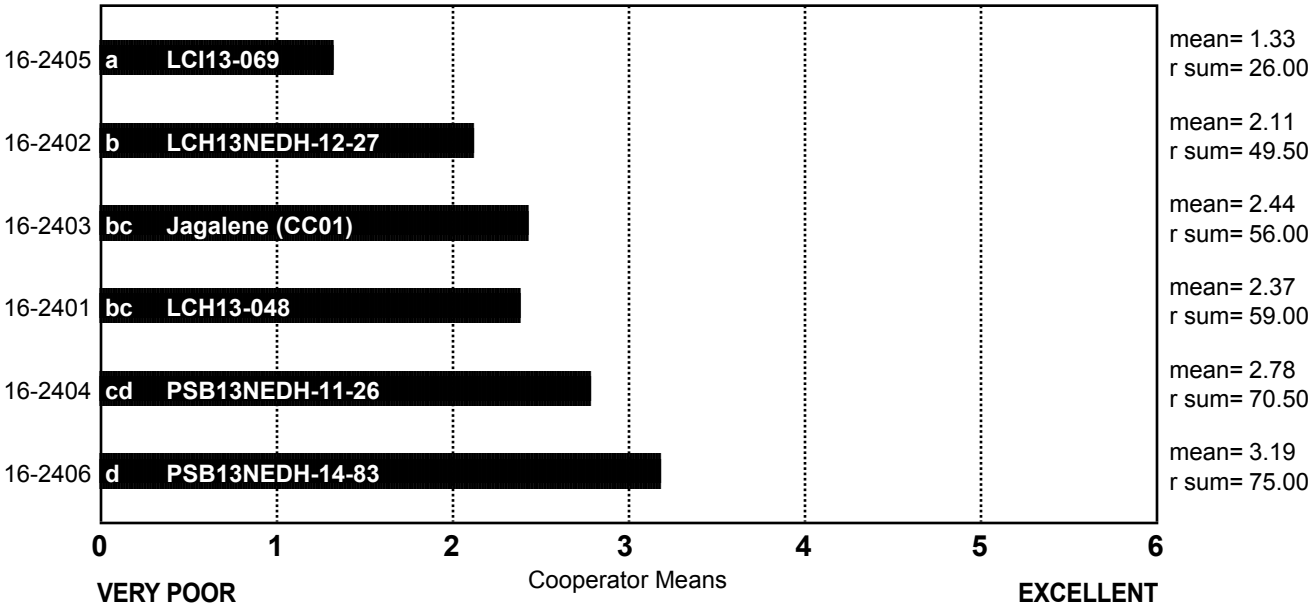
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2401 LCH13-048	**825**	**2150**	**2503**	**913**	**836**	**900**	**2600**	**755**	**785**	**2463**	**710**	**835**	**2375**	**825**	**2839**	**752**
16-2402 LCH13NEDH-12-27	**835**	**2250**	**2311**	**880**	**801**	**840**	**2625**	**660**	**740**	**2438**	**690**	**800**	**2475**	**855**	**2839**	**732**
16-2403 Jagalene (CC01)	**840**	**2138**	**2228**	**768**	**773**	**840**	**2700**	**635**	**820**	**2413**	**750**	**705**	**2425**	**840**	**3015**	**744**
16-2404 PSB13NEDH-11-26	**935**	**2238**	**2465**	**955**	**890**	**930**	**2650**	**825**	**895**	**2388**	**840**	**810**	**2375**	**800**	**2897**	**746**
16-2405 LCI13-069	**780**	**2063**	**1783**	**740**	**716**	**700**	**2400**	**600**	**815**	**2225**	**650**	**625**	**2300**	**775**	**2721**	**666**
16-2406 PSB13NEDH-14-83	**850**	**2375**	**2422**	**935**	**855**	**870**	**2575**	**730**	**880**	**2525**	**805**	**800**	**2450**	**900**	**3104**	**758**

LOAF VOLUME

(Small Scale) Limagrain

ncoop= 16
chisq= 27.19
chisqc= 33.83
cvchisq= 11.07
crdiff= 14.94

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

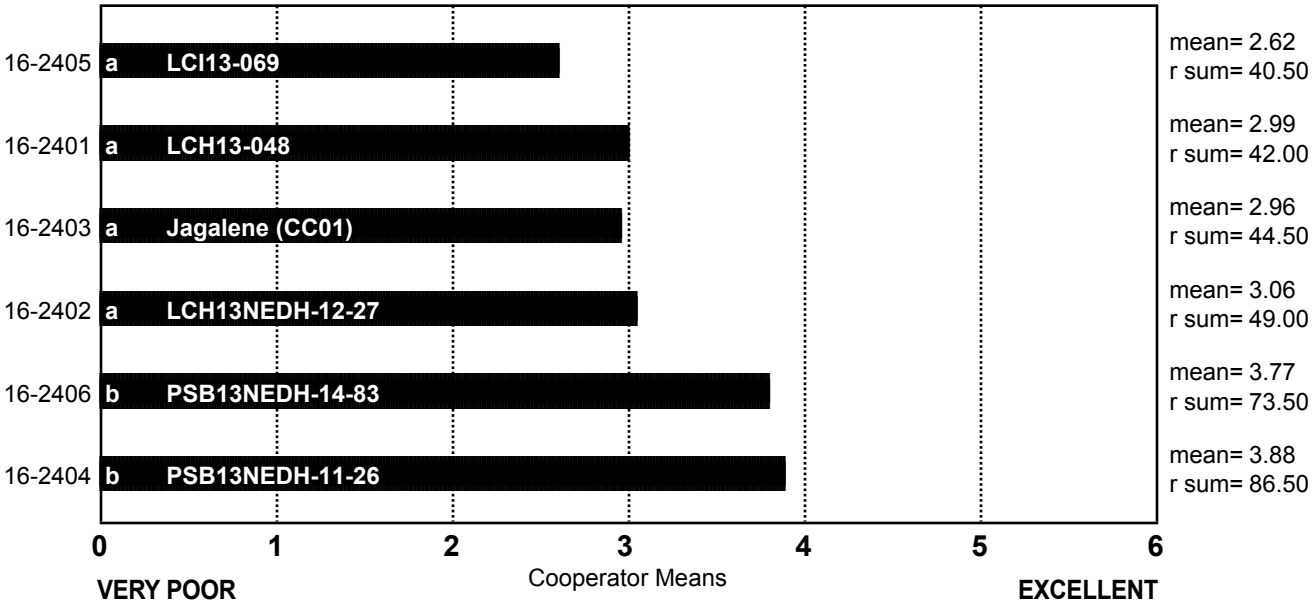


OVERALL BAKING QUALITY

(Small Scale) Limagrain

ncoop= 16
chisq= 33.11
chisqc= 35.72
cvchisq= 11.07
crdiff= 15.71

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Limagrain

COOP. 16-2401 LCH13-048

A. No comment.
B. Above average absorption, short mix time, very low volume, yellow, open, flat.
C. Over-mixed, texture issues.
D. Low protein %, short mixing time, dough strength OK for protein level, bread volume and grain average.
E. Normal water absorption and mix time, slight sticky & strong dough, OK volume, yellow crumb, slight open elongated cells, resilient & smooth texture.
F. Good texture and feel but not very white color.
G. Sticky out of mixer, good recovery at makeup, lower loaf volume.
H. Poor performance for protein level.
I. No comment.
J. Good absorption, sticky wet dough, average grain, low volume.
K. Very good absorption for protein, small/harsh.
L. Good absorption & mix time, questionable crumb grain.
M. No comment.
N. No comment.
O. Slightly open, consistent, slightly course grain, low volume.
P. No comment.

COOP. 16-2402 LCH13NEDH-12-27

A. No comment.
B. Above average absorption, short mix time, very low volume, creamy, open.
C. Over-mixed, texture issues.
D. Low protein %, mix time OK, poor dough strength, bread volume OK for protein, poor grain.
E. Normal water absorption and mix time, slight sticky & strong dough, fair volume, yellow crumb, slight open elongated cells, resilient & smooth texture.
F. No comment.
G. Good out of mixer, low volume.
H. High ash, poor performance for protein level.
I. No comment.
J. Average absorption, good dough, good grain, low volume.
K. Very good absorption for protein, small/harsh.
L. Good absorption & mix time, sticky at pan yet satisfactory crumb grain.
M. Second best bread of the set, excellent mix time and makeup with a high absorption, bread was creamy white in color with a fine grain rating.
N. No comment.
O. Tight, consistent, slightly course grain, low volume.
P. No comment.

COOP. 16-2403 Jagalene (CC01)

A. No comment.
B. Slightly above average absorption, short mix time, very low volume, yellow, open.
C. Very low mix time but did well considering stability, texture issues.
D. Very low protein %, mix time good, dough strength looks promising for protein level, bread volume and grain good for such low protein.
E. Low water absorption, long mix time, slight sticky & weak dough, fair volume, yellow crumb, slight open elongated cells, resilient & slightly harsh texture.
F. No comment.
G. Better volume, low protein.
H. No elasticity, low protein, high ash.
I. Poor color from dough to loaf, large and irregular cells in crumb.
J. Low absorption, tough dough, good grain, low volume.
K. Very poor protein, excellent absorption.
L. Good absorption, long mix time, excellent out of mixer, questionable-satisfactory crumb grain, low loaf volume.
M. No comment.
N. No comment.
O. Tight, consistent, smooth grain, very good volume.
P. No comment.

COOP. 16-2404 PSB13NEDH-11-26

A. Excellent externals.
B. High absorption, slightly above average mix time, very low volume, creamy, open.
C. Could have mixed longer.
D. Good mix time and dough strength, volume and crumb grain fairly good.
E. Normal water absorption, long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & silky smooth texture.
F. Good loaf volume and in range for mixing and crumb characteristics.
G. Higher protein.
H. Best protein in set.
I. No comment.
J. Good absorption, good mix time, good grain, low volume.
K. Very poor protein, excellent absorption.
L. Excellent absorption, long mix time, excellent out of mixer, questionable-satisfactory crumb grain.
M. Best bread of the set, excellent mix time and makeup, excellent absorption, bread was above average in volume with a fine grain rating, bright white in color.
N. Elastic at mix.
O. Consistent, slightly coarse grain, average volume.
P. No comment.

COOP. 16-2405 LCI13-069

A. No comment.
B. High absorption, average mix time, very low volume, creamy, open.
C. Very sticky and low stability, texture issues.
D. Very low protein %, mix time good, dough strength looks promising for protein level, bread volume good for such low protein, crumb grain very poor.
E. Low water absorption, very long mix time, slight sticky & strong dough, low volume, creamy crumb, slight open elongated cells, resilient & smooth texture.
F. Not suitable for bread wheat.
G. Low volume, low protein.
H. No elasticity, low protein.
I. Mix time did not reflect farinograph development time, crumb has soft and smooth texture, but feels slightly damp/sticky.
J. Average absorption, good mix time, good dough, good grain, very low volume considering other parameters were much better.
K. Very poor protein/strength, excellent absorption.
L. Low flour protein, high absorption, long mix time, dense-round poor crumb grain, very low loaf volume, poor overall rating.
M. Had a hard time with this flour, high absorption with low mix time, couldn't make a sponge so had to add more flour, very wet but ended with decent bread.
N. No comment.
O. Slightly open, variable, slightly coarse grain, poor volume.
P. No comment.

COOP. 16-2406 PSB13NEDH-14-83

A. No comment.
B. Average absorption, average mix time, very low volume, creamy, open.
C. Crust color was dark since the bread was in the oven too long, texture issues.
D. Very low protein %, mix time good, dough strength looks promising for protein level, bread volume and grain good for such low protein.
E. Normal water absorption and mix time, slight sticky & strong dough, OK volume, creamy crumb, open elongated cells, resilient & smooth texture.
F. No comment.
G. Good out of mixer, best color.
H. Low protein, good mix tolerance.
I. Mix time did not reflect farinograph development time.
J. Excellent dough out of mixer, very fine grain, average volume.
K. Very poor protein, good absorption.
L. Good absorption and mix time, elongated cells, excellent crumb grain.
M. No comment.
N. No comment.
O. Slightly open, consistent, slightly coarse grain, excellent volume.
P. No comment.

Notes: **B, G, J, M, N, and O** conducted sponge and dough bake tests

KANSAS-HAYS

16-2407	KS12H56-6-4 (Tatanka)
16-2408	Danby
16-2409	Jagalene (CC02)

Description of Test Plots and Breeder Entries

Kansas-Hays - Gourong Zhang

The samples submitted were grown at Hays experimental station in 2016. The field has sandy-loam soil. Test plots were not irrigated, not fertilized, and not sprayed with fungicide. Early spring (March and first half of April) was very dry. Precipitation in April and May was above normal. Plots had good stands and grew well. Stripe rust showed up at the end of April and was the dominant disease this year. The common check Jagalene was moderately susceptible to stripe rust. Local check Danby had moderately resistant reaction to stripe rust. The breeder entry Tatanka showed resistance to stripe rust. In general, the yield level of our test plots was above normal.

Jagalene (common check)

Danby (local check)

Tatanka (KS12H56-6-4)

Tatanka is a hard red winter wheat variety, released in 2016. It has a medium maturity and medium height. Tatanka has good winter-hardiness and medium-long coleoptile. It has good tolerance to grain shattering and pre-harvest sprouting. Tatanka is moderately tolerant to acid soil. It has good resistance to stripe rust and soilborne mosaic virus. Tatanka has competitive yield potential. It has an average test weight and acceptable to good milling and baking quality.

Kansas-Hays: 2016 (Small-Scale) Samples

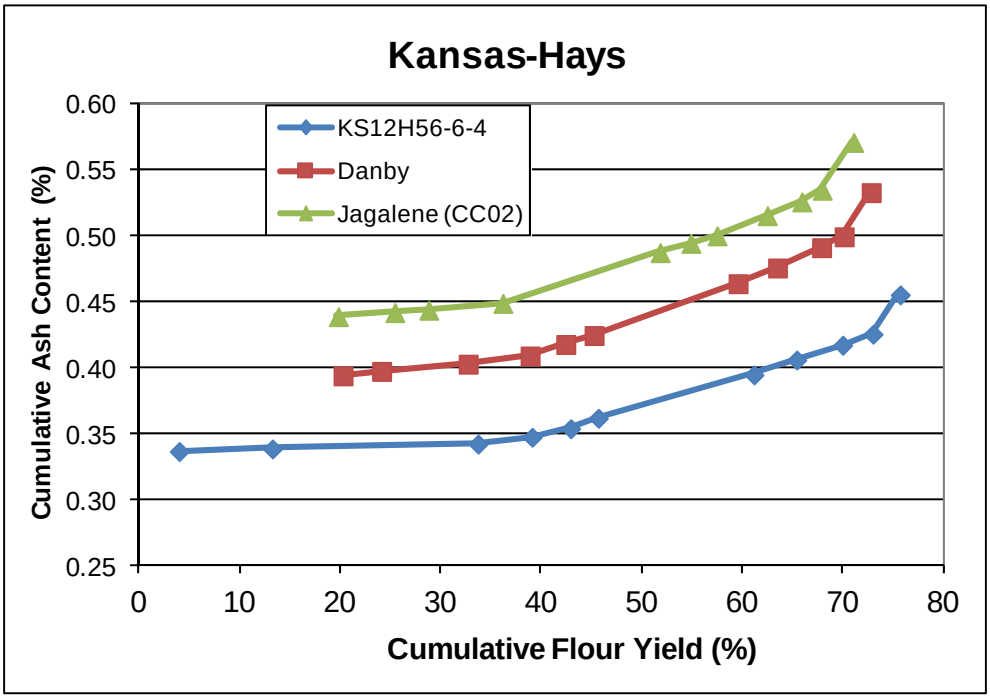
Test entry number	16-2407	16-2408	16-2409
Sample identification	**KS12H56-6-4**	**Danby**	**Jagalene (CC02)**
Wheat Data			
GIPSA classification	1 HRW	2 HDWH	3 HRW
Test weight (lb/bu)	62.0	59.0	57.1
Hectoliter weight (kg/hl)	81.5	77.6	75.2
1000 kernel weight (gm)	28.1	27.5	26.8
Wheat kernel size (Rotap)			
Over 7 wire (%)	47.5	57.1	47.4
Over 9 wire (%)	51.9	41.8	50.5
Through 9 wire (%)	0.6	1.1	2.1
Single kernel (skcs)[a]			
Hardness (avg /s.d)	81.2/15.6	75.4/16.9	76.2/16.8
Weight (mg) (avg/s.d)	28.1/6.7	27.5/7.4	26.8/7.7
Diameter (mm)(avg/s.d)	2.46/0.27	3.43/0.29	2.53/0.34
Moisture (%) (avg/s.d)	10.9/0.4	11.1/0.4	10.9/0.3
SKCS distribution	01-01-05-93-01	01-05-10-84-01	01-03-13-83-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	11.6	11.0	11.9
Wheat ash (12% mb)	1.38	1.50	1.60
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	75.6	72.8	71.0
Quadrumat Sr. Mill	70.1	65.3	65.5
Flour moisture (%)	14.1	13.4	13.2
Flour protein (14% mb)	10.4	9.7	10.7
Flour ash (14% mb)	0.45	0.53	0.59
Rapid Visco-Analyser			
Peak time (min)	6.2	6.2	6.1
Peak viscosity (RVU)	256.9	256.5	180.3
Breakdown (RVU)	110.6	115.7	60.5
Final viscosity at 13 min (RVU)	247.8	241.9	236.3
Minolta color meter			
L*	91.54	91.57	90.91
a*	-1.59	-1.59	-1.85
b*	9.58	9.15	11.27
PPO	0.493	0.522	0.413
Falling number (sec)	494	454	441
Damaged Starch			
(AI%)	97.0	96.4	97.6
(AACC76-31)	7.0	6.6	7.6

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Kansas-Hays: Physical Dough Tests and Gluten Analysis For 2016 (Small-Scale) Samples

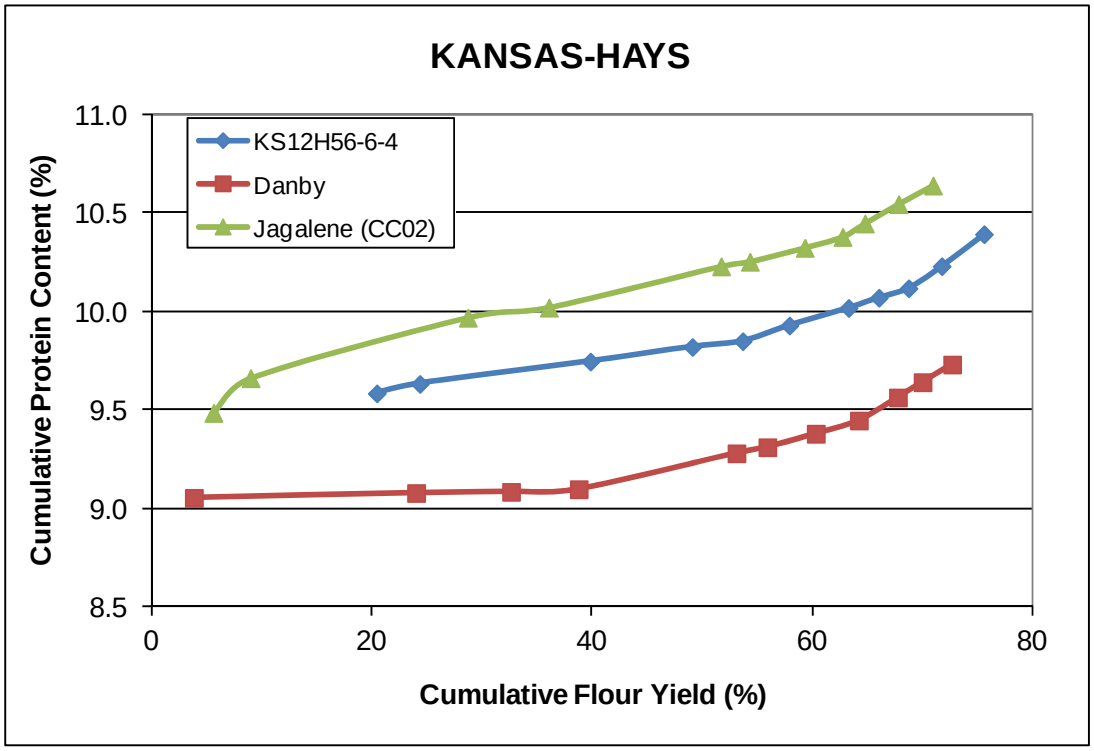
Test Entry Number	16-2407	16-2408	15-2409
Sample Identification	KS12H56-6-4	Danby	Jagalene (CC02)
MIXOGRAPH			
Flour Abs (% as-is)	63.4	61.4	64.6
Flour Abs (14% mb)	63.3	60.6	63.7
Mix Time (min)	4.5	3.4	3.1
Mix tolerance (0-6)	4	2	2
FARINOGRAPH			
Flour Abs (% as-is)	61.2	61.3	62.4
Flour Abs (14% mb)	61.2	60.5	61.5
Development time (min)	7.7	5.4	5.9
Mix stability (min)	17.8	7.3	9.4
Mix Tolerance Index (FU)	18	35	28
Breakdown time (min)	20.0	9.0	12.0
ALVEOGRAPH			
P(mm): Tenacity	113	81	100
L(mm): Extensibility	74	81	75
G(mm): Swelling index	19.1	20.0	19.3
W(10^{-4} J): strength (curve area)	314	204	259
P/L: curve configuration ratio	1.53	1.00	1.33
Ie(P_{200}/P): elasticity index	60.0	47.8	53.4
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	401/592/708	214/279/318	310348/383
Extensibility (mm at 45/90/135 min)	135/131/126	143/151/134	137/147/144
Energy (cm^2 at 45/90/135 min)	92/132/141	54/73/71	74/88/98
Resist $_{max}$ (BU at 45/90/135min)	526/817/918	269/350/382	400/445/525
Ratio (at 45/90/135 min)	2.97/4.52/5.63	1.50/1.85/2.37	2.26/2.38/2.65
PROTEIN ANALYSIS			
HMW-GS Composition	2*,7+8,5+10	2*,7+9,5+10	2*,1, 17+18,5+10
%IPP	51.3	48.6	53.5
SEDIMENTATION TEST			
Volume (ml)	44.5	40.2	46.1

Kansas-Hays: Cumulative Ash Curves



KS12H56-6-4"Tatanka"					Danby					Jagalene (CC02)				
Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash	Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash	Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash
1M Red	3.9	0.34	3.9	0.34	2M	20.2	0.39	20.2	0.39	2M	19.7	0.44	19.7	0.44
1M	9.3	0.34	13.2	0.34	1M Red	3.8	0.42	24.0	0.40	1BK	5.6	0.45	25.3	0.44
2M	20.5	0.34	33.6	0.34	1M	8.6	0.42	32.6	0.40	1M Red	3.4	0.46	28.7	0.44
1BK	5.4	0.38	39.0	0.35	1BK	6.1	0.44	38.8	0.41	1M	7.4	0.47	36.1	0.45
2BK	3.8	0.42	42.8	0.35	2BK	3.6	0.51	42.3	0.42	3M	15.6	0.58	51.7	0.49
Grader	2.7	0.48	45.6	0.36	Grader	2.8	0.53	45.2	0.42	2BK	3.1	0.61	54.8	0.49
3M	15.5	0.49	61.1	0.39	3M	14.3	0.59	59.5	0.46	Grader	2.6	0.62	57.4	0.50
FILTER FLR	4.2	0.57	65.3	0.41	FILTER FLR	3.9	0.65	63.4	0.48	4M	5.0	0.69	62.4	0.51
4M	4.6	0.58	69.9	0.42	4M	4.4	0.71	67.8	0.49	FILTER FLR	3.4	0.71	65.8	0.53
3BK	3.0	0.62	72.9	0.43	3BK	2.2	0.75	70.0	0.50	3BK	2.0	0.82	67.8	0.53
5M	2.7	1.26	75.6	0.46	5M	2.7	1.40	72.7	0.53	5M	3.1	1.36	71.0	0.57
Break Shorts	2.7	3.79	78.3	0.57	Break Shorts	3.0	3.75	75.7	0.66	Break Shorts	3.2	3.80	74.2	0.71
Red Dog	2.0	2.78	80.2	0.62	Red Dog	2.5	2.88	78.2	0.73	Red Dog	2.4	2.89	76.6	0.78
Red Shorts	0.4	3.41	80.7	0.64	Red Shorts	0.5	3.53	78.7	0.75	Red Shorts	0.8	3.90	77.4	0.81
Filter Bran	3.0	3.20	83.7	0.73	Filter Bran	3.5	3.34	82.3	0.86	Filter Bran	5.3	3.78	82.6	1.00
Bran	16.3	5.03	100.0	1.43	Bran	17.7	4.85	100.0	1.57	Bran	17.4	4.79	100.0	1.66
Wheat		1.35					1.47					1.57		
St. Grd. Fl.		0.45					0.53					0.59		

Kansas-Hays: Cumulative Protein Curves

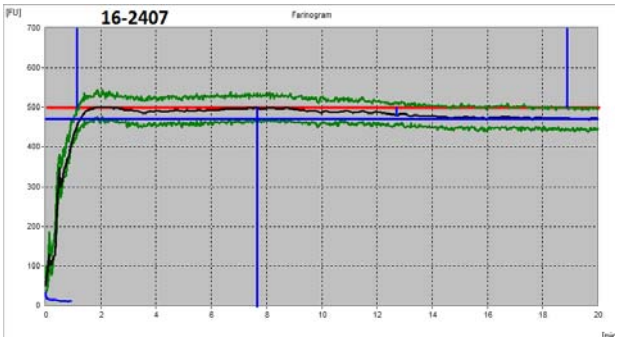


KS12H56-6-4					Danby					Jagalene (CC02)				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein	Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein	Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
2M	20.5	9.6	20.5	9.6	1M Red	3.8	9.1	3.8	9.1	1BK	5.6	9.5	5.6	9.5
1M Red	3.9	9.9	24.4	9.6	2M	20.2	9.1	24.0	9.1	1M Red	3.4	10.0	9.0	9.7
3M	15.5	9.9	39.8	9.7	1M	8.6	9.1	32.6	9.1	2M	19.7	10.1	28.7	10.0
1M	9.3	10.1	49.1	9.8	1BK	6.1	9.2	38.8	9.1	1M	7.4	10.2	36.1	10.0
4M	4.6	10.2	53.7	9.8	3M	14.3	9.8	53.1	9.3	3M	15.6	10.7	51.7	10.2
FILTER FLR	4.2	10.9	57.9	9.9	Grader	2.8	9.9	55.9	9.3	Grader	2.6	10.7	54.3	10.3
1BK	5.4	11.0	63.3	10.0	4M	4.4	10.3	60.3	9.4	4M	5.0	11.1	59.3	10.3
Grader	2.7	11.3	66.0	10.1	FILTER FLR	3.9	10.5	64.2	9.4	FILTER FLR	3.4	11.3	62.8	10.4
5M	2.7	11.3	68.7	10.1	2BK	3.6	11.7	67.8	9.6	3BK	2.0	12.5	64.8	10.4
3BK	3.0	12.8	71.8	10.2	3BK	2.2	12.0	70.0	9.6	2BK	3.1	12.6	67.8	10.5
2BK	3.8	13.4	75.6	10.4	5M	2.7	12.1	72.7	9.7	5M	3.1	12.7	71.0	10.6
Break Shorts	2.7	15.6	78.3	10.6	Break Shorts	3.0	15.4	75.7	10.0	Break Shorts	3.2	15.6	74.2	10.9
Red Dog	2.0	14.0	80.2	10.7	Red Dog	2.5	14.1	78.2	10.1	Red Dog	2.4	14.4	76.6	11.0
Red Shorts	0.4	12.9	80.7	10.7	Red Shorts	0.5	13.6	78.7	10.1	Red Shorts	0.8	13.7	77.4	11.0
Filter Bran	3.0	12.5	83.7	10.7	Filter Bran	3.5	13.2	82.3	10.2	Filter Bran	5.3	13.4	82.6	11.1
Bran	16.3	15.4	100.0	11.5	Bran	17.7	15.1	100.0	11.1	Bran	17.4	15.1	100.0	11.8
Wheat		11.3					10.8					11.6		
St. Grd. Fl		10.4					9.7					10.7		

Physical Dough Tests

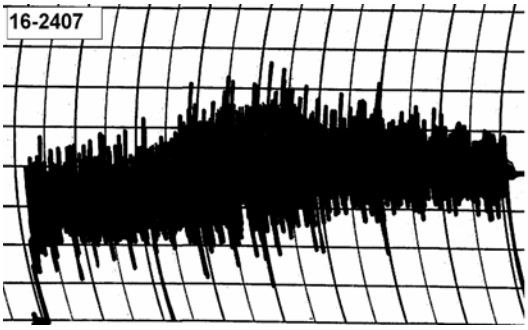
2016 (Small Scale) Samples - Kansas-Hays

Farinograms



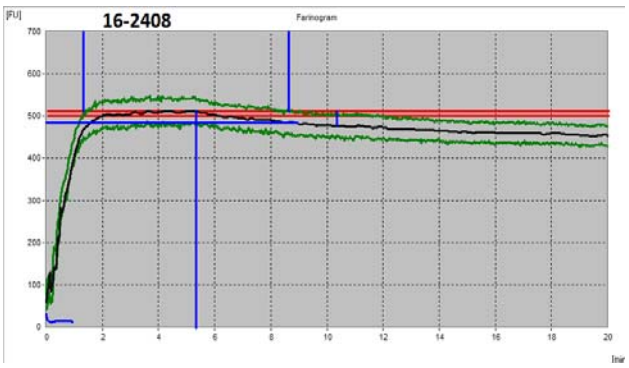
Water abs = 61.2%, Peak time = 7.7 min,
Mix stab = 17.8 min, MTI = 18 FU

Mixograms

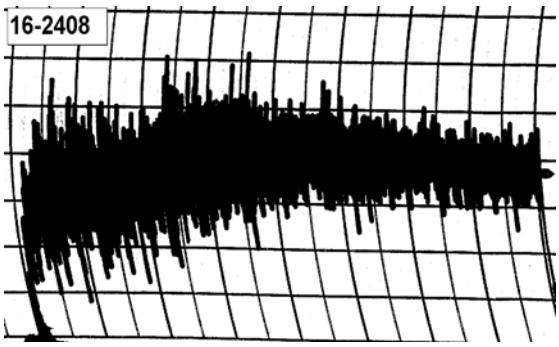


Water abs = 63.3%
Mix time = 4.5 min

16-2407, KS12H56-6-4



Water abs = 60.5%, Peak time = 5.4 min,
Mix stab = 7.3 min, MTI = 35 FU



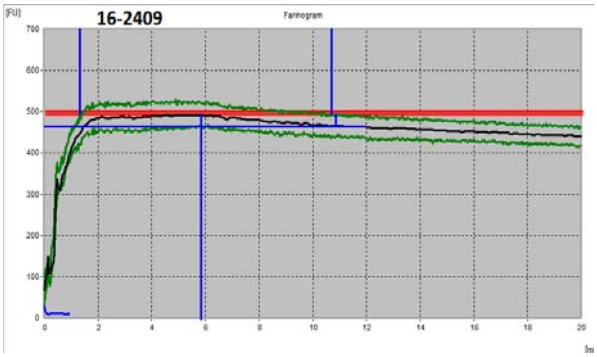
Water abs = 60.6%
Mix time = 3.4 min

16-2408, Danby

Physical Dough Tests

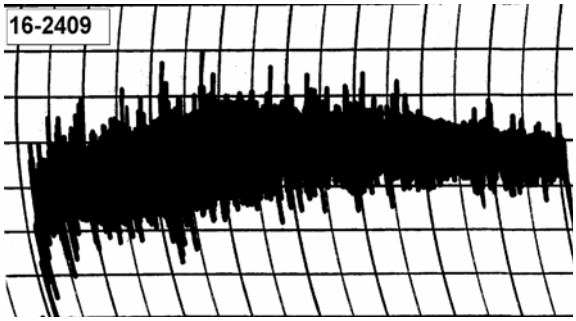
2016 (Small Scale) Samples - Kansas-Hays (continued)

Farinograms



Water abs= 61.5%, Peak time = 5.9 min,
Mix stab = 9.4 min, MTI = 28 FU

Mixograms

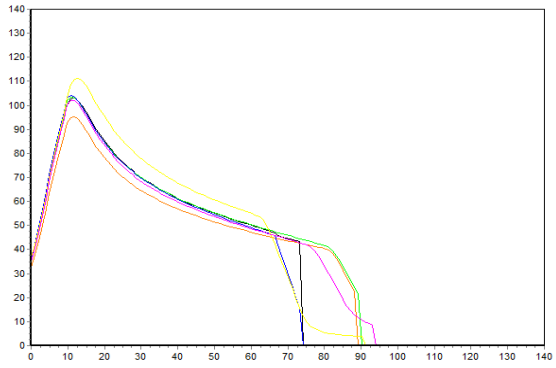


Water abs = 63.7%
Mix time = 3.1 min

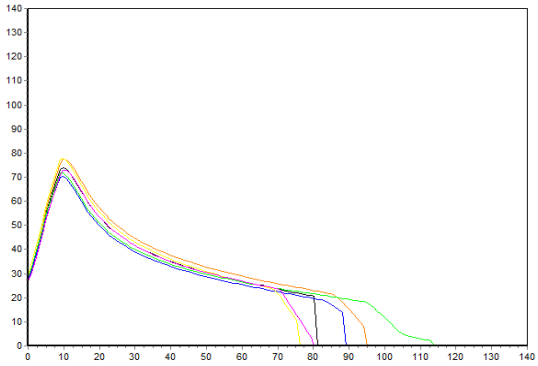
16-2409, Jagalene (CC02)

Physical Dough Tests - Alveograph

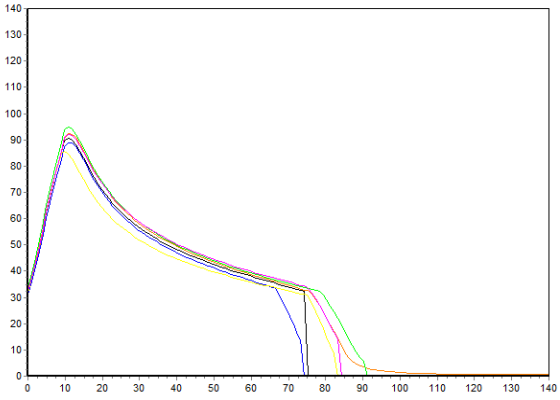
2016 (Small Scale) Samples – Kansas-Hays



16-2407, KS12H56-6-4
P(mm H_20)=113, L(mm)=74, W($10E^{-4}$ J)=314



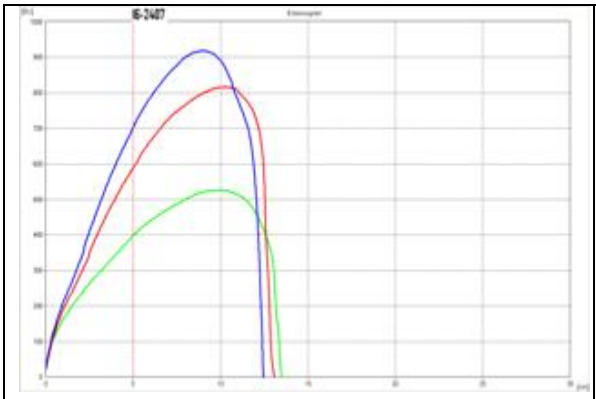
16-2408, Danby
P(mm H_20)=81, L(mm)=81, W($10E^{-4}$ J)=204



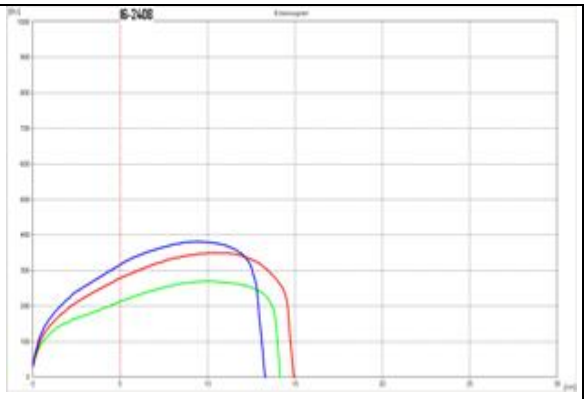
16-2409, Jagalene (CC02)
P(mm H_20)=100, L(mm)=75, W($10E^{-4}$ J)=259

Physical Dough Tests - Extensigraph

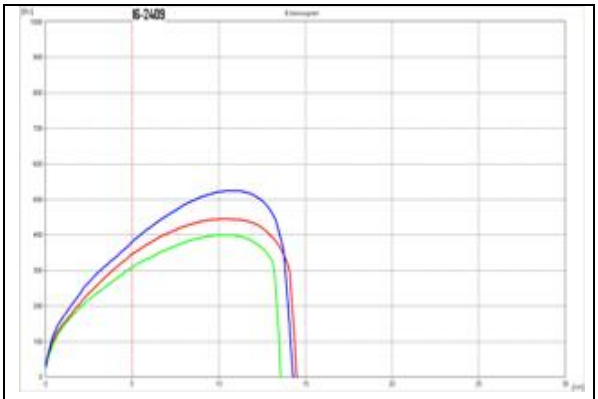
2016 (Small Scale) Samples – Kansas-Hays



16-2407, KS12H56-6-4
R (BU) = 592, E (mm) =131, W (cm^2) = 132
Rmax (BU) = 817, Ratio = 4.5 at 90 min



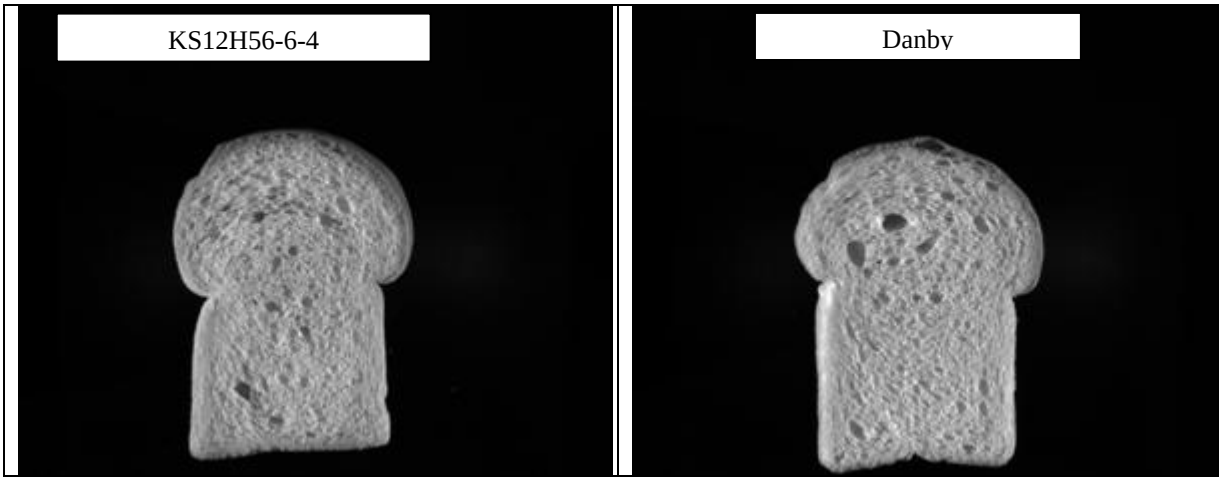
16-2408, Danby
R (BU) = 279, E (mm) =151, W (cm^2) = 73
Rmax (BU) = 350, Ratio = 1.9 at 90 min



16-2409, Jagalene (CC02)
R (BU) = 348, E (mm) = 147, W (cm^2) = 88
Rmax (BU) = 445, Ratio = 2.4 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Kansas-Hays: C-Cell Bread Images and Analysis for 2016 (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 (^{0})
2407	5991	142.6	3883	0.436	1.872	9.068	1.660	-5.10
2408	6131	146.1	3993	0.441	1.906	1.887	1.648	-18.48

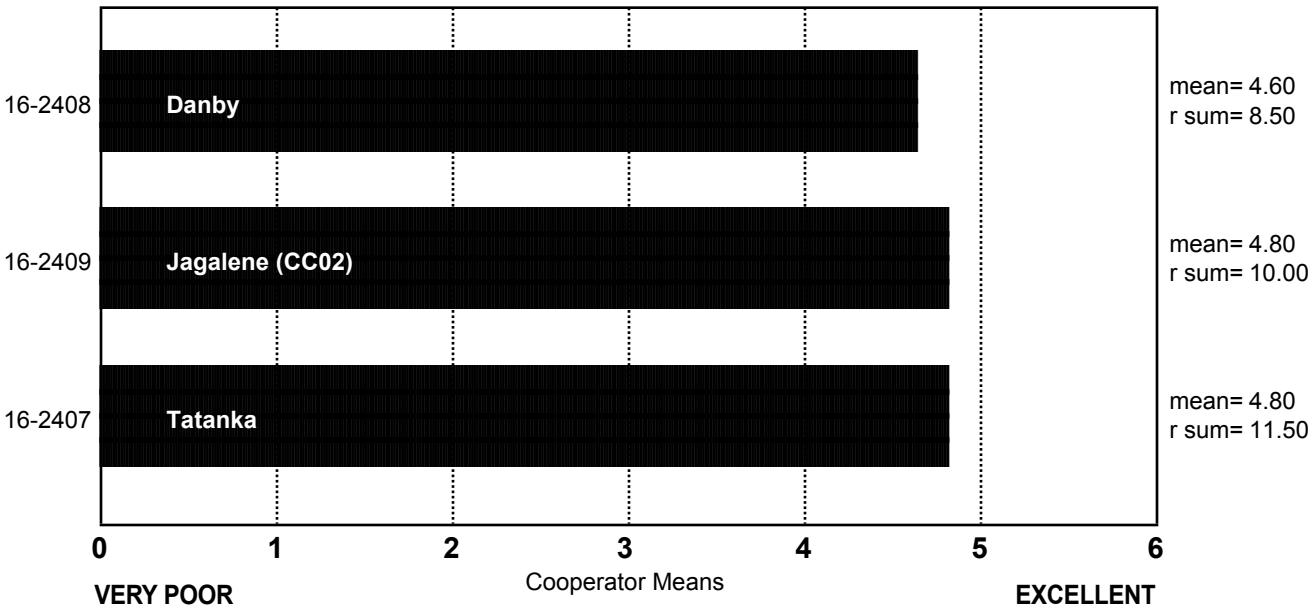
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2409	6310	141.1	4135	0.436	1.849	1.271	1.690	-18.05

SPONGE CHARACTERISTICS

(Small Scale) Kansas-Hays

ncoop= 5
chisq= 0.90
chisqc= 1.50
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

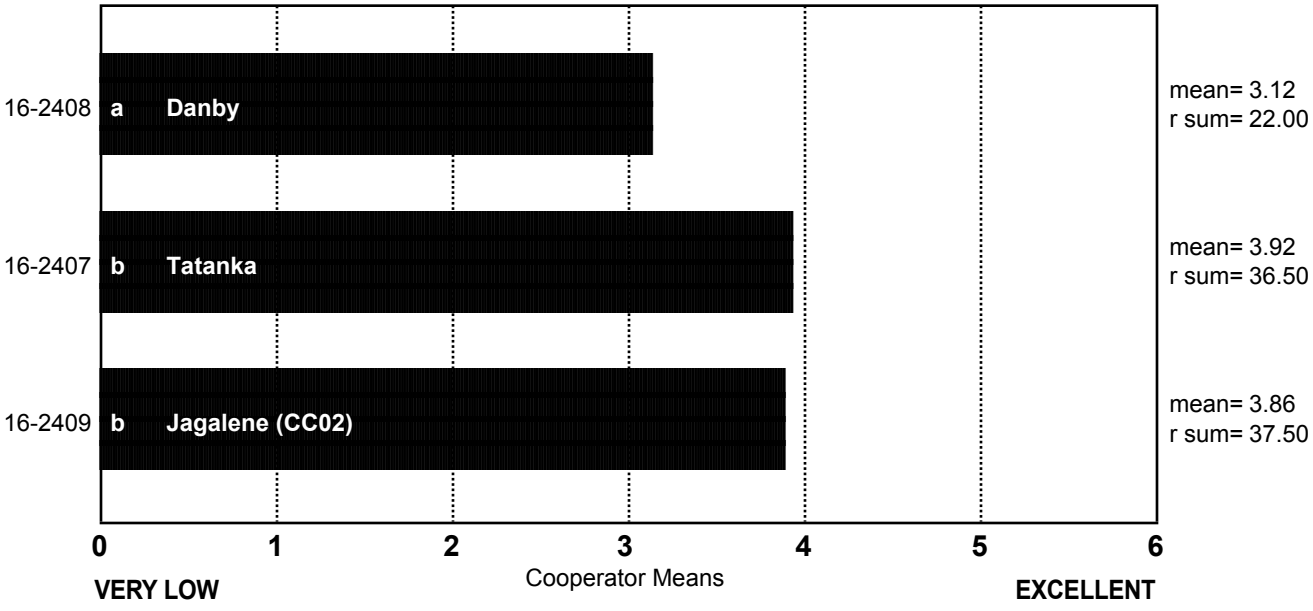


BAKE ABSORPTION

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 9.41
chisqc= 14.00
cvchisq= 5.99
crdiff= 6.70

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) 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
16-2407 Tatanka	**62.9**	**61.2**	**61.2**	**65.3**	**62.0**	**64.1**	**56.0**	**59.5**	**66.1**	**59.1**	**60.9**	**64.6**	**61.2**	**60.0**	**61.0**	**63.4**
16-2408 Danby	**59.7**	**60.5**	**60.5**	**63.6**	**61.3**	**65.7**	**56.0**	**58.4**	**64.7**	**57.4**	**59.2**	**61.9**	**60.5**	**60.0**	**60.0**	**60.4**
16-2409 Jagalene (CC02)	**62.3**	**61.5**	**61.5**	**64.3**	**62.5**	**66.0**	**57.0**	**59.7**	**65.2**	**59.1**	**61.1**	**62.8**	**61.5**	**60.0**	**61.0**	**63.6**

BAKE MIX TIME, ACTUAL

(Small Scale) Kansas-Hays

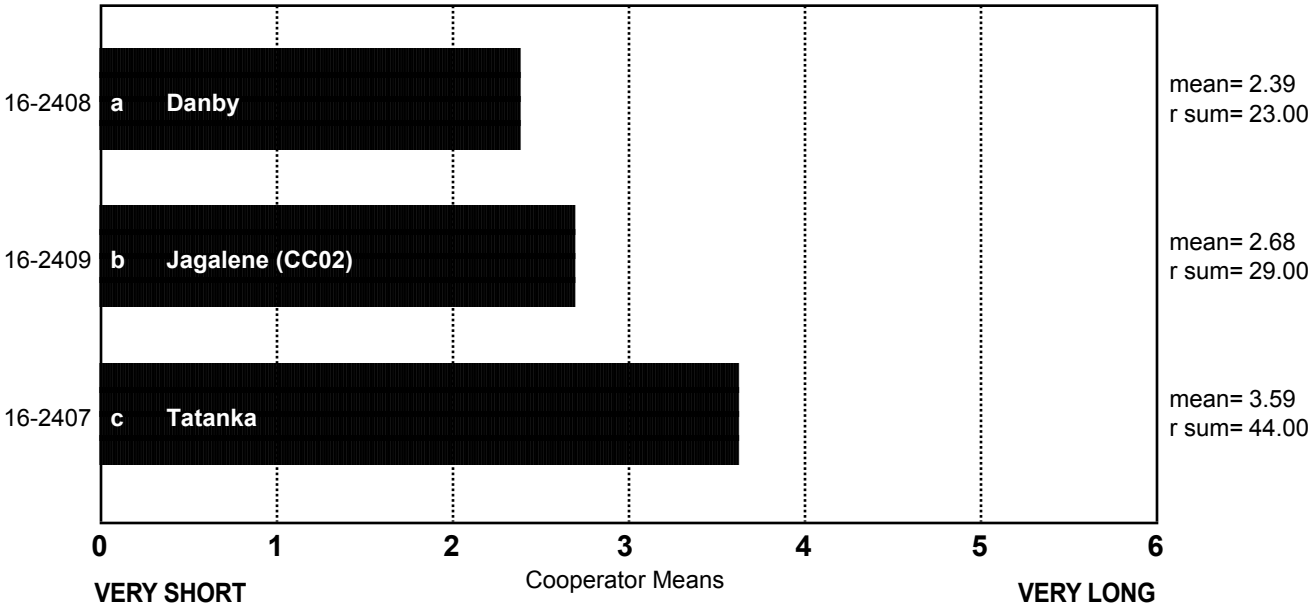
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2407 Tatanka	**4.3**	**8.0**	**8.0**	**3.9**	**6.5**	**4.5**	**7.0**	**4.0**	**3.3**	**4.0**	**3.6**	**4.9**	**5.0**	**4.0**	**16.0**	**4.1**
16-2408 Danby	**3.3**	**5.0**	**6.0**	**3.8**	**5.2**	**3.5**	**4.0**	**3.3**	**2.5**	**4.0**	**2.9**	**3.8**	**3.5**	**3.0**	**6.0**	**3.2**
16-2409 Jagalene (CC02)	**3.8**	**6.0**	**7.0**	**3.9**	**5.8**	**3.5**	**5.0**	**4.0**	**3.0**	**4.0**	**3.4**	**4.5**	**3.5**	**3.0**	**8.0**	**3.1**

BAKE MIX TIME

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 14.63
chisqc= 22.29
cvchisq= 5.99
crdiff= 5.32

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

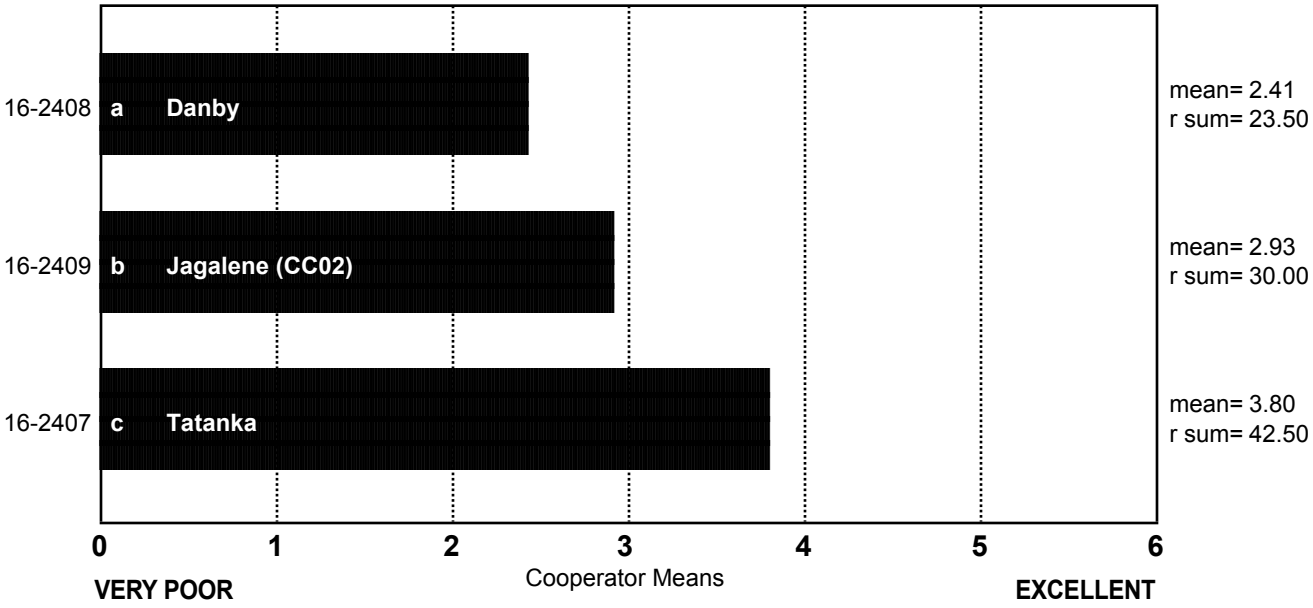


MIXING TOLERANCE

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 11.66
chisqc= 19.63
cvchisq= 5.99
crdiff= 5.72

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



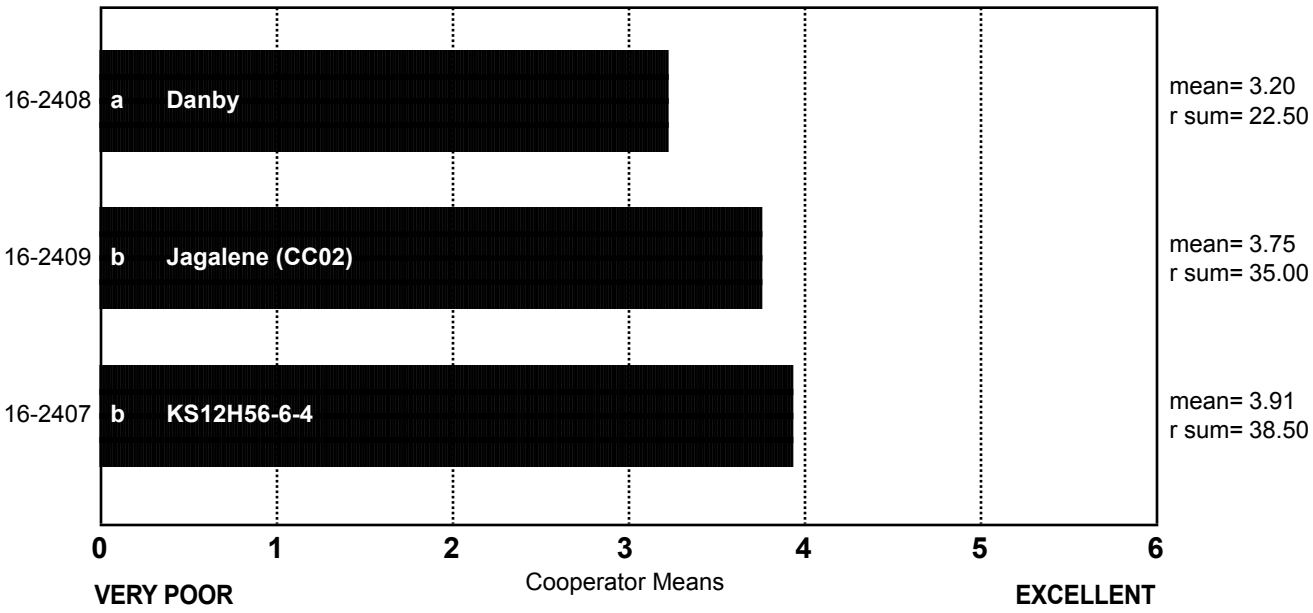
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 8.84
chisqc= 13.16
cvchisq= 5.99
crdiff= 7.50

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
16-2407 KS12H56-6-4	**1**	**2**	**2**	**9**	**2**
16-2408 Danby	**3**	**3**	**4**	**6**	**0**
16-2409 Jagalene (CC02)	**1**	**1**	**1**	**12**	**1**

Frequency Table

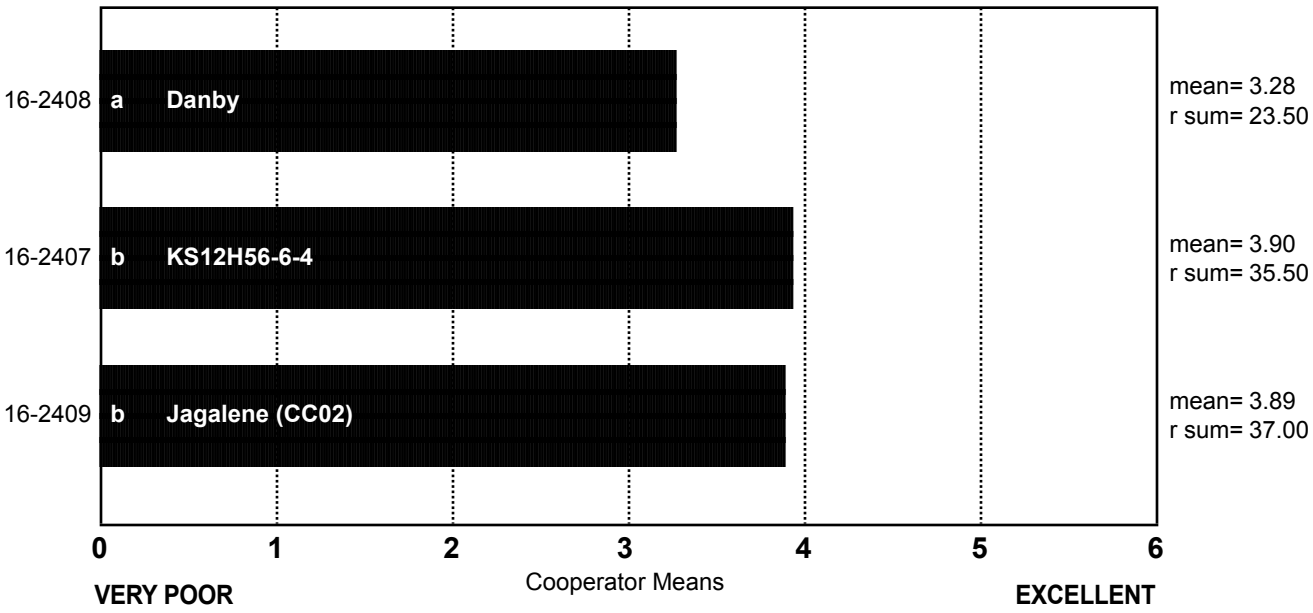
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 6.84
chisqc= 12.51
cvchisq= 5.99
crdiff= 6.88

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
16-2407 KS12H56-6-4	**0**	**2**	**1**	**12**	**1**
16-2408 Danby	**1**	**4**	**2**	**8**	**1**
16-2409 Jagalene (CC02)	**1**	**2**	**0**	**12**	**1**

Frequency Table

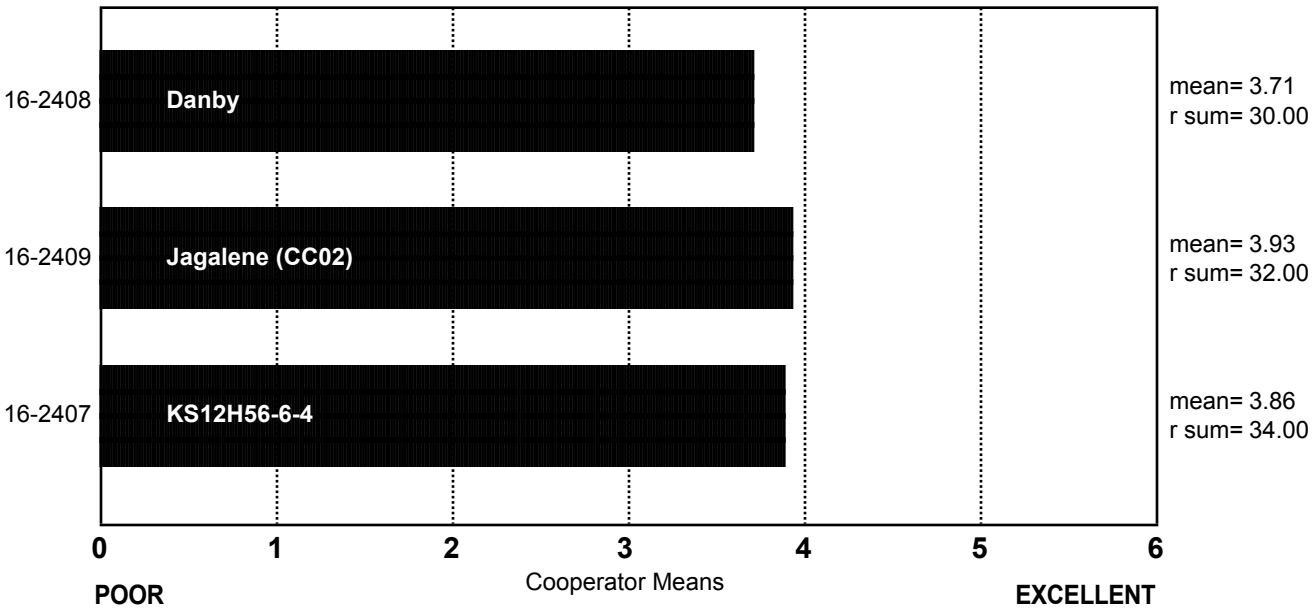
CRUMB GRAIN

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 0.50
chisqc= 0.74
cvchisq= 5.99
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
16-2407 KS12H56-6-4	**6**	**9**	**1**
16-2408 Danby	**7**	**7**	**2**
16-2409 Jagalene (CC02)	**6**	**8**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Kansas-Hays

	Round	Irregular	Elongated
16-2407 KS12H56-6-4	**2**	**6**	**8**
16-2408 Danby	**6**	**3**	**7**
16-2409 Jagalene (CC02)	**2**	**8**	**6**

Frequency Table

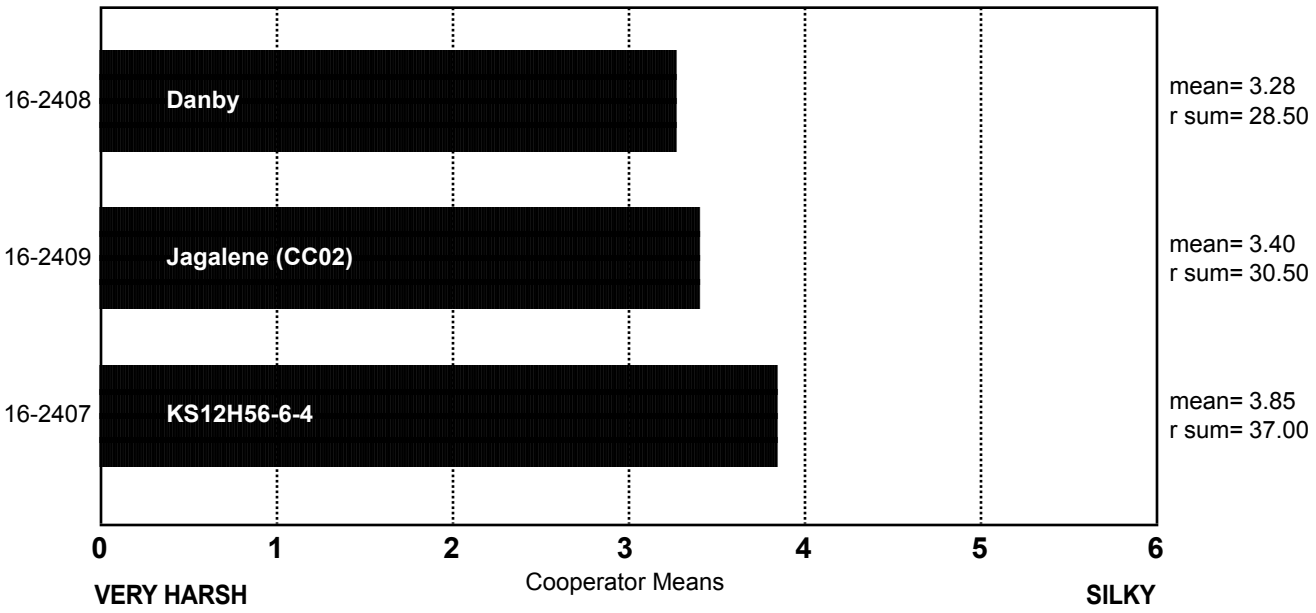
CRUMB TEXTURE

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 2.47
chisqc= 3.51
cvchisq= 5.99
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
16-2407 KS12H56-6-4	**1**	**14**	**1**
16-2408 Danby	**6**	**10**	**0**
16-2409 Jagalene (CC02)	**6**	**10**	**0**

Frequency Table

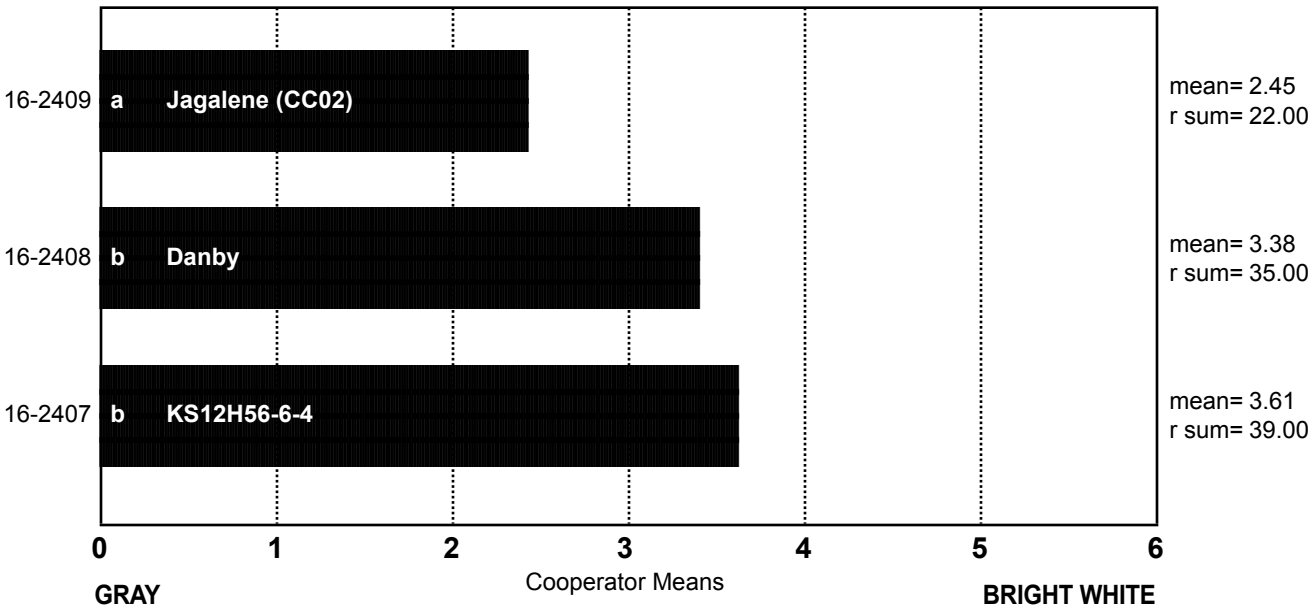
CRUMB COLOR

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 9.88
chisqc= 14.70
cvchisq= 5.99
crdiff= 7.19

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
16-2407 KS12H56-6-4	**0**	**1**	**2**	**1**	**10**	**2**	**0**
16-2408 Danby	**0**	**1**	**4**	**3**	**6**	**2**	**0**
16-2409 Jagalene (CC02)	**1**	**4**	**7**	**1**	**3**	**0**	**0**

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
16-2407 Tatanka	**142.3**	**482.7**	**457.8**	**154.7**	**139.7**	**133.0**	**415.0**	**138.5**	**134.4**	**475.5**	**138.6**	**151.3**	**444.6**	**146.5**		**138.6**
16-2408 Danby	**142.5**	**465.7**	**458.1**	**152.6**	**134.4**	**133.0**	**412.0**	**138.4**	**132.6**	**477.2**	**137.4**	**147.5**	**447.3**	**144.6**		**137.8**
16-2409 Jagalene (CC02)	**142.7**	**460.0**	**462.4**	**153.2**	**136.1**	**134.8**	**410.0**	**135.2**	**133.6**	**474.0**	**137.6**	**149.5**	**446.9**	**146.1**		**137.6**

LOAF VOLUME, ACTUAL

(Small Scale) Kansas-Hays

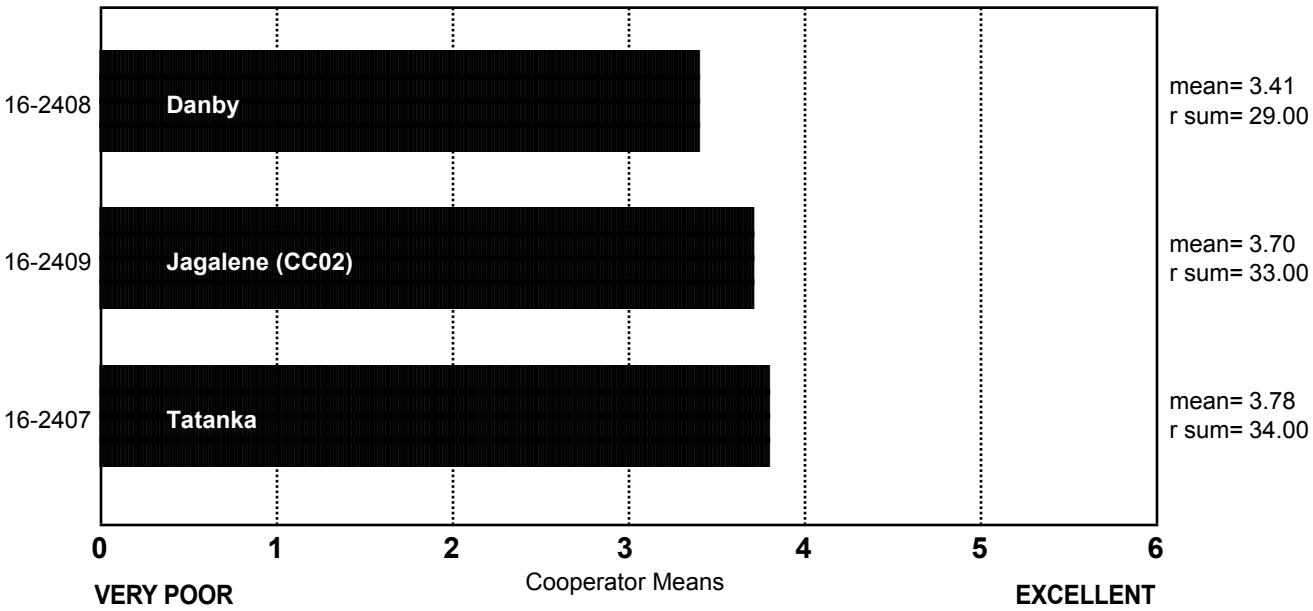
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2407 Tatanka	**950**	**2375**	**2465**	**995**	**923**	**940**	**2675**	**890**	**938**	**2600**	**895**	**890**	**2425**	**925**	**3104**	**823**
16-2408 Danby	**820**	**2438**	**2604**	**983**	**940**	**950**	**2700**	**800**	**795**	**2563**	**770**	**880**	**2425**	**900**	**2927**	**790**
16-2409 Jagalene (CC02)	**960**	**2475**	**2415**	**930**	**968**	**885**	**3000**	**835**	**893**	**2663**	**815**	**880**	**2400**	**840**	**3104**	**851**

LOAF VOLUME

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 0.88
chisqc= 1.12
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

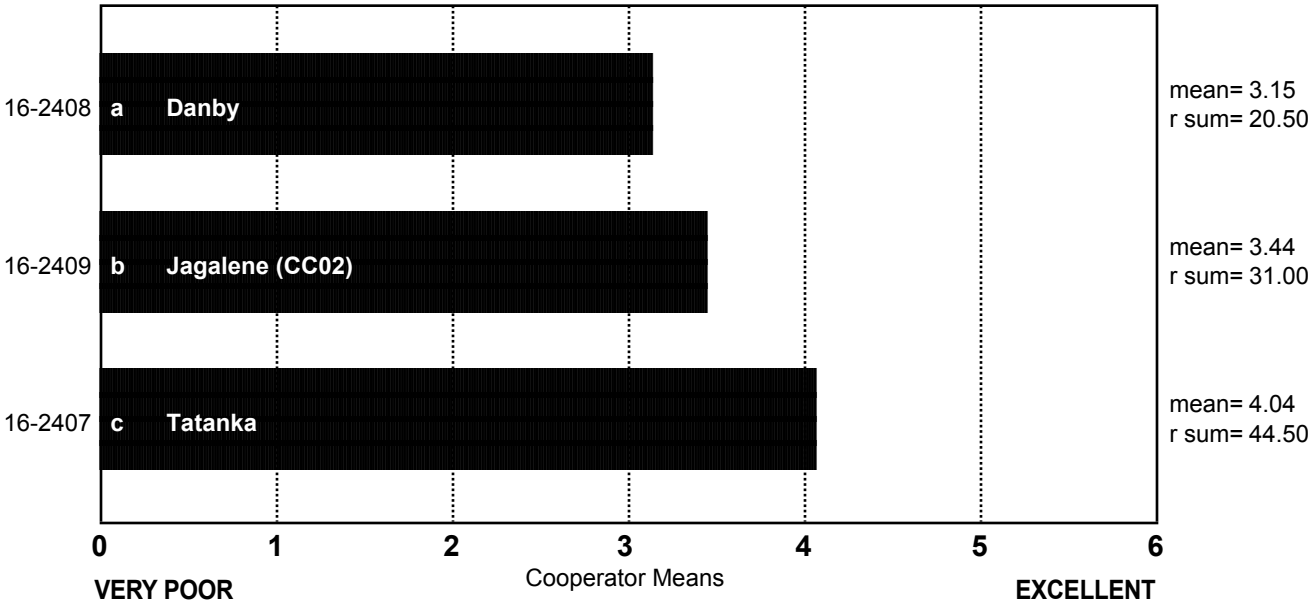


OVERALL BAKING QUALITY

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 18.09
chisqc= 18.68
cvchisq= 5.99
crdiff= 7.58

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. **16-2407 KS12H56-6-4**

A. No comment.
B. Average absorption, average mix time, very low volume, creamy, open.
C. Slightly sticky while moulding.
D. Very low protein %, mixing time good, dough strength looks promising for protein level, bread volume and grain good for low protein.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, slight open elongated cells, resilient & smooth texture.
F. Very suitable for bread wheat.
G. Average mix, soft out of mixer, nice interior.
H. Exceeds target loaf volume.
I. Impressive dough performance, producing a light and airy dough, crumb has irregular large holes, overall poor crumb structure.
J. Very fine grain, yellow crumb, good volume.
K. No comment.
L. Good absorption & mix time, excellent out of mixer, elongated crumb grain, creamy.
M. Best bread of the set, best volume with excellent mix time and makeup, bread had the best volume of the set with a dense grain.
N. No comment.
O. Slightly open, consistent, slightly course grain, excellent volume.
P. No comment.

