Milling and Baking Test Results for Hard Winter Wheat

Harvested in 2018

69th 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, Lenexa, KS, The United States Department of Agriculture (USDA) - ARS, The Agricultural Experiment Stations of Colorado, Kansas, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas, private wheat breeding companies including Syngenta (AgriPro Wheat), Monsanto (Westbred, LLC), Limagrain, 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.

Downloading or printing of this report is available through the Wheat Quality Council (http://www.wheatqualitycouncil.org), if you are member of WQC or a registered participant of the annual WQC meeting. Otherwise, please contact:

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2018

Milling and Baking Test Results for

Hard Winter Wheats

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The MISSION
of the WHEAT QUALITY COUNCIL:

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

The GOAL
of the WHEAT QUALITY COUNCIL:

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

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Description of the 2018 Testing Program

Founded in 1949, this is the **69th** year for the Hard Winter Wheat Milling and Baking Evaluation Program. This program is sponsored by the Wheat Quality Council and coordinated by the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL) and Kansas State University Department of Grain Science and Industry. Wheat experimental lines and check varieties (including common check and internal check) were submitted by public and private breeding programs in the Great Plains growing region. This technical report includes GIPSA wheat market classification, physical grain testing, milling, analytical, rheological, and bread baking results.

A total of 32 entries this year were grown in specific locations and submitted for small-scale testing by 10 wheat breeding programs. 9 of the entries were submitted as a set representing the new growout in the Northern States including NE, MT, SD and ND. 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 19 cooperators (17 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.

2018 WQC HWW Entries & Breeding Programs

Breeding Programs	Entry Number	Sample Identification
TEXAS	18-2401	Jagalene (CC01)
	18-2402	TAM 111
	18-2403	TX12V7415
LIMAGRAIN	18-2404	LINK
	18-2405	Jagalene (CC02)
	18-2406	DH11HRW53-34
	18-2407	LCI13DH-22-22
MONSANTO(Westbred)	18-2408	MOD14-4919
	18-2409	Jagalene (CC03)
	18-2410	H4N13-0253
KANSAS-HAYS	18-2411	Danby
	18-2412	Jagalene (CC04)
	18-2413	KS14H180-4-63
SYNGENTA(Agripro)	18-2414	Jagalene (CC05)
	18-2415	10BC107#115
	18-2416	SY Monument
	18-2417	08BC379-40-1
OKLAHOMA	18-2418	Jagalene (CC06)
	18-2419	Ruby Lee
	18-2420	OK12716-159319-13
	18-2421	OK13621
	18-2422	OK12206-127206-2
	18-2423	OK1059018-129332-5

NORTHERN STATES	18-2424	Jagalene (CC07)
	18-2425	NE10478-1
	18-2426	NHH144913-3
	18-2427	MT1564
	18-2428	MTS1588
	18-2429	NORD58
	18-2430	NORD62
	18-2431	SD09227
	18-2432	SD14115-5

CC = Common Check

2018 Wheat Classification Results from GIPSA

GIPSA Wheat Market Classification

ID	CL	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	GRADE
18-2401	HRW	0.00	63.5	10.5	OK	0.0	0.6	0.0	0.5	1.1	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2402	HRW	0.00	63.2	10.8	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.3	U.S. NO. 1 HRW, DKG 0.0%
18-2403	HRW	0.00	64.9	10.7	OK	0.0	0.3	0.0	0.3	0.6	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2404	HRW	0.00	59.5	12.5	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.1	U.S. NO. 2 HRW, DKG 0.0%
18-2405	HRW	0.01	59.8	11.7	OK	0.0	0.0	0.0	1.9	1.9	0.0	0.5	U.S. NO. 2 HRW, DKG 0.0%
18-2406	HRW	0.00	58.8	12.4	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
18-2407	HDWH	0.00	61.7	10.6	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.3	U.S. NO. 1 HDWH, DKG 0.0%
18-2408	HRW	0.00	64.2	9.2	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.4	U.S. NO. 1 HRW, DKG 0.0%
18-2409	HRW	0.00	65.3	9.1	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2410	HRW	0.00	64.7	9.2	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2411	HDWH	0.00	62.5	13.5	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	U.S. NO. 1 HDWH, DKG 0.0%
18-2412	HRW	0.00	60.9	13.5	OK	0.0	0.2	0.0	0.0	0.2	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2413	HRW	0.00	61.7	13.5	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2414	HRW	0.00	63.9	11.4	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2415	HRW	0.00	63.8	11.7	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2416	HRW	0.00	61.4	11.7	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2417	HRW	0.00	63.5	11.5	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.4	U.S. NO. 1 HRW, DKG 0.0%
18-2418	HRW	0.00	60.4	12.7	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.7	U.S. NO. 1 HRW, DKG 0.0%
18-2419	HRW	0.25	59.5	12.4	OK	0.0	0.0	0.0	1.6	1.6	0.0	0.0	U.S. NO. 2 HRW, DKG 0.3%
18-2420	HRW	0.10	57.6	12.0	OK	0.0	0.0	0.0	0.5	0.5	0.0	0.0	U.S. NO. 3 HRW, DKG 0.1%
18-2421	HRW	0.00	59.7	12.3	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
18-2422	HRW	0.10	57.0	12.3	OK	0.0	0.1	0.0	0.3	0.4	0.0	0.0	U.S. NO. 3 HRW, DKG 0.1%
18-2423	HRW	0.00	58.2	12.3	OK	0.0	0.0	0.0	0.8	0.8	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
18-2424	HRW	0.00	59.8	12.2	OK	0.0	0.3	0.0	0.2	0.5	0.0	0.6	U.S. NO. 2 HRW, DKG 0.0%
18- 2425	HRW	0.00	60.0	12.1	OK	0.0	0.1	0.0	0.2	0.3	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
18-2426	SRW	0.00	57.4	12.4	OK	0.0	0.1	0.0	0.0	0.1	0.0	0.0	U.S. NO. 3 SRW, DKG 0.0%
18-2427	HRW	0.00	59.0	12.4	OK	0.0	5.2	0.0	0.2	5.4	0.0	0.0	U.S. NO. 3 HRW, DKG 0.0%
18-2428	HRW	0.00	58.8	12.0	OK	0.0	0.1	0.0	1.0	1.1	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
18-2429	HDWH	0.00	58.7	12.1	OK	0.0	18.4	0.0	0.3	18.7	0.0	4.8	U.S. SG HDWH, DKG 0.0%
18-2430	HDWH	0.00	59.5	12.2	OK	0.0	24.5	0.0	0.1	24.6	0.0	2.5	U.S. SG HDWH, DKG 0.0%
18-2431	HRW	0.00	58.8	12.2	OK	0.0	1.3	0.0	0.2	1.5	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
18-2432	HRW	0.00	58.9	12.3	OK	0.0	0.2	0.0	0.2	0.4	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%

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

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

TEXAS

18-2401	**Jagalene (CC01)**
18-2402	**TAM 111**
18-2403	**TX12V7415**

Description of Test Plots and Breeder Entries

Texas – Jackie Rudd

Texas A&M AgriLife Research, Amarillo
The Wheat Quality Council samples submitted by Texas A&M AgriLife Research were harvested in June 2018 from strips planted adjacent to our irrigated yield trials at Bushland (near Amarillo in the Texas Panhandle). We fertilized for a yield goal of 100 bu/a. The grain yields of Jagalene, TAM 111 and TX12V7415 from trials adjacent to the WQC strips, were 85, 90 and 95 bu/a respectively. The crop was irrigated with a linear at regular intervals from early March to early May. Crop development was normal for the Texas Panhandle and there were no significant abiotic or biotic stresses except some post-anthesis heat.

TX12V7415

This hard red winter wheat experimental was selected from the TAM Wheat Improvement Program from the cross "X05A650 [=ND 801/TX02D5813]/RonL". It is resistant to leaf rust, stripe rust, stem rust including the race TTKSK (Ug99 of Kenyan origin), and *Soil-borne wheat mosaic virus* and *Spindle streak mosaic virus*. Marker data indicates it has *Wsm2* from RonL and *Fhb1* from ND 801. It has large seeds, high test weight, and strong dough properties. It has performed exceedingly well under irrigation particularly in the Texas High Plains.

TAM 111 (CHECK)

TAM 111 (TX95A3091), a hard red winter wheat released in 2002 and licensed to Syngenta. It has good yield under dryland and irrigated conditions. It has been the most widely grown wheat cultivar in Texas since 2008 and in 2018 it still occupied 8.9% of the total state acreage and 18.9% of the acreage in the Texas Panhandle.

Jagalene (CHECK)

Jagalene, a hard red winter wheat from the cross Jagger/Abilene, was grown together with TAM 111 and TX12V7415 at Bushland. It is used as a standard check for WQC winter wheat evaluation

Texas: 2018 (Small-Scale) Samples

Test entry number	18-2401	18-2402	18-2403
Sample identification	**Jagalene (CC01)**	**TAM 111**	**TX12V7415**
Wheat Data			
GIPSA classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	63.5	63.2	64.9
Hectoliter weight (kg/hl)	83.4	83.0	85.2
1000 kernel weight (gm)	32.1	31.6	37.0
Wheat kernel size (Rotap)			
Over 7 wire (%)	75.0	71.3	79.2
Over 9 wire (%)	24.9	28.5	20.7
Through 9 wire (%)	0.1	0.2	0.1
Single kernel (skcs)[a]			
Hardness (avg /s.d)	75.4/15.7	71.1/15.4	69.9/15.7
Weight (mg) (avg/s.d)	32.1/7.3	31.6/8.0	37.0/11.3
Diameter (mm)(avg/s.d)	2.73/0.33	2.66/0.34	2.80/0.35
Moisture (%) (avg/s.d)	10.7/0.4	10.9/0.5	10.8/0.4
SKCS distribution	01-03-14-82-01	01-04-17-78-01	01-04-20-75-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	12.7	11.9	11.6
Wheat ash (12% mb)	1.24	1.30	1.29
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	77.7	77.5	78.8
Quadrumat Sr. Mill	70.0	69.6	69.7
Flour moisture (%)	13.6	13.5	13.4
Flour protein (14% mb)	12.0	10.9	10.5
Flour ash (14% mb)	0.53	0.51	0.54
Rapid Visco-Analyser			
Peak Time (min)	6.2	6.2	6.3
Peak Viscosity (RVU)	201.4	214.2	217.5
Breakdown (RVU)	69.3	71.3	68.1
Final Viscosity at 13 min (RVU)	250.4	262.7	264.4
Minolta color meter			
L*	91.38	91.76	91.77
a*	-1.25	-1.36	-1.49
b*	9.16	9.15	9.38
PPO	0.440	0.461	0.474
Falling number (sec)	448	441	433
Damaged Starch			
(AI%)	98.0	98.1	98.7
(AACC76-31)	7.9	8.0	8.6

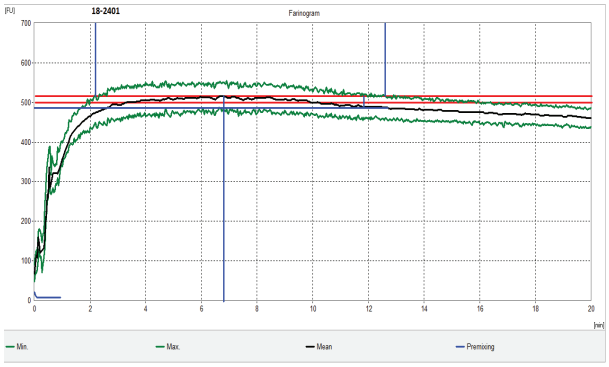
[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Texas: Physical Dough Tests and Gluten Analysis For 2018 (Small-Scale) Samples

Test Entry Number	18-2401	18-2402	18-2403
Sample Identification	Jagalene (CC01)	TAM 111	TX12V7415
MIXOGRAPH			
Flour Abs (% as-is)	65.5	64.5	65.4
Flour Abs (14% mb)	65.2	64.2	64.9
Mix Time (min)	3.1	3.0	5.9
Mix tolerance (0-6)	3	2	4
FARINOGRAPH			
Flour Abs (% as-is)	65.0	63.6	63.4
Flour Abs (14% mb)	64.8	63.2	62.8
Peak time (min)	6.8	5.4	5.2
Mix stability (min)	10.4	7.2	17.1
Mix Tolerance Index (FU)	27	37	11
Breakdown time (min)	12.7	9.6	17.3
ALVEOGRAPH			
P(mm): Tenacity	113	93	127
L(mm): Extensibility	80	80	52
G(mm): Swelling index	19.9	19.9	16.1
W(10^{-4} J): strength (curve area)	325	231	277
P/L: curve configuration ratio	1.41	1.16	2.44
Ie(P_{200}/P): elasticity index	58.5	47.7	62.4
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	394/481/464	284/369/423	482/716/914
Extensibility (mm at 45/90/135 min)	154/155/149	165/166/159	142/127/112
Energy (cm^2 at 45/90/135 min)	113/138/127	89/122/132	133/158/154
Resist $_{max}$ (BU at 45/90/135 min)	568/705/688	400/577/653	766/1041/1176
Ratio (at 45/90/135 min)	2.6/3.1/3.1	1.7/2.2/2.7	3.4/5.7/8.2
PROTEIN ANALYSIS			
HMW-GS Composition	1,2*, 17+18, 5+10	2*, 7+9, 2+12	2*, 7+8, 5+10
TMP/TTP	1.02	0.89	0.97
SEDIMENTATION TEST			
Volume (ml)	49.4	38.9	45.7

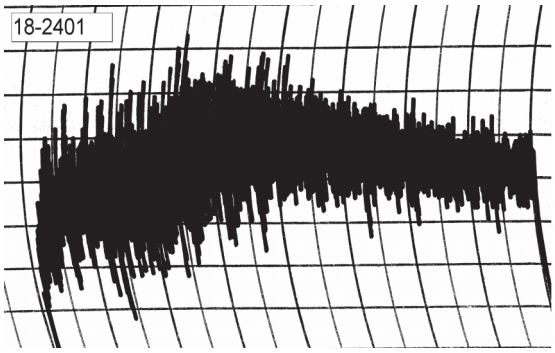
Physical Dough Tests
2018 (Small Scale) Samples – Texas

Farinograms



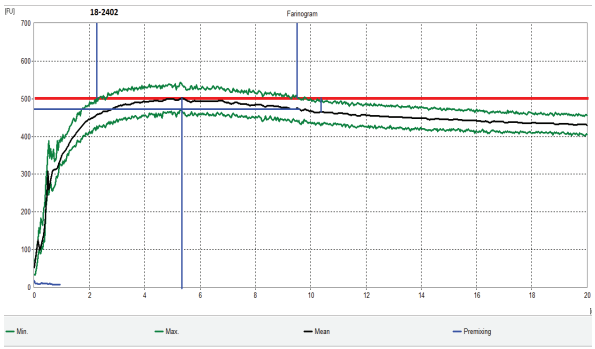
Water abs = 64.8%, Peak time = 6.8 min,
Mix stab = 10.4 min, MTI = 27 FU

Mixograms

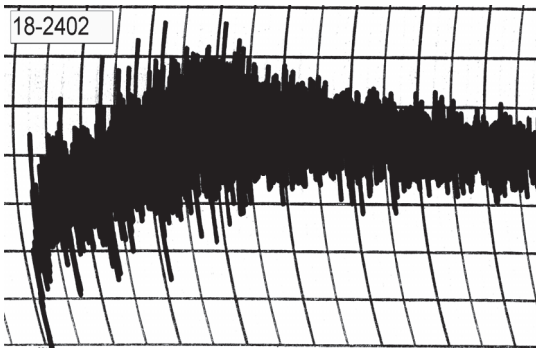


Water abs = 65.2%
Mix time = 3.1 min

18-2401, Jagalene (CC01)



Water abs = 63.2%, Peak time = 5.4 min,
Mix stab = 7.2 min, MTI = 37 FU



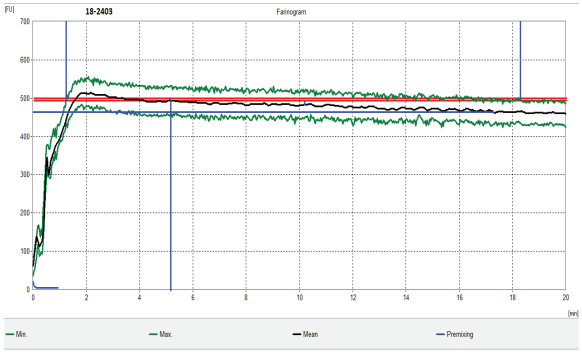
Water abs = 64.2%
Mix time = 3.0 min

18-2402, TAM 111

Physical Dough Tests

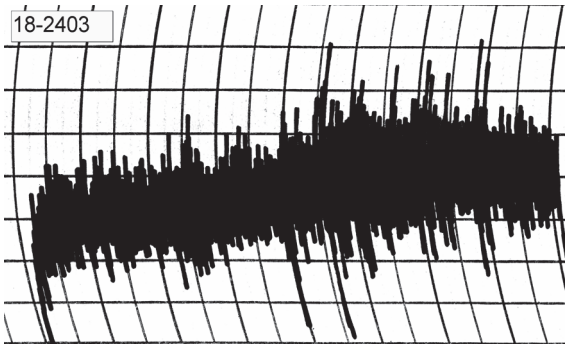
2018 (Small Scale) Samples – Texas

Farinograms



Water abs = 62.8%, Peak time = 5.2 min,
Mix stab = 17.1 min, MTI = 11 FU

Mixograms

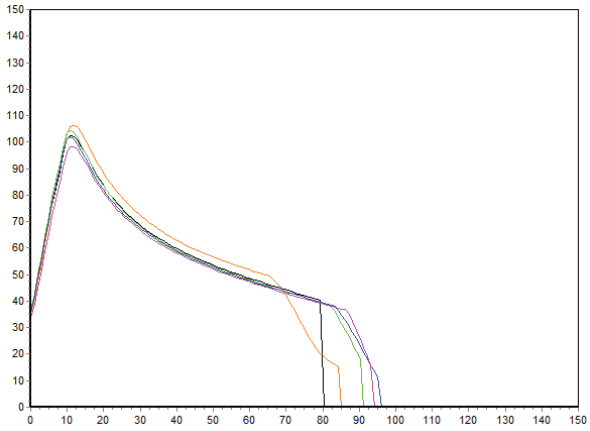


Water abs = 64.9%
Mix time = 5.9 min

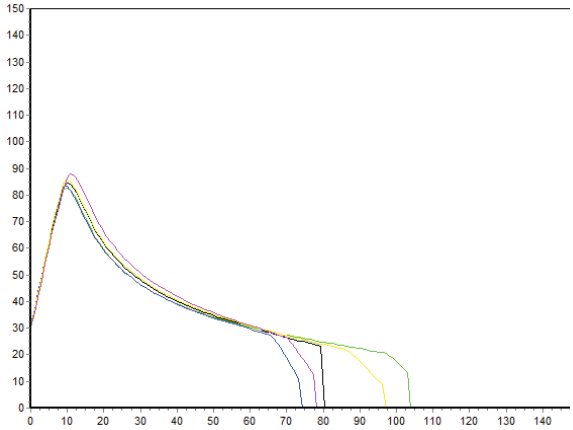
18-2403, TX12V7415

Physical Dough Tests - Alveograph

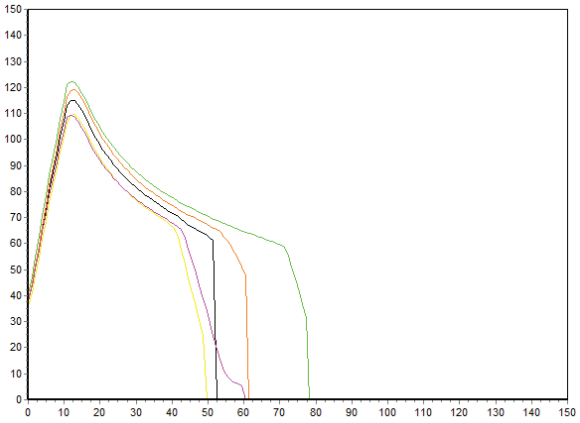
2018 (Small Scale) Samples – Texas



18-2401, Jagalene (CC01)
P (mm H_20) = 113, L (mm) = 80, W ($10E^{-4}J$) = 325



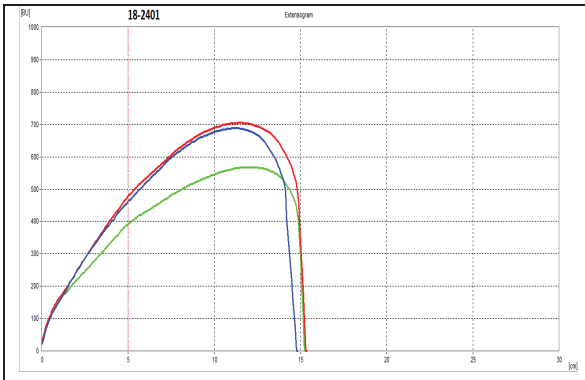
18-2402, TAM 111
P (mm H_20) = 93, L (mm) = 80, W ($10E^{-4}J$) = 231



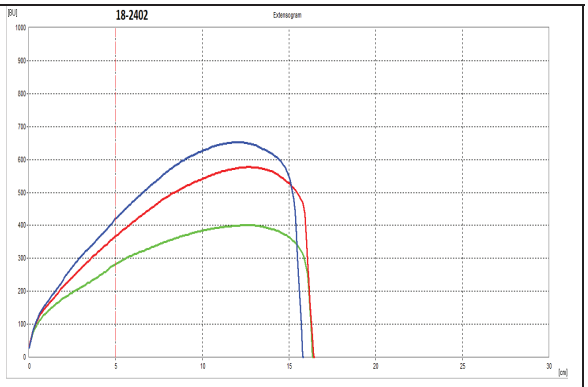
18-2403, TX12V7415
P (mm H_20) = 127, L (mm) = 52, W ($10E^{-4}J$) = 277

Physical Dough Tests - Extensigraph

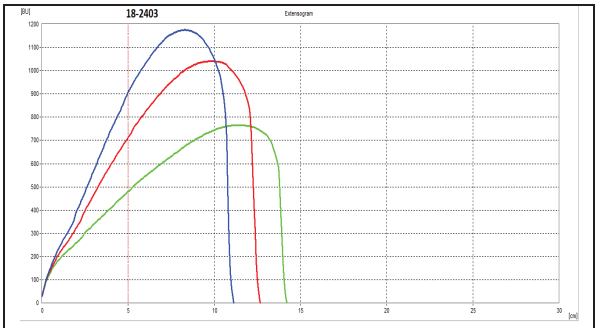
2018 (Small Scale) Samples – Texas



18-2401, Jagalene (CC01)
R (BU) = 481, E (mm) = 155, W (cm^2) = 138
Rmax (BU) = 705, Ratio = 3.1 at 90 min



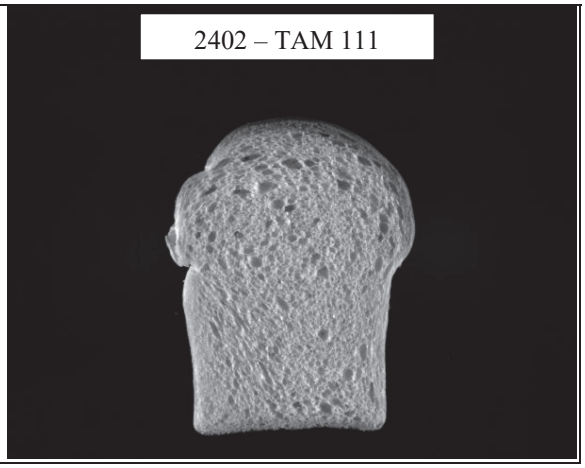
18-2402, TAM 111
R (BU) = 369, E (mm) = 166, W (cm^2) = 122
Rmax (BU) = 577, Ratio = 2.2 at 90 min



18-2403, TX12V7415
R (BU) = 716, E (mm) = 127, W (cm^2) = 158
Rmax (BU) = 1041, Ratio = 5.7 at 90 min

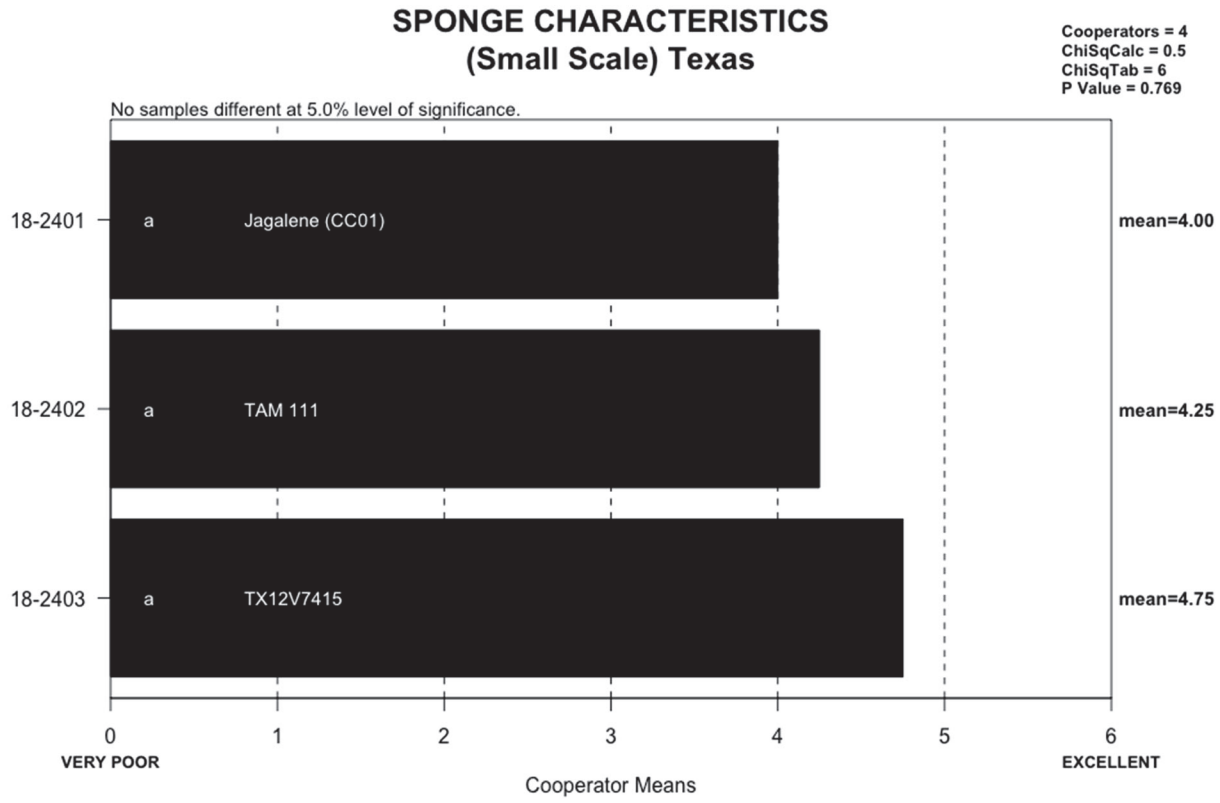
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

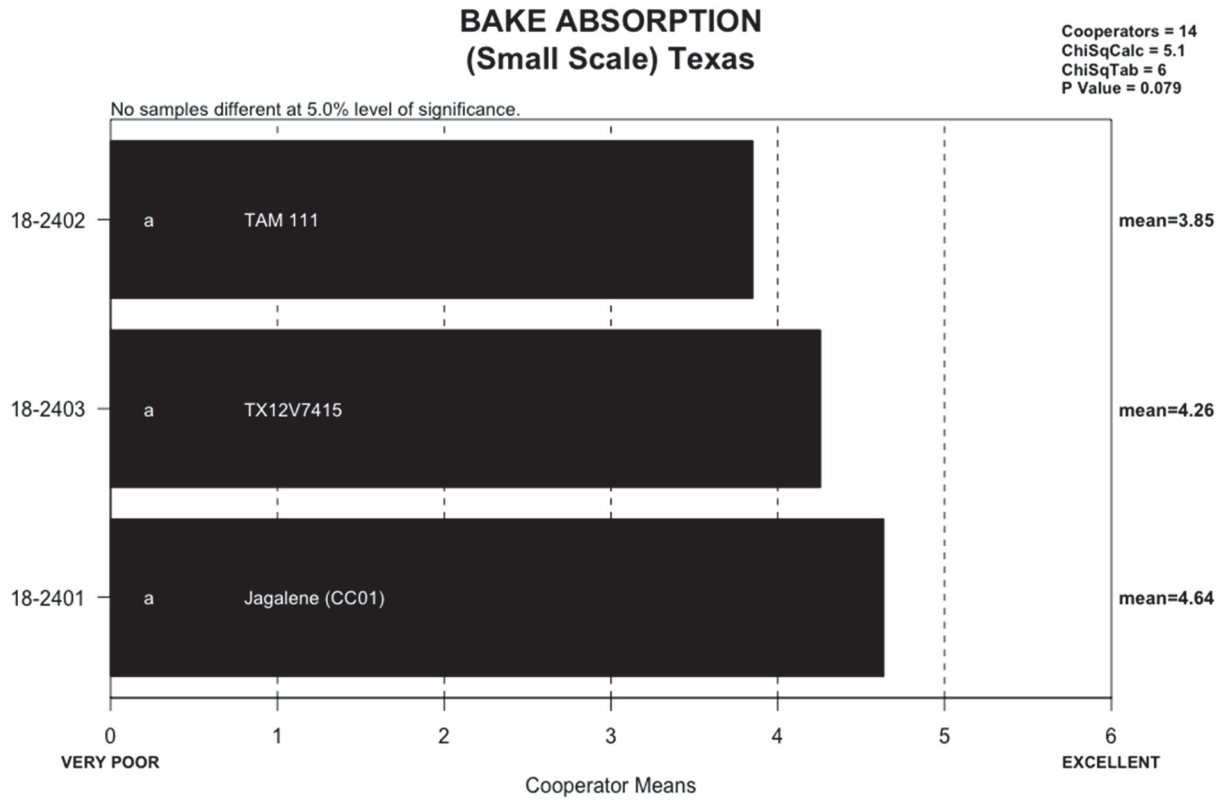
Texas: C-Cell Bread Images and Analysis
2018 (Small-Scale) Samples



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	6810	139	4196	0.439	2.026	10.531	1.730	-10.05
2402	6418	146	4188	0.434	1.935	0.558	1.650	-11.40

Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	6199	142	3969	0.435	1.919	1.18	1.730	-11.88


SPONGE CHARACTERISTICS
(Small Scale) Texas
Cooperators = 4
ChiSqCalc = 0.5
ChiSqTab = 6
P Value = 0.769
No samples different at 5.0% level of significance.
18-2401
a
Jagalene (CC01)
mean=4.00
18-2402
a
TAM 111
mean=4.25
18-2403
a
TX12V7415
mean=4.75
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