COOP. **16-2408 Danby**

A. No comment.
B. Average absorption, short mix time, low volume, creamy, open.
C. Slightly sticky while moulding.
D. Very low protein %, mix time OK, dough strength OK for protein level, bread volume and grain good for low protein.
E. Normal water absorption and mix time, sticky & slight strong dough, high volume, creamy crumb, slight open elongated cells, resilient & smooth texture.
F. Good loaf volume and crumb characteristics but poor mixing characteristics.
G. Lower protein, average volume.
H. Low protein, poor mix tolerance.
I. No comment.
J. Low absorption, sticky dough, average grain and volume.
K. Very low protein.
L. Low absorption, good mix time and dough strength, elongated cells, satisfactory crumb grain.
M. No comment.
N. Partially broken down at mix.
O. Open, variable, coarse grain, above average volume.
P. No comment.

COOP. 16-2409 Jagalene (CC02)

A. No comment.
B. Slightly above average absorption, average mix time, low volume, creamy, open.
C. No comment.
D. Low protein %, mix time OK and dough strength looks promising for protein level, good bread volume and grain for protein.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, open elongated cells, resilient & smooth texture.
F. No comment.
G. Best volume of the set.
H. High ash.
I. Very even closed crumb, nice structure, poor color.
J. Average absorption, average grain, dark yellow crumb, good volume.
K. Poor color, good crumb.
L. Good absorption, excellent out of mixer, satisfactory crumb grain.
M. No comment.
N. No comment.
O. Slightly open, consistent, slightly coarse grain, excellent volume.
P. No comment.

Notes: **B, G, J, M, N, and O** conducted sponge and dough bake tests

NEBRASKA

16-2410	LCH13NEDH-14-53
16-2411	Jagalene (CC03)
16-2412	LCH13NEDH-4-16

Description of Test Plots and Breeder Entries

Nebraska - Stephen Baenziger

Growing Location & Conditions

The hard winter Wheat Quality Council samples from Nebraska and Limagrain Cereal Seeds originated from strip increases grown at Sidney, North Platte, and Mead Nebraska. Growing conditions included timely planting into generally good soil moisture, good fall stands and growth. The fields were planted on time for their respective ecogeographic zones and fertilizer was applied before planting. Sidney and North Platte were sprayed with fungicides to reduce the damaging effects of fungal diseases (primarily stripe rust). Grass and broadleaf herbicide was applied in the spring. The average grain yield at Sidney was 51 bu/a, at North Platte was 82 bu/a, and at Mead was 46 bu/a (in part due to disease and also due to rain at harvest). To represent the samples that a commercial elevator or mill might receive; the three location samples were blended into one sample.

LCH13NEDH-14-53

LCH13NEDH-14-53 is a hard white winter wheat double-haploid line jointly developed by the University of Nebraska and LCS. LCH13NEDH-14-53 has excellent winter-hardiness, tolerance to Fusarium head blight, and very good straw strength. Maturity is full season, two days later than LCS Chrome. Yield data can be attained from the 2014 and 2015 USDA Northern Regional Performance Nursery and the 2015 USDA Southern Regional Performance Nursery. The experimental line is resistant to stem rust and leaf rust while containing intermediate levels of resistance to stripe rust. This line is on increase for potential release in 2017. Pedigree is NW03681 / SD07W084.

Milling and baking quality data from LCS show acceptable overall milling and baking qualities. In 2016 LCS trials across multiple locations, LCS13NEDH-14-53 had an average flour protein of 11.6%, 60.9% water absorption, and a mixograph mid-line peak time of 3.2 minutes. Loaf volume is good at 850 cc.

LCH13NEDH-4-16

LCH13NEDH-4-16 is a hard white winter wheat double-haploid line jointly developed by the University of Nebraska and LCS. LCH13NEDH-4-16 has good winter-hardiness, tolerance to Fusarium head blight, and adequate straw strength. This line has a very erect winter growth habit. Maturity is full season equal to LCS Chrome. The experimental line is resistant to stem rust and stripe rust but is susceptible to leaf rust. This line is on increase for potential release in 2017. Pedigree is NE01481/Mace.

Milling and baking quality data from LCS show excellent overall milling and baking qualities. In 2016 LCS trials across multiple locations, LCH13NEDH-4-16 had an average flour protein of 12.6%, 62.4% water absorption, and a mixograph mid-line peak time of 5.2 minutes. Loaf volume is excellent at 915 cc.

Check – Jagalene

Nebraska: 2016 (Small-Scale) Samples

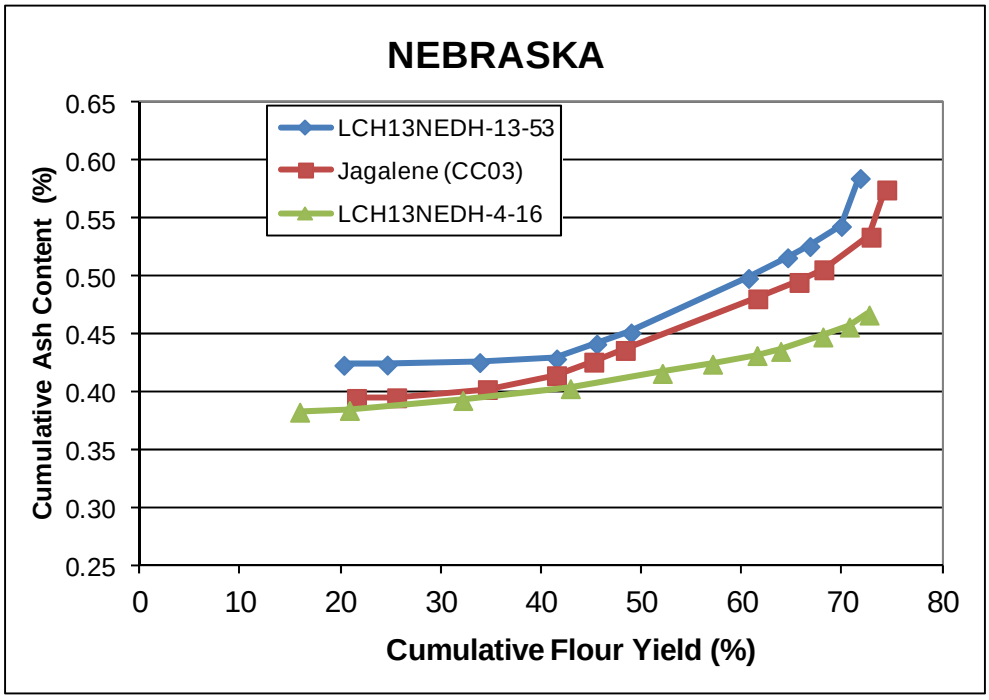
Test entry number	16-2410	16-2411	16-2412
Sample identification	**LCH13NEDH-14-53**	**Jagalene (CC03)**	**LCHN13EDH-4-16**
Wheat Data			
GIPSA classification	4HDWH	2HRW	5HDWH
Test weight (lb/bu)	55.6	58.2	55.9
Hectoliter weight (kg/hl)	73.3	76.6	73.6
1000 kernel weight (gm)	28.2	28.2	30.8
Wheat kernel size (Rotap)			
Over 7 wire (%)	58.8	58.2	65.7
Over 9 wire (%)	39.3	39.6	32.9
Through 9 wire (%)	1.9	2.2	1.4
Single kernel (skcs)[a]			
Hardness (avg /s.d)	63.2/19.0	69.8/18.0	49.6/18.2
Weight (mg) (avg/s.d)	28.2/9.2	28.2/8.9	30.8/8.9
Diameter (mm)(avg/s.d)	2.53/0.35	2.58/0.36	2.60/0.33
Moisture (%) (avg/s.d)	11.9/0.4	11.6/0.4	11.7/0.4
SKCS distribution	03-17-20-60-01	02-07-20-71-01	21-19-28-32-03
Classification	Hard	Hard	Mixed
Wheat protein (12% mb)	12.0	12.7	12.9
Wheat ash (12% mb)	1.67	1.63	1.63
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	71.7	74.4	72.6
Quadrumat Sr. Mill	66.7	66.6	66.1
Flour moisture (%)	13.1	13.7	13.9
Flour protein (14% mb)	10.7	11.4	11.4
Flour ash (14% mb)	0.60	0.57	0.50
Rapid Visco-Analyser			
Peak Time (min)	5.3	6.0	4.7
Peak Viscosity (RVU)	104.8	180.2	79.4
Breakdown (RVU)	79.3	74.3	66.3
Final Viscosity at 13 min (RVU)	60.3	211.4	32.3
Minolta color meter			
L*	91.65	91.12	91.43
a*	-1.63	-1.66	-1.69
b*	8.82	9.71	9.16
PPO	0.670	0.473	0.303
Falling number (sec)	253	414	213
Damaged Starch			
(AI%)	96.1	96.9	95.5
(AACC76-31)	6.4	7.0	5.9

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Nebraska: Physical Dough Tests and Gluten Analysis For 2016 (Small-Scale) Samples

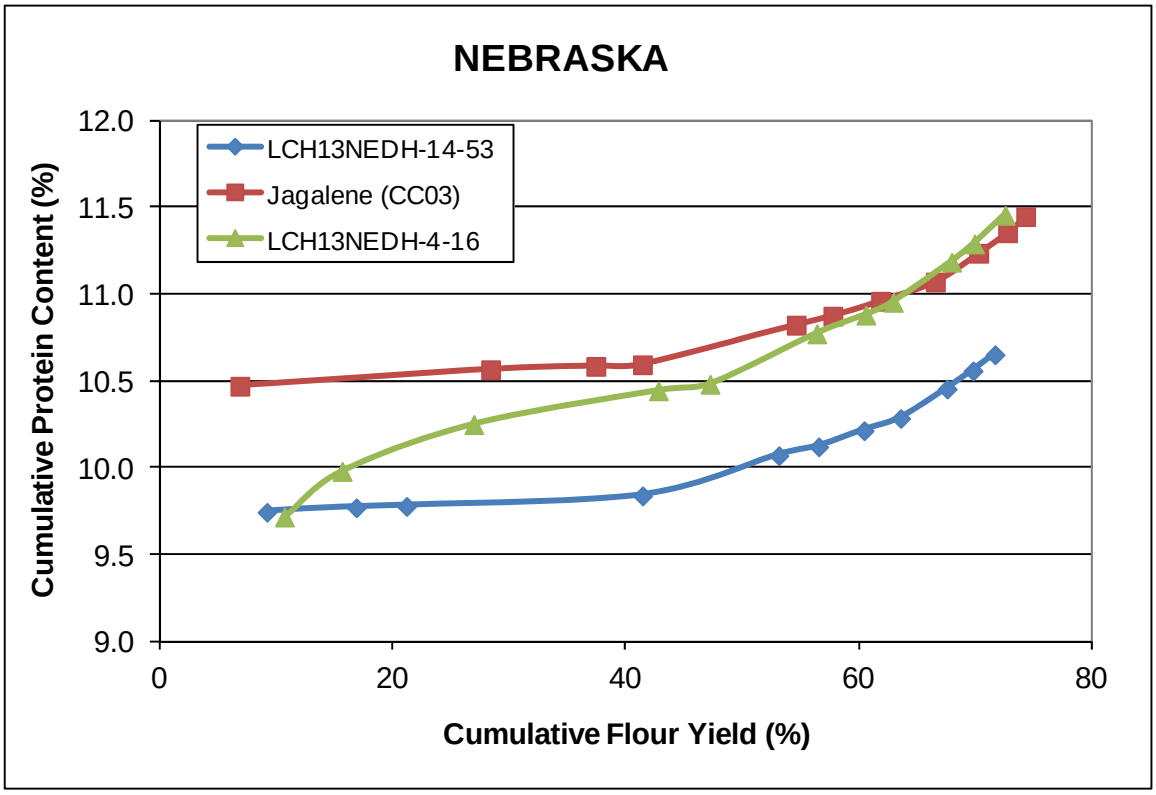
Test Entry Number	16-2410	16-2411	16-2412
Sample Identification	LCH13NEDH-14-53	Jagalene (CC03)	LCH13NEDH-4-16
MIXOGRAPH			
Flour Abs (% as-is)	64.6	64.3	64.5
Flour Abs (14% mb)	63.7	63.8	64.3
Mix Time (min)	4.4	5.9	10.5
Mix tolerance (0-6)	3	4	5
FARINOGRAPH			
Flour Abs (% as-is)	56.4	57.8	58.1
Flour Abs (14% mb)	55.5	57.3	57.9
Development time (min)	3.1	2.8	1.8
Mix stability (min)	7.4	9.8	2.1
Mix Tolerance Index (FU)	22	18	78
Breakdown time (min)	8.8	10.3	3.2
ALVEOGRAPH			
P(mm): Tenacity	58	81	90
L(mm): Extensibility	117	72	62
G(mm): Swelling index	24.1	18.9	17.5
W(10^{-4} J): strength (curve area)	215	233	233
P/L: curve configuration ratio	0.50	1.12	1.45
Ie(P_{200}/P): elasticity index	57.3	64.0	65.2
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	303/437/451	454/688/754	681/992/994
Extensibility (mm at 45/90/135 min)	151/147/154	139/120/123	134/96/101
Energy (cm^2 at 45/90/135 min)	84/115/127	108/130/146	157/128/137
Resist $_{max}$ (BU at 45/90/135 min)	418/591/639	614/871/979	953/992/994
Ratio (at 45/90/135 min)	2.00/2.97/2.94	3.27/5.73/6.13	5.09/10.33/9.84
PROTEIN ANALYSIS			
HMW-GS Composition	2*,7+8,5+10	2*,1,17+18,5+10	2*,7+9,5+10
%IPP	50.2	55.8	58.1
SEDIMENTATION TEST			
Volume (ml)	42.1	52.8	62.9

Nebraska: Cumulative Ash Curves



LCH13NEDH-14-53					Jagalene (CC03)					LCH13NEDH-4-16				
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	20.2	0.42	20.2	0.42	2M	21.5	0.39	21.5	0.39	2M	15.8	0.38	15.8	0.38
1M Red	4.3	0.43	24.6	0.42	1M Red	4.0	0.40	25.5	0.40	1M Red	5.0	0.39	20.8	0.38
1M	9.2	0.43	33.8	0.43	1M	9.0	0.42	34.5	0.40	1M	11.3	0.41	32.1	0.39
1BK	7.7	0.44	41.4	0.43	1BK	6.9	0.47	41.4	0.41	1BK	10.7	0.43	42.8	0.40
2BK	4.0	0.58	45.4	0.44	2BK	3.7	0.56	45.2	0.43	3M	9.2	0.48	52.0	0.42
Grader	3.4	0.58	48.9	0.45	Grader	3.1	0.58	48.3	0.44	2BK	5.0	0.51	57.0	0.42
3M	11.7	0.70	60.6	0.50	3M	13.2	0.64	61.5	0.48	Grader	4.4	0.53	61.4	0.43
FILTER FLR	3.9	0.80	64.5	0.52	FILTER FLR	4.1	0.71	65.6	0.50	4M	2.4	0.53	63.8	0.44
3BK	2.2	0.81	66.7	0.53	3BK	2.5	0.79	68.1	0.51	FILTER FLR	4.2	0.64	68.0	0.45
4M	3.1	0.91	69.8	0.54	4M	4.7	0.94	72.8	0.53	3BK	2.6	0.68	70.6	0.46
5M	1.9	2.12	71.7	0.59	5M	1.6	2.48	74.3	0.58	5M	2.0	0.84	72.6	0.47
Break Shorts	2.8	4.27	74.5	0.72	Break Shorts	3.0	4.23	77.4	0.72	Break Shorts	3.6	3.61	76.2	0.62
Red Dog	1.9	3.42	76.4	0.79	Red Dog	1.8	3.29	79.2	0.78	Red Dog	2.5	2.21	78.7	0.67
Red Shorts	0.5	3.96	76.9	0.81	Red Shorts	0.4	3.64	79.6	0.79	Red Shorts	0.7	3.80	79.3	0.69
Filter Bran	2.9	4.45	79.8	0.94	Filter Bran	3.3	4.37	82.9	0.93	Filter Bran	3.3	3.70	82.6	0.81
Bran	20.2	5.23	100.0	1.81	Bran	17.1	5.30	100.0	1.68	Bran	17.4	4.83	100.0	1.51
Wheat		1.63					1.59					1.59		
St. Grd. Fl.		0.60					0.57					0.50		

Nebraska: Cumulative Protein Curves

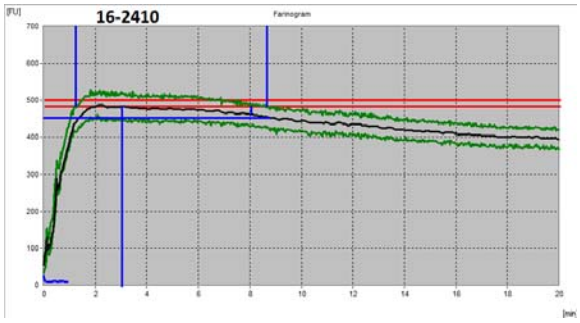


LCH13NEDH-14-53					Jagalene (CC03)					LCH13NEDH-4-16				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1M	9.2	9.7	9.2	9.7	1BK	6.9	10.5	6.9	10.5	1BK	10.7	9.7	10.7	9.7
1BK	7.7	9.8	16.9	9.8	2M	21.5	10.6	28.4	10.6	1M Red	5.0	10.6	15.7	10.0
1M Red	4.3	9.8	21.2	9.8	1M	9.0	10.7	37.4	10.6	1M	11.3	10.6	27.0	10.3
2M	20.2	9.9	41.4	9.8	1M Red	4.0	10.7	41.4	10.6	2M	15.8	10.8	42.8	10.4
3M	11.7	10.9	53.1	10.1	3M	13.2	11.5	54.6	10.8	Grader	4.4	10.8	47.2	10.5
Grader	3.4	10.9	56.6	10.1	Grader	3.1	11.8	57.8	10.9	3M	9.2	12.3	56.4	10.8
FILTER FLR	3.9	11.6	60.5	10.2	FILTER FLR	4.1	12.2	61.9	11.0	FILTER FLR	4.2	12.3	60.6	10.9
4M	3.1	11.6	63.6	10.3	4M	4.7	12.5	66.6	11.1	4M	2.4	12.9	63.0	11.0
2BK	4.0	13.2	67.6	10.5	2BK	3.7	14.2	70.3	11.2	2BK	5.0	14.1	68.0	11.2
3BK	2.2	13.7	69.8	10.6	3BK	2.5	14.7	72.8	11.4	5M	2.0	14.9	69.9	11.3
5M	1.9	14.1	71.7	10.7	5M	1.6	15.8	74.3	11.5	3BK	2.6	15.8	72.6	11.5
Break Shorts	2.8	16.6	74.5	10.9	Break Shorts	3.0	16.5	77.4	11.7	Break Shorts	3.6	17.2	76.2	11.7
Red Dog	1.9	15.7	76.4	11.0	Red Dog	1.8	15.4	79.2	11.7	Red Dog	2.5	16.5	78.7	11.9
Red Shorts	0.5	14.3	76.9	11.0	Red Shorts	0.4	13.3	79.6	11.7	Red Shorts	0.7	15.3	79.3	11.9
Filter Bran	2.9	15.0	79.8	11.2	Filter Bran	3.3	13.7	82.9	11.8	Filter Bran	3.3	14.6	82.6	12.0
Bran	20.2	16.5	100.0	12.2	Bran	17.1	16.0	100.0	12.5	Bran	17.4	17.9	100.0	13.0
Wheat		11.8					12.4					12.6		
St. Grd. Fl		10.7					11.4					11.4		

Physical Dough Tests

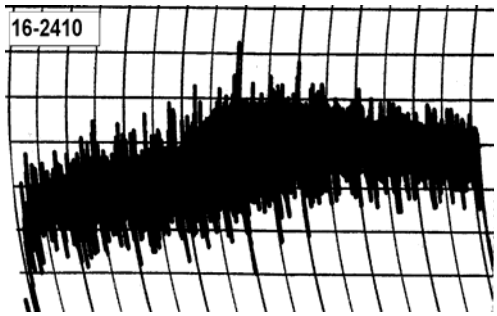
2016 (Small Scale) Samples – Nebraska

Farinograms



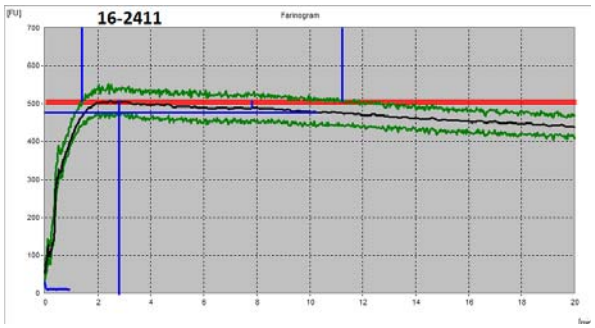
Water abs = 55.5%, Peak time = 3.1 min,
Mix stab = 7.4 min, MTI = 22 FU

Mixograms

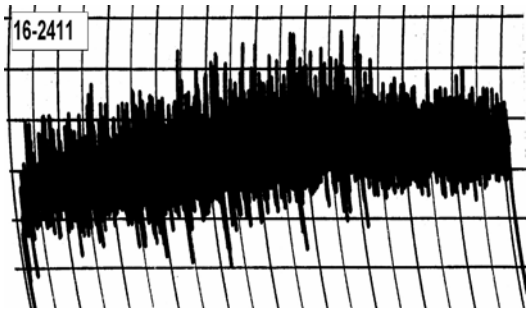


Water abs = 63.7%
Mix time = 4.4 min

16-2410, LCH13NEDH-14-53



Water abs = 57.3%, Peak time = 2.8 min,
Mix stab = 9.8 min, MTI = 18 FU



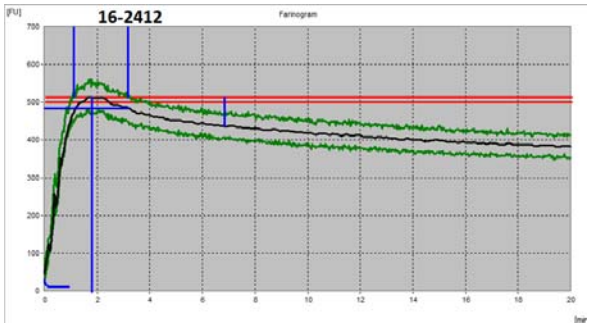
Water abs = 63.8%
Mix time = 5.9 min

16-2411, Jagalene (CC03)

Physical Dough Tests

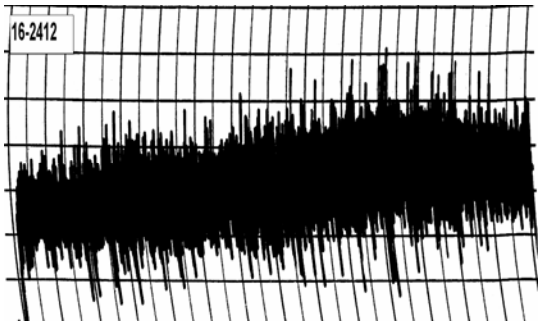
2016 (Small Scale) Samples – Nebraska

Farinograms



Water abs = 57.9%, Peak time = 1.8 min,
Mix stab = 2.1 min, MTI = 78 FU

Mixograms

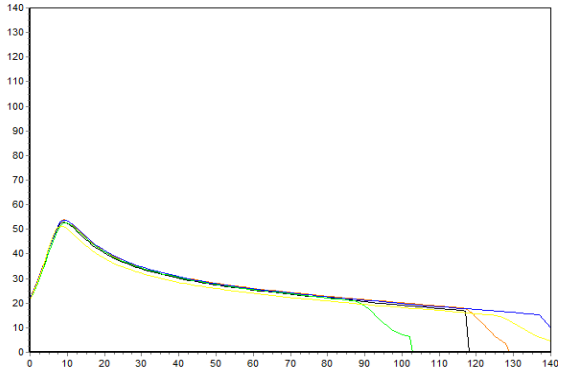


Water abs = 64.3%
Mix time = 10.5 min

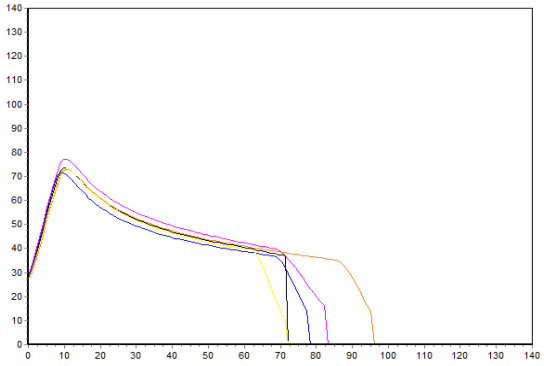
16-2412, LCH13NEDH-4-16

Physical Dough Tests - Alveograph

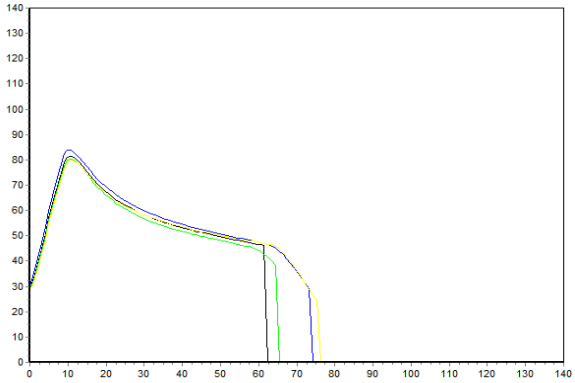
2016 (Small Scale) Samples – Nebraska



16-2410, LCH13NEDH-14-53
P (mm H_20) = 58, L (mm) = 117, W ($10E^{-4}J$) = 215



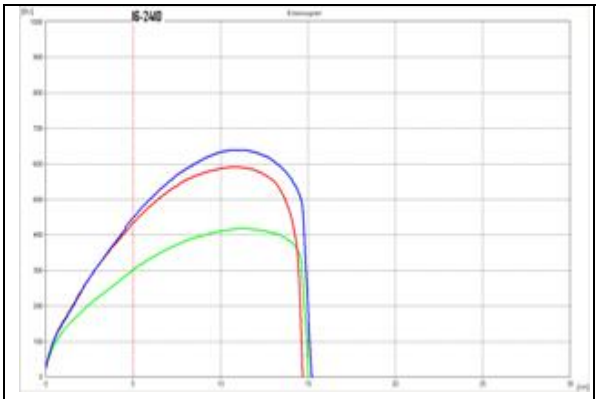
16-2411, Jagalene (CC03)
P (mm H_20) = 81, L (mm) = 72, W ($10E^{-4}J$) = 233



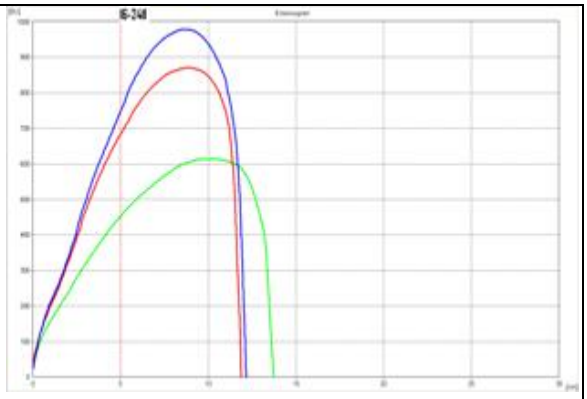
16-2412, LCH13NEDH-4-16
P (mm H_20) = 90, L (mm) = 62, W ($10E^{-4}J$) = 233

Physical Dough Tests - Extensigraph

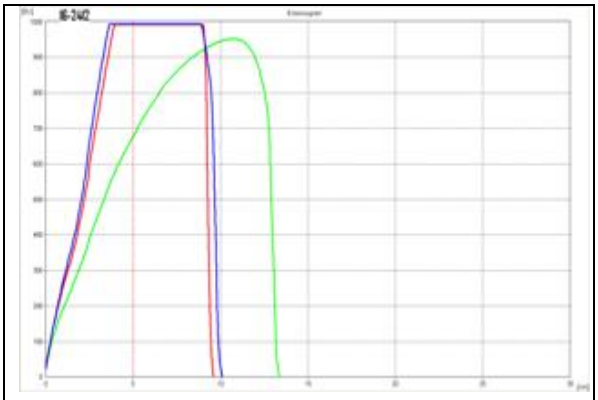
2016 (Small Scale) Samples – Nebraska



16-2410, LCH13NEDH-14-53
R (BU) = 437, E (mm) = 147, W (cm^2) = 115
Rmax (BU) = 591, Ratio = 3.0 at 90 min



16-2411, Jagalene (CC03)
R (BU) = 688, E (mm) = 120, W (cm^2) = 130
Rmax (BU) = 871, Ratio = 5.7 at 90 min

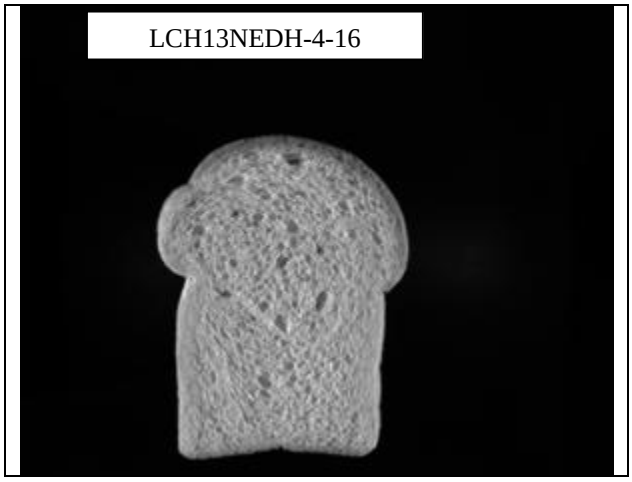


16-2412, LCH13NEDH-4-16
R (BU) = 992, E (mm) = 96, W (cm^2) = 128
Rmax (BU) = 992, Ratio = 10.3 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Nebraska: C-Cell Bread Images and Analysis
2016 (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 (^{0})
2410	6118	141.9	4330	0.424	1.698	9.878	1.675	-17.90
2411	6150	143.7	4263	0.434	1.762	6.413	1.750	-12.45



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2412	6191	141.9	4320	0.429	1.724	5.949	1.745	-8.85

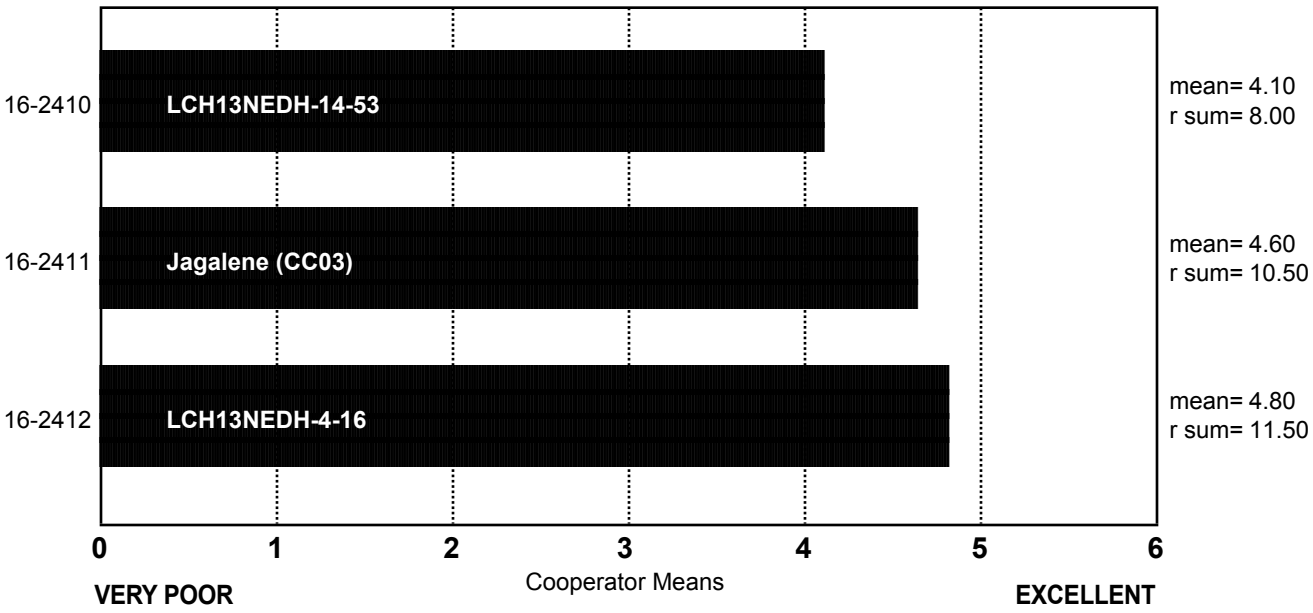
SPONGE CHARACTERISTICS

(Small Scale) Nebraska

ncoop= 5
chisq= 1.30
chisqc= 3.71
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



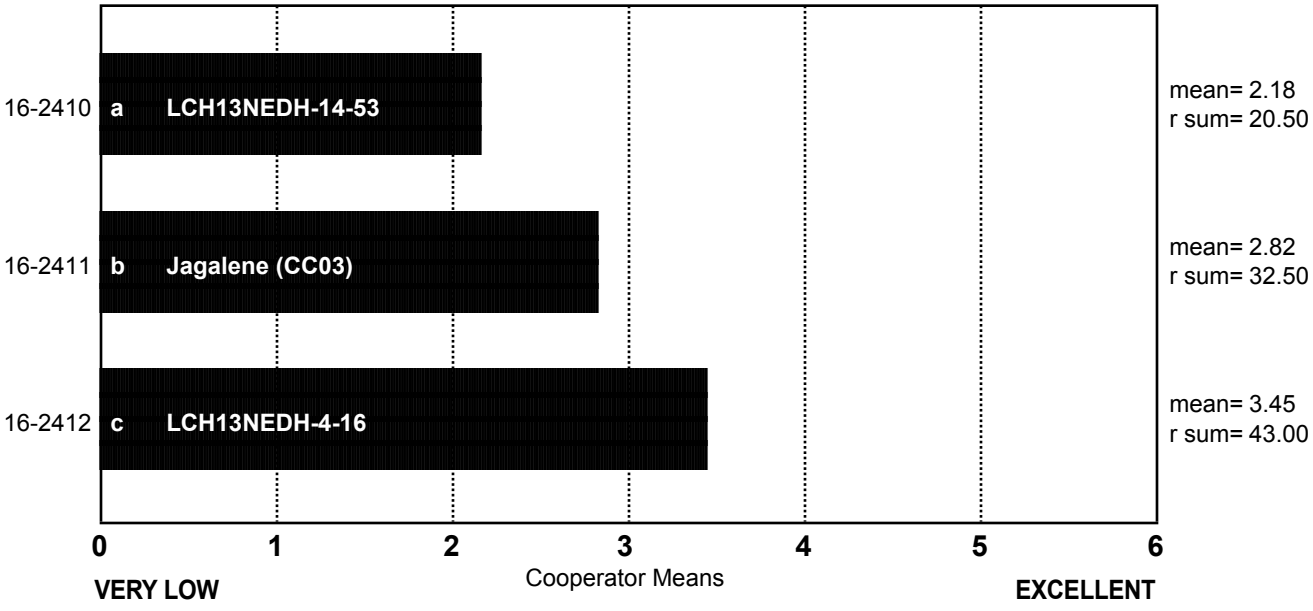
BAKE ABSORPTION

(Small Scale) Nebraska

ncoop= 16
chisq= 15.84
chisqc= 22.53
cvchisq= 5.99
crdiff= 5.44

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) 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
16-2410 LCH13NEDH-14-53	**61.1**	**55.5**	**55.5**	**62.8**	**62.0**	**60.0**	**57.0**	**59.7**	**59.9**	**55.1**	**59.1**	**62.8**	**55.5**	**60.0**	**56.0**	**63.6**
16-2411 Jagalene (CC03)	**61.8**	**57.3**	**57.3**	**64.5**	**62.3**	**60.9**	**57.0**	**60.8**	**60.5**	**56.8**	**61.5**	**63.7**	**57.3**	**60.0**	**57.0**	**63.7**
16-2412 LCH13NEDH-4-16	**63.7**	**57.9**	**57.9**	**65.1**	**63.5**	**62.2**	**57.0**	**60.7**	**62.1**	**60.9**	**62.3**	**65.0**	**57.9**	**60.0**	**57.0**	**64.1**

BAKE MIX TIME, 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
16-2410 LCH13NEDH-14-53	**4.5**	**4.0**	**6.0**	**4.7**	**6.7**	**3.5**	**5.0**	**4.2**	**3.3**	**4.0**	**3.4**	**6.0**	**3.5**	**3.0**	**10.0**	**4.4**
16-2411 Jagalene (CC03)	**5.0**	**5.0**	**8.0**	**5.2**	**7.8**	**4.5**	**6.0**	**4.5**	**3.8**	**5.0**	**4.0**	**11.0**	**4.5**	**5.0**	**19.0**	**5.1**
16-2412 LCH13NEDH-4-16	**9.0**	**9.0**	**9.0**	**9.7**	**12.3**	**5.0**	**10.0**	**7.0**	**6.0**	**9.0**	**7.2**	**12.0**	**7.5**	**17.0**	**25.0**	**9.5**

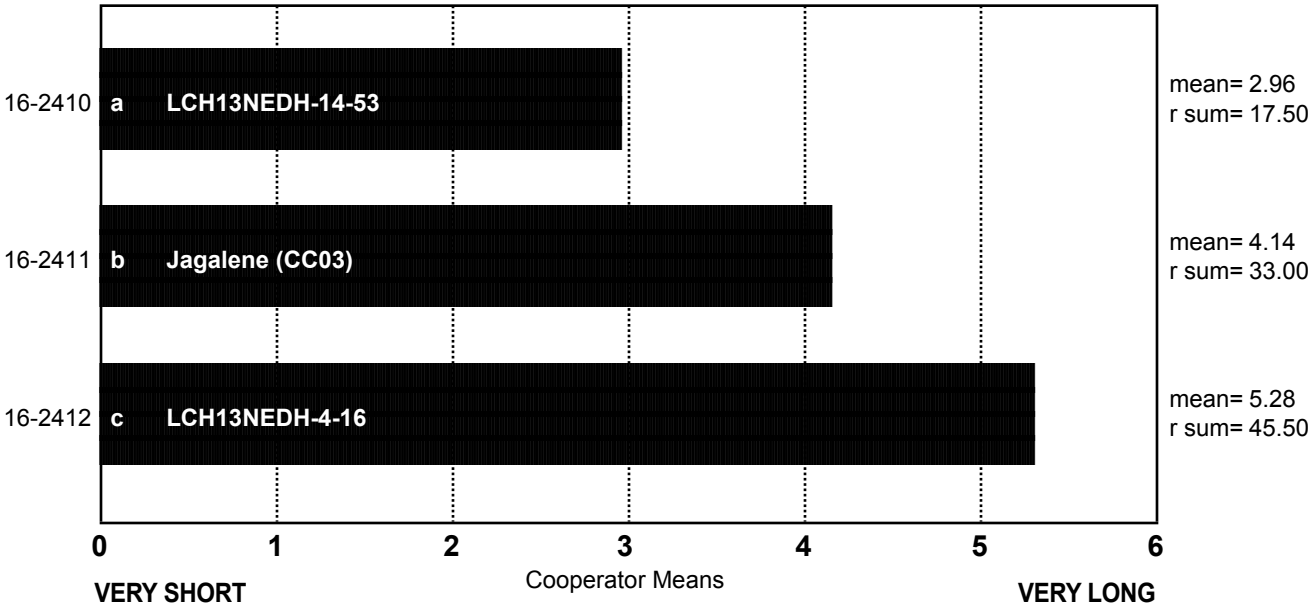
BAKE MIX TIME

(Small Scale) Nebraska

ncoop= 16
chisq= 24.59
chisqc= 26.23
cvchisq= 5.99
crdiff= 4.90

Variety order by rank sum.

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



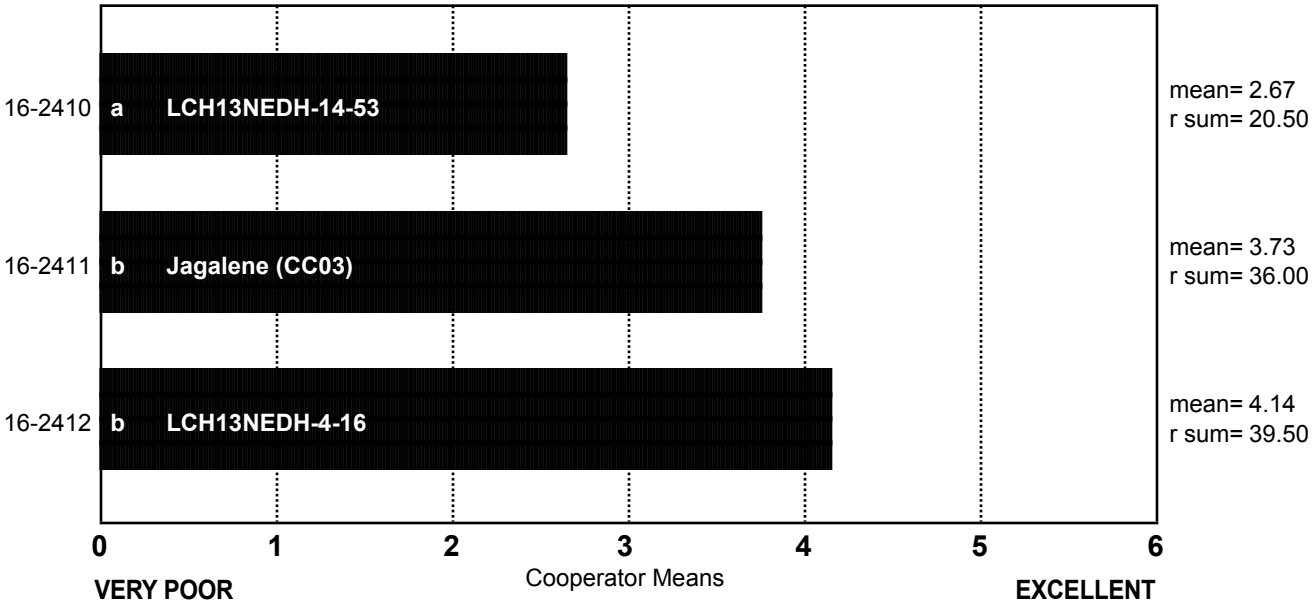
MIXING TOLERANCE

(Small Scale) Nebraska

ncoop= 16
chisq= 12.78
chisqc= 14.10
cvchisq= 5.99
crdiff= 8.49

Variety order by rank sum.

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



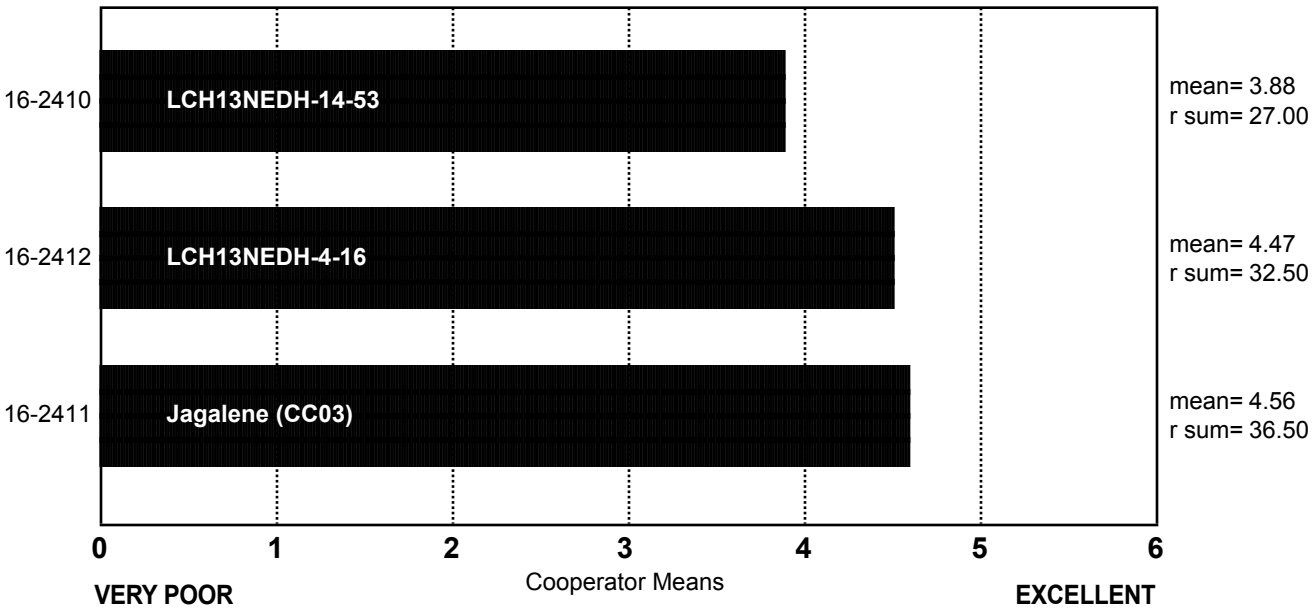
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Nebraska

ncoop= 16
chisq= 2.84
chisqc= 4.44
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
16-2410 LCH13NEDH-14-53	**0**	**4**	**1**	**9**	**2**
16-2411 Jagalene (CC03)	**0**	**0**	**1**	**12**	**3**
16-2412 LCH13NEDH-4-16	**0**	**1**	**5**	**7**	**3**

Frequency Table

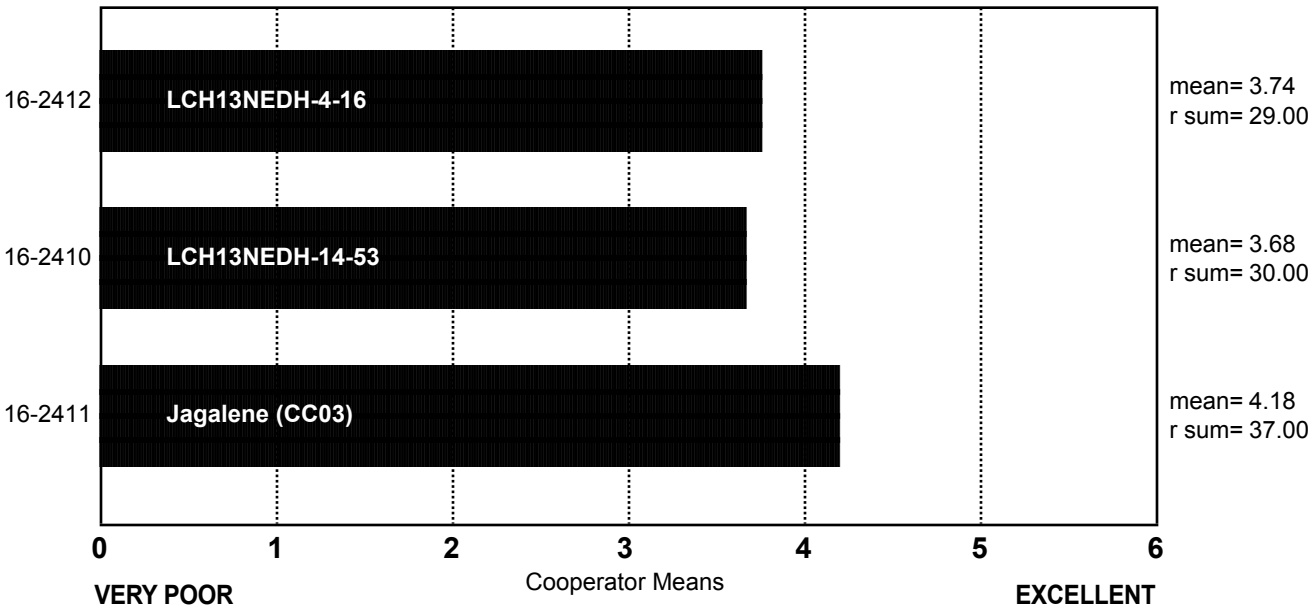
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Nebraska

ncoop= 16
chisq= 2.38
chisqc= 3.23
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
16-2410 LCH13NEDH-14-53	**2**	**5**	**0**	**8**	**1**
16-2411 Jagalene (CC03)	**0**	**0**	**4**	**12**	**0**
16-2412 LCH13NEDH-4-16	**0**	**1**	**6**	**7**	**2**

Frequency Table

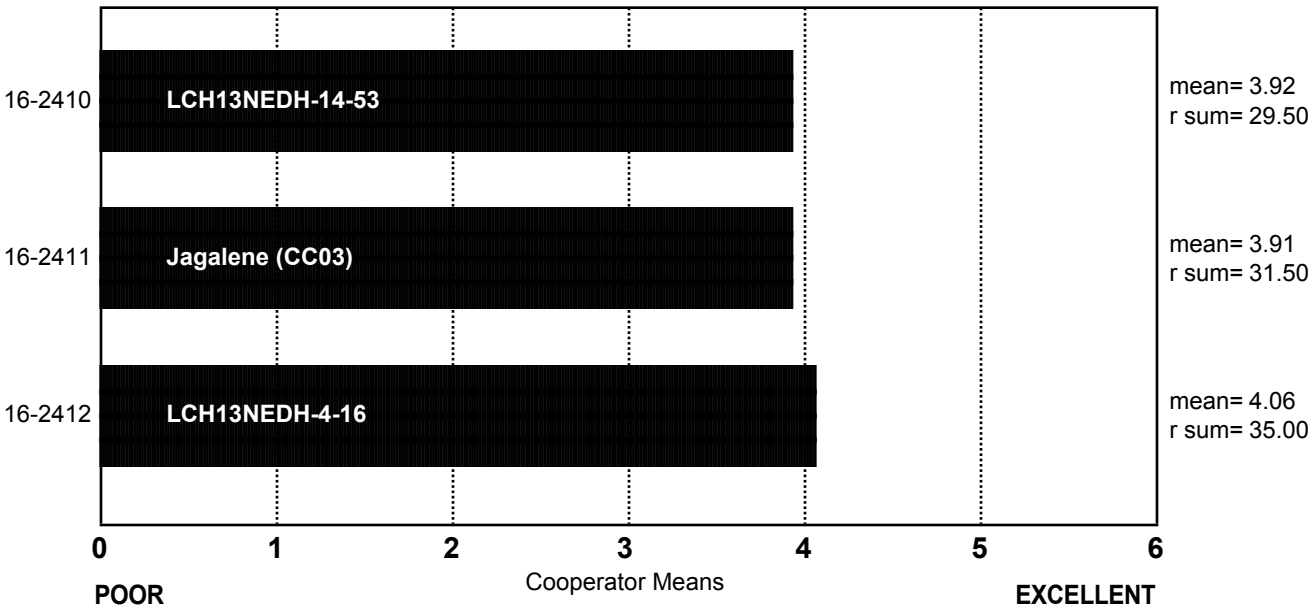
CRUMB GRAIN

(Small Scale) Nebraska

ncoop= 16
chisq= 0.97
chisqc= 1.55
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Nebraska

	Open	Fine	Dense
16-2410 LCH13NEDH-14-53	**8**	**7**	**1**
16-2411 Jagalene (CC03)	**7**	**9**	**0**
16-2412 LCH13NEDH-4-16	**4**	**10**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Nebraska

	Round	Irregular	Elongated
16-2410 LCH13NEDH-14-53	**7**	**4**	**5**
16-2411 Jagalene (CC03)	**2**	**8**	**6**
16-2412 LCH13NEDH-4-16	**1**	**6**	**9**

Frequency Table

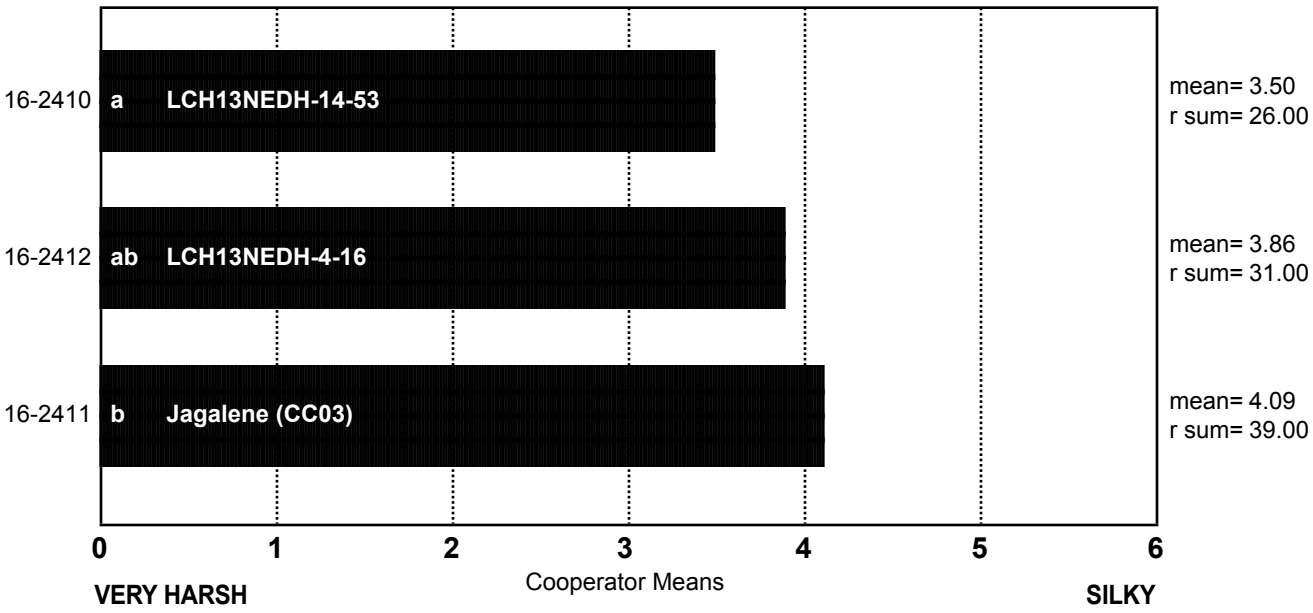
CRUMB TEXTURE

(Small Scale) Nebraska

ncoop= 16
chisq= 5.38
chisqc= 8.19
cvchisq= 5.99
crdiff= 8.34

Variety order by rank sum.

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Nebraska

	Harsh	Smooth	Silky
16-2410 LCH13NEDH-14-53	**6**	**10**	**0**
16-2411 Jagalene (CC03)	**2**	**12**	**2**
16-2412 LCH13NEDH-4-16	**5**	**8**	**3**

Frequency Table

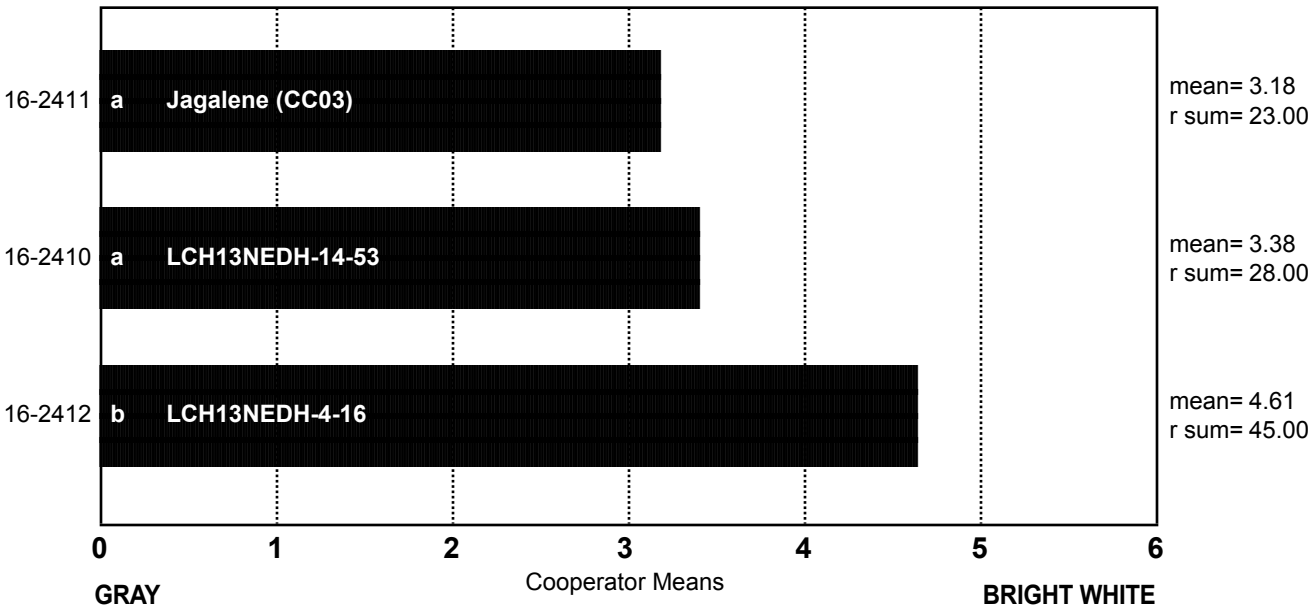
CRUMB COLOR

(Small Scale) Nebraska

ncoop= 16
chisq= 16.63
chisqc= 20.08
cvchisq= 5.99
crdiff= 6.63

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
16-2410 LCH13NEDH-14-53	**0**	**0**	**2**	**6**	**6**	**2**	**0**
16-2411 Jagalene (CC03)	**0**	**0**	**4**	**7**	**3**	**2**	**0**
16-2412 LCH13NEDH-4-16	**0**	**0**	**0**	**1**	**6**	**6**	**3**

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
16-2410 LCH13NEDH-14-53	**140.3**	**465.8**	**465.6**	**150.4**	**137.4**	**128.2**	**411.0**	**141.4**	**129.0**	**483.5**	**135.8**	**151.2**	**452.4**	**145.1**		**137.6**
16-2411 Jagalene (CC03)	**139.4**	**465.7**	**467.6**	**151.4**	**135.9**	**132.8**	**410.0**	**137.8**	**129.4**	**479.6**	**137.4**	**149.3**	**452.1**	**145.6**		**136.6**
16-2412 LCH13NEDH-4-16	**141.0**	**468.2**	**465.4**	**153.1**	**134.8**	**131.9**	**411.0**	**143.4**	**131.2**	**482.1**	**136.9**	**148.7**	**447.8**	**154.2**		**136.8**

LOAF VOLUME, ACTUAL

(Small Scale) Nebraska

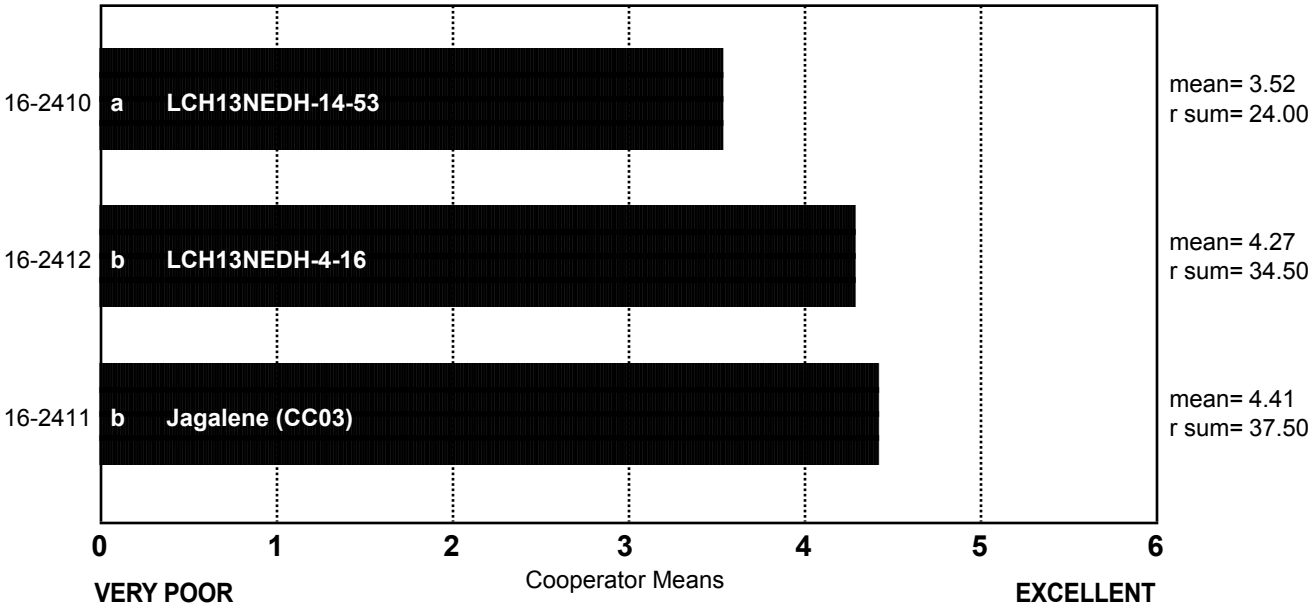
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2410 LCH13NEDH-14-53	**940**	**2338**	**2527**	**1000**	**1004**	**965**	**2700**	**830**	**868**	**2575**	**940**	**850**	**2350**	**890**	**2897**	**816**
16-2411 Jagalene (CC03)	**1025**	**2475**	**2601**	**993**	**914**	**1015**	**2925**	**1010**	**900**	**2713**	**950**	**875**	**2475**	**925**	**3074**	**857**
16-2412 LCH13NEDH-4-16	**1065**	**2463**	**2879**	**905**	**855**	**850**	**3025**	**865**	**1025**	**2588**	**1005**	**855**	**2525**	**975**	**2986**	**889**

LOAF VOLUME

(Small Scale) Nebraska

ncoop= 16
chisq= 6.28
chisqc= 7.31
cvchisq= 5.99
crdiff= 9.71

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

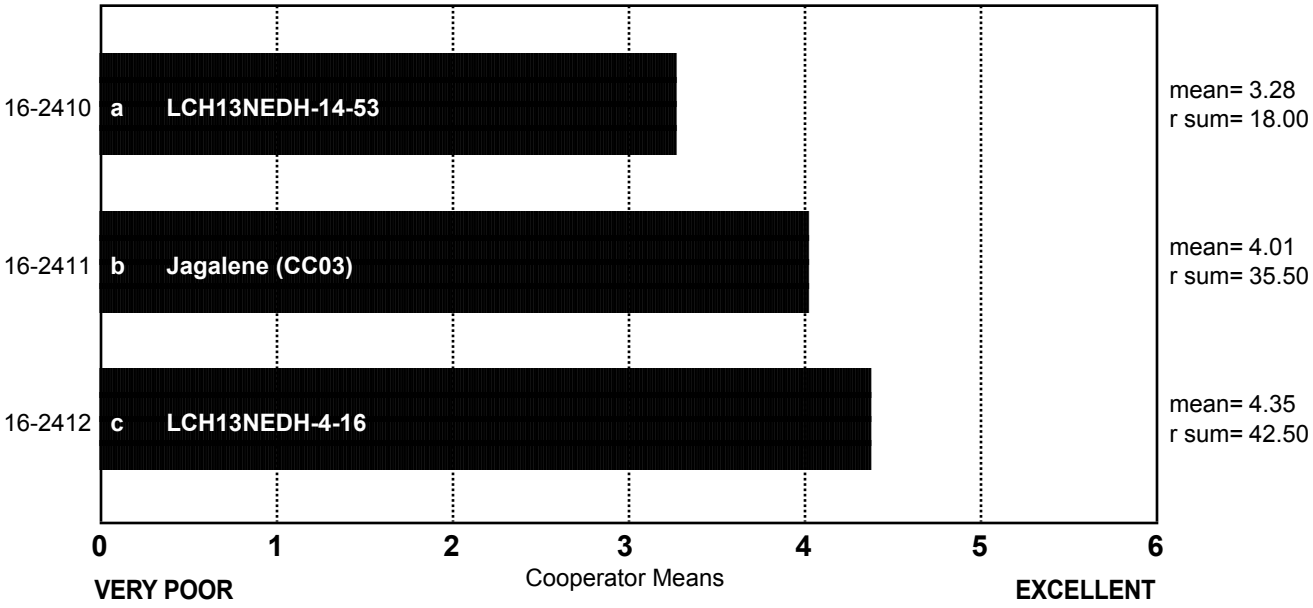


OVERALL BAKING QUALITY

(Small Scale) Nebraska

ncoop= 16
chisq= 19.91
chisqc= 22.75
cvchisq= 5.99
crdiff= 6.00

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. **16-2410 LCH13NEDH-14-53**

A. No comment.
B. Low absorption, short mix time, very low volume, yellow, open, very flat.
C. Low mix time.
D. Low protein %, mixing time OK and dough strength looks promising for protein level, bread volume and grain good for protein.
E. Normal water absorption, long mix time, slight sticky & weak dough, high volume, yellow crumb, open round cells, resilient & slight harsh texture.
F. No comment.
G. Soft at makeup.
H. Good.
I. Even, closed crumb.
J. Very low absorption, wet dough, good grain, average volume.
K. Good volume and crumb for protein but weaker.
L. Long mix time, excellent out of mixer, satisfactory crumb grain, good loaf volume.
M. Low absorption and mix time, bread had a low volume with a fine grain.
N. Mellow at the bench.
O. Open, consistent, coarse grain, average volume.
P. No comment.

COOP. **16-2411 Jagalene (CC03)**

A. No comment.
B. Low absorption, short mix time, low volume, creamy, open.
C. Tough while moulding.
D. Good mix time with dough strength somewhat weak for protein level, good bread volume and grain.
E. Normal water absorption, long mix time, slight sticky & strong dough, high volume, dull crumb, slight open elongated cells, resilient & smooth texture.
F. Good loaf volume and crumb but low baking absorption and poor crumb color.
G. Good out of mixer.
H. Exceeds target loaf volume.
I. Nice dough performance, smooth soft dough with good gas production and retention, even closed fine crumb, very nice structure.
J. Low absorption, excellent dough, average grain, yellow crumb, excellent volume.
K. No comment.
L. Long mix time, excellent out of mixer, good crumb grain and loaf volume.
M. No comment.
N. No comment.
O. Slightly open, consistent, slightly coarse grain, excellent volume.
P. No comment.

COOP. 16-2412 LCH13NEDH-4-16

A. No comment.
B. Low absorption, slightly above average mix time, low volume, creamy, open.
C. No comment.
D. Good mix time with dough strength somewhat weak for protein level, good bread volume and grain.
E. Normal water absorption, very long mix time, slight sticky & strong dough, OK volume, creamy crumb, fine elongated cells, resilient & silky smooth texture.
F. No comment.
G. Strong dough.
H. Very long mix time, exceeds target loaf volume.
I. Mix time did not reflect farinograph development time, very nice oven spring, great crumb color, even structure, silky texture, very nice bread overall.
J. Good absorption, long mix time, tough dough at makeup, very fine grain, white crumb, average volume.
K. Excellent color, strong.
L. Long mix time, good out of mixer, excellent crumb grain.
M. Best bread of the set, had the highest absorption and mix time, bread had the highest volume with a dense white grain.
N. Elastic at mix.
O. Slightly open, consistent, coarse grain, good volume.
P. No comment.

Notes: **B, G, J, M, N, and O** conducted sponge and dough bake tests

SYNGENTA (AGRIPRO)

16-2413	Postrock
16-2414	Jagalene (CC04)
16-2415	AP11T2409

Description of Test Plots and Breeder Entries

Syngenta (Agripro) - Jon Rich

Increase strips were planted on 10/20/15 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 was applied 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.

AP11T2409 was developed from a cross of (X07T015/Greer) in 2006 out of our Vernon, Texas group led by Dr. David Worrall. X07T015 is (Fuller/U4024R-4-1-7-1R//Cutter). AP11T2409 as you can see has a strong genetic base that allows it to fit in many regions within the Hard Winter Wheat growing area.

AP11T2409 is a hard red winter wheat broadly adapted to the major growing regions of Texas, Oklahoma, Kansas, Colorado and Nebraska. Is currently being tested in the SRPN. AP11T2409 is a later maturing line similar to SY Monument. A medium tall type with good straw strength. AP11T2409 has a very strong disease package. Resistance to stripe rust and moderately resistant to leaf rust, Powdery mildew and BYDV. Milling and baking data compiled over three years indicates a line with average milling properties compared to Jagalene but similar to Jagalene in baking properties. Good tolerance and loaf volumes.

Syngenta (Agripro): 2016 (Small-Scale) Samples

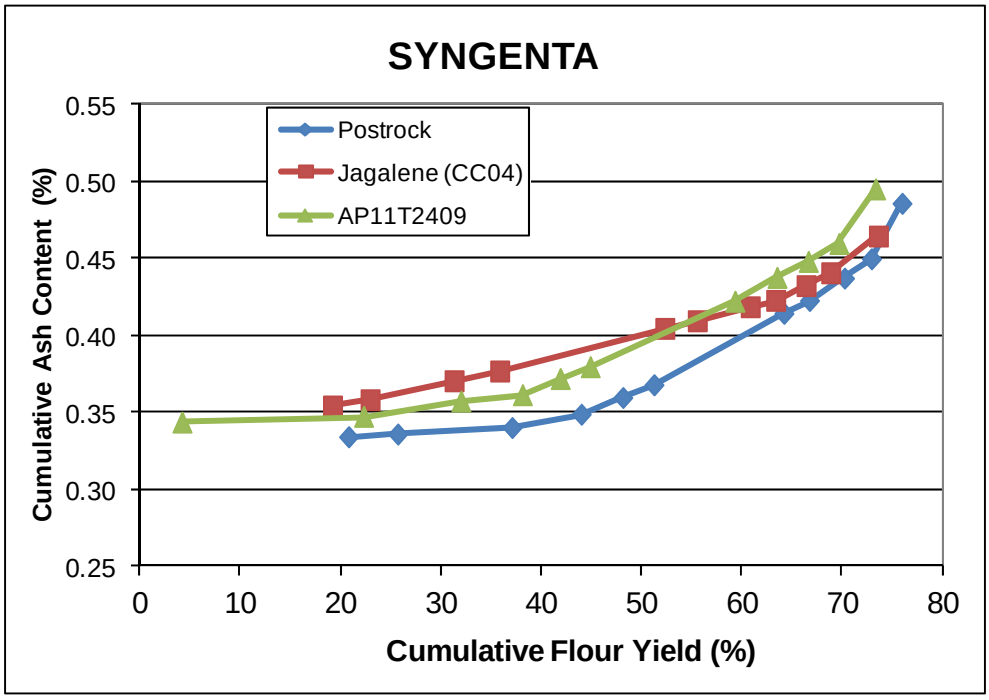
Test entry number	16-2413	16-2414	16-2415
Sample identification	**Postrock**	**Jagalene (CC04)**	**AP11T2409**
Wheat Data			
GIPSA classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	63.2	63.8	62.8
Hectoliter weight (kg/hl)	83.1	83.8	82.6
1000 kernel weight (gm)	32.7	32.3	36.0
Wheat kernel size (Rotap)			
Over 7 wire (%)	79.8	75.1	89.3
Over 9 wire (%)	20.2	24.9	10.7
Through 9 wire (%)	0.0	0.0	0.0
Single kernel (skcs)[a]			
Hardness (avg /s.d)	67.1/13.7	81.7/12.8	78.4/12.9
Weight (mg) (avg/s.d)	32.7/6.0	32.3/7.6	36.0/6.8
Diameter (mm)(avg/s.d)	2.79/0.25	2.79/0.33	2.86/0.29
Moisture (%) (avg/s.d)	10.5/0.4	10.4/0.3	10.7/0.3
SKCS distribution	01-04-23-72-01	00-01-03-96-01	00-00-07-93-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	15.1	15.1	13.2
Wheat ash (12% mb)	1.48	1.50	1.56
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	75.9	73.5	73.3
Quadrumat Sr. Mill	69.7	67.7	66.8
Flour moisture (%)	13.4	13.5	13.2
Flour protein (14% mb)	13.7	13.6	11.4
Flour ash (14% mb)	0.48	0.49	0.48
Rapid Visco-Analyser			
Peak Time (min)	5.7	5.9	6.2
Peak Viscosity (RVU)	162.3	175.2	196.9
Breakdown (RVU)	72.2	61.9	57.0
Final Viscosity at 13 min (RVU)	180.4	217.9	255.3
Minolta color meter			
L*	91.39	91.47	91.76
a*	-1.26	-1.42	-1.33
b*	8.98	9.62	8.76
PPO	0.426	0.392	0.526
Falling number (sec)	395	459	501
Damaged Starch			
(AI%)	96.0	97.3	97.4
(AACC76-31)	6.3	7.3	7.4

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Syngenta (Agripro): Physical Dough Tests and Gluten Analysis For 2016 (Small-Scale) Samples

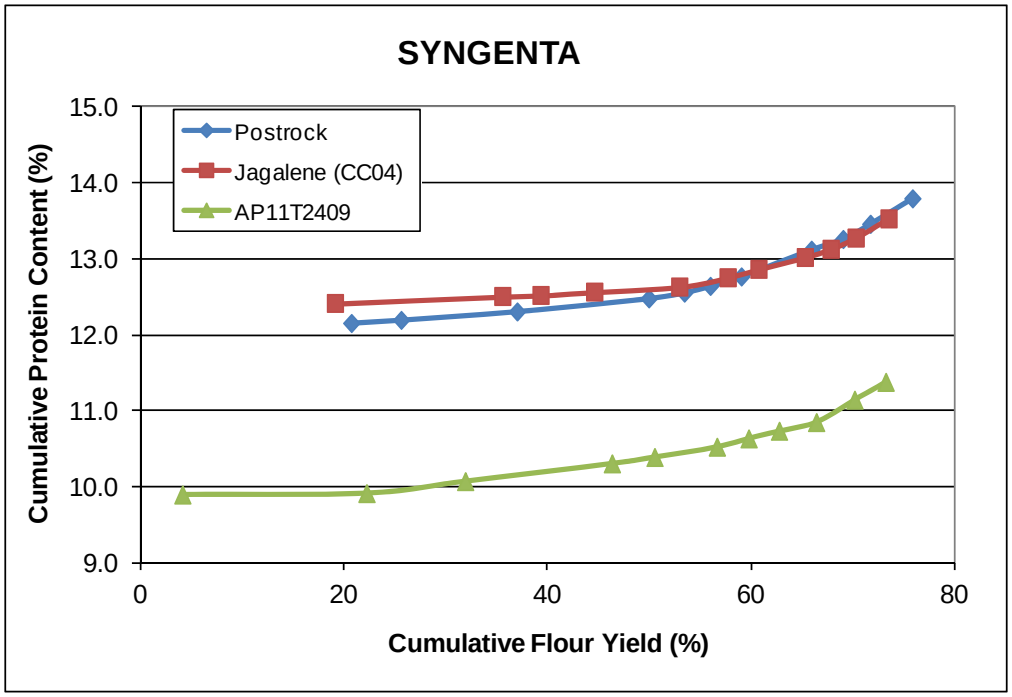
Test Entry Number	16-2413	16-2414	16-2415
Sample Identification	Postrock	Jagalene (CC04)	AP11T2409
MIXOGRAPH			
Flour Abs (% as-is)	66.2	67.3	65.8
Flour Abs (14% mb)	65.7	66.9	65.0
Mix Time (min)	3.3	4.0	5.0
Mix tolerance (0-6)	3	4	5
FARINOGRAPH			
Flour Abs (% as-is)	59.7	62.5	64.5
Flour Abs (14% mb)	59.1	62.0	63.7
Development time (min)	6.4	6.7	6.2
Mix stability (min)	8.3	12.6	12.5
Mix Tolerance Index (FU)	32	25	22
Breakdown time (min)	10.7	12.8	14.6
ALVEOGRAPH			
P(mm): Tenacity	70	111	129
L(mm): Extensibility	89	77	53
G(mm): Swelling index	21.0	19.5	16.2
W(10^{-4} J): strength (curve area)	227	356	281
P/L: curve configuration ratio	0.79	1.44	2.43
Ie(P_{200}/P): elasticity index	61.9	69.5	60.2
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	326/442/462	458/630/641	442/524/592
Extensibility (mm at 45/90/135 min)	160/160/147	141/145/136	150/141/142
Energy (cm^2 at 45/90/135 min)	93/135/118	113/159/145	124/131/148
Resist $_{max}$ (BU at 45/90/135 min)	444/660/650	650/885/877	659/748/851
Ratio (at 45/90/135 min)	2.04/2.76/3.15	3.25/4.34/4.72	2.95/3.72/4.18
PROTEIN ANALYSIS			
HMW-GS Composition	2*,7+8,5+10	2*,1, 17+18,5+10	2*,1,17+18,5+10
%IPP	49.5	55.5	53.3
SEDIMENTATION TEST			
Volume (ml)	55.2	59.8	51.1

Syngenta (Agripro): Cumulative Ash Curves



Postrock					Jagalene (CC04)					AP11T2409				
Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash
2M	20.7	0.33	20.7	0.33	2M	19.1	0.35	19.1	0.35	1M Red	4.1	0.34	4.1	0.34
1M Red	4.9	0.34	25.6	0.34	1M Red	3.8	0.38	22.9	0.36	2M	18.1	0.35	22.2	0.35
1M	11.4	0.35	37.0	0.34	1M	8.4	0.40	31.2	0.37	1M	9.7	0.38	31.9	0.36
1BK	6.9	0.39	43.9	0.35	1BK	4.6	0.42	35.8	0.38	1BK	6.1	0.38	38.0	0.36
2BK	4.1	0.47	48.0	0.36	3M	16.5	0.46	52.2	0.40	2BK	3.8	0.48	41.8	0.37
Grader	3.1	0.50	51.1	0.37	2BK	3.2	0.49	55.5	0.41	Grader	3.0	0.49	44.8	0.38
3M	12.9	0.60	64.1	0.41	4M	5.3	0.51	60.7	0.42	3M	14.4	0.55	59.2	0.42
FILTER FLR	2.5	0.63	66.6	0.42	Grader	2.5	0.52	63.3	0.42	4M	4.2	0.66	63.4	0.44
4M	3.5	0.71	70.1	0.44	FILTER FLR	3.0	0.63	66.3	0.43	FILTER FLR	3.1	0.66	66.5	0.45
3BK	2.7	0.78	72.8	0.45	3BK	2.5	0.66	68.8	0.44	3BK	3.1	0.71	69.6	0.46
5M	3.0	1.34	75.9	0.49	5M	4.8	0.81	73.5	0.46	5M	3.6	1.17	73.2	0.49
Break Shorts	3.6	4.35	79.5	0.66	Break Shorts	3.1	3.56	76.6	0.59	Break Shorts	3.6	4.06	76.9	0.66
Red Dog	2.7	2.65	82.2	0.73	Red Dog	2.8	2.19	79.4	0.65	Red Dog	2.9	2.75	79.7	0.74
Red Shorts	0.6	3.98	82.9	0.75	Red Shorts	0.5	3.78	79.9	0.66	Red Shorts	1.1	3.97	80.9	0.78
Filter Bran	2.3	4.49	85.2	0.86	Filter Bran	3.0	3.69	82.8	0.77	Filter Bran	2.8	4.68	83.7	0.92
Bran	14.8	5.18	100.0	1.50	Bran	17.2	4.80	100.0	1.46	Bran	16.3	4.85	100.0	1.56
Wheat		1.44					1.46					1.52		
St. Grd. Fl.		0.48					0.49					0.48		

Syngenta (Agripro): Cumulative Protein Curves

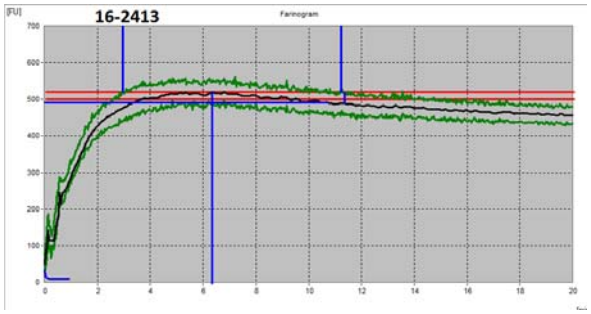


Postrock					Jagalene (CC04)					AP11T2409				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
2M	20.7	12.1	20.7	12.1	2M	19.1	12.4	19.1	12.4	1M Red	4.1	9.9	4.1	9.9
1M Red	4.9	12.4	25.6	12.2	3M	16.5	12.6	35.6	12.5	2M	18.1	9.9	22.2	9.9
1M	11.4	12.6	37.0	12.3	1M Red	3.8	12.6	39.3	12.5	1M	9.7	10.4	31.9	10.1
3M	12.9	13.0	49.9	12.5	4M	5.3	12.9	44.6	12.6	3M	14.4	10.8	46.3	10.3
4M	3.5	13.6	53.4	12.5	1M	8.4	13.0	52.9	12.6	4M	4.2	11.3	50.5	10.4
FILTER FLR	2.5	14.5	56.0	12.6	5M	4.8	14.1	57.7	12.7	1BK	6.1	11.6	56.6	10.5
5M	3.0	15.1	59.0	12.8	FILTER FLR	3.0	15.0	60.7	12.9	FILTER FLR	3.1	12.6	59.8	10.6
1BK	6.9	16.1	65.9	13.1	1BK	4.6	15.1	65.3	13.0	Grader	3.0	12.7	62.8	10.7
Grader	3.1	16.2	69.0	13.3	Grader	2.5	15.9	67.8	13.1	5M	3.6	12.8	66.4	10.8
3BK	2.7	18.6	71.7	13.5	3BK	2.5	17.4	70.3	13.3	2BK	3.8	16.3	70.2	11.1
2BK	4.1	19.6	75.9	13.8	2BK	3.2	19.0	73.5	13.5	3BK	3.1	16.8	73.2	11.4
Break Shorts	3.6	18.5	79.5	14.0	Break Shorts	3.1	17.9	76.6	13.7	Break Shorts	3.6	17.3	76.9	11.7
Red Dog	2.7	16.5	82.2	14.1	Red Dog	2.8	16.9	79.4	13.8	Red Dog	2.9	15.6	79.7	11.8
Red Shorts	0.6	15.4	82.9	14.1	Red Shorts	0.5	15.4	79.9	13.8	Red Shorts	1.1	14.9	80.9	11.8
Filter Bran	2.3	18.1	85.2	14.2	Filter Bran	3.0	17.7	82.8	14.0	Filter Bran	2.8	17.0	83.7	12.0
Bran	14.8	19.3	100.0	15.0	Bran	17.2	19.4	100.0	14.9	Bran	16.3	17.8	100.0	13.0
Wheat		14.8					14.8					12.9		
St. Grd. Fl		13.7					13.6					11.4		

Physical Dough Tests

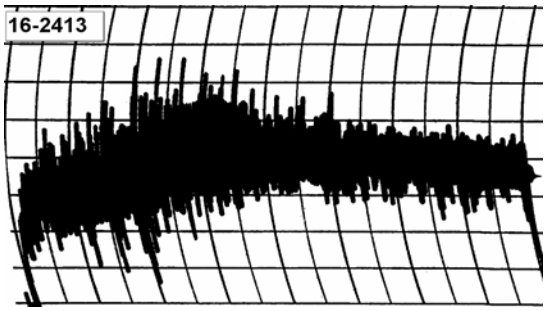
2016 (Small Scale) Samples – Syngenta(Agripro)

Farinograms



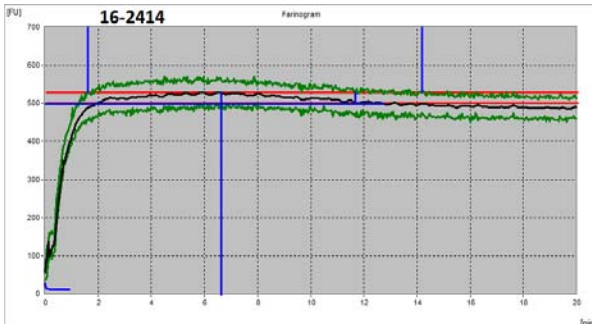
Water abs = 59.1%, Peak time = 6.4 min,
Mix stab = 8.3 min, MTI = 32 FU

Mixograms

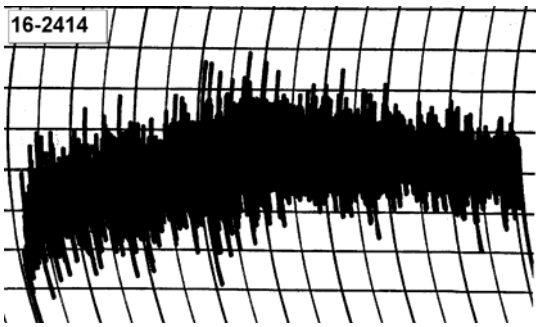


Water abs = 65.7%
Mix time = 3.3 min

16-2413, Postrock



Water abs = 62.0%, Peak time = 6.7 min,
Mix stab = 12.6 min, MTI = 25 FU



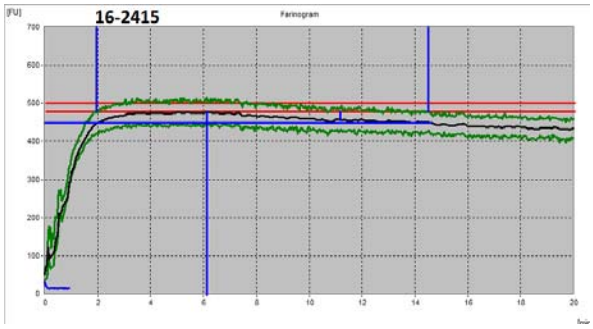
Water abs = 66.9%
Mix time = 4.0 min

16-2414, Jagalene (CC04)

Physical Dough Tests

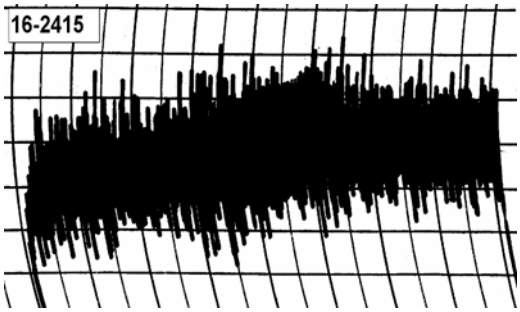
2016 (Small Scale) Samples – Syngenta

Farinograms



Water abs = 63.7%, Peak time = 6.2 min,
Mix stab = 12.5 min, MTI = 22 FU

Mixograms

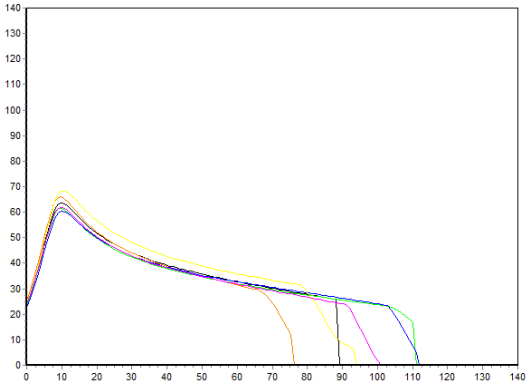


Water abs = 65.0%
Mix time = 5.0 min

16-2415, AP11T2409

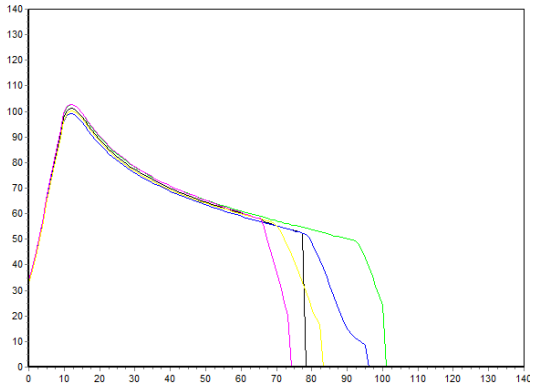
Physical Dough Tests - Alveograph

2016 (Small Scale) Samples – Syngenta



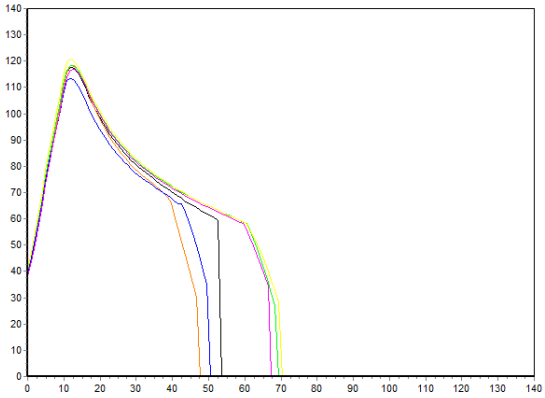
16-2413, Postrock

P (mm H_20) = 70, L (mm) = 89, W ($10E^{-4}J$) = 227



16-2414, Jagalene (CC04)

P (mm H_20) = 111, L (mm) = 77, W ($10E^{-4}J$) = 356

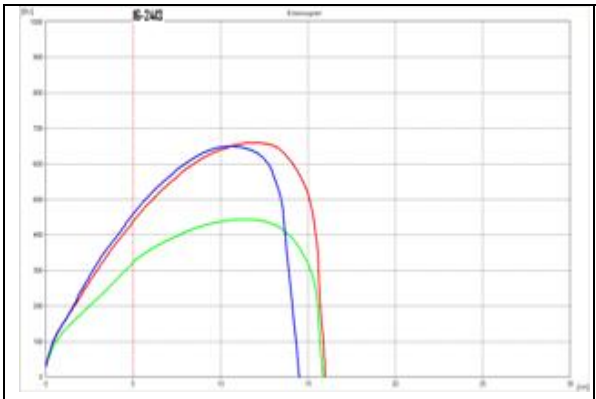


16-2415, AP11T2409

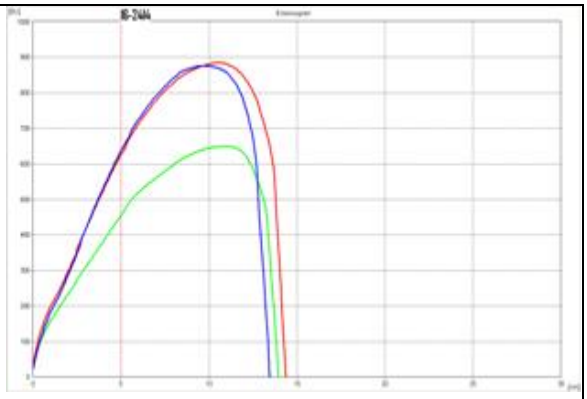
P (mm H_20) = 129, L (mm) = 53, W ($10E^{-4}J$) = 281

Physical Dough Tests - Extensigraph

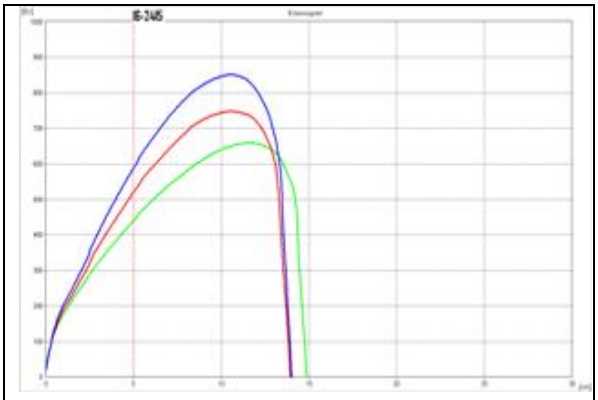
2016 (Small Scale) Samples – Syngenta



16-2413, Postrock
R (BU) = 442, E (mm) = 160, W (cm^2) = 135
Rmax (BU) = 660, Ratio = 2.8 at 90 min



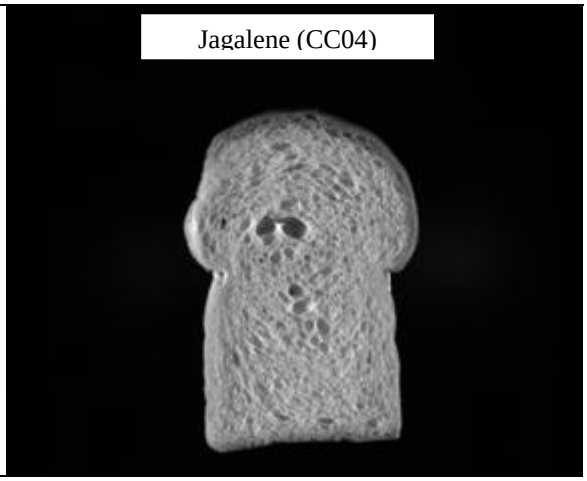
16-2414, Jagalene (CC04)
R (BU) = 630, E (mm) = 145, W (cm^2) = 159
Rmax (BU) = 885, Ratio = 4.3 at 90 min



16-2415, AP11T2409
R (BU) = 524, E (mm) = 141, W (cm^2) = 131
Rmax (BU) = 748, Ratio = 3.7 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Syngenta: C-Cell Bread Images and Analysis
2016 (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 (^{0})
2413	6568	135.4	4456	0.425	1.791	1.504	1.675	-13.95
2414	6177	139.8	4017	0.436	1.950	4.762	1.693	-11.65

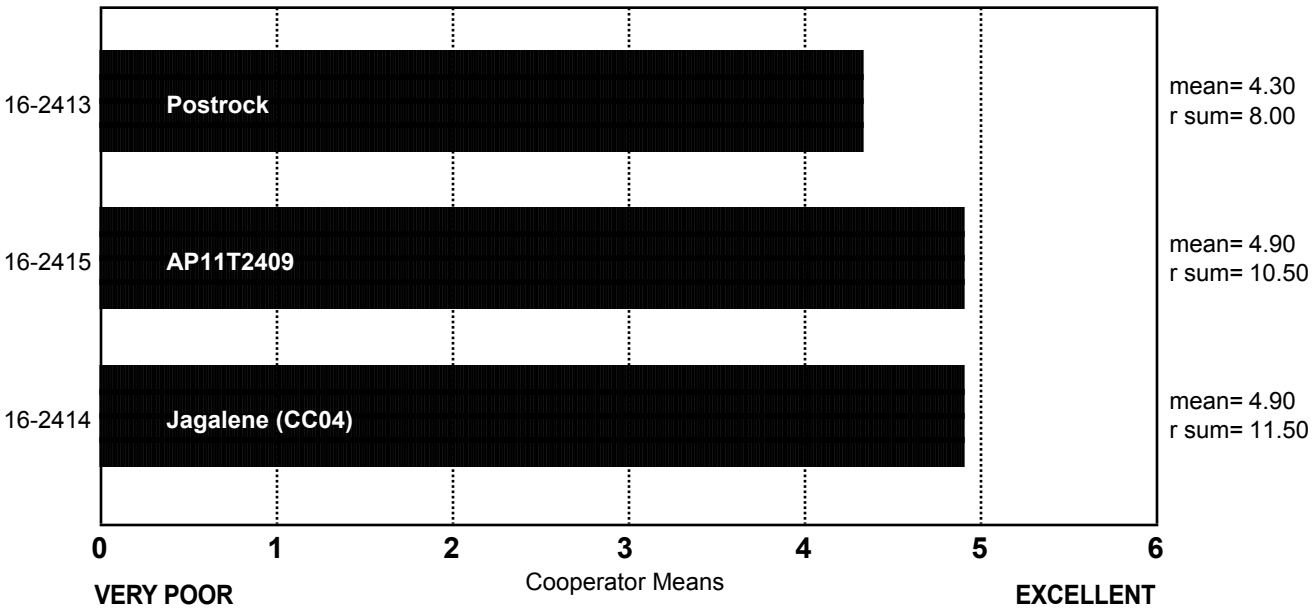
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2415	5459	142.9	3736	0.435	1.827	9.667	1.683	-15.90

SPONGE CHARACTERISTICS

(Small Scale) Agripro

ncoop= 5
chisq= 1.30
chisqc= 2.36
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

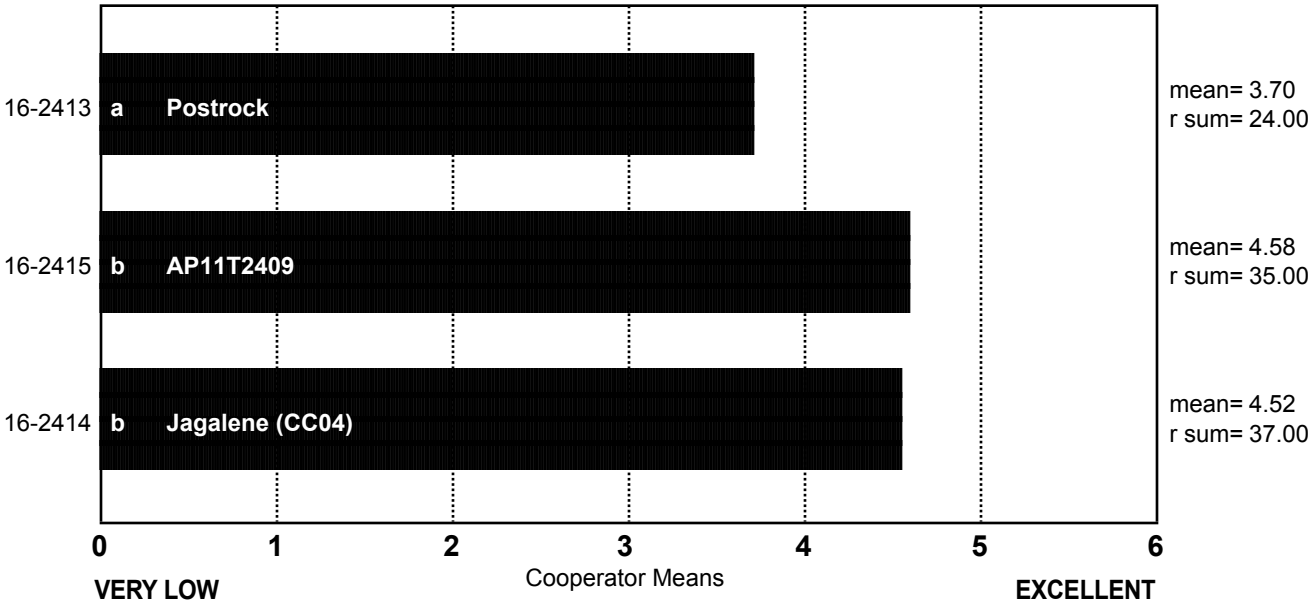


BAKE ABSORPTION

(Small Scale) Agripro

ncoop= 16
chisq= 6.13
chisqc= 7.00
cvchisq= 5.99
crdiff= 9.86

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) 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
16-2413 Postrock	**66.4**	**59.1**	**59.1**	**65.5**	**65.0**	**63.1**	**59.0**	**64.2**	**62.8**	**57.3**	**63.5**	**65.7**	**59.1**	**63.0**	**58.0**	**65.5**
16-2414 Jagalene (CC04)	**67.8**	**62.0**	**62.0**	**67.1**	**65.3**	**66.9**	**59.0**	**64.2**	**65.5**	**59.4**	**65.6**	**67.8**	**62.0**	**63.0**	**61.0**	**66.9**
16-2415 AP11T2409	**62.3**	**63.7**	**63.7**	**64.9**	**63.5**	**69.1**	**57.0**	**60.9**	**67.6**	**61.2**	**63.7**	**67.4**	**63.7**	**60.0**	**62.0**	**66.0**

BAKE MIX TIME, ACTUAL

(Small Scale) Agripro

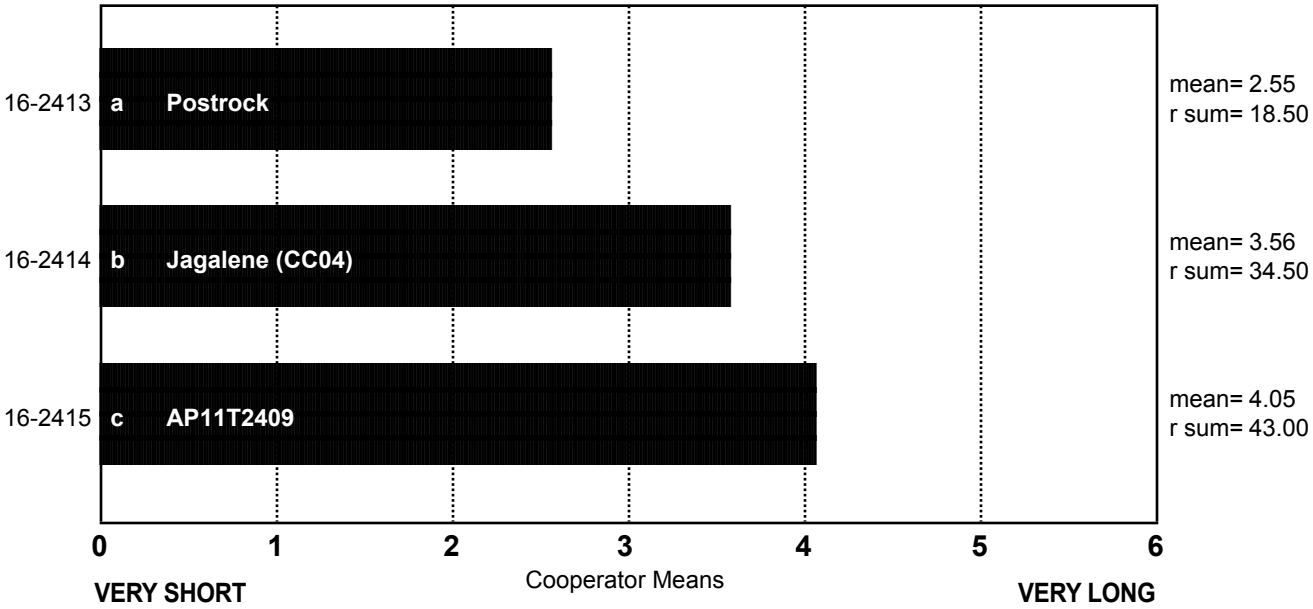
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2413 Postrock	**3.3**	**6.0**	**7.0**	**3.4**	**4.6**	**3.5**	**5.0**	**3.0**	**2.3**	**4.0**	**2.6**	**3.6**	**4.5**	**3.0**	**16.0**	**2.8**
16-2414 Jagalene (CC04)	**4.0**	**6.0**	**8.0**	**4.2**	**6.5**	**4.8**	**10.0**	**4.0**	**2.5**	**6.0**	**3.6**	**4.8**	**6.0**	**5.0**	**20.0**	**3.9**
16-2415 AP11T2409	**4.5**	**8.0**	**9.0**	**4.5**	**6.7**	**4.0**	**10.0**	**4.3**	**3.5**	**6.0**	**3.6**	**6.8**	**5.5**	**8.0**	**16.0**	**5.0**

BAKE MIX TIME

(Small Scale) Agripro

ncoop= 16
chisq= 19.34
chisqc= 24.27
cvchisq= 5.99
crdiff= 5.23

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

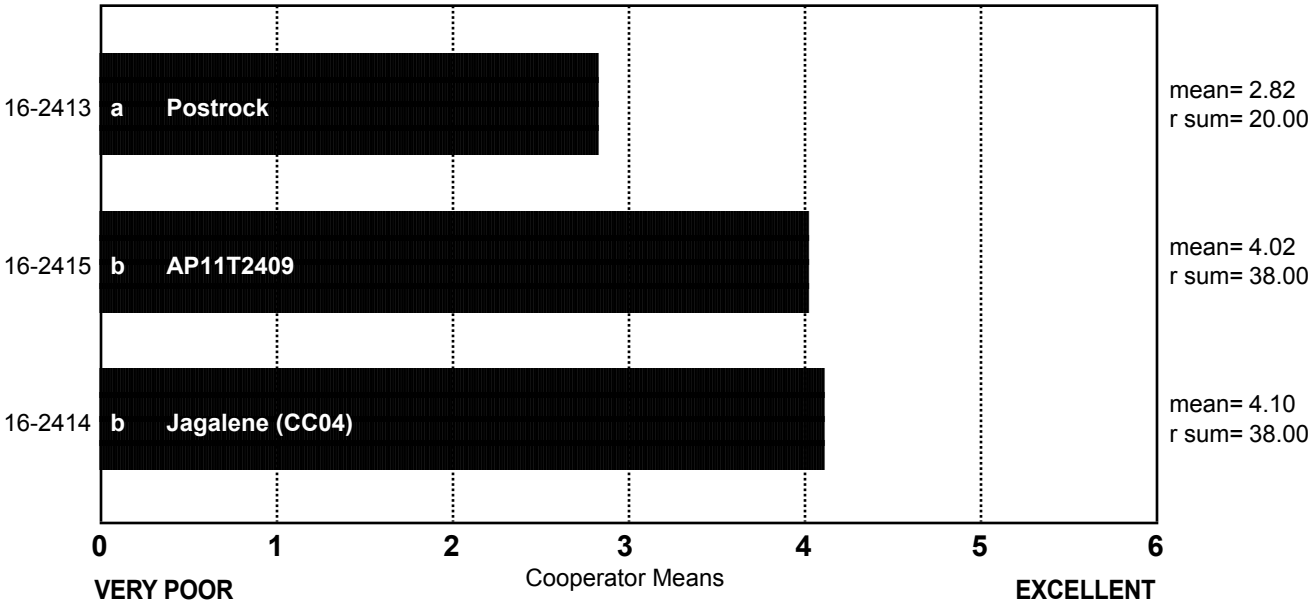


MIXING TOLERANCE

(Small Scale) Agripro

ncoop= 16
chisq= 13.50
chisqc= 18.78
cvchisq= 5.99
crdiff= 6.50

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

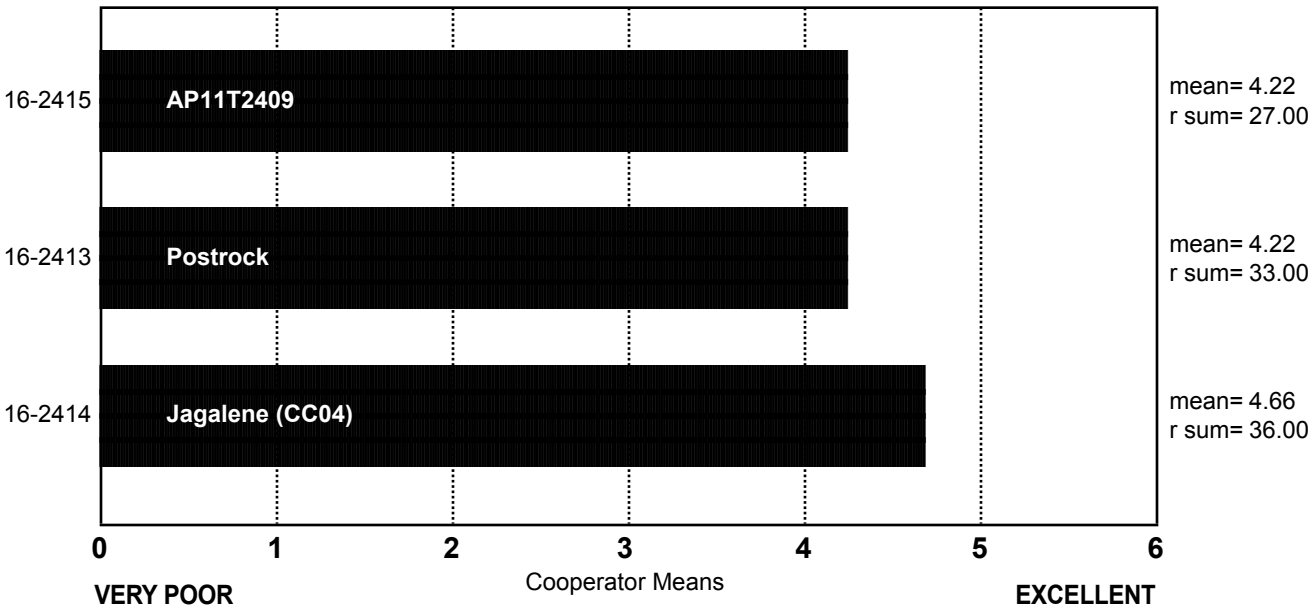


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Agripro

ncoop= 16
chisq= 2.63
chisqc= 4.54
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) Agripro

	Sticky	Wet	Tough	Good	Excellent
16-2413 Postrock	**0**	**3**	**1**	**8**	**4**
16-2414 Jagalene (CC04)	**0**	**0**	**1**	**10**	**5**
16-2415 AP11T2409	**0**	**2**	**3**	**8**	**3**

Frequency Table

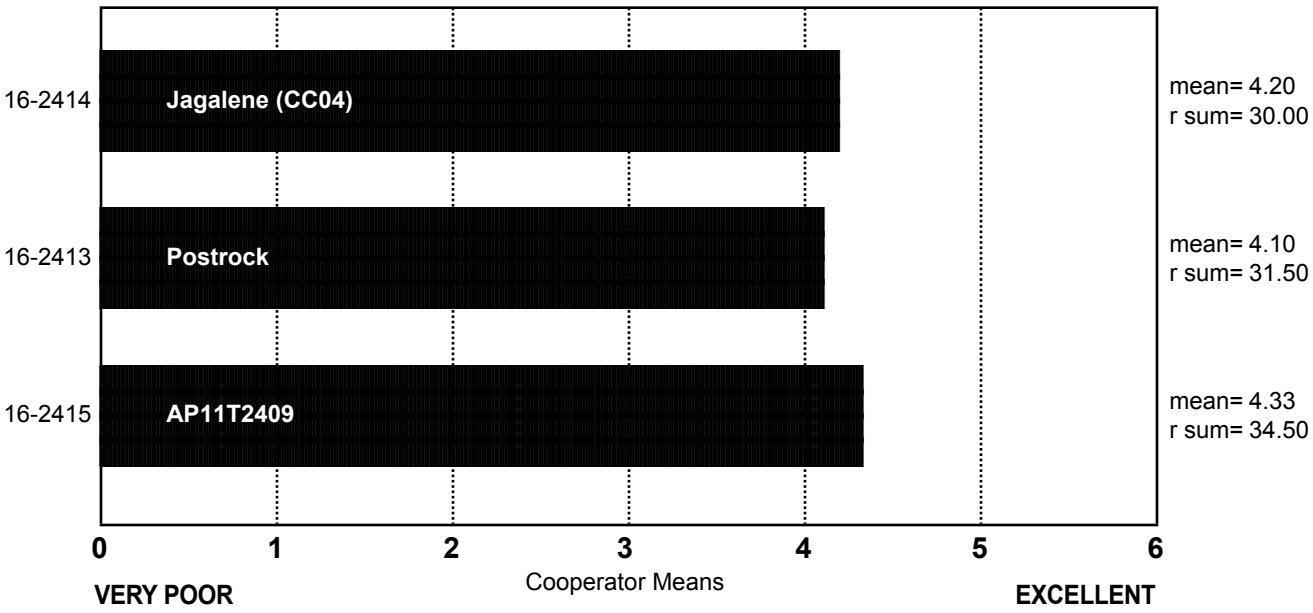
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Agripro

ncoop= 16
chisq= 0.66
chisqc= 1.08
cvchisq= 5.99
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
16-2413 Postrock	**1**	**2**	**0**	**9**	**4**
16-2414 Jagalene (CC04)	**1**	**0**	**1**	**12**	**2**
16-2415 AP11T2409	**0**	**1**	**3**	**7**	**5**

Frequency Table

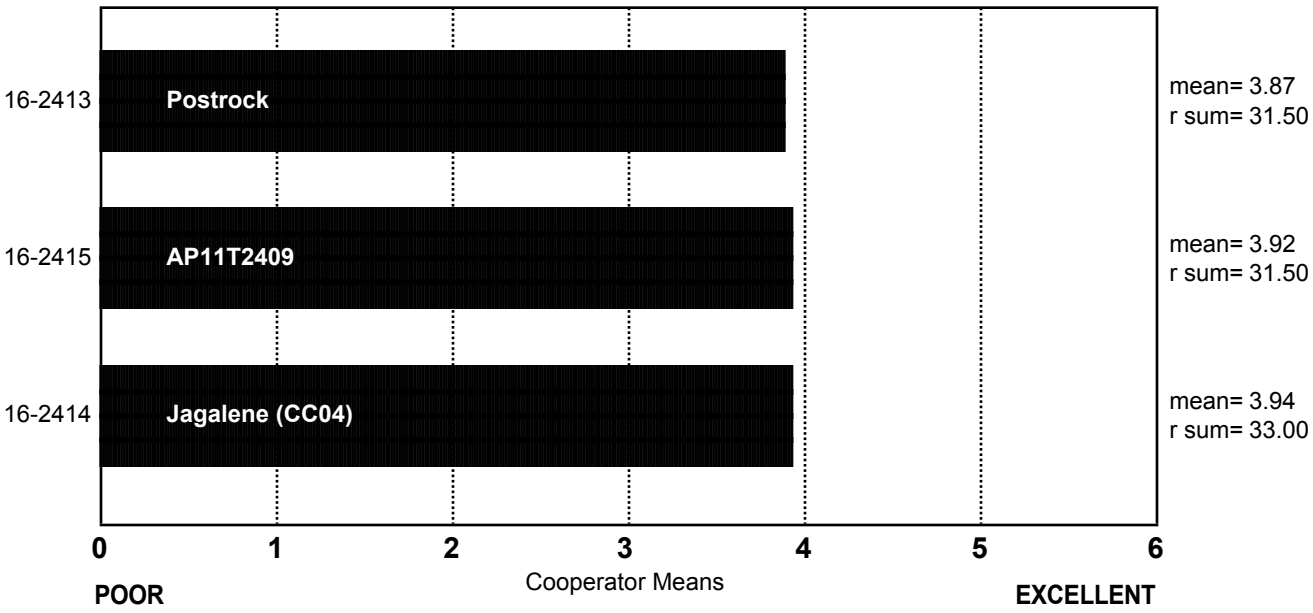
CRUMB GRAIN

(Small Scale) Agripro

ncoop= 16
chisq= 0.09
chisqc= 0.11
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Agripro

	Open	Fine	Dense
16-2413 Postrock	**7**	**7**	**2**
16-2414 Jagalene (CC04)	**9**	**7**	**0**
16-2415 AP11T2409	**5**	**9**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Agripro

	Round	Irregular	Elongated
16-2413 Postrock	**2**	**6**	**8**
16-2414 Jagalene (CC04)	**5**	**6**	**5**
16-2415 AP11T2409	**2**	**5**	**9**

Frequency Table

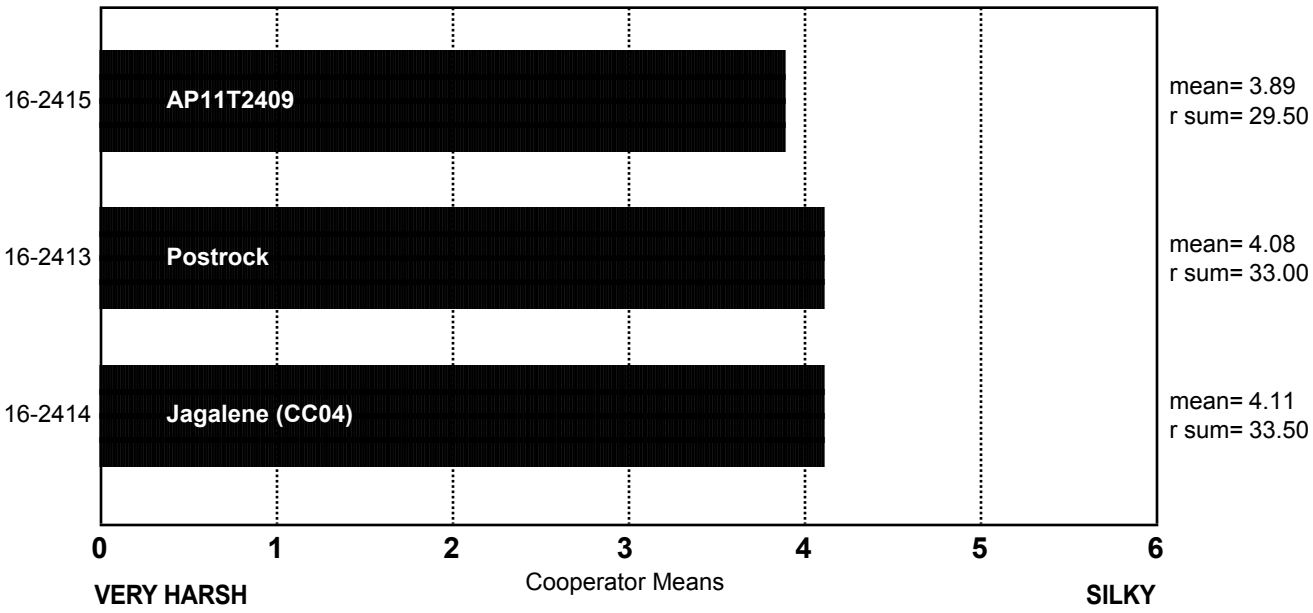
CRUMB TEXTURE

(Small Scale) Agripro

ncoop= 16
chisq= 0.59
chisqc= 0.88
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Agripro

	Harsh	Smooth	Silky
16-2413 Postrock	**2**	**13**	**1**
16-2414 Jagalene (CC04)	**3**	**11**	**2**
16-2415 AP11T2409	**3**	**11**	**2**

Frequency Table

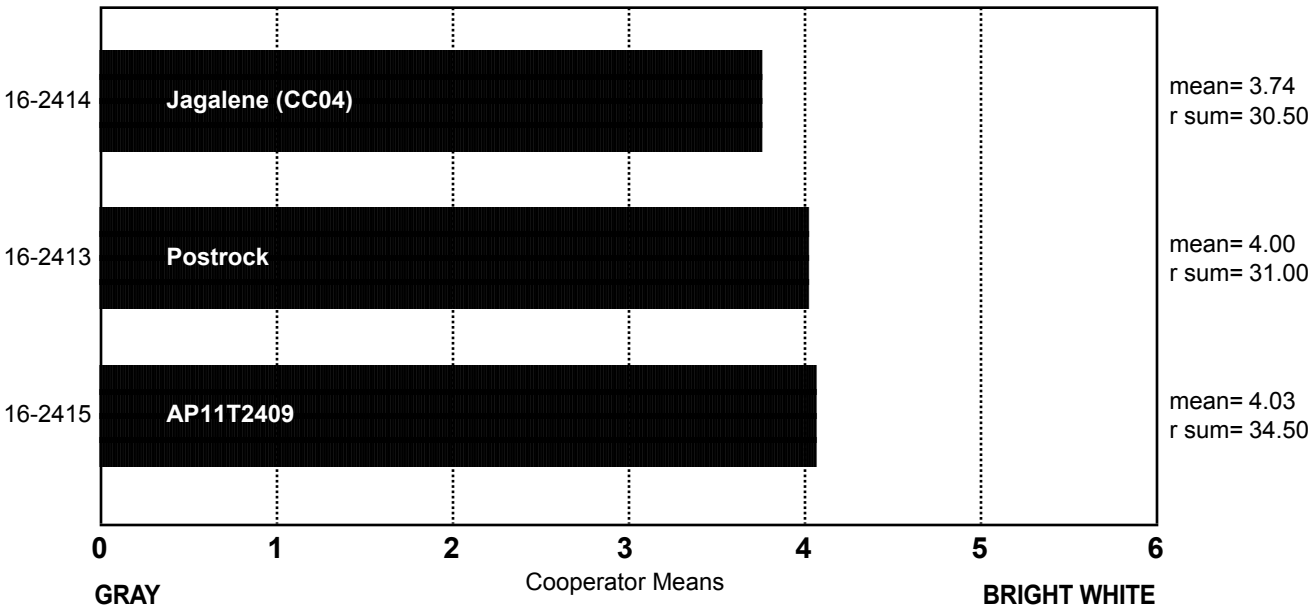
CRUMB COLOR

(Small Scale) Agripro

ncoop= 16
chisq= 0.59
chisqc= 0.90
cvchisq= 5.99
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
16-2413 Postrock	**0**	**1**	**0**	**3**	**7**	**5**	**0**
16-2414 Jagalene (CC04)	**0**	**0**	**5**	**2**	**4**	**4**	**1**
16-2415 AP11T2409	**1**	**0**	**1**	**3**	**6**	**4**	**1**

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
16-2413 Postrock	**144.9**	**465.0**	**456.2**	**154.2**	**138.9**	**128.7**	**413.0**	**143.8**	**132.9**	**479.5**	**139.5**	**151.2**	**443.9**	**147.1**		**138.8**
16-2414 Jagalene (CC04)	**146.3**	**464.4**	**455.6**	**154.1**	**140.4**	**130.6**	**412.0**	**141.9**	**133.3**	**479.6**	**142.1**	**151.6**	**443.4**	**147.4**		**138.4**
16-2415 AP11T2409	**143.5**	**467.8**	**452.4**	**155.8**	**137.4**	**138.8**	**413.0**	**142.0**	**136.9**	**476.0**	**140.5**	**153.4**	**443.4**	**149.5**		**138.7**

LOAF VOLUME, ACTUAL

(Small Scale) Agripro

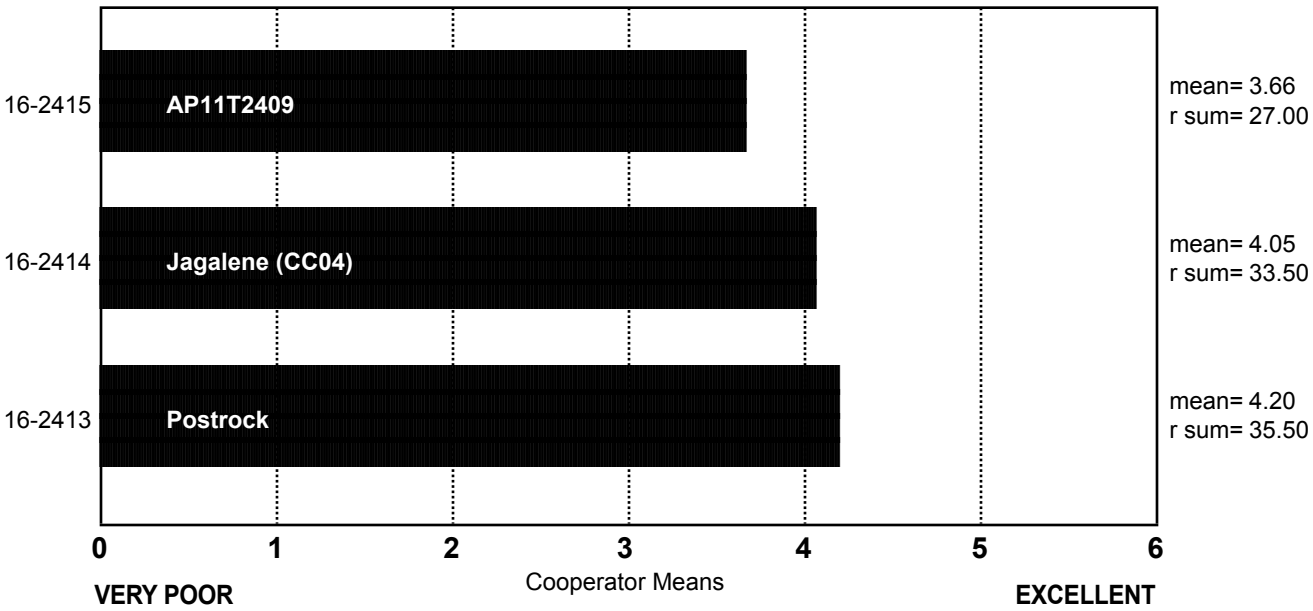
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2413 Postrock	**1000**	**2475**	**2854**	**1015**	**973**	**1000**	**3000**	**1030**	**803**	**2575**	**950**	**960**	**2450**	**950**	**3015**	**852**
16-2414 Jagalene (CC04)	**1080**	**2363**	**2647**	**1025**	**986**	**925**	**3050**	**965**	**833**	**2650**	**965**	**940**	**2500**	**925**	**3104**	**828**
16-2415 AP11T2409	**940**	**2313**	**2788**	**935**	**863**	**910**	**2900**	**805**	**860**	**2575**	**855**	**820**	**2425**	**900**	**3104**	**789**

LOAF VOLUME

(Small Scale) Agripro

ncoop= 16
chisq= 2.47
chisqc= 3.29
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

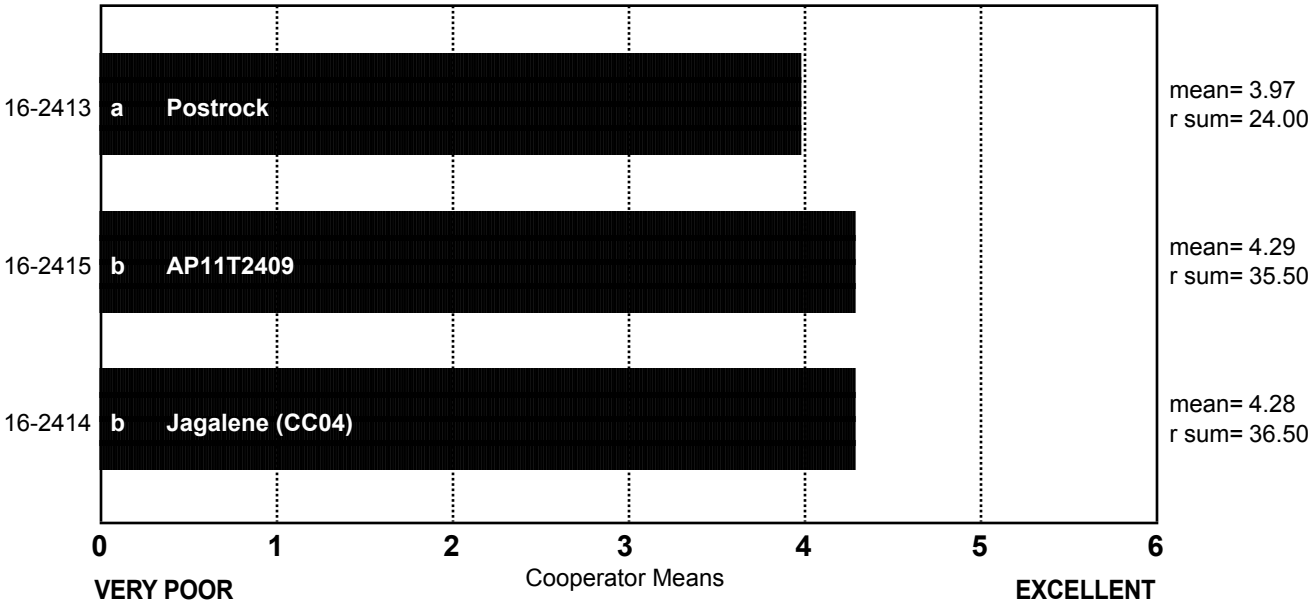


OVERALL BAKING QUALITY

(Small Scale) Agripro

ncoop= 16
chisq= 6.03
chisqc= 7.42
cvchisq= 5.99
crdiff= 9.42

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Agripro

COOP. **16-2413 Postrock**

A. Excellent externals.
B. Low absorption, average mix time, low volume, creamy, open.
C. Good moulding.
D. Fairly short mixing time with dough strength borderline for protein level but felt good, good volume and grain.
E. High water absorption, normal mix time, slight sticky & weak dough, high volume, dull crumb, slight open elongated cells, resilient & smooth texture.
F. Good volume and color, not best crumb characteristics.
G. Higher protein.
H. Exceeds target loaf volume.
I. Really nice dough, smooth soft and silky, overall good crumb structure, but poor color.
J. Low absorption, excellent dough, good grain, average volume.
K. Excellent protein, good crumb, slightly lower volume.
L. Good flour protein, good bake absorption, excellent dough during bake, satisfactory crumb grain, good loaf volume.
M. No comment.
N. No comment.
O. Tight, consistent, slightly coarse grain, very good volume.
P. No comment.

COOP. **16-2414 Jagalene (CC04)**

A. No comment.
B. Slightly above average absorption, average mix time, very low volume, creamy, open.
C. Good moulding.
D. Fairly short mix time with good dough strength, good volume and grain.
E. High water absorption, normal mix time, slight sticky & strong dough, high volume, yellow crumb, open round cells, resilient & slightly harsh texture.
F. Good loaf volume and color but has harsh texture.
G. Higher protein.
H. Exceeds target loaf volume.
I. Even crumb with good cell structure, smooth overall.
J. Average absorption and mix time, excellent dough out of mixer, average grain, yellow crumb, good volume.
K. Excellent protein, very good crumb, slightly lower volume.
L. Good flour protein, good bake absorption, excellent dough during bake, satisfactory crumb grain, good loaf volume.
M. Best bread of the set, excellent mix time and makeup with a great absorption, bread was the highest volume of the set with a fine white grain.
N. Lively at the bench.
O. Slightly open, variable, slightly coarse grain, excellent volume.
P. No comment.