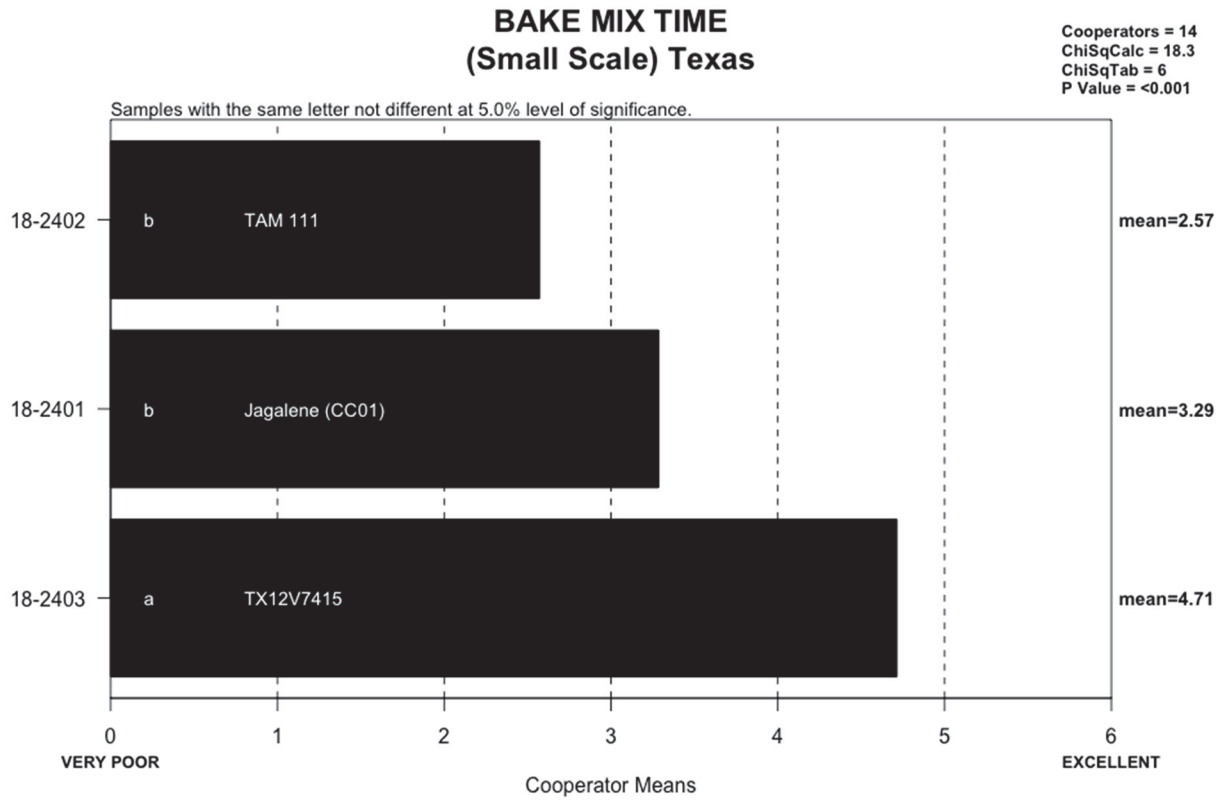

BAKE ABSORPTION
(Small Scale) Texas
Cooperators = 14
ChiSqCalc = 5.1
ChiSqTab = 6
P Value = 0.079
No samples different at 5.0% level of significance.
18-2402
a
TAM 111
mean=3.85
18-2403
a
TX12V7415
mean=4.26
18-2401
a
Jagalene (CC01)
mean=4.64
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

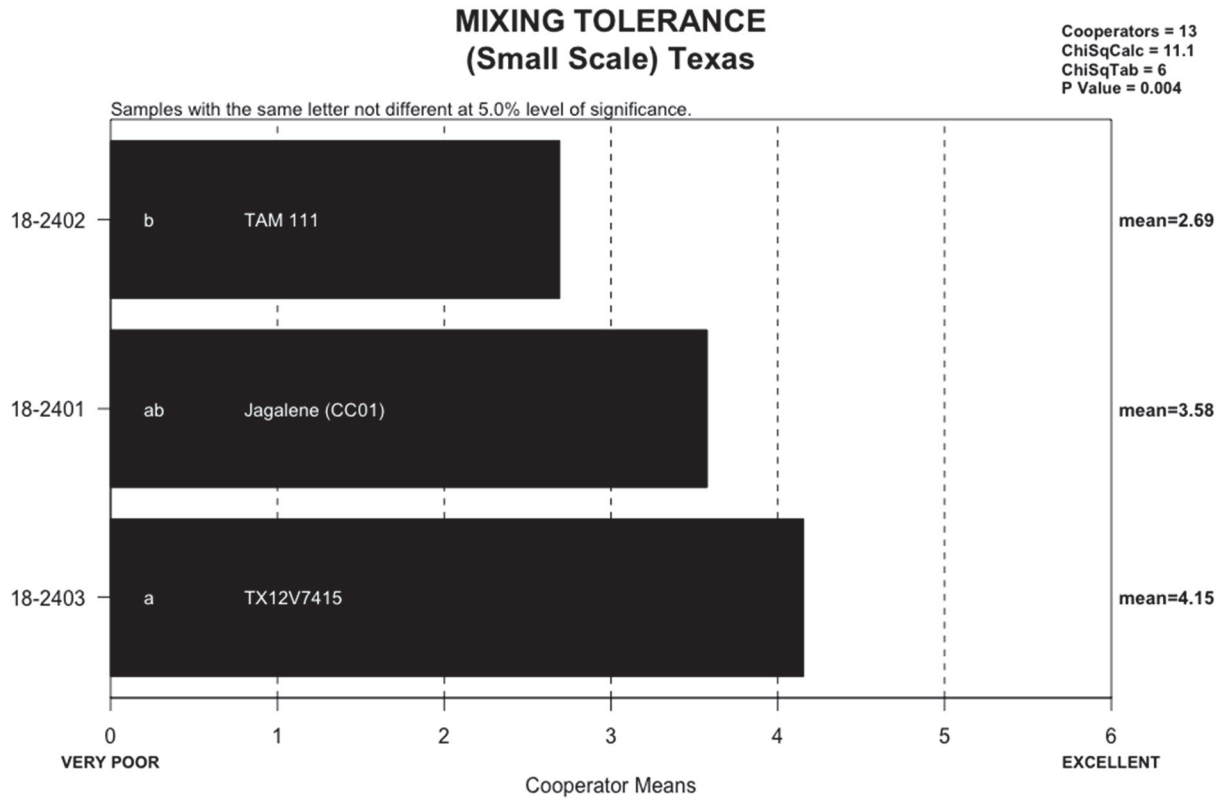
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Texas
Cooperators A – N

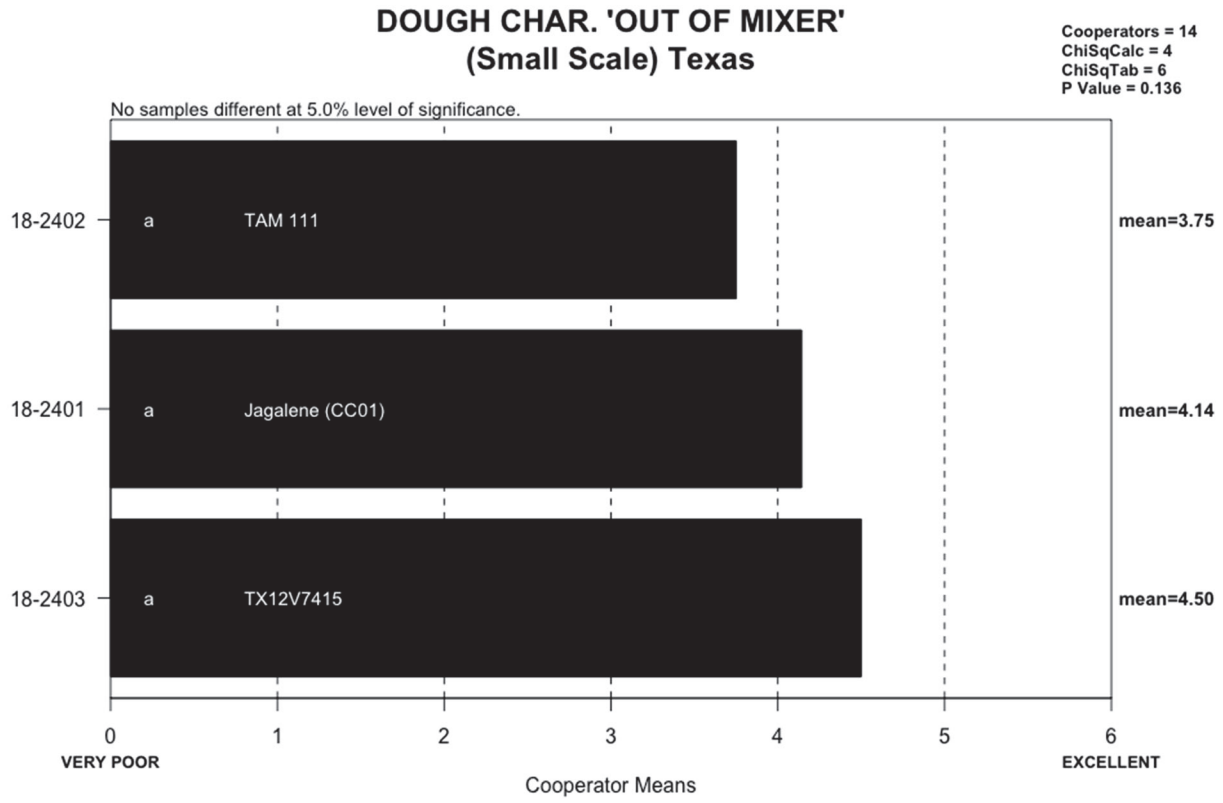
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2401	Jagalene (CC01)	63.2	64.9	68.2	63.4	59	64.8	60.8	70.0	66.4	63	67.6	65.2	61	66.4
18-2402	TAM 111	63.0	62.7	68.1	61.9	58	63.2	59.5	66.8	64.5	63	66.6	65.2	59	64.4
18-2403	TX12V7415	64.0	63.4	65.9	61.6	57	62.8	58.8	71.1	65.1	66	66.0	62.5	61	68.2

BAKE MIX TIME, ACTUAL
(Small Scale) Texas
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2401	Jagalene (CC01)	4.2	3.8	4.0	5.0	8	6	3.5	4.5	3.5	3.0	9	3.3	10	4.3
18-2402	TAM 111	3.3	3.0	3.5	4.5	5	5	2.7	3.5	2.8	3.0	8	3.2	9	3.5
18-2403	TX12V7415	6.3	5.5	6.2	8.8	10	5	4.8	5.0	5.5	4.5	17	5.2	25	7.3

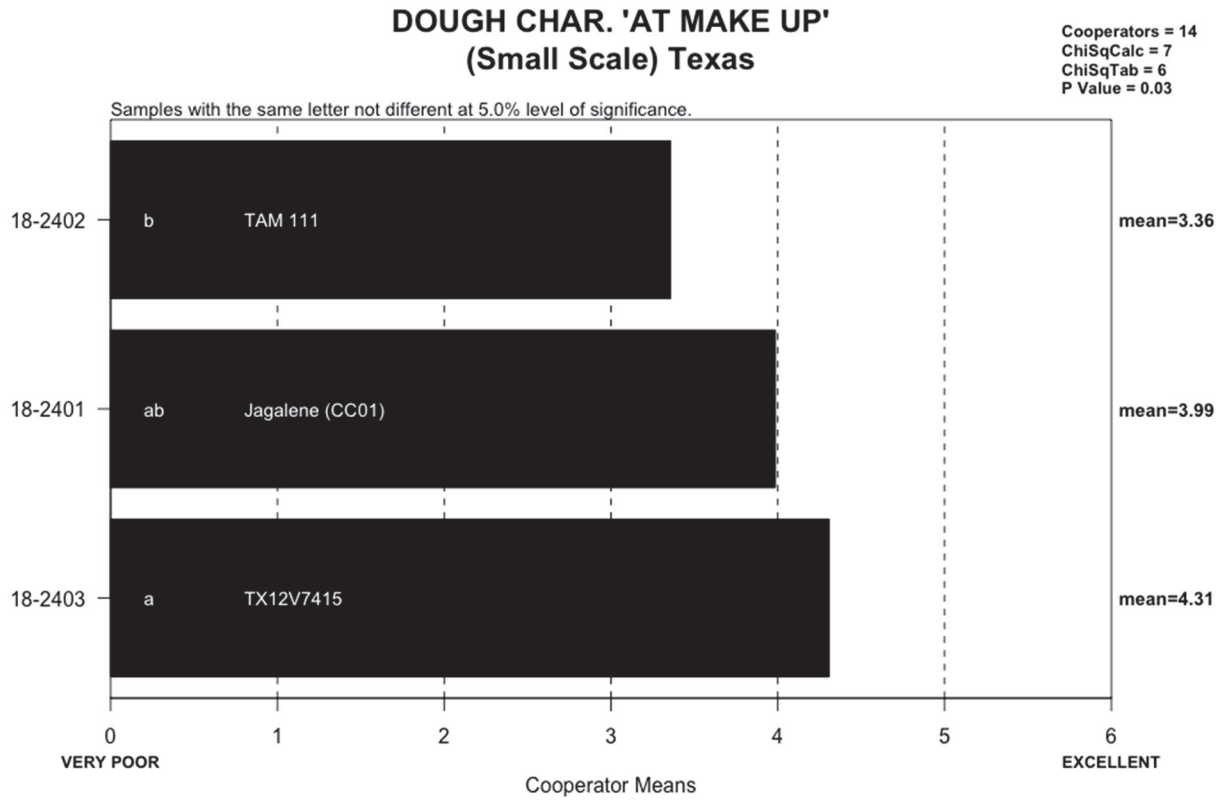

BAKE MIX TIME
(Small Scale) Texas
Cooperators = 14
ChiSqCalc = 18.3
ChiSqTab = 6
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2402
b
TAM 111
mean=2.57
18-2401
b
Jagalene (CC01)
mean=3.29
18-2403
a
TX12V7415
mean=4.71
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Texas
Cooperators = 13
ChiSqCalc = 11.1
ChiSqTab = 6
P Value = 0.004
Samples with the same letter not different at 5.0% level of significance.
18-2402
b
TAM 111
mean=2.69
18-2401
ab
Jagalene (CC01)
mean=3.58
18-2403
a
TX12V7415
mean=4.15
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means



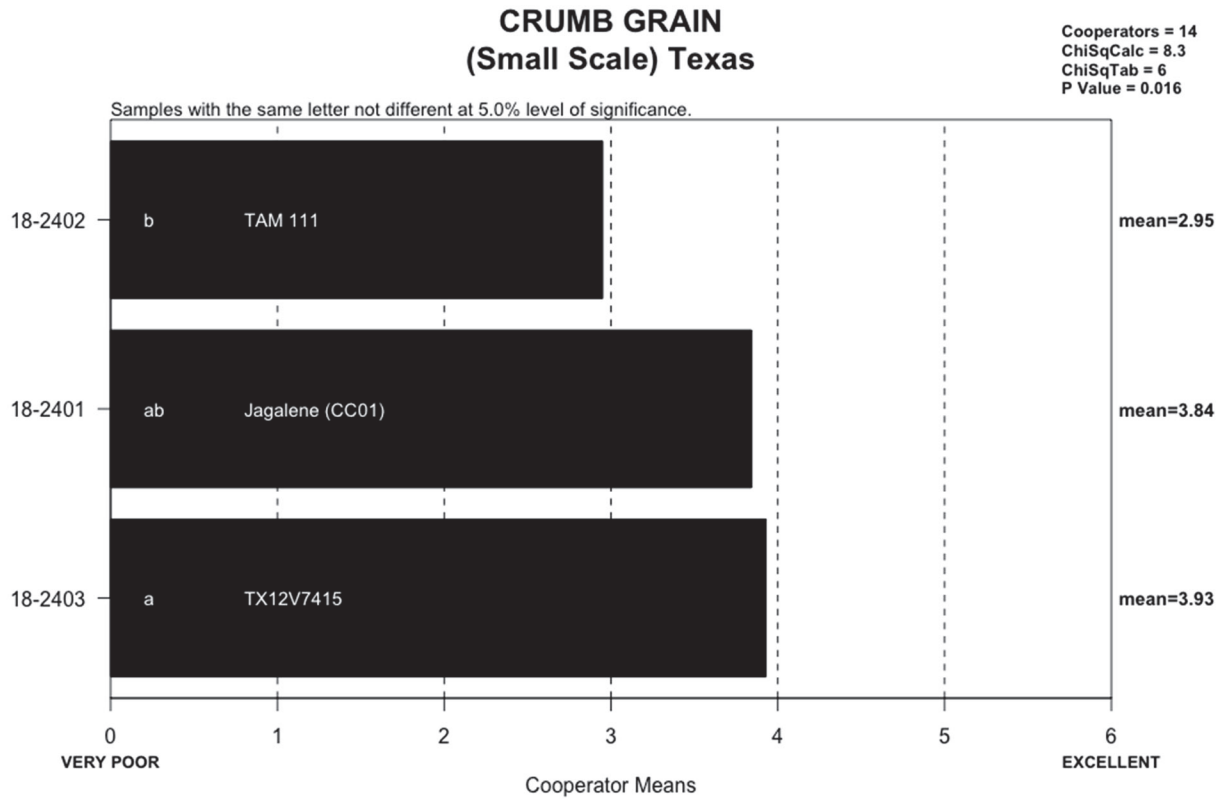
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Texas

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2401	Jagalene (CC01)	2	0	2	9	1
18-2402	TAM 111	4	2	1	7	0
18-2403	TX12V7415	2	1	3	6	2



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Small Scale) Texas

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2401	Jagalene (CC01)	2	0	1	9	2
18-2402	TAM 111	2	4	1	7	0
18-2403	TX12V7415	0	1	3	10	0

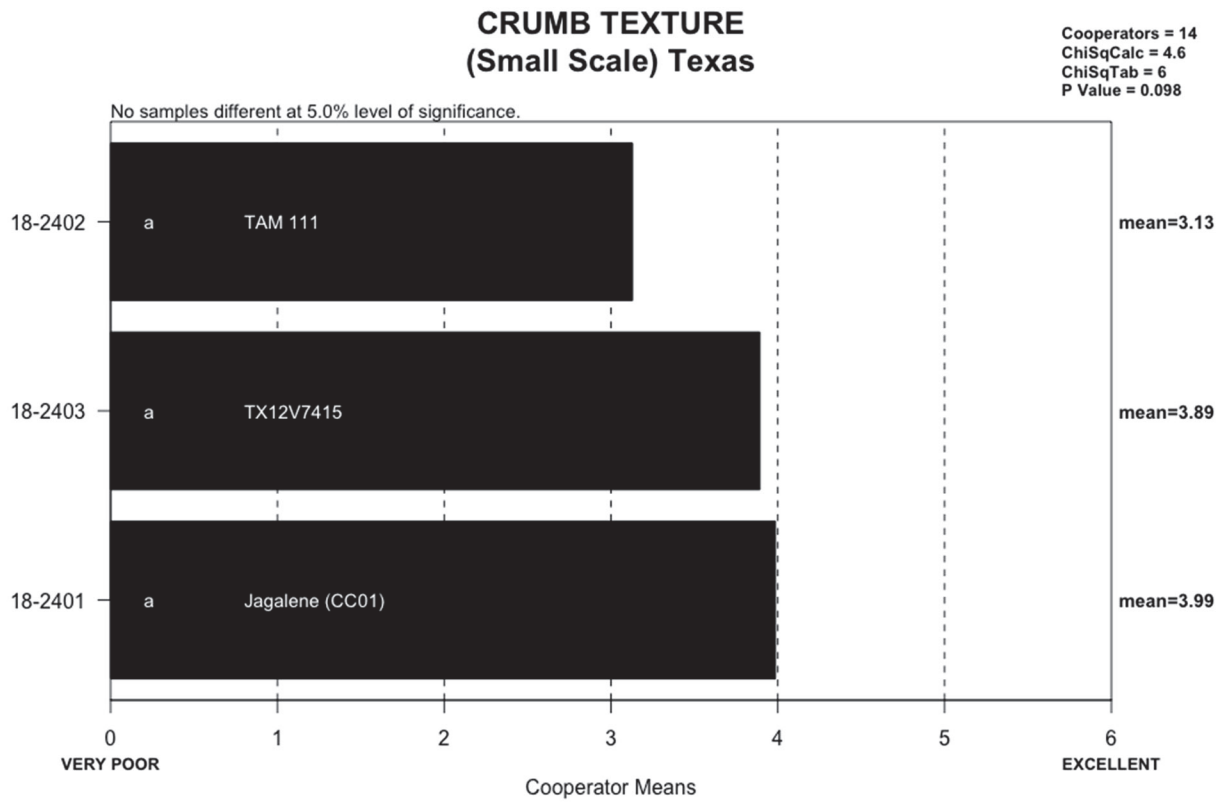


CRUMB GRAIN, DESCRIBED
(Small Scale) Texas

IDCODE	ID	Open	Fine	Dense
18-2401	Jagalene (CC01)	6	7	1
18-2402	TAM 111	7	4	3
18-2403	TX12V7415	3	10	1

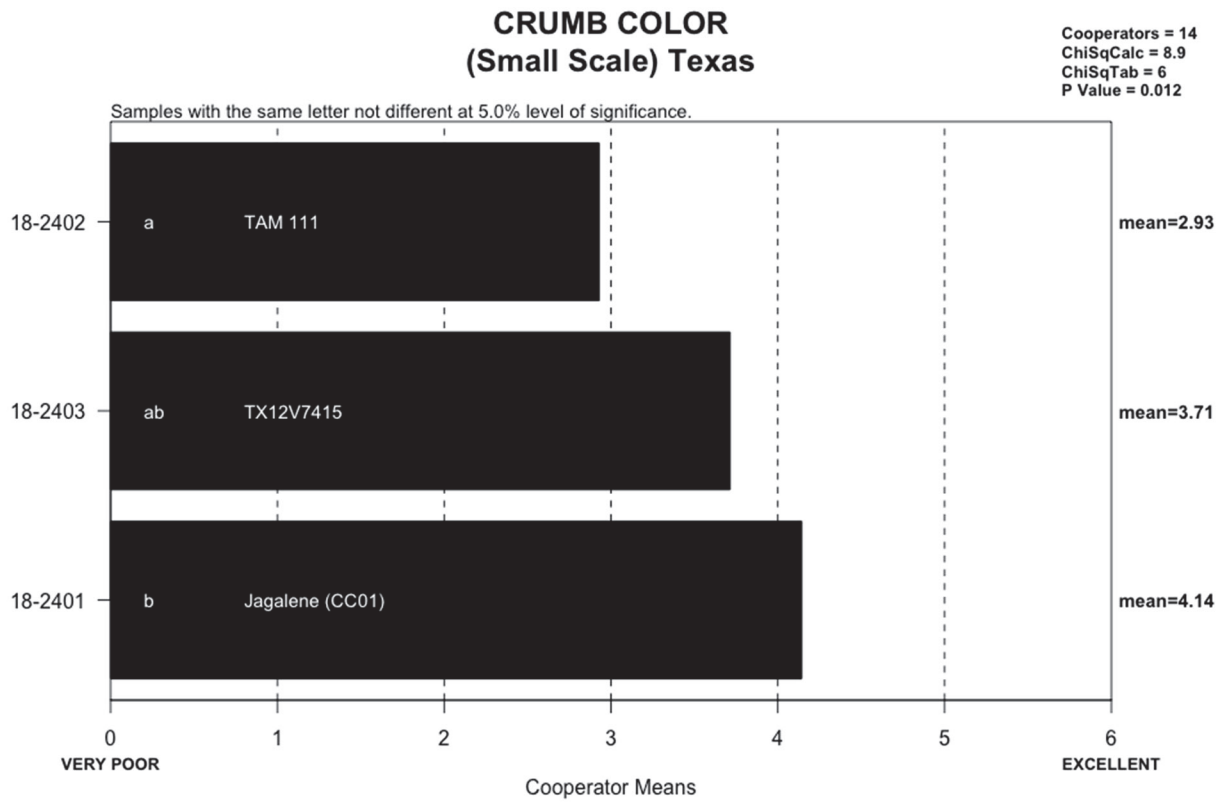
CELL SHAPE, DESCRIBED
(Small Scale) Texas

IDCODE	ID	Round	Irregular	Elongated
18-2401	Jagalene (CC01)	5	4	5
18-2402	TAM 111	8	2	4
18-2403	TX12V7415	4	3	7



CRUMB TEXTURE, DESCRIBED
(Small Scale) Texas

IDCODE	ID	Harsh	Smooth	Silky
18-2401	Jagalene (CC01)	3	7	4
18-2402	TAM 111	6	8	0
18-2403	TX12V7415	3	8	3



CRUMB COLOR, DESCRIBED
(Small Scale) Texas

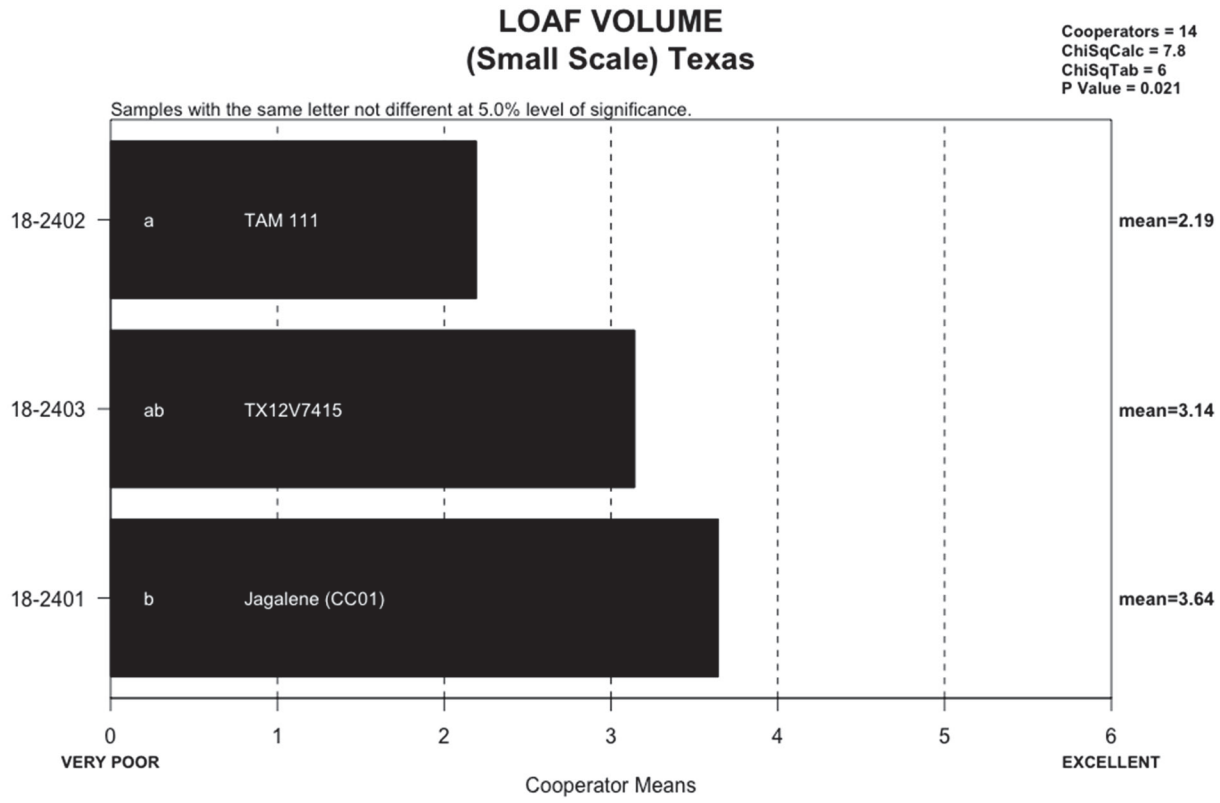
IDCODE	ID	Gray	DarkYellow	Yellow	Dull	Creamy	White	Bright White
18-2401	Jagalene (CC01)	0	0	3	1	4	5	1
18-2402	TAM 111	0	0	4	4	6	0	0
18-2403	TX12V7415	0	0	3	1	9	1	0

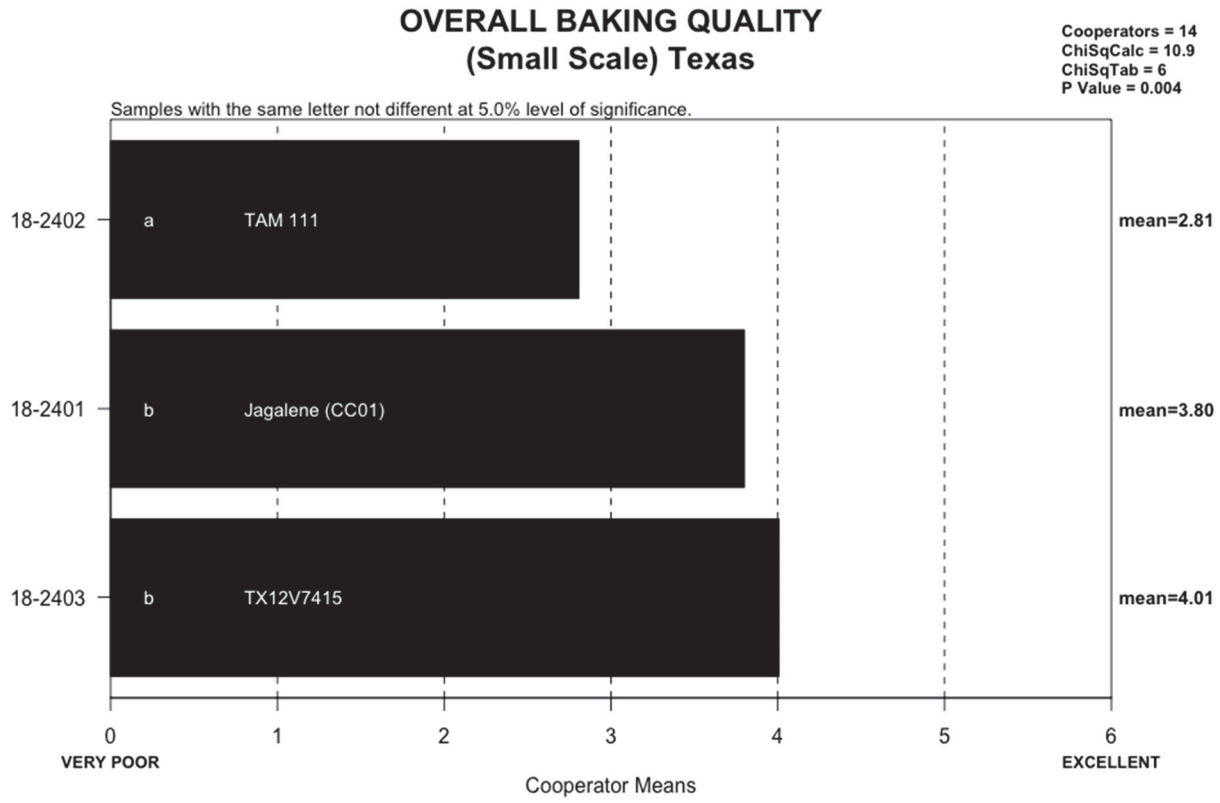
LOAF WEIGHT, ACTUAL
(Small Scale) Texas
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2401	Jagalene (CC01)	141.4	143.3	156.7	141.3	412	458.7	132.9	133.5	132.6	145.1	432.9	142.2	483.3	150.5
18-2402	TAM 111	140.8	143.6	154.9	138.5	410	464.2	133.5	133.2	134.2	146.0	434.4	143.4	481.8	152.2
18-2403	TX12V7415	142.2	143.0	154.6	142.8	413	465.5	131.7	136.4	130.1	145.9	439.4	141.6	492.4	153.8

LOAF VOLUME, ACTUAL
(Small Scale) Texas
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2401	Jagalene (CC01)	985	940	943	948	2925	2188	755	825	900	905	2600	806	2868	920
18-2402	TAM 111	850	740	878	865	2675	2075	680	815	775	745	2400	690	2662	835
18-2403	TX12V7415	925	895	860	853	2750	2263	705	830	915	895	2725	784	2927	810


LOAF VOLUME
(Small Scale) Texas
Cooperators = 14
ChiSqCalc = 7.8
ChiSqTab = 6
P Value = 0.021
Samples with the same letter not different at 5.0% level of significance.
18-2402
a
TAM 111
mean=2.19
18-2403
ab
TX12V7415
mean=3.14
18-2401
b
Jagalene (CC01)
mean=3.64
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Small Scale) Texas
Cooperators = 14
ChiSqCalc = 10.9
ChiSqTab = 6
P Value = 0.004
Samples with the same letter not different at 5.0% level of significance.
18-2402
a
TAM 111
mean=2.81
18-2401
b
Jagalene (CC01)
mean=3.80
18-2403
b
TX12V7415
mean=4.01
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Small Scale) Texas

COOP. **18-2401 Jagalene (CC01)**

A. Loaf volume better than protein predicted LV.
B. Excellent loaf externals.
C. Weaker dough performance, good volume performance for protein level.
D. Average protein, normal water absorption & MT, Slight Sticky & Strong Dough, High Volume, Yellow Crumb, Open Elongated Cells, Resilient & Smooth Texture.
E. Slightly soft out of mixer but recovered at makeup. Nice interior, best volume of group. Slightly creamy crumb.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Average protein, weaker, ok crumb but good color.
K. Shorter mix time but good overall dough notes. Absorption high and good protein. Good for bread application.
L. No comment.
M. Good absorption, low mix strength and good loaf volume.
N. High absorption, open grain, yellow crumb.

COOP. **18-2402 TAM 111**

A. No comment.
B. Weak at pan, slight cap.
C. Weaker dough performance but protein fairly low. Average bread performance.
D. Medium Protein, Low Water Abs, Normal MT, Slight Sticky & Strong Dough, Medium Volume, Yellow Crumb, Fine Elongated Cells, Resilient & Smooth Texture.
E. Soft out of mixer and makeup, low loaf volume, fine grain.
F. No comment.
G. No comment.
H. Lower loaf volume but good absorption.
I. No comment.
J. Poor volume/texture, weak.
K. Short mix time, slightly wet dough characteristics and low volume and protein. Okay for bread application and good for blending.
L. No comment.
M. Fair absorption, low mix strength and loaf volume.
N. Yellow crumb, average volume.

COOP. **18-2403 TX12V7415**

A. Loaf volume better than protein predicted LV, protein does not meet target range of 11%.
B. Rough break, cap.
C. Low protein, dough strength promising. Good volume for protein level.
D. Medium Protein, Low Water Abs, Long MT, Slight Sticky & Strong Dough, Medium Volume, Creamy Crumb, Fine Elongated Cells, Resilient & Smooth Texture.
E. Good pliable dough, good volume and mix time.
F. No comment.
G. No comment.
H. Even crumb, soft.
I. No comment.
J. Baked well for protein, very good ABS.
K. Protein low. Slightly longer mix time but great overall. Great to blend and for bread application.
L. No comment.
M. Good absorption, very good mix strength and good loaf volume.
N. High absorption, dense grain, yellow crumb, low volume.

Notes: **E, F, K and M** conducted sponge and dough bake tests

LIMAGRAIN

18-2404	LINK
18-2405	Jagalene (CC02)
18-2406	DH11HRW53-34
18-2407	LCI13DH-22-22

Description of Test Plots and Breeder Entries

Limagrain – Maria Barnett

Growing Location & Conditions

The hard winter Wheat Quality Council samples from Limagrain Cereal Seeds originated from strip increases grown in Leoti, KS. The WQC strips were planted on October 13, 2017 into good soil moisture with good fall stands and decent growth. The field received 90 lbs actual N top-dressed in early December, a broadleaf herbicide in early March, and one foliar fungicide (tebuconazole and azoxystrobin) application in mid-May. It was a dry growing season. Adjacent yield plots averaged 46 bushels/acre.

LCS Link – internal check

LCS Link is a double-haploid line jointly developed by the University of Nebraska and LCS. The sample yield averaged 59 bu/ac. LCS Link is a later maturing, hard red winter wheat adapted to the western High Plains and areas along I-70. It shows an intermediate reaction to stripe rust and is resistant to prevalent North American stem rust and leaf rust races. LCS Link has excellent winter-hardiness and straw strength. Pedigree is NW03681/SD07W084. The experimental name for LCS Link was LCH13NEDH-14-70.

Milling and baking quality data from LCS show promising overall milling and baking qualities, notably having highly desirable flour yields and mixo data.

LCI13DH-22-22

LCI13DH-22-22 is a double-haploid, early, hard white winter wheat line with good sprouting tolerance. The sample yield averaged 55 bu/ac. It is resistant to prevalent North American races of both stripe rust and stem rust. It is moderately susceptible to leaf rust. LCI13DH-22-22 has average winter-hardiness, good straw strength, large seed, and tolerance to acid soils. The line is best adapted to western Kansas, but also has favorable yield and quality reports coming from the Pacific Northwest as well. This line has recently been released as LCS Yeti.

Milling and baking quality data from LCS show highly desirable overall milling and baking qualities.

DH11HRW053-34

DH11HRW053-34 is a hard red winter wheat double-haploid line with medium-early maturity. DH11HRW053-34 has excellent straw strength and is moderately resistant to acid soils, leaf rust, stripe rust and stem rust. DH11HRW053-34 has intermediate resistance to Fusarium head blight being inferior to Everest yet superior to Karl92 and Overley. The targeted adaptation region is central Kansas and central Oklahoma. This line is on increase for potential release in August of 2019. Pedigree is KS010729TM-3/Vision 20. The line was tested in the 2018 USDA/ARS Uniform Bread Wheat Trial.

Milling and baking quality data from LCS show above average protein, above average mixo tolerance, and above average loaf volume.

Jagalene – common check

Limagrain: 2018 (Small-Scale) Samples

Test entry number	18-2404	18-2405	18-2406	18-2407
Sample identification	**LINK**	**Jagalene (CC02)**	**DH11HRW53-34**	**LCI13DH-22-22**
Wheat Data				
GIPSA classification	2 HRW	2 HRW	2 HDWH	1 HDWH
Test weight (lb/bu)	59.5	59.8	58.8	61.7
Hectoliter weight (kg/hl)	78.2	78.6	77.3	81.1
1000 kernel weight (gm)	33.1	33.4	29.2	36.8
Wheat kernel size (Rotap)				
Over 7 wire (%)	77.4	64.7	56.5	90.8
Over 9 wire (%)	22.4	34.2	42.9	9.2
Through 9 wire (%)	0.2	1.1	0.6	0.0
Single kernel (skcs)[a]				
Hardness (avg /s.d)	59.3/16.5	62.6/18.1	56.0/14.7	56.6/13.4
Weight (mg) (avg/s.d)	33.1/8.4	33.4/10.3	29.2/9.6	36.8/7.4
Diameter (mm)(avg/s.d)	2.68/0.35	2.70/0.32	2.46/0.33	2.86/0.31
Moisture (%) (avg/s.d)	112.9/0.3	12.2/0.3	12.6/0.3	10.4/0.5
SKCS distribution	03-17-33-47-01	04-11-29-56-01	07-18-32-43-01	04-19-35-42-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	14.1	14.5	15.2	13.3
Wheat ash (12% mb)	1.53	1.53	1.57	1.53
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	78.0	78.9	75.4	76.3
Quadrumat Sr. Mill	70.7	69.8	69.9	70.4
Flour moisture (%)	13.4	12.8	12.8	13.0
Flour protein (14% mb)	13.2	13.6	14.2	12.2
Flour ash (14% mb)	0.58	0.62	0.52	0.51
Rapid Visco-Analyser				
Peak Time (min)	6.3	6.2	6.3	6.3
Peak Viscosity (RVU)	240.7	204.6	252.8	264.0
Breakdown (RVU)	93.1	70.8	92.2	89.5
Final Viscosity at 13 min (RVU)	256.9	252.3	270.3	283.3
Minolta color meter				
L*	91.46	90.94	91.53	92.03
a*	-0.87	-0.92	-0.89	-1.37
b*	7.62	8.53	7.39	8.28
PPO	0.643	0.737	0.946	0.708
Falling number (sec)	427	439	413	448
Damaged Starch				
(AI%)	97.0	97.8	96.4	96.9
(AACC76-31)	7.0	7.8	6.6	7.0

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

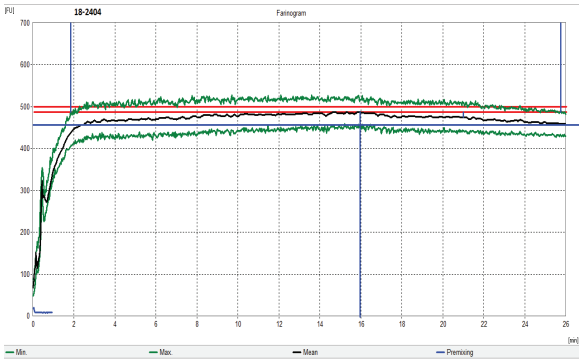
Limagrain: Physical Dough Tests and Gluten Analysis
2018 (Small-Scale) Samples

Test Entry Number	18-2404	18-2405	18-2406	18-2407
Sample Identification	LINK	Jagalene (CC02)	DH11HRW53-34	LCI13DH-22-22
MIXOGRAPH				
Flour Abs (% as-is)	67.1	69.0	68.9	65.3
Flour Abs (14% mb)	66.6	67.9	67.6	64.2
Mix Time (min)	4.5	4.5	8.9	4.0
Mix tolerance (0-6)	4	5	6	4
FARINOGRAPH				
Flour Abs (% as-is)	62.3	63.1	62.0	63.1
Flour Abs (14% mb)	61.8	61.9	60.7	61.9
Peak time (min)	16.0	4.7	8.4	8.3
Mix stability (min)	23.9	23.5	27.8	17.4
Mix Tolerance Index (FU)	12	10	13	16
Breakdown time (min)	26.8	22.0	29.0	18.6
ALVEOGRAPH				
P(mm): Tenacity	94	103	115	97
L(mm): Extensibility	103	91	83	87
G(mm): Swelling index	22.6	21.2	20.3	20.8
W(10^{-4} J): strength (curve area)	370	376	427	315
P/L: curve configuration ratio	0.91	1.13	1.39	1.11
Ie(P_{200}/P): elasticity index	67.0	69.3	77.5	63.0
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	455/756/751	511/665/682	704/1430/1638	412/498/506
Extensibility (mm at 45/90/135 min)	150/140/126	166/157/154	137/102/85	146/137/138
Energy (cm^2 at 45/90/135 min)	125/197/162	171/203/200	164/181/151	106/120/124
Resist $_{max}$ (BU at 45/90/135 min)	656/1181/1066	834/1084/1065	999/1556/1638	561/701/705
Ratio (at 45/90/135 min)	3.0/5.4/6.0	3.1/4.2/4.4	5.1/14.0/19.1	2.8/3.6/3.7
PROTEIN ANALYSIS				
HMW-GS Composition	2*, 7+8, 5+10	1,2*,17+18, 5+10	2*, 7+8, 5+10	2*,17+18,5+10
TMP/TPP	0.87	1.02	0.97	0.78
SEDIMENTATION TEST				
Volume (ml)	59.7	66.3	70.1	51.9

Physical Dough Tests

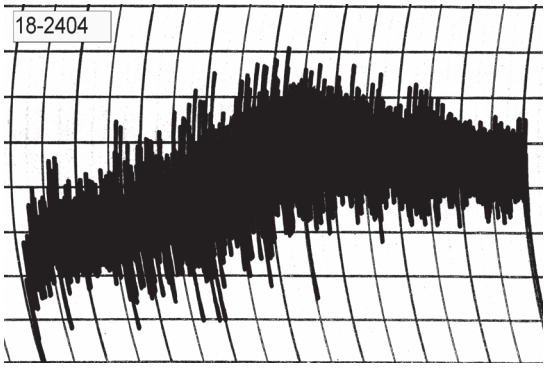
2018 (Small Scale) Samples – Limagrain

Farinograms



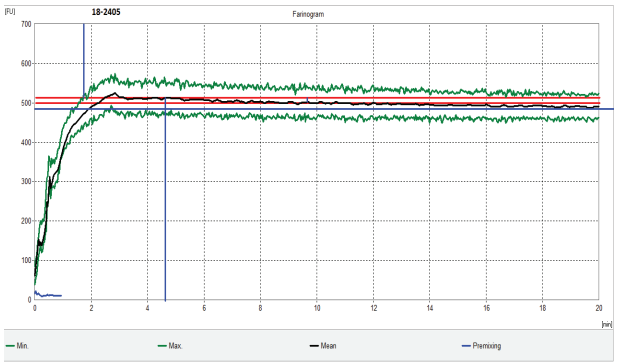
Water abs = 61.8%, Peak time = 16.0 min
Mix stab = 23.9 min, MTI = 12 FU

Mixograms

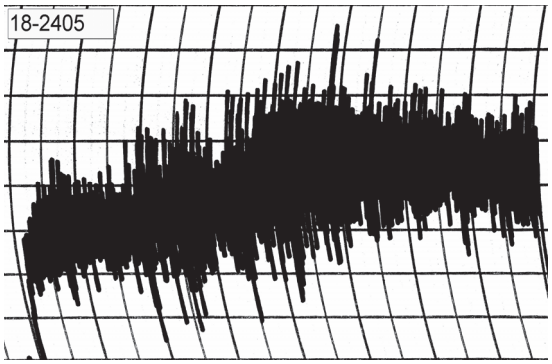


Water abs = 66.6%
Mix time = 4.5 min

18-2404, LINK



Water abs = 61.9%, Peak time = 4.7 min,
Mix stab = 23.5 min, MTI = 10 FU



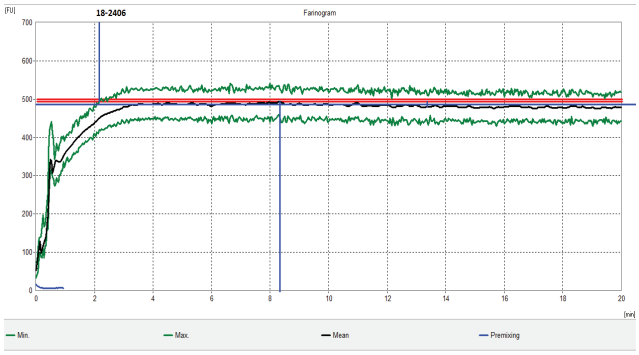
Water abs = 67.9%
Mix time = 4.5 min

18-2405, Jagalene (CC02)

Physical Dough Tests

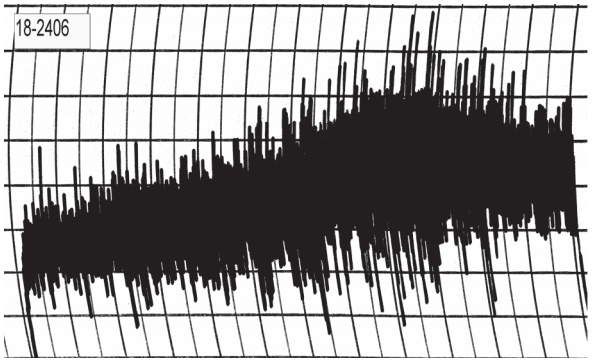
2018 (Small Scale) Samples – Limagrain (continued)

Farinograms



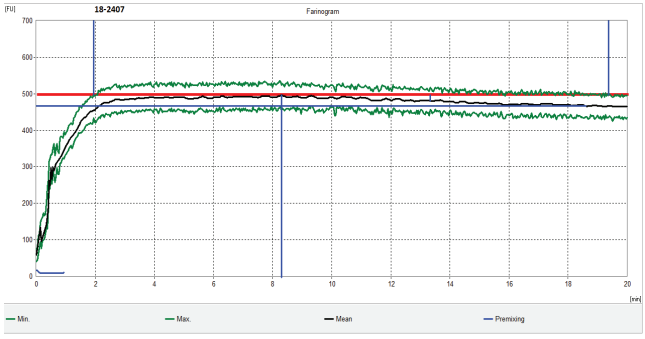
Water abs. = 60.7%, Peak time = 8.4 min,
Mix stab = 27.8 min, MTI = 13 FU

Mixograms

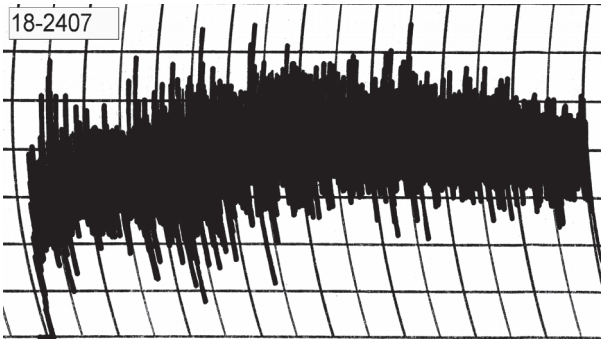


Water abs = 67.6%
Mix time = 8.9 min

18-2406, DH11HRW53-34



Water abs. = 61.9%, Peak time = 8.3 min,
Mix stab = 17.4 min, MTI = 16 FU

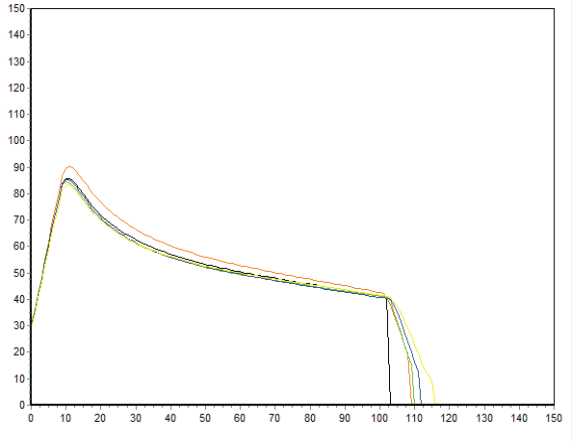


Water abs = 64.2%
Mix time = 4.0 min

18-2407, LCI13DH-22-22

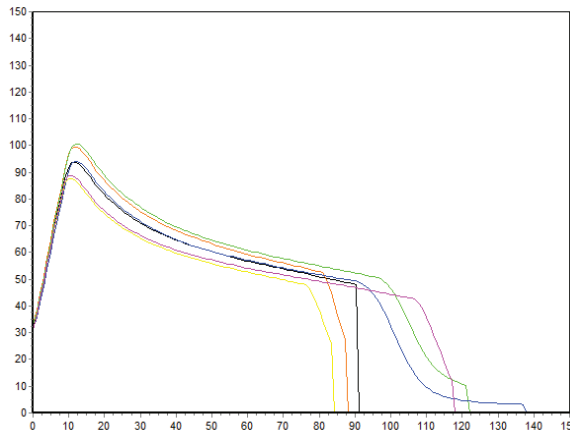
Physical Dough Tests - Alveograph

2018 (Small Scale) Samples – Limagrain



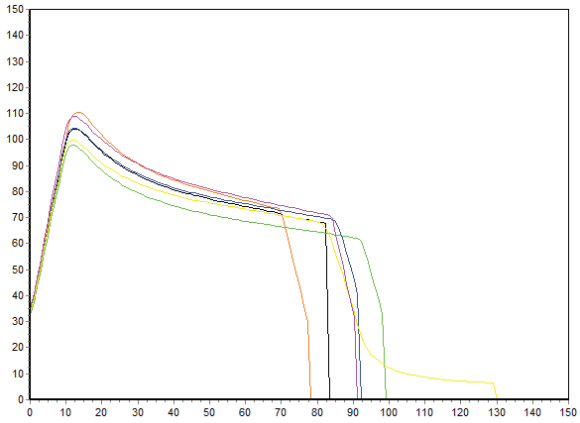
18-2404, LINK

P (mm H_20) = 94, L (mm) = 103, W ($10E^{-4}J$) = 370



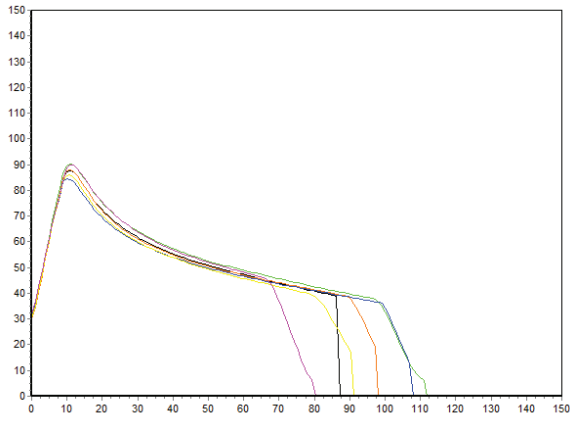
18-2405, Jagalene (CC02)

P (mm H_20) = 103, L (mm) = 91, W ($10E^{-4}J$) = 376



18-2406, DH11HRW53-34

P (mm H_20) = 115, L (mm) = 83, W ($10E^{-4}J$) = 427

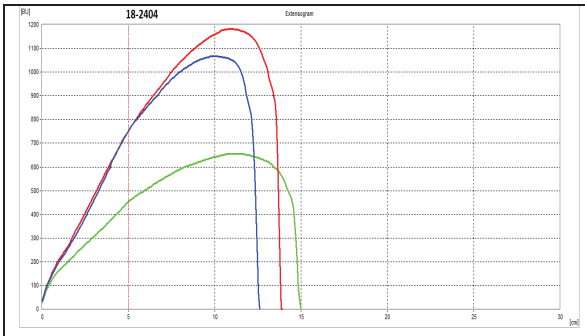


18-2407, LCI3DH-22-22

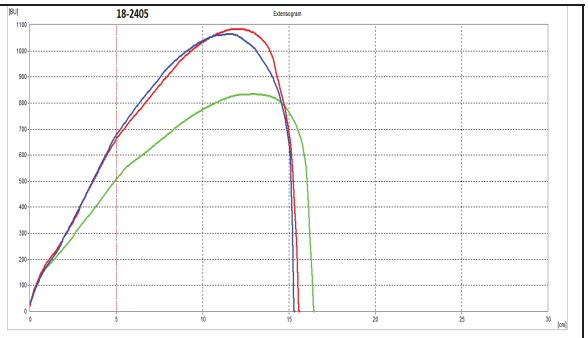
P (mm H_20) = 97, L (mm) = 87, W ($10E^{-4}J$) = 315

Physical Dough Tests - Extensigraph

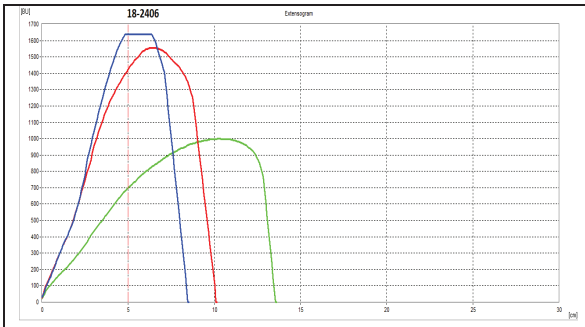
2018 (Small Scale) Samples – Limagrain



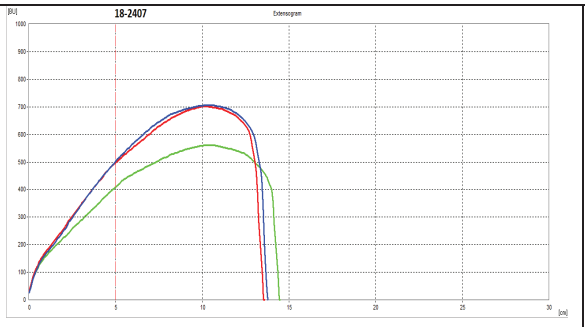
18-2404, LINK
R (BU) = 756 E (mm) = 140, W (cm^2) = 197
Rmax (BU) = 1181, Ratio = 5.4 at 90 min



18-2405, Jagalene (CC02)
R (BU) = 665, E (mm) = 157, W (cm^2) = 203
Rmax (BU) = 1084, Ratio = 4.2 at 90 min



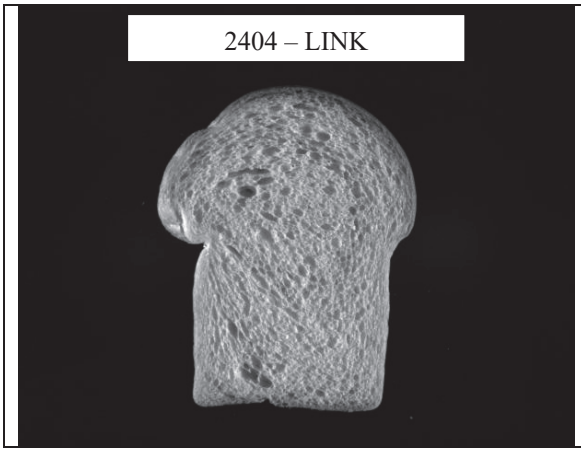
18-2406, DH11HRW53-34
R (BU) = 1430, E (mm) = 102, W (cm^2) = 81
Rmax (BU) = 1556, Ratio = 14.0 at 90 min

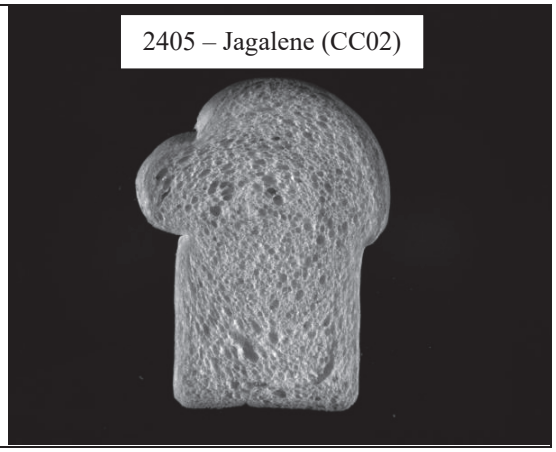


18-2407, LCI13DH-22-22
R (BU) = 498, E (mm) = 137, W (cm^2) = 120
Rmax (BU) = 701, Ratio = 3.6 at 90 min

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.

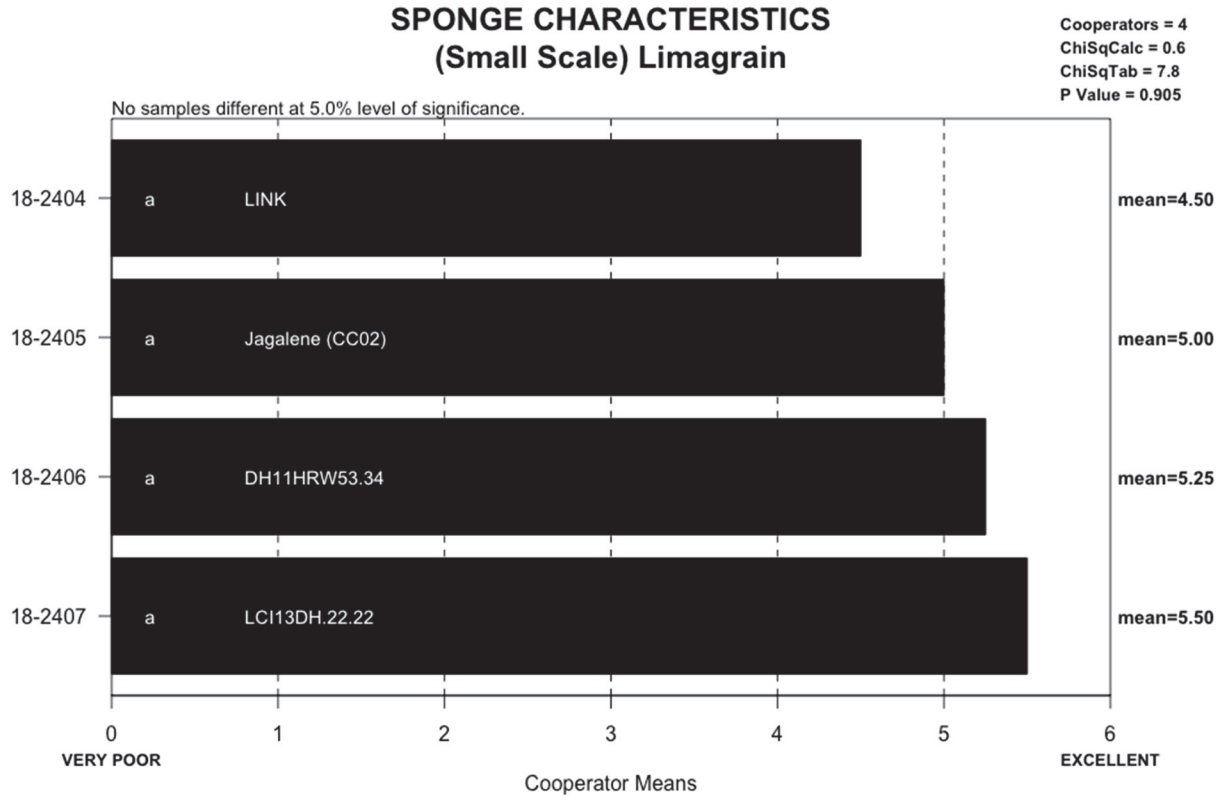
Limagrain: C-Cell Bread Images and Analysis
2018 (Small-Scale) Samples

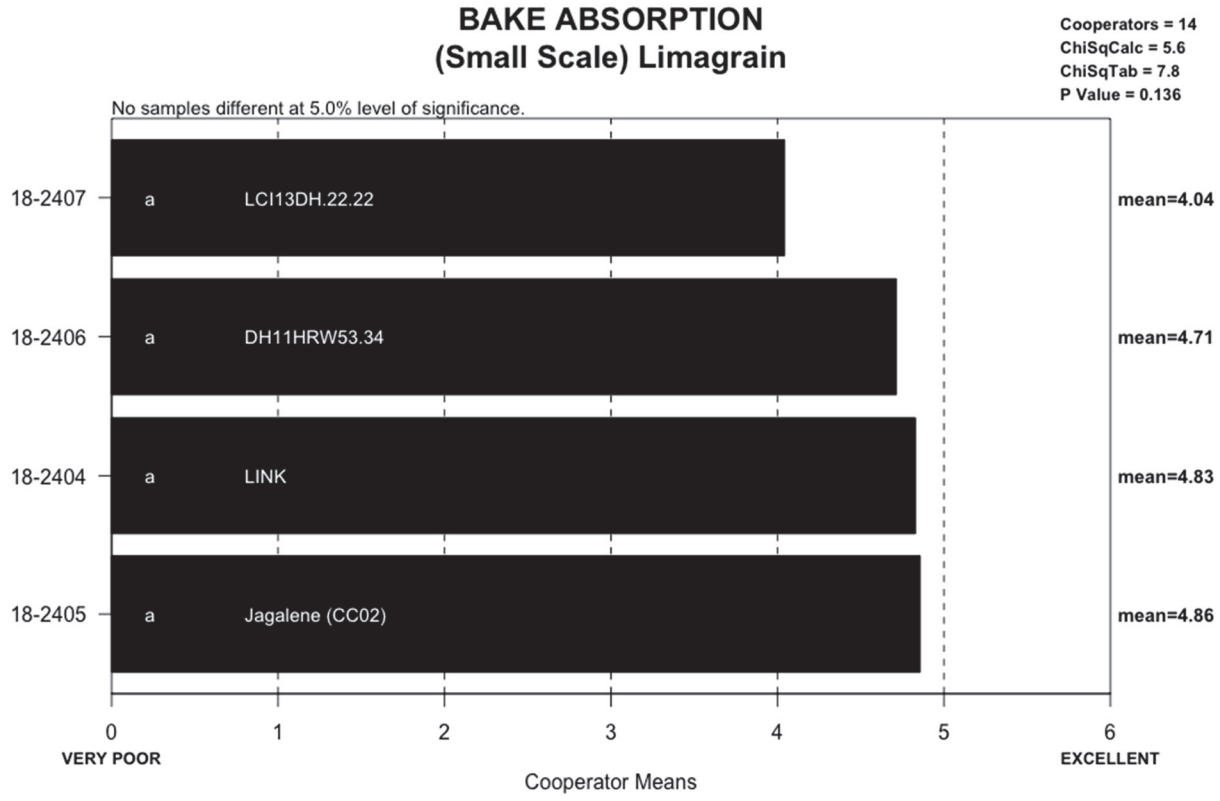




Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2404	6954	141	4143	0.447	2.155	0.918	1.775	-16.15
2405	7080	135	4371	0.436	2.017	1.227	1.740	-12.85

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})
2406	7121	135	4149	0.444	2.082	5.357	1.713	-18.78
2407	6449	144	3875	0.441	2.095	0.941	1.730	-15.70


SPONGE CHARACTERISTICS
(Small Scale) Limagrain
Cooperators = 4
ChiSqCalc = 0.6
ChiSqTab = 7.8
P Value = 0.905
No samples different at 5.0% level of significance.
18-2404
a
LINK
mean=4.50
18-2405
a
Jagalene (CC02)
mean=5.00
18-2406
a
DH11HRW53.34
mean=5.25
18-2407
a
LCI13DH.22.22
mean=5.50
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