COOP. 16-2415 AP11T2409

A. No comment.
B. Above average absorption, average mix time, very low volume, creamy, open.
C. One of the best in the set.
D. Generally good properties all around.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
F. Fairly good in all categories except dull loaf color.
G. Average protein.
H. Good.
I. Crumb texture is harsh, crumbles/separates when pressed, but overall acceptable.
J. Good absorption and grain, average mix time and volume, excellent dough out of mixer.
K. Nice crumb.
L. Excellent bake absorption, good dough during bake, questionable-satisfactory crumb grain, low loaf volume.
M. No comment.
N. Slightly dry at the bench.
O. Tight, variable, slightly coarse grain, excellent volume.
P. No comment.

Notes: **B, G, J, M, N, and O** conducted sponge and dough bake tests

MONSANTO (WESTBRED)

16-2416	Jagalene (CC05)
16-2417	HV9W10_0458

Description of Test Plots and Breeder Entries

Monsanto (Westbred) - Sid Perry

The test samples were grown in Filer, Idaho. The plots were planted on October 10, 2015. 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)

HV9W10-0458

HV9W10-0458 is a hard red winter wheat, with medium maturity, very good straw strength, and above average test weight. It does not break dormancy early, and has done quite well in the southern OK/north TX areas that have been prone to late freeze events over the last few years. It is moderately resistant to leaf and stripe rust. It is resistant to soil borne mosaic virus, and moderately tolerant to low pH soils. It is susceptible to Fusarium Head Blight. Internal quality testing indicates HV9W10-0458 to have good baking characteristics. HV9W10-0458 will be marketed as WB4515.

Westbred: 2016 (Small-Scale) Samples

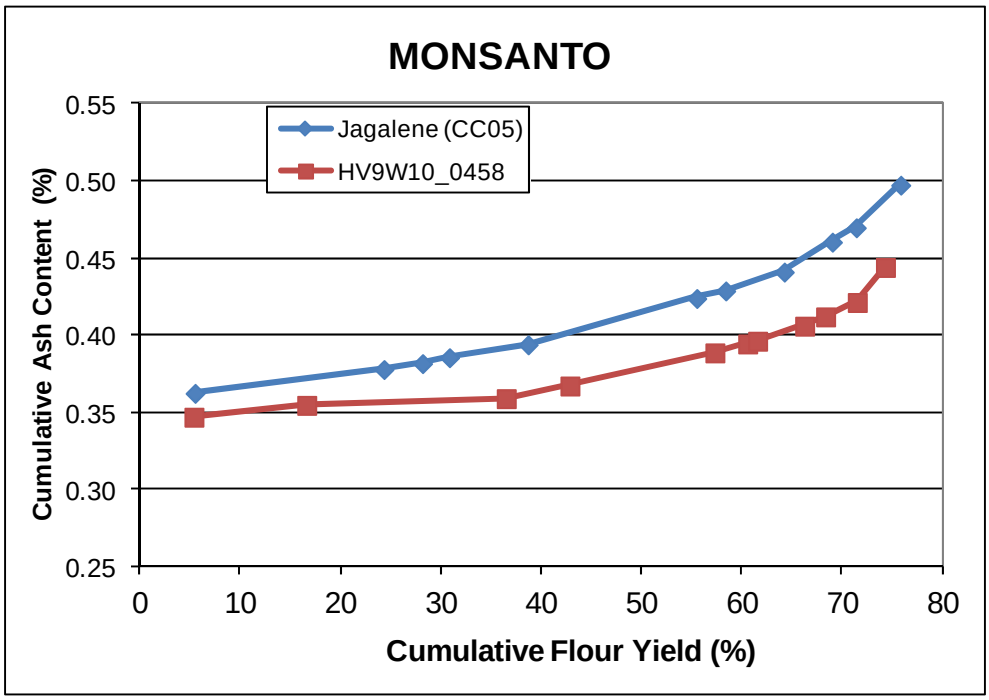
Test entry number	16-2416	16-2417
Sample identification	**Jagalene (CC05)**	**HV9W10_0458**
Wheat Data		
GIPSA classification	1 HRW	1 HRW
Test weight (lb/bu)	65.7	66.1
Hectoliter weight (kg/hl)	86.3	86.8
1000 kernel weight (gm)	44.7	37.9
Wheat kernel size (Rotap)		
Over 7 wire (%)	97.3	88.9
Over 9 wire (%)	2.7	11.1
Through 9 wire (%)	0.0	0.0
Single kernel (skcs)[a]		
Hardness (avg /s.d)	70.8/12.5	68.6/13.6
Weight (mg) (avg/s.d)	44.7/8.2	37.9/7.9
Diameter (mm)(avg/s.d)	3.17/0.34	2.86/0.33
Moisture (%) (avg/s.d)	8.8/0.4	8.6/0.5
SKCS distribution	00-02-12-86-01	01-04-15-80-01
Classification	Hard	Hard
Wheat protein (12% mb)	11.7	11.8
Wheat ash (12% mb)	1.61	1.62
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	75.7	74.1
Quadrumat Sr. Mill	69.1	70.1
Flour moisture (%)	13.7	13.5
Flour protein (14% mb)	10.3	10.6
Flour ash (14% mb)	0.50	0.44
Rapid Visco-Analyser		
Peak time (min)	6.2	6.3
Peak viscosity (RVU)	186.0	201.2
Breakdown (RVU)	61.9	56.5
Final viscosity at 13 min (RVU)	222.1	250.1
Minolta color meter		
L*	92.34	92.52
a*	-1.54	-1.72
b*	8.80	9.16
PPO	0.339	0.417
Falling number (sec)	402	404
Damaged Starch		
(AI%)	97.9	96.6
(AACC76-31)	7.8	6.7

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Westbred: Physical Dough Tests and Gluten Analysis
2016 (Small-Scale) Samples

Test Entry Number	**16-2416**	**16-2417**
Sample Identification	**Jagalene (CC05)**	**HV9W10_0458**
MIXOGRAPH		
Flour Abs (% as-is)	60.3	61.9
Flour Abs (14% mb)	59.9	61.5
Mix Time (min)	2.1	2.9
Mix tolerance (0-6)	2	1
FARINOGRAPH		
Flour Abs (% as-is)	63.0	60.0
Flour Abs (14% mb)	62.6	59.5
Development time (min)	4.7	6.3
Mix stability (min)	6.0	7.3
Mix Tolerance Index (FU)	32	26
Breakdown time (min)	9.4	11.8
ALVEOGRAPH		
P(mm): Tenacity	95	79
L(mm): Extensibility	87	84
G(mm): Swelling index	20.8	20.4
W(10^{-4} J): strength (curve area)	261	210
P/L: curve configuration ratio	1.09	0.94
Ie(P_{200}/P): elasticity index	50.7	50.5
EXTENSIGRAPH		
Resist (BU at 45/90/135 min)	235/286/301	201/285/368
Extensibility (mm at 45/90/135 min)	158/161/152	161/149146
Energy (cm^2 at 45/90/135 min)	69/86/81	60/78/95
Resist $_{max}$ (BU at 45/90/135min)	318/397/401	273/396/508
Ratio (at 45/90/135 min)	1.49/1.78/1.98	1.25/1.91/2.53
PROTEIN ANALYSIS		
HMW-GS Composition	2*,1, 17+18, 5+10	2*, 7+8, 5+10
%IPP	48.2	44.1
SEDIMENTATION TEST		
Volume (ml)	39.9	36.8

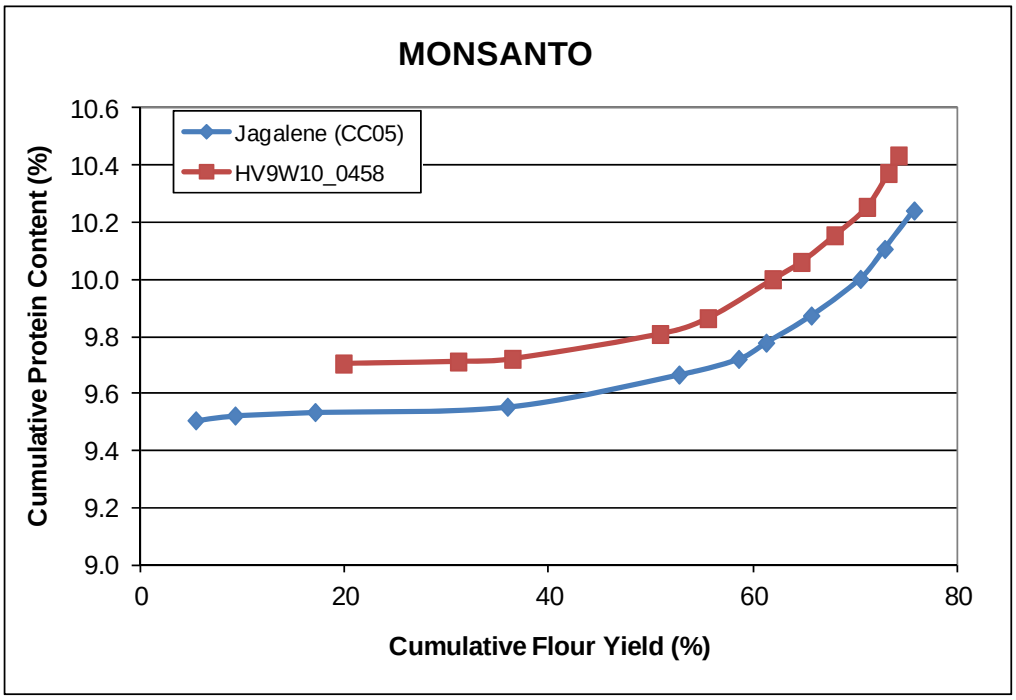
Westbred: Cumulative Ash Curves



Jagalene (CC05)					HV9W10_0458				
Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash
1BK	5.4	0.36	5.4	0.36	1M Red	5.3	0.35	5.3	0.35
2M	18.8	0.38	24.2	0.38	1M	11.2	0.36	16.5	0.35
1M Red	3.8	0.41	28.1	0.38	2M	19.9	0.36	36.4	0.36
Grader	2.7	0.43	30.8	0.39	1BK	6.3	0.41	42.8	0.37
1M	7.8	0.43	38.6	0.39	3M	14.4	0.45	57.2	0.39
3M	16.8	0.49	55.4	0.42	Grader	3.3	0.50	60.5	0.39
2BK	2.9	0.52	58.3	0.43	2BK	1.0	0.51	61.5	0.40
4M	5.8	0.56	64.1	0.44	4M	4.7	0.53	66.2	0.41
FILTER FLR	4.8	0.72	68.9	0.46	3BK	2.1	0.60	68.3	0.41
3BK	2.4	0.74	71.3	0.47	FILTER FLR	3.2	0.62	71.4	0.42
5M	4.4	0.94	75.7	0.50	5M	2.8	1.02	74.2	0.44
Break Shorts	3.1	3.80	78.8	0.63	Break Shorts	2.4	3.40	76.7	0.54
Red Dog	2.6	2.85	81.4	0.70	Red Dog	1.4	2.82	78.1	0.58
Red Shorts	0.5	4.26	81.9	0.72	Red Shorts	0.3	4.12	78.4	0.59
Filter Bran	3.0	3.82	84.8	0.83	Filter Bran	2.8	4.30	81.2	0.72
Bran	15.2	5.28	100.0	1.50	Bran	18.8	5.41	100.0	1.60

Wheat	1.57		1.58
St. Grd. Fl.	0.50		0.44

Westbred: Cumulative Protein Curves

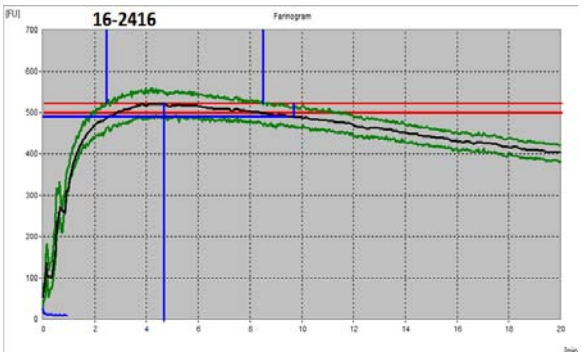


Jagalene (CC05)					HV9W10_0458				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1BK	5.4	9.5	5.4	9.5	2M	19.9	9.7	19.9	9.7
1M Red	3.8	9.5	9.3	9.5	1M	11.2	9.7	31.1	9.7
1M	7.8	9.5	17.1	9.5	1M Red	5.3	9.8	36.4	9.7
2M	18.8	9.6	35.9	9.6	3M	14.4	10.0	50.9	9.8
3M	16.8	9.9	52.7	9.7	4M	4.7	10.5	55.6	9.9
4M	5.8	10.2	58.6	9.7	1BK	6.3	11.2	61.9	10.0
Grader	2.7	11.0	61.2	9.8	5M	2.8	11.4	64.7	10.1
5M	4.4	11.2	65.7	9.9	Grader	3.3	12.0	68.0	10.2
FILTER FLR	4.8	11.8	70.5	10.0	FILTER FLR	3.2	12.4	71.1	10.3
3BK	2.4	13.2	72.8	10.1	3BK	2.1	14.4	73.2	10.4
2BK	2.9	13.6	75.7	10.2	2BK	1.0	15.0	74.2	10.4
Break Shorts	3.1	14.8	78.8	10.4	Break Shorts	2.4	13.7	76.7	10.5
Red Dog	2.6	14.2	81.4	10.5	Red Dog	1.4	13.3	78.1	10.6
Red Shorts	0.5	13.2	81.9	10.6	Red Shorts	0.3	12.5	78.4	10.6
Filter Bran	3.0	14.3	84.8	10.7	Filter Bran	2.8	14.4	81.2	10.7
Bran	15.2	16.2	100.0	11.5	Bran	18.8	16.1	100.0	11.7
Wheat		11.4					11.5		
St. Grd. Fl		10.3					10.6		

Physical Dough Tests

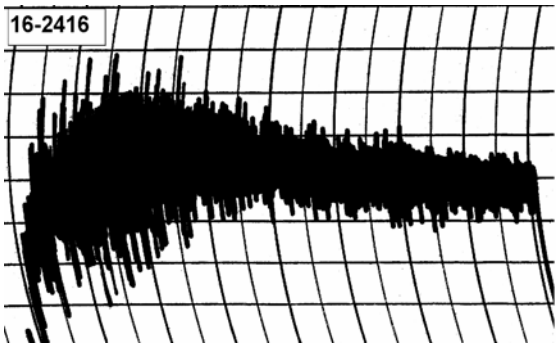
2015 (Small Scale) Samples - Westbred

Farinograms



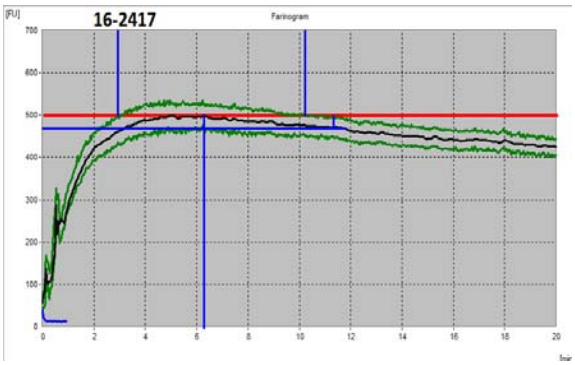
Water abs = 62.6%, Peak time = 4.7 min,
Mix stab = 6.0 min, MTI = 32 FU

Mixograms

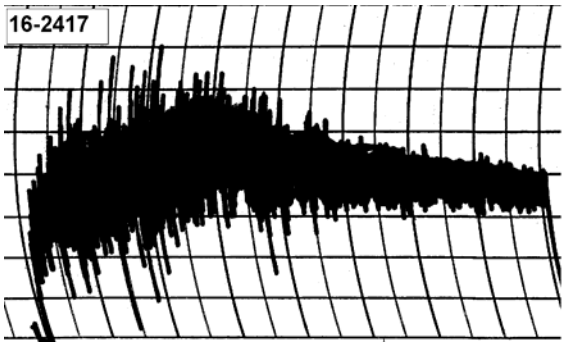


Water abs = 59.9%
Mix time = 2.1 min

16-2416, Jagalene (CC05)



Water abs = 59.5%, Peak time = 6.3 min,
Mix stab = 7.3 min, MTI = 26 FU

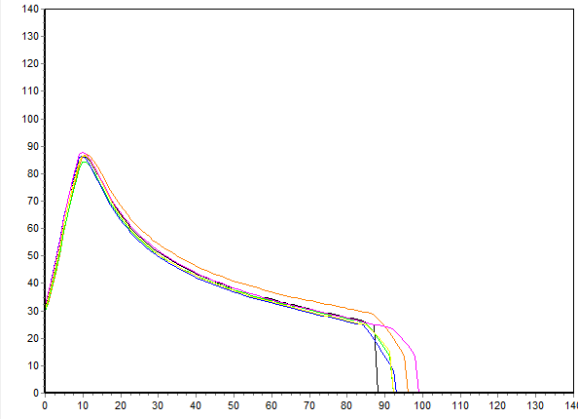


Water abs = 61.5%
Mix time = 2.9 min

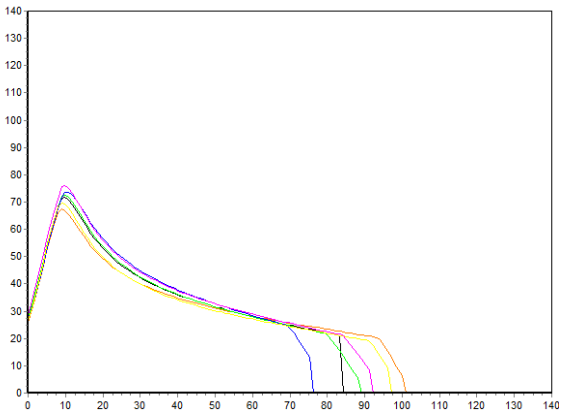
16-2417, HV9W10_0458

Physical Dough Tests - Alveograph

2016 (Small Scale) Samples – Westbred



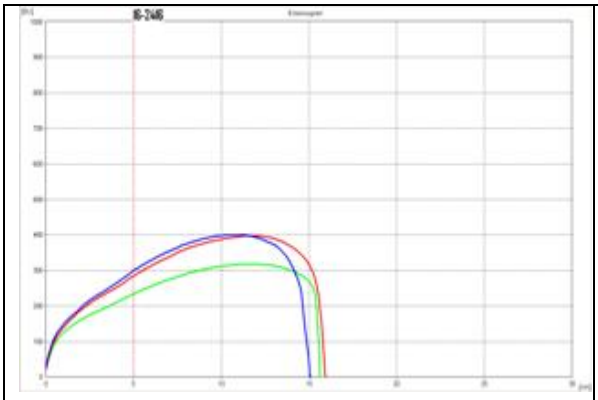
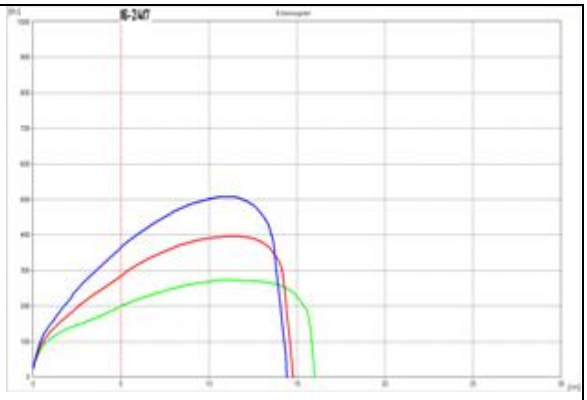
16-2416, Jagalene (CC05)
P(mm H_20)=95, L(mm)=87, W($10E^{-4}$ J)=261



16-2417, HV9W10_0458
P(mm H_20)=79, L(mm)=84, W($10E^{-4}$ J)=210

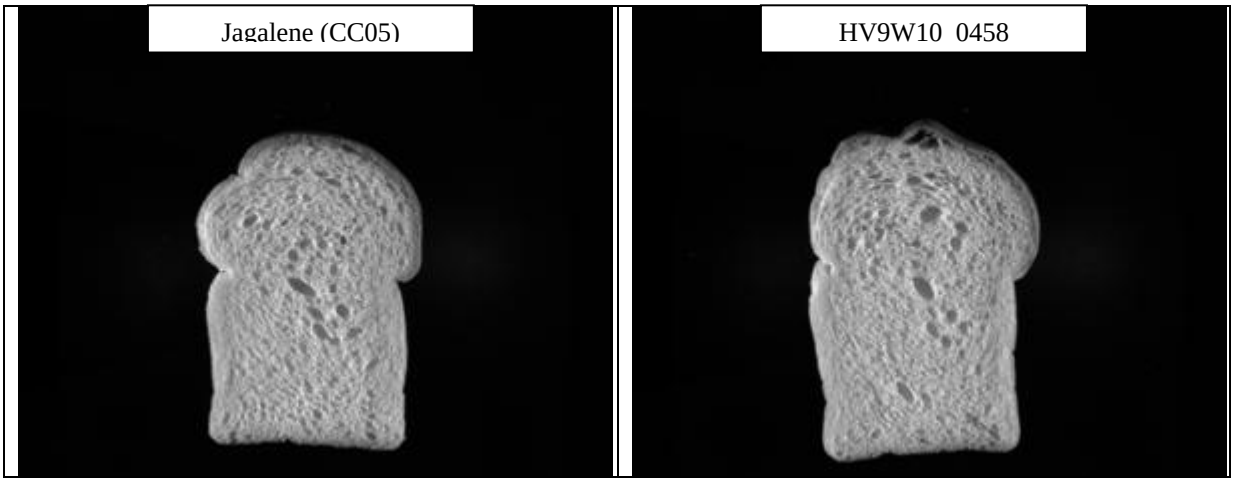
Physical Dough Tests - Extensigraph

2016 (Small Scale) Samples – Westbred

	
16-2416, Jagalene (CC05) R (BU) = 286, E (mm) =161, W (cm^2) = 86 Rmax (BU) = 397, Ratio = 1.8 at 90 min	**16-2417, HV9W10_0458** R (BU) = 285, E (mm) =149, W (cm^2) = 78 Rmax (BU) = 396, Ratio = 1.9 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Westbred: C-Cell Bread Images and Analysis for 2016 (Small-Scale) Samples



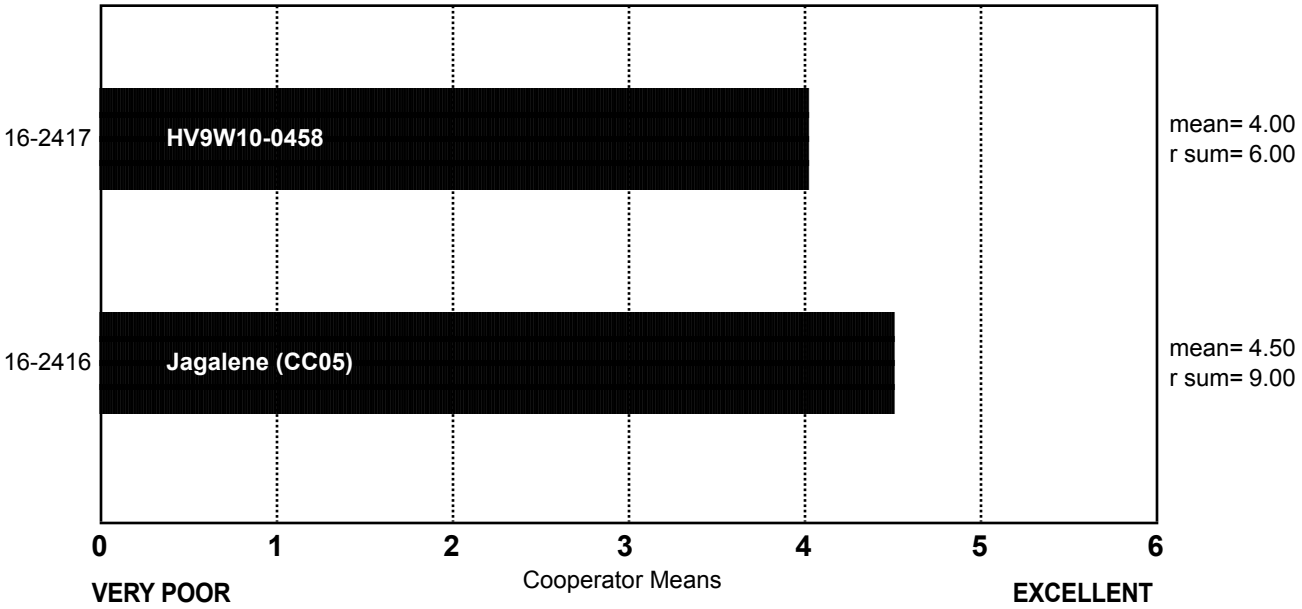
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2416	5635	150.5	3822	0.435	1.889	4.255	1.650	-26.05
2417	6076	149.9	4141	0.432	1.872	6.160	1.665	-18.75

SPONGE CHARACTERISTICS

(Small Scale) Westbred

ncoop= 5
chisq= 1.80
chisqc= 3.00
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

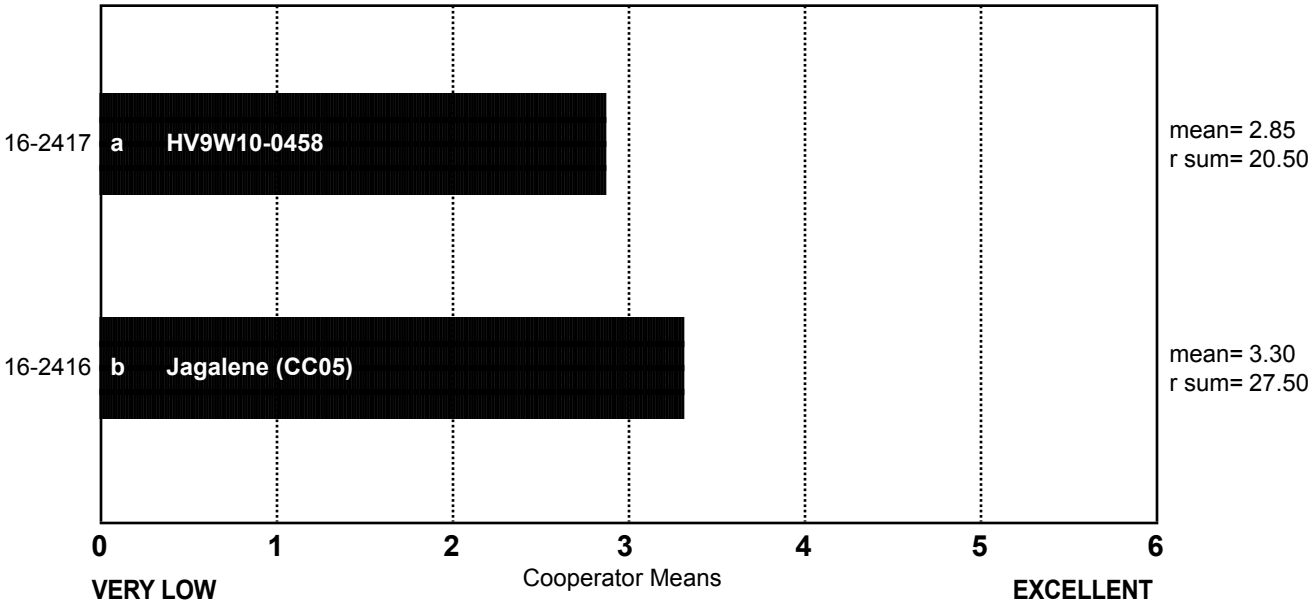


BAKE ABSORPTION

(Small Scale) Westbred

ncoop= 16
chisq= 3.06
chisqc= 4.45
cvchisq= 3.84
crdiff= 6.20

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) Westbred

	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
16-2416 Jagalene (CC05)	**58.2**	**62.6**	**62.6**	**64.2**	**61.8**	**66.3**	**56.0**	**59.2**	**65.9**	**58.5**	**59.6**	**62.3**	**62.6**	**60.0**	**61.0**	**59.7**
16-2417 HV9W10-0458	**58.6**	**59.5**	**59.5**	**62.6**	**62.0**	**63.4**	**57.0**	**59.8**	**63.1**	**57.4**	**59.6**	**63.3**	**59.5**	**60.0**	**58.0**	**61.4**

BAKE MIX TIME, ACTUAL

(Small Scale) Westbred

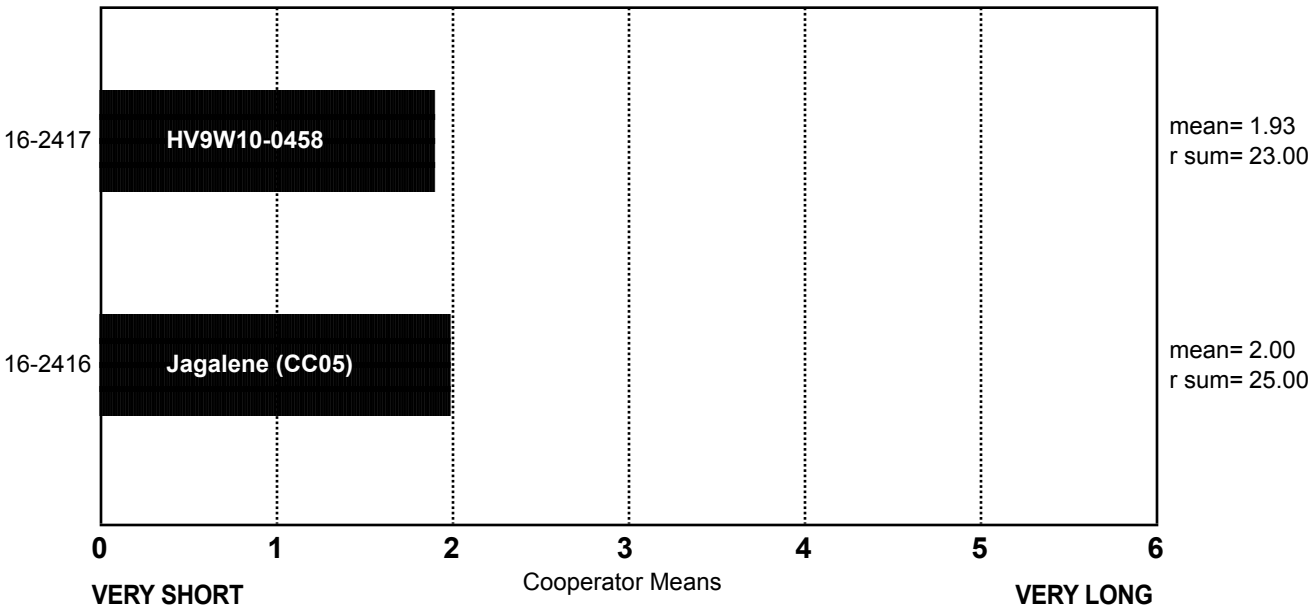
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2416 Jagalene (CC05)	**3.0**	**4.0**	**5.0**	**3.1**	**3.8**	**3.5**	**5.0**	**3.0**	**2.3**	**4.0**	**2.5**	**3.3**	**3.5**	**3.0**	**8.0**	**2.6**
16-2417 HV9W10-0458	**3.0**	**6.0**	**5.0**	**2.7**	**3.6**	**3.0**	**5.0**	**3.0**	**2.3**	**4.0**	**2.1**	**3.0**	**3.5**	**3.0**	**10.0**	**2.6**

BAKE MIX TIME

(Small Scale) Westbred

ncoop= 16
chisq= 0.25
chisqc= 0.67
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

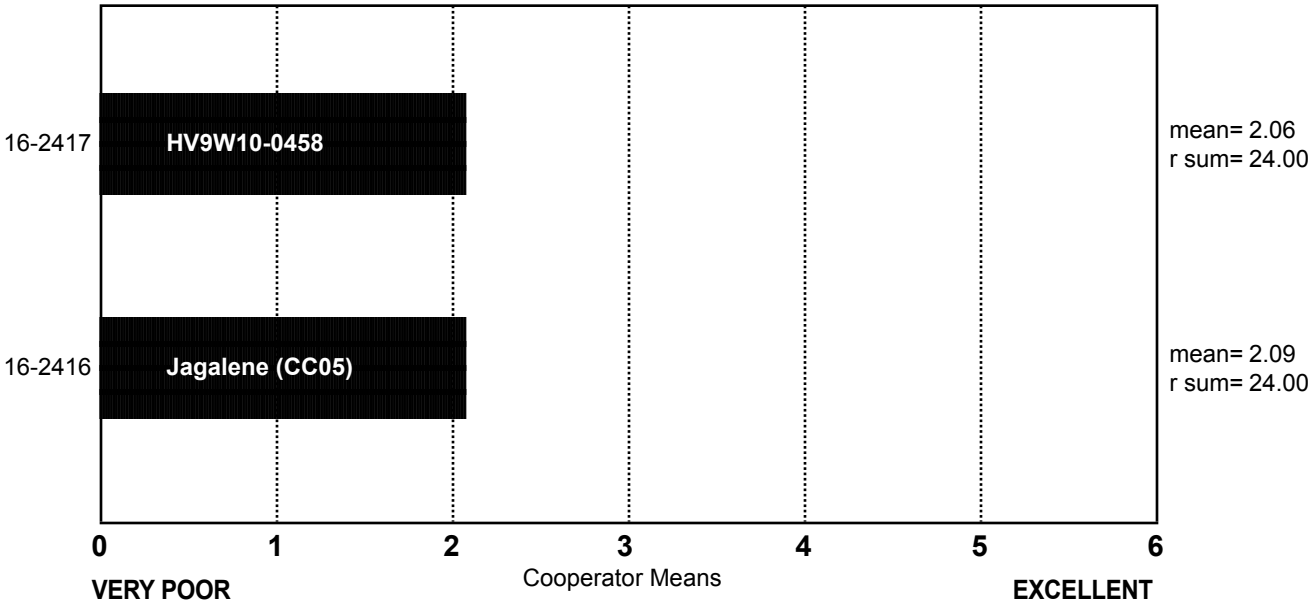


MIXING TOLERANCE

(Small Scale) Westbred

ncoop= 16
chisq= 0.00
chisqc= 0.00
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

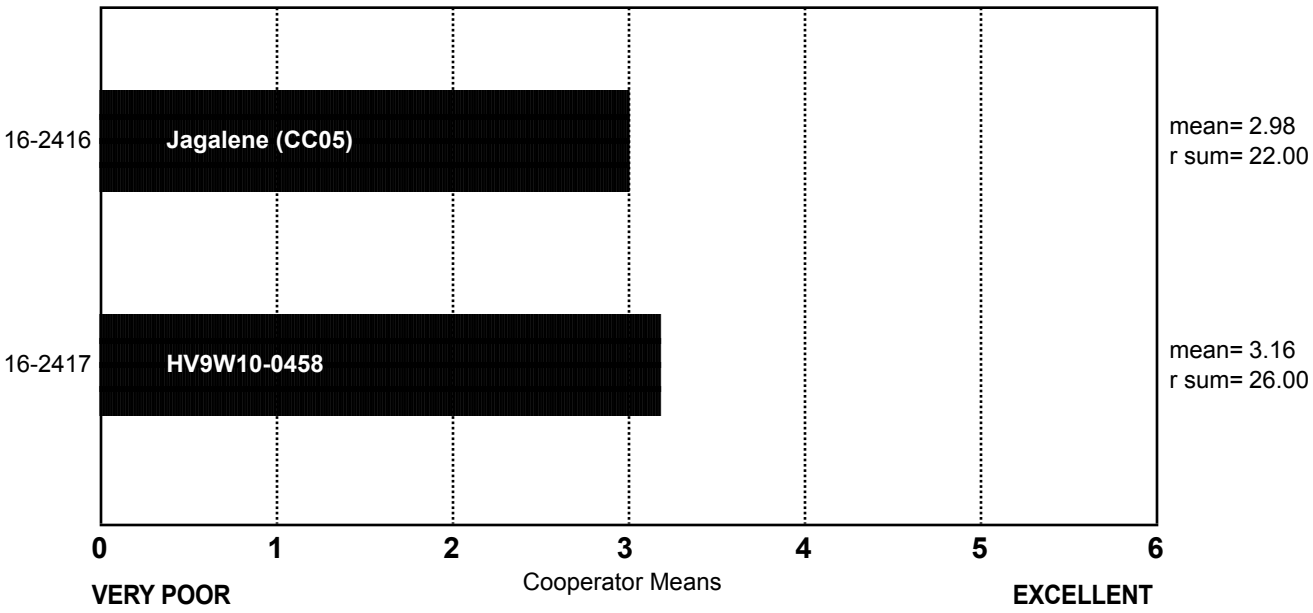


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Westbred

ncoop= 16
chisq= 1.00
chisqc= 1.45
cvchisq= 3.84
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
16-2416 Jagalene (CC05)	**4**	**3**	**2**	**6**	**1**
16-2417 HV9W10-0458	**3**	**4**	**2**	**6**	**1**

Frequency Table

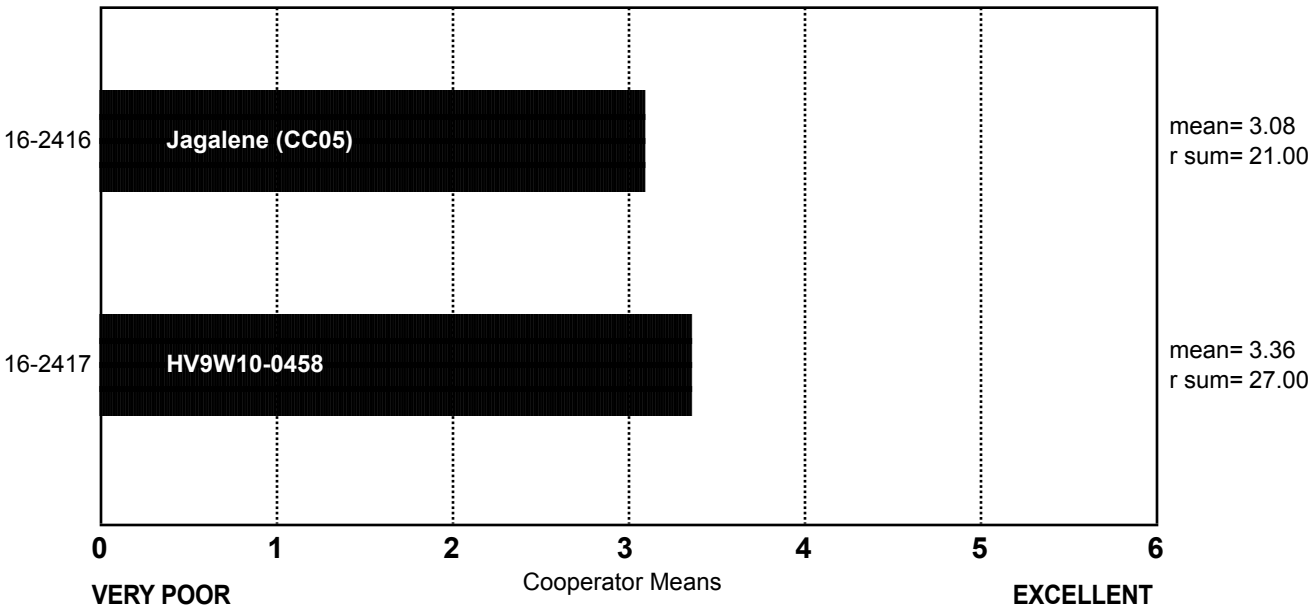
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Westbred

ncoop= 16
chisq= 2.25
chisqc= 3.00
cvchisq= 3.84
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
16-2416 Jagalene (CC05)	**6**	**3**	**2**	**5**	**0**
16-2417 HV9W10-0458	**4**	**3**	**3**	**5**	**1**

Frequency Table

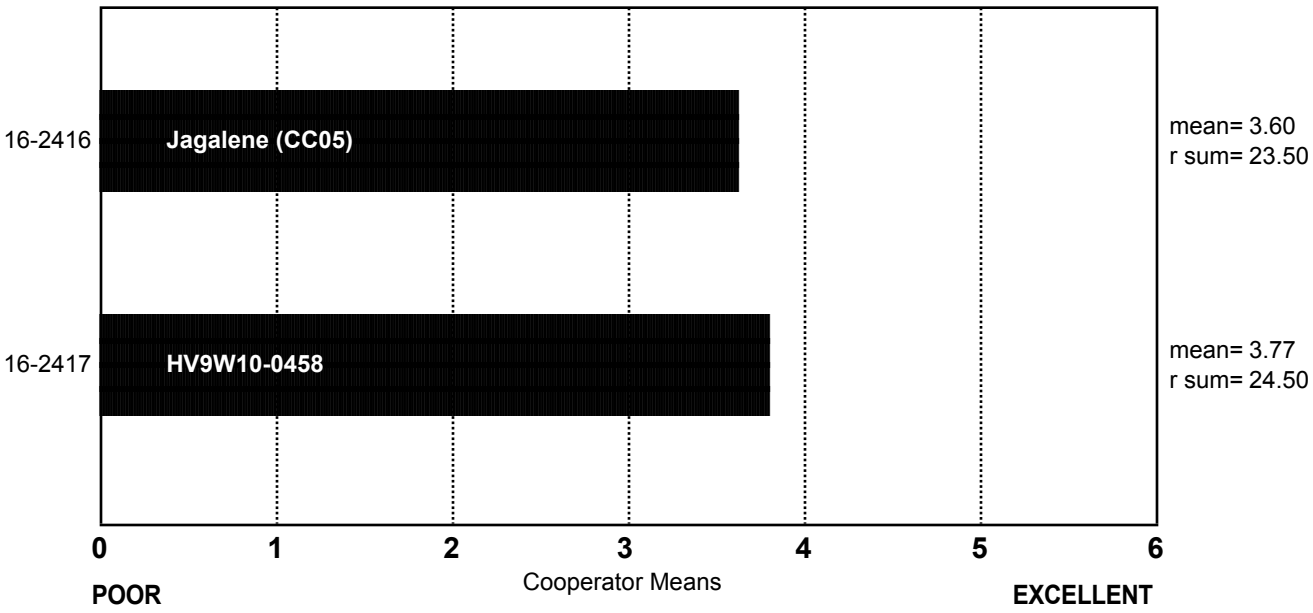
CRUMB GRAIN

(Small Scale) Westbred

ncoop= 16
chisq= 0.06
chisqc= 0.11
cvchisq= 3.84
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Westbred

	Open	Fine	Dense
16-2416 Jagalene (CC05)	**8**	**5**	**3**
16-2417 HV9W10-0458	**6**	**8**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Westbred

	Round	Irregular	Elongated
16-2416 Jagalene (CC05)	**4**	**5**	**7**
16-2417 HV9W10-0458	**4**	**4**	**8**

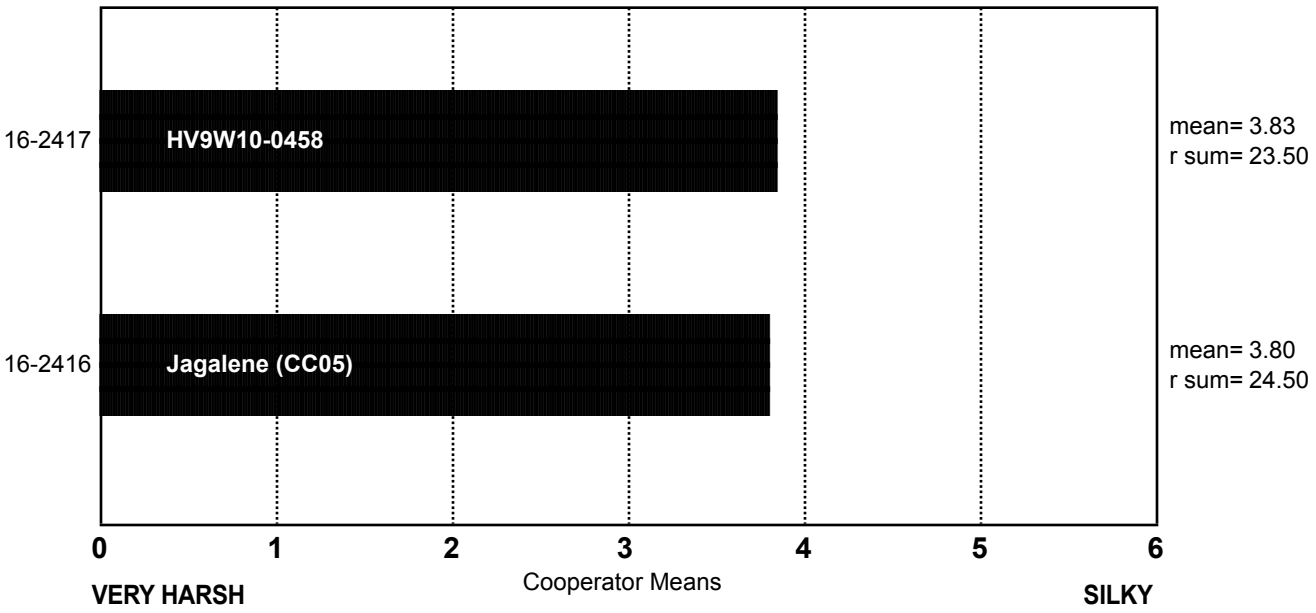
Frequency Table

CRUMB TEXTURE

(Small Scale) Westbred

ncoop= 16
chisq= 0.06
chisqc= 0.08
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Westbred

	Harsh	Smooth	Silky
16-2416 Jagalene (CC05)	**3**	**9**	**4**
16-2417 HV9W10-0458	**6**	**7**	**3**

Frequency Table

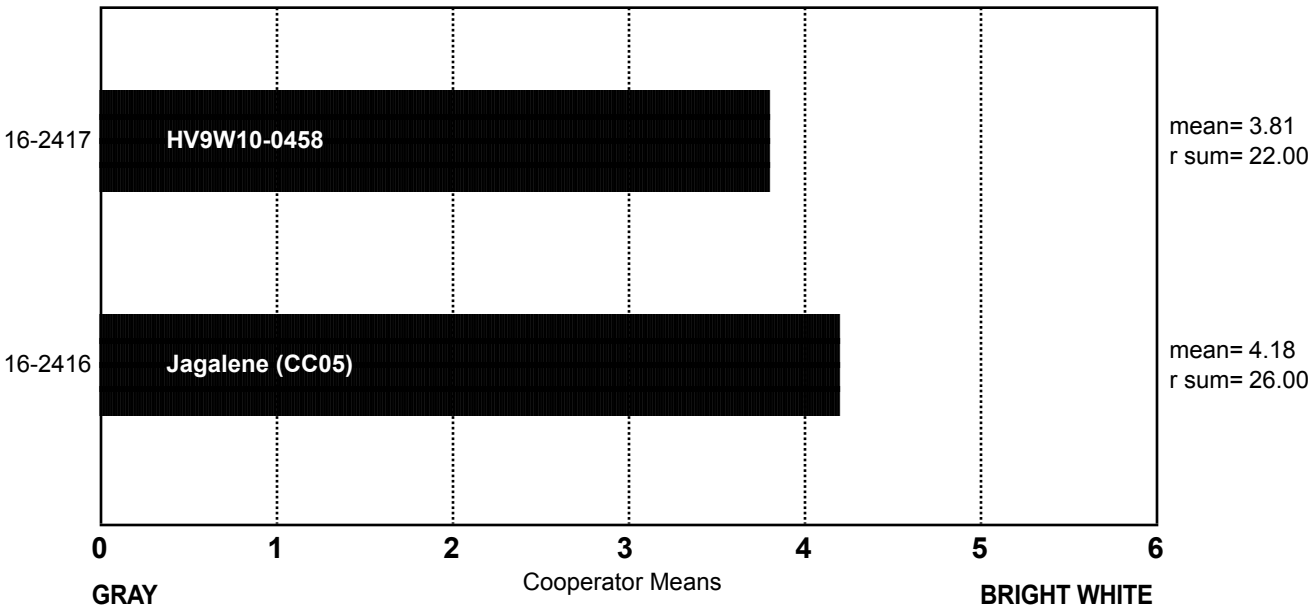
CRUMB COLOR

(Small Scale) Westbred

ncoop= 16
chisq= 1.00
chisqc= 2.29
cvchisq= 3.84
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Westbred

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
16-2416 Jagalene (CC05)	**0**	**0**	**1**	**2**	**8**	**3**	**2**
16-2417 HV9W10-0458	**0**	**0**	**3**	**3**	**7**	**1**	**2**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Westbred

	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
16-2416 Jagalene (CC05)	**142.0**	**466.3**	**454.6**	**153.8**	**134.8**	**132.7**	**414.0**	**140.8**	**133.2**	**479.2**	**139.2**	**149.6**	**437.7**	**146.5**		**138.6**
16-2417 HV9W10-0458	**139.0**	**467.4**	**456.5**	**150.9**	**135.5**	**133.3**	**412.0**	**139.4**	**130.8**	**479.9**	**135.9**	**149.2**	**442.3**	**145.7**		**140.4**

LOAF VOLUME, ACTUAL

(Small Scale) Westbred

	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
16-2416 Jagalene (CC05)	**870**	**2275**	**2515**	**918**	**895**	**880**	**2850**	**755**	**805**	**2575**	**765**	**810**	**2450**	**775**	**2897**	**790**
16-2417 HV9W10-0458	**975**	**2425**	**2591**	**933**	**923**	**940**	**2850**	**860**	**765**	**2575**	**835**	**895**	**2450**	**935**	**2956**	**798**

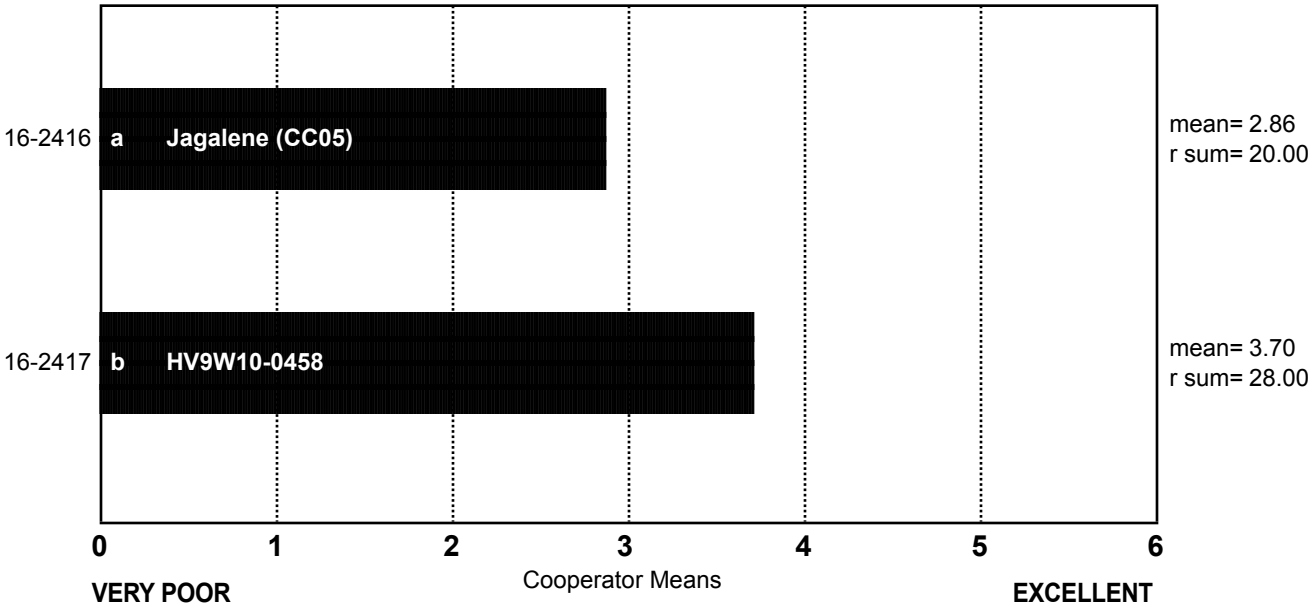
LOAF VOLUME

(Small Scale) Westbred

ncoop= 16
chisq= 4.00
chisqc= 6.40
cvchisq= 3.84
crdiff= 5.39

Variety order by rank sum.

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



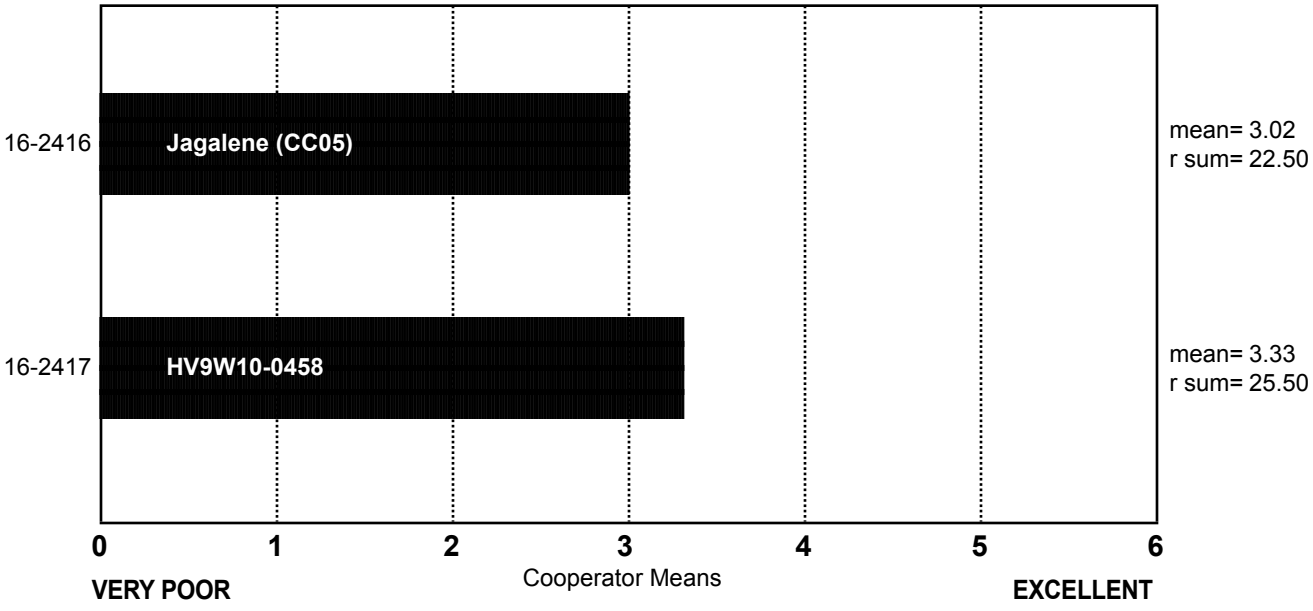
OVERALL BAKING QUALITY

(Small Scale) Westbred

ncoop= 16
chisq= 0.56
chisqc= 0.69
cvchisq= 3.84
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Westbred

COOP. **16-2416 Jagalene (CC05)**

A. No comment.
B. Slightly above average absorption, short mix time, very low volume, creamy, open.
C. Sticky while rounding and moulding.
D. Low protein %, short mixing time, dough strength weak, volume good for protein with poor crumb grain.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, slight open elongated cells, resilient & smooth texture.
F. No comment.
G. Slightly soft dough.
H. Low protein, poor mix tolerance.
I. Weaker dough but not sticky out of mixer, good crumb color, even cells and soft to the touch, overall good.
J. Sticky dough, average grain and volume.
K. Weak.
L. Short mix time, open crumb, low loaf volume.
M. Best bread of the set by a small number, slightly higher absorption and makeup score, bread had the same volume as the other but a dense bright white grain.
N. No comment.
O. Tight, consistent, smooth grain, average volume.
P. No comment.

COOP. **16-2417 HV9W10_0458**

A. No comment.
B. Average absorption, average mix time, low volume, creamy, open.
C. Sticky while rounding and moulding.
D. Low protein %, short mixing time, dough strength weak, good volume for protein with poor crumb grain.
E. Normal water absorption, short mix time, slight sticky & weak dough, high volume, yellow crumb, slight open elongated cells, resilient & smooth texture.
F. Low absorption, poor dough handling.
G. No comment.
H. Low ash, exceeds target loaf volume.
I. Weaker dough but not sticky out of mixer.
J. Low absorption, sticky wet dough, open grain, average volume.
K. Good crumb, ok volume, weaker.
L. Short mix time, tough at makeup but satisfactory crumb grain and good loaf volume.
M. No comment.
N. No comment.
O. Tight, consistent, smooth grain, above average volume.
P. No comment.

Notes: **B, G, J, M, N, and O** conducted sponge and dough bake tests

OKLAHOMA

16-2418	Jagalene (CC06)
16-2419	Ruby Lee
16-2420	OK10126
16-2421	OK12D22004-016
16-2422	OK12912C
16-2423	OK13209

Description of Test Plots and Breeder Entries

Oklahoma - Brett Carver

Grain samples for the 2016 WQC hard winter wheat evaluation program were produced at the North Central Agronomy Research Station at Lahoma, OK (12 miles west of Enid). No supplemental irrigation is available at this location. Grain yield of the submitted WQC entries and checks averaged 76 bu/ac, and varied from 68 bu/ac (Ruby Lee) to 86 bu/ac (OK12D22004-016). This difference was mostly driven by an early and extended infection of stripe rust. Leaf rust was the only other significant foliar disease present during grain filling.

Although the plot area was fertilized for a yield goal of 60 bu/ac, wheat protein still averaged 12.3% among submitted entries and checks, which would be on target. Even the highest yielding entry, OK12D22004-016, checked in with a wheat protein level of 13.3%. Sedimentation volumes, adjusted to a constant flour protein level, were above average (8.3 mL) compared with long-term trends, yet loaf volume was below average (894 cc). Kernel size was unusually large, even for entries most sensitive to stripe rust such as Ruby Lee (37g TKW).

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, except for OK12912C.

2016 Wheat Quality Council growout, Lahoma, OK, 22 April 2016, shown in lower right corner. The Jagalene check strip is located immediately inside a single guard strip, on the bottom. The

2016 OSU Wheat Variety Trial at Lahoma (including ± funcigide treatments) is shown above the WQC growout, and OSU wheat breeding nurseries are to the left of the variety trial. Photography by Brian Arnall.

16-2419 **Ruby Lee (local check)**

This 2011 release with pedigree KS94U275/OK94P549 remains a local favorite in Oklahoma statewide junior wheat show contests, testimonial to its reliable milling and baking excellence. On the surface, this challenges logical reasoning, because i) Ruby Lee carries the oft-outcast 2+12 HMW glutenin subunit pair, and ii) its parentage includes Endurance, which rarely passed the eye test during its short tenure in the wheat show to even qualify for baking. With its namesake being the responsible breeder's great aunt and uncle from Roanoke Rapids, NC, Ruby Lee is a favored relative to many experimental lines coming though the OSU variety development pipeline. 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. 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 very high yield potential that is often realized when protected against stripe rust with a fungicide.

16-2420 **OK10126**

Making a comeback appearance in the WQC is OK10126, previously tested as sample 14-2425 in 2014. Given its high probability for release in early 2017, a second look at this candidate seemed sensible for environmental conditions vastly different from the severe drought season of 2014. Touting a very high yield ceiling with excellent straw strength, OK10126 (OK Bullet/OK98680) will be targeted for intensively managed acres, irrigated or not, primarily in northern Oklahoma and in the panhandle. OK10126 occupies the leading position for 3-year mean grain yield (2014-2016) in the OSU wheat variety trial at Goodwell, OK (supplemental irrigation). Though early stand establishment is exceptional, its place in the sun is likely not under a steer's tongue, due to inclination to late winter freeze damage especially when planted early. Leaf hygiene is outstanding in the absence of a severe infection of barley yellow dwarf or powdery mildew. OK10126 has *Lr34*, but not the one present in Duster. It also has *Yr17*, *Rht8*, and *Wx-B1b*, and it performs well in acidic soils but is absent the Atlas 66 allele at *ALMT1*. In OSU tests, OK10126 has provided good to excellent bake performance (dough properties, loaf volume, and crumb grain). Its mixogram is a spit and image of OK Bullet – nice bandwidth but with a descending slope a bit on the steep side that would caution against overmixing.

16-2421 **OK12D22004-016**

This doubled haploid from Everest/OK08328//OK09634 is so short that one must lie flat on the ground to get a good head shot. The OK09634 parent (OK95616-98-6756/Overley) consistently, and strangely, produces short progeny. Straw strength is very good, though it is not tall enough to lodge anyway. Though short in stature, it is not short on quality yield. Thus OK12D22004-016 will be positioned for intensively managed and high-quality acres. Maturity is very early, from first-hollow-stem to finish. A known carrier of *Yr17* and *Xa21*, OK12D22004-016

has shown intermediate to moderate resistance to prevailing stripe rust races in Oklahoma. Leaf rust reaction is too inconsistent to call, though it shows seedling resistance in greenhouse assays involving spore collections from Oklahoma. OK12D22004-016 has consistently performed impressively for flour yield on our quad senior. Dough quality and baking scores have also been above-average to very good. Unless the WQC offers a different opinion, stripe rust reaction could be the only factor holding OK12D22004-016 back from release in late 2017.

16-2422 **OK12912C**

In direct contrast to OK12D22004-016, this two-gene Clearfield experimental line shops for apparel in the big and tall section. OK12912C (N91D2308-13/OK03926C//OK03928C) is targeted as one of two elite lines to replace Doublestop CL+, with no falloff in milling and baking quality. OK12912C has marginal kernel hardness and below-average flour yield. A reselection with acceptable hardness score and flour yield, but otherwise identical baking attributes, has been identified to perpetuate OK12912C for foundation seed increase. Agronomic improvements in this experimental over Doublestop CL+ include stripe rust resistance, straw strength, earlier maturity, and higher yield potential. Dough quality and baking scores, again, have been good to impressive. Much of the Clearfield germplasm at OSU has performed well in our quality laboratory, despite the soft wheat background of the second herbicide resistance gene carried by N91D2308-13. A release decision is pending this evaluation and Year 2 variety trial performance in 2016-2017.

16-2423 **OK13209**

This selection from OK Bullet/TX00D1390//Shocker may have the best overall disease resistance package among the candidates presented here. Nevertheless with only four years of statewide yield and quality testing so far, OK13209 was told to chill and wait its turn. OK13209 has shown high inconsistency year to year for test weight and mixing tolerance, varying from stellar to below-average. Though not necessarily evident in this grain sample, OK13209 typically takes the lead in protein content. It has consistently performed well in nitrogen-deprived environments, both for grain yield and in baking tests. Artisan baking reviews have been highly favorable. If asked “What is your greatest weakness?” it would have to say the ability to cope with early spring freeze events, else it would be lying. In addition to disease resistance and nitrogen-use efficiency, OK13209 stands out for green-leaf retention combined with early maturity, acid soil tolerance, straw strength, and pre-harvest sprouting tolerance. It is on foundation seed increase for 2017 and on the wait-and-see list. OK13209 would demand a much broader adoption area than other candidates mentioned and tested here.