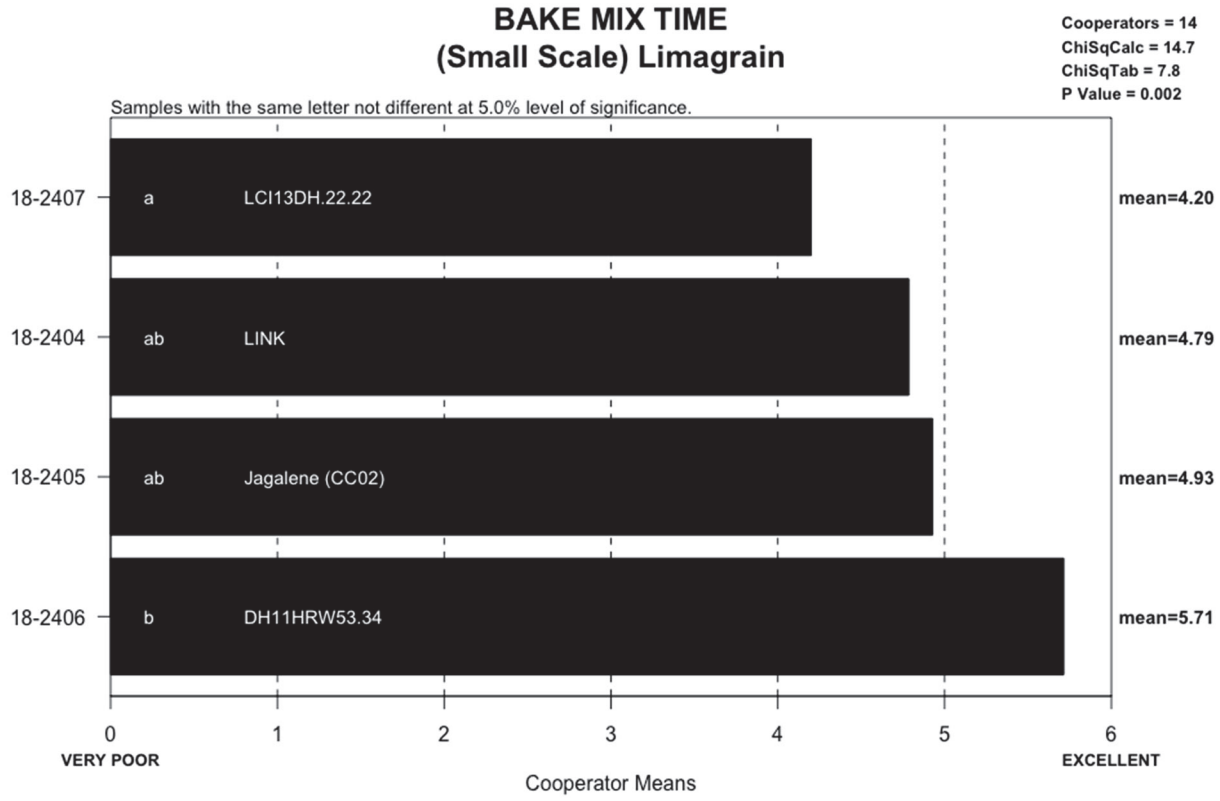

BAKE ABSORPTION
(Small Scale) Limagrain
Cooperators = 14
ChiSqCalc = 5.6
ChiSqTab = 7.8
P Value = 0.136
No samples different at 5.0% level of significance.
18-2407
a
LCI13DH.22.22
mean=4.04
18-2406
a
DH11HRW53.34
mean=4.71
18-2404
a
LINK
mean=4.83
18-2405
a
Jagalene (CC02)
mean=4.86
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

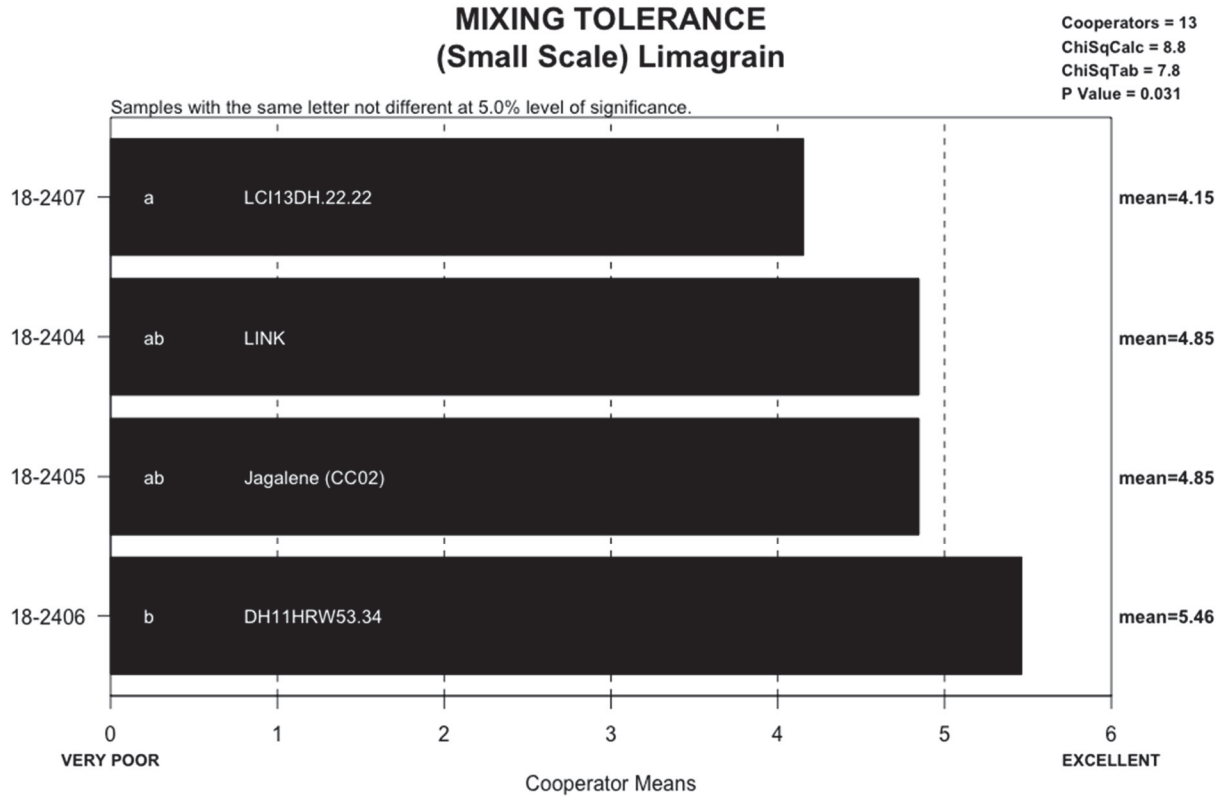
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Limagrain
Cooperators A – N

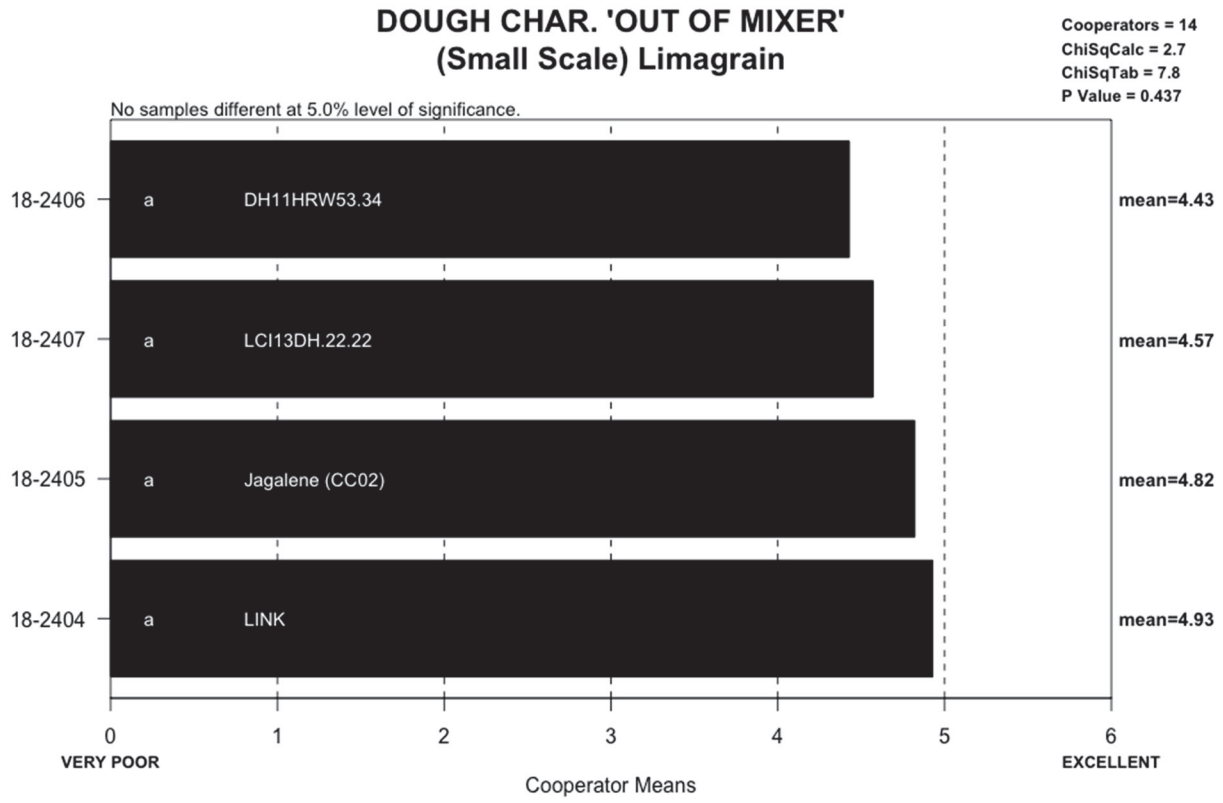
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2404	LINK	65.3	66.5	67.6	64.6	60	61.8	62.7	69.0	64.2	67	65.8	64.9	58	67.2
18-2405	Jagalene (CC02)	66.1	67.0	67.5	66.1	60	61.9	63.2	70.1	64.4	68	65.8	63.9	59	68.6
18-2406	DH11HRW53-34	67.3	68.8	67.7	65.6	61	60.7	64.3	70.1	62.8	70	64.4	61.8	58	68.4
18-2407	LCI13DH-22-22	63.7	62.1	66.9	63.1	59	61.9	61.1	67.9	64.5	66	65.9	61.8	59	65.6

BAKE MIX TIME, ACTUAL
(Small Scale) Limagrain
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2404	LINK	5.3	5.3	6.0	7.5	16	10	3.9	4.5	4.5	4.2	24	4.3	25	6.3
18-2405	Jagalene (CC02)	6.0	5.0	5.8	7.8	19	11	4.0	5.5	4.5	3.8	24	4.5	25	6.8
18-2406	DH11HRW53-34	10.0	9.0	9.5	12.0	20	26	6.4	7.3	6.0	6.5	24	5.2	25	11.3
18-2407	LCI13DH-22-22	4.3	4.5	5.3	5.3	9	9	4.2	4.5	3.5	3.9	12	3.7	25	4.8

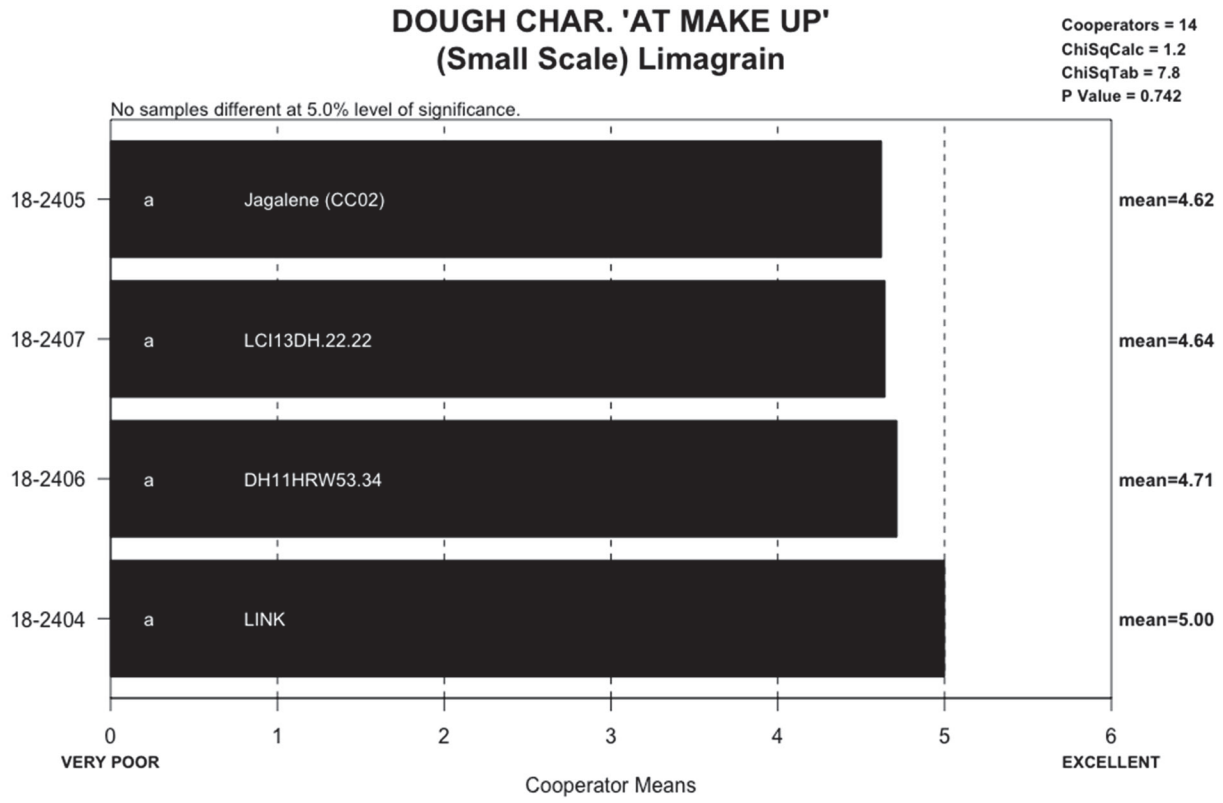

BAKE MIX TIME
(Small Scale) Limagrain
Cooperators = 14
ChiSqCalc = 14.7
ChiSqTab = 7.8
P Value = 0.002
Samples with the same letter not different at 5.0% level of significance.
18-2407
a
LCI13DH.22.22
mean=4.20
18-2404
ab
LINK
mean=4.79
18-2405
ab
Jagalene (CC02)
mean=4.93
18-2406
b
DH11HRW53.34
mean=5.71
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Limagrain
Cooperators = 13
ChiSqCalc = 8.8
ChiSqTab = 7.8
P Value = 0.031
Samples with the same letter not different at 5.0% level of significance.
18-2407
a
LCI13DH.22.22
mean=4.15
18-2404
ab
LINK
mean=4.85
18-2405
ab
Jagalene (CC02)
mean=4.85
18-2406
b
DH11HRW53.34
mean=5.46
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means



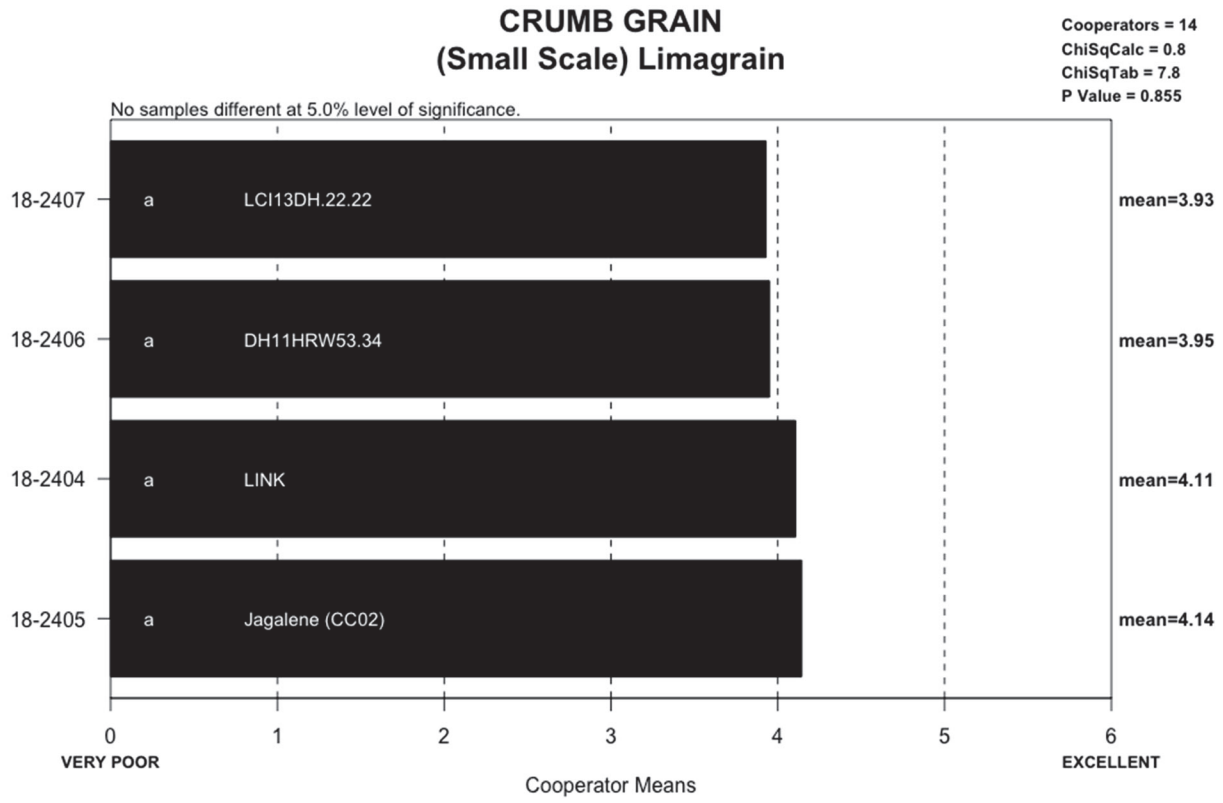
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Limagrain

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2404	LINK	0	1	1	9	3
18-2405	Jagalene (CC02)	0	1	2	8	3
18-2406	DH11HRW53-34	1	1	7	4	1
18-2407	LCI13DH-22-22	1	0	3	9	1



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Small Scale) Limagrain

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2404	LINK	0	0	3	7	4
18-2405	Jagalene (CC02)	1	1	3	6	3
18-2406	DH11HRW53-34	0	0	8	3	3
18-2407	LCI13DH-22-22	2	0	1	10	1

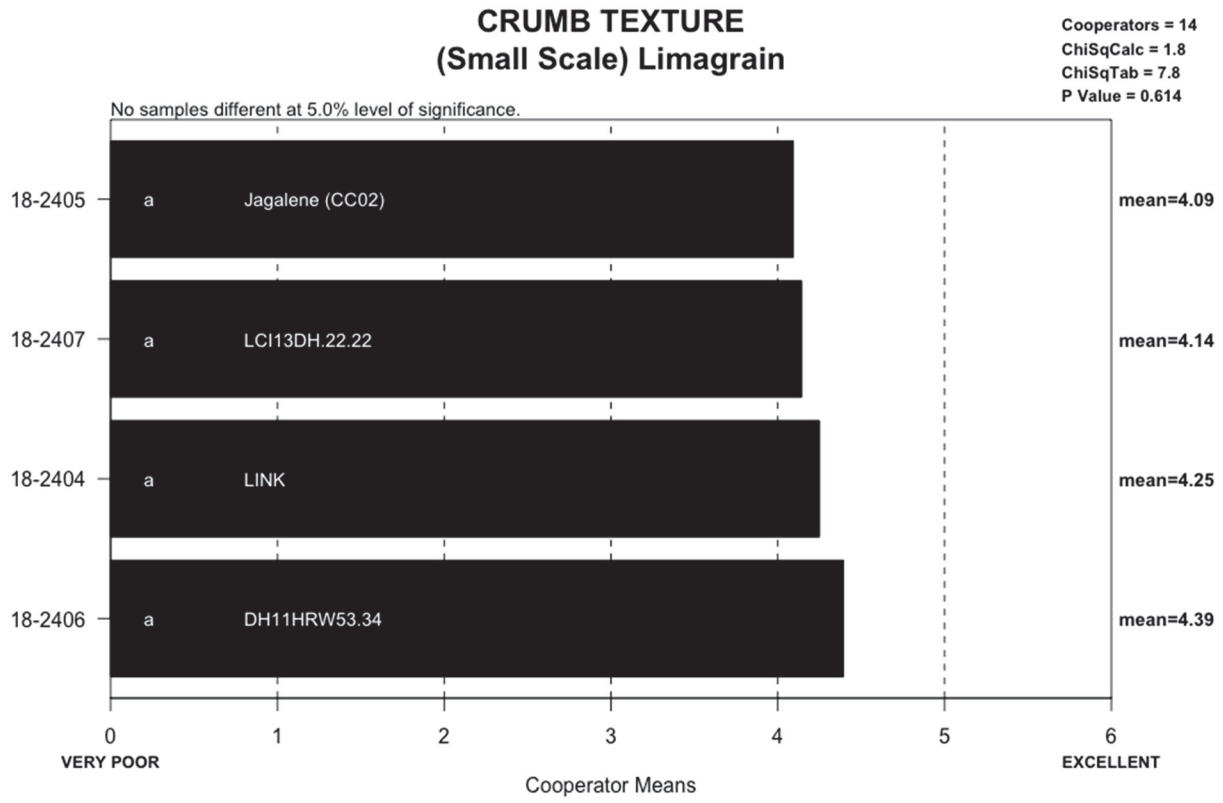


CRUMB GRAIN, DESCRIBED
(Small Scale) Limagrain

IDCODE	ID	Open	Fine	Dense
18-2404	LINK	5	9	0
18-2405	Jagalene (CC02)	5	8	1
18-2406	DH11HRW53-34	9	4	1
18-2407	LCI13DH-22-22	7	6	1

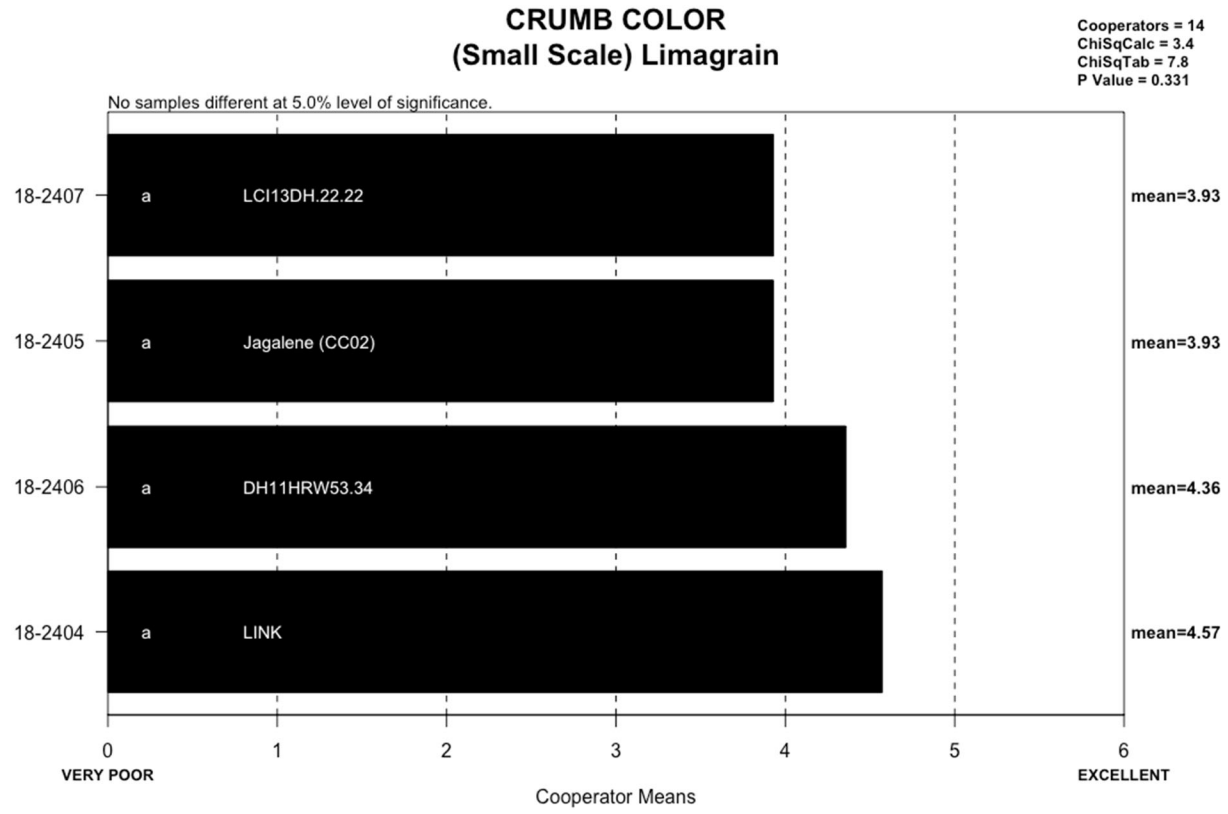
CELL SHAPE, DESCRIBED
(Small Scale) Limagrain

IDCODE	ID	Round	Irregular	Elongated
18-2404	LINK	2	4	8
18-2405	Jagalene (CC02)	4	6	4
18-2406	DH11HRW53-34	5	3	6
18-2407	LCI13DH-22-22	6	2	6



CRUMB TEXTURE, DESCRIBED
(Small Scale) Limagrain

IDCODE	ID	Harsh	Smooth	Silky
18-2404	LINK	1	6	7
18-2405	Jagalene (CC02)	3	8	3
18-2406	DH11HRW53-34	1	8	5
18-2407	LCI13DH-22-22	2	8	4



CRUMB COLOR, DESCRIBED
(Small Scale) Limagrain

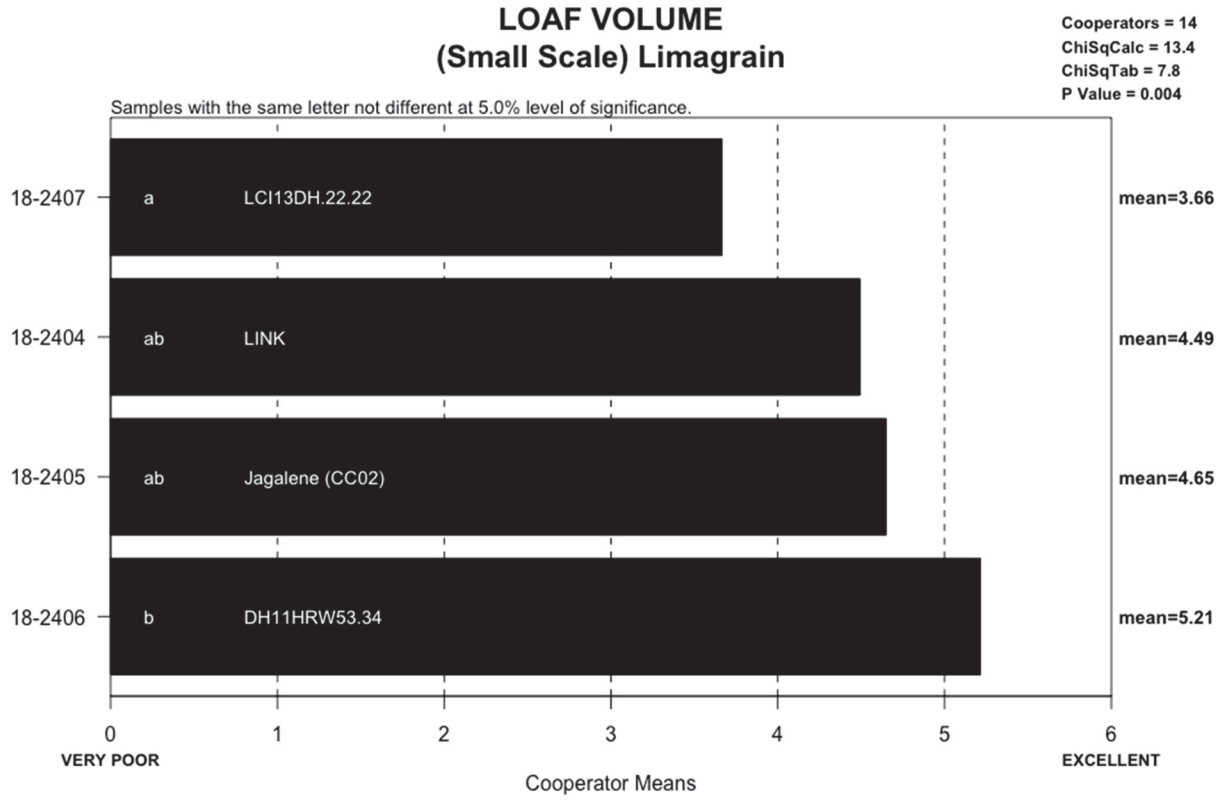
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
18-2404	LINK	0	0	0	0	8	5	1
18-2405	Jagalene (CC02)	0	1	0	4	5	4	0
18-2406	DH11HRW53-34	0	0	0	4	4	5	1
18-2407	LCI13DH-22-22	0	0	2	1	8	3	0

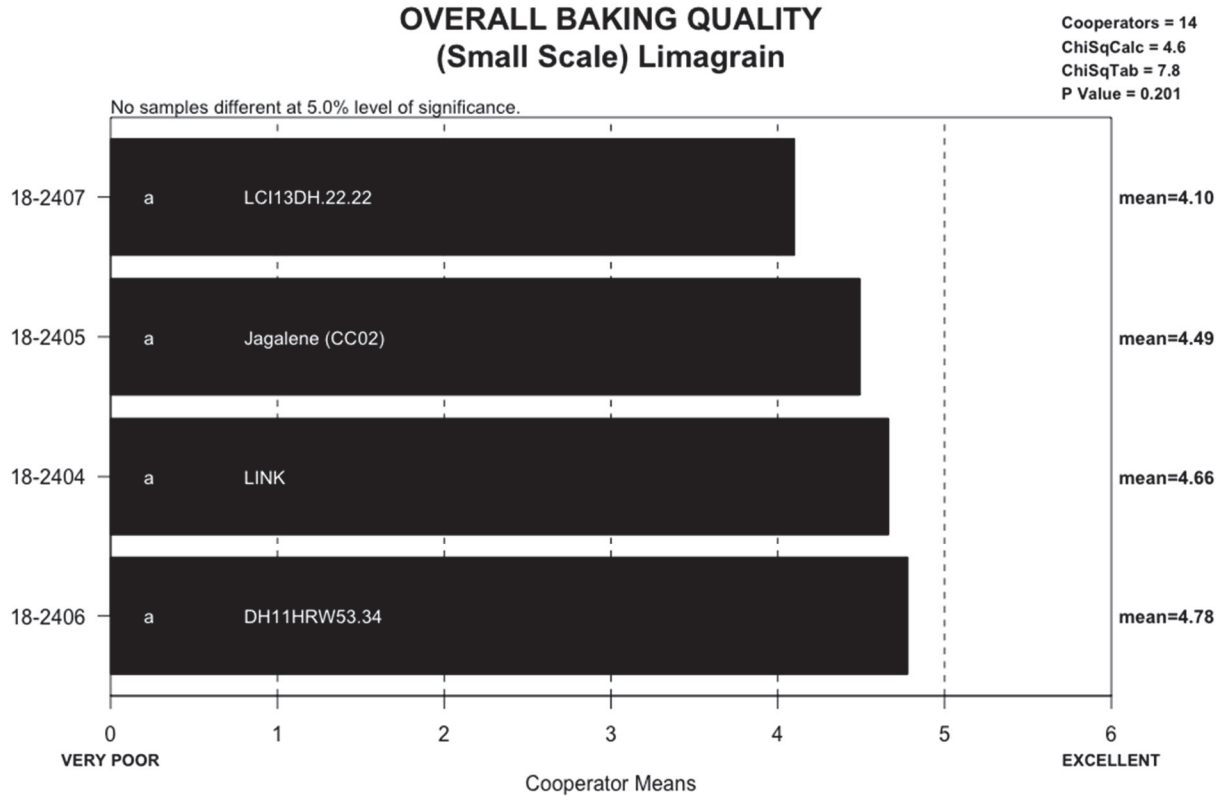
LOAF WEIGHT, ACTUAL
(Small Scale) Limagrain
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2404	LINK	142.2	144.1	155.9	143.0	410	462.7	133.0	134.2	131.6	144.6	436.4	140.7	480.9	154.2
18-2405	Jagalene (CC02)	141.9	143.7	159.3	141.5	410	466.7	132.9	135.0	133.0	146.5	438.0	140.4	497.4	153.7
18-2406	DH11HRW53-34	142.5	144.2	157.2	141.7	413	469.9	130.5	134.0	129.8	147.4	440.9	140.1	496.0	152.9
18-2407	LCI13DH-22-22	140.5	138.9	151.3	139.7	415	466.5	133.0	135.0	132.7	145.0	438.7	140.2	490.6	151.7

LOAF VOLUME, ACTUAL
(Small Scale) Limagrain
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2404	LINK	1050	1035	1030	993	3000	2375	745	945	1000	1090	2750	814	2956	975
18-2405	Jagalene (CC02)	1075	1065	983	960	3100	2400	730	950	1055	1050	2775	894	3045	1065
18-2406	DH11HRW53-34	1100	1165	1055	950	3000	2400	805	1020	1070	1225	2725	942	3045	1115
18-2407	LCI13DH-22-22	1015	945	1028	930	2850	2213	715	890	865	935	2650	814	2927	925


LOAF VOLUME
(Small Scale) Limagrain
Cooperators = 14
ChiSqCalc = 13.4
ChiSqTab = 7.8
P Value = 0.004
Samples with the same letter not different at 5.0% level of significance.
18-2407
a
LCI13DH.22.22
mean=3.66
18-2404
ab
LINK
mean=4.49
18-2405
ab
Jagalene (CC02)
mean=4.65
18-2406
b
DH11HRW53.34
mean=5.21
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Small Scale) Limagrain
Cooperators = 14
ChiSqCalc = 4.6
ChiSqTab = 7.8
P Value = 0.201
No samples different at 5.0% level of significance.
18-2407
a
LCI13DH.22.22
mean=4.10
18-2405
a
Jagalene (CC02)
mean=4.49
18-2404
a
LINK
mean=4.66
18-2406
a
DH11HRW53.34
mean=4.78
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Small Scale) Limagrain

COOP. **18-2404 LINK**

A. Nice at pan, Loaf Volume better than protein predicted LV.
B. Excellent loaf externals.
C. Very good dough performance. Good bread character and volume performance for protein level.
D. High Protein, Large Water Abs, Long MT, Slight Sticky & Strong Dough, Very High Volume, Creamy Crumb, Open Elongated Cells, Resilient & Smooth Texture.
E. Higher protein group, excellent volume, strong mix.
F. No comment.
G. No comment.
H. Best crumb of set.
I. No comment.
J. Good protein, excellent color, good at mix and makeup, very good grain.
K. High protein. Long mix time and strong dough. Great for blending.
L. No comment.
M. Slightly low absorption, very good mix strength and good loaf volume.
N. High absorption, fine grain, good volume.