Oklahoma: 2016 (Small-Scale) Samples

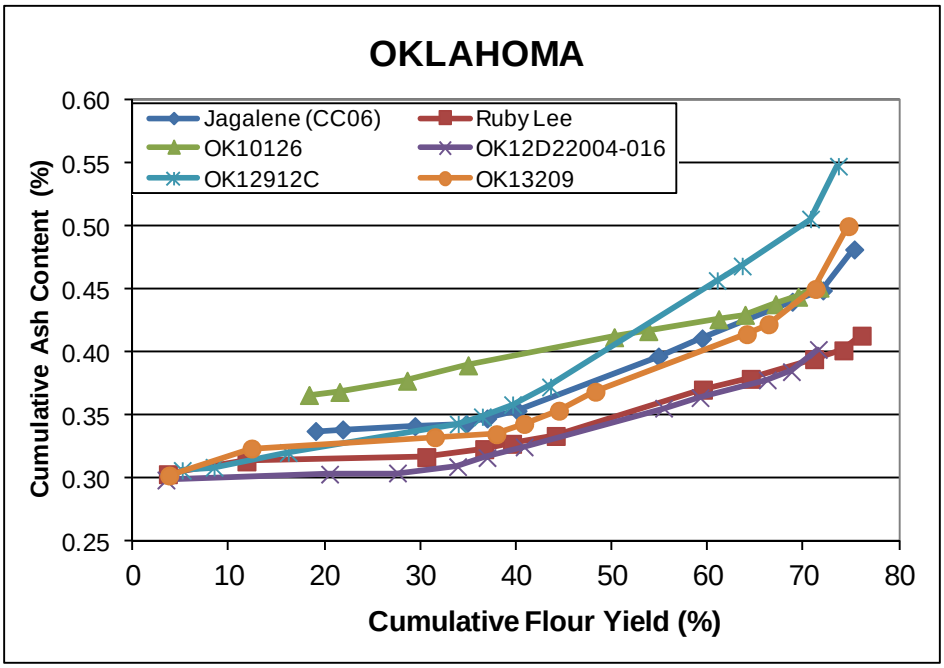
Test entry number	16-2418	16-2419	16-2420	16-2421	16-2422	16-2423
Sample identification	**Jagalene (CC06)**	**Ruby Lee**	**OK10126**	**OK12D2200 4-016**	**OK12912C**	**OK13209**
Wheat Data						
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	62.2	60.7	61.7	62.2	61.6	61.0
Hectoliter weight (kg/hl)	81.8	79.8	81.1	81.8	81.0	80.2
1000 kernel weight (gm)	35.1	38.2	29.8	35.2	35.0	33.0
Wheat kernel size (Rotap)						
Over 7 wire (%)	84.5	90.7	64.9	82.2	87.2	82.3
Over 9 wire (%)	15.2	9.3	33.2	17.4	12.4	15.8
Through 9 wire (%)	0.3	0.0	1.9	0.4	0.4	1.9
Single kernel (skcs)[a]						
Hardness (avg /s.d)	60.0/15.7	47.4/13.4	76.7/15.4	54.5/12.7	44.3/22.7	60.3/14.0
Weight (mg) (avg/s.d)	35.1/8.3	38.2/8.1	29.8/7.9	35.2/7.8	35.0/7.6	33.0/9.6
Diameter (mm)(avg/s.d)	2.87/0.32	2.91/0.31	2.65/0.37	2.85/0.31	2.79/0.31	2.77/0.47
Moisture (%) (avg/s.d)	14.0/0.3	14.3/0.3	11.9/0.3	12.7/0.4	12.9/0.4	13.0/0.3
SKCS distribution	04-16-29-51-01	13-35-33-19-03	00-03-10-87-01	04-23-38-35-01	37-21-13-29-03	03-12-31-54-01
Classification	Hard	Mixed	Hard	Hard	Mixed	Hard
Wheat protein (12% mb)	11.8	11.3	12.2	11.8	12.0	12.5
Wheat ash (12% mb)	1.22	1.29	1.32	1.37	1.37	1.39
Milling and Flour Quality Data						
Flour yield (%, str. grade)						
Miag Multomat Mill	72.9	73.6	72.4	73.5	72.4	74.9
Quadrumat Sr. Mill	70.8	70.1	67.3	69.9	64.2	67.9
Flour moisture (%)	13.5	14.1	13.6	13.5	13.5	13.4
Flour protein (14% mb)	10.6	10.0	10.8	10.5	10.3	11.3
Flour ash (14% mb)	0.44	0.41	0.44	0.39	0.47	0.48
Rapid Visco-Analyser						
Peak time (min)	6.1	6.1	6.0	6.3	6.1	6.1
Peak viscosity (RVU)	209.1	220.2	259.1	235.9	212.7	226.1
Breakdown (RVU)	73.6	79.8	118.3	67.6	75.6	81.3
Final viscosity at 13 min (RVU)	243.8	258.8	245.0	285.0	249.2	259.5
Minolta color meter						
L*	91.83	92.07	91.20	91.80	91.78	91.37
a*	-1.79	-1.67	-1.61	-1.67	-1.39	-1.39
b*	9.29	8.42	8.79	8.13	7.54	7.96
PPO	0.481	0.520	0.455	0.138	0.447	0.517
Falling number (sec)	450	463	553	507	424	512
Damaged Starch						
(AI%)	95.9	95.6	97.1	96.3	95.7	96.6
(AACC76-31)	6.2	6.0	7.1	6.5	6.0	6.8

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Oklahoma: Physical Dough Tests and Gluten Analysis
2016 (Small-Scale) Samples

Test Entry Number	16-2418	16-2419	16-2420	16-2421	16-2422	16-2423
Sample Identification	Jagalene (CC06)	Ruby Lee	OK10126	OK12D22004-016	OK12912C	OK13209
MIXOGRAPH						
Flour Abs (% as-is)	63.6	63.6	65.3	65.6	64.8	6.0
Flour Abs (14% mb)	63.1	63.5	64.8	65.0	64.2	66.1
Mix Time (min)	4.0	5.3	4.4	4.5	3.4	3.5
Mix tolerance (0-6)	3	4	4	4	4	2
FARINOGRAPH						
Flour Abs (% as-is)	58.9	57.3	61.5	62.9	61.3	61.4
Flour Abs (14% mb)	58.3	57.3	61.0	62.3	60.7	60.5
Development time (min)	5.8	3.5	6.2	5.7	3.5	5.8
Mix stability (min)	11.9	15.7	11.3	18.1	7.0	10.0
Mix Tolerance Index (FU)	15	14	25	15	28	23
Breakdown time (min)	12.8	16.1	12.4	20.0	8.9	12.8
ALVEOGRAPH						
P(mm): Tenacity	83	87	98	109	91	79
L(mm): Extensibility	101	94	87	71	84	112
G(mm): Swelling index	22.4	21.6	20.8	18.8	20.4	23.6
W(10^{-4} J): strength (curve area)	290	295	296	282	238	262
P/L: curve configuration ratio	0.82	0.93	1.13	1.54	1.08	0.71
Ie(P_{200}/P): elasticity index	60.2	60.8	57.3	55.8	49.2	52.7
EXTENSIGRAPH						
Resist (BU at 45/90/135 min)	337/474/529	510/838/990	339/451/461	334/589/642	246/335/377	265/311/336
Extensibility (mm at 45/90/135 min)	157/148/135	138/123/115	148/152/149	142/124/117	151/149/147	156/174/171
Energy (cm^2 at 45/90/135 min)	100/126/130	117/161/157	92/124/123	84/108/108	66/88/95	74/110/112
Resist $_{max}$ (BU at 45/90/135min)	486/697/790	668/995/990	469/626/647	442/699/751	314/431/484	340/472/495
Ratio (at 45/90/135 min)	2.14/3.21/3.91	3.70/6.81/8.64	2.29/2.98/3.10	2.35/4.76/5.51	1.63/2.24/2.57	1.69/1.78/1.97
PROTEIN ANALYSIS						
HMW-GS Composition	2*,1,17+18, 5+10	2*, 7+8, 2+12	1,7+8,5+10	2*,1,17+18,5+10	2*,7+8,5+10	1,17+18,5+10
%IPP	50.6	53.5	47.6	46.6	47.7	48.3
SEDIMENTATION TEST						
Volume (ml)	50.2	60.0	40.3	53.2	48.7	55.5

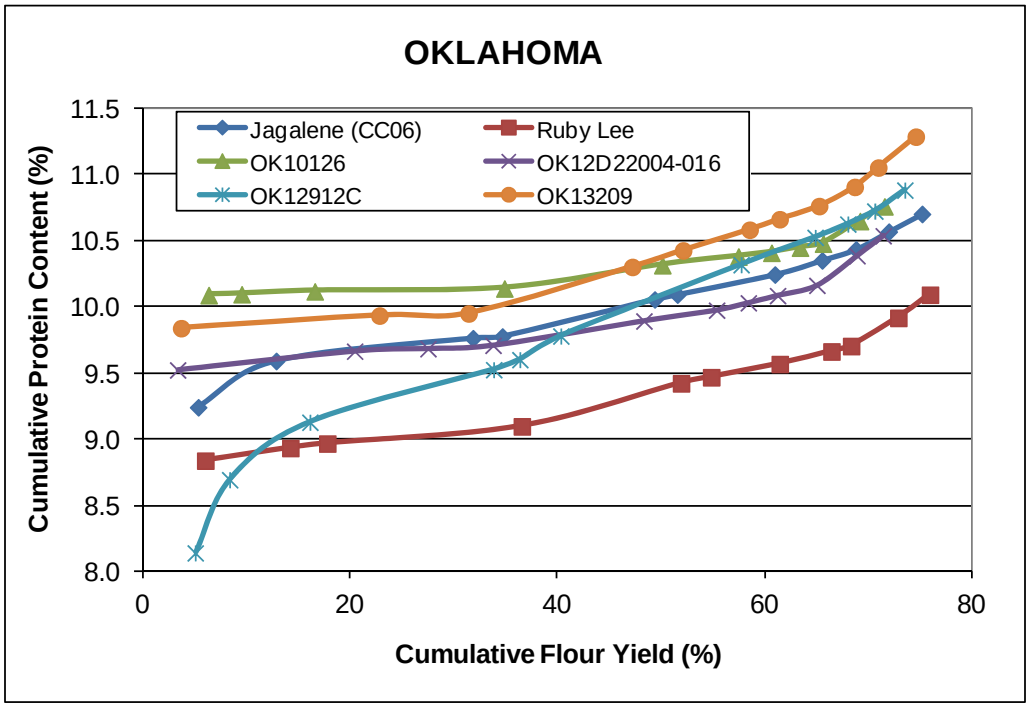
Oklahoma: Cumulative Ash Curves



Jagalene (CC06)					Ruby Lee					OK10126				
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	19.0	0.34	19.0	0.34	1M Red	3.6	0.30	3.6	0.30	2M	18.3	0.37	18.3	0.37
1M Red	2.8	0.35	21.8	0.34	1M	8.2	0.32	11.8	0.31	1M Red	3.2	0.38	21.5	0.37
1M	7.5	0.35	29.3	0.34	2M	18.8	0.32	30.5	0.32	1M	7.1	0.40	28.5	0.38
1BK	5.3	0.35	34.7	0.34	1BK	6.0	0.35	36.6	0.32	1BK	6.4	0.44	34.9	0.39
Grader	2.2	0.42	36.9	0.35	Grader	2.9	0.38	39.5	0.33	3M	15.2	0.46	50.1	0.41
2BK	3.2	0.42	40.1	0.35	2BK	4.6	0.39	44.0	0.33	2BK	3.6	0.48	53.7	0.42
3M	14.7	0.51	54.8	0.40	3M	15.4	0.48	59.4	0.37	4M	7.3	0.49	61.0	0.43
FILTER FLR	4.6	0.58	59.3	0.41	FILTER FLR	5.0	0.48	64.4	0.38	Grader	2.8	0.51	63.8	0.43
4M	9.4	0.62	68.7	0.44	4M	6.6	0.55	71.0	0.39	FILTER FLR	3.2	0.61	67.0	0.44
3BK	3.2	0.64	71.9	0.45	3BK	3.1	0.56	74.1	0.40	3BK	2.4	0.61	69.3	0.44
5M	3.3	1.20	75.2	0.48	5M	1.9	0.87	76.0	0.41	5M	2.2	0.68	71.6	0.45
Break Shorts	3.8	3.30	79.0	0.62	Break Shorts	3.5	3.34	79.5	0.54	Break Shorts	3.6	3.05	75.2	0.58
Red Dog	2.8	2.43	81.8	0.68	Red Dog	2.0	1.94	81.5	0.58	Red Dog	2.7	2.16	77.8	0.63
Red Shorts	0.5	3.10	82.3	0.69	Red Shorts	0.4	3.29	81.9	0.59	Red Shorts	0.5	3.37	78.3	0.65
Filter Bran	1.7	3.26	84.0	0.75	Filter Bran	1.7	3.23	83.5	0.64	Filter Bran	2.2	3.08	80.5	0.71
Bran	16.0	4.07	100.0	1.28	Bran	16.5	4.37	100.0	1.26	Bran	19.5	4.26	100.0	1.40
Wheat		1.19					1.26					1.29		
St. Grd. Fl.		0.44					0.41					0.44		

OK12D22004-016					OK12912C					OK13209				
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	3.4	0.30	3.4	0.30	1BK	5.1	0.31	5.1	0.31	1M Red	3.7	0.30	3.7	0.30
2M	17.1	0.30	20.4	0.30	1M Red	3.3	0.31	8.4	0.31	1M	8.6	0.33	12.3	0.32
1M	7.1	0.31	27.5	0.30	1M	7.7	0.33	16.1	0.32	2M	19.1	0.34	31.4	0.33
1BK	6.3	0.33	33.8	0.31	2M	17.7	0.36	33.9	0.34	1BK	6.4	0.35	37.9	0.33
Grader	3.1	0.40	36.9	0.32	Grader	2.5	0.42	36.4	0.35	Grader	2.9	0.45	40.7	0.34
2BK	3.9	0.41	40.7	0.32	2BK	3.2	0.47	39.5	0.36	2BK	3.6	0.47	44.4	0.35
3M	14.6	0.44	55.3	0.36	FILTER FLR	4.0	0.51	43.5	0.37	FILTER FLR	3.8	0.54	48.2	0.37
FILTER FLR	3.8	0.48	59.1	0.36	3M	17.4	0.67	60.9	0.46	3M	15.8	0.55	64.0	0.41
4M	7.0	0.50	66.1	0.38	3BK	2.6	0.74	63.5	0.47	3BK	2.3	0.64	66.2	0.42
3BK	2.5	0.55	68.6	0.38	4M	7.1	0.84	70.6	0.51	4M	4.9	0.83	71.2	0.45
5M	2.8	0.83	71.4	0.40	5M	2.9	1.57	73.5	0.55	5M	3.4	1.53	74.6	0.50
Break Shorts	3.3	3.39	74.7	0.53	Break Shorts	2.8	3.32	76.4	0.65	Break Shorts	2.7	3.36	77.3	0.60
Red Dog	2.7	2.12	77.5	0.59	Red Dog	1.8	2.48	78.2	0.69	Red Dog	2.2	2.47	79.5	0.65
Red Shorts	0.5	3.52	78.0	0.61	Red Shorts	0.6	3.32	78.7	0.71	Red Shorts	0.4	2.70	79.8	0.66
Filter Bran	1.5	3.59	79.5	0.67	Filter Bran	1.7	3.34	80.4	0.77	Filter Bran	2.5	3.14	82.3	0.73
Bran	20.5	4.68	100.0	1.49	Bran	19.6	3.98	100.0	1.39	Bran	17.7	4.36	100.0	1.38
Wheat		1.34					1.34					1.36		
St. Grd. Fl.		0.38					0.47					0.48		

Oklahoma: Cumulative Protein Curves



Jagalene (CC06)				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1BK	5.3	9.2	5.3	9.2
1M	7.5	9.8	12.9	9.6
2M	19.0	9.9	31.9	9.8
1M Red	2.8	9.9	34.7	9.8
3M	14.7	10.7	49.4	10.1
Grader	2.2	10.9	51.6	10.1
4M	9.4	11.1	61.0	10.2
FILTER FLR	4.6	11.8	65.5	10.4
5M	3.3	12.1	68.8	10.4
2BK	3.2	13.5	72.0	10.6
3BK	3.2	13.7	75.2	10.7
Break Shorts	3.8	15.0	79.0	10.9
Red Dog	2.8	14.3	81.8	11.0
Red Shorts	0.5	13.0	82.3	11.0
Filter Bran	1.7	14.8	84.0	11.1
Bran	16.0	15.8	100.0	11.9
Wheat		11.5		
St. Grd. Fl		10.5		

Ruby Lee				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1BK	6.0	8.8	6.0	8.8
1M	8.2	9.0	14.2	8.9
1M Red	3.6	9.1	17.8	9.0
2M	18.8	9.2	36.6	9.1
3M	15.4	10.2	51.9	9.4
Grader	2.9	10.3	54.9	9.5
4M	6.6	10.4	61.5	9.6
FILTER FLR	5.0	10.8	66.5	9.7
5M	1.9	11.1	68.4	9.7
2BK	4.6	13.1	72.9	9.9
3BK	3.1	14.2	76.0	10.1
Break Shorts	3.5	14.7	79.5	10.3
Red Dog	2.0	12.6	81.5	10.4
Red Shorts	0.4	12.6	81.9	10.4
Filter Bran	1.7	13.6	83.5	10.4
Bran	16.5	15.0	100.0	11.2
Wheat		11.1		
St. Grd. Fl		10.0		

OK10126				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1BK	6.4	10.1	6.4	10.1
1M Red	3.2	10.1	9.5	10.1
1M	7.1	10.1	16.6	10.1
2M	18.3	10.2	34.9	10.1
3M	15.2	10.7	50.1	10.3
4M	7.3	10.8	57.5	10.4
FILTER FLR	3.2	10.9	60.7	10.4
Grader	2.8	11.3	63.4	10.4
5M	2.2	11.4	65.6	10.5
2BK	3.6	13.8	69.2	10.6
3BK	2.4	14.0	71.6	10.8
Break Shorts	3.6	15.1	75.2	11.0
Red Dog	2.7	14.0	77.8	11.1
Red Shorts	0.5	13.4	78.3	11.1
Filter Bran	2.2	14.9	80.5	11.2
Bran	19.5	15.7	100.0	12.1
Wheat		12.0		
St. Grd. Fl		10.8		

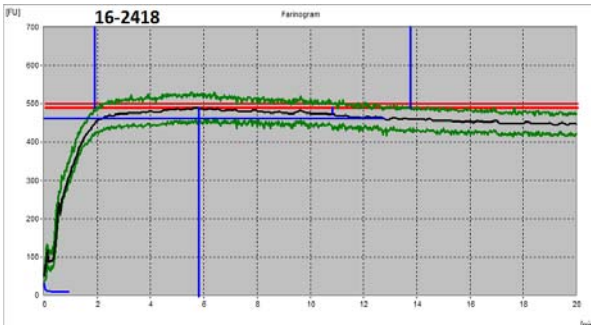
OK12D22004-016				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1M Red	3.4	9.5	3.4	9.5
2M	17.1	9.7	20.4	9.7
1M	7.1	9.7	27.5	9.7
1BK	6.3	9.8	33.8	9.7
3M	14.6	10.3	48.4	9.9
4M	7.0	10.5	55.4	10.0
Grader	3.1	11.0	58.4	10.0
5M	2.8	11.2	61.3	10.1
FILTER FLR	3.8	11.4	65.0	10.2
2BK	3.9	14.2	68.9	10.4
3BK	2.5	14.7	71.4	10.5
Break Shorts	3.3	14.0	74.7	10.7
Red Dog	2.7	12.6	77.5	10.8
Red Shorts	0.5	12.3	78.0	10.8
Filter Bran	1.5	14.6	79.5	10.8
Bran	20.5	14.9	100.0	11.7
Wheat		11.5		
St. Grd. Fl		10.5		

OK12912C				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
5.1	8.1	5.1	8.1	9.4
3.3	9.5	8.4	8.7	9.4
7.7	9.6	16.1	9.1	9.5
17.7	9.9	33.9	9.5	9.6
2.5	10.6	36.4	9.6	9.7
4.0	11.4	40.3	9.8	9.9
17.4	11.6	57.7	10.3	10.0
7.1	12.2	64.9	10.5	10.1
3.2	12.7	68.0	10.6	10.2
2.6	13.3	70.6	10.7	10.5
2.9	14.7	73.5	10.9	10.7
2.8	16.3	76.4	11.1	10.9
1.8	15.9	78.2	11.2	11.0
0.6	13.6	78.7	11.2	11.0
1.7	14.8	80.4	11.3	11.0
19.6	16.5	100.0	12.3	11.9
		11.7		
		10.3		

OK13209				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1M Red	3.7	9.8	3.7	9.8
2M	19.1	10.0	22.8	9.9
1M	8.6	10.0	31.4	10.0
3M	15.8	11.0	47.2	10.3
4M	4.9	11.6	52.1	10.4
1BK	6.4	11.9	58.6	10.6
Grader	2.9	12.3	61.5	10.7
FILTER FLR	3.8	12.4	65.3	10.8
5M	3.4	13.7	68.7	10.9
3BK	2.3	15.5	71.0	11.1
2BK	3.6	15.9	74.6	11.3
Break Shorts	2.7	15.6	77.3	11.4
Red Dog	2.2	13.6	79.5	11.5
Red Shorts	0.4	12.4	79.8	11.5
Filter Bran	2.5	14.6	82.3	11.6
Bran	17.7	15.9	100.0	12.4
Wheat		12.2		
St. Grd. Fl		11.3		

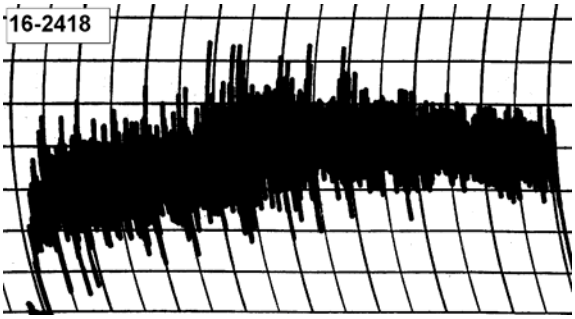
Physical Dough Tests
2016 (Small Scale) Samples - Oklahoma

Farinograms



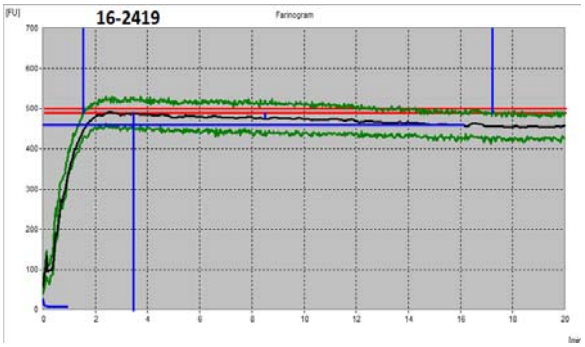
Water abs = 58.3%, Peak time = 5.8 min,
Mix stab = 11.9 min, MTI = 15 FU

Mixograms

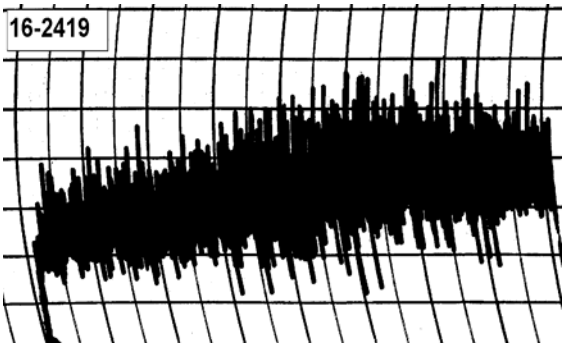


Water abs = 63.1%
Mix time = 4.0 min

16-2418, Jagalene (CC06)



Water abs = 57.3%, Peak time = 3.5 min,
Mix stab = 15.7 min, MTI = 14 FU

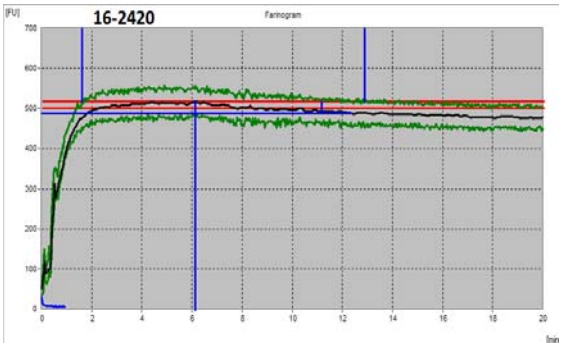


Water abs = 63.5%
Mix time = 5.3 min

16-2419, Ruby Lee

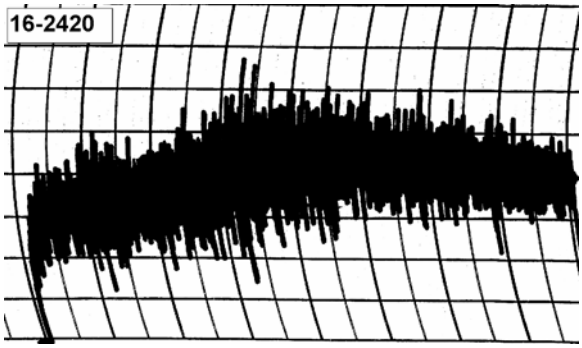
Physical Dough Tests
2016 (Small Scale) Samples - Oklahoma

Farinograms



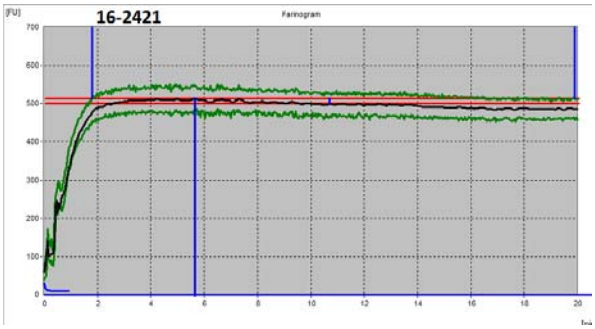
Water abs = 61.0%, Peak time = 6.2 min,
Mix stab = 11.3 min, MTI = 25 FU

Mixograms

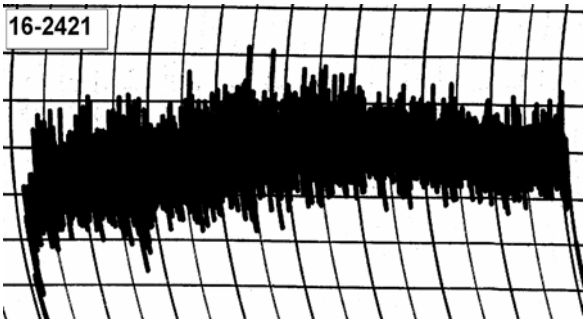


Water abs = 64.8%
Mix time = 4.4 min

16-2420, OK10125



Water abs = 62.3%, Peak time = 5.7 min,
Mix stab = 18.1 min, MTI = 15 FU

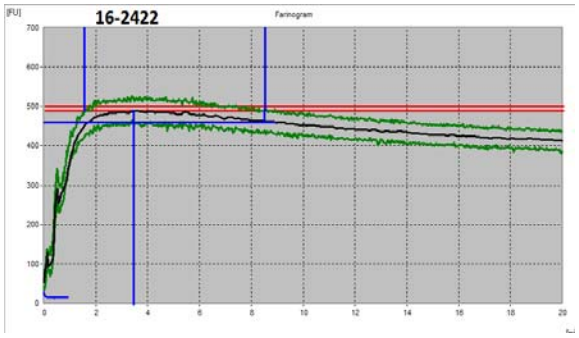


Water abs = 65.0%
Mix time = 4.5 min

16-2421, OK12D22004-016

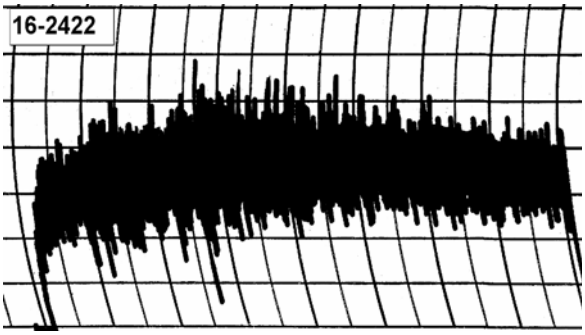
Physical Dough Tests
2016 (Small Scale) Samples - Oklahoma

Farinograms



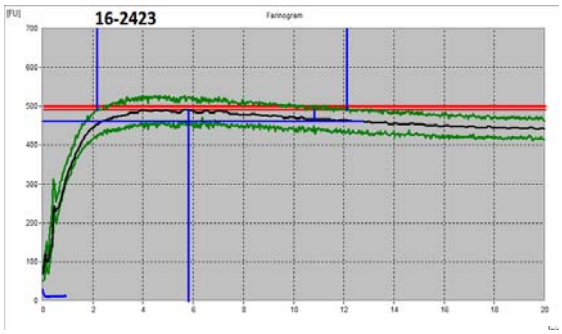
Water abs = 60.7%, Peak time = 3.5 min,
Mix stab = 7.0 min, MTI = 28 FU

Mixograms

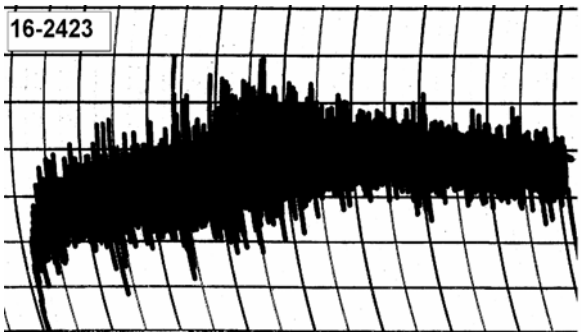


Water abs = 64.2%
Mix time = 3.4 min

16-2422, OK12912C



Water abs = 60.5%, Peak time = 5.8 min,
Mix stab = 10.0 min, MTI = 23 FU

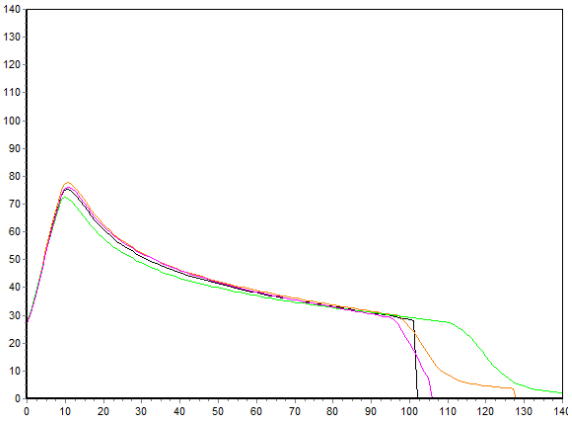


Water abs = 66.1%
Mix time = 3.5 min

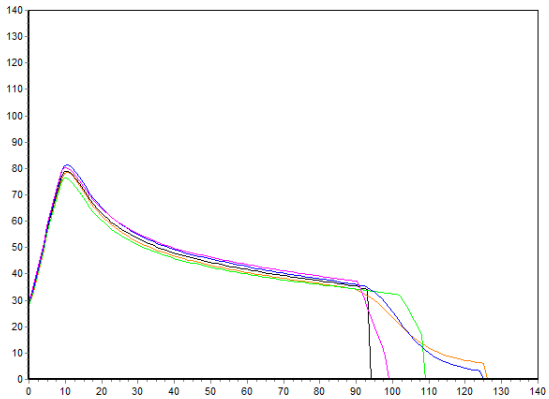
16-2423, OK13209

Physical Dough Tests - Alveograph

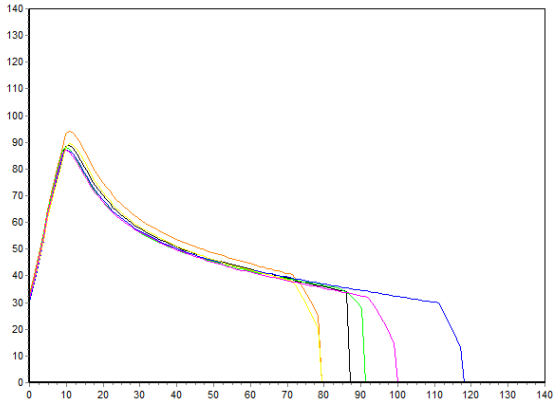
2016 (Small Scale) Samples – Oklahoma



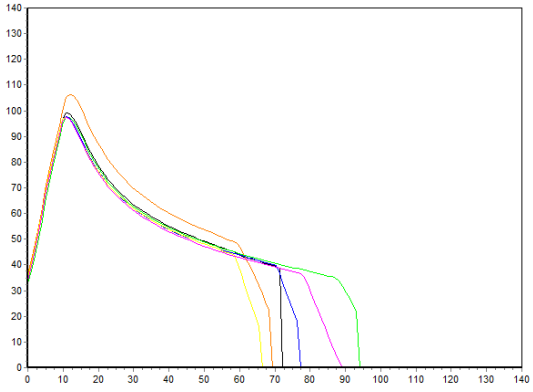
16-2418, Jagalene (CC06)
P(mm H_20) =83, L(mm) = 101, W($10E^{-4}$ J) = 290



16-2419, Ruby Lee
P(mm H_20) = 87, L(mm) = 94, W($10E^{-4}$ J) = 295



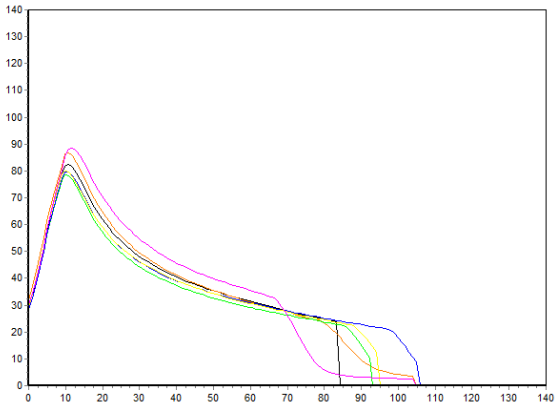
16-2420, OK10126
P(mm H_20) =98, L(mm) = 87, W($10E^{-4}$ J) = 296



16-2421, OK12D22004-016
P(mm H_20) = 109, L(mm) = 71, W($10E^{-4}$ J) = 283

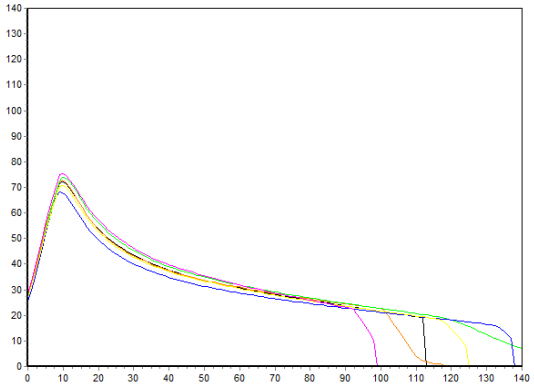
Physical Dough Tests - Alveograph

2016 (Small Scale) Samples – Oklahoma



16-2422, OK12912C

P(mm H_20) =91, L(mm) = 84, W($10E^{-4}$ J) = 238

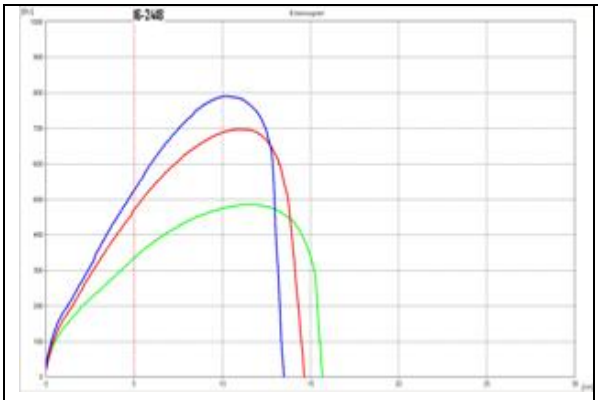


16-2423, OK13209

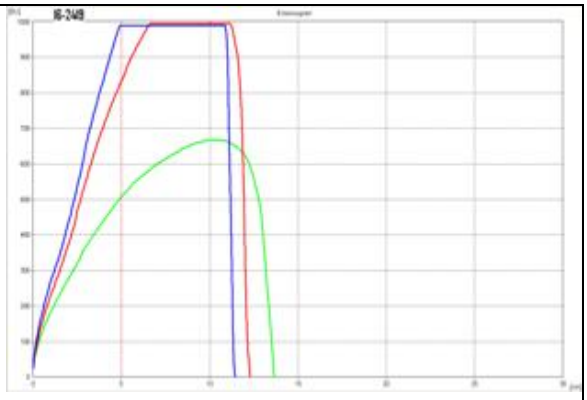
P(mm H_20) = 79, L(mm) = 112, W($10E^{-4}$ J) = 262

Physical Dough Tests - Extensigraph

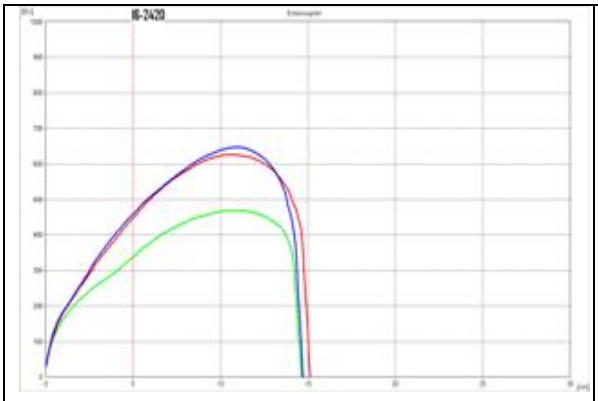
2016 (Small Scale) Samples – Oklahoma



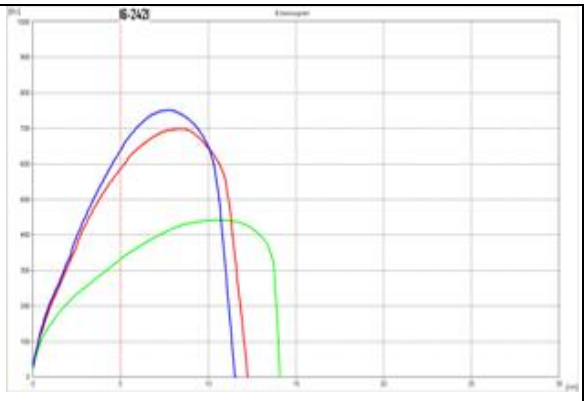
16-2418, Jagalene (CC06)
R (BU) = 474, E (mm) = 148, W (cm^2) = 126
Rmax (BU) = 697, Ratio = 3.2 at 90 min



16-2419, Ruby Lee
R (BU) = 838, E (mm) = 123, W (cm^2) = 161
Rmax (BU) = 995, Ratio = 6.8 at 90 min



16-2420, OK10126
R (BU) = 451, E (mm) = 152, W (cm^2) = 124
Rmax (BU) = 626, Ratio = 3.0 at 90 min

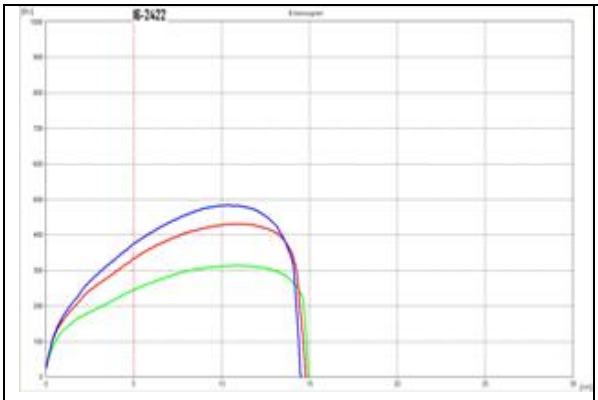


16-2421, OK12D22004-016
R (BU) = 589, E (mm) = 124, W (cm^2) = 108
Rmax (BU) = 699, Ratio = 4.8 at 90 min

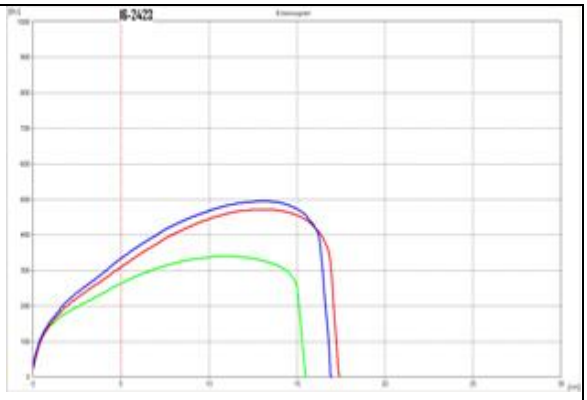
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigraph

2016 (Small Scale) Samples – Oklahoma

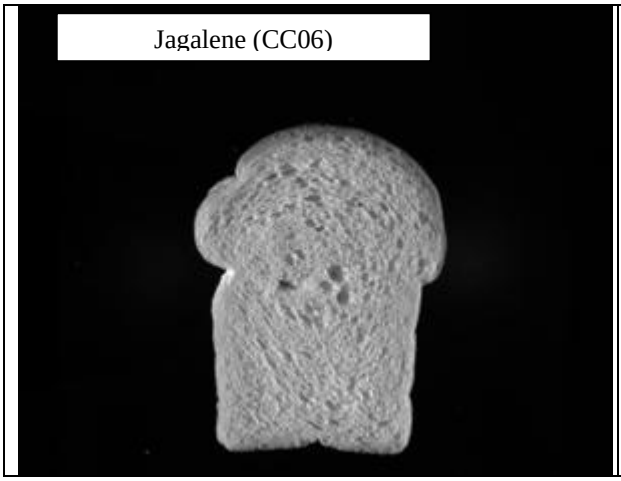


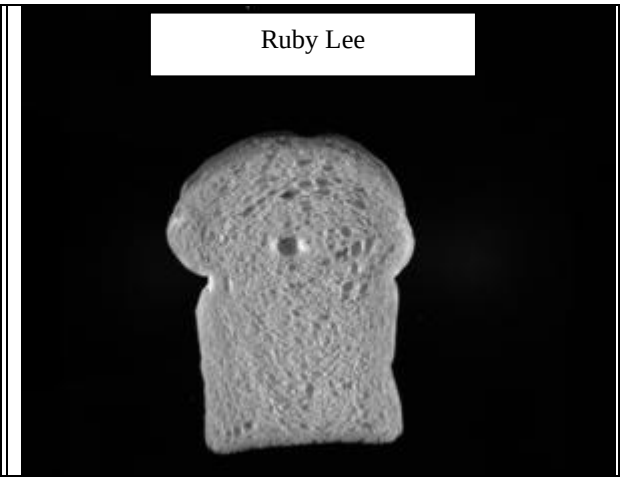
16-2422, OK12912C
R (BU) = 335, E (mm) = 149, W (cm^2) = 88
Rmax (BU) = 431, Ratio = 2.2 at 90 min



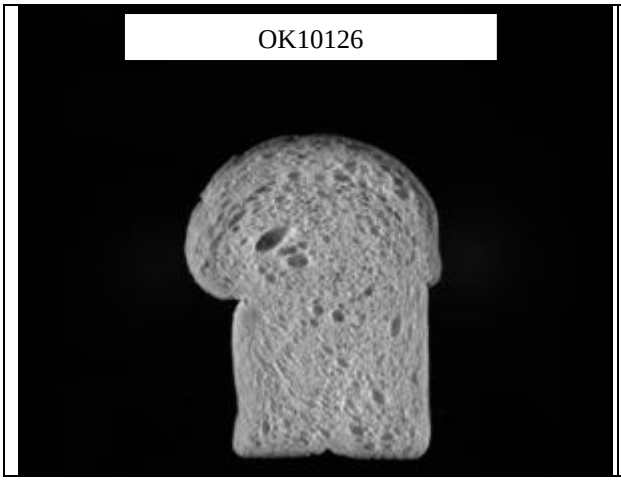
16-2423, OK13209
R (BU) = 311, E (mm) = 174, W (cm^2) = 110
Rmax (BU) = 472, Ratio = 1.8 at 90 min

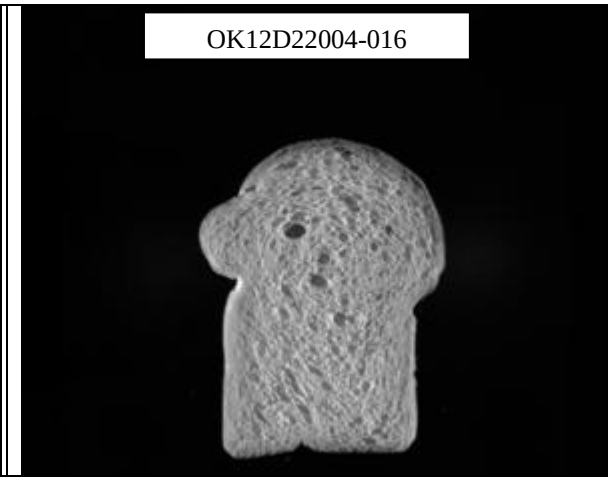
Oklahoma: C-Cell Bread Images and Analysis
2016 (Small-Scale) Samples





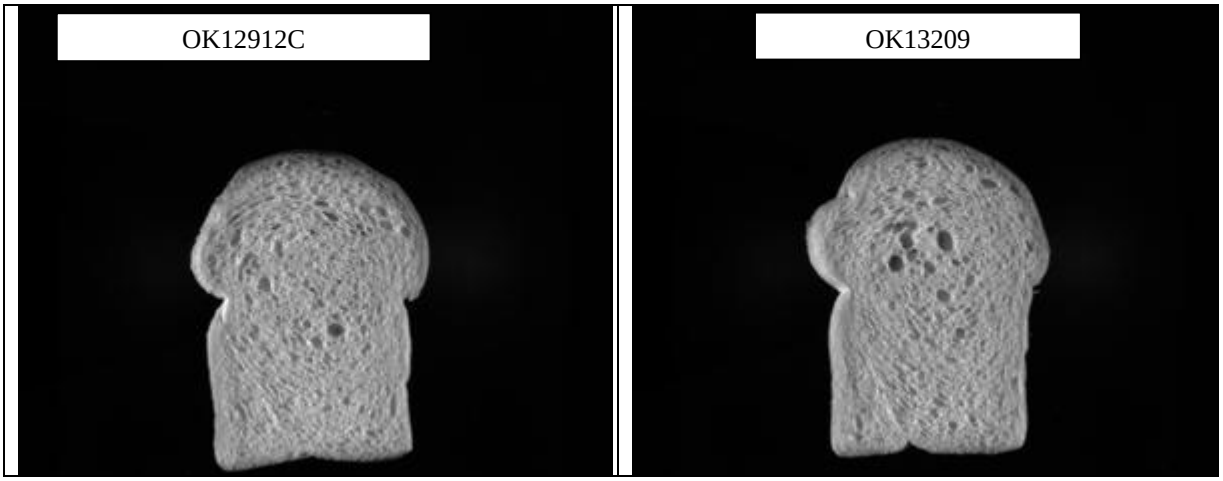
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2418	6185	147.4	4540	0.419	1.698	1.097	1.700	-18.80
2419	5928	143.6	4615	0.414	1.615	3.921	1.690	-10.50





Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2420	6173	141.3	4293	0.428	1.805	1.150	1.720	-21.65
2421	5590	140.6	3754	0.438	1.846	1.166	1.715	-16.20

Oklahoma: C-Cell Bread Images and Analysis
2016 (Small-Scale) Samples



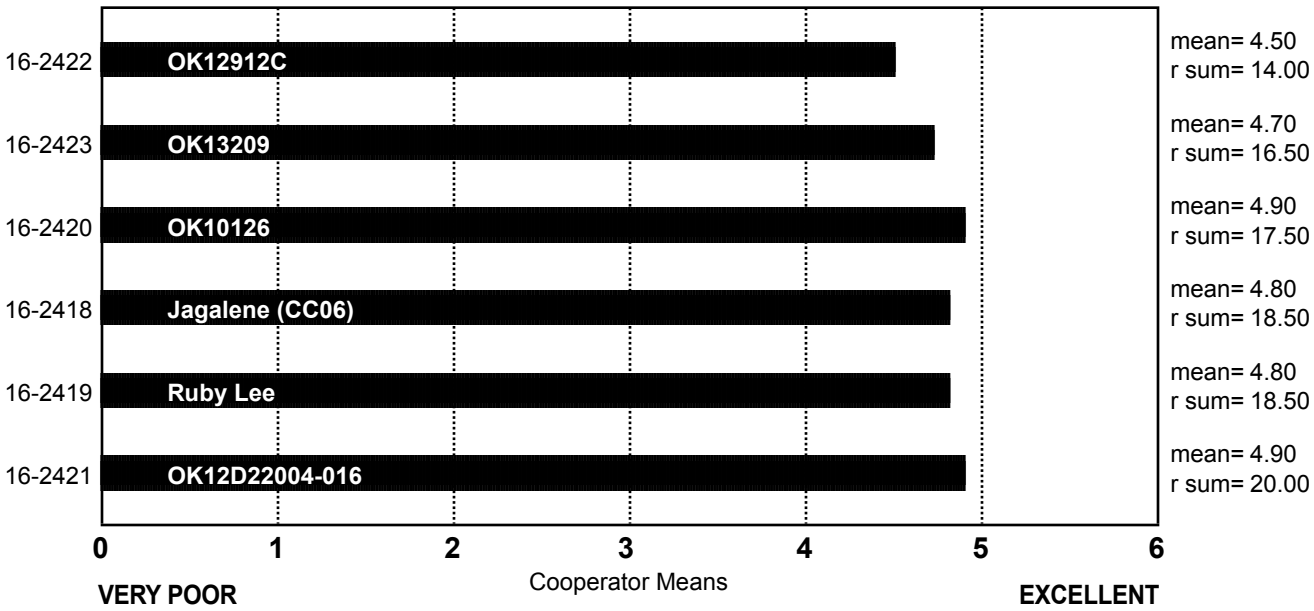
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2422	5805	142.2	4083	0.431	1.741	4.351	1.708	-17.35
2423	5732	137.4	4237	0.423	1.699	3.281	1.675	-19.20

SPONGE CHARACTERISTICS

(Small Scale) Oklahoma

ncoop= 5
chisq= 1.23
chisqc= 2.09
cvchisq= 11.07
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

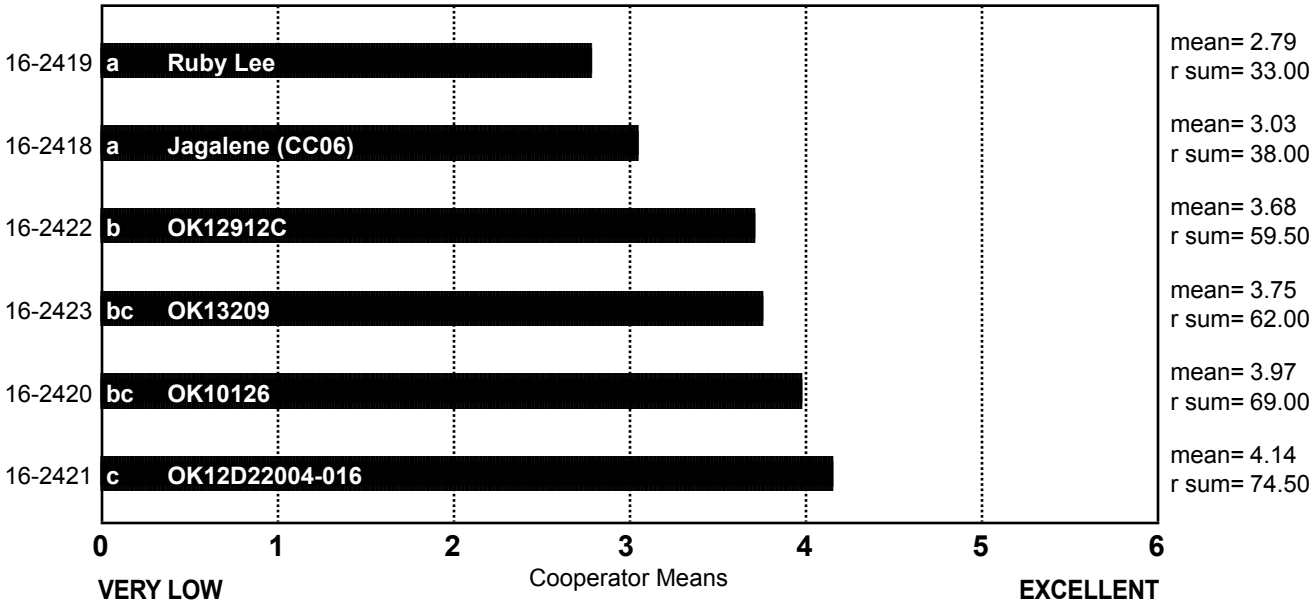


BAKE ABSORPTION

(Small Scale) Oklahoma

ncoop= 16
chisq= 25.22
chisqc= 34.45
cvchisq= 11.07
crdiff= 14.16

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
16-2418 Jagalene (CC06)	**61.4**	**58.3**	**58.3**	**64.1**	**62.0**	**61.3**	**57.0**	**59.8**	**61.6**	**60.4**	**60.5**	**63.2**	**58.3**	**60.0**	**57.0**	**62.9**
16-2419 Ruby Lee	**62.4**	**57.3**	**57.3**	**63.7**	**60.5**	**61.3**	**56.0**	**59.0**	**62.0**	**57.0**	**62.4**	**62.1**	**57.3**	**60.0**	**57.0**	**63.5**
16-2420 OK10126	**62.7**	**61.0**	**61.0**	**65.2**	**62.5**	**65.8**	**57.0**	**60.0**	**65.1**	**60.5**	**63.0**	**64.2**	**61.0**	**60.0**	**60.0**	**64.8**
16-2421 OK12D22004-016	**62.6**	**62.3**	**62.3**	**66.1**	**62.5**	**66.3**	**56.0**	**59.9**	**66.2**	**59.4**	**62.4**	**64.1**	**62.3**	**60.0**	**61.0**	**64.9**
16-2422 OK12912C	**61.5**	**60.7**	**60.7**	**65.0**	**62.5**	**64.7**	**56.0**	**59.4**	**64.6**	**58.3**	**60.4**	**64.1**	**60.7**	**60.0**	**59.0**	**65.5**
16-2423 OK13209	**62.5**	**60.5**	**60.5**	**64.0**	**63.5**	**65.4**	**57.0**	**60.6**	**64.2**	**58.3**	**61.1**	**63.8**	**60.5**	**60.0**	**59.0**	**66.0**

BAKE MIX TIME, ACTUAL

(Small Scale) Oklahoma

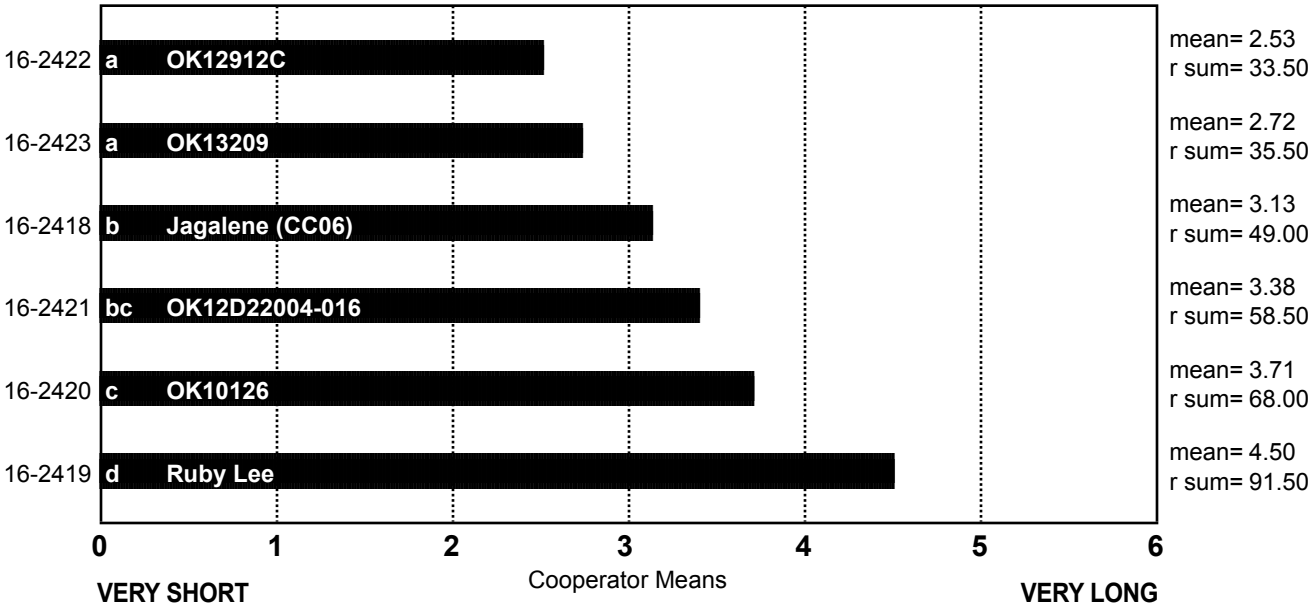
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2418 Jagalene (CC06)	**4.3**	**6.0**	**8.0**	**3.9**	**5.8**	**4.0**	**6.0**	**4.0**	**2.5**	**4.0**	**3.4**	**4.6**	**4.0**	**4.0**	**12.0**	**4.0**
16-2419 Ruby Lee	**5.3**	**11.0**	**10.3**	**5.3**	**6.6**	**4.5**	**8.0**	**5.0**	**3.5**	**6.0**	**4.5**	**6.5**	**7.0**	**5.0**	**25.0**	**5.3**
16-2420 OK10126	**4.5**	**8.0**	**8.0**	**4.0**	**6.4**	**4.3**	**8.0**	**4.3**	**2.8**	**5.0**	**3.1**	**5.0**	**5.5**	**5.0**	**24.0**	**4.4**
16-2421 OK12D22004-016	**3.5**	**6.0**	**8.0**	**3.8**	**5.7**	**4.0**	**6.0**	**4.0**	**2.8**	**4.0**	**3.1**	**4.9**	**5.0**	**5.0**	**14.0**	**4.5**
16-2422 OK12912C	**3.3**	**4.0**	**6.0**	**4.3**	**5.0**	**4.8**	**5.0**	**3.0**	**2.8**	**4.0**	**3.2**	**4.5**	**4.0**	**3.0**	**7.0**	**3.4**
16-2423 OK13209	**3.5**	**6.0**	**8.0**	**3.6**	**5.0**	**3.8**	**4.0**	**4.0**	**2.5**	**4.0**	**2.9**	**4.5**	**4.0**	**4.0**	**9.0**	**3.5**

BAKE MIX TIME

(Small Scale) Oklahoma

ncoop= 16
chisq= 42.61
chisqc= 55.62
cvchisq= 11.07
crdiff= 10.60

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

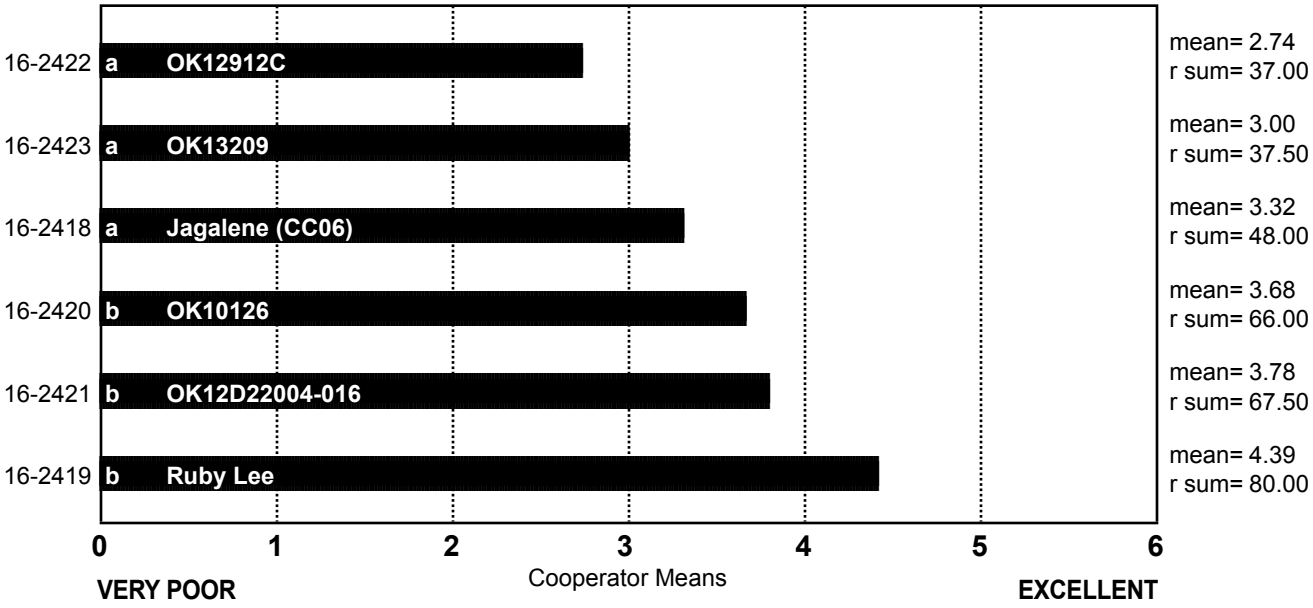


MIXING TOLERANCE

(Small Scale) Oklahoma

ncoop= 16
chisq= 28.13
chisqc= 34.86
cvchisq= 11.07
crdiff= 14.80

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



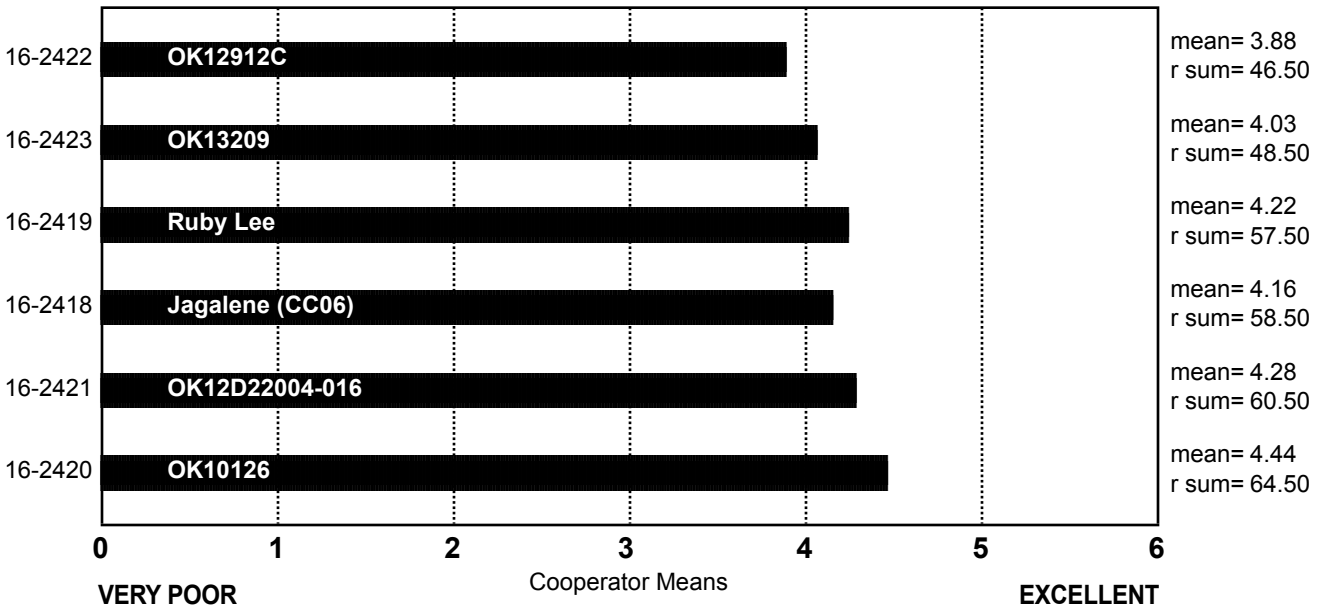
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Oklahoma

ncoop= 16
chisq= 4.42
chisqc= 7.05
cvchisq= 11.07
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
16-2418 Jagalene (CC06)	**2**	**1**	**1**	**10**	**2**
16-2419 Ruby Lee	**0**	**1**	**4**	**8**	**3**
16-2420 OK10126	**0**	**2**	**4**	**6**	**4**
16-2421 OK12D22004-016	**0**	**2**	**3**	**7**	**4**
16-2422 OK12912C	**0**	**2**	**2**	**9**	**3**
16-2423 OK13209	**1**	**2**	**2**	**9**	**2**

Frequency Table

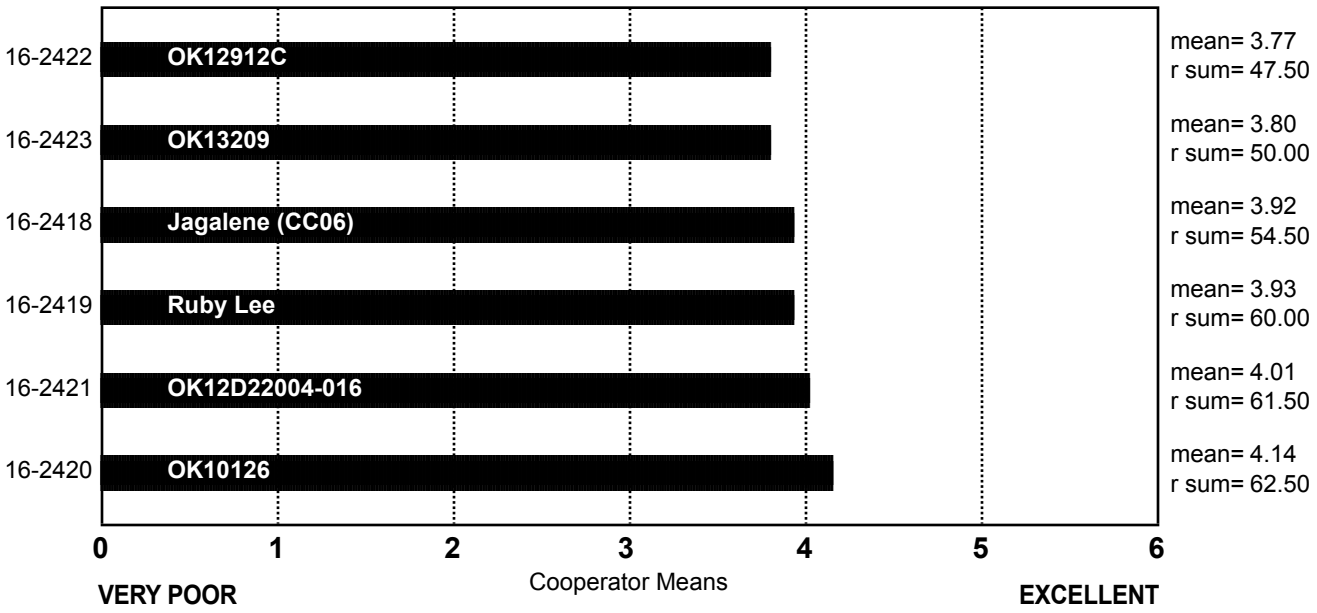
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Oklahoma

ncoop= 16
chisq= 3.55
chisqc= 5.64
cvchisq= 11.07
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
16-2418 Jagalene (CC06)	**2**	**2**	**0**	**10**	**2**
16-2419 Ruby Lee	**0**	**0**	**3**	**11**	**2**
16-2420 OK10126	**2**	**2**	**1**	**8**	**3**
16-2421 OK12D22004-016	**0**	**0**	**5**	**8**	**3**
16-2422 OK12912C	**0**	**3**	**2**	**10**	**1**
16-2423 OK13209	**1**	**1**	**1**	**12**	**1**

Frequency Table

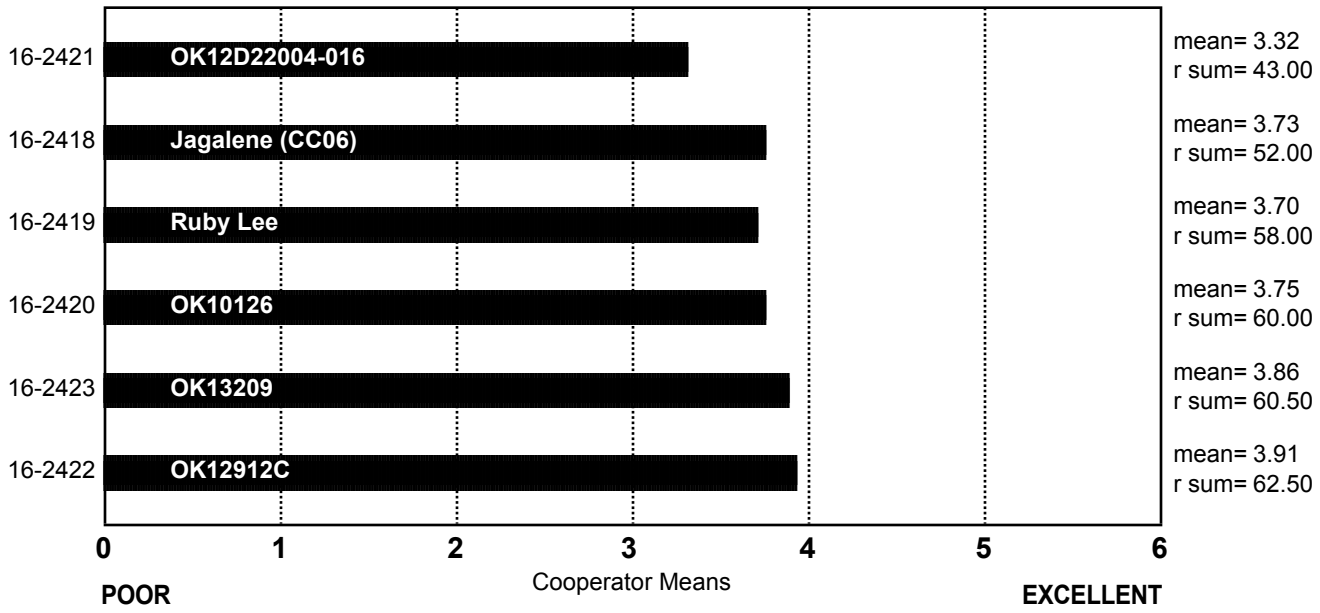
CRUMB GRAIN

(Small Scale) Oklahoma

ncoop= 16
chisq= 4.78
chisqc= 6.57
cvchisq= 11.07
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Oklahoma

	Open	Fine	Dense
16-2418 Jagalene (CC06)	**10**	**5**	**1**
16-2419 Ruby Lee	**7**	**8**	**1**
16-2420 OK10126	**9**	**5**	**2**
16-2421 OK12D22004-016	**10**	**5**	**1**
16-2422 OK12912C	**7**	**7**	**2**
16-2423 OK13209	**7**	**7**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Oklahoma

	Round	Irregular	Elongated
16-2418 Jagalene (CC06)	**3**	**8**	**5**
16-2419 Ruby Lee	**3**	**6**	**7**
16-2420 OK10126	**1**	**10**	**5**
16-2421 OK12D22004-016	**4**	**8**	**4**
16-2422 OK12912C	**3**	**6**	**7**
16-2423 OK13209	**3**	**5**	**8**