COOP. **18-2405 Jagalene (CC02)**

A. Nice at 1st punch, Loaf Volume better than protein predicted LV.
B. Excellent loaf externals.
C. Very good dough performance. Average bread character.
D. High Protein, Large Water Abs, Long MT, Slight Sticky & Strong Dough, High Volume, Dark Yellow Crumb, Open Irregular Cells, Resilient & Slight Harsh Texture.
E. Strong dough expected with high protein.
F. No comment.
G. No comment.
H. Long mixer.
I. No comment.
J. Very good protein, baked well, white and good grain.
K. High protein. Long mix time and dough notes. Great for bread application or blending.
L. No comment.
M. Fair absorption, very good mix strength and loaf volume. High ash.
N. High absorption, high volume, strong mixing tolerance.

COOP. 18-2406 DH11HRW53-34

A. Very elastic nice at 1st punch.
B. Long time to pick up, excellent loaf externals.
C. Very good dough performance. Good bread character and volume performance for protein level.
D. High Protein, Large Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Volume, Creamy Crumb, Open Elongated Cells, Resilient & Smooth Texture.
E. Bright interior good volume.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Very good protein & Abs, excellent volume, very white with good grain.
K. Protein Higher. Long mix time and strong dough. Great for blending.
L. No comment.
M. Slightly low absorption, very good mix strength and loaf volume.
N. High absorption, good grain, high volume, strong mixing tolerance.

COOP. 18-2407 LCI13DH-22-22

A. Nice out of mixer, Loaf Volume better than protein predicted LV.
B. Cap, rough break.
C. Very good dough performance. Good bread character and volume performance for protein level.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, Medium High Volume, Creamy Crumb, Open Elongated Cells, Resilient & Smooth Texture.
E. Short mix but good pliable dough.
F. No comment.
G. No comment.
H. Poor volume and crumb.
I. No comment.
J. Best crumb grain of group.
K. Protein and all characteristics are average. Great for bread application. Absorption high.
L. No comment.
M. Fair absorption, very good mix strength and good loaf volume.
N. Good grain, yellow crumb.

Notes: **E, F, K and M** conducted sponge and dough bake tests

MONSANTO (WESTBRED)

18-2408	MOD14-4919
18-2409	Jagalene (CC03)
18-2410	H4N13-0253

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 13, 2017. 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)

MODI4-4919

A hard red winter wheat adapted to Montana and portions of the Central High Plains. Medium-late maturity. Medium height. Good straw strength and winterhardiness. Good test weight. MS stripe rust resistance. Solid stem with good tolerance to wheat stem sawfly. Susceptible to soil borne mosaic virus and Fusarium head blight.

H4N13-0253

A hard red winter wheat adapted to the Central and Southern Plains. Medium maturity, medium height. Good test weight. Good winterhardiness. Average standability. MR to leaf rust and stripe rust. Susceptible to FHB.

Monsanto (Westbred): 2018 (Small-Scale) Samples

Test entry number	18-2408	18-2409	18-2410
Sample identification	**MOD14-4919**	**Jagalene (CC03)**	**H4N13-0253**
Wheat Data			
GIPSA classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	64.2	65.3	64.7
Hectoliter weight (kg/hl)	84.3	85.7	84.9
1000 kernel weight (gm)	37.5	41.2	37.4
Wheat kernel size (Rotap)			
Over 7 wire (%)	88.3	93.6	88.3
Over 9 wire (%)	11.7	6.4	11.7
Through 9 wire (%)	0.0	0.0	0.0
Single kernel (skcs)[a]			
Hardness (avg /s.d)	73.5/15.1	67.4/15.2	63.9/14.2
Weight (mg) (avg/s.d)	37.5/8.8	41.2/8.3	37.4/9.1
Diameter (mm)(avg/s.d)	2.87/0.35	3.03/0.33	2.75/0.35
Moisture (%) (avg/s.d)	8.5/0.8	8.6/0.8	8.6/0.8
SKCS distribution	01-03-12-84-01	02-06-20-72-01	03-07-26-64-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	11.2	11.6	11.7
Wheat ash (12% mb)	1.41	1.37	1.32
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	77.3	78.2	77.6
Quadrumat Sr. Mill	70.2	69.7	71.0
Flour moisture (%)	13.4	12.6	12.6
Flour protein (14% mb)	10.1	10.5	10.6
Flour ash (14% mb)	0.45	0.53	0.44
Rapid Visco-Analyser			
Peak Time (min)	6.3	6.1	6.2
Peak Viscosity (RVU)	213.6	165.6	195.6
Breakdown (RVU)	72.9	51.8	58.1
Final Viscosity at 13 min (RVU)	241.5	213.7	252.0
Minolta color meter			
L*	91.92	91.73	92.17
a*	-1.71	-1.41	-1.33
b*	10.01	9.19	8.45
PPO	0.358	0.300	0.292
Falling number (sec)	402	385	418
Damaged Starch			
(AI%)	97.1	99.0	97.9
(AACC76-31)	7.1	8.8	7.8

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

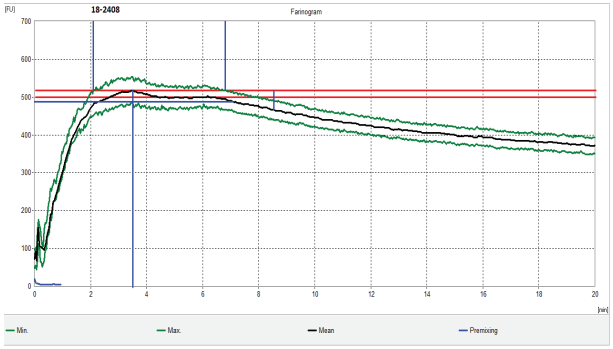
Monsanto: Physical Dough Tests and Gluten Analysis For 2018 (Small-Scale) Samples

Test Entry Number	18-2408	18-2409	18-2410
Sample Identification	MOD14-4919	Jagalene (CC03)	H4N13-0253
MIXOGRAPH			
Flour Abs (% as-is)	62.1	63.5	63.7
Flour Abs (14% mb)	61.7	62.1	62.6
Mix Time (min)	2.0	2.4	2.1
Mix tolerance (0-6)	0	1	1
FARINOGRAPH			
Flour Abs (% as-is)	69.8	68.1	66.7
Flour Abs (14% mb)	69.4	66.7	66.5
Peak time (min)	3.5	4.2	3.4
Mix stability (min)	4.7	6.3	7.5
Mix Tolerance Index (FU)	51	38	20
Breakdown time (min)	7.1	8.5	10.5
ALVEOGRAPH			
P(mm): Tenacity	126	118	93
L(mm): Extensibility	50	53	75
G(mm): Swelling index	15.7	16.2	19.3
W(10^{-4} J): strength (curve area)	216	219	203
P/L: curve configuration ratio	2.52	2.23	1.24
Ie(P_{200}/P): elasticity index	37.0	42.0	41.2
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	180/257/265	212/282/287	165/203/207
Extensibility (mm at 45/90/135 min)	154/137/131	154/130/147	171/165/170
Energy (cm^2 at 45/90/135 min)	48/58/57	57/58/73	52/58/63
Resist $_{max}$ (BU at 45/90/135 min)	335/409/409	594/840/902	1031/1466/1465
Ratio (at 45/90/135 min)	1.4/1.7/1.7	3.0/3.7/4.4	4.8/10.7/12.4
PROTEIN ANALYSIS			
HMW-GS Composition	2*,20a+20b, 5+10	1,2* 17+18, 5+10	2*,7+9, 2+12
TMP/TTP	0.86	1.02	0.77
SEDIMENTATION TEST			
Volume (ml)	34.9	37.0	37.6

Physical Dough Tests

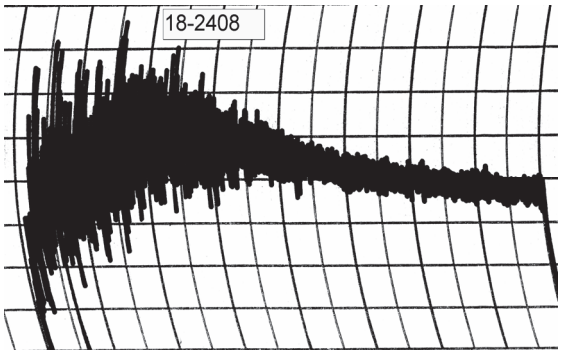
2018 (Small Scale) Samples – Monsanto

Farinograms



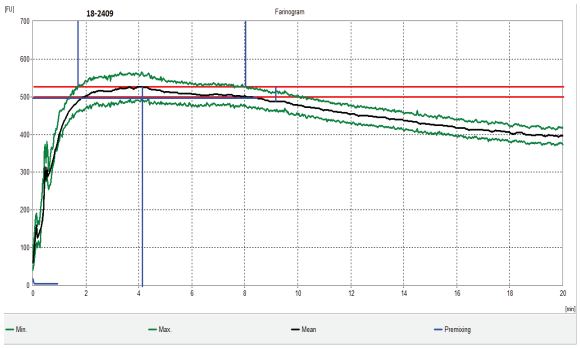
Water abs = 69.4%, Peak time = 3.5 min,
Mix stab = 4.7 min, MTI = 51 FU

Mixograms

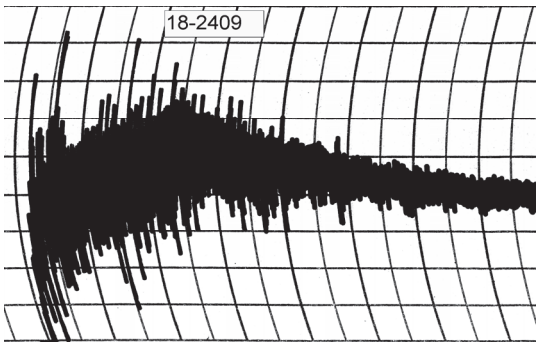


Water abs = 61.7%
Mix time = 2.0 min

18-2408, MOD14-4919



Water abs = 66.7%, Peak time = 4.2 min,
Mix stab = 6.3 min, MTI = 38 FU



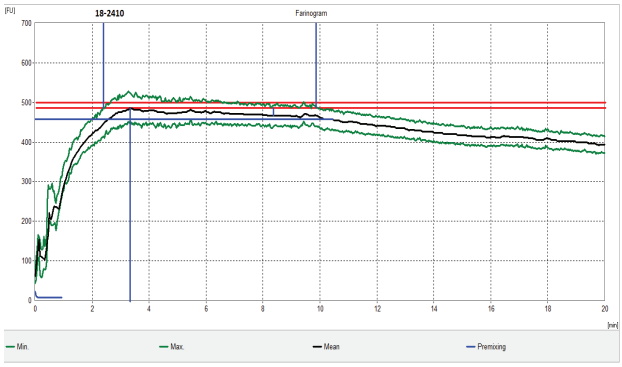
Water abs = 62.1%
Mix time = 2.4 min

18-2409, Jagalene (CC03)

Physical Dough Tests

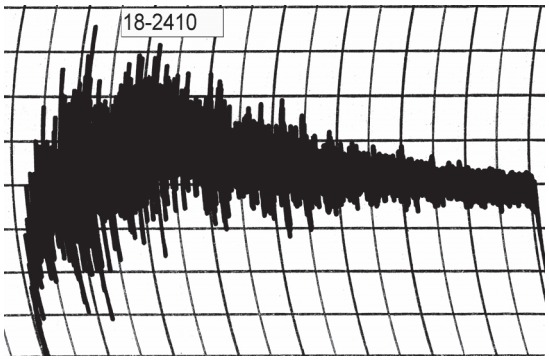
2018 (Small Scale) Samples – Monsanto

Farinograms



Water abs = 66.5%, Peak time = 3.4 min,
Mix stab = 7.5 min, MTI = 20 FU

Mixograms

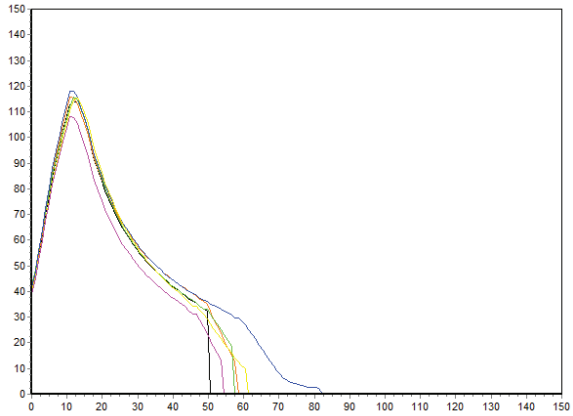


Water abs = 62.6%
Mix time = 2.1 min

18-2410, H4N13-0253

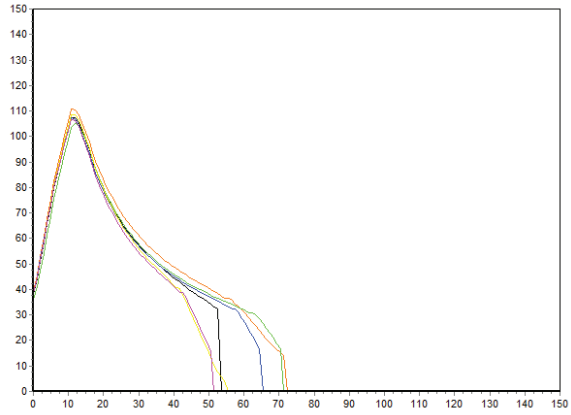
Physical Dough Tests - Alveograph

2018 (Small Scale) Samples – Monsanto



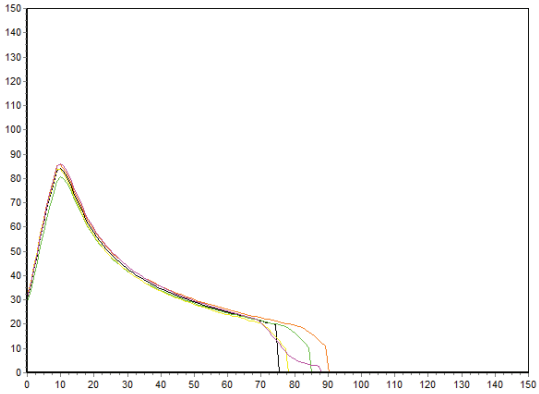
18-2408, MOD14-4919

P (mm H_20) = 126, L (mm) = 50, W ($10E^{-4}J$) = 216



18-2409, Jagalene (CC03)

P (mm H_20) = 118, L (mm) = 53, W ($10E^{-4}J$) = 219

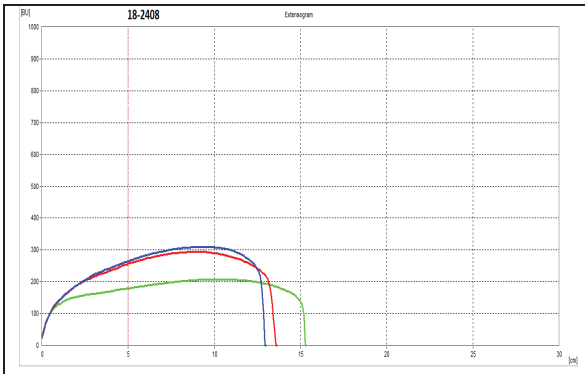


18-2410, H4N13-0253

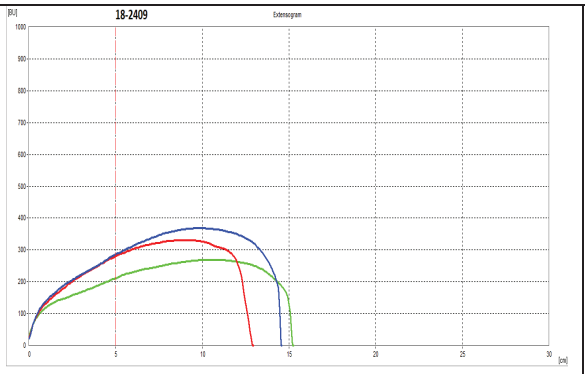
P (mm H_20) = 93, L (mm) = 75, W ($10E^{-4}J$) = 203

Physical Dough Tests - Extensigraph

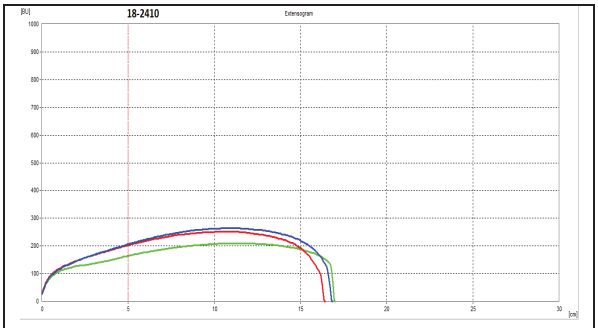
2018 (Small Scale) Samples – Monsanto



18-2408, MOD14-4919
R (BU) = 257, E (mm) = 137, W (cm^2) = 58
Rmax (BU) = 295, Ratio = 1.9 at 90 min



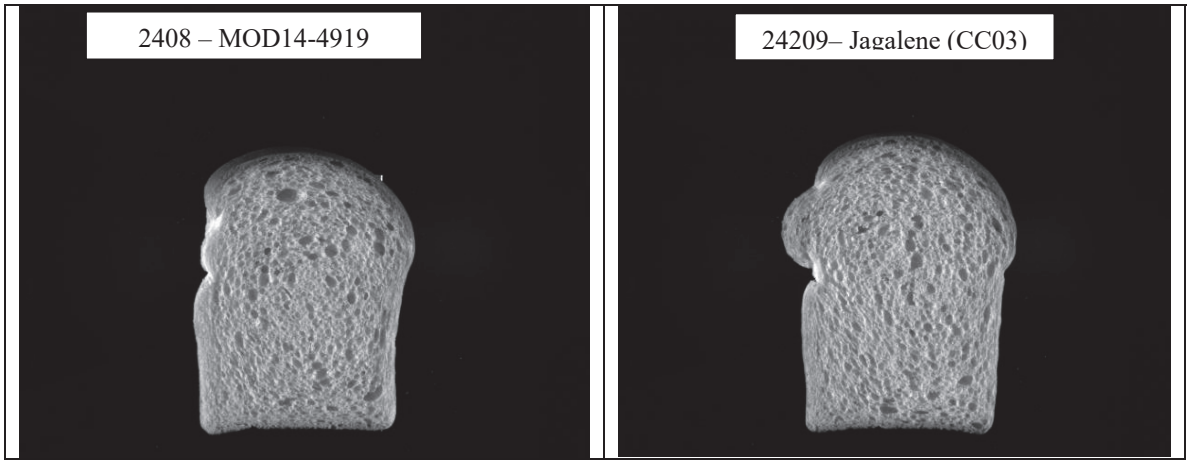
18-2409, Jagalene (CC03)
R (BU) = 282, E (mm) = 130, W (cm^2) = 58
Rmax (BU) = 331, Ratio = 2.2 at 90 min



18-2410, H4N13-0253
R (BU) = 203, E (mm) = 165, W (cm^2) = 58
Rmax (BU) = 251, Ratio = 1.2 at 90 min

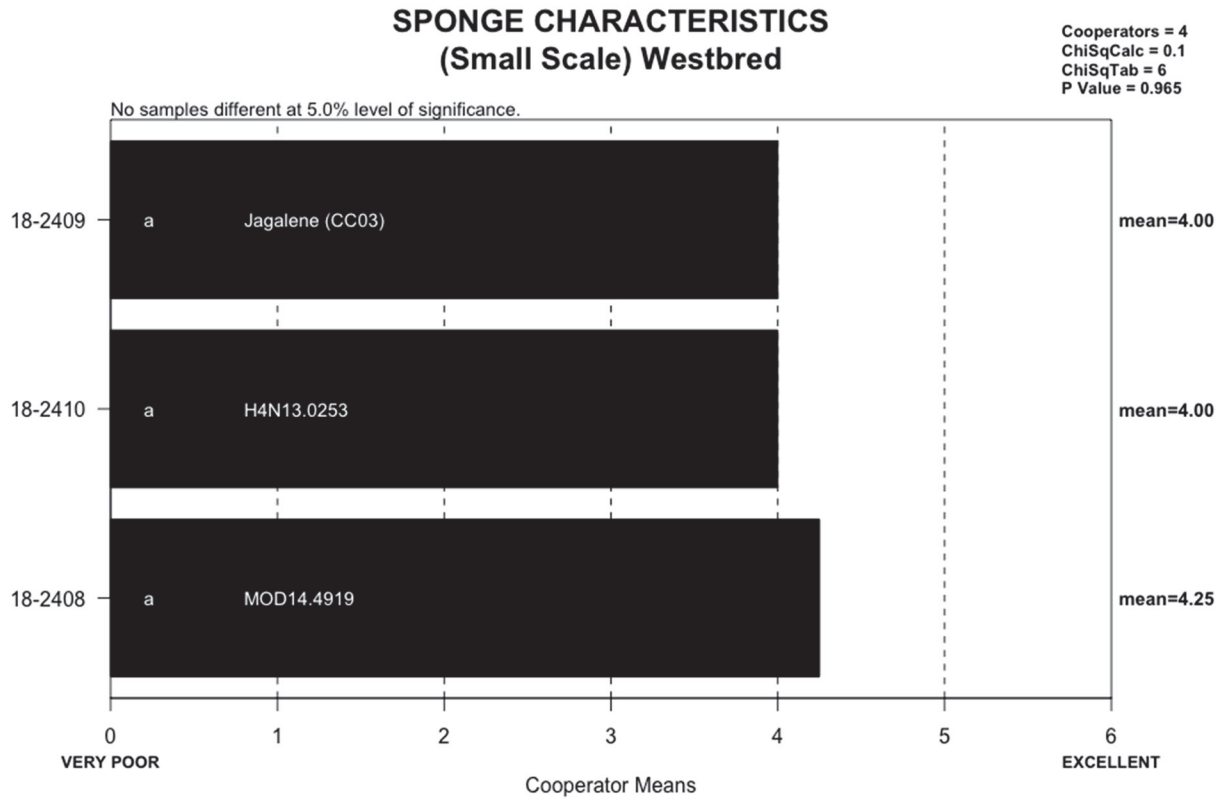
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

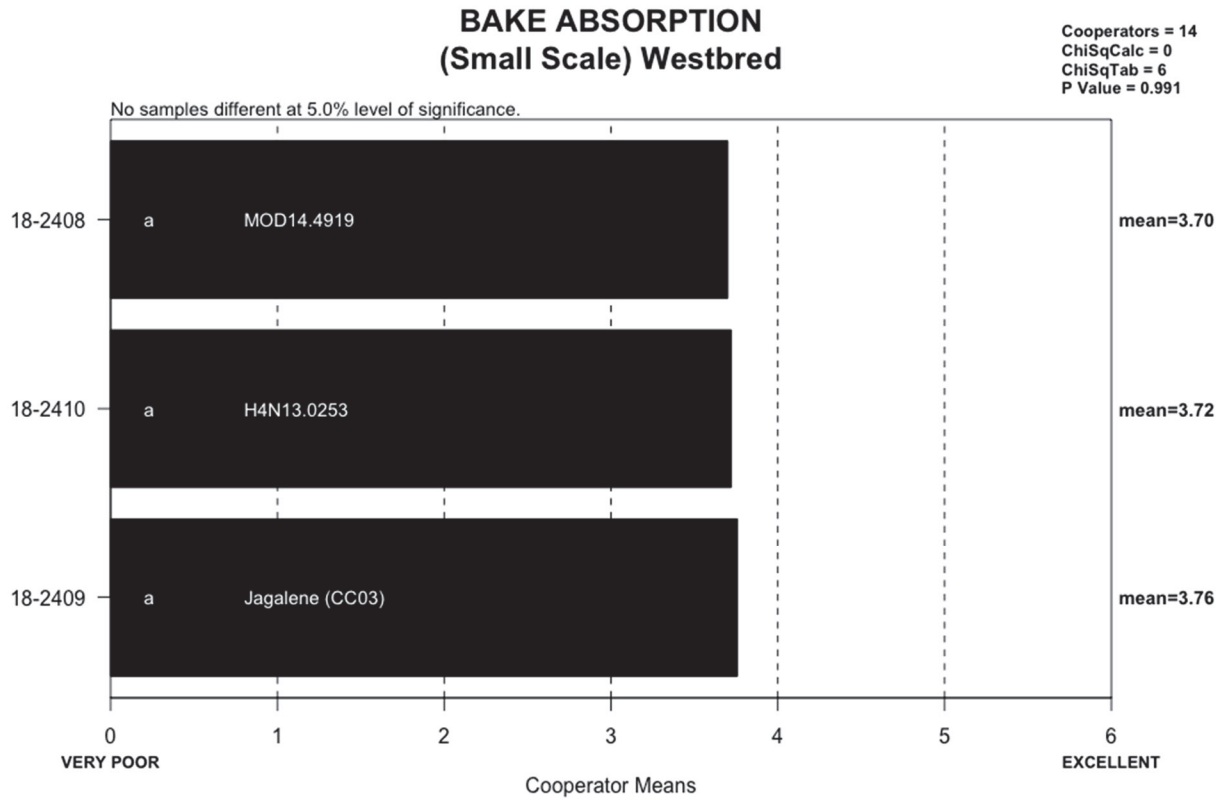
Monsanto: C-Cell Bread Images and Analysis
2018 (Small-Scale) Samples



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})
2408	5477	142	3165	0.452	2.149	0.685	1.635	-9.70
2409	6024	142	3541	0.449	2.127	1.142	1.700	-12.20

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	5660	147	3595	0.438	1.976	1.937	1.660	-8.75


SPONGE CHARACTERISTICS
(Small Scale) Westbred
Cooperators = 4
ChiSqCalc = 0.1
ChiSqTab = 6
P Value = 0.965
No samples different at 5.0% level of significance.
18-2409
a
Jagalene (CC03)
mean=4.00
18-2410
a
H4N13.0253
mean=4.00
18-2408
a
MOD14.4919
mean=4.25
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

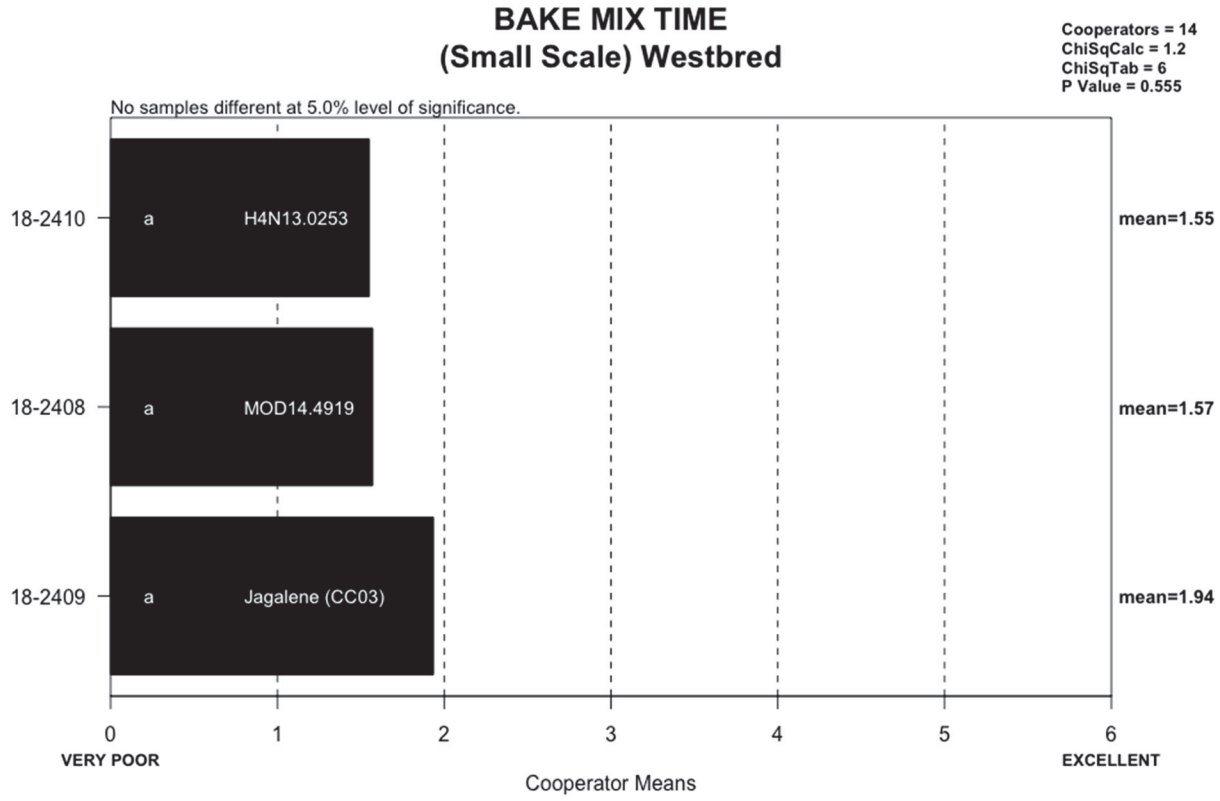

BAKE ABSORPTION
(Small Scale) Westbred
Cooperators = 14
ChiSqCalc = 0
ChiSqTab = 6
P Value = 0.991
No samples different at 5.0% level of significance.
18-2408
a
MOD14.4919
mean=3.70
18-2410
a
H4N13.0253
mean=3.72
18-2409
a
Jagalene (CC03)
mean=3.76
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

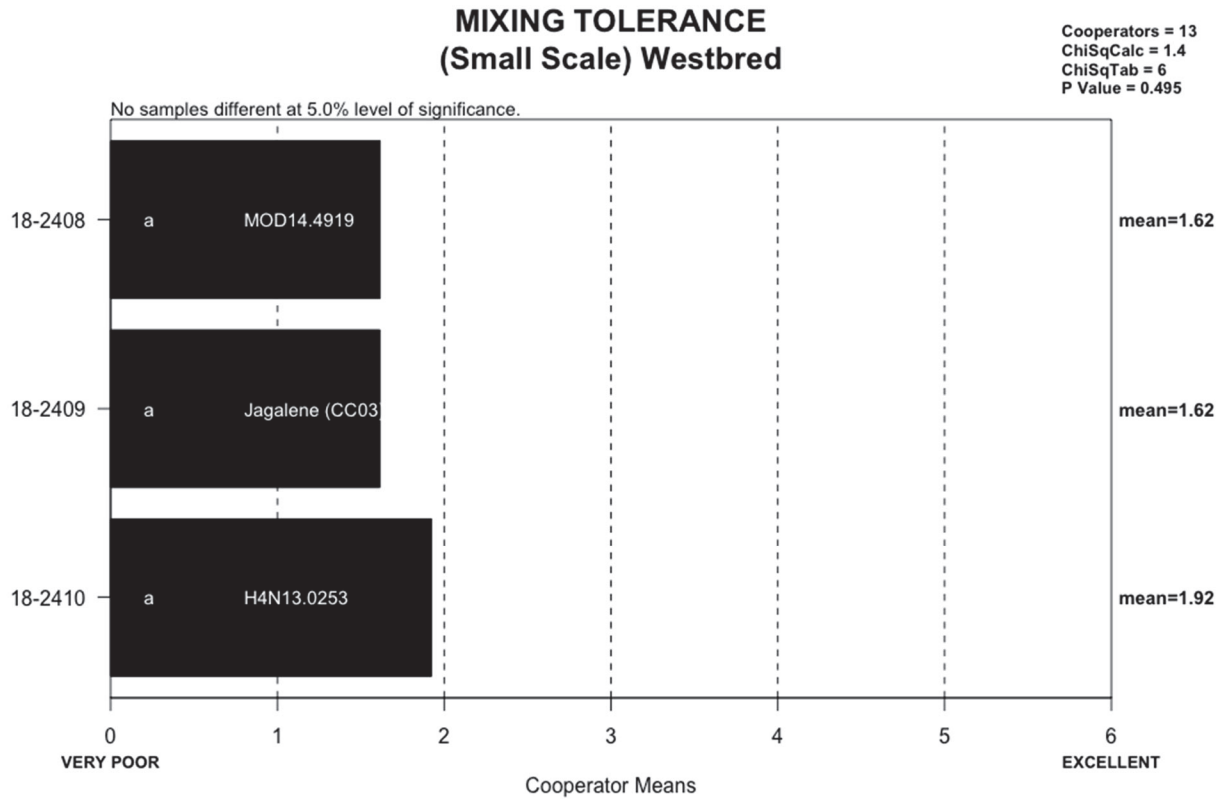
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Westbred
Cooperators A – N