Frequency Table

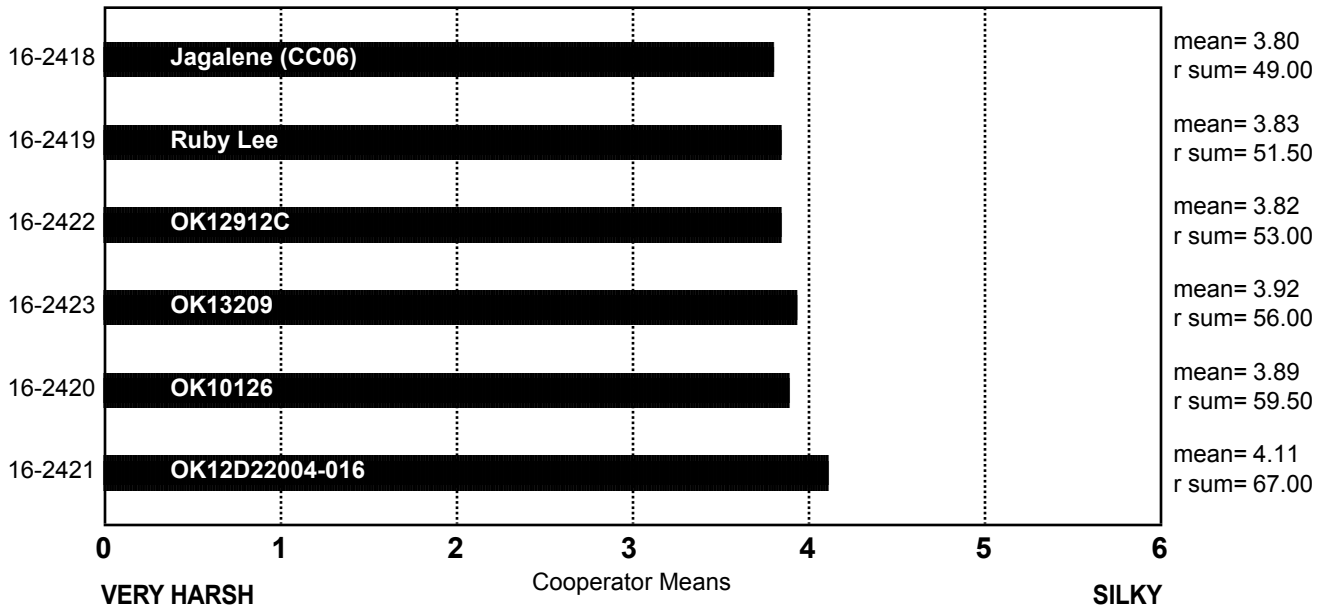
CRUMB TEXTURE

(Small Scale) Oklahoma

ncoop= 16
chisq= 3.78
chisqc= 5.35
cvchisq= 11.07
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Oklahoma

	Harsh	Smooth	Silky
16-2418 Jagalene (CC06)	**4**	**11**	**1**
16-2419 Ruby Lee	**5**	**7**	**4**
16-2420 OK10126	**3**	**9**	**4**
16-2421 OK12D22004-016	**3**	**7**	**6**
16-2422 OK12912C	**5**	**9**	**2**
16-2423 OK13209	**4**	**11**	**1**

Frequency Table

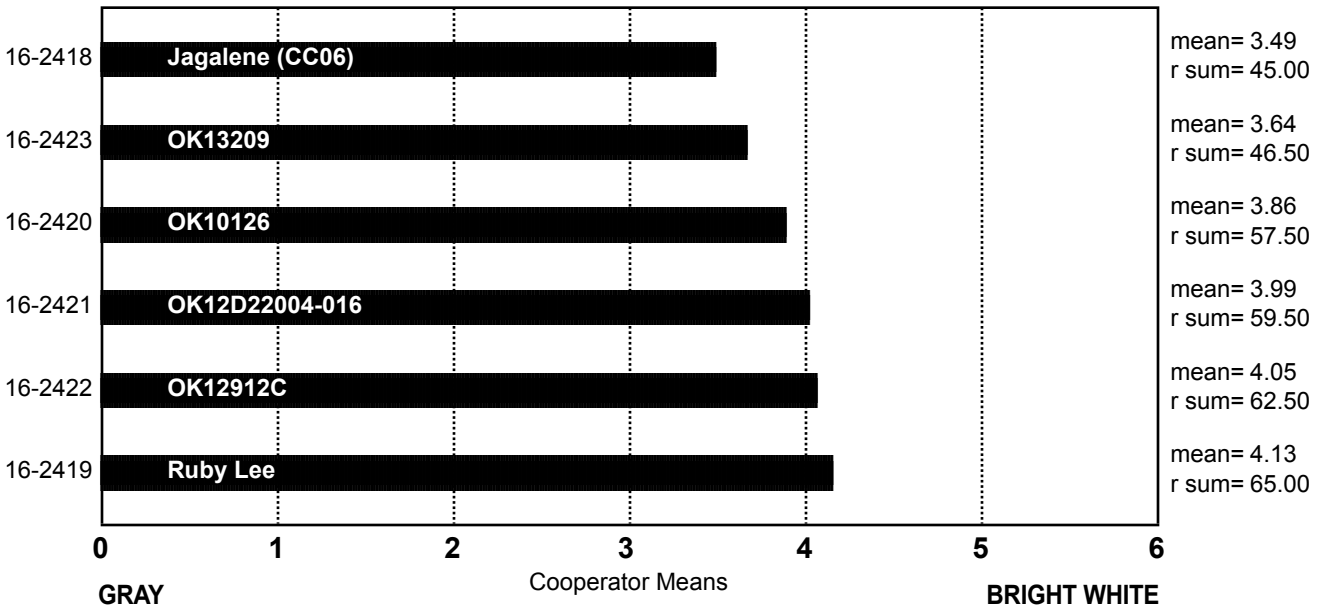
CRUMB COLOR

(Small Scale) Oklahoma

ncoop= 16
chisq= 6.23
chisqc= 10.61
cvchisq= 11.07
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Oklahoma

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
16-2418 Jagalene (CC06)	**0**	**0**	**3**	**4**	**7**	**1**	**1**
16-2419 Ruby Lee	**0**	**0**	**1**	**2**	**7**	**5**	**1**
16-2420 OK10126	**1**	**1**	**0**	**2**	**9**	**3**	**0**
16-2421 OK12D22004-016	**1**	**0**	**1**	**3**	**6**	**5**	**0**
16-2422 OK12912C	**0**	**0**	**0**	**4**	**9**	**1**	**1**
16-2423 OK13209	**1**	**0**	**2**	**5**	**5**	**3**	**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
16-2418 Jagalene (CC06)	**141.8**	**468.7**	**458.2**	**152.4**	**133.9**	**130.9**	**412.0**	**139.7**	**132.4**	**482.2**	**136.8**	**149.1**	**446.0**	**145.9**		**139.9**
16-2419 Ruby Lee	**141.3**	**465.6**	**456.2**	**151.2**	**137.2**	**132.9**	**412.0**	**140.3**	**131.5**	**482.6**	**138.7**	**148.1**	**444.1**	**144.5**		**139.6**
16-2420 OK10126	**140.9**	**463.0**	**457.8**	**152.1**	**136.1**	**132.6**	**415.0**	**139.5**	**133.6**	**479.1**	**139.4**	**148.0**	**445.1**	**142.5**		**139.2**
16-2421 OK12D22004-016	**143.0**	**466.1**	**458.2**	**154.8**	**139.1**	**136.6**	**416.0**	**142.8**	**135.6**	**485.2**	**140.1**	**150.0**	**444.7**	**145.8**		**139.5**
16-2422 OK12912C	**143.1**	**468.7**	**457.2**	**152.5**	**136.2**	**135.1**	**415.0**	**140.9**	**133.2**	**482.1**	**139.2**	**151.3**	**445.7**	**142.1**		**138.8**
16-2423 OK13209	**142.3**	**467.7**	**460.8**	**152.9**	**136.1**	**133.6**	**416.0**	**140.6**	**132.3**	**480.1**	**138.0**	**151.1**	**446.1**	**146.0**		**139.5**

LOAF VOLUME, ACTUAL

(Small Scale) Oklahoma

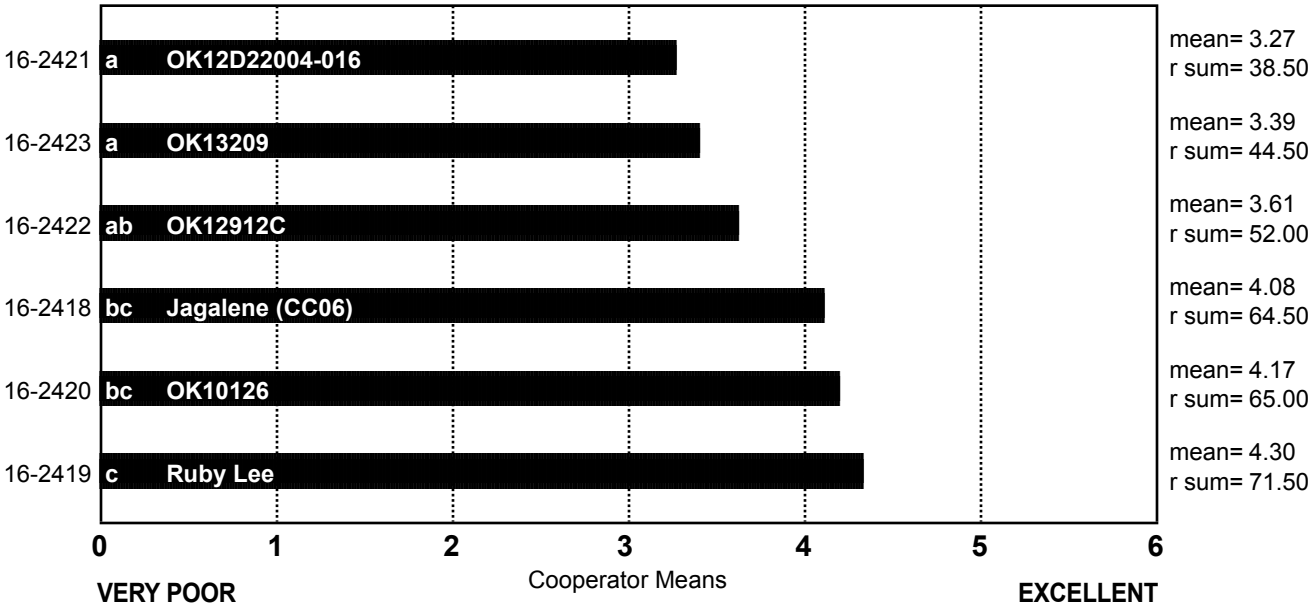
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2418 Jagalene (CC06)	**1015**	**2413**	**2752**	**998**	**918**	**910**	**3100**	**905**	**795**	**2650**	**935**	**880**	**2450**	**885**	**3104**	**803**
16-2419 Ruby Lee	**1050**	**2550**	**2918**	**1020**	**885**	**960**	**3050**	**835**	**875**	**2588**	**955**	**860**	**2650**	**800**	**3045**	**828**
16-2420 OK10126	**985**	**2325**	**2754**	**1015**	**944**	**950**	**2950**	**905**	**855**	**2488**	**880**	**905**	**2500**	**1000**	**3104**	**809**
16-2421 OK12D22004-016	**935**	**2425**	**2701**	**935**	**870**	**850**	**2750**	**725**	**845**	**2488**	**810**	**835**	**2600**	**900**	**3045**	**768**
16-2422 OK12912C	**860**	**2413**	**2873**	**978**	**933**	**865**	**2700**	**820**	**818**	**2588**	**870**	**850**	**2600**	**910**	**2986**	**785**
16-2423 OK13209	**875**	**2375**	**2748**	**1008**	**915**	**910**	**2550**	**840**	**783**	**2600**	**850**	**840**	**2500**	**885**	**3045**	**809**

LOAF VOLUME

(Small Scale) Oklahoma

ncoop= 16
chisq= 15.14
chisqc= 18.12
cvchisq= 11.07
crdiff= 17.64

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

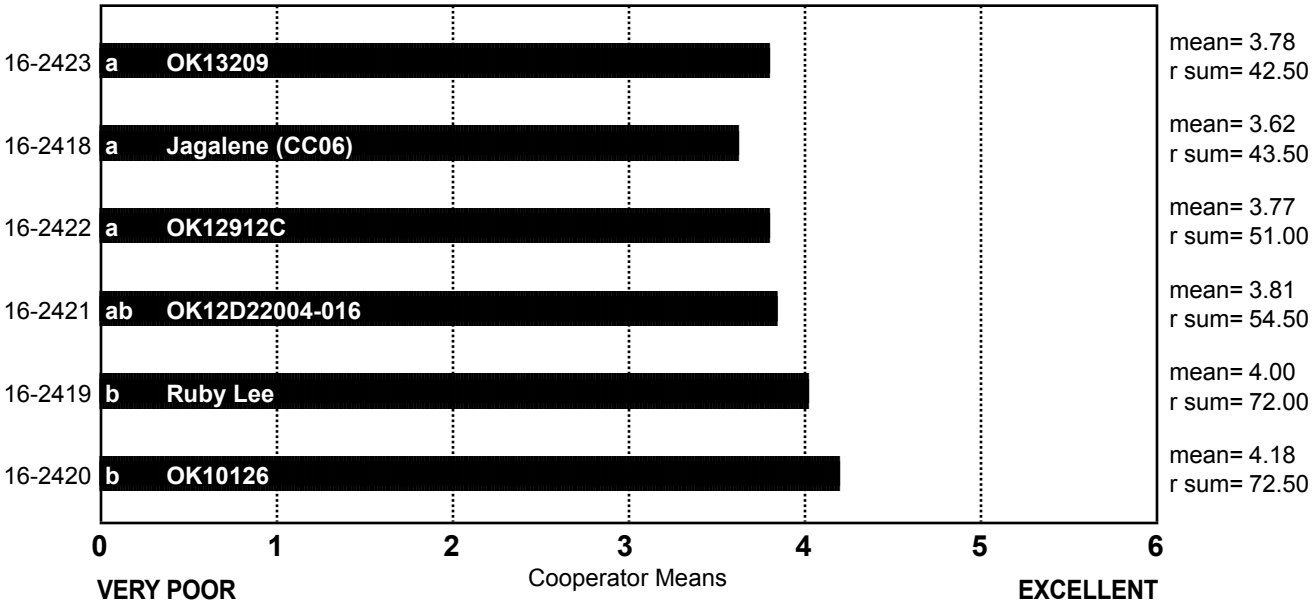


OVERALL BAKING QUALITY

(Small Scale) Oklahoma

ncoop= 16
chisq= 15.96
chisqc= 17.33
cvchisq= 11.07
crdiff= 18.64

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. **16-2418 Jagalene (CC06)**

A. Excellent externals.
B. Low absorption, average mix time, low volume, creamy, open.
C. No comment.
D. Low protein %, mixing time OK and dough strength looks promising for protein level, good bread volume and grain for protein.
E. Normal water absorption and mix time, slight sticky & weak dough, high volume, dull crumb, slight open elongated cells, resilient & smooth texture.
F. No comment.
G. Good out of mixer.
H. Exceeds target loaf volume.
I. Crumb separates when pressed.
J. Good absorption, sticky dough, average grain, yellow crumb, good volume.
K. Good volume for the protein.
L. Good mix time, good dough strength, satisfactory crumb grain.
M. No comment.
N. Mellow and slightly wet at the bench.
O. Slightly open, variable, slightly course grain, excellent volume.
P. No comment.

COOP. **16-2419 Ruby Lee**

A. Excellent externals.
B. Low absorption, slightly above average mix time, average volume, creamy, open.
C. Could have mixed longer.
D. Low protein %, mix time and dough strength OK for protein level, very good bread volume with weaker looking grain.
E. Low water absorption, normal mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
F. Good loaf volume and mixing characteristics but lacked good crumb characteristics.
G. No comment.
H. Low ash, low protein, good mix tolerance.
I. No comment.
J. Low absorption, average mix time, excellent dough, good grain, average volume.
K. Lower protein, good absorption, good volume and grain, stronger.
L. Long mix time, good dough strength, satisfactory crumb grain.
M. No comment.
N. No comment.
O. Slightly open, consistent, slightly coarse grain, very good volume.
P. No comment.

COOP. **16-2420 OK10126**

A. Excellent externals.
B. Average absorption, average mix time, very low volume, creamy, open.
C. No comment.
D. Low protein %, mix time and dough strength OK for protein level, very good bread volume with weaker looking grain.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, dark yellow crumb, open irregular cells, resilient & slightly harsh texture.
F. Good mixing and baking characteristics.
G. No comment.
H. Exceeds target loaf volume.
I. Very nice, even structure.
J. Good absorption, good grain, low volume.
K. Lower protein, good absorption.
L. Excellent bake absorption, good dough during bake, satisfactory crumb grain, excellent loaf volume.
M. No comment.
N. No comment.
O. Slightly open, variable, slightly coarse grain, excellent volume.
P. No comment.

COOP. **16-2421 OK12D22004-016**

A. Excellent externals.
B. Slightly above average absorption, average mix time, low volume, creamy, open.
C. No comment.
D. Low protein %, short mixing time, dough strength weak, good volume for protein with poor crumb grain.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, slight open elongated cells, resilient & smooth texture.
F. No comment.
G. No comment.
H. Average.
I. No comment.
J. Average absorption, good grain, low volume.
K. Lower protein, good absorption.
L. Good absorption, dough excellent during bake, crumb grain open.
M. Best bread of the set, highest score of all the breads, excellent mix time and makeup, excellent absorption, largest volume with a creamy white fine grain.
N. Extensible at mix.
O. Slightly open, consistent, smooth grain, very good volume.
P. No comment.

COOP. 16-2422 OK12912C

A. No comment.
B. Average absorption, short mix time, low volume, creamy, open.
C. Low mix time.
D. Low protein %, short mixing time, dough strength weak, good bread volume for protein with poor crumb grain.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, slight open elongated cells, resilient & smooth texture.
F. No comment.
G. Slightly soft dough.
H. Low protein, poor mix tolerance.
I. No comment.
J. Wet dough, average grain and volume.
K. Excellent color, performed well for protein, weaker.
L. Good absorption, dough excellent during bake, crumb grain satisfactory.
M. Also a very good bread with excellent volume and a white dense grain rating.
N. No comment.
O. Open, variable, slightly coarse grain, good volume.
P. No comment.

COOP. 16-2423 OK13209

A. No comment.
B. Average absorption, average mix time, very low volume, creamy, open, flat.
C. No comment.
D. Mix time and dough strength OK, volume and crumb grain fairly good.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, slight open elongated cells, resilient & smooth texture.
F. Good volume but poor crumb color.
G. No comment.
H. High ash.
I. No comment.
J. Average grain, good volume.
K. No comment.
L. Good mix time, good dough strength, excellent crumb grain.
M. No comment.
N. No comment.
O. Slightly open, consistent, slightly coarse grain, very good volume.
P. No comment.

Notes: **B, G, J, M, N, and O** conducted sponge and dough bake tests

KANSAS-MANHATTAN

16-2424	EVEREST
16-2425	Jagalene (CC07)
16-2426	LARRY
16-2427	ZENDA

Description of Test Plots and Breeder Entries

Kansas-Manhattan - Allan Fritz

Larry is a hard red winter wheat selected from the cross Overley ‘S’//Karl 92 *2/Kakatsi/4/ KS89180B-2-1-1/CMSW89Y267/3/ Heyne/HBF0435//Karl 92. Larry has performed very well statewide, but it best adapted east of US Highway 283. It has an excellent yield record. In three years of testing, Larry has yielded 2.7 bu/ac better than WB 4458 and 10.5 bu/ac higher than Everest in Central Kansas and has out-yielded Byrd by 3.6 bu/ac and TAM 111 by 13.7 bu/ac in western Kansas. Larry has a good test weight pattern and is similar to Everest and is resistant to stripe rust but susceptible to leaf rust. Larry is also resistant to soil-borne mosaic virus and spindle streak mosaic virus. It is moderately resistant to stem rust race QFCS, but susceptible to Ug99. It is also intermediate for speckled leaf blotch and tan spot. Larry has good tolerance to acid soils. It is moderately susceptible to wheat streak mosaic and barley yellow dwarf virus, is susceptible to prevalent biotypes of Hessian fly and is intermediate to moderately susceptible to Fusarium head blight. In our testing, Larry has good milling quality and acceptable baking quality.

Zenda is a hard red winter wheat selected from the cross Overley ‘s’/W040-417//Everest. Zenda has performed best east of US Highway 183 and is intended for production in central and eastern Kansas. It has an excellent yield record with 5.2 bu/ac advantage over WB 4458 and 12.9 bu/ac over Everest in central and eastern Kansas. Zenda has excellent resistant to stripe rust and is moderately resistant to leaf rust. Zenda is resistant to soil-borne mosaic virus and spindle streak mosaic virus. It is moderately resistant to stem rust race QFCS. It is intermediate for speckled leaf blotch and tan spot and has good tolerance to acid soils. It is moderately susceptible to wheat streak mosaic, intermediate in its response to barley yellow dwarf and susceptible to prevalent biotypes of Hessian fly. Zenda is intermediate to moderately resistant to Fusarium head blight and is comparable to Everest for this trait. Zenda is seen as an Everest replacement. Zenda has a good to very good test weight pattern, averaging about 0.4 pounds per bushel less than Everest. Using Hard Winter Wheat Quality Targets as a guide, Zenda has acceptable milling and baking quality. In bake tests, Zenda has an average mix time about 0.55 minutes longer than Everest and an average loaf volume that is approximately 30 cc higher than Everest. Kernel diameter and kernel weight, as measure by SCKS, meet the target values.

Everest and Jagalene are included as checks.

All four lines were grown at K-State’s North Agronomy Farm in Manhattan, KS. They were planted no-till after soybeans on October 25, 2015. Starter and top dress applications resulted in a total of 100 pounds of N applied to all plots.

Kansas-Manhattan: 2016 (Small-Scale) Samples

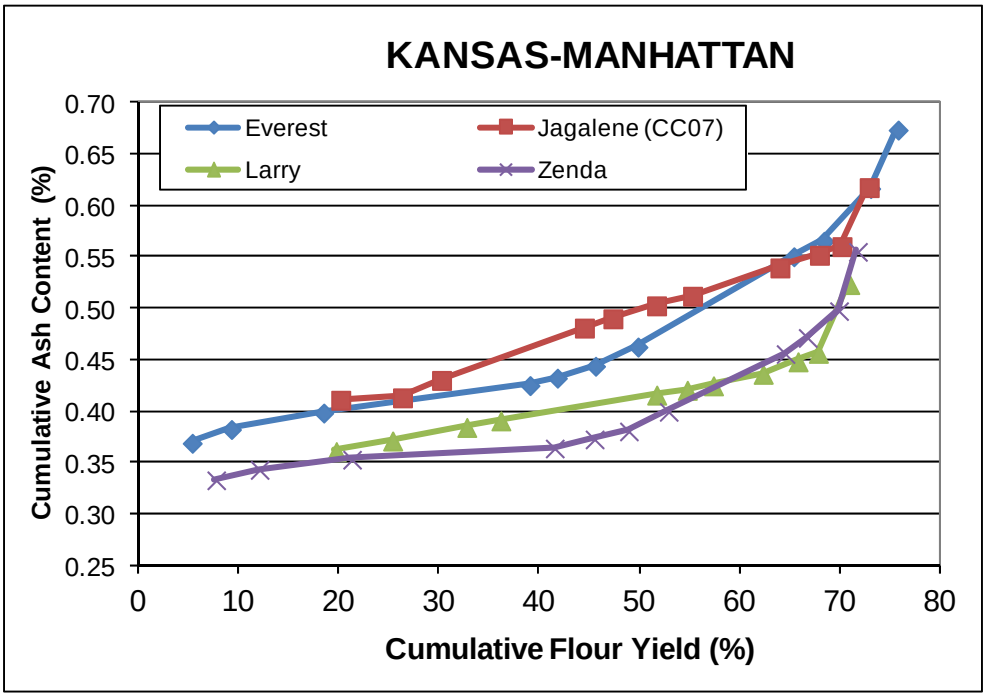
Test entry number	16-2424	16-2425	16-2426	16-2427
Sample identification	**Everest**	**Jagalene (CC07)**	**Larry**	**Zenda**
Wheat Data				
GIPSA classification	2 HRW	2 HRW	3 HRW	2 HRW
Test weight (lb/bu)	58.6	58.7	57.3	58.4
Hectoliter weight (kg/hl)	77.1	77.3	75.5	76.9
1000 kernel weight (gm)	32.4	34.3	32.4	31.5
Wheat kernel size (Rotap)				
Over 7 wire (%)	77.7	79.7	84.9	81.9
Over 9 wire (%)	22.1	20.1	15.0	18.1
Through 9 wire (%)	0.2	0.2	0.1	0.0
Single kernel (skcs)[a]				
Hardness (avg /s.d)	54.2/16.2	59.6/13.8	52.1/13.2	50.1/13.8
Weight (mg) (avg/s.d)	32.4/7.9	34.3//9.8	32..4//8.4	31.5/7.9
Diameter (mm)(avg/s.d)	2.74/0.33	2.84/038	2.78/0.37	2.65/0.35
Moisture (%) (avg/s.d)	10.8/0.4	10.9/0.4	11.0/0.4	11.0/0.4
SKCS distribution	07-18-40-35-02	02-16-30-52-01	07-24-41-28-02	10-33-33-24-02
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	12.3	12.6	11.5	11.8
Wheat ash (12% mb)	1.87	1.77	1.69	1.77
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	74.8	75.8	75.0	74.8
Quadrumat Sr. Mill	65.9	67.0	68.0	67.6
Flour moisture (%)	13.6	13.5	13.6	14.0
Flour protein (14% mb)	10.9	11.2	10.1	10.5
Flour ash (14% mb)	0.62	0.58	0.47	0.53
Rapid Visco-Analyser				
Peak Time (min)	6.4	6.1	6.2	6.5
Peak Viscosity (RVU)	210.9	189.4	190.0	224.7
Breakdown (RVU)	57.6	62.8	52.9	55.0
Final Viscosity at 13 min (RVU)	258.1	233.8	246.3	275.6
Minolta color meter				
L*	91.62	91.26	91.71	91.79
a*	-1.58	-1.46	-1.71	-1.39
b*	8.50	8.70	9.16	7.72
PPO	0.515	0.553	0.702	0.709
Falling number (sec)	515	487	468	468
Damaged Starch				
(AI%)	95.0	96.2	95.6	94.6
(AACC76-31)	5.5	6.4	6.0	5.3

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Kansas-Manhattan: Physical Dough Tests and Gluten Analysis 2016 (Small-Scale) Samples

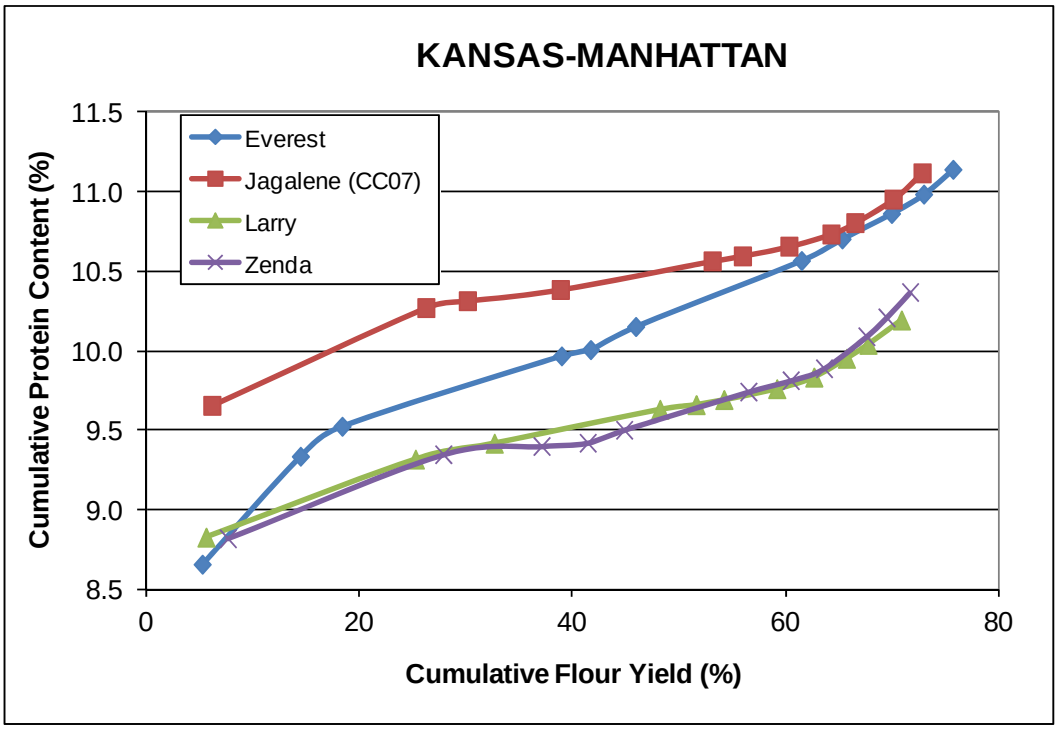
Test Entry Number	16-2424	16-2425	16-2426	16-2427
Sample Identification	Everest	Jagalene (CC07)	Larry	Zenda
MIXOGRAPH				
Flour Abs (% as-is)	60.7	62.9	58.7	61.3
Flour Abs (14% mb)	60.1	62.4	58.3	61.3
Mix Time (min)	2.9	5.0	4.8	3.9
Mix tolerance (0-6)	1	4	1	4
FARINOGRAPH				
Flour Abs (% as-is)	60.4	59.2	56.4	58.6
Flour Abs (14% mb)	59.8	58.7	56.0	58.6
Development time (min)	4.0	2.0	2.3	7.4
Mix stability (min)	6.0	6.9	15.1	12.2
Mix Tolerance Index (FU)	35	25	19	27
Breakdown time (min)	8.2	7.5	16.6	13.8
ALVEOGRAPH				
P(mm): Tenacity	74	89	72	88
L(mm): Extensibility	67	75	57	59
G(mm): Swelling index	18.2	19.3	16.8	17.1
W(10^{-4} J): strength (curve area)	154	263	169	206
P/L: curve configuration ratio	1.10	1.19	1.26	1.49
Ie(P_{200}/P): elasticity index	41.6	64.0	61.8	58.5
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	195/276/313	450/635/774	322/584/704	332/513/666
Extensibility (mm at 45/90/135 min)	144/136/130	128/119/116	117/102/87	136/127/116
Energy (cm^2 at 45/90/135 min)	48/61/63	94/119/133	60/82/76	79/107/113
Resist $_{max}$ (BU at 45/90/135 min)	234/318/354	594/851/958	390/667/739	445/688/787
Ratio (at 45/90/135 min)	1.36/2.03/2.41	3.52/5.32/6.68	2.76/5.74/8.11	2.45/4.03/5.75
PROTEIN ANALYSIS				
HMW-GS Composition	1, 7+8, 2+12	2*,1,17+18,5+10	1,17+18,5+10	1,7+8,5+10
%IPP	51.3	59.9	55.6	53.1
SEDIMENTATION TEST				
Volume (ml)	31.3	39.8	34.9	37.0

Kansas-Manhattan: Cumulative Ash Curves



Everest					Jagalene (CC07)					Larry					Zenda				
Mill	Strm-yld	Ash	Cumul (14%)		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	Streams	(14%mb)		Yield	Ash
1BK	5.3	0.37	5.3	0.37	2M	20.1	0.41	20.1	0.41	2M	19.6	0.36	19.6	0.36	1BK	7.7	0.33	7.7	0.33
1M Red	3.9	0.40	9.2	0.38	1BK	6.2	0.42	26.3	0.41	1BK	5.6	0.41	25.3	0.37	1M Red	4.3	0.36	12.0	0.34
1M	9.2	0.41	18.4	0.40	1M Red	3.9	0.55	30.1	0.43	1M	7.4	0.43	32.7	0.38	1M	9.2	0.37	21.2	0.35
2M	20.6	0.45	39.0	0.43	3M	14.2	0.59	44.4	0.48	1M Red	3.4	0.45	36.1	0.39	2M	20.2	0.38	41.4	0.36
Grader	2.7	0.54	41.7	0.43	Grader	2.8	0.63	47.2	0.49	3M	15.5	0.47	51.6	0.42	2BK	4.0	0.47	45.4	0.37
2BK	3.8	0.57	45.5	0.44	4M	4.4	0.64	51.6	0.50	2BK	3.1	0.50	54.7	0.42	Grader	3.4	0.48	48.8	0.38
FILTER FLR	4.2	0.66	49.7	0.46	2BK	3.6	0.65	55.2	0.51	Grader	2.6	0.52	57.3	0.43	FILTER FLR	4.0	0.63	52.8	0.40
3M	15.6	0.83	65.3	0.55	1M	8.7	0.71	63.9	0.54	4M	5.0	0.57	62.2	0.44	3M	11.7	0.71	64.5	0.46
3BK	3.0	0.89	68.3	0.57	FILTER FLR	3.9	0.75	67.9	0.55	FILTER FLR	3.5	0.67	65.7	0.45	3BK	2.2	0.93	66.7	0.47
4M	4.6	1.37	73.0	0.62	3BK	2.2	0.82	70.1	0.56	3BK	2.0	0.73	67.7	0.46	4M	3.1	1.05	69.8	0.50
5M	2.7	2.19	75.7	0.67	5M	2.7	2.10	72.8	0.62	5M	3.1	1.97	70.9	0.52	5M	1.9	2.69	71.7	0.56
Break Shorts	2.7	4.68	78.4	0.81	Break Shorts	3.0	4.73	75.8	0.78	Break Shorts	3.2	3.99	74.1	0.67	Break Shorts	2.8	4.83	74.5	0.72
Red Dog	2.0	3.63	80.4	0.88	Red Dog	2.5	3.44	78.3	0.86	Red Dog	2.4	2.91	76.5	0.75	Red Dog	1.9	3.72	76.4	0.79
Red Shorts	0.4	4.10	80.8	0.90	Red Shorts	0.5	4.10	78.8	0.89	Red Shorts	0.8	3.54	77.3	0.77	Red Shorts	0.5	3.88	76.9	0.81
Filter Bran	3.0	4.39	83.8	1.02	Filter Bran	3.5	4.25	82.4	1.03	Filter Bran	5.3	4.58	82.6	1.02	Filter Bran	3.0	4.13	79.8	0.93
Bran	16.2	5.51	100.0	1.75	Bran	17.6	5.65	100.0	1.85	Bran	17.4	5.66	100.0	1.83	Bran	20.2	5.53	100.0	1.86
Wheat		1.83					1.73					1.65					1.73		
St. Grd. Fl.		0.62					0.58					0.47					0.53		

Kansas-Manhattan: Cumulative Protein Curves

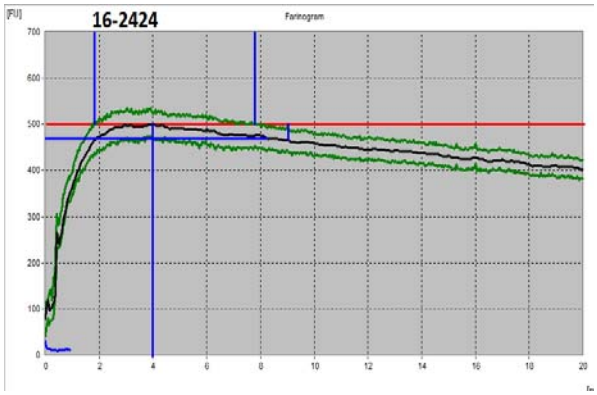


	Everest					Jagalene (CC07)					Larry					Zenda				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1BK	5.3	8.7	5.3	8.7	1BK	6.2	9.7	6.2	9.7	1BK	5.6	8.8	5.6	8.8	1BK	7.7	8.8	7.7	8.8
1M	9.2	9.7	14.5	9.3	2M	20.1	10.5	26.3	10.3	2M	19.6	9.5	25.3	9.3	2M	20.2	9.5	27.9	9.3
1M Red	3.9	10.2	18.4	9.5	1M Red	3.9	10.6	30.1	10.3	1M	7.4	9.8	32.7	9.4	1M	9.2	9.6	37.1	9.4
2M	20.6	10.4	39.0	10.0	1M	8.7	10.6	38.9	10.4	3M	15.5	10.1	48.2	9.6	1M Red	4.3	9.6	41.4	9.4
Grader	2.7	10.6	41.7	10.0	3M	14.2	11.1	53.1	10.6	1M Red	3.4	10.1	51.6	9.7	Grader	3.4	10.5	44.9	9.5
FILTER FLR	4.2	11.6	45.9	10.1	Grader	2.8	11.2	56.0	10.6	Grader	2.6	10.3	54.2	9.7	3M	11.7	10.7	56.5	9.7
3M	15.6	11.8	61.5	10.6	4M	4.4	11.4	60.3	10.7	4M	5.0	10.5	59.2	9.8	FILTER FLR	4.0	10.8	60.5	9.8
2BK	3.8	12.9	65.3	10.7	FILTER FLR	3.9	11.9	64.3	10.7	FILTER FLR	3.5	11.1	62.7	9.8	4M	3.1	11.3	63.6	9.9
4M	4.6	13.1	69.9	10.9	3BK	2.2	12.8	66.5	10.8	2BK	3.1	12.4	65.7	9.9	2BK	4.0	13.3	67.6	10.1
3BK	3.0	13.8	73.0	11.0	2BK	3.6	13.7	70.1	11.0	3BK	2.0	12.9	67.7	10.0	5M	1.9	14.5	69.5	10.2
5M	2.7	15.3	75.7	11.1	5M	2.7	15.4	72.8	11.1	5M	3.1	13.5	70.9	10.2	3BK	2.2	15.4	71.7	10.4
Break Shorts	2.7	16.4	78.4	11.3	Break Shorts	3.0	16.5	75.8	11.3	Break Shorts	3.2	15.4	74.1	10.4	Break Shorts	2.8	15.7	74.5	10.6
Red Dog	2.0	15.0	80.4	11.4	Red Dog	2.5	15.2	78.3	11.5	Red Dog	2.4	14.1	76.5	10.5	Red Dog	1.9	14.2	76.4	10.7
Red Shorts	0.4	13.3	80.8	11.4	Red Shorts	0.5	13.8	78.8	11.5	Red Shorts	0.8	12.3	77.3	10.5	Red Shorts	0.5	12.5	76.9	10.7
Filter Bran	3.0	14.6	83.8	11.5	Filter Bran	3.5	14.4	82.4	11.6	Filter Bran	5.3	12.7	82.6	10.7	Filter Bran	3.0	13.0	79.8	10.8
Bran	16.2	15.7	100.0	12.2	Bran	17.6	17.9	100.0	12.7	Bran	17.4	15.5	100.0	11.5	Bran	20.2	15.1	100.0	11.6
Wheat		12.1					12.3					11.2					11.5		
St. Grd. Fl		10.9					11.2					10.1					10.5		

Physical Dough Tests

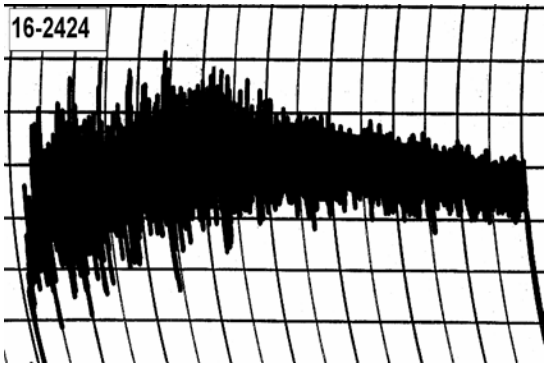
2016 (Small Scale) Samples – Kansas-Manhattan

Farinograms



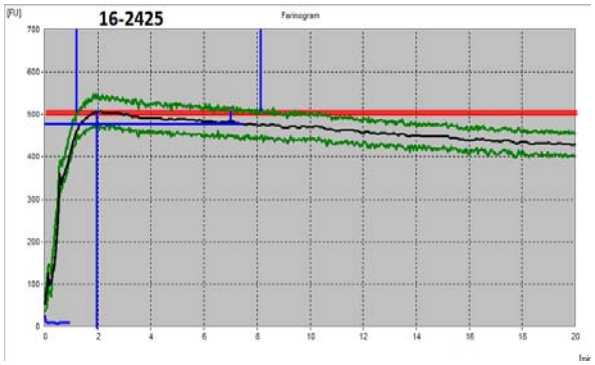
Water abs = 59.8%, Peak time = 4.0 min
Mix stab = 6.0 min, MTI = 35 Fu

Mixograms

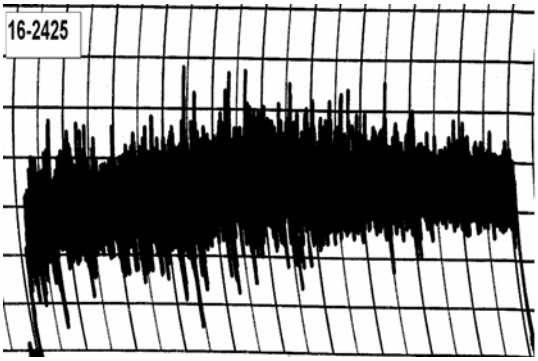


Water abs = 60.1%
Mix time = 2.9 min

16-2424, Everest



Water abs = 58.7%, Peak time = 2.0 min,
Mix stab = 6.9 min, MTI = 25 FU



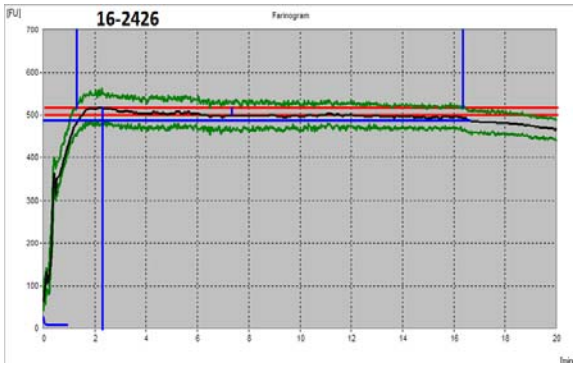
Water abs = 62.4%
Mix time = 5.0 min

16-2425, Jagalene (CC07)

Physical Dough Tests

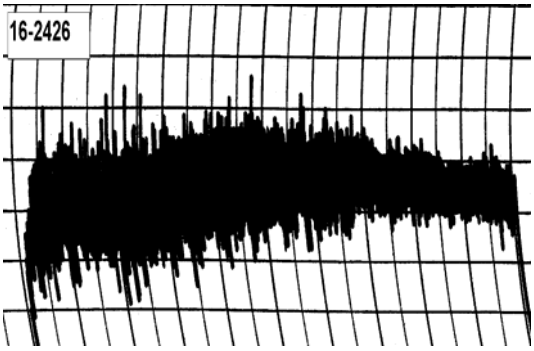
2016 (Small Scale) Samples – Kansas-Manhattan (continued)

Farinograms



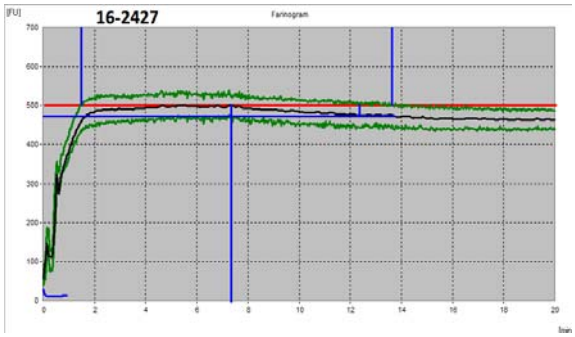
Water abs. = 56.0%, Peak time = 2.3 min,
Mix stab = 15.1 min, MTI = 19 FU

Mixograms

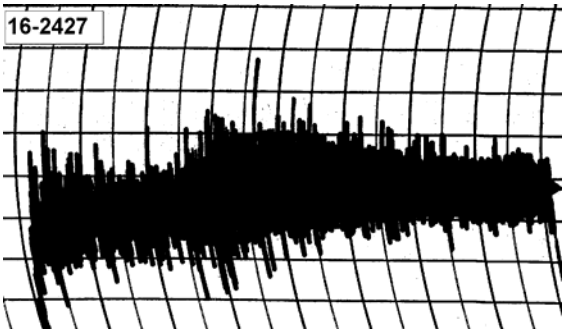


Water abs = 58.3%
Mix time = 4.8 min

16-2426, Larry



Water abs. = 58.6%, Peak time = 7.4 min,
Mix stab = 12.2 min, MTI = 27 FU

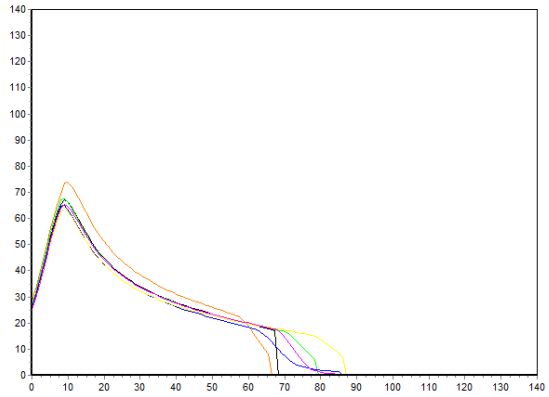


Water abs = 61.3%
Mix time = 3.9 min

16-2427, Zenda

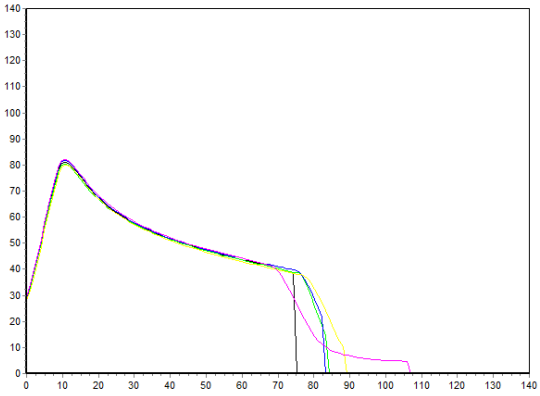
Physical Dough Tests - Alveograph

2016 (Small Scale) Samples – Kansas-Manhattan



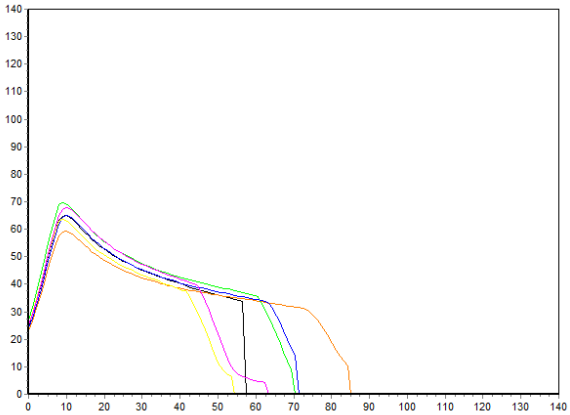
16-2424, Everest

P (mm H_20) = 74, L (mm) = 67, W ($10E^{-4}J$) = 154



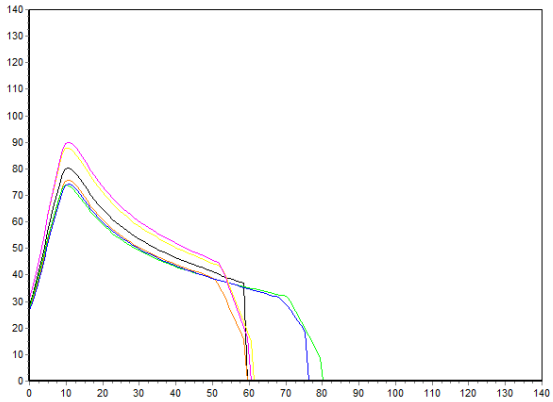
16-2425, Jagalene (CC07)

P (mm H_20) = 89, L (mm) = 75, W ($10E^{-4}J$) = 263



16-2426, Larry

P (mm H_20) = 72, L (mm) = 57, W ($10E^{-4}J$) = 169

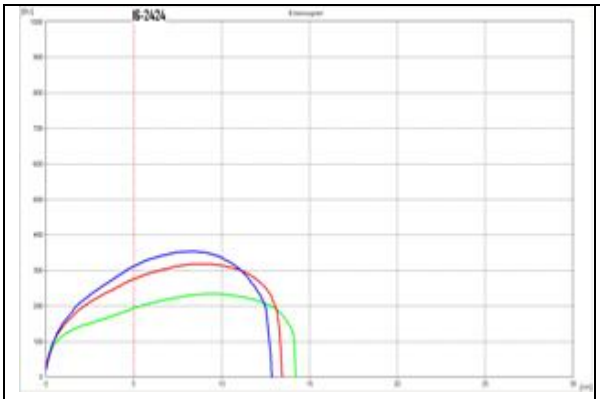


16-2427, Zenda

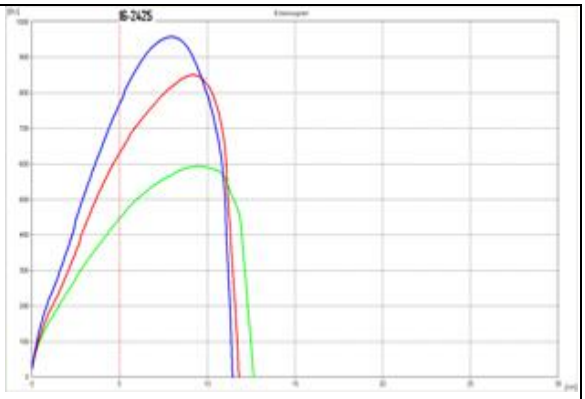
P (mm H_20) = 88, L (mm) = 59, W ($10E^{-4}J$) = 206

Physical Dough Tests - Extensigraph

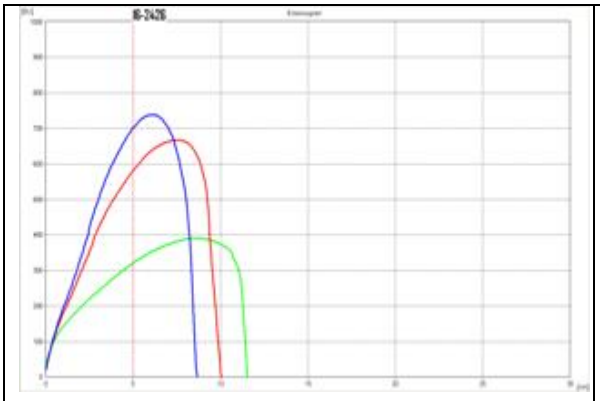
2016 (Small Scale) Samples – Kansas-Manhattan



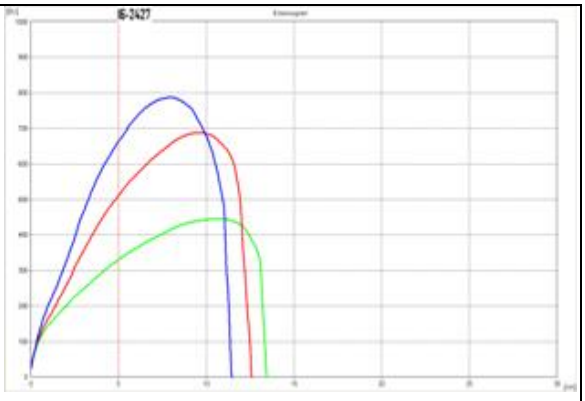
16-2424, Everest
R (BU) = 276, E (mm) = 134, W (cm^2) = 61
Rmax (BU) = 318, Ratio = 2.0 at 90 min



16-2425, Jagalene (CC07)
R (BU) = 635, E (mm) = 119, W (cm^2) = 119
Rmax (BU) = 851, Ratio = 5.3 at 90 min



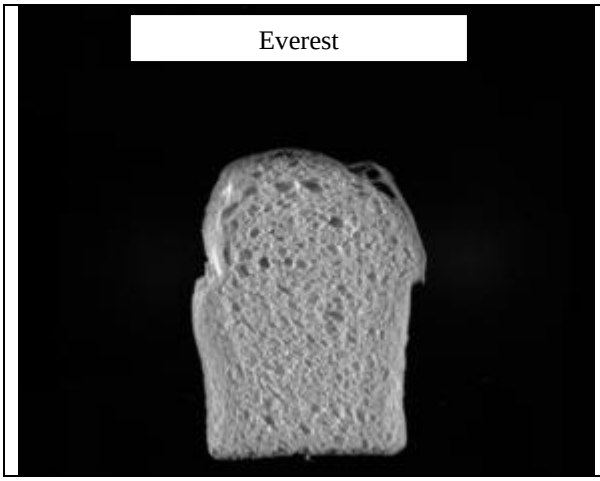
16-2426, Larry
R (BU) = 584, E (mm) = 102, W (cm^2) = 82
Rmax (BU) = 667, Ratio = 5.7 at 90 min

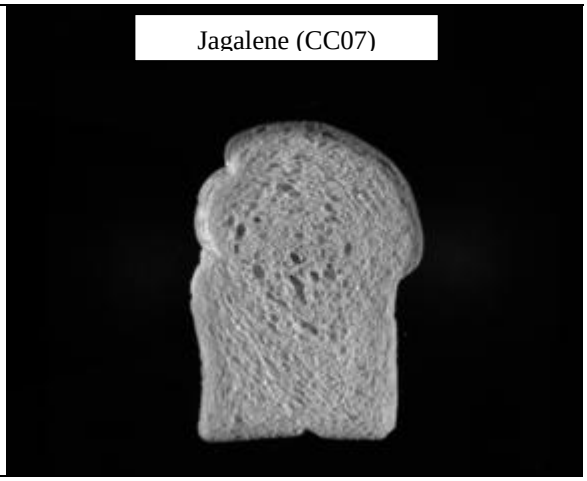


16-2427, Zenda
R (BU) = 513, E (mm) = 127, W (cm^2) = 107
Rmax (BU) = 688, Ratio = 4.0 at 90 min

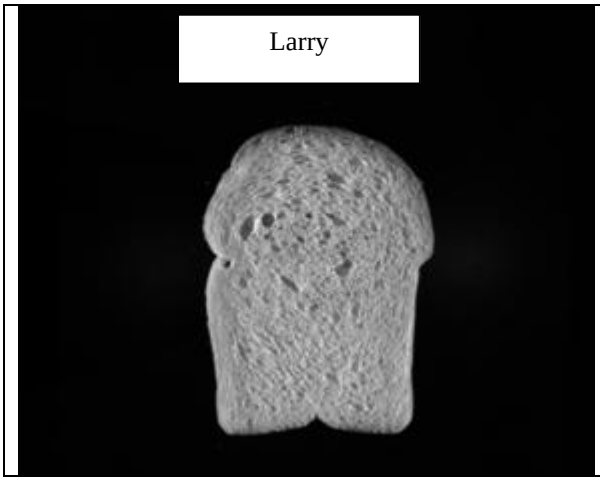
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

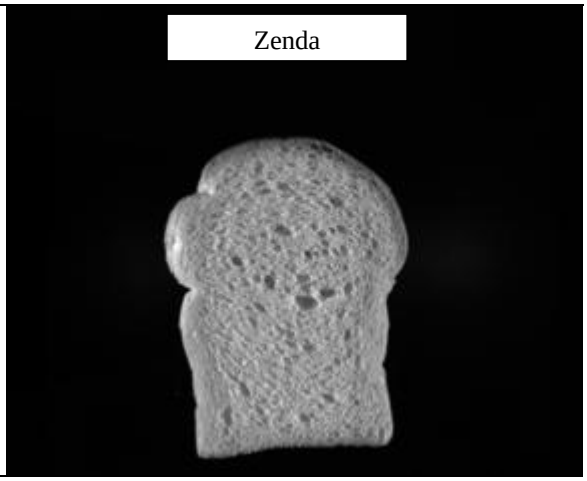
Kansas-Manhattan: C-Cell Bread Images and Analysis
2016 (Small-Scale) Samples





Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2424	5559	144.7	3787	0.436	1.879	1.052	1.610	-21.15
2425	5837	141.3	4064	0.431	1.776	4.161	1.703	-20.98





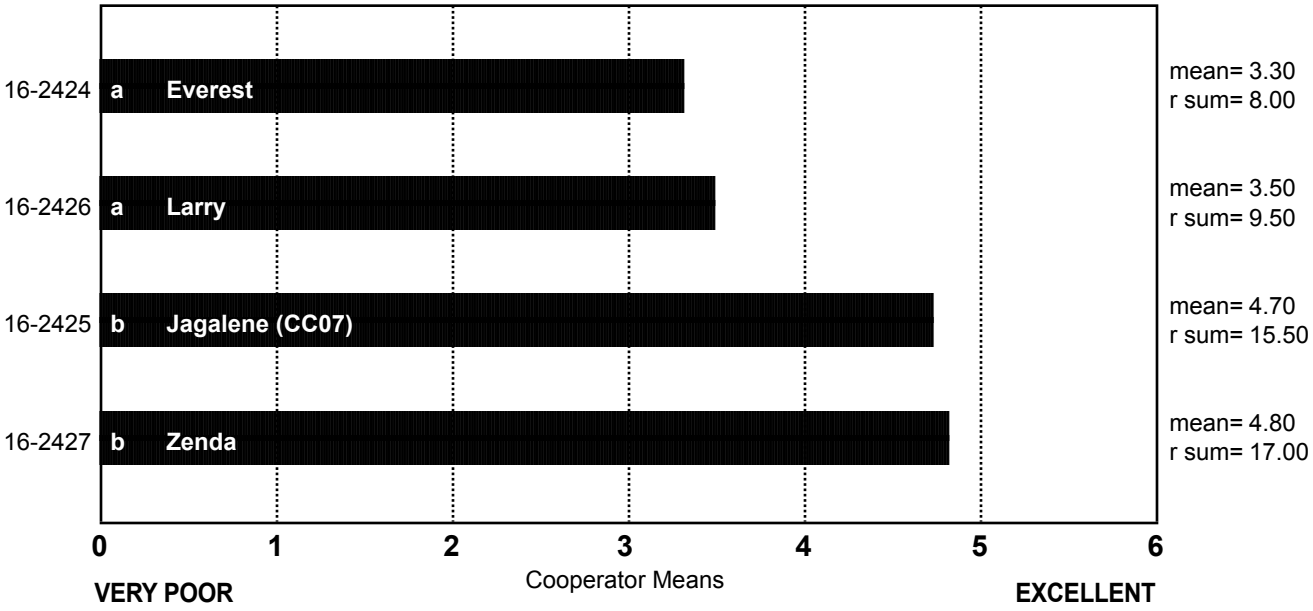
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2426	5649	144.0	4210	0.423	1.693	5.909	1.660	-22.48
2427	5841	141.9	4265	0.421	1.694	1.168	1.660	-34.15

SPONGE CHARACTERISTICS

(Small Scale) Kansas-Manhattan

ncoop= 5
chisq= 7.02
chisqc= 8.78
cvchisq= 7.82
crdiff= 5.73

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

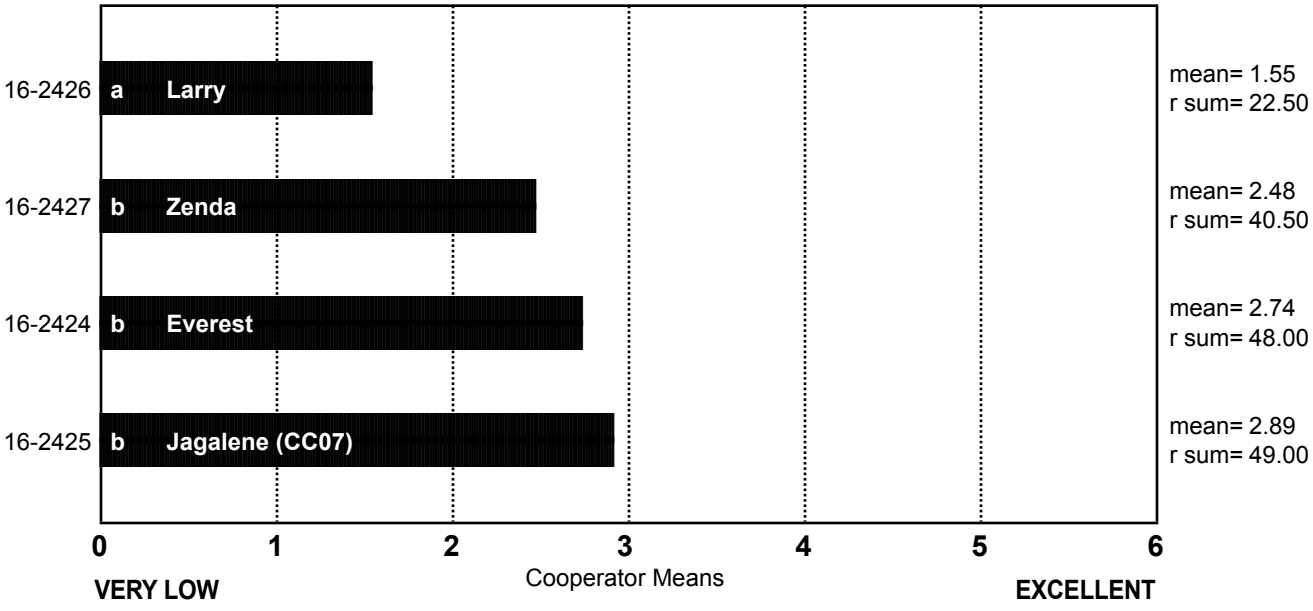


BAKE ABSORPTION

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 16.93
chisqc= 23.56
cvchisq= 7.82
crdiff= 9.19

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) Kansas-Manhattan

	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
16-2424 Everest	**59.6**	**59.8**	**59.8**	**62.1**	**62.5**	**63.8**	**57.0**	**60.3**	**63.1**	**57.4**	**59.4**	**61.1**	**59.8**	**60.0**	**58.0**	**60.4**
16-2425 Jagalene (CC07)	**61.5**	**58.7**	**58.7**	**61.6**	**62.5**	**62.6**	**57.0**	**60.4**	**63.3**	**56.4**	**61.0**	**64.2**	**58.7**	**60.0**	**58.0**	**62.9**
16-2426 Larry	**57.6**	**56.0**	**56.0**	**57.6**	**58.5**	**59.7**	**56.0**	**59.1**	**59.6**	**56.4**	**56.6**	**59.8**	**56.0**	**60.0**	**56.0**	**58.9**
16-2427 Zenda	**60.0**	**58.6**	**58.6**	**60.5**	**61.8**	**61.6**	**56.0**	**59.4**	**62.4**	**58.0**	**59.0**	**62.2**	**58.6**	**60.0**	**57.0**	**61.5**

BAKE MIX TIME, ACTUAL

(Small Scale) Kansas-Manhattan

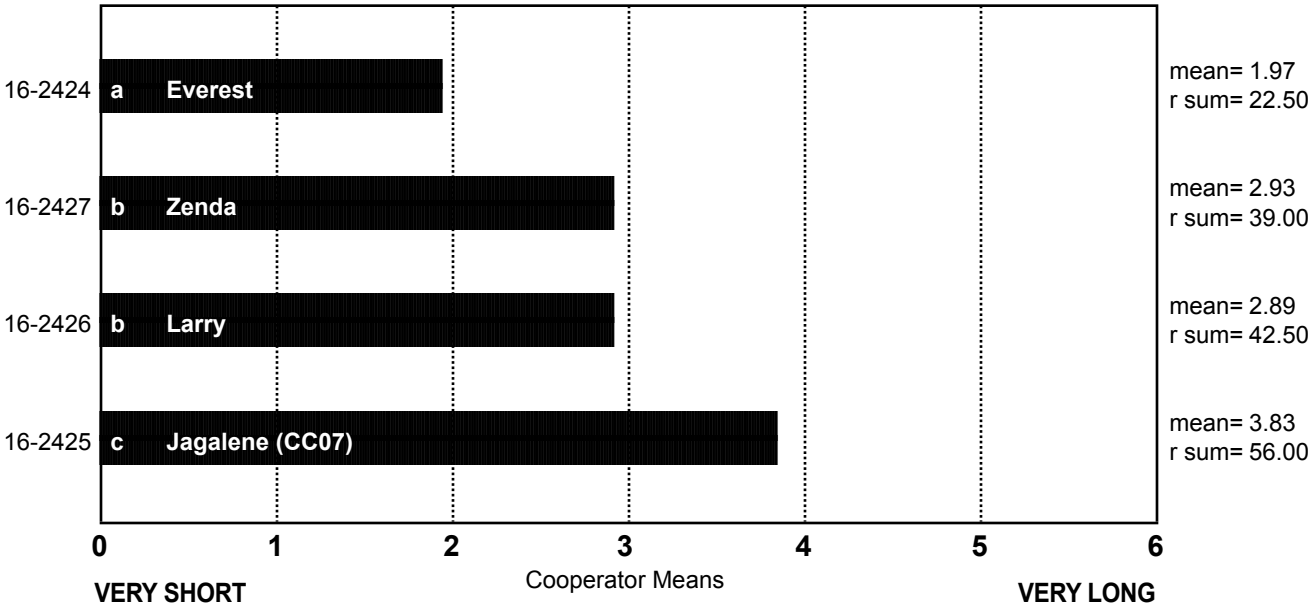
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2424 Everest	**2.8**	**4.0**	**6.0**	**3.9**	**3.8**	**3.3**	**4.0**	**3.0**	**2.5**	**4.0**	**2.4**	**3.0**	**3.0**	**3.0**	**7.0**	**3.0**
16-2425 Jagalene (CC07)	**4.8**	**6.0**	**6.0**	**5.2**	**8.4**	**4.0**	**7.0**	**4.3**	**3.5**	**4.0**	**3.7**	**6.3**	**4.5**	**5.0**	**16.0**	**4.7**
16-2426 Larry	**3.8**	**4.0**	**8.0**	**5.1**	**6.3**	**4.0**	**4.0**	**3.5**	**3.0**	**4.0**	**3.4**	**5.0**	**4.5**	**3.0**	**7.0**	**4.2**
16-2427 Zenda	**4.0**	**6.0**	**6.0**	**4.9**	**6.0**	**4.0**	**4.0**	**3.5**	**2.8**	**4.0**	**3.3**	**4.3**	**3.5**	**3.0**	**10.0**	**3.9**

BAKE MIX TIME

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 21.36
chisqc= 30.24
cvchisq= 7.82
crdiff= 7.77

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

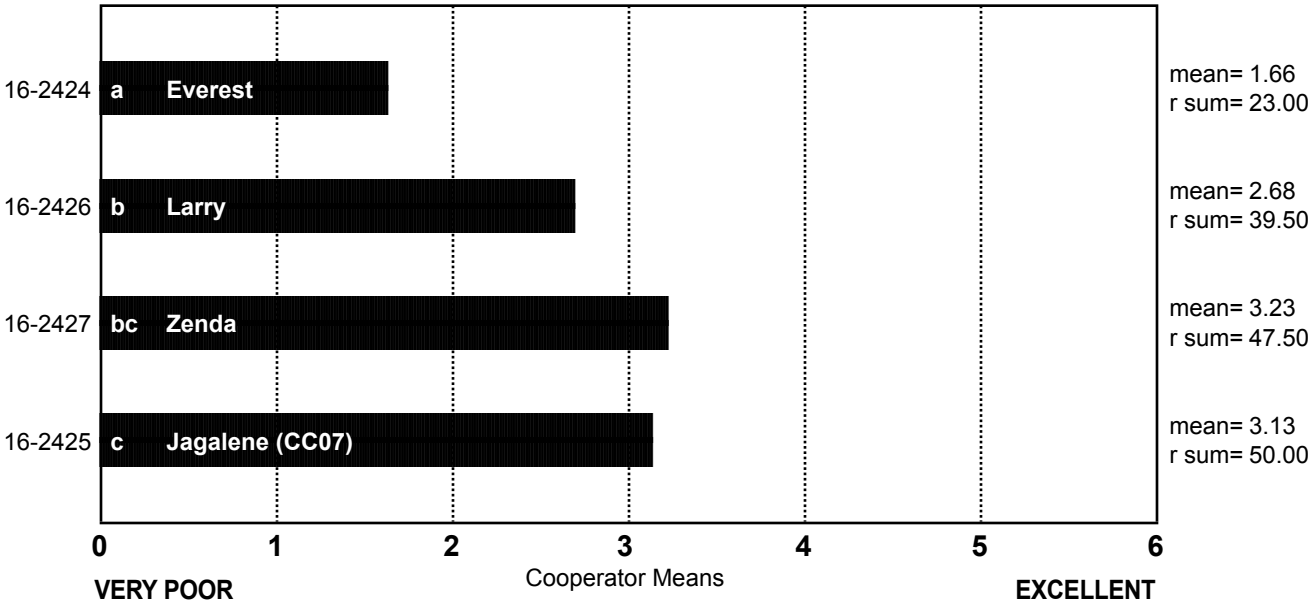


MIXING TOLERANCE

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 16.71
chisqc= 21.56
cvchisq= 7.82
crdiff= 9.93

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



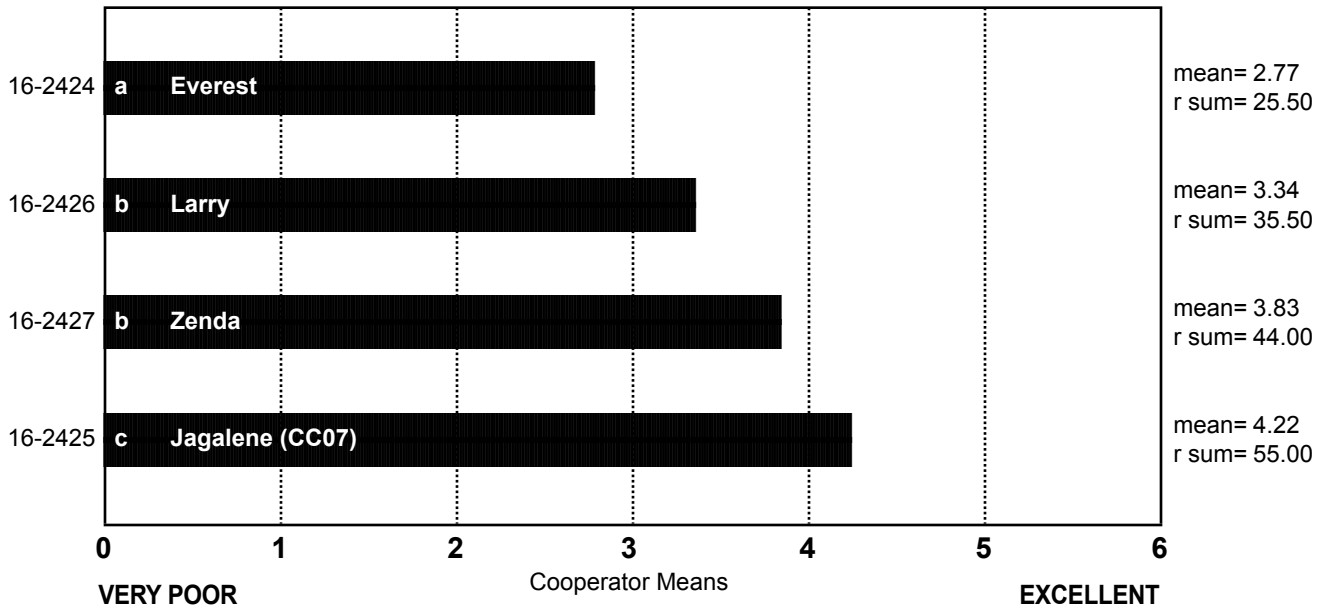
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 17.68
chisqc= 23.38
cvchisq= 7.82
crdiff= 9.46

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-Manhattan

	Sticky	Wet	Tough	Good	Excellent
16-2424 Everest	**3**	**3**	**3**	**7**	**0**
16-2425 Jagalene (CC07)	**0**	**0**	**1**	**12**	**3**
16-2426 Larry	**4**	**0**	**3**	**8**	**1**
16-2427 Zenda	**3**	**1**	**1**	**9**	**2**

Frequency Table

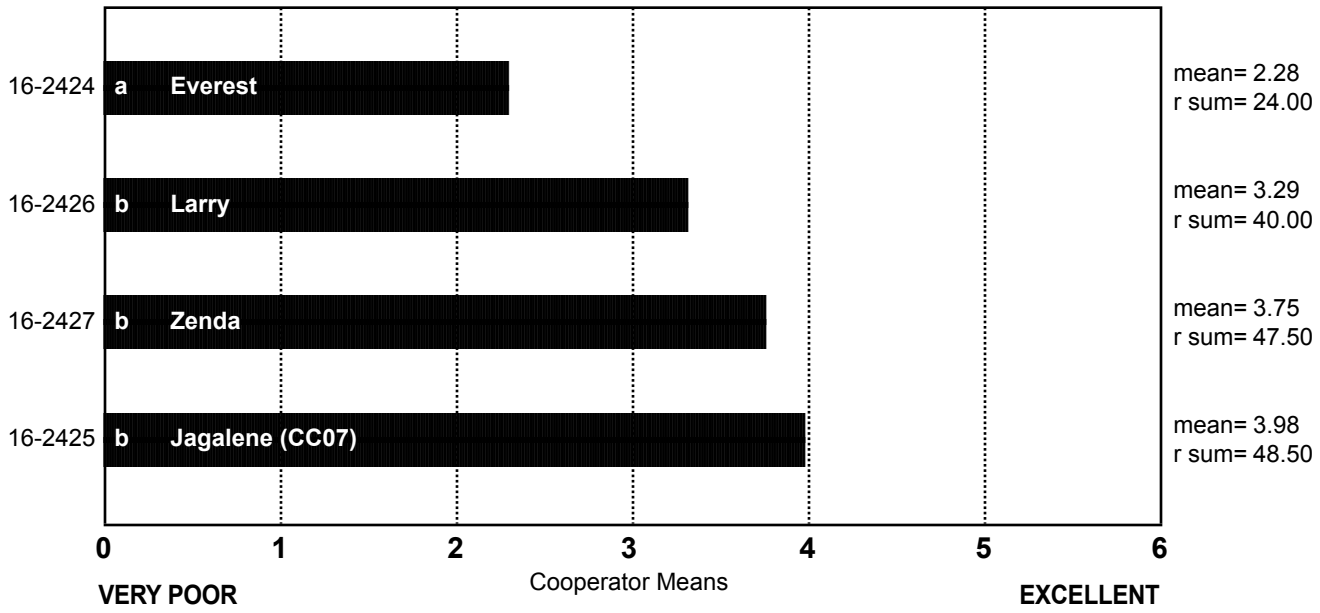
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 14.42
chisqc= 20.24
cvchisq= 7.82
crdiff= 9.75

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-Manhattan

	Sticky	Wet	Tough	Good	Excellent
16-2424 Everest	**5**	**5**	**4**	**1**	**1**
16-2425 Jagalene (CC07)	**1**	**0**	**2**	**9**	**4**
16-2426 Larry	**4**	**1**	**2**	**7**	**2**
16-2427 Zenda	**1**	**3**	**1**	**8**	**3**

Frequency Table

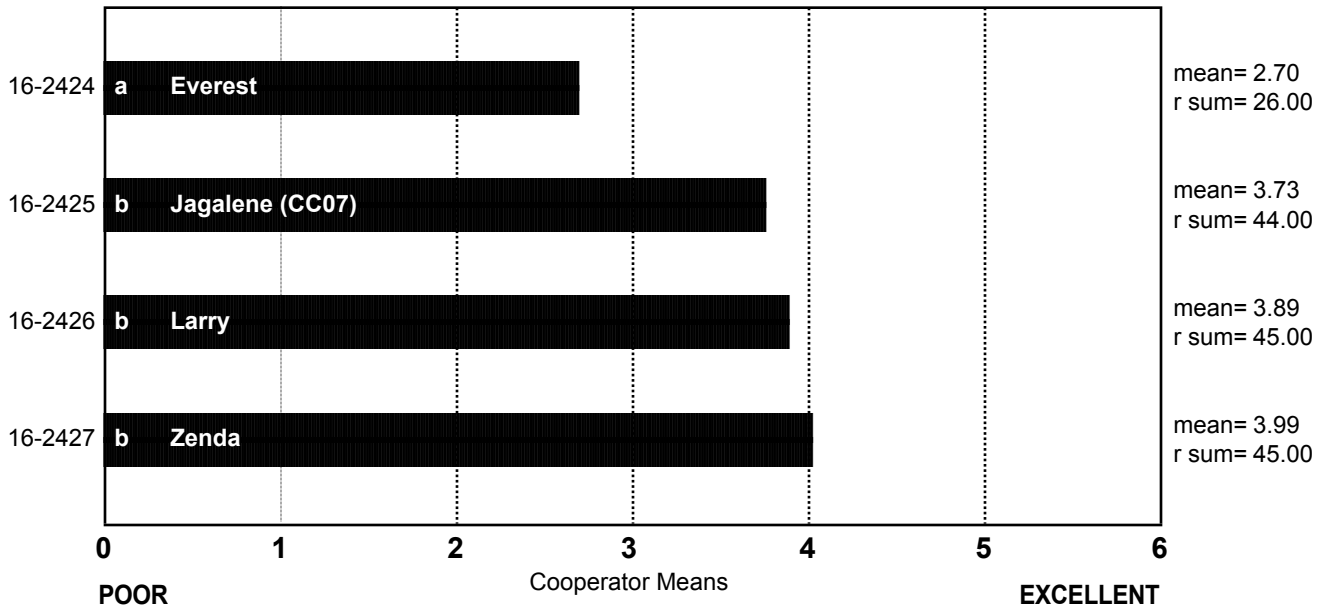
CRUMB GRAIN

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 9.83
chisqc= 11.64
cvchisq= 7.82
crdiff= 12.14

Variety order by rank sum.

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Kansas-Manhattan

	Open	Fine	Dense
16-2424 Everest	**6**	**4**	**6**
16-2425 Jagalene (CC07)	**8**	**6**	**2**
16-2426 Larry	**6**	**6**	**4**
16-2427 Zenda	**5**	**10**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Kansas-Manhattan

	Round	Irregular	Elongated
16-2424 Everest	**10**	**5**	**1**
16-2425 Jagalene (CC07)	**4**	**5**	**7**
16-2426 Larry	**2**	**7**	**7**
16-2427 Zenda	**1**	**7**	**8**

Frequency Table

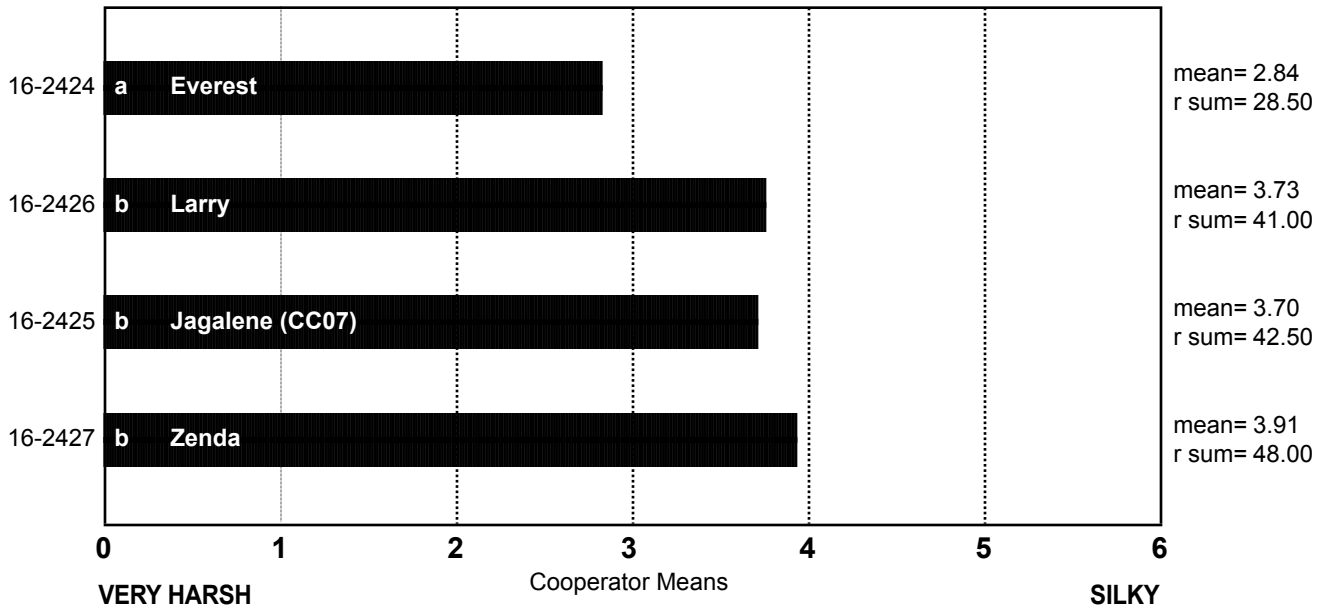
CRUMB TEXTURE

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 7.63
chisqc= 11.63
cvchisq= 7.82
crdiff= 10.71

Variety order by rank sum.

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Kansas-Manhattan

	Harsh	Smooth	Silky
16-2424 Everest	**10**	**5**	**1**
16-2425 Jagalene (CC07)	**5**	**10**	**1**
16-2426 Larry	**6**	**8**	**2**
16-2427 Zenda	**1**	**12**	**3**

Frequency Table

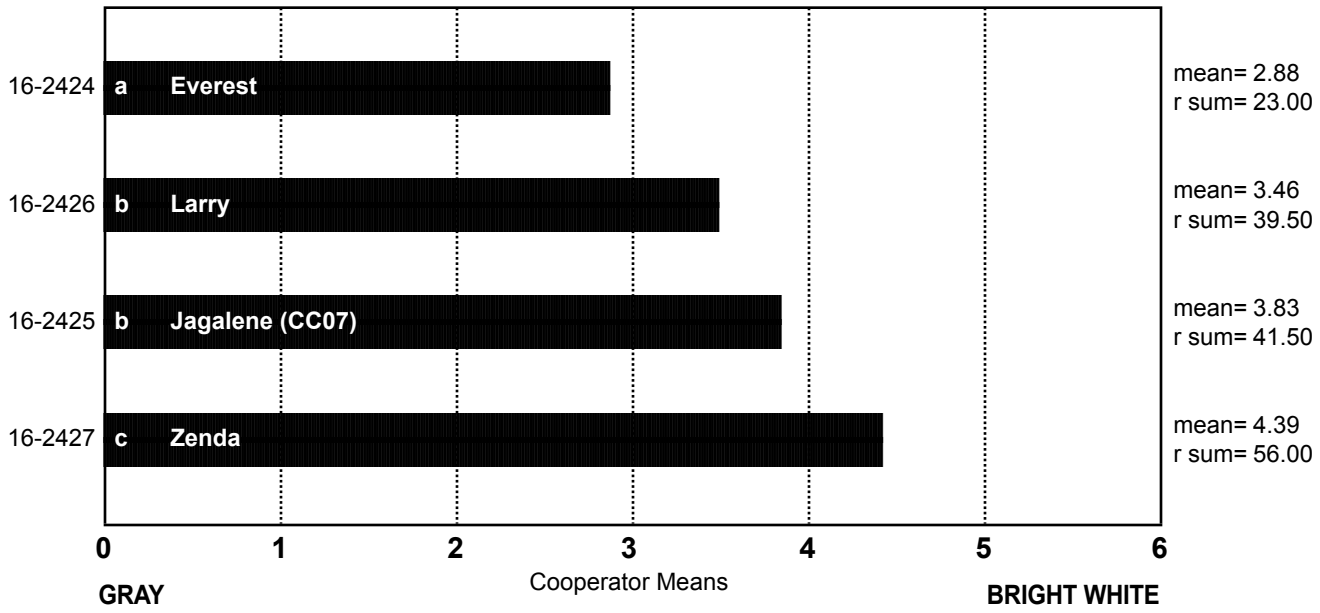
CRUMB COLOR

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 20.53
chisqc= 27.61
cvchisq= 7.82
crdiff= 8.54

Variety order by rank sum.

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



CRUMB COLOR, DESCRIBED

(Small Scale) Kansas-Manhattan

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
16-2424 Everest	**1**	**2**	**3**	**6**	**3**	**1**	**0**
16-2425 Jagalene (CC07)	**1**	**0**	**2**	**2**	**6**	**5**	**0**
16-2426 Larry	**0**	**0**	**5**	**2**	**6**	**3**	**0**
16-2427 Zenda	**0**	**0**	**0**	**2**	**6**	**7**	**1**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Kansas-Manhattan

	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
16-2424 Everest	**142.9**	**466.8**	**461.1**	**149.4**	**133.4**	**133.5**	**417.0**	**143.0**	**136.7**	**489.1**	**140.0**	**149.2**	**437.8**	**146.3**		**140.4**
16-2425 Jagalene (CC07)	**139.5**	**469.5**	**455.7**	**152.6**	**133.3**	**132.5**	**412.0**	**141.9**	**129.9**	**480.7**	**138.5**	**148.9**	**443.9**	**143.4**		**138.0**
16-2426 Larry	**139.6**	**469.7**	**461.9**	**148.8**	**127.2**	**130.0**	**412.0**	**139.7**	**129.9**	**483.5**	**135.5**	**148.6**	**444.9**	**142.8**		**139.9**
16-2427 Zenda	**139.1**	**467.8**	**458.2**	**150.2**	**131.8**	**131.6**	**411.0**	**142.4**	**130.3**	**482.4**	**135.9**	**149.8**	**443.7**	**145.9**		**139.2**

LOAF VOLUME, ACTUAL

(Small Scale) Kansas-Manhattan

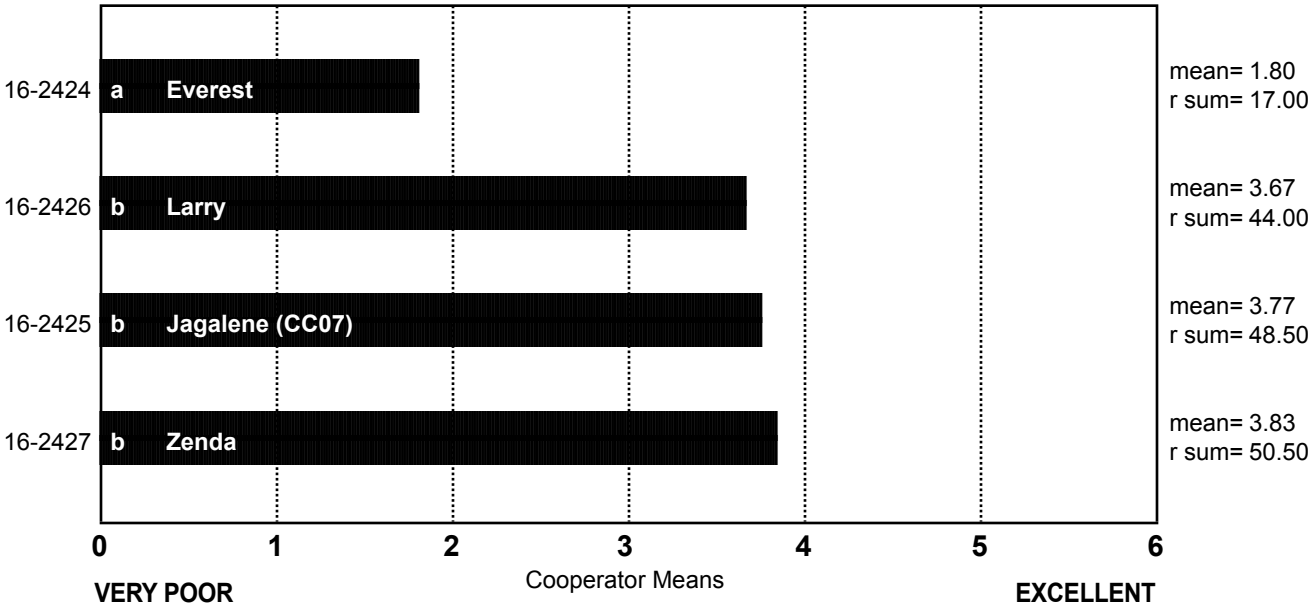
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2424 Everest	**775**	**2425**	**2396**	**793**	**839**	**790**	**2650**	**735**	**633**	**2188**	**695**	**775**	**2450**	**885**	**2809**	**742**
16-2425 Jagalene (CC07)	**1030**	**2475**	**2976**	**860**	**868**	**880**	**3000**	**850**	**855**	**2650**	**860**	**835**	**2500**	**900**	**3045**	**818**
16-2426 Larry	**970**	**2538**	**2818**	**893**	**825**	**870**	**2850**	**800**	**823**	**2513**	**810**	**835**	**2625**	**960**	**2956**	**818**
16-2427 Zenda	**995**	**2513**	**2768**	**913**	**873**	**860**	**2800**	**825**	**820**	**2588**	**865**	**845**	**2625**	**915**	**2927**	**829**

LOAF VOLUME

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 27.28
chisqc= 31.63
cvchisq= 7.82
crdiff= 8.24

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

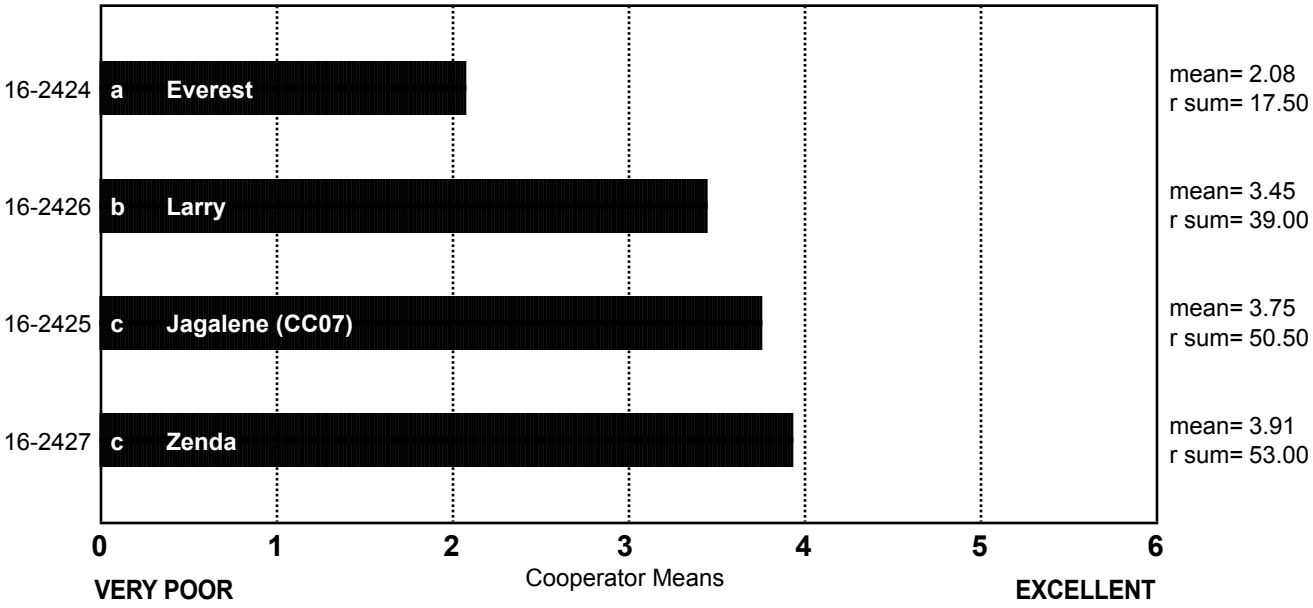


OVERALL BAKING QUALITY

(Small Scale) Kansas-Manhattan

ncoop= 16
chisq= 29.49
chisqc= 31.05
cvchisq= 7.82
crdiff= 8.80

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Kansas-Manhattan

COOP. **16-2424 Everest**

A. No comment.
B. Average absorption, short mix time, low volume, creamy, open.
C. Over mixed, weak stability and sticky while moulding, no volume or crumb color.
D. Short mixing, fairly weak dough, very poor loaf volume and crumb grain.
E. Normal water absorption, short mix time, slight sticky & weak dough, OK volume, dark yellow crumb, open irregular cells, resilient & slightly harsh texture.
F. Not suitable for bread wheat.
G. Soft sponge, sticky dough.
H. Bad at 2nd punch and pan.
I. Weaker dough but not sticky or wet from mix to makeup, little to no oven spring, unacceptable crumb structure and color, thick cell walls, large holes and very harsh texture.
J. Low absorption, very wet dough, open grain, yellow crumb, very low volume.
K. Harsh/poor grain, poor volume and mixograph.
L. Low absorption, short mix time, tough at pan, poor crumb grain, low loaf volume.
M. No comment.
N. Mellow and slightly wet at the bench.
O. Slightly open, variable, slightly course grain, low volume.
P. No comment.

COOP. **16-2425 Jagalene (CC07)**

A. Excellent externals.
B. Low absorption, average mix time, low volume, creamy, open.
C. Small flour sample, only a single dough was made and also the reason for high volume.
D. Good mix time with dough strength somewhat weak, OK volume with weaker crumb grain.
E. Normal water absorption, long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
F. No comment.
G. No comment.
H. Exceeds target loaf volume.
I. No comment.
J. Low absorption, tough dough at makeup, open grain, good volume.
K. Nice crumb.
L. Good absorption and dough tolerance, satisfactory crumb grain.
M. No comment.
N. No comment.
O. Open, consistent, coarse grain, very good volume.
P. No comment.

COOP. **16-2426 Larry**

A. Excellent externals.
B. Low absorption, short mix time, average volume, creamy, open.
C. Sticky out of the mixer, even though high stability.
D. Low protein %, mix time OK, dough strength weaker but promising for protein level, OK bread volume for protein, poor grain.
E. Low water absorption, normal mix time, slight sticky & weak dough, fair volume, yellow crumb, slight open elongated cells, resilient & smooth texture.
F. Low absorption.
G. Soft sponge, sticky dough.
H. Low protein, poor mix tolerance.
I. No comment.
J. Low absorption, good grain, yellow crumb, average volume.
K. Poor absorption, good crumb, OK volume, poor mixograph.
L. Low bake absorption, poor tolerance, questionable-satisfactory crumb grain.
M. Samples 2426 and 2427 were very close, scored 2426 higher with a better mix time and grain score, volume of 2426 was the highest of all the breads.
N. No comment.
O. Slightly open, variable, slightly coarse grain, above average volume.
P. No comment.

COOP. **16-2427 Zenda**

A. Very rough break and shred.
B. Low absorption, average mix time, average volume, creamy, open.
C. One of the best in the set.
D. Low protein %, mix time OK, dough strength weaker but promising for protein level, OK bread volume for protein, poor grain.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, dull crumb, slight open elongated cells, resilient & smooth texture.
F. Average loaf volume but good crumb characteristics.
G. No comment.
H. Lower protein.
I. No comment.
J. Low absorption, sticky wet dough, very fine grain, white crumb, average volume.
K. Good volume for protein.
L. Good mix time, good out of mixer, questionable-satisfactory crumb grain.
M. No comment.
N. No comment.
O. Slightly open, variable, slightly coarse grain, above average volume.
P. No comment.

Notes: **B, G, J, M, N, and O** conducted sponge and dough bake tests

COMMOM CHECK

16-2428	Jagalene (CC01)
16-2429	Jagalene (CC02)
16-2430	Jagalene (CC03)
16-2431	Jagalene (CC04)
16-2432	Jagalene (CC05)
16-2433	Jagalene (CC06)
16-2434	Jagalene (CC07)

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 2016. Seven breeding programs submitted their common checks with their breeding lines for WQC baking evaluation. They were:

16-2403	Jagalene (CC01)	Limagrain
16-2409	Jagalene (CC02)	Kansas-Hays
16-2411	Jagalene (CC03)	Nebraska
16-2414	Jagalene (CC04)	Syngenta (Agripro)
16-2416	Jagalene (CC05)	Monsanto (Westbred)
16-2418	Jagalene (CC06)	Oklahoma
16-2425	Jagalene (CC07)	Kansas-Manhattan

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.	**16-2403**	**16-2409**	**16-2411**	**16-2414**	**16-2416**	**16-2418**	**16-2425**
ID for CC[1] comparison	**16-2428**	**16-2429**	**16-2430**	**16-2431**	**16-2432**	**16-2433**	**16-2434**
Breeding Programs	**Limagrain**	**KS-Hays**	**NE**	**Agripro**	**Westbred**	**OK**	**KS-MHT**
Wheat Protein (14%mb)	10.0	11.6	12.4	14.8	11.4	11.5	12.3
Flour Protein (14%mb)	9.3	10.7	11.4	13.6	10.3	10.5	11.2
Flour Ash (14%mb)	0.60	0.59	0.57	0.49	0.50	0.44	0.58
IPP (%)*	57.4	53.5	55.8	55.5	48.2	50.6	59.9
TPP/TMP*	0.89	1.03	0.92	0.91	0.92	0.97	0.92
Sedimentation (ml 14%mc)	42.4	46.1	52.8	59.8	39.9	50.2	39.8
Mixograph Abs (14%mb)	63.0	63.7	63.8	66.9	59.9	63.1	62.4
Mix Time (min)	5.4	3.1	5.9	4.0	2.1	4.0	5.0
Tolerance	3	2	4	4	2	3	4
Farinograph Abs (14%mb)	62.2	61.5	57.3	62.0	62.6	58.3	58.7
Development time (min)	1.9	5.9	2.8	6.7	4.7	5.8	2.0
Stability (min)	2.1	9.4	9.8	12.6	6.0	11.9	6.9
MTI (FU)	42	28	18	25	32	15	25
Bake Abs (14%mb)+	63.0	63.0	61.8	66.0	62.2	61.5	61.8
Bake Mix Time (min) +	5.0	3.9	5.0	4.2	3.0	4.0	4.8
Loaf Volume (cc) +	775	898	972	968	841	925	886
Crumb Color Rating (0-5) +	2.3	2.1	3.0	4.0	4.0	3.3	3.7
Crumb Grain Rating (0-5) +	2.8	3.9	4.1	4.1	3.7	3.7	3.9
Crumb Texture Rating (0-5) +	3.1	3.3	4.1	4.0	3.4	3.3	3.7

[1] CC = Common Check.

* IPP- Insoluble polymeric protein, 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

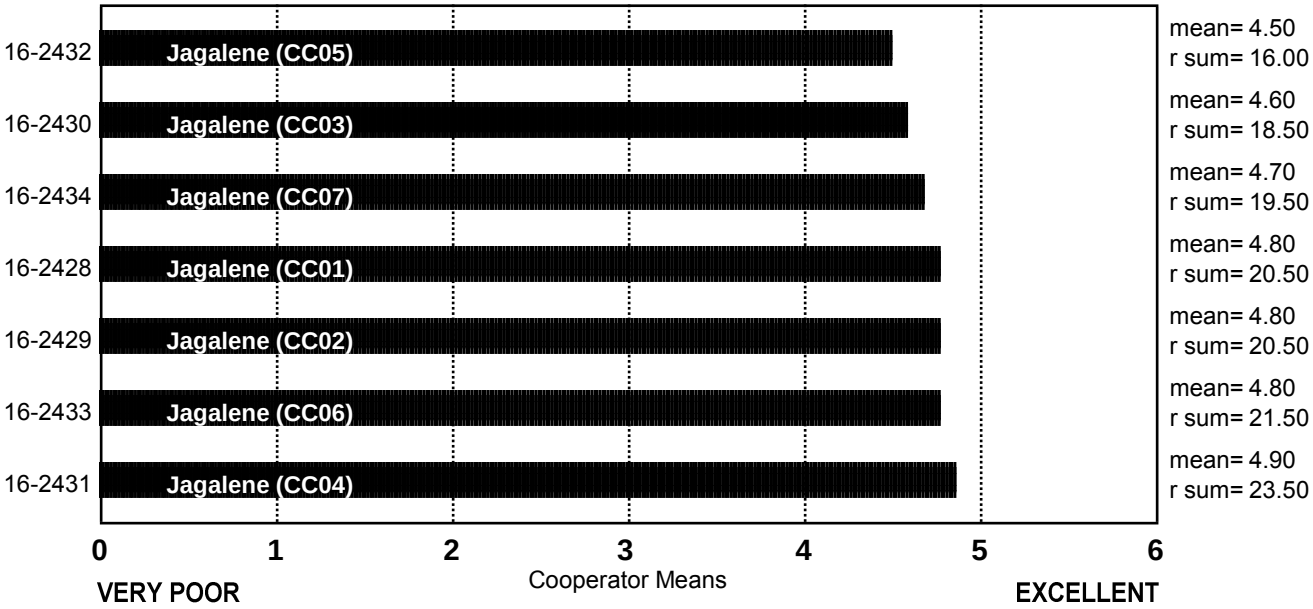
Five of 16 cooperators conducted the sponge-and-dough baking test and didn't find any statistically significant differences in the sponge dough characteristics of the common checks at the 5% level of signficance. However, other baking performance quality characteristics evaluated by the 16 cooperators 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, loaf volume, and overall baking quality. No significant differences were found among crumb grain and crumb texture. Details can be found on the following pages.

SPONGE CHARACTERISTICS

(Small Scale) Common Check

ncoop= 5
chisq= 1.44
chisqc= 2.81
cvchisq= 12.59
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

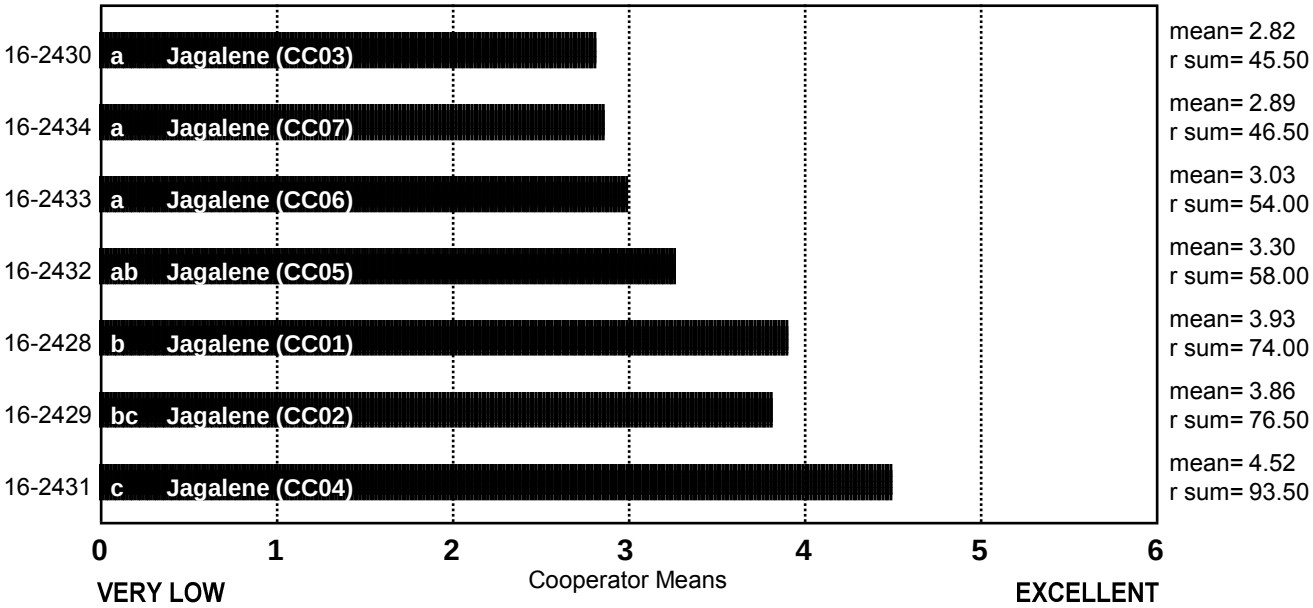


BAKE ABSORPTION

(Small Scale) Common Check

ncoop= 16
chisq= 25.59
chisqc= 30.45
cvchisq= 12.59
crdiff= 19.19

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
16-2428 Jagalene (CC01)	**63.1**	**62.2**	**62.2**	**65.2**	**60.5**	**66.4**	**55.0**	**57.7**	**66.6**	**58.0**	**61.8**	**64.0**	**62.2**	**60.0**	**62.0**	**63.0**
16-2429 Jagalene (CC02)	**62.3**	**61.5**	**61.5**	**64.3**	**62.5**	**66.0**	**57.0**	**59.7**	**65.2**	**59.1**	**61.1**	**62.8**	**61.5**	**60.0**	**61.0**	**63.6**
16-2430 Jagalene (CC03)	**61.8**	**57.3**	**57.3**	**64.5**	**62.3**	**60.9**	**57.0**	**60.8**	**60.5**	**56.8**	**61.5**	**63.7**	**57.3**	**60.0**	**57.0**	**63.7**
16-2431 Jagalene (CC04)	**67.8**	**62.0**	**62.0**	**67.1**	**65.3**	**66.9**	**59.0**	**64.2**	**65.5**	**59.4**	**65.6**	**67.8**	**62.0**	**63.0**	**61.0**	**66.9**
16-2432 Jagalene (CC05)	**58.2**	**62.6**	**62.6**	**64.2**	**61.8**	**66.3**	**56.0**	**59.2**	**65.9**	**58.5**	**59.6**	**62.3**	**62.6**	**60.0**	**61.0**	**59.7**
16-2433 Jagalene (CC06)	**61.4**	**58.3**	**58.3**	**64.1**	**62.0**	**61.3**	**57.0**	**59.8**	**61.6**	**60.4**	**60.5**	**63.2**	**58.3**	**60.0**	**57.0**	**62.9**
16-2434 Jagalene (CC07)	**61.5**	**58.7**	**58.7**	**61.6**	**62.5**	**62.6**	**57.0**	**60.4**	**63.3**	**56.4**	**61.0**	**64.2**	**58.7**	**60.0**	**58.0**	**62.9**

BAKE MIX TIME, ACTUAL

(Small Scale) Common Check

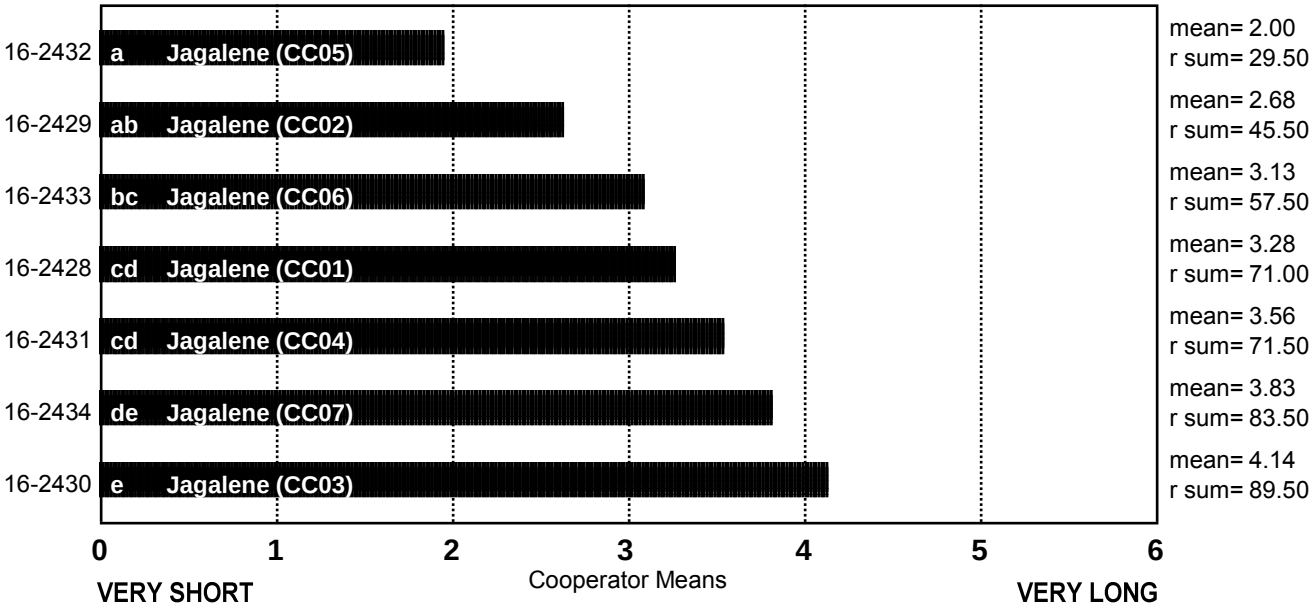
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2428 Jagalene (CC01)	**5.0**	**3.0**	**4.3**	**4.6**	**8.1**	**4.5**	**7.0**	**5.0**	**3.8**	**4.0**	**4.0**	**6.0**	**3.0**	**4.0**	**10.0**	**4.9**
16-2429 Jagalene (CC02)	**3.8**	**6.0**	**7.0**	**3.9**	**5.8**	**3.5**	**5.0**	**4.0**	**3.0**	**4.0**	**3.4**	**4.5**	**3.5**	**3.0**	**8.0**	**3.1**
16-2430 Jagalene (CC03)	**5.0**	**5.0**	**8.0**	**5.2**	**7.8**	**4.5**	**6.0**	**4.5**	**3.8**	**5.0**	**4.0**	**11.0**	**4.5**	**5.0**	**19.0**	**5.1**
16-2431 Jagalene (CC04)	**4.0**	**6.0**	**8.0**	**4.2**	**6.5**	**4.8**	**10.0**	**4.0**	**2.5**	**6.0**	**3.6**	**4.8**	**6.0**	**5.0**	**20.0**	**3.9**
16-2432 Jagalene (CC05)	**3.0**	**4.0**	**5.0**	**3.1**	**3.8**	**3.5**	**5.0**	**3.0**	**2.3**	**4.0**	**2.5**	**3.3**	**3.5**	**3.0**	**8.0**	**2.6**
16-2433 Jagalene (CC06)	**4.3**	**6.0**	**8.0**	**3.9**	**5.8**	**4.0**	**6.0**	**4.0**	**2.5**	**4.0**	**3.4**	**4.6**	**4.0**	**4.0**	**12.0**	**4.0**
16-2434 Jagalene (CC07)	**4.8**	**6.0**	**6.0**	**5.2**	**8.4**	**4.0**	**7.0**	**4.3**	**3.5**	**4.0**	**3.7**	**6.3**	**4.5**	**5.0**	**16.0**	**4.7**

BAKE MIX TIME

(Small Scale) Common Check

ncoop= 16
chisq= 36.30
chisqc= 43.48
cvchisq= 12.59
crdiff= 17.12

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

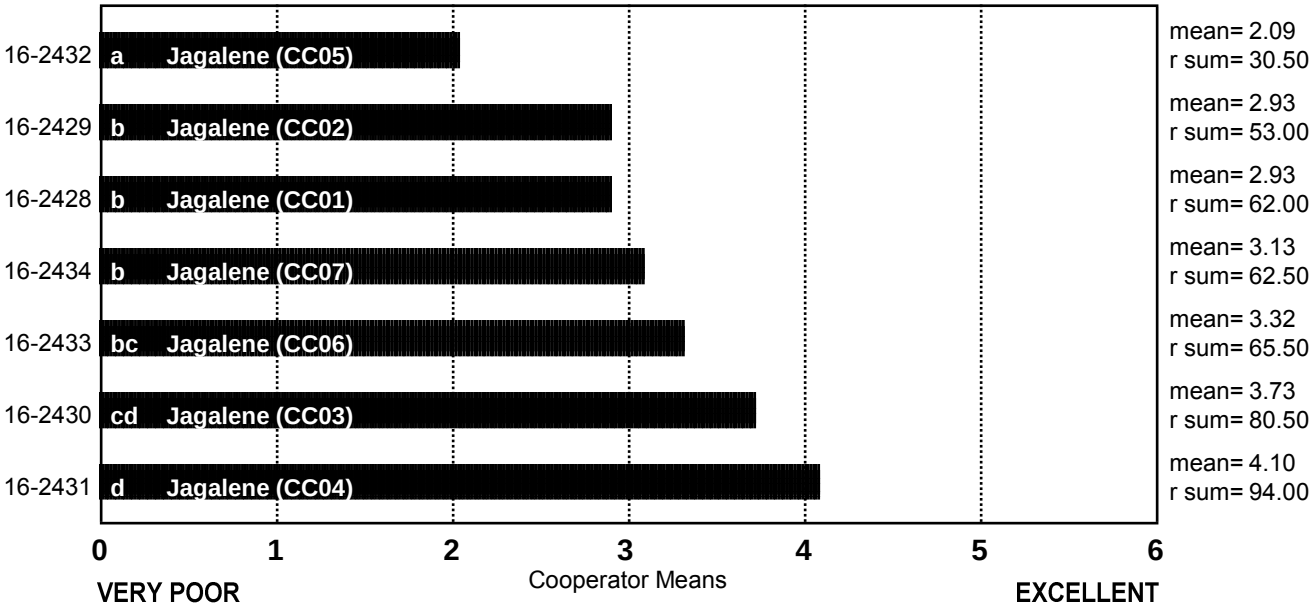


MIXING TOLERANCE

(Small Scale) Common Check

ncoop= 16
chisq= 32.46
chisqc= 39.20
cvchisq= 12.59
crdiff= 17.73

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

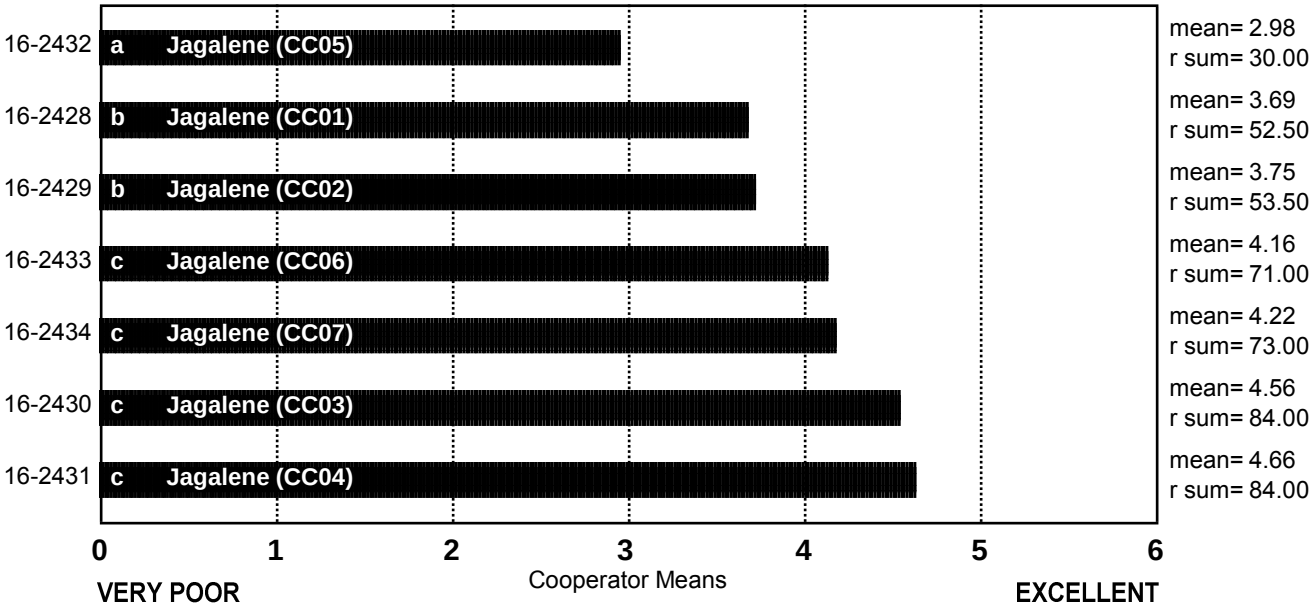


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Common Check

ncoop= 16
chisq= 31.19
chisqc= 39.35
cvchisq= 12.59
crdiff= 17.32

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
16-2428 Jagalene (CC01)	0	1	6	8	1
16-2429 Jagalene (CC02)	1	1	1	12	1
16-2430 Jagalene (CC03)	0	0	1	12	3
16-2431 Jagalene (CC04)	0	0	1	10	5
16-2432 Jagalene (CC05)	4	3	2	6	1
16-2433 Jagalene (CC06)	2	1	1	10	2
16-2434 Jagalene (CC07)	0	0	1	12	3

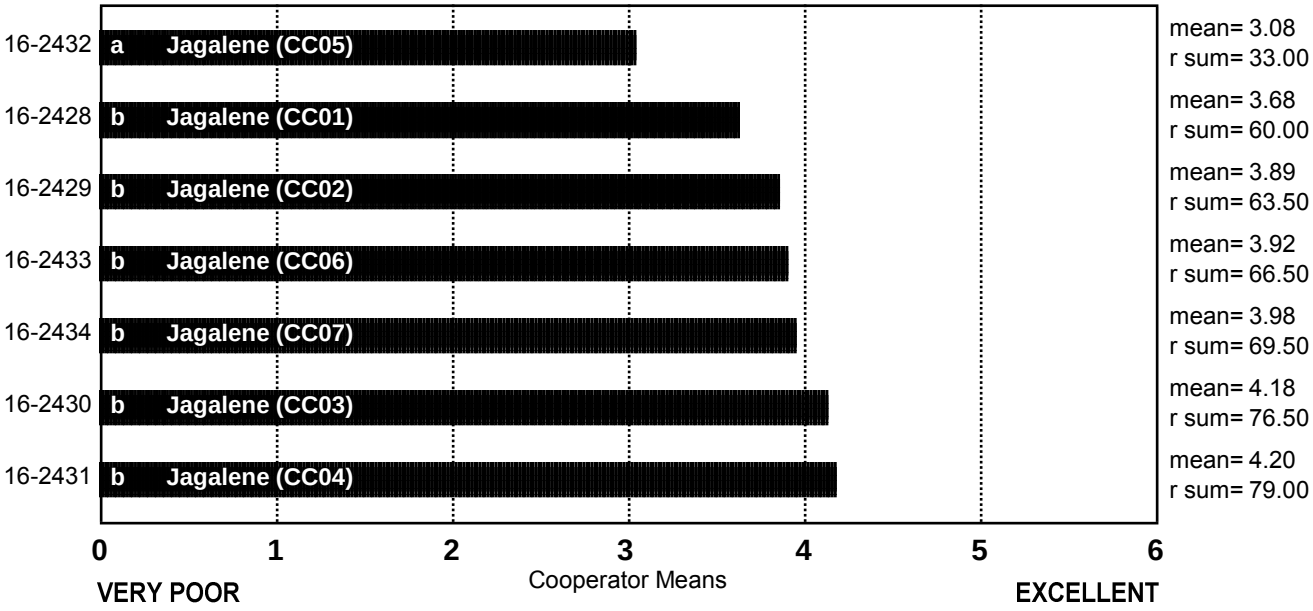
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Common Check

ncoop= 16
chisq= 18.68
chisqc= 24.51
cvchisq= 12.59
crdiff= 19.08

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) Common Check

	Sticky	Wet	Tough	Good	Excellent
16-2428 Jagalene (CC01)	1	0	4	10	1
16-2429 Jagalene (CC02)	1	2	0	12	1
16-2430 Jagalene (CC03)	0	0	4	12	0
16-2431 Jagalene (CC04)	1	0	1	12	2
16-2432 Jagalene (CC05)	6	3	2	5	0
16-2433 Jagalene (CC06)	2	2	0	10	2
16-2434 Jagalene (CC07)	1	0	2	9	4

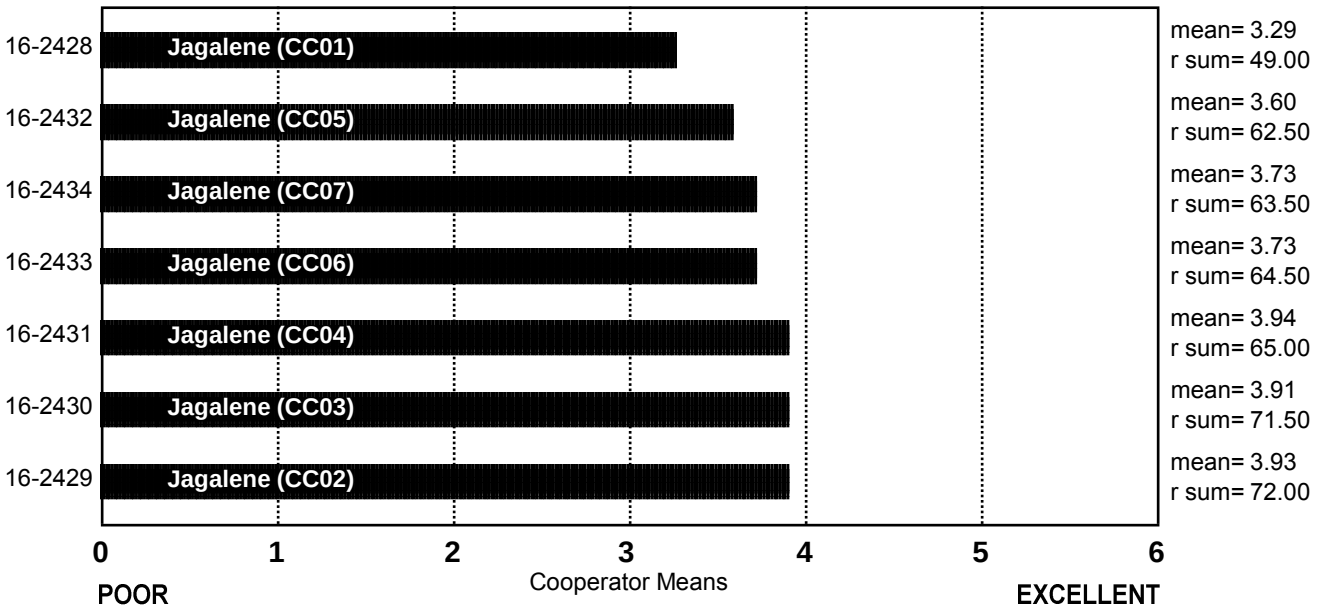
Frequency Table

CRUMB GRAIN

(Small Scale) Common Check

ncoop= 16
chisq= 4.67
chisqc= 5.68
cvchisq= 12.59
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Common Check

	Open	Fine	Dense
16-2428 Jagalene (CC01)	7	6	3
16-2429 Jagalene (CC02)	6	8	2
16-2430 Jagalene (CC03)	7	9	0
16-2431 Jagalene (CC04)	9	7	0
16-2432 Jagalene (CC05)	8	5	3
16-2433 Jagalene (CC06)	10	5	1
16-2434 Jagalene (CC07)	8	6	2

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Common Check

	Round	Irregular	Elongated
16-2428 Jagalene (CC01)	**2**	**8**	**6**
16-2429 Jagalene (CC02)	**2**	**8**	**6**
16-2430 Jagalene (CC03)	**2**	**8**	**6**
16-2431 Jagalene (CC04)	**5**	**6**	**5**
16-2432 Jagalene (CC05)	**4**	**5**	**7**
16-2433 Jagalene (CC06)	**3**	**8**	**5**
16-2434 Jagalene (CC07)	**4**	**5**	**7**

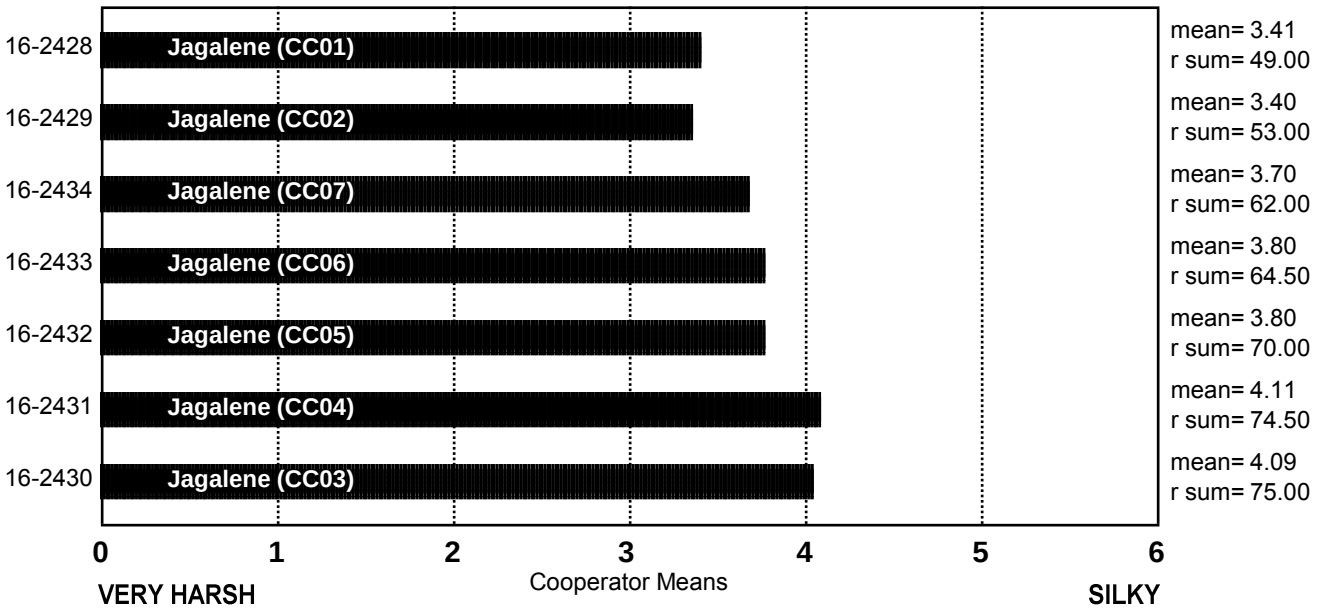
Frequency Table

CRUMB TEXTURE

(Small Scale) Common Check

ncoop= 16
chisq= 8.27
chisqc= 10.28
cvchisq= 12.59
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Common Check

	Harsh	Smooth	Silky
16-2428 Jagalene (CC01)	9	5	2
16-2429 Jagalene (CC02)	6	10	0
16-2430 Jagalene (CC03)	2	12	2
16-2431 Jagalene (CC04)	3	11	2
16-2432 Jagalene (CC05)	3	9	4
16-2433 Jagalene (CC06)	4	11	1
16-2434 Jagalene (CC07)	5	10	1

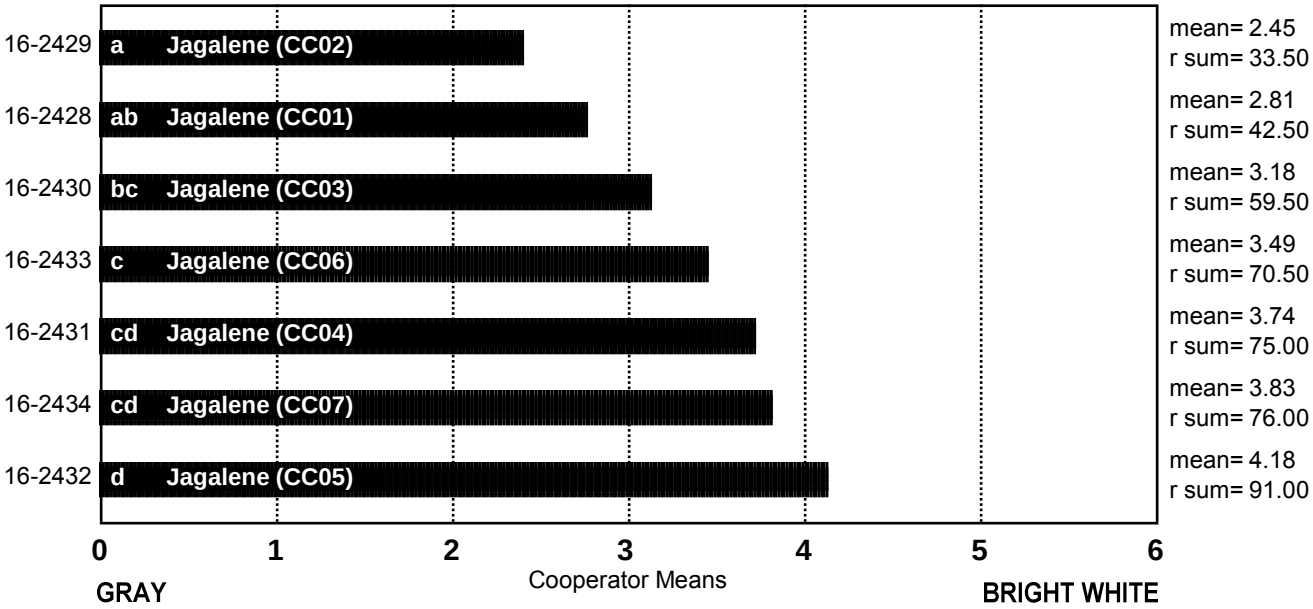
Frequency Table

CRUMB COLOR

(Small Scale) Common Check

ncoop= 16
chisq= 32.80
chisqc= 40.54
cvchisq= 12.59
crdiff= 17.32

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Common Check

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
16-2428 Jagalene (CC01)	**1**	**2**	**4**	**4**	**4**	**1**	**0**
16-2429 Jagalene (CC02)	**1**	**4**	**7**	**1**	**3**	**0**	**0**
16-2430 Jagalene (CC03)	**0**	**0**	**4**	**7**	**3**	**2**	**0**
16-2431 Jagalene (CC04)	**0**	**0**	**5**	**2**	**4**	**4**	**1**
16-2432 Jagalene (CC05)	**0**	**0**	**1**	**2**	**8**	**3**	**1**
16-2433 Jagalene (CC06)	**0**	**0**	**3**	**4**	**7**	**1**	
16-2434 Jagalene (CC07)	**1**	**0**	**2**	**2**	**6**	**5**	**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
16-2428 Jagalene (CC01)	**142.5**	**467.7**	**461.5**	**153.7**	**137.8**	**134.6**	**413.0**	**142.0**	**135.8**	**480.2**	**141.4**	**153.0**	**440.0**	**144.7**		**138.6**
16-2429 Jagalene (CC02)	**142.7**	**460.0**	**462.4**	**153.2**	**136.1**	**134.8**	**410.0**	**135.2**	**133.6**	**474.0**	**137.6**	**149.5**	**446.9**	**146.1**		**137.6**
16-2430 Jagalene (CC03)	**139.4**	**465.7**	**467.6**	**151.4**	**135.9**	**132.8**	**410.0**	**137.8**	**129.4**	**479.6**	**137.4**	**149.3**	**452.1**	**145.6**		**136.6**
16-2431 Jagalene (CC04)	**146.3**	**464.4**	**455.6**	**154.1**	**140.4**	**130.6**	**412.0**	**141.9**	**133.3**	**479.6**	**142.1**	**151.6**	**443.4**	**147.4**		**138.4**
16-2432 Jagalene (CC05)	**142.0**	**466.3**	**454.6**	**153.8**	**134.8**	**132.7**	**414.0**	**140.8**	**133.2**	**479.2**	**139.2**	**149.6**	**437.7**	**146.5**		**138.6**
16-2433 Jagalene (CC06)	**141.8**	**468.7**	**458.2**	**152.4**	**133.9**	**130.9**	**412.0**	**139.7**	**132.4**	**482.2**	**136.8**	**149.1**	**446.0**	**145.9**		**139.9**
16-2434 Jagalene (CC07)	**139.5**	**469.5**	**455.7**	**152.6**	**133.3**	**132.5**	**412.0**	**141.9**	**129.9**	**480.7**	**138.5**	**148.9**	**443.9**	**143.4**		**138.0**

LOAF VOLUME, ACTUAL

(Small Scale) Common Check

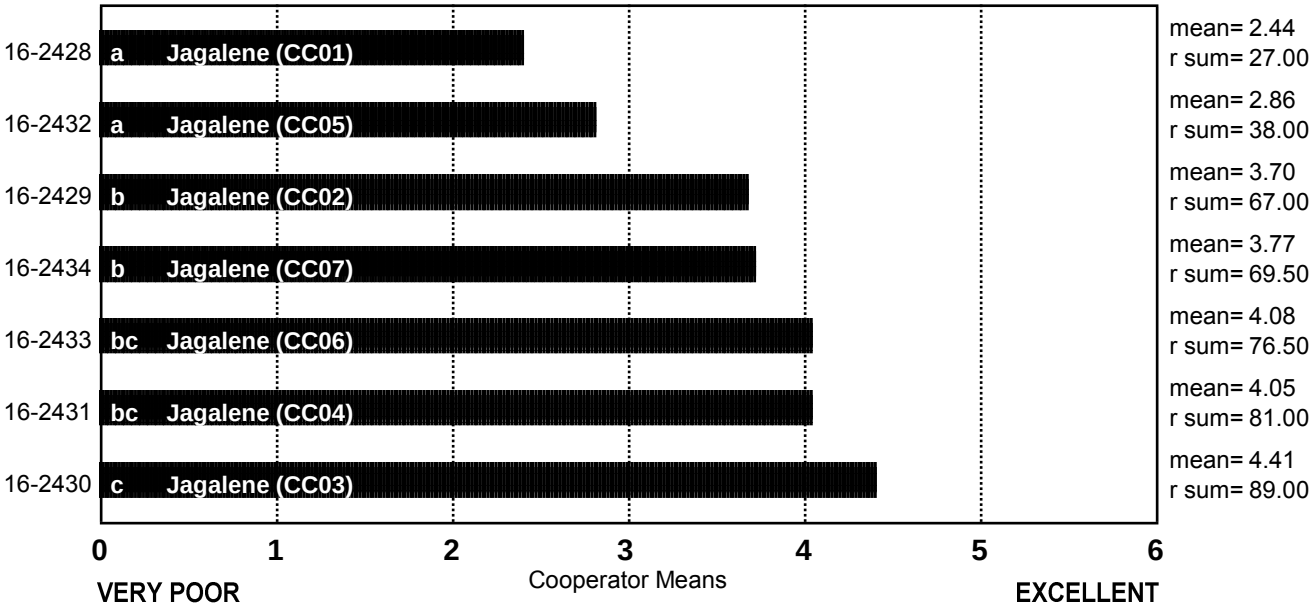
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P
16-2428 Jagalene (CC01)	**840**	**2138**	**2228**	**768**	**773**	**840**	**2700**	**635**	**820**	**2413**	**750**	**705**	**2425**	**840**	**3015**	**744**
16-2429 Jagalene (CC02)	**960**	**2475**	**2415**	**930**	**968**	**885**	**3000**	**835**	**893**	**2663**	**815**	**880**	**2400**	**840**	**3104**	**851**
16-2430 Jagalene (CC03)	**1025**	**2475**	**2601**	**993**	**914**	**1015**	**2925**	**1010**	**900**	**2713**	**950**	**875**	**2475**	**925**	**3074**	**857**
16-2431 Jagalene (CC04)	**1080**	**2363**	**2647**	**1025**	**986**	**925**	**3050**	**965**	**833**	**2650**	**965**	**940**	**2500**	**925**	**3104**	**828**
16-2432 Jagalene (CC05)	**870**	**2275**	**2515**	**918**	**895**	**880**	**2850**	**755**	**805**	**2575**	**765**	**810**	**2450**	**775**	**2897**	**790**
16-2433 Jagalene (CC06)	**1015**	**2413**	**2752**	**998**	**918**	**910**	**3100**	**905**	**795**	**2650**	**935**	**880**	**2450**	**885**	**3104**	**803**
16-2434 Jagalene (CC07)	**1030**	**2475**	**2976**	**860**	**868**	**880**	**3000**	**850**	**855**	**2650**	**860**	**835**	**2500**	**900**	**3045**	**818**

LOAF VOLUME

(Small Scale) Common Check

ncoop= 16
chisq= 42.25
chisqc= 47.92
cvchisq= 12.59
crdiff= 16.83

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

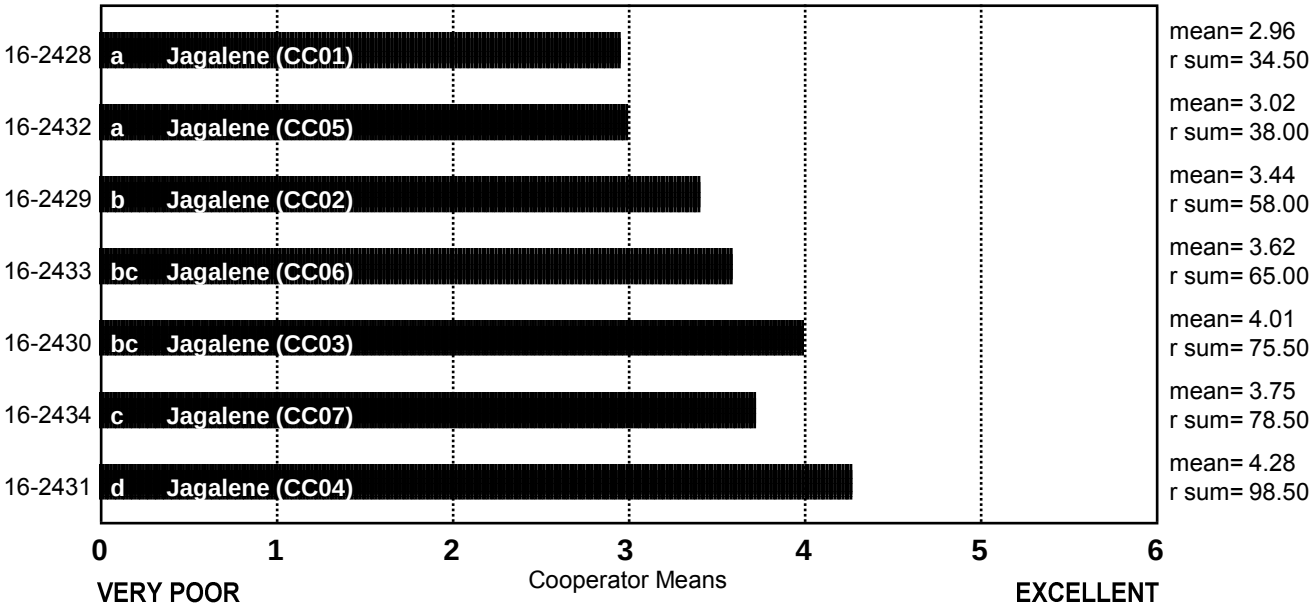


OVERALL BAKING QUALITY

(Small Scale) Common Check

ncoop= 16
chisq= 41.73
chisqc= 44.04
cvchisq= 12.59
crdiff= 18.14

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. **16-2428 Jagalene (CC01)**

A. No comment.
B. Slightly above average absorption, short mix time, very low volume, yellow, open.
C. Very low mix time but did well considering stability, texture issues.
D. Very low protein %, mix time good, dough strength looks promising for protein level, bread volume and grain good for such low protein.
E. Low water absorption, long mix time, slight sticky & weak dough, fair volume, yellow crumb, slight open elongated cells, resilient & slightly harsh texture.
F. No comment.
G. Better volume, low protein.
H. No elasticity, low protein, high ash.
I. Poor color from dough to loaf, large and irregular cells in crumb.
J. Low absorption, tough dough, good grain, low volume.
K. Very poor protein, excellent absorption.
L. Good absorption, long mix time, excellent out of mixer, questionable-satisfactory crumb grain, low loaf volume.
M. No comment.
N. No comment.
O. Tight, consistent, smooth grain, very good volume.
P. No comment.