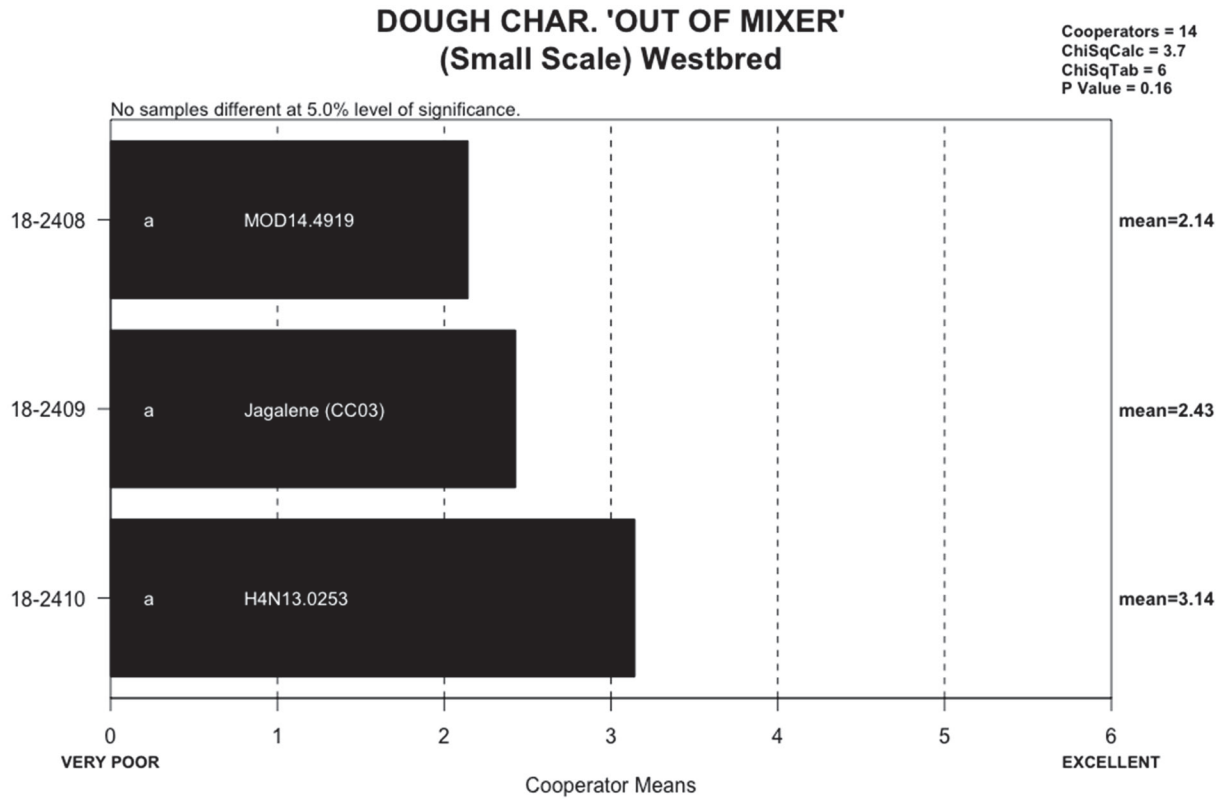
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2408	MOD14-4919	59.0	58.6	65.9	60.3	57	69.4	57.8	69.0	69.5	62	68.8	68.1	63	61.3
18-2409	Jagalene (CC03)	60.0	58.9	65.2	62.1	57	66.7	57.7	69.1	67.4	62	70.0	68.1	62	61.3
18-2410	H4N13-0253	61.1	58.6	63.8	62.1	58	66.5	58.3	69.0	66.2	62	67.1	68.5	61	61.6

BAKE MIX TIME, ACTUAL
(Small Scale) Westbred
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2408	MOD14-4919	3.0	2.3	2.4	3.0	4	4	2.9	3.5	2.0	1.8	6	2.2	5	3.0
18-2409	Jagalene (CC03)	3.3	2.8	2.9	3.1	4	4	3.4	3.3	2.3	2.3	6	2.8	5	3.0
18-2410	H4N13-0253	2.3	2.5	2.6	3.2	3	4	2.7	2.8	1.8	1.8	6	2.0	5	2.5

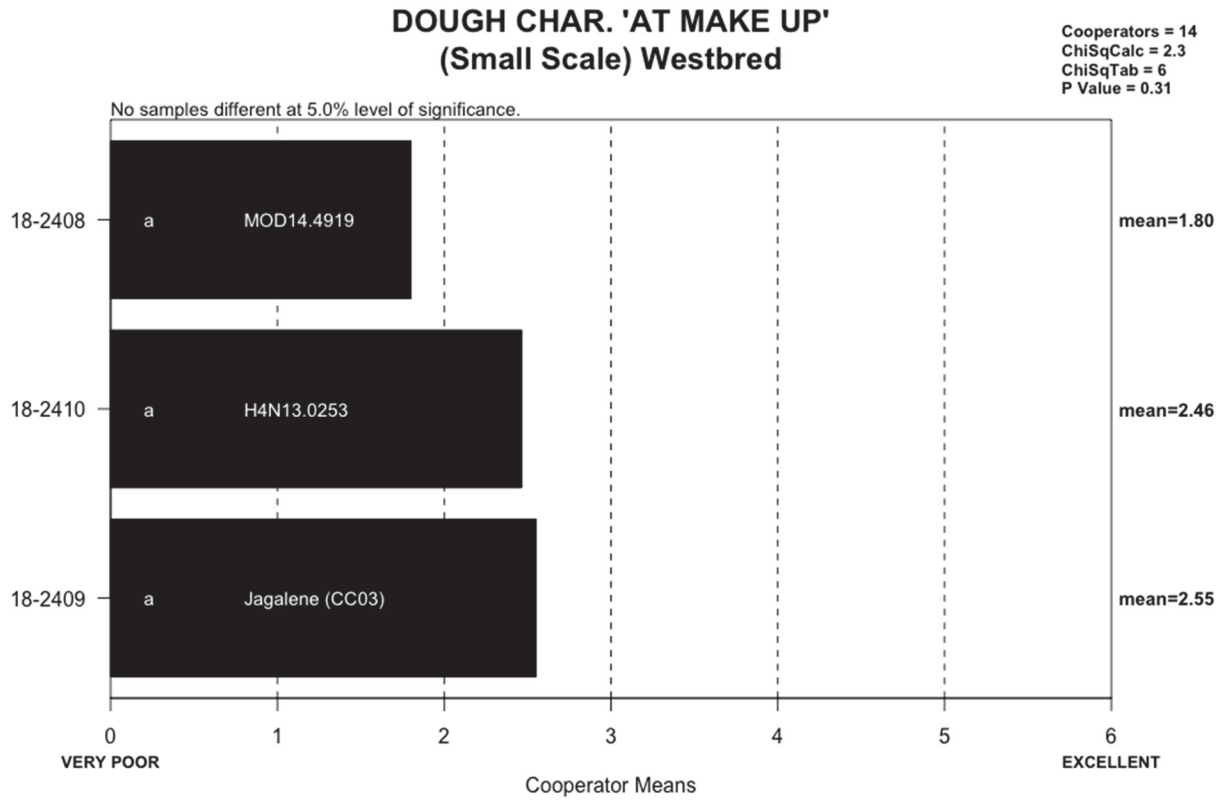

BAKE MIX TIME
(Small Scale) Westbred
Cooperators = 14
ChiSqCalc = 1.2
ChiSqTab = 6
P Value = 0.555
No samples different at 5.0% level of significance.
18-2410
a
H4N13.0253
mean=1.55
18-2408
a
MOD14.4919
mean=1.57
18-2409
a
Jagalene (CC03)
mean=1.94
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Westbred
Cooperators = 13
ChiSqCalc = 1.4
ChiSqTab = 6
P Value = 0.495
No samples different at 5.0% level of significance.
18-2408
a
MOD14.4919
mean=1.62
18-2409
a
Jagalene (CC03
mean=1.62
18-2410
a
H4N13.0253
mean=1.92
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means



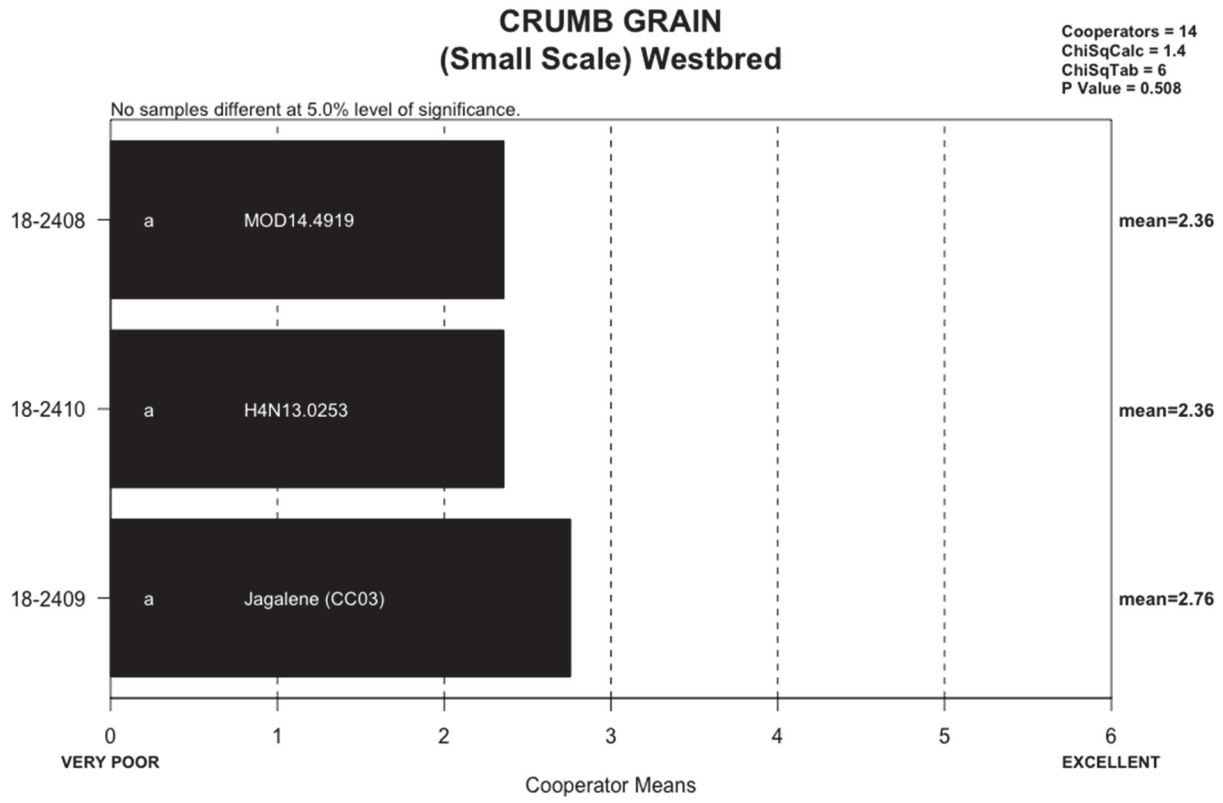
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Westbred

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2408	MOD14-4919	4	4	5	1	0
18-2409	Jagalene (CC03)	5	2	4	3	0
18-2410	H4N13-0253	4	3	1	6	0



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Small Scale) Westbred

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2408	MOD14-4919	4	4	5	1	0
18-2409	Jagalene (CC03)	4	3	2	5	0
18-2410	H4N13-0253	5	3	2	4	0

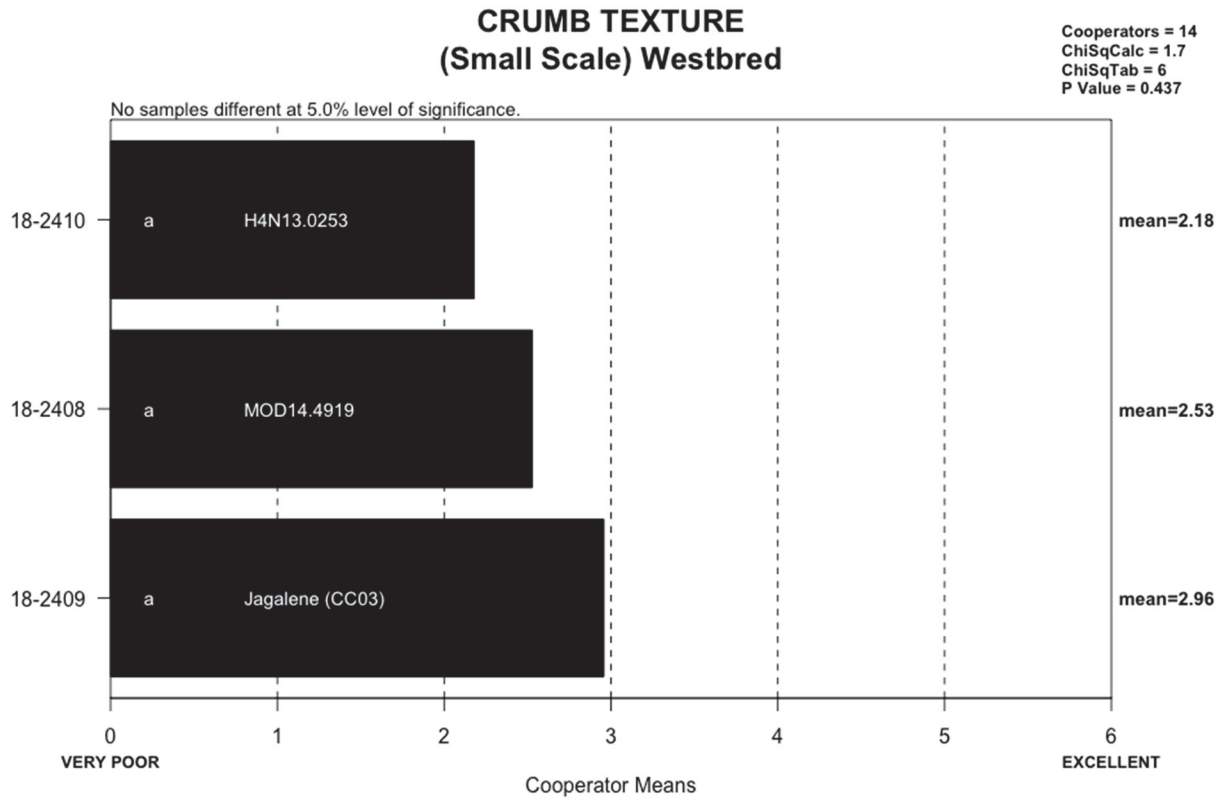


CRUMB GRAIN, DESCRIBED
(Small Scale) Westbred

IDCODE	ID	Open	Fine	Dense
18-2408	MOD14-4919	6	1	7
18-2409	Jagalene (CC03)	7	4	3
18-2410	H4N13-0253	7	3	4

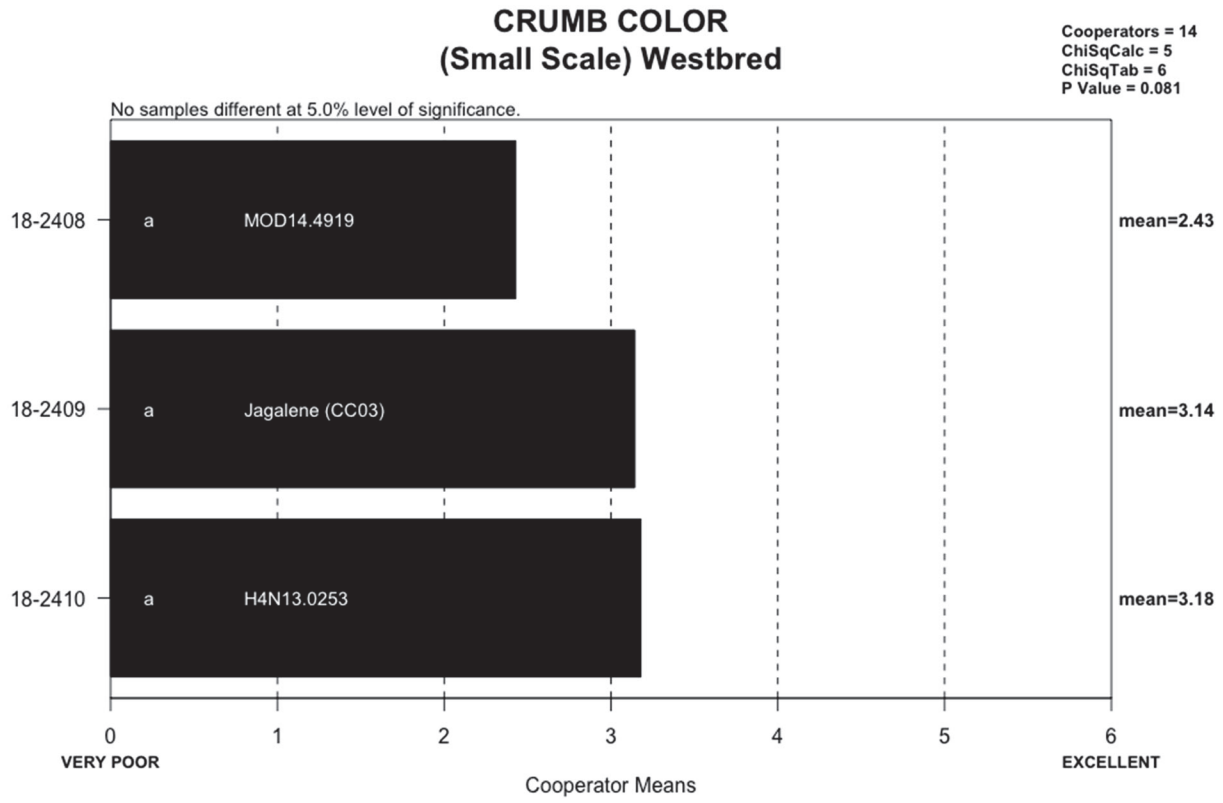
CELL SHAPE, DESCRIBED
(Small Scale) Westbred

IDCODE	ID	Round	Irregular	Elongated
18-2408	MOD14-4919	9	4	1
18-2409	Jagalene (CC03)	10	2	2
18-2410	H4N13-0253	12	2	0



CRUMB TEXTURE, DESCRIBED
(Small Scale) Westbred

IDCODE	ID	Harsh	Smooth	Silky
18-2408	MOD14-4919	9	3	2
18-2409	Jagalene (CC03)	8	5	1
18-2410	H4N13-0253	8	6	0



CRUMB COLOR, DESCRIBED
(Small Scale) Westbred

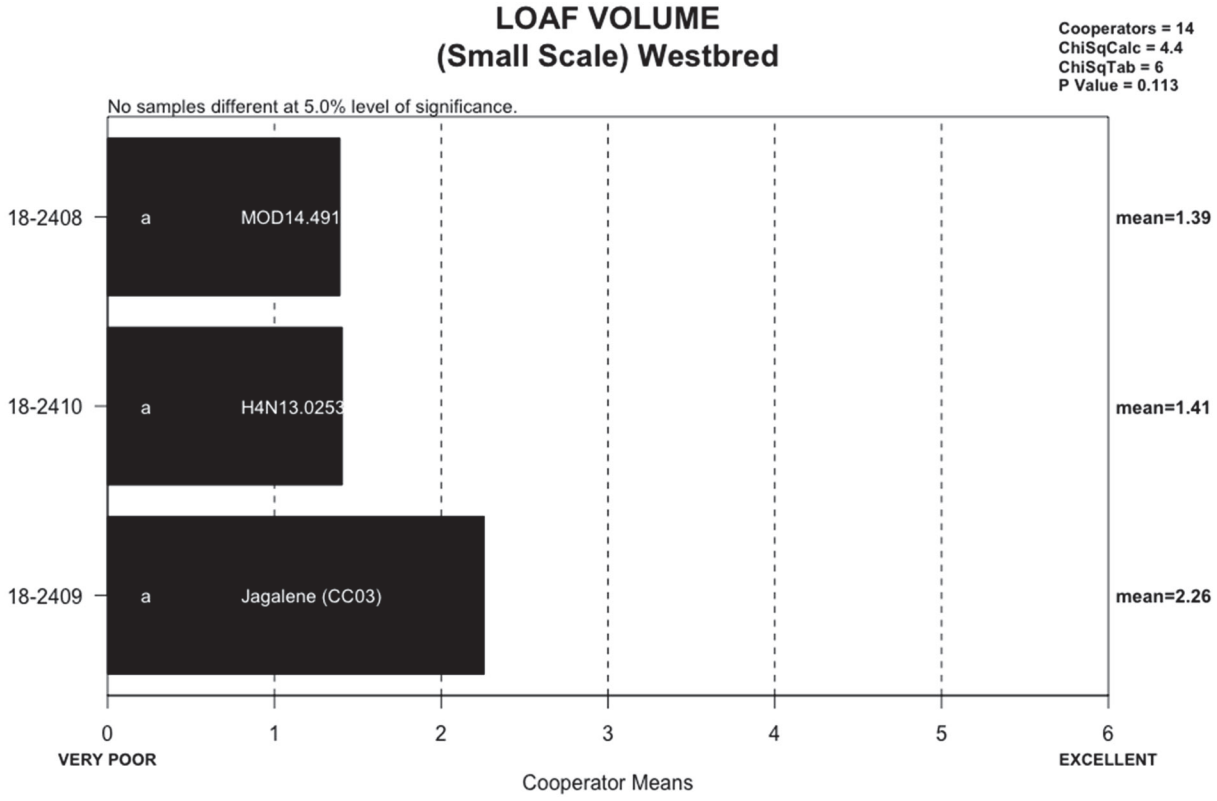
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	BrightWhite
18-2408	MOD14-4919	0	1	9	2	1	1	0
18-2409	Jagalene (CC03)	0	1	3	2	8	0	0
18-2410	H4N13-0253	0	0	4	5	5	0	0

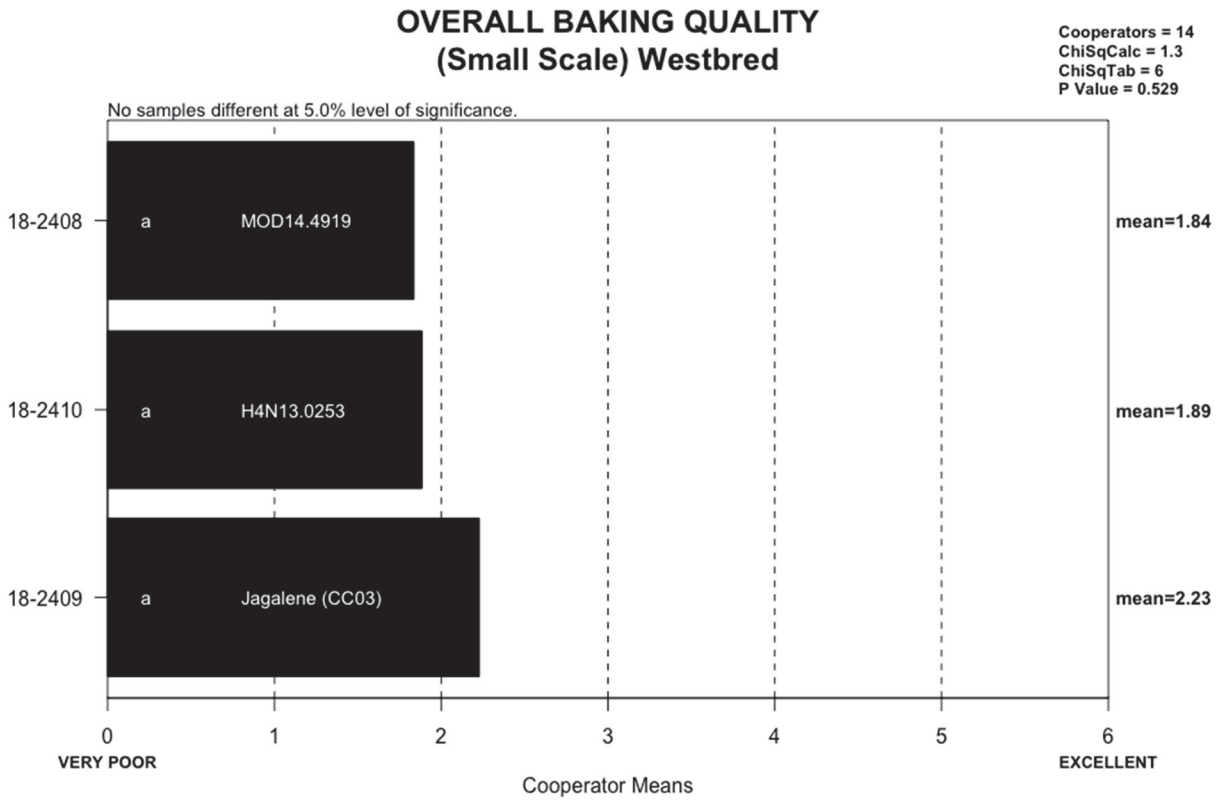
LOAF WEIGHT, ACTUAL
(Small Scale) Westbred
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2408	MOD14-4919	141.3	144.7	158.0	142.3	411	461.5	131.5	139.3	140.9	147.0	439.9	142.7	495.3	151.4
18-2409	Jagalene (CC03)	139.8	142.6	157.0	139.7	414	463.4	129.7	137.2	137.5	148.5	440.6	139.4	483.3	149.4
18-2410	H4N13-0253	141.5	143.4	157.2	141.0	413	464.0	134.4	137.6	138.9	149.7	439.5	140.8	493.0	151.4

LOAF VOLUME, ACTUAL
(Small Scale) Westbred
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2408	MOD14-4919	625	620	733	804	2600	2225	685	700	760	605	2540	624	2603	730
18-2409	Jagalene (CC03)	730	765	820	913	2650	2363	780	755	845	645	2575	738	2780	810
18-2410	H4N13-0253	725	705	790	919	2450	2150	670	796	685	605	2450	654	2633	745


LOAF VOLUME
(Small Scale) Westbred
Cooperators = 14
ChiSqCalc = 4.4
ChiSqTab = 6
P Value = 0.113
No samples different at 5.0% level of significance.
18-2408
a
MOD14.491
mean=1.39
18-2410
a
H4N13.0253
mean=1.41
18-2409
a
Jagalene (CC03)
mean=2.26
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Small Scale) Westbred
Cooperators = 14
ChiSqCalc = 1.3
ChiSqTab = 6
P Value = 0.529
No samples different at 5.0% level of significance.
18-2408
a
MOD14.4919
mean=1.84
18-2410
a
H4N13.0253
mean=1.89
18-2409
a
Jagalene (CC03)
mean=2.23
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Small Scale) Monsanto (Westbred)

COOP. 18-2408 MOD14-4919

A. Elastic not extensible, protein does not meet target range of 11%, low ABS.
B. Yellow dough.
C. Very weak dough performance. Bread quality very bad.
D. Low Protein, Low Water Abs, Short MT, Sticky & Weak Dough, Fair Volume, Yellow Crumb, Open Irregular Cells with Keyhole, Resilient & Harsh Texture.
E. Soft and sticky doughs, Low loaf volume.
F. No comment.
G. No comment.
H. Poor volume and yellow crumb.
I. Crumb: very spongy; slightly crumbles.
J. Short weak mixing, unacceptable volume and poor flour.
K. Short mix time, low protein, unfavorable dough characteristics, and undesirable color and texture. All around problematic.
L. No comment.
M. Good absorption, very low mix strength and loaf volume.
N. Low absorption, poor grain, dark yellow crumb, low volume, poor tolerance.

COOP. 18-2409 Jagalene (CC03)

A. Protein does not meet target range of 11%, low ABS.
B. Left and Right break.
C. Weak dough performance. Bread quality marginal.
D. Medium Protein, Normal Water Abs, Short MT, Slight Sticky & Strong Dough, High Volume, Yellow Crumb, Open Irregular Cells, with Keyhole, Resilient & Slight Harsh Texture.
E. Very short mix times.
F. No comment.
G. No comment.
H. No comment.
I. Crumb feels spongy.
J. Short weak mixing, unacceptable volume and poor flour.
K. Short mix time, low protein, unfavorable dough characteristics, and undesirable color and texture. All around problematic.
L. No comment.
M. Good absorption, very low mix strength and low loaf volume.
N. Low absorption, poor grain, dark yellow crumb, low volume, poor tolerance.

COOP. 18-2410 H4N13-0253

A. Mix time does not meet target range of 3-5mins., low ABS.
B. No comment.
C. Weak dough performance. Bread quality marginal.
D. Medium Protein, Normal Water Abs, Short MT, Sticky & Weak Dough, High Volume, Yellow Crumb, Open Irregular Cells, Resilient & Slight Harsh Texture.
E. Unacceptable baking quality.
F. No comment.
G. No comment.
H. Short mixer very harsh crumb.
I. No comment.
J. Short weak mixing, unacceptable volume and poor flour.
K. Short mix time, low protein, and unfavorable dough characteristics. Texture and color okay. Would not recommend.
L. No comment.
M. Good absorption, very low mix strength and loaf volume.
N. Low absorption, poor grain, yellow crumb, low volume, poor tolerance.

Notes: **E, F, K and M** conducted sponge and dough bake tests

KANSAS-HAYS

18-2411	Danby
18-2412	Jagalene (CC04)
18-2413	KS14H180-4-63

Description of Test Plots and Breeder Entries

Kansas-Hays – Gourong Zhang

The samples submitted were grown at Hays experimental station in 2018. Jagalene, Danby, and KS14H180-4-6 were planted on Oct. 3 in a field with sandy-loam soil. Test plots were fertilized with 60 lb/a N before planting. Plots were not irrigated, and were not treated with fungicide. 2018 crop had decent moisture during planting, but dry in winter and spring. Plots had good stands and little disease pressure. Winter temperature was below normal and crop had fewer tillers and progressed slower than normal. Plot yield was about average

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Jagalene (common check)

Danby (local check)

KS14H180-4-6

KS14H180-4-6 is a hard red winter wheat with medium early maturity and medium height. It has good shattering resistance and moderate pre-harvest sprouting resistance. Its straw strength is about average. KS14H180-4-6 has good resistance to wheat streak mosaic virus and stripe rust. It is susceptible to leaf rust, stem rust, and Hessian fly. KS14H180-4-6 has good drought tolerance and yielded well in western Kansas.