COOP. **16-2429 Jagalene (CC02)**

A. No comment.
B. Slightly above average absorption, average mix time, low volume, creamy, open.
C. No comment.
D. Low protein %, mix time OK and dough strength looks promising for protein level, good bread volume and grain for protein.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, open elongated cells, resilient & smooth texture.
F. No comment.
G. Best volume of the set.
H. High ash.
I. Very even closed crumb, nice structure, poor color.
J. Average absorption, average grain, dark yellow crumb, good volume.
K. Poor color, good crumb.
L. Good absorption, excellent out of mixer, satisfactory crumb grain.
M. No comment.
N. No comment.
O. Slightly open, consistent, slightly coarse grain, excellent volume.
P. No comment.

COOP. 16-2430 Jagalene (CC03)

A. No comment.
B. Low absorption, short mix time, low volume, creamy, open.
C. Tough while moulding.
D. Good mix time with dough strength somewhat weak for protein level, good bread volume and grain.
E. Normal water absorption, long mix time, slight sticky & strong dough, high volume, dull crumb, slight open elongated cells, resilient & smooth texture.
F. Good loaf volume and crumb but low baking absorption and poor crumb color.
G. Good out of mixer.
H. Exceeds target loaf volume.
I. Nice dough performance, smooth soft dough with good gas production and retention, even closed fine crumb, very nice structure.
J. Low absorption, excellent dough, average grain, yellow crumb, excellent volume.
K. No comment.
L. Long mix time, excellent out of mixer, good crumb grain and loaf volume.
M. No comment.
N. No comment.
O. Slightly open, consistent, slightly coarse grain, excellent volume.
P. No comment.

COOP. 16-2431 Jagalene (CC04)

A. No comment.
B. Slightly above average absorption, average mix time, very low volume, creamy, open.
C. Good moulding.
D. Fairly short mix time with good dough strength, good volume and grain.
E. High water absorption, normal mix time, slight sticky & strong dough, high volume, yellow crumb, open round cells, resilient & slightly harsh texture.
F. Good loaf volume and color but has harsh texture.
G. Higher protein.
H. Exceeds target loaf volume.
I. Even crumb with good cell structure, smooth overall.
J. Average absorption and mix time, excellent dough out of mixer, average grain, yellow crumb, good volume.
K. Excellent protein, very good crumb, slightly lower volume.
L. Good flour protein, good bake absorption, excellent dough during bake, satisfactory crumb grain, good loaf volume.
M. Best bread of the set, excellent mix time and makeup with a great absorption, bread was the highest volume of the set with a fine white grain.
N. Lively at the bench.
O. Slightly open, variable, slightly coarse grain, excellent volume.
P. No comment.

COOP. 16-2432 Jagalene (CC05)

A. No comment.
B. Slightly above average absorption, short mix time, very low volume, creamy, open.
C. Sticky while rounding and moulding.
D. Low protein %, short mixing time, dough strength weak, volume good for protein with poor crumb grain.
E. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, slight open elongated cells, resilient & smooth texture.
F. No comment.
G. Slightly soft dough.
H. Low protein, poor mix tolerance.
I. Weaker dough but not sticky out of mixer, good crumb color, even cells and soft to the touch, overall good.
J. Sticky dough, average grain and volume.
K. Weak.
L. Short mix time, open crumb, low loaf volume.
M. Best bread of the set by a small number, slightly higher absorption and makeup score, bread had the same volume as the other but a dense bright white grain.
N. No comment.
O. Tight, consistent, smooth grain, average volume.
P. No comment.

COOP. 16-2433 Jagalene (CC06)

A. Excellent externals.
B. Low absorption, average mix time, low volume, creamy, open.
C. No comment.
D. Low protein %, mixing time OK and dough strength looks promising for protein level, good bread volume and grain for protein.
E. Normal water absorption and mix time, slight sticky & weak dough, high volume, dull crumb, slight open elongated cells, resilient & smooth texture.
F. No comment.
G. Good out of mixer.
H. Exceeds target loaf volume.
I. Crumb separates when pressed.
J. Good absorption, sticky dough, average grain, yellow crumb, good volume.
K. Good volume for the protein.
L. Good mix time, good dough strength, satisfactory crumb grain.
M. No comment.
N. Mellow and slightly wet at the bench.
O. Slightly open, variable, slightly course grain, excellent volume.
P. No comment.

COOP. 16-2434 Jagalene (CC07)

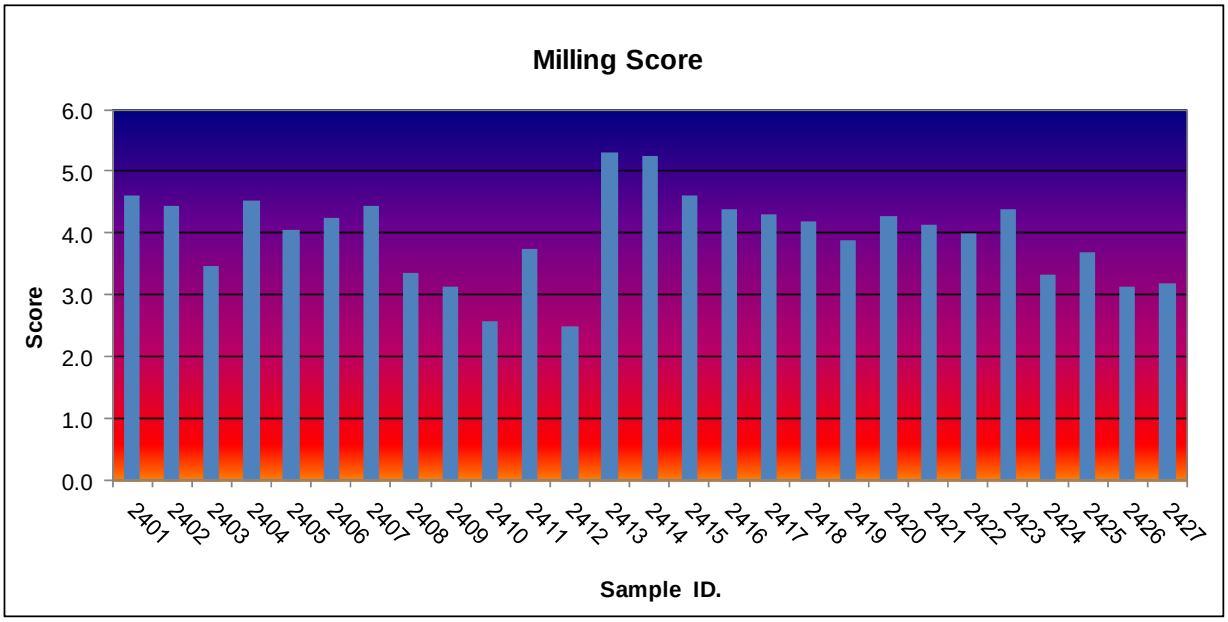
A. Excellent externals.
B. Low absorption, average mix time, low volume, creamy, open.
C. Small flour sample, only a single dough was made and also the reason for high volume.
D. Good mix time with dough strength somewhat weak, OK volume with weaker crumb grain.
E. Normal water absorption, long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
F. No comment.
G. No comment.
H. Exceeds target loaf volume.
I. No comment.
J. Low absorption, tough dough at makeup, open grain, good volume.
K. Nice crumb.
L. Good absorption and dough tolerance, satisfactory crumb grain.
M. No comment.
N. No comment.
O. Open, consistent, coarse grain, very good volume.
P. No comment.

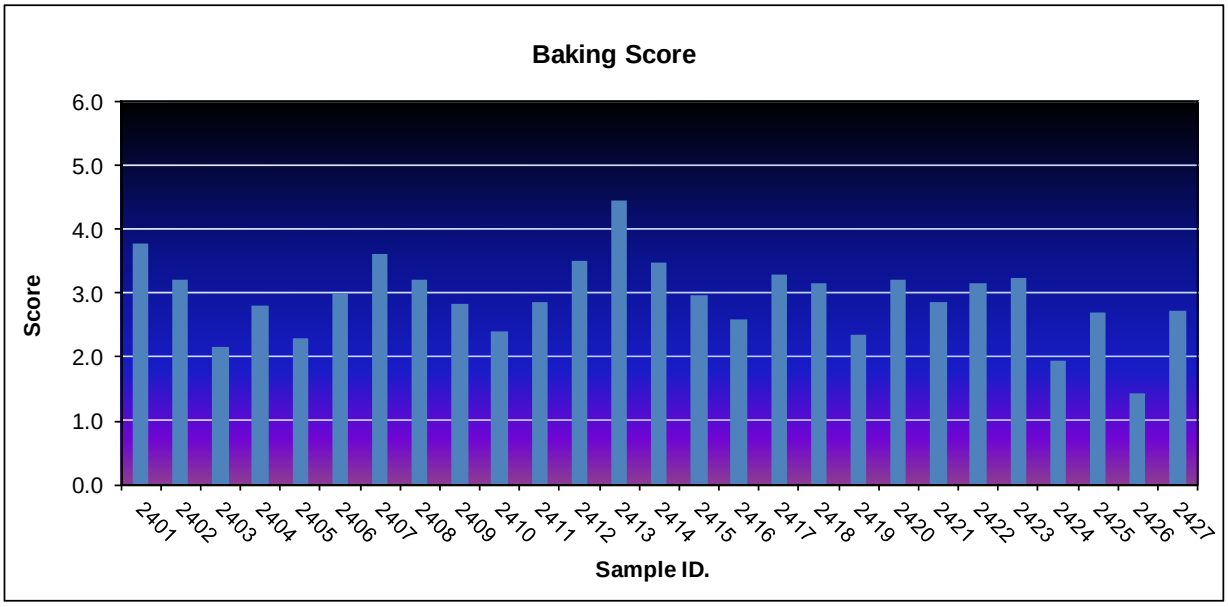
Notes: **B, G, J, M, N, and O** conducted sponge and dough bake tests

2016 WQC Milling and Baking Marketing Scores

2016 WQC Milling & Baking Marketing Scores

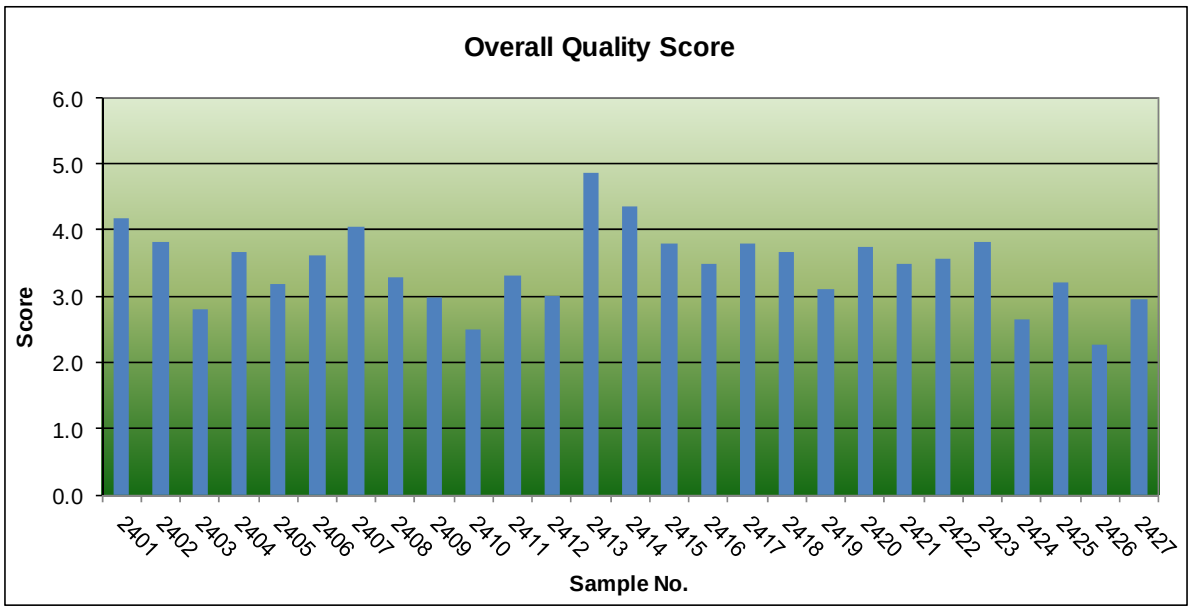
(Based upon HWWQL Quality Data and KSU Milling Data)





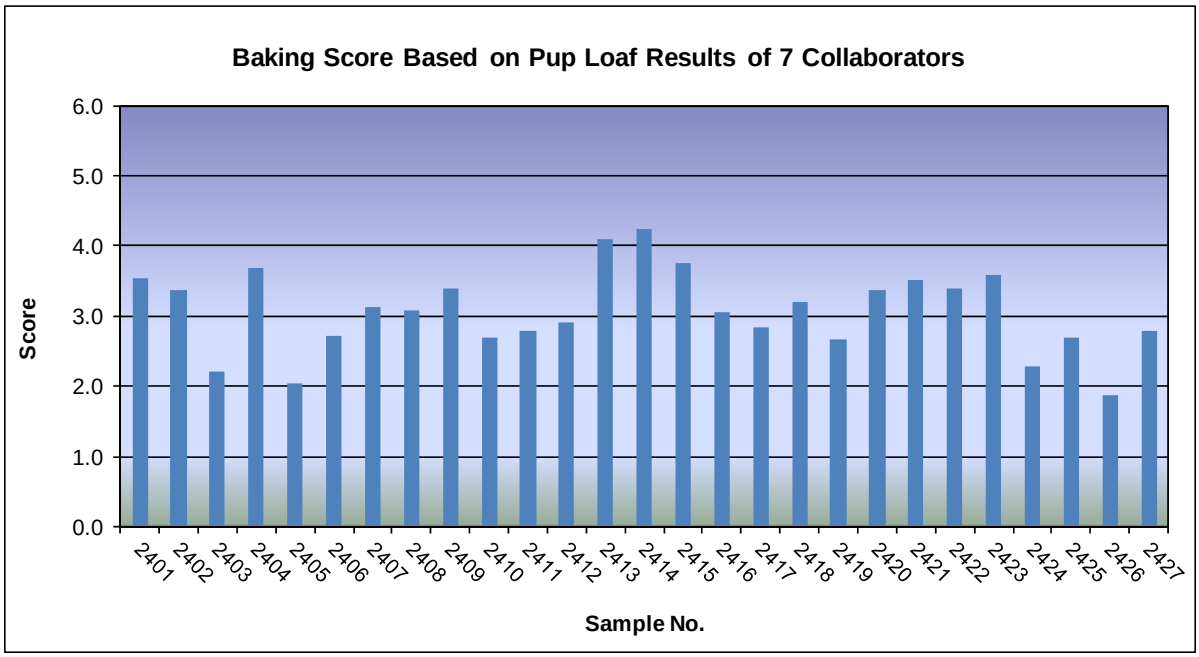
2016 WQC Milling & Baking Marketing Scores

(Based upon HWWQL Quality Data and KSU Milling Data)



2016 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	TW lbs/bu	Kernel Size % Large	Kernel Weight g/1000	Wheat Protein 12%mb	Kernel Hardness NIR	Str Grd Flour Yield %	Wheat Ash 14%mb	Wheat Falling Number 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:	SCORE	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
2016 WQC Hard Winter Wheat Entries

USDA-ARS Hard Winter Wheat Quality Laboratory
1515 College Avenue
Manhattan, KS 66502

Bradford W. Seabourn, **brad.seabourn@ars.usda.gov**
Richard Chen, **richard.chen@ars.usda.gov**

Alkaline Noodle Quality Report

Objectives: Evaluate alkaline noodle color and cooking characteristics.

Materials: 27 WQC hard winter wheat samples harvested in 2016.

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 Na_2CO_3, and 35 mL of water (fixed).

Procedure:

100 g flour ← 1 g Na_2CO_3 + 35 mL Water

↓

Mix at medium speed for 10 min (100 g Micro Mixer-no pins in the bowl, National MFG. Co., Lincoln, NE)

↓

Rest for 30 min in a plastic bag

↓

Plug roll gap with plastic tubing and pour mixed dough

↓

Sheeting: roll gaps 4 (2 x), 3, 2.3, 1.75, 1.35, 1.1 (mm) → Measure color at 0 and 24 hr

↓

Cutting

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^{o}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^{o}C.
   Drying time is about 20 hr.
4. Cool beakers and weigh to 0.01 g.
   For 25 g sample, multiply by 4 → % cooking loss.

Water Uptake:

Water Uptake (%) = (Cooked noodle weight-Raw noodle weight)/Raw noodle weight x 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 x cohesiveness x 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***: 2405 (83.93), 2406(83.11), 2416 (80.00)

Noodle Color (*L* value, Higher is better.) ***at 24 hr***: 2405 (74.68), 2406 (72.16), 2421 (69.72)

Delta L (Change of *L* value, Lower absolute value is better.)
2405 (-9.24), 2421 (-9.44), 2412 (-9.74)

PPO (Lower is better.): 2421 (0.138), 2412 (0.303), 2406 (0.322)

Table II shows the following:

Hardness: 2422(2.909), 2423 (2.684), 2426 (2.666)

Springiness: 2404 (0.913), 2421 (0.909), 2420 (0.906)

Chewiness: 2422 (1.615), 2413 (1.610), 2414 (1.600)

Resilience: 2404 (0.437), 2420 (0.436), 2414 (0.433)

Cohesiveness: 2404 (0.694), 2413 (0.694), 2414 (0.693)

Water Uptake: 2427 (92.76), 2422 (92.68), 2420 (92.36)

Cooking Loss: 2420 (6.12), 2413 (6.20), 2419 (6.48)

Discussion

Sample 2406 had the second highest L-value (brightness) at both 0 and 24 hrs, and had the third lowest PPO value. This sample also had relatively high springiness and hardness in texture after cooking. Bright noodle color 24 hr after production and a firmer texture following cooking are

considered desirable characteristics for alkaline noodles. Thus, sample 2406 would be considered the most favorable variety overall for alkaline noodle quality.

Sample 2405 had the highest L-value (brightness) at both 0 and 24 hrs, and had the lowest delta *L**. This sample also had the lowest hardness, and had relatively higher resilience and cohesiveness after cooking. Therefore, sample 2405 would be a good noodle flour for white salted noodles (Japanese Udon-type), which are preferred to have a bright, creamy white color, and smooth, soft texture.

Sample 2421 had the third highest L-value (brightness) at 24 hrs, the second lowest delta *L** and the lowest PPO value*. This sample also had second highest springiness after cooking.

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	77.04	64.10	-1.15	1.30	23.70	25.35	-12.94	2.45	1.65	0.361
2402	77.19	63.59	-0.88	1.50	22.47	25.52	-13.60	2.38	3.05	0.423
2403	78.83	66.86	-1.59	0.61	23.42	27.29	-11.97	2.20	3.87	0.366
2404	78.38	64.74	-1.10	1.12	22.05	26.59	-13.64	2.22	4.54	0.426
2405	83.93	74.68	-2.14	-0.97	20.11	23.39	-9.24	1.17	3.28	0.395
2406	83.11	72.16	-2.29	-1.10	20.25	25.82	-10.95	1.20	5.57	0.322
2407	79.73	68.55	-1.60	0.41	22.30	26.83	-11.18	2.01	4.54	0.493
2408	79.10	67.11	-1.74	0.72	24.18	27.95	-11.99	2.46	3.77	0.522
2409	78.22	65.55	-1.72	0.76	25.65	28.55	-12.67	2.48	2.90	0.413
2410	76.10	65.06	-1.76	1.03	25.99	26.36	-11.04	2.79	0.38	0.670
2411	75.78	64.56	-1.36	0.82	24.56	26.40	-11.22	2.18	1.85	0.473
2412	78.97	69.23	-1.78	-0.32	22.36	26.65	-9.74	1.47	4.29	0.303
2413	74.95	64.63	-0.96	1.12	26.24	26.87	-10.32	2.08	0.63	0.426
2414	78.86	67.06	-1.33	0.35	22.95	26.71	-11.80	1.68	3.76	0.392
2415	78.41	66.21	-1.33	0.55	23.70	26.76	-12.20	1.87	3.07	0.526
2416	80.00	68.78	-2.22	-0.16	23.26	25.34	-11.22	2.06	2.09	0.339
2417	79.60	67.48	-2.25	-0.01	24.42	25.05	-12.12	2.24	0.63	0.417
2418	79.61	68.48	-1.89	-0.31	21.88	26.72	-11.13	1.59	4.84	0.481
2419	78.69	68.42	-1.71	0.08	21.74	26.02	-10.27	1.79	4.29	0.520
2420	78.24	67.94	-1.75	-0.21	21.88	25.54	-10.30	1.54	3.66	0.455
2421	79.15	69.72	-1.72	-0.66	19.84	25.58	-9.44	1.06	5.74	0.138
2422	75.90	65.37	-1.36	0.72	22.26	25.68	-10.54	2.08	3.42	0.447
2423	76.40	64.80	-1.39	0.93	22.48	25.94	-11.60	2.32	3.47	0.517
2424	76.46	64.46	-1.45	0.79	22.62	25.84	-12.00	2.24	3.22	0.515
2425	77.16	64.87	-1.44	0.62	22.37	25.74	-12.29	2.06	3.37	0.553
2426	78.82	67.33	-1.67	0.03	21.76	25.78	-11.49	1.70	4.02	0.702
2427	77.39	65.13	-1.41	0.49	20.69	24.62	-12.26	1.90	3.93	0.709
Avg	78.37	66.92	-1.59	0.38	22.78	26.10	-11.45	1.97	3.32	0.455

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	0.906	2.359	1.438	0.424	0.673	84.00	7.20
2402	0.899	2.546	1.529	0.408	0.668	82.88	7.68
2403	0.896	2.164	1.251	0.380	0.645	85.72	8.48
2404	0.913	2.422	1.534	0.437	0.694	87.72	6.96
2405	0.900	2.154	1.305	0.421	0.673	81.24	9.64
2406	0.896	2.461	1.435	0.409	0.651	89.32	8.52
2407	0.895	2.504	1.474	0.424	0.658	91.60	7.76
2408	0.879	2.498	1.397	0.380	0.637	89.28	8.24
2409	0.896	2.488	1.462	0.385	0.656	90.92	7.36
2410	0.839	2.445	1.251	0.344	0.610	91.20	6.96
2411	0.884	2.671	1.501	0.367	0.636	89.08	7.08
2412	0.831	2.647	1.419	0.382	0.645	88.72	6.84
2413	0.891	2.606	1.610	0.432	0.694	86.68	6.20
2414	0.888	2.601	1.600	0.433	0.693	83.96	6.68
2415	0.878	2.555	1.504	0.420	0.670	81.36	7.60
2416	0.904	2.387	1.423	0.400	0.660	85.24	8.04
2417	0.906	2.549	1.501	0.394	0.650	85.28	7.80
2418	0.885	2.562	1.493	0.403	0.658	87.52	7.32
2419	0.899	2.614	1.548	0.400	0.659	84.92	6.48
2420	0.906	2.578	1.577	0.436	0.675	92.36	6.12
2421	0.909	2.639	1.598	0.405	0.667	89.00	6.76
2422	0.888	2.909	1.615	0.362	0.625	92.68	7.64
2423	0.877	2.684	1.554	0.397	0.660	84.80	7.28
2424	0.828	2.593	1.304	0.333	0.606	86.96	7.56
2425	0.870	2.525	1.419	0.389	0.646	88.72	7.60
2426	0.835	2.666	1.340	0.351	0.602	81.20	9.52
2427	0.859	2.469	1.324	0.355	0.624	92.76	7.76
Avg	0.884	2.529	1.459	0.395	0.653	87.23	7.52

TORTILLA BAKING TEST of 2016 WQC SAMPLES

Audrey L. Girard and Joseph M. Awika
Cereal Quality Lab, Department of Soil and Crop Sciences
Texas A&M University, College Station, TX
(December 2016)

Introduction

Flour tortillas continue to expand into the mainstream of consumers' eating habits. For example, breakfast burritos are continuing to increase in popularity as a portable convenience food that can be consumed on the drive to work.

The quality of the tortilla used for encasing fillings is of major importance. A tortilla must not crack or break and create a mess. In many cases, people use tortilla wraps instead of bread because the hot-press type of tortilla resists moisture uptake, and the wrap can be eaten without worrying about crumbs.

This report includes information on the procedure for production and evaluation as well as data of the 2016 WQC samples. At the end of the report are general observations on the relationship between flour properties and tortilla quality. Note that this data analysis was completed over 12 days (~2 weeks).

Procedures to Produce and Evaluate Wheat Flour Tortillas Using a Commercial Hot Press Baking Procedure

Tortilla Formulation

Ingredients	Amount
Wheat flour	100%
Doh-Tone 2	0.4%
Salt	1.5%
Sodium Propionate	0.4%
Potassium Sorbate	0.6%
All-purpose Shortening	6.0%
Sodium Bicarbonate	0.6%
Fumaric Acid - encapsulated	0.33%
Sodium Aluminum Phosphate	0.58%

Tortilla Processing

MIX

Dry ingredients - 1 min, low speed, paddle
Add shortening - 3 min, low speed, paddle
Add water (35°C) + dissolved Doh-Tone 2 - 1 min, low speed, hook, then mix at variable time at medium speed.

↓

PROOF
5 min, 32°C, 70% RH

← Subjective Dough Evaluation

↓

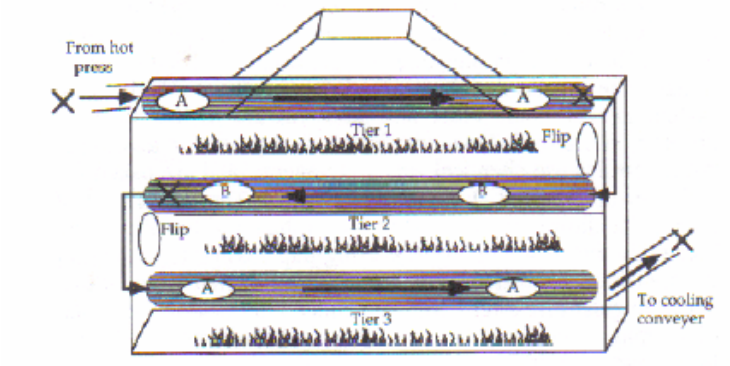
DIVIDE and ROUND
Obtain 43-g dough balls

↓

PROOF
10 min, 32°C, 70% RH

Top and bottom of press platen = 395°F; pressure = 1100 psi; press time = 1.4 sec

HOT-PRESS



Oven temperature = 390°F; baking time = 30 sec

BAKE

COOL and PACKAGE

Cool tortillas on cooling conveyor and on a clean table, then package in low density polyethylene bags.

Subjective Dough Evaluation

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

Smoothness refers to the appearance and texture of the dough surface and gives an idea how cohesive the dough is.
Softness refers to the viscosity or firmness of the dough when compressed. It is obtained by pressing the dough with the fingers.
Force to extend refers to the elasticity of the dough when pulled apart. It is obtained by pulling the dough at the same point where softness is ranked.
Extensibility refers to the length the dough extends when pulled apart. It is obtained by pulling the dough.
Press rating refers to the force required to press the dough on the stainless steel round plate before dividing and rounding.

Scales:	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

First day after processing, tortillas are evaluated for weight, diameter, and thickness.

1. Weight
Ten tortillas are weighed on an analytical balance. The weight of one tortilla is calculated by dividing total weight by 10. These ranged from 38 to 44 g.

2. Diameter
Ten tortillas are measured by using a ruler at two points across the tortilla: the larger diameter and the smaller diameter. Values from measurements of ten tortillas are averaged. This varies widely among wheat samples depending on flour quality; desired values are> 165 mm.

3. Thickness
Ten tortillas are stacked and a digital caliper is used to measure their height. The thickness of one tortilla is calculated by dividing the height of the stack by 10. These ranged from 2.2 to 3.8 mm.

4. Moisture
Moisture is determined using a two-stage procedure (AACC, Method 44-15A, 2000). These ranged from 19 to 37%.

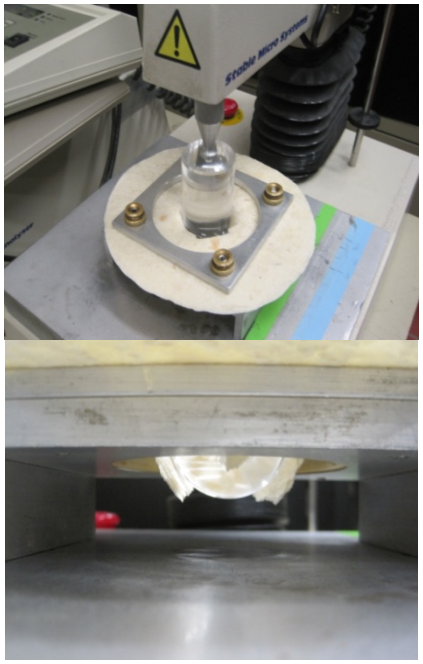
5. Color Values
The color values of lightness (L*), +a* (redness and greenness) and +b* (yellowness and blueness) of tortillas are determined using a handheld colorimeter (model CR-300, Minolta Camera Co., Ltd., Chuo-Ku, Osaka, Japan). L*-values correlate with opacity and are usually greater than 80.

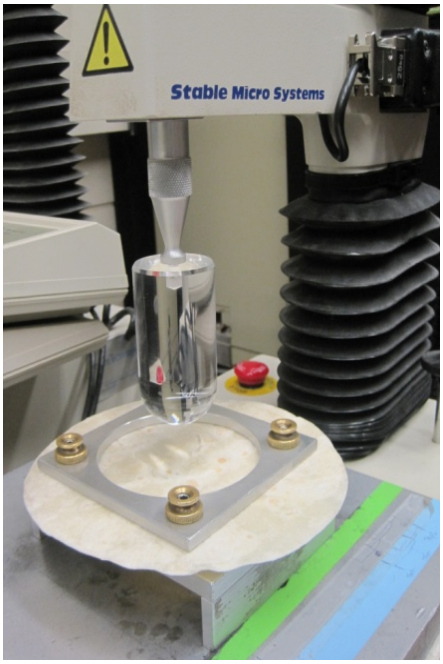
6. Specific Volume
Specific volume (cm^3/g) is calculated: $= \pi * (Diameter/2)^2 * height * 1000/ weight$. This corresponds to fluffiness of the tortilla; desired value is > 1.5 cm^3/g.

7. Tortilla Rollability Score
Two tortillas are evaluated on 1, 8, and 12 days of storage by wrapping a tortilla around a dowel (1.0 cm diameter). The cracking and breakage of the tortilla is 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 measures shelf-stability, and the desired value is >3 on the 12^{th} day.

8. Objective rheological test

Extensibility of two tortillas is measured on 1, 8 and 12 days of storage using a texture analyzer (model TA XT2, Texture Technologies Corp., Scarsdale, NY/Stable Micro Systems, Godalming, Surrey, UK). The tortilla is mounted on the circular frame and a rounded nose probe (The TA-33: 1.5 inch diameter, 3 inch tall rounded end acrylic probe) pushes into the tortilla during the test. Deformation modulus, force, work and distance required to rupture are measured.





WHEAT QUALITY COUNCIL - 2016 DATA WORKSHEET

COOPERATOR NAME:	Audrey L. Girard, J.M. Awika
COOOPERATOR TYPE: MILLER, BAKER, QUALITY LAB	University, Quality Lab
MIXING TOLERANCE METHOD: FARINOGRAPH, MIXOGRAPH, MIXING SERIES, OTHER	
BAKE TEST METHOD: STRAIGHT DOUGH, SPONGE & DOUGH, OTHER	Tortilla Bake Test
DOUGH WEIGHT:	43 gram
Resting TIME:	10 min
Hot-Press Temp (top/bottom):	395 / 395 F
Hot-Press Time:	1.40 sec
Hot-Press Pressure:	1100 psi
OVEN TEMPERATURE:	390 F
BAKE TIME:	30 sec

Special note: The data presented in this report is based on one replication of tortilla processing.

Table 1. Water absorption, mixing time, and subjectively evaluated dough properties.

TEST No.	*Dough Absorp** %	*Mix time at medium* (min)	*Dough Temp* (^{o}C)	*Smooth-ness* (Rating)	*Soft-ness* (Rating)	*Extensi-bility* (Rating)	*Force to Extend* (Rating)	*Press Rating* (Rating)
Tortilla Ref.	52.0	10:00	21.1	2.0	2.0	3.0	2.0	2.0
2401	54.9	9:30	21.5	2.0	2.0	3.0	2.0	2.0
2402	54.8	9:30	22.3	2.0	2.0	3.0	2.0	2.0
2403	52.4	11:00	22.0	2.0	2.0	3.0	3.0	2.0
2404	54.8	11:00	22.3	2.0	2.0	3.0	3.0	2.0
2405	56.6	10:00	21.3	2.0	2.0	3.0	3.0	2.0
2406	52.0	9:00	21.6	2.0	2.0	3.0	2.0	2.0
2407	51.2	10:00	21.9	2.0	2.0	3.0	2.0	2.0
2408	51.3	8:00	21.2	2.0	2.0	3.0	2.0	2.0
2409	52.4	10:00	21.9	2.0	2.0	3.0	2.0	2.0
2410	46.4	10:00	21.8	2.0	2.0	3.0	2.0	2.0
2411	47.8	12:00	21.3	2.0	3.0	2.0	4.0	3.0
2412	48.1	12:00	21.5	4.0	3.0	4.0	3.0	3.0
2413	49.7	9:00	23.4	2.0	2.0	3.0	4.0	2.0
2414	52.5	9:00	22.1	2.0	2.0	3.0	3.0	2.0
2415	54.5	10:00	22.0	3.0	2.0	2.0	2.0	2.0
2416	53.0	8:00	22.5	2.0	2.0	3.0	2.0	2.0
2417	50.0	8:00	21.3	3.0	3.0	2.0	3.0	3.0
2418	48.9	9:00	22.6	3.0	3.0	2.0	3.0	2.0
2419	47.3	9:00	22.5	3.0	3.0	2.0	3.0	3.0
2420	51.5	10:00	22.8	2.0	2.0	3.0	3.0	2.0
2421	52.9	11:00	21.5	3.0	3.0	2.0	3.0	3.0
2422	51.3	9:00	20.5	3.0	3.0	2.0	3.0	3.0
2423	51.4	8:00	23.2	2.0	2.0	3.0	2.0	2.0
2424	50.4	8:00	21.8	2.0	2.0	3.0	2.0	2.0
2425	49.2	11:00	22.3	2.0	2.0	3.0	2.0	2.0
2426	46.4	10:00	22.3	2.0	2.0	3.0	2.0	2.0
2427	48.6	8:00	22.6	2.0	2.0	3.0	2.0	2.0
Descriptors or Scale	record actual absorption		record actual	*from* 1 = satin smooth *to* 5 = very rough	*from* 1 = very soft *to* 5 = very hard	*from* 1 = breaks immediately *to* 5 = extends readily	*from* 1 = less force *to* 5 = extreme force	*from* 1 = less force *to* 5 = extreme force

*Tortilla dough water absorption was the percent absorption from Farinograph analysis minus 10 units, e.g., if Farinograph absorption was 61% then the tortilla dough absorption was 51%.

** Dough was mixed at medium speed at variable mixing times which were adjusted to ensure complete gluten formation.

Overall the doughs were quite soft, easy to process, and readily extended. All samples trended toward the middle of the subjective scale: none of the samples were extreme. Samples 2411, 2412, 2413, 2417, 2419, 2421, and 2422 required the most force to flatten and to press on the stainless steel plate, but they were not overly hard.

Table 2. Physical properties of tortillas.

TEST No.	Moisture	Weight	Thickness	Diameter	Sp. Volume	Lightness*
	%	g	mm	mm	cm^3/g	L-value
Tortilla Ref.	28.3	43.1	2.64	173	1.4	87.5
2401	18.9	38.8	2.64	180	1.7	86.7
2402	37.1	39.2	2.91	179	1.9	86.6
2403	27.3	39.0	2.67	174	1.6	87.0
2404	29.5	39.1	2.45	176	1.5	87.0
2405	27.7	38.2	2.51	182	1.7	88.0
2406	28.2	39.2	2.19	181	1.4	90.3
2407	28.5	39.5	2.68	172	1.6	87.5
2408	28.1	38.0	2.67	175	1.7	86.6
2409	26.8	39.7	2.55	175	1.5	85.5
2410	26.2	39.4	3.78	155	1.8	85.2
2411	27.7	40.3	3.32	154	1.5	84.8
2412	28.4	40.5	3.64	132	1.2	84.8
2413	27.2	39.8	2.82	167	1.6	86.2
2414	29.8	39.9	2.58	170	1.5	85.6
2415	29.2	39.1	3.05	172	1.8	86.4
2416	28.7	38.4	2.76	184	1.9	86.8
2417	26.3	39.0	2.81	181	1.9	87.3
2418	27.3	40.1	3.30	167	1.8	85.9
2419	28.7	40.8	3.13	150	1.4	86.1
2420	29.3	40.1	2.58	175	1.5	85.0
2421	29.9	39.8	2.84	168	1.6	84.1
2422	27.9	40.5	3.09	169	1.7	84.4
2423	27.9	39.9	2.80	172	1.6	85.2
2424	28.5	39.7	2.52	181	1.6	85.5
2425	27.4	40.6	2.98	169	1.7	85.1
2426	30.0	41.0	2.86	169	1.6	85.8
2427	26.4	40.4	2.96	169	1.7	85.7
Descriptors or Scale	Calculate using two-step method	Record actual weight	Record actual thickness	Record actual diameter	Calculate as = $p(radius)^2$ *thickness *1000/wt	Record actual L-value; 0 = black to 100 = white

*L-value measured from twice-baked side of tortilla

Most tortillas had good diameter (at least 170 mm). Samples with ≥170 mm tortilla diameter had lightness scores ≥85 and ≥1.4 cm^3/g specific volume indicating that the dough discs did not shrink back during hot-pressing. Samples 2413, 2418, 2421, 2422, 2425, 2426, and 2427 ranged from 160-169 mm, which is fair quality. Generally, smaller diameter tortillas (<160 mm) had lower specific volume and were less fluffy, darker, and dense. This was especially true with sample 2412, which had a much smaller diameter (132 mm).

Table 3. Texture profile of tortillas measured 1 and 12 days after processing.

TEST No.	*Force day 1*	*Distance day 1*	*Work day 1*	*Force day 12*	*Distance day 12*	*Work day 12*
	(N)	(mm)	(N.mm)	(N)	(mm)	(N.mm)
Tortilla Ref.	10.1	18.6	187	6.2	16.9	105
2401	10.6	18.1	192	6.8	16.2	110
2402	10.1	18.0	180	7.1	17.3	122
2403	9.6	14.6	141	6.5	15.0	98
2404	13.4	21.4	286	8.7	19.4	168
2405	9.5	17.4	165	6.1	16.1	97
2406	9.8	16.6	162	6.1	15.0	91
2407	7.0	12.7	88	6.7	14.5	97
2408	6.4	12.4	79	5.1	14.2	72
2409	8.2	14.3	117	7.3	16.7	122
2410	9.3	15.7	146	6.3	16.1	102
2411	13.9	18.0	251	8.8	17.6	155
2412	9.0	17.6	159	16.2	29.0	471
2413	10.6	19.0	203	10.3	20.5	211
2414	12.7	19.6	250	9.9	18.5	184
2415	10.9	18.0	196	7.7	16.9	131
2416	7.8	15.5	120	6.0	15.4	92
2417	7.3	16.0	117	5.3	14.5	77
2418	10.6	16.2	171	7.8	15.0	116
2419	13.2	17.1	226	8.0	15.2	122
2420	8.9	16.3	144	8.0	16.6	133
2421	12.2	19.9	244	8.8	16.9	149
2422	8.9	15.3	136	8.0	14.9	120
2423	8.6	16.2	139	8.3	17.7	146
2424	7.6	16.4	125	4.7	14.1	66
2425	10.3	16.1	166	7.3	15.3	112
2426	8.7	15.8	137	6.9	17.0	117
2427	9.3	17.6	164	6.4	15.1	97
Descriptors or Scale	Determine parameters using texture analyzer 1 day after			Determine parameters using texture analyzer 12 days after		

Tortillas from all the samples had a reduction or negligible increase in extensibility distance from day 1 to day 12, except samples 2407, 2408, 2409, 2412, 2413, 2423, and 2426. Sample 2420 had the least change in force, distance, and work needed to rupture the tortillas after 12 days of storage at room temperature, meaning that it appeared to have staled the least. Samples 2404, 2419, 2421, and 2427 had the most drastic reductions in distance before rupture and work to rupture, suggesting their quality degraded quickly over time. As an outlier, sample 2412 had an increase in extensibility of 11 mm after 12 days, likely because the dough shrank after being pressed during processing which resulted in smaller diameter and greater thickness than other tortillas. This increase in thickness likely altered its baking profile and subsequent staling conditions.

Table 4. Subjective rollability scores, tortilla diameter, and sample ratings.

TEST No.	*Rollability Scores (RS)*			*Diameter*	Rating*
	1 day	8 days	12 days	mm	
Tortilla Ref.	5.0	4.3	4.0	173	Good
2401	5.0	4.3	3.8	180	Good
2402	5.0	4.5	4.3	179	V. Good
2403	4.8	4.3	3.0	174	Poor
2404	4.8	5.0	4.8	176	V. Good
2405	5.0	4.0	4.0	182	Good
2406	4.3	3.3	2.8	181	Poor
2407	4.3	3.8	2.8	172	Poor
2408	4.5	3.3	2.5	175	Poor
2409	4.8	3.3	2.8	175	Poor
2410	4.3	2.3	2.0	155	Poor
2411	5.0	3.8	3.5	154	Poor
2412	4.8	3.8	3.8	132	V. Poor
2413	5.0	4.5	4.5	167	Fair
2414	5.0	4.8	4.8	170	Good
2415	5.0	4.5	4.5	172	Good
2416	4.8	3.3	3.0	184	Poor
2417	5.0	4.3	3.3	181	Poor
2418	5.0	3.3	2.3	167	Poor
2419	5.0	3.3	3.3	150	Poor
2420	5.0	3.8	3.8	175	Good
2421	4.8	4.0	3.3	168	Poor
2422	5.0	2.3	2.0	169	Poor
2423	5.0	4.3	3.8	172	Good
2424	4.8	3.8	3.3	181	Poor
2425	4.8	3.8	3.0	169	Poor
2426	4.5	4.0	3.8	169	Fair
2427	4.8	3.8	2.8	169	Poor
Descriptors or Scale	*from* 1 = breaks when rolled to 5 = rolls easily			Record actual diameter	

*Subjective rating based mainly on diameter and rollability scores (day 12):
Good = rollability score >3.5 on day 12, ≥170 mm
Fair = rollability score >3.5 on day 12, 160-170 mm
Poor = rollability score <3.5 on day 12, any diameter

Tortillas from samples 2402 and 2404 had high diameter and day 12 rollability scores (usually a sign of moderately strong flour with good extensibility characteristics), thus rated very good. Samples 2414 and 2415 also had good diameter and very little decrease in rollability over 12 days of storage. 2403, 2406, 2407, 2408, 2409, 2416, 2418, 2422, 2425, and 2427 had good diameters but low rollability scores (typical of weak flours). Samples 2411, 2412, and 2419 had acceptable rollability scores but inferior diameter (typical of strong flours that cause dough to shrink when hot-pressed). 2410 had an inferior diameter and low rollability score. All other samples had acceptable diameter and day 12 rollability scores (Figure 1).

Fig. 1 - Relationship of tortilla diameter, rollability score (day 12), and flour protein content (14% mb; shown as numbers inside the box). Quadrant A: good shelf-stability, poor diameter; B: acceptable diameter and shelf-stability; C: poor diameter, poor shelf-stability; D: good diameter, poor shelf-stability.

Waniska et al. (2004) stated that the list of flour properties should include intermediate protein content (10-12%), intermediate protein quality and low levels of starch damage. Sample 2413 and 2414, which (along with many others) gave good tortilla quality, did not fall into this category (i.e., had 13.7% and 13.6% protein, respectively). Thus, protein content (PC) alone cannot predict tortilla quality. In Figure 1, the shelf-stable samples (rollability score >3) had PC from 8.5-14%.

Protein quality, on the other hand, seems to be a better (but still not perfect) predictor of tortilla quality. Figure 2 shows that samples with longer than 3 min farinograph mixing time generally had smaller diameters (though still well beyond the 165mm benchmark) and good shelf-stability, while two samples in the B quadrant with less than 3 min mixing time yielded tortillas with good diameter and acceptable shelf-stability. Further studies on specific protein and/or gluten components that affect tortilla quality are required to improve the current understanding of the relationships involved.

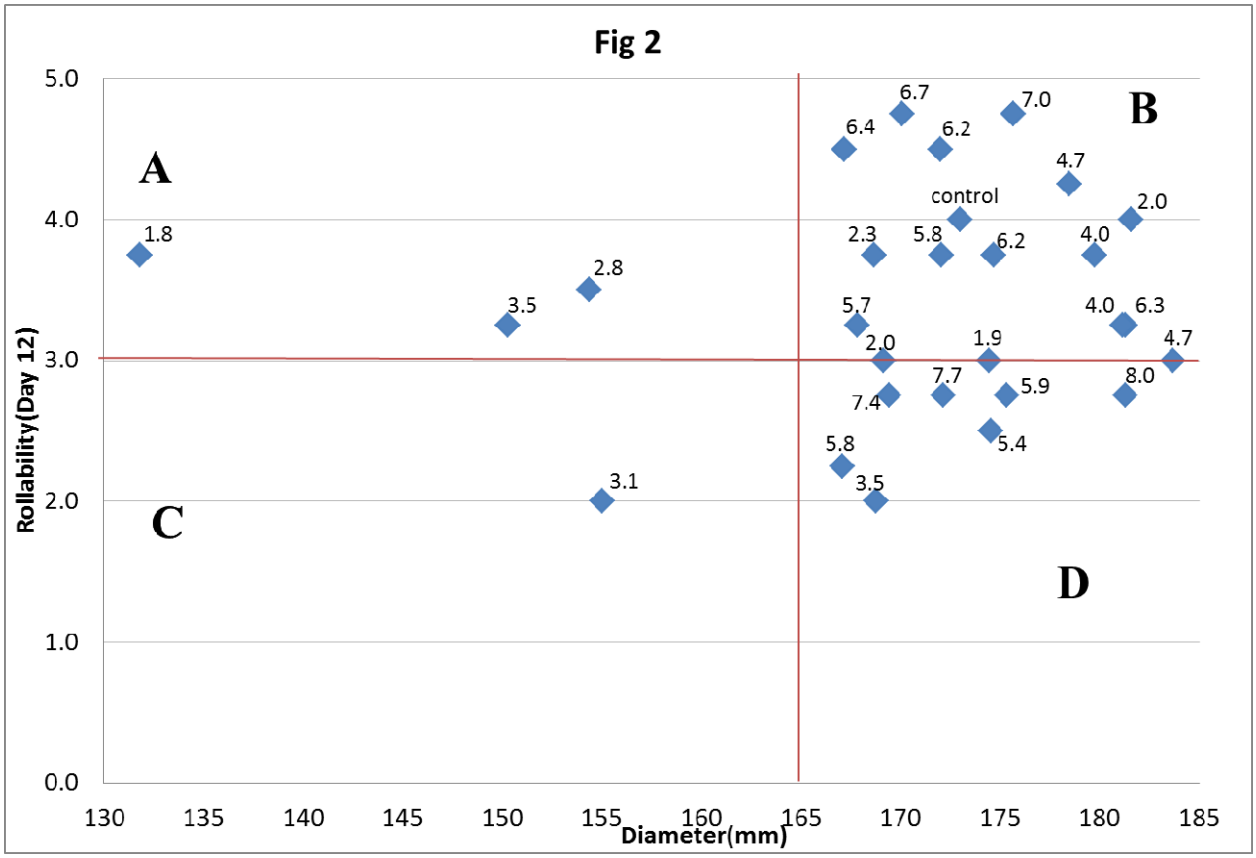


Fig. 2 - Relationship of tortilla diameter, rollability score (day 12), and farinograph development time (shown as numbers inside the box). Quadrant A: good shelf-stability, poor diameter; B: acceptable diameter and shelf-stability; C: poor diameter, poor shelf-stability; D: good diameter, poor shelf-stability.

References:

Jondiko, T. J., Yang, L., Tilley, M., Awika, J. M. Prediction of tortilla quality using multivariate model of kernel, flour and dough properties.2013 AACC International Meeting, Albuquerque, NM.

Serna-Saldivar, S.O., Rooney, L.W., Waniska, R.D. 1988. Wheat flour tortilla production. Cereal Foods World. 33: 855-864.

Waniska, R.D., Cepeda, M., King, B.S., Adams, J.L., Rooney, L.W., Torres, P.I., Lookhart, G.L., Bean, S.R., Wilson, J.D., Bechtel, D.B. 2004. Effects of flour properties on tortilla qualities. Cereal Food World. 49 (4): 237-244.

Waniska, R.D. 1999. Perspectives on flour tortillas. Cereal Foods World. 44:471-473.

2016 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.
- Lyophylize 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

SAMPLE	HMW-GS			TPP/TMP	IPP (%)
	GLU-A1	GLU- B1	GLU- D1		
16-2401	2*,1	7+8	2+12	0.71	51.36
16-2402	2*	7+8	5+10	0.8	53.8
16-2403	2*,1	17+18	5+10	0.89	57.37
16-2404	2*	7+9	5+10	0.77	49.68
16-2405	2*	7+9	5+10	0.77	51.51
16-2406	2*	7+8	5+10	0.85	48.76
16-2407	2*	7+8	5+10	0.88	51.31
16-2408	2*	7+9	5+10	0.93	48.55
16-2409	2*,1	17+18	5+10	1.03	53.5
16-2410	2*	7+8	5+10	0.85	50.24
16-2411	2*,1	17+18	5+10	0.92	55.79
16-2412	2*	7+9	5+10	0.96	58.13
16-2413	2*	7+8	5+10	0.81	49.47
16-2414	2*,1	17+18	5+10	0.91	55.47
16-2415	2*,1	17+18	5+10	0.83	53.26
16-2416	2*,1	17+18	5+10	0.92	48.16
16-2417	2*	7+8	5+10	0.79	44.12
16-2418	2*,1	17+18	5+10	0.97	50.57
16-2419	2*	7+8	2+12	1.09	53.48
16-2420	1	7+8	5+10	0.95	47.57
16-2421	2*,1	17+18	5+10	0.93	46.64
16-2422	2*	7+8	5+10	0.95	47.69
16-2423	1	17+18	5+10	0.96	48.34
16-2424	1	7+8	2+12	0.78	51.26
16-2425	2*,1	17+18	5+10	0.92	59.94
16-2426	1	17+18	5+10	0.72	55.57
16-2427	1	7+8	5+10	0.9	53.08

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

Wheat Breeders

Stephen Baenziger
University of Nebraska
Dept. of Agronomy and Horticulture
362D Plant Science Building
Lincoln, NE 68583-0915
(402) 472-1538
Pbaenziger1@unl.edu

Marla Dale Barnett
Limagrain Cereal Seeds LLC
6414 N Sheridan
Wichita, KS 67204
(316) 755-2042
Marla.Barnett@limagrain.com

Brett Carver
Oklahoma State University
Dept. of Plant and Soil Sciences
368 Ag Hall
Stillwater, OK 74078-6028
(405) 744-9580
Brett.carver@okstate.edu

Allan Fritz
Kansas State University
Dept. of Agronomy
4012 Throckmorton Hall
Manhattan, KS 66506
(785) 532-7245
akf@ksu.edu

Sid Perry
Monsanto Wheat Technology Center
21120 HWY 30
Filer, ID 83328
(208) 326-6115
sid.perry@monsanto.com

Jon Rich
Syngenta - Agripro
11783 Ascher Rd.
Junction, KS 66441
(785) 210-2108
jon.rich@syngenta.com

Guorong Zhang
Kansas State University
Ft. Hays Branch Exp. Station
1232 240th Ave.
Hays, KS 67601
(785) 625-3425
gzhang@k-state.edu

CREDITS

Baking Collaborators

Address	Collaborator Type	Contact
ADM Milling Co. 100 Paniplus Roadway Olathe, KS 66061	Miller	**Vickie Correll** (913)491-7588 Vickie.Correll@adm.com
American Institute of Baking 1213 Baker's Way Manhattan, KS 66502	Baker	**Renee Boeckman** (785)537-4750 rboeckman@aibonline.org
Ardent Mills 3794 Williston, Rd., Minnetonka, MN 55345	Miller	**Tim Howdeshell/Jie Hu** (952)238-4894 Timothy.Howdeshell@ArdentMills.com Jie.Hu@ardentmills.com
Grain Craft 701 E. 17th Street Wichita, KS 67214	Miller	**Reuben McLean** (208) 785-6293 rmclean@graincraft.com
Colorado State University Dept. Soil and Crop Sciences Ft. Collins, CO 80523	Wheat Quality Lab	**John Stromberger** (970)491-2664 John.Stromberger@colostate.edu
General Mill RTC 9931 419 2nd Street Minneapolis, MN 55414	Miller	**Steve Cheruvathoor** (776)764-2737 Steve.Cheruvathoor@genmills.com

CREDITS

Baking Collaborators

Address	Collaborator Type	Contact
Kansas State University Dept of Grain Science Shellenberger Hall Manhattan, KS 66506	Wheat Quality Lab	**Becky Miller** (785)532-6194 beckym@ksu.edu
Limagrain Cereal Seeds LLC 2040 SE Frontage Road Fort Collins, CO 80525	Quality Lab	**Hayley Butler** (970)498-2205 hayley.butler@limagrain.com
Mennel Milling Co. Findlay & Vine Street Fostoria, OH 44830	Miller	**Tom Baker/C.J. Lin** (419) 436-5130 Tbaker@mennel.com Cjlin@mennel.com
North Dakota State Univ. Plant Science Department 1250 Bolley Drive Fargo, ND 58108	Wheat Quality Lab	**Senay Simsek** (701)231-7737 Senay.simsek@ndsu.edu
Syngenta (Agripro) PO Box 30 Berthound, CO 80512-0030	Wheat Quality Lab	**Cathy Butti** (970) 532-3721 cathy.butti@agripro.com
Texas A&M University Soil & Crop Science Dept 2474 TAMU College Station, TX 77843-2472	Wheat Quality Lab	**Joseph Awika** (979) 845-2985 awika@tamu.edu
Univ. of Nebraska Dept of Agronomy 180 Plant Science Bldg.	Wheat Quality Lab	**Lan Xu** (402)472-6243 lxu4@unlnotes.unl.edu

CREDITS

Baking Collaborators

Address	Collaborator Type	Contact
USDA/ARS/HWWQL 1515 College Ave. Manhattan, KS 66502	Wheat Quality Lab	**Margo Caley/Theresa Sutton** (785) 776-2755/776-2764 margo.caley@ars.usda.gov Theresa.Sutton@ars.usda.gov
USDA/ARS/WQL Harris Hall North Dakota State Univ. Fargo, ND 58105	Wheat Quality Lab	**Linda Dykes** (701) 239-1412 Linda.Dykes@.ars.usda.gov
USDA/ARS/WWQL E-202 FSHN Washington State Univ. Pullman, WA 99614	Wheat Quality Lab	**Doug Engle** (509) 335-4062 doug_engle@wsu.edu
Wheat Marketing Center 1200 NW Naito PRKWY STE 230 Portland, OR 97209	Wheat Quality Lab	**Bon Lee** (503)295-0823 blee@wmcinc.org

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 130^0 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), Ie = P200/P, elasticity index (P200: pressure 4 cm from the start of the curve, Ie 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.

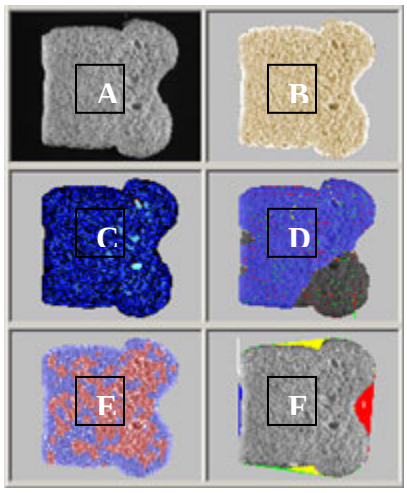
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein 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:



(A) Raw Image *(B) Brightness Correction Image*

(C) Cell Image *(D) Elongation Image*

(E) Cell Distribution Image *(F) Cell Size & Shape Image*

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 (mm^2).

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 (^{0}): 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

2016 WQC COLLABORATORS' BAKING TEST PROFILES AND OTHER INFORMATION

Coop	No.	Name of Cooperators	Test Methods	Est. Flour and Dough Wt (g)	Mixing Tolerance	Fermentation time (min)	Oven Temp	Baking Time
A	1	Colorado	Pup-loaf straight dough	100 g, approx 170 g	Mixograph	90 min	400	25
B	2	AIBI	Sponge and dough	700 g, 524 g dough	Mixing series	240 min (sponge time) and 60 min (fermentation)	420	20
C	3	General Mill	Straight dough	700 g flour, 525 g dough	Mixing series	120 min	400	25
D	4	USDA-WWQL	Pup-loaf straight dough	100 g flour, approx 175 g dough	Mixograph	90 min	425	21
E	5	Nebraska	Straight dough	100 g flour, approx. 175 g dough	Farinograph and Mixograph	180 fermentation and 60 min proof time	400	25
F	6	NDSU	Pup-loaf straight dough	100 g flour, approx 160 g dough	Farinograph	120 min	425	20
G	7	ADM	Sponge and dough	600 g flour, 480 g dough	Other	240 min (sponge time) and 45 min (fermentation)	420	20
H	8	Limagrain	Pup-loaf straight dough	100 g	Mixograph	90 min	400	25
I	9	USDA-HRSQL	Pup-loaf straight dough	100 g flour	Farinograph	120 min	390	25
J	10	USDA-HWWQL	Sponge and dough	700 g flour, 524 g dough	Farinograph with mixing evalu	240 min (sponge time) and 60 min (fermentation)	420	20
K	11	Syngenta-Agripro	Pop loaf straight	100 g	Mixograph	90 min	400	25
L	12	USDA-HWWQL	Pup-loaf straight dough	100 g flour, approx 170 g dough	Mixograph	120 min	420	18
M	13	Mennel	Sponge and dough	1000 g flour, 500 g dough	Farinograph	240 min	425	20
N	14	Ardent Mills	Sponge and dough	600 g flour, 160 g dough	Mixing series	240 min	425	16
O	15	Grain Craft	Sponge and dough	540 g dough	Mixing series	210 min	430	23
P	16	WMC	Pup-loaf straight dough	200g, 170 g dough	Mixograph	180 min	419	24

APPENDIX B

Hard Winter Wheat Quality Council
Goals for Hard Winter Wheat Breeders

Hard Winter Wheat Quality Council

2016 Technical Board Officers

CHAIR:	**Vance Lamb,** ADM
VICE CHAIR:	**Sid Perry**, Monsanto/WestBred
SECRETARY:	**Scott Baker,** Ardent Mills
MEMBER:	**Charlie Moon,** Flowers Food
MEMBER:	**Mike Wolt,** Bimbo Bakeries USA

2016 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.

	Objective	Minimum Acceptable
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

	Objective	Acceptable
Straight Grade Extraction % at .48% ash	76	74 (minimum)
Str.-Gr. Agtron 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.

APPENDIX C

Hard Red Winter Wheat Quality Targets

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
Wheat	
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***
Flour	
Flour Color L-Value (Minolta Colorimeter)	***> 90***
Gluten Index	***> 95***
Sedimentation Volume (cc)	***> 40***
Farinograph:	
Water Absorption (%, 14% mb)	***62+***
Peak Time (min)	***4.00 – 8.00***
Stability (min)	***10.00-16.00***
Mixograph:	
Water Absorption (%, 14% mb)	***62+***
Peak Time (min)	***3.00 – 6.00***
Mixing Tolerance (HWWQL Score, 0-6)	***3.0***
Straight Dough Pup Method:	
Water Absorption (%, 14% mb)	***62+***
Mix Time (min)	***3.00 – 5.00***
Loaf Volume (cc)	***> 850***
Crumb Score (HWWQL Score, 0-6)	***> 3.0***

CONTACT:
USDA/ARS CGAHR
Hard Winter Wheat Quality Laboratory
1515 College Avenue, Manhattan, KS 66502-2796
VOICE: (785) 776-2751 FAX: (785) 537- 5534 EMAIL: brad.seabourn@ars.usda.gov

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 27^0C 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. 17, 2016

Hard Winter Wheat Quality Council Meeting Minutes
Annual Meeting February 18, 2016

Ben Handcock opened this year's meeting

Review of 2015 Minutes – **Janet Lewis**, Chair HWWQC Board

Minutes approved as-is (Vance Lamb motioned to approve; Lee Sanders seconded the motion)

Nominations for 1 new member:

Mike Wolt, Bimbo Bakeries USA, nominated and elected

Board for 2016:

Chair – Vance Lamb, ADM
Vice Chair – Sid Perry, Monsanto/WestBred
Secretary – Scott Baker, Ardent Mills
Member – Charlie Moon, Flowers Foods
Member – Mike Wolt, Bimbo Bakeries USA

Jon Rich presented a proposal for withdrawal of entries to the Wheat Quality Council

- Applies to samples which are not representative of what a breeder wants in their program
- Establish standard quality expectations and a team to review experimental data
- If the team agrees an entry does not meet the quality expectations, the breeder can opt to remove the data from the report
- Comments
    - When should this decision be made due to the cost incurred by the Council?
    - Will the breeder reimburse the costs to the council? How to reimburse collaborators, especially if there are multiple withdrawals in a given year?
    - Who will be on the team?
    - What are breeder requirements for submitting an entry
        - Choose location
        - 3 bu cleaned seed
        - Quality lab check
    - Is there a need for a common check and local check to help highlight a specific location effect?
- Needs additional clarification around members and protocol

Brad Seabourn, WQC Report for 2015

- 25 entries, 8 programs, 17 cooperators
- Jagalene was used as a common check by six breeders

- First time a common check was used as a normal part of the evaluation process
- Limagrain / CSU shared a common check due to an issue with the Limagrain sample

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

- Still completing repairs on Miag
    - Sifter frame repair - ~ $10,000 for parts and labor
    - Sifter motor repair planned for 2016 - ~$20,000
    - Biggest problem is the cyclone / air handling system – can't get a tight seal
- Sample Milling
    - started about a month later due to air compressor being disconnected during feed mill destruction
    - Break Extractions – 1st and 2nd Break = 48%, 3 Break = 43-48%
    - Only one break down on the main machine drive
    - Samples finished by 11/16

Ben Handcock

- Budget surplus will be used to increase the spring wheat grow out budget to include Montana as well as increasing the milling budget for KSU& ARS in Fargo in order to handle more samples.
- Wheat tours were well attended (100 HRW, 65 HRS) with many international participants due weather issues in the plains.
- Hard Winter wheat tours will be changing:
    - Tours will start and end in Manhattan
    - Some hotels will change

Dave Green, Review of Quality Issues in 2015 Crop

- Exceptionally dry until May and then couldn't stop raining
- Temperature slightly above average
- Avg crop yield was 38 bpa (28 bpa estimated)
- Protein is about 1% lower, farinograph absorption is up (not for sure of the cause) but increased absorption not noticed in the bake, and farinograph stability lower
- Generally a good baking crop but weaker than 2014
- Most transitions have been smooth with minor absorption and mix adjustments

Submitted by **Scott Baker,** Ardent Mills, Acting Secretary

APPENDIX F

Historical WQC Hard Winter Wheat Entries from 2001 to 2016

A History of WQC Hard Winter Wheat Entries

2016

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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
lCS 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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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

Overley (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
Overley (check)	06-2405	HRW				Westbred
Smoky Hill	06-2406	HRW	yes			Westbred
Aspen	06-2407	HRW	yes			Westbred
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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 2016 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