Kansas-Hays: 2018 (Small-Scale) Samples

Test entry number	18-2411	18-2412	18-2413
Sample identification	**Danby**	**Jagalene (CC04)**	**KS14H180-4-63**
Wheat Data			
GIPSA classification	1 HDWH	1 HRW	1 HRW
Test weight (lb/bu)	62.5	60.9	61.7
Hectoliter weight (kg/hl)	82.1	80.0	81.1
1000 kernel weight (gm)	30.7	32.5	33.7
Wheat kernel size (Rotap)			
Over 7 wire (%)	68.1	75.9	79.4
Over 9 wire (%)	31.8	24.1	20.5
Through 9 wire (%)	0.1	0.0	0.1
Single kernel (skcs)[a]			
Hardness (avg /s.d)	73.3/17.0	77.1/16.2	65.1/15.5
Weight (mg) (avg/s.d)	30.7/8.5	32.5/9.5	33.7/8.9
Diameter (mm)(avg/s.d)	2.57/0.33	2.73/0.34	2.64/0.32
Moisture (%) (avg/s.d)	13.4/0.3	13.5/0.4	13.5/0.3
SKCS distribution	01-04-13-82-01	02-02-10-86-01	02-10-27-61-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	13.3	15.1	12.5
Wheat ash (12% mb)	1.28	1.35	1.35
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	77.3	78.6	78.5
Quadrumat Sr. Mill	70.6	70.3	72.4
Flour moisture (%)	12.7	12.8	13.0
Flour protein (14% mb)	12.3	14.1	11.6
Flour ash (14% mb)	0.49	0.55	0.49
Rapid Visco-Analyser			
Peak Time (min)	6.1	6.0	6.1
Peak Viscosity (RVU)	257.7	198.3	252.8
Breakdown (RVU)	119.8	73.4	102.3
Final Viscosity at 13 min (RVU)	235.3	237.7	271.7
Minolta color meter			
L*	91.96	90.49	91.60
a*	-1.25	-0.92	-1.34
b*	8.25	9.21	8.83
PPO	0.497	0.455	0.529
Falling number (sec)	396	415	375
Damaged Starch			
(AI%)	96.9	97.8	96.2
(AACC76-31)	7.0	7.7	6.4

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

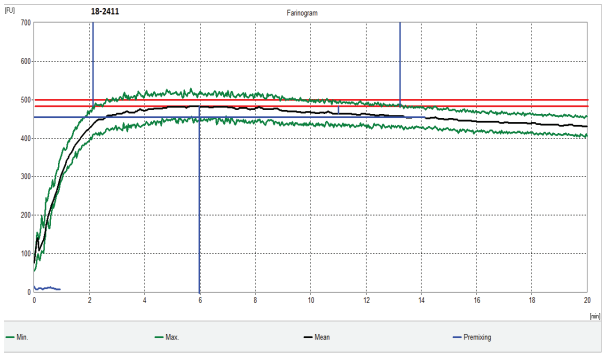
Kansas-Hays: Physical Dough Tests and Gluten Analysis For 2018 (Small-Scale) Samples

Test Entry Number	18-2411	18-2412	18-2413
Sample Identification	Danby	Jagalene (CC04)	KS14H180-4-63
MIXOGRAPH			
Flour Abs (% as-is)	66.9	68.5	63.2
Flour Abs (14% mb)	65.4	67.2	62.2
Mix Time (min)	3.0	4.4	8.3
Mix tolerance (0-6)	2	3	5
FARINOGRAPH			
Flour Abs (% as-is)	63.6	64.8	58.3
Flour Abs (14% mb)	62.1	63.5	57.4
Peak time (min)	6.0	8.0	3.2
Mix stability (min)	11.1	16.9	28.3
Mix Tolerance Index (FU)	19	12	23
Breakdown time (min)	14.1	19.2	10.5
ALVEOGRAPH			
P(mm): Tenacity	81	108	81
L(mm): Extensibility	87	83	70
G(mm): Swelling index	20.8	20.3	18.6
W(10^{-4} J): strength (curve area)	241	353	248
P/L: curve configuration ratio	0.93	1.30	1.16
Ie(P_{200}/P): elasticity index	56.3	66.1	70.4
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	226/281/291	425/544/629	673/1160/1220
Extensibility (mm at 45/90/135 min)	166/163/167	143/148/146	139/109/99
Energy (cm^2 at 45/90/135 min)	74/88/93	108/152/163	174/188/162
Resist $_{max}$ (BU at 45/90/135 min)	335/409/409	594/840/902	1031/1466/1465
Ratio (at 45/90/135 min)	1.4/1.7/1.7	3.0/3.7/4.3	4.8/10.7/12.4
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+8/7+9, 5+10	1,2*,17+18, 5+10	2*,7+8/7+9, 5+10
TMP/TTP	0.95	0.97	0.92
SEDIMENTATION TEST			
Volume (ml)	57.1	66.1	59.9

Physical Dough Tests

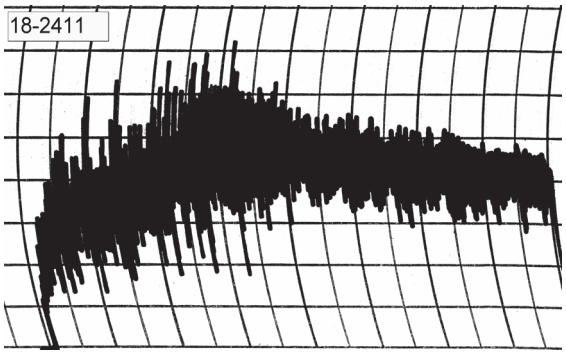
2018 (Small Scale) Samples – Kansas-Hays

Farinograms



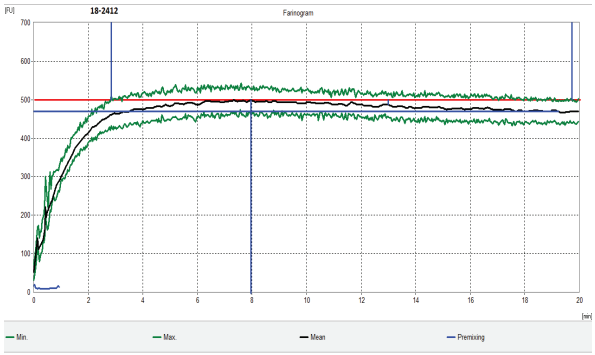
Water abs = 62.1%, Peak time = 6.0 min,
Mix stab = 11.1min, MTI = 19 FU

Mixograms

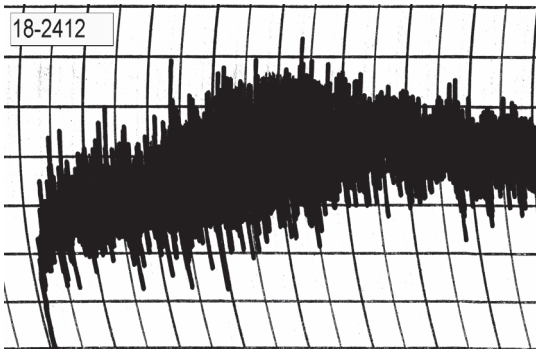


Water abs = 65.4%
Mix time = 3.0 min

18-2411, Danby



Water abs = 63.5%, Peak time = 8.0 min,
Mix stab = 16.9 min, MTI = 12 FU



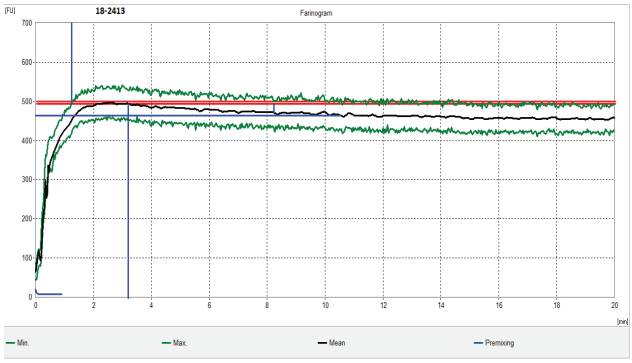
Water abs = 67.2%
Mix time = 4.4 min

18-2412, Jagalene (CC04)

Physical Dough Tests

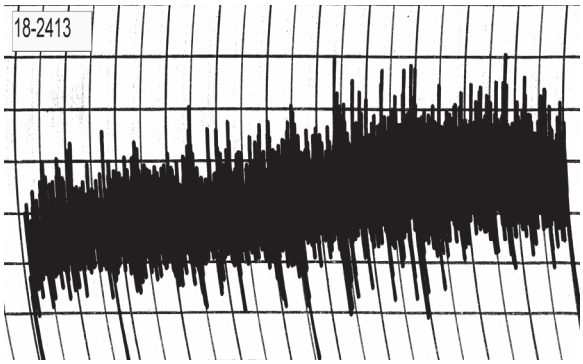
2018 (Small Scale) Samples – Kansas-Hays

Farinograms



Water abs = 57.4, Peak time = 3.2 min,
Mix stab = 28.3 min, MTI = 23 FU

Mixograms

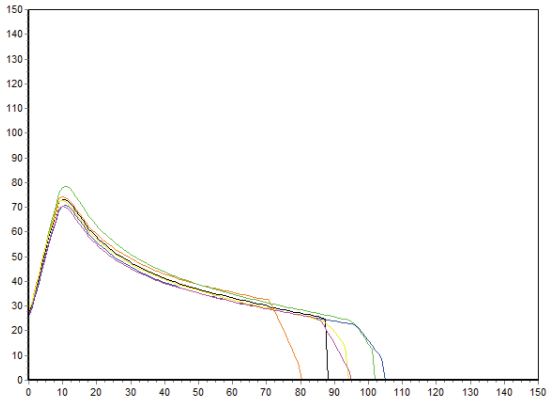


Water abs = 62.2%
Mix time = 8.3 min

18-2413, KS14H180-4-63

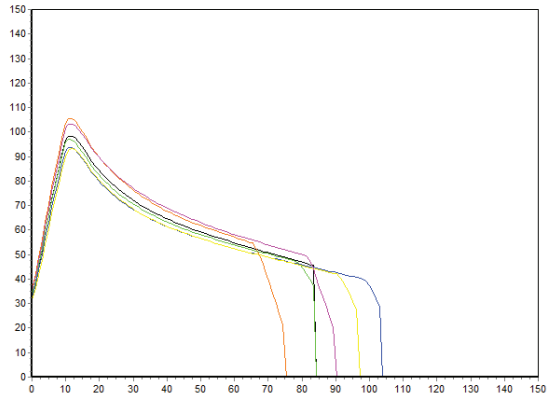
Physical Dough Tests - Alveograph

2018 (Small Scale) Samples – Kansas-Hays



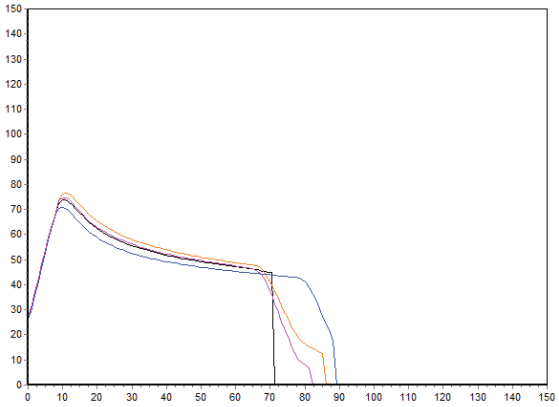
18-2411, Danby

P (mm H_20) = 81, L (mm) = 87, W ($10E^{-4}J$) = 241



18-2412, Jagalene (CC04)

P (mm H_20) = 108, L (mm) = 83, W ($10E^{-4}J$) = 353

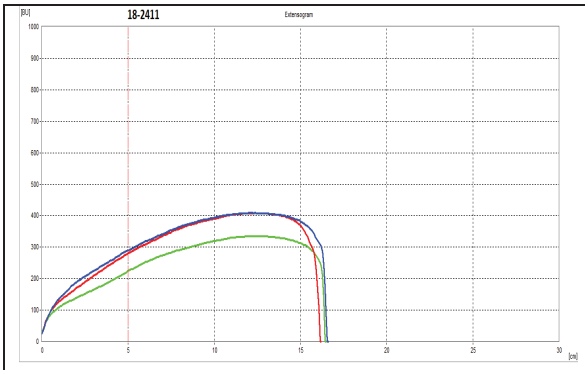


18-2413, KS14H180-4-63

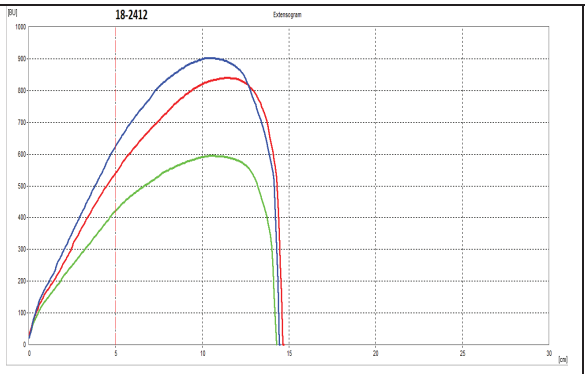
P (mm H_20) = 81, L (mm) = 70, W ($10E^{-4}J$) = 248

Physical Dough Tests - Extensigraph

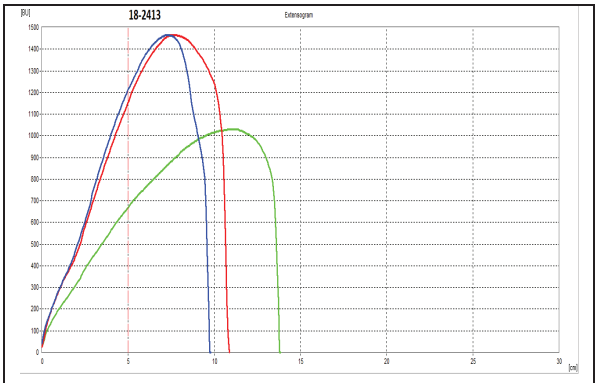
2018 (Small Scale) Samples – Kansas-Hays



18-2411, Danby
R (BU) = 281, E (mm) = 163, W (cm^2) = 88
Rmax (BU) = 409, Ratio = 1.7 at 90 min



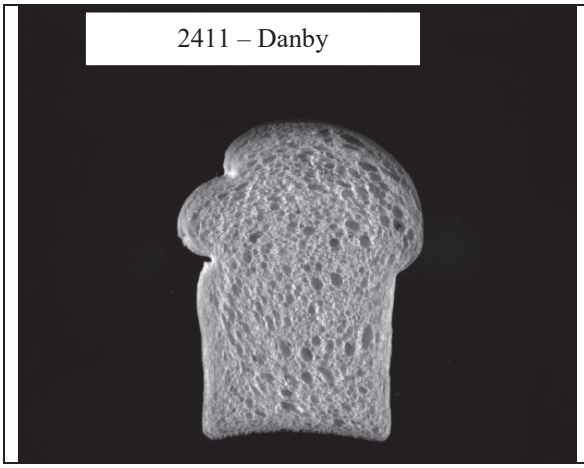
18-2412, Jagalene (CC04)
R (BU) = 544, E (mm) = 148, W (cm^2) = 152
Rmax (BU) = 840, Ratio = 3.7 at 90 min

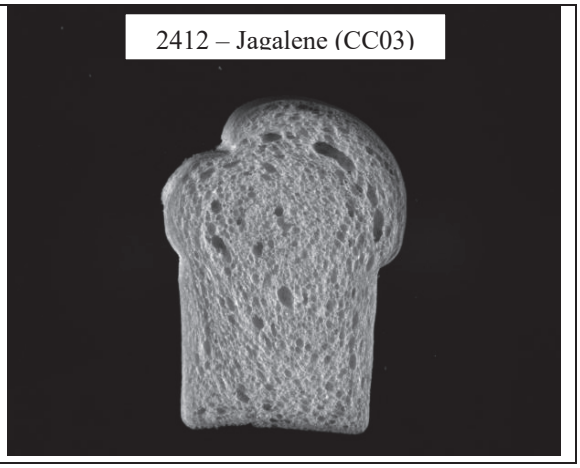


18-2413, KS14H180-4-63
R (BU) = 1160, E (mm) = 109, W (cm^2) = 188
Rmax (BU) = 1466, Ratio = 10.7 at 90 min

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.

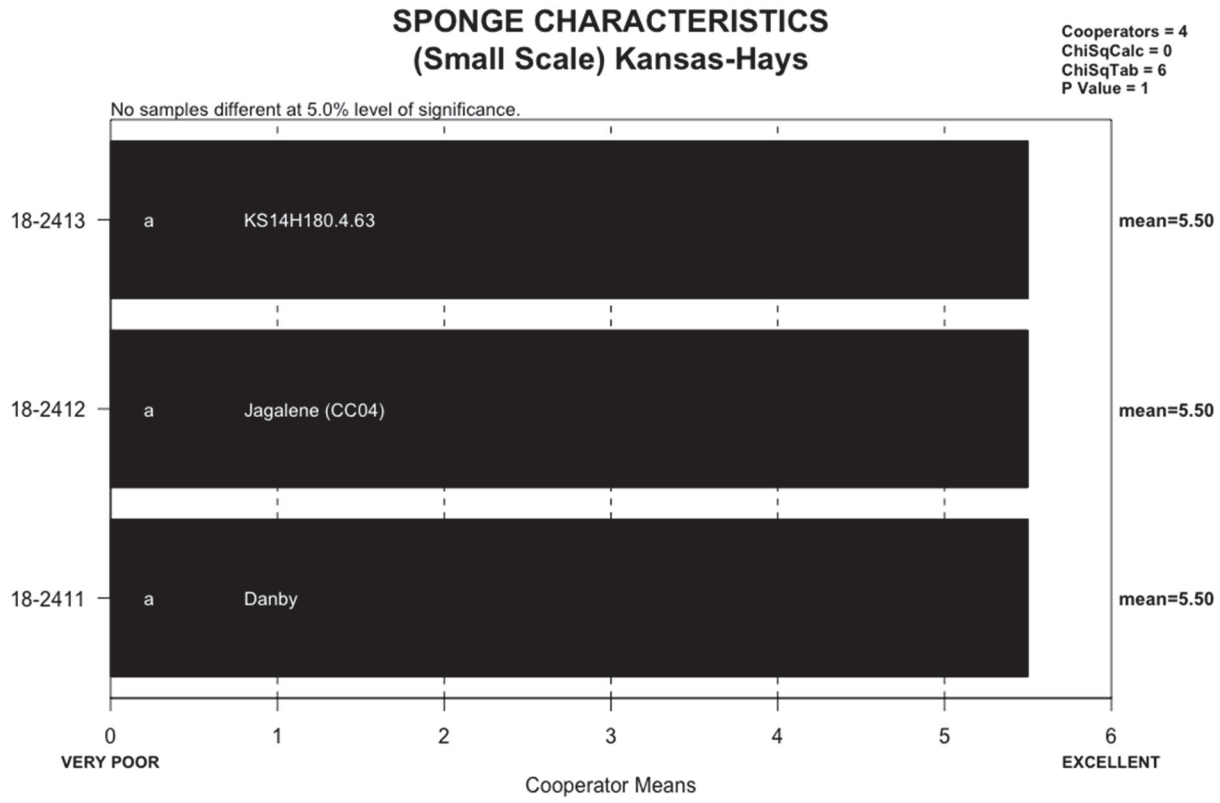
Kansas-Hays: C-Cell Bread Images and Analysis
2018 (Small-Scale) Samples

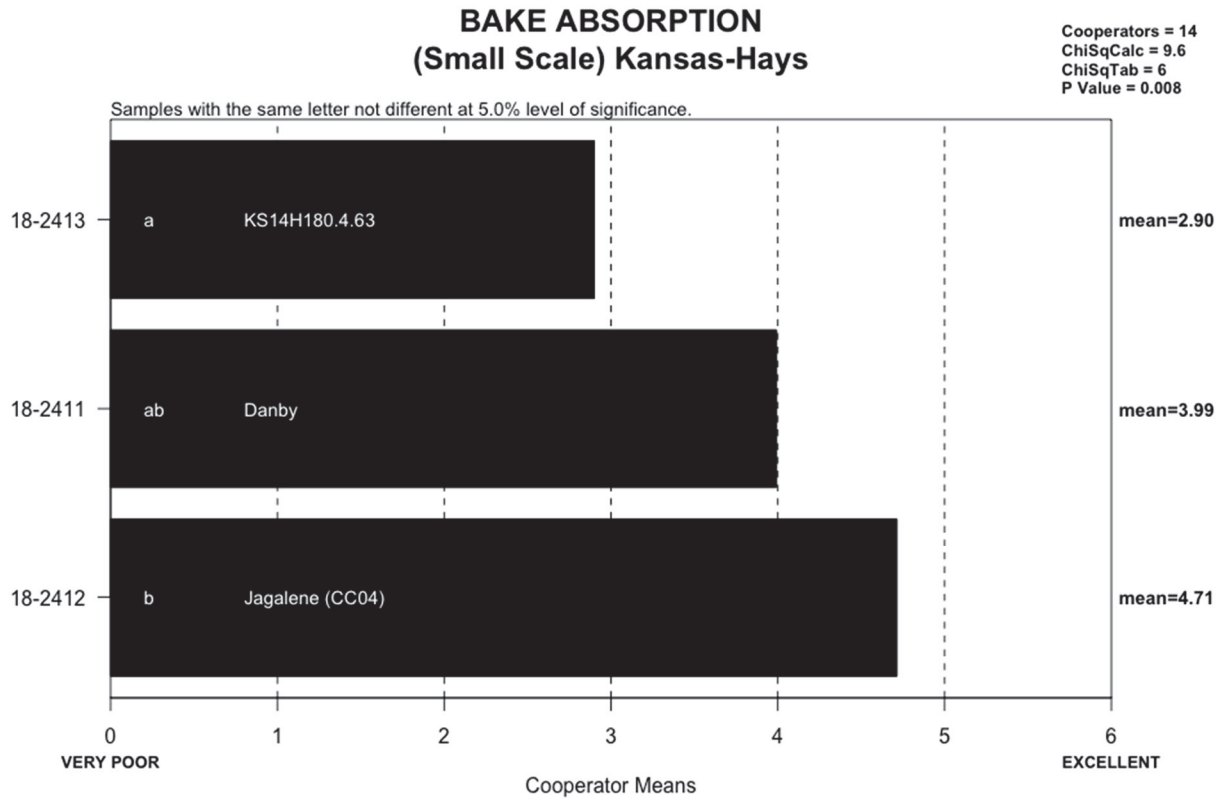




Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2411	6469	146	3772	0.451	2.207	1.155	1.635	-12.75
2412	6972	136	4087	0.443	2.108	1.172	1.765	-14.10

Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2413	6803	144	4192	0.435	1.976	0.352	1.775	-10.70


SPONGE CHARACTERISTICS
(Small Scale) Kansas-Hays
Cooperators = 4
ChiSqCalc = 0
ChiSqTab = 6
P Value = 1
No samples different at 5.0% level of significance.
18-2413
a
KS14H180.4.63
mean=5.50
18-2412
a
Jagalene (CC04)
mean=5.50
18-2411
a
Danby
mean=5.50
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

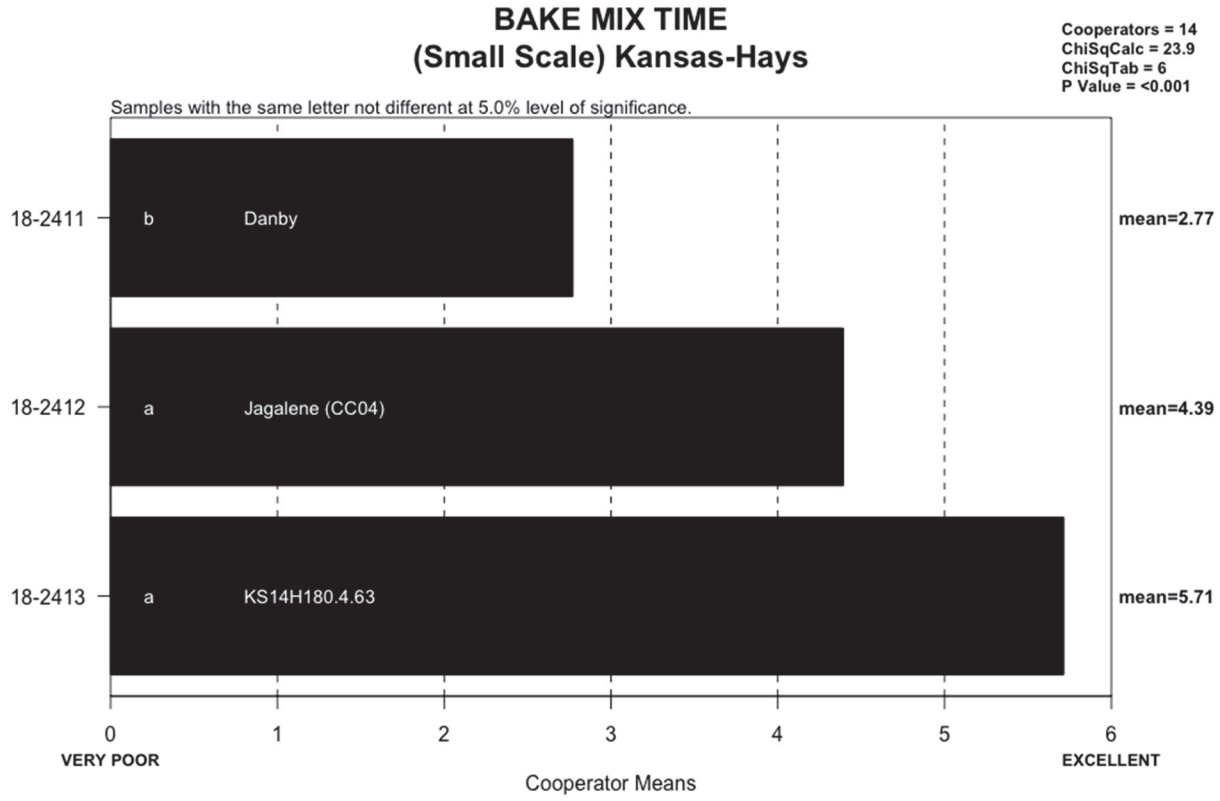

BAKE ABSORPTION
(Small Scale) Kansas-Hays
Cooperators = 14
ChiSqCalc = 9.6
ChiSqTab = 6
P Value = 0.008
Samples with the same letter not different at 5.0% level of significance.
18-2413
a
KS14H180.4.63
mean=2.90
18-2411
ab
Danby
mean=3.99
18-2412
b
Jagalene (CC04)
mean=4.71
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

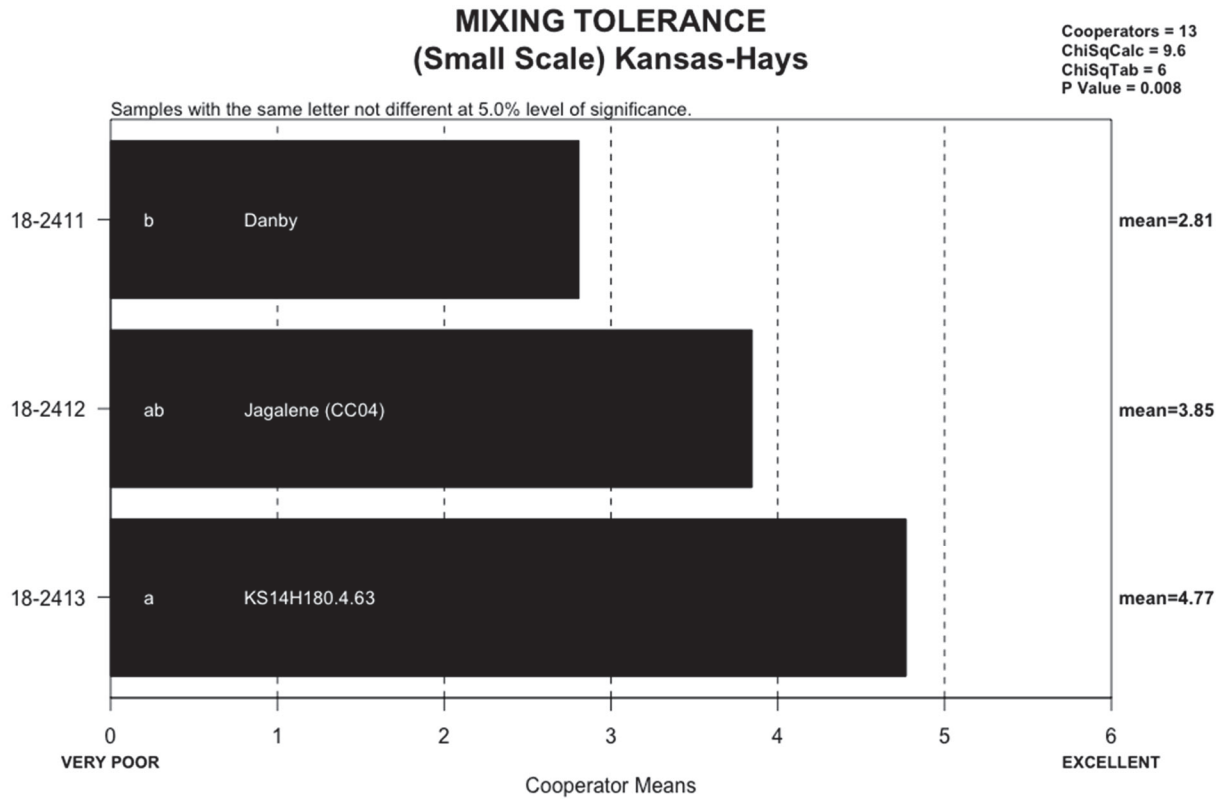
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Kansas-Hays
Cooperators A – N

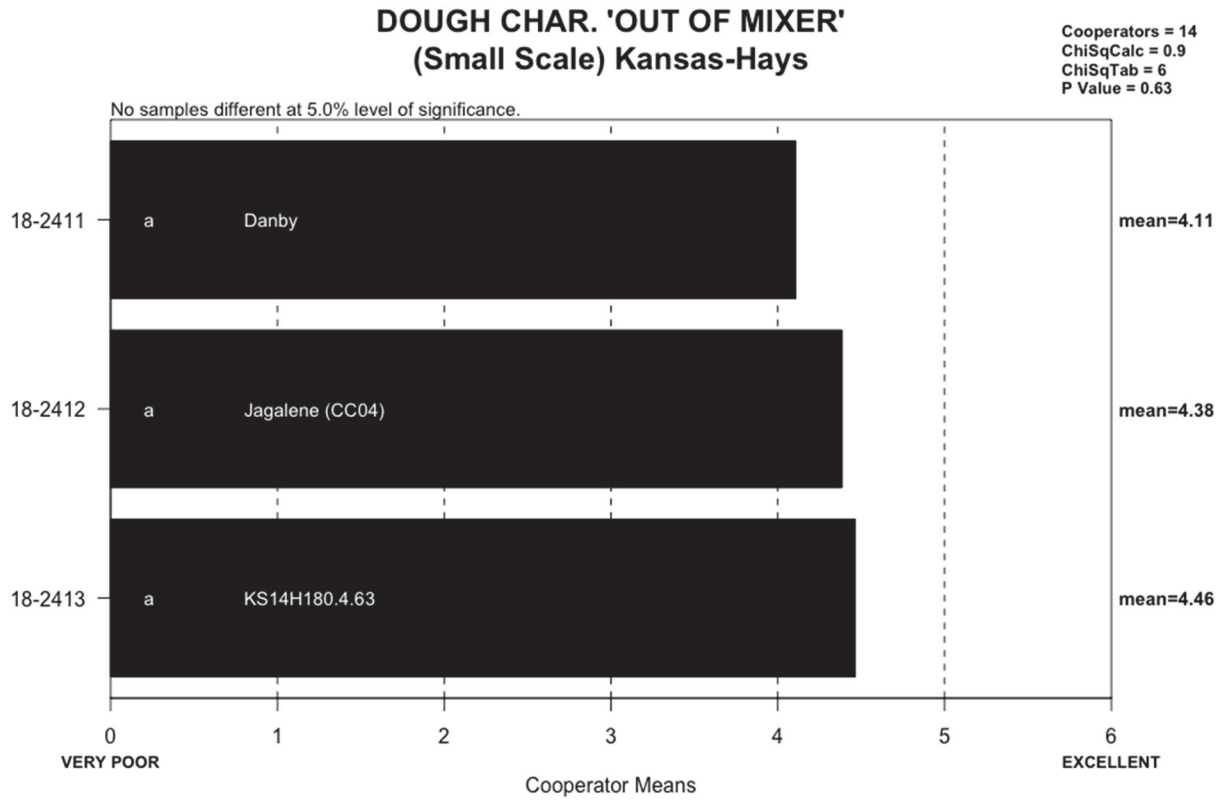
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2411	Danby	63.8	61.7	65.0	63.9	59	62.1	61.5	68.7	63.7	64.5	65.5	65.9	58	65.2
18-2412	Jagalene (CC04)	66.9	65.7	66.3	66.6	61	63.5	63.9	70.2	65.4	68.0	65.9	66.5	58	67.4
18-2413	KS14H180-4-63	65.0	61.9	62.7	62.1	59	57.4	60.4	65.2	60.7	64.5	59.4	61.2	56	63.7

BAKE MIX TIME, ACTUAL
(Small Scale) Kansas-Hays
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2411	Danby	3.2	2.8	3.3	4.3	5	6	3.3	3.5	2.5	2.2	8	2.8	12	3.5
18-2412	Jagalene (CC04)	5.2	4.3	5.8	6.3	6	8	4.9	4.5	3.5	3.5	17	3.7	25	5.3
18-2413	KS14H180-4-63	9.0	7.8	9.9	12.5	20	9	6.5	8.5	7.0	6.9	24	7.4	25	11.5

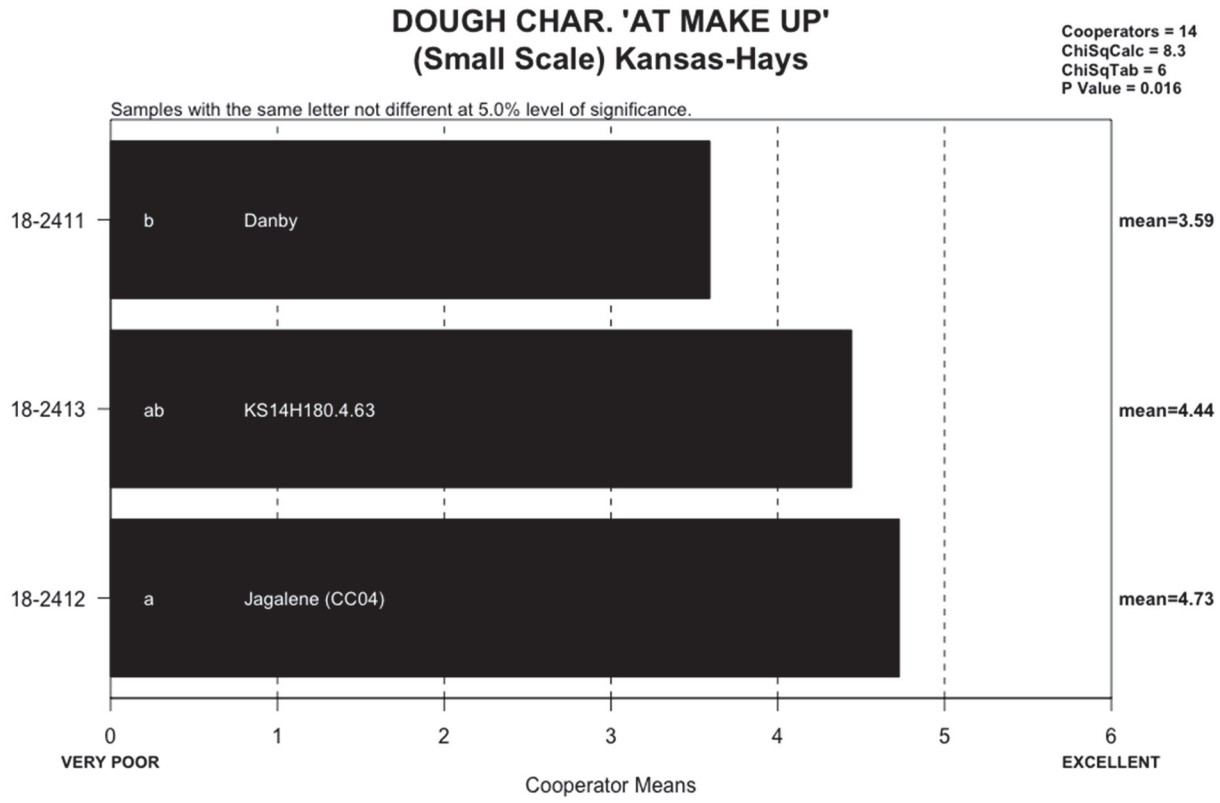

BAKE MIX TIME
(Small Scale) Kansas-Hays
Cooperators = 14
ChiSqCalc = 23.9
ChiSqTab = 6
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2411
b
Danby
mean=2.77
18-2412
a
Jagalene (CC04)
mean=4.39
18-2413
a
KS14H180.4.63
mean=5.71
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Kansas-Hays
Cooperators = 13
ChiSqCalc = 9.6
ChiSqTab = 6
P Value = 0.008
Samples with the same letter not different at 5.0% level of significance.
18-2411
b
Danby
mean=2.81
18-2412
ab
Jagalene (CC04)
mean=3.85
18-2413
a
KS14H180.4.63
mean=4.77
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means



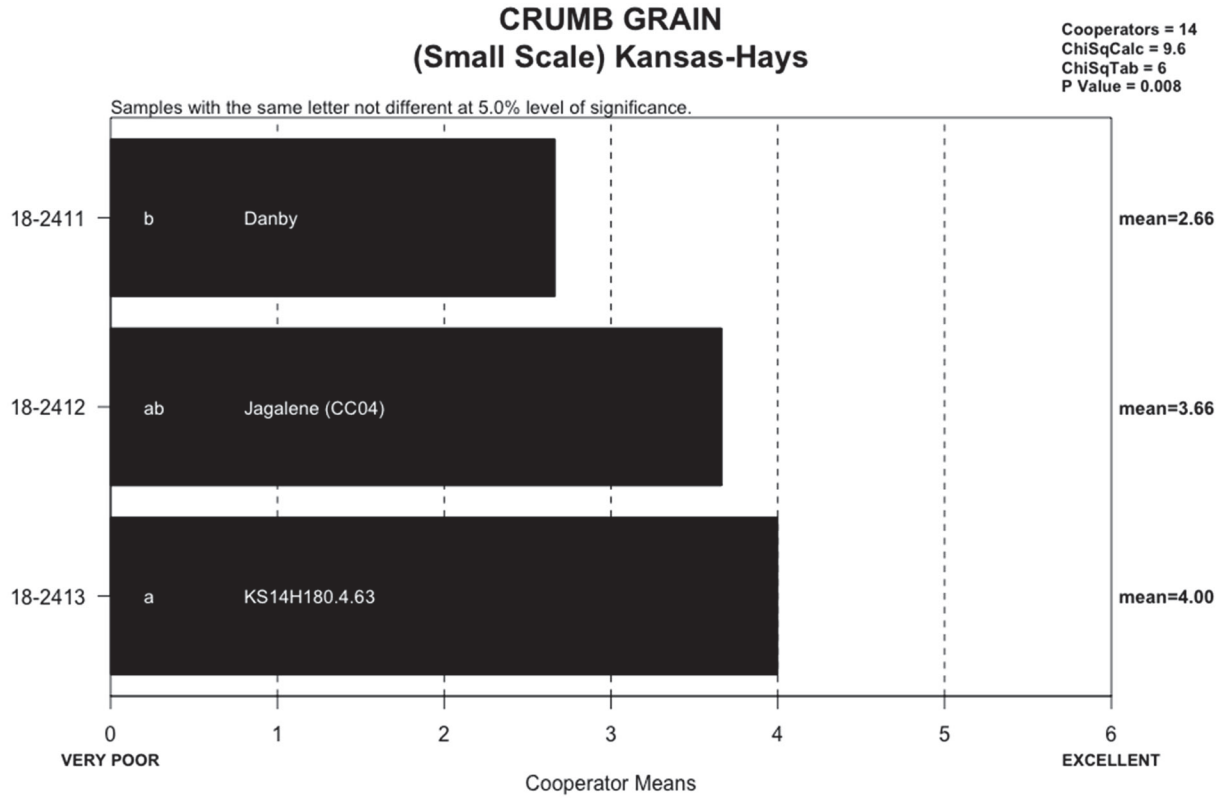
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Kansas-Hays

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2411	Danby	4	2	2	6	0
18-2412	Jagalene (CC04)	2	1	1	8	1
18-2413	KS14H180-4-63	2	2	5	4	1



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Small Scale) Kansas-Hays

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2411	Danby	6	1	1	6	0
18-2412	Jagalene (CC04)	1	0	1	10	2
18-2413	KS14H180-4-63	0	0	7	5	2

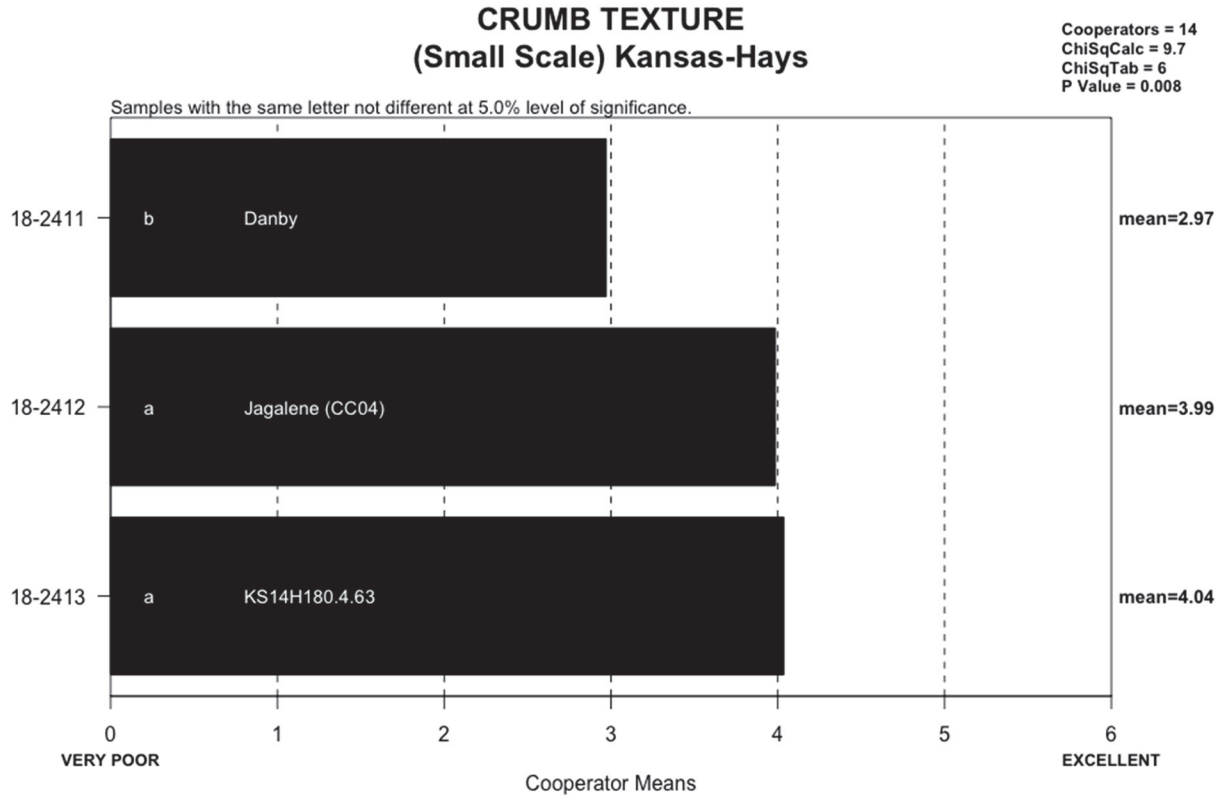


CRUMB GRAIN, DESCRIBED
(Small Scale) Kansas-Hays

IDCODE	ID	Open	Fine	Dense
18-2411	Danby	10	3	1
18-2412	Jagalene (CC04)	9	5	0
18-2413	KS14H180-4-63	6	8	0

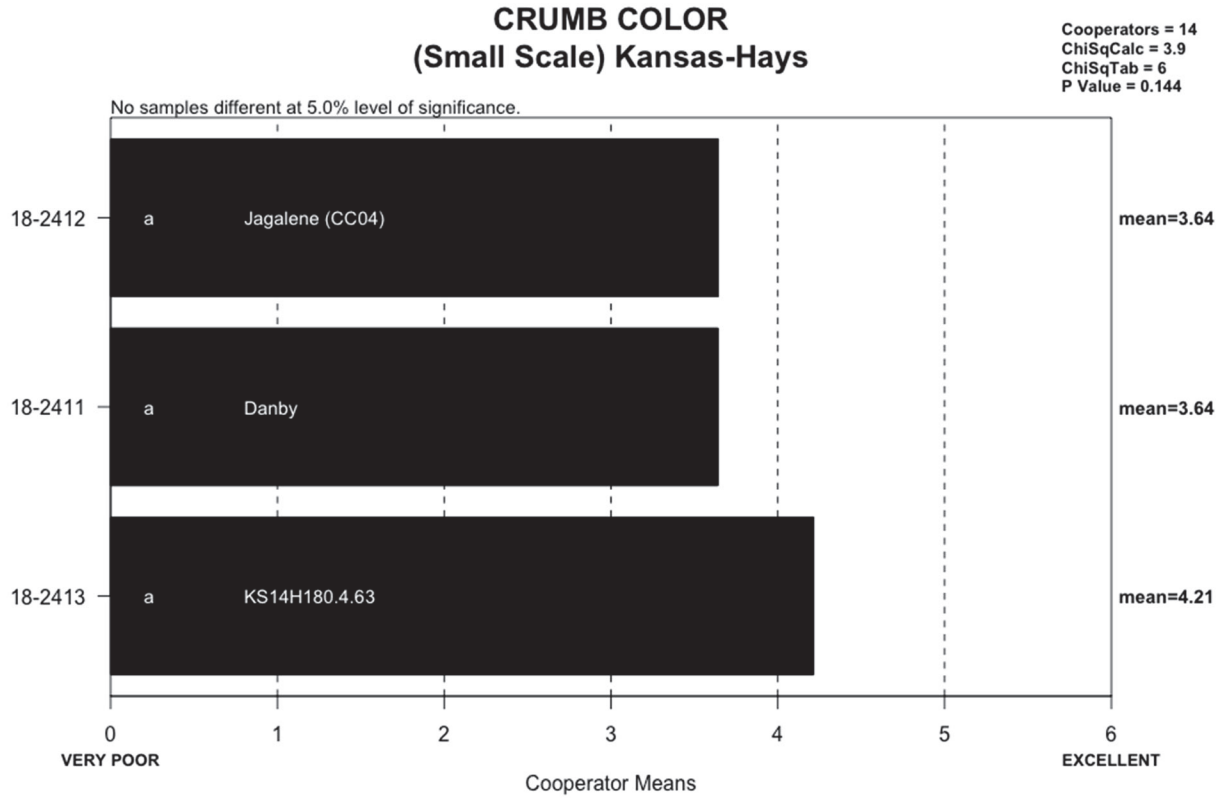
CELL SHAPE, DESCRIBED
(Small Scale) Kansas-Hays

IDCODE	ID	Round	Irregular	Elongated
18-2411	Danby	9	1	4
18-2412	Jagalene (CC04)	5	2	7
18-2413	KS14H180-4-63	2	4	8



CRUMB TEXTURE, DESCRIBED
(Small Scale) Kansas-Hays

IDCODE	ID	Harsh	Silky	Smooth
18-2411	Danby	8	1	5
18-2412	Jagalene (CC04)	3	2	9
18-2413	KS14H180-4-63	3	4	7



CRUMB COLOR, DESCRIBED
(Small Scale) Kansas-Hays

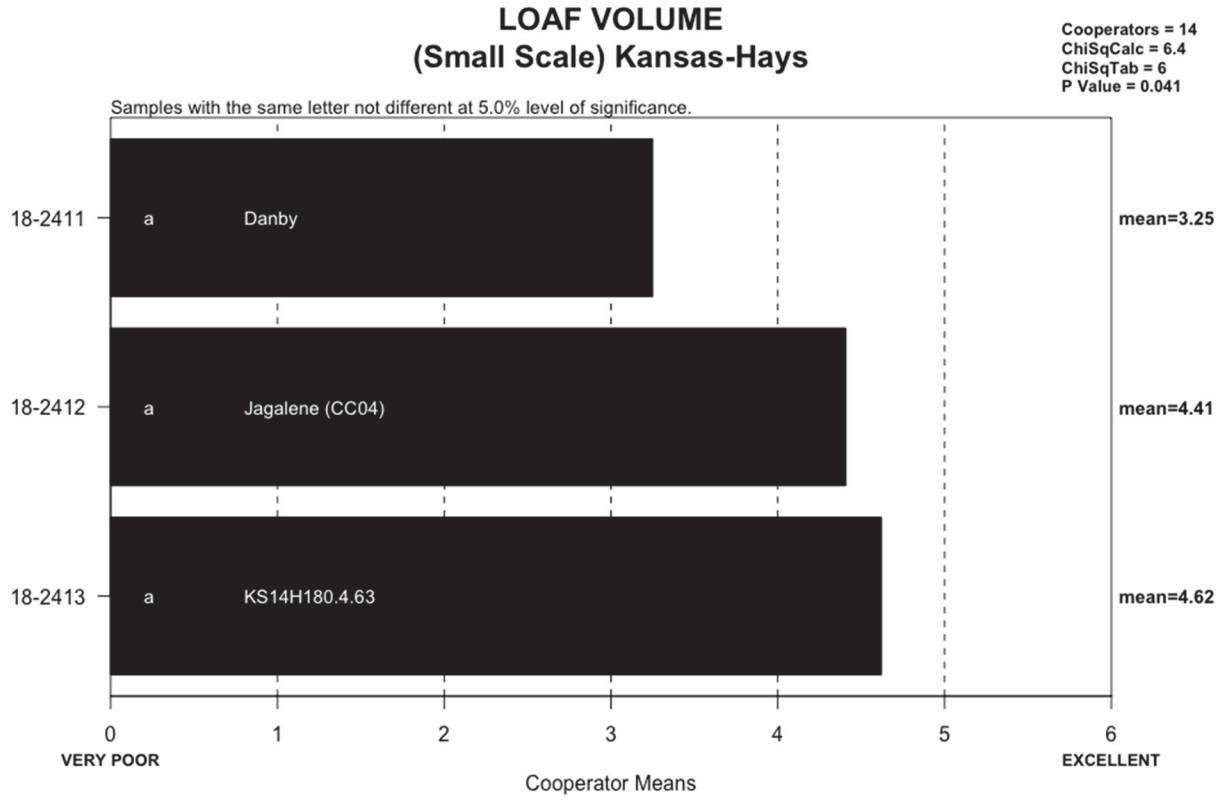
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	BrightWhite
18-2411	Danby	0	0	2	3	7	2	0
18-2412	Jagalene (CC04)	0	1	2	2	5	4	0
18-2413	KS14H180-4-63	0	0	0	1	10	3	0

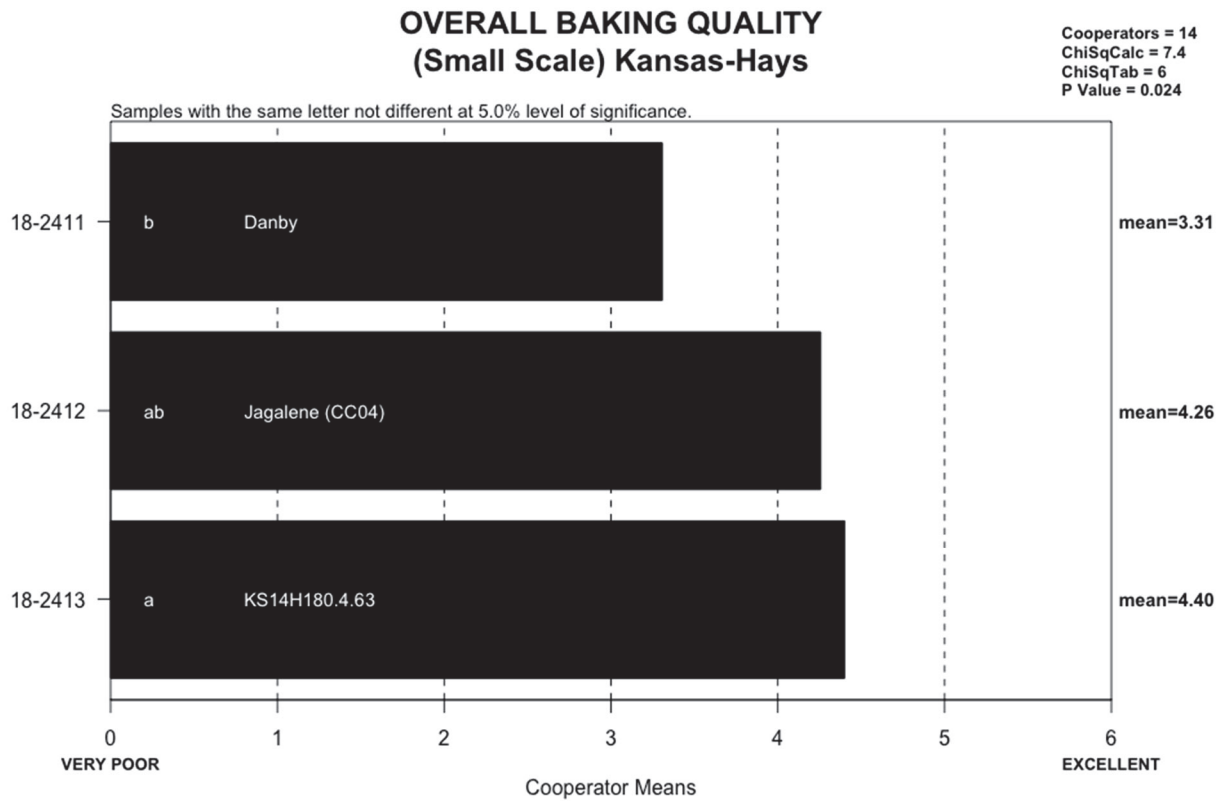
LOAF WEIGHT, ACTUAL
(Small Scale) Kansas-Hays
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2411	Danby	140.5	145.9	156.6	141.5	415	459.1	130.8	135.7	136.1	146.4	440.4	141.5	480.1	150.6
18-2412	Jagalene (CC04)	141.9	143.5	159.1	141.9	410	460.8	129.4	138.8	133.7	144.5	441.0	139.9	480.7	153.0
18-2413	KS14H180-4-63	141.7	138.6	151.9	139.4	420	466.7	129.7	131.0	128.2	142.8	447.4	140.6	479.2	148.7

LOAF VOLUME, ACTUAL
(Small Scale) Kansas-Hays
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2411	Danby	1010	805	1020	1050	2675	2275	865	865	840	775	2500	754	2750	930
18-2412	Jagalene (CC04)	1050	1040	1040	1035	2900	2288	945	885	990	1000	2650	851	2927	1020
18-2413	KS14H180-4-63	1050	1115	1015	915	2900	2413	740	945	1000	1145	2700	884	2986	970


LOAF VOLUME
(Small Scale) Kansas-Hays
Cooperators = 14
ChiSqCalc = 6.4
ChiSqTab = 6
P Value = 0.041
Samples with the same letter not different at 5.0% level of significance.
18-2411
a
Danby
mean=3.25
18-2412
a
Jagalene (CC04)
mean=4.41
18-2413
a
KS14H180.4.63
mean=4.62
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Small Scale) Kansas-Hays
Cooperators = 14
ChiSqCalc = 7.4
ChiSqTab = 6
P Value = 0.024
Samples with the same letter not different at 5.0% level of significance.
18-2411
b
Danby
mean=3.31
18-2412
ab
Jagalene (CC04)
mean=4.26
18-2413
a
KS14H180.4.63
mean=4.40
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Small Scale) Kansas-Hays

COOP. **18-2411 Danby**

A. Loaf Volume better than protein predicted LV.
B. No comment.
C. Somewhat weaker dough type. Bread performance very good for protein level.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, Extreme Volume, Creamy Crumb, Open Elongated Cells with Keyhole, Resilient & Less Smooth Texture.
E. Soft out of mixer and makeup, low loaf volume.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Weaker, did not perform at protein.
K. High protein. Shorter mix time. Crumb and texture questionable. Blending suggested.
L. No comment.
M. Slightly low absorption and mix strength, low loaf volume.
N. Open grain.

COOP. **18-2412 Jagalene (CC04)**

A. No comment.
B. Brownish dough, excellent loaf externals.
C. Good overall dough strength but tolerance to mixing very poor. Bread quality generally good.
D. High Protein, Large Water Abs, Normal MT, Slight Sticky & Strong Dough, Extreme High Volume, Yellow Crumb, Slight Open Elongated Cells, Resilient & Smooth Texture.
E. Higher protein with short mix time.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Good grain, white.
K. Higher protein and mix time. Characteristics and notes favorable. Good for bread application.
L. No comment.
M. Slightly low absorption, very good mix strength and good loaf volume.
N. High absorption, yellow crumb, high volume.

COOP. **18-2413 KS14H180-4-63**

A. Loaf Volume better than protein predicted LV.
B. Long time to pick up, excellent loaf externals.
C. Excellent dough strength and good bread quality. Very good loaf volume performance for protein.
D. Average Protein, Normal Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Volume, Creamy Crumb, Fine Elongated Cells, Resilient & Smooth Texture.
E. Strong dough for lower protein, open grain.
F. No comment.
G. No comment.
H. Very slack at panning, very long mixer.
I. No comment.
J. Long mixing, very good volume and color.
K. High protein but low absorption. High mixing tolerance/time, and great volume. Recommend use for blending.
L. No comment.
M. Low absorption, very good mix strength and good loaf volume.
N. Good grain, good volume, strong mixing tolerance.

Notes: **E, F, K and M** conducted sponge and dough bake tests

SYNGENTA (AGRIPRO)

18-2414	Jagalene (CC05)
18-2415	10BC107#115
18-2416	SY Monument
18-2417	08BC379-40-1

Description of Test Plots and Breeder Entries

Syngenta (Agripro) – Joe Bevilacqua

Growing conditions in Junction City, KS for all Syngenta lines:

Increase strips were planted on 10/28/17 on an irrigated location in Junction City, KS. Very good fall stand establishment. All increases had 80lbs of 11-52-0 applied with the planter, additionally 70lbs of N and 23 pounds of S were applied prior to planting. An additional 60lbs of N was applied in the spring prior to jointing. All strips were sprayed with a 10oz rate of Trivapro at flag leaf to insure good quality seed.

10BC107#115

10BC107#115 was developed from a cross of 06BC796#8/SY WOLF made in 2008 and double haploid created in Junction City, KS. 06BC796#8 is a sib line of SY Sunrise.

10BC107#115 is a hard red winter wheat broadly adapted to the irrigated Western High Plains and Northern High Plains. This line is short, similar to Everest. 10BC107#115 later maturing similar to SY Wolf, with good standability. 10BC107#115 has a good disease package similar to SY Wolf. 10BC107#115 has good drought tolerance and moderate resistance to wheat streak mosaic virus. 10BC107#115 shows good resistance to leaf rust, is moderately susceptible to stripe rust, but in a slow rusting pattern similar to SY Wolf, resistant to soil borne mosaic virus and moderate tolerance to BYDV. Milling and baking data compiled over three years indicates a line with acceptable protein content and flour yield, moderate tolerance and loaf volume.

08BC379-40-1

08BC379-40-1 was developed from the cross - (EVEREST/PLATTE//SY WOLF) made in Junction City, KS. The single cross EVEREST/PLATTE was made in the Spring of 2008, with the top cross to SY Wolf being made in the Fall of 2008. The line was selected out of segregating population and purified by head row.

08BC379-40-1 is a hard red winter wheat broadly adapted across the Western High Plains, Central Plains and Northern Plains. The height is short similar to WB-Cedar. 08BC379-40-1 is early maturing similar to Everest, with good standability. 08BC379-40-1 shows good resistance to leaf rust, is moderately susceptible to stripe rust, but in a slow rusting pattern similar to SY Wolf, resistant to soil borne mosaic virus, moderate tolerance to BYDV and WSMV. Milling and baking data compiled over three years indicates a line with high protein, good flour yield, intermediate tolerance and loaf volume.

Syngenta (Agripro): 2018 (Small-Scale) Samples

Test entry number	18-2414	18-2415	18-2416	18-2417
Sample identification	**Jagalene (CC05)**	**10BC107#115**	**SY Monument**	**08BC379-40-1**
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	63.9	63.8	61.4	63.5
Hectoliter weight (kg/hl)	83.9	83.8	80.7	83.4
1000 kernel weight (gm)	35.9	32.5	33.2	32.2
Wheat kernel size (Rotap)				
Over 7 wire (%)	83.3	81.2	82.0	66.1
Over 9 wire (%)	16.7	18.8	18.0	33.9
Through 9 wire (%)	0.0	0.0	0.0	0.0
Single kernel (skcs)[a]				
Hardness (avg /s.d)	76.5/16.8	77.9/15.1	81.1/18.0	75.9/15.8
Weight (mg) (avg/s.d)	35.9/9.1	32.5/8.4	33.2/8.7	32.2/9.8
Diameter (mm)(avg/s.d)	2.82/0.31	2.67/0.29	2.69/0.32	2.53/0.31
Moisture (%) (avg/s.d)	11.3/0.3	11.9/0.3	12.1/0.4	12.0/0.3
SKCS distribution	01-03-10-86-01	01-02-07-90-01	01-03-08-88-01	01-04-10-85-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	12.5	12.1	12.3	12.5
Wheat ash (12% mb)	1.58	1.71	1.63	1.62
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	79.6	77.3	77.8	77.4
Quadrumat Sr. Mill	70.7	68.4	70.7	71.1
Flour moisture (%)	12.8	12.8	12.8	12.7
Flour protein (14% mb)	11.5	10.9	11.1	11.5
Flour ash (14% mb)	0.60	0.64	0.58	0.56
Rapid Visco-Analyser				
Peak Time (min)	6.1	6.3	6.1	6.1
Peak Viscosity (RVU)	205.3	224.3	220.9	198.1
Breakdown (RVU)	77.8	71.1	80.7	69.8
Final Viscosity at 13 min (RVU)	235.3	265.9	255.8	237.9
Minolta color meter				
L*	91.06	90.85	91.06	91.43
a*	-1.21	-1.30	-1.20	-1.50
b*	9.36	9.70	9.25	9.79
PPO	0.389	0.500	0.233	0.473
Falling number (sec)	374	431	395	384
Damaged Starch				
(AI%)	98.2	97.3	97.7	97.5
(AACC76-31)	8.1	7.3	7.6	7.5

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

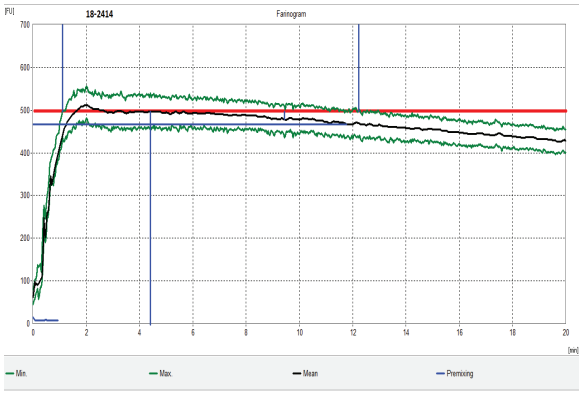
Syngenta: Physical Dough Tests and Gluten Analysis
2018 (Small-Scale) Samples

Test Entry Number	18-2414	18-2415	18-2416	18-2417
Sample Identification	Jagalene (CC05)	10BC107#115	SY Monument	08BC379-40-1
MIXOGRAPH				
Flour Abs (% as-is)	65.1	62.2	64.2	62.7
Flour Abs (14% mb)	63.9	61.0	62.8	61.4
Mix Time (min)	3.9	3.3	7.3	4.3
Mix tolerance (0-6)	3	2	5	4
FARINOGRAPH				
Flour Abs (% as-is)	61.9	61.8	62.8	61.6
Flour Abs (14% mb)	60.6	60.5	61.4	60.3
Peak time (min)	4.4	6.7	2.2	10.4
Mix stability (min)	11.1	9.3	4.9	15.7
Mix Tolerance Index (FU)	19	41	41	23
Breakdown time (min)	11.8	10.5	4.3	18.6
ALVEOGRAPH				
P(mm): Tenacity	96	97	114	92
L(mm): Extensibility	74	54	51	74
G(mm): Swelling index	19.1	16.4	15.9	19.1
W(10^{-4} J): strength (curve area)	263	202	247	255
P/L: curve configuration ratio	1.30	1.80	2.23	1.24
Ie(P_{200}/P): elasticity index	58.9	52.8	64.1	59.2
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	374/471/521	289/363/353	507/787/805	300/421/465
Extensibility (mm at 45/90/135 min)	139/127/129	128/133/125	133/120/103	141/127/123
Energy (cm^2 at 45/90/135 min)	90/98/114	63/79/71	121/150/112	74/87/91
Resist $_{max}$ (BU at 45/90/135 min)	489/605/706	367/455/434	754/1046/952	400/543/591
Ratio (at 45/90/135 min)	2.7/3.7/4.1	2.3/2.7/2.8	3.8/6.6/7.8	2.1/3.3/3.8
PROTEIN ANALYSIS				
HMW-GS Composition	1,2* 17+18, 5+10	1, 7+9, 5+10	2*, 7+9, 5+10	2*, 7+9, 5+10
TMP/TPP	1.11	0.85	0.99	0.77
SEDIMENTATION TEST				
Volume (ml)	45.4	31.6	46.9	36.0

Physical Dough Tests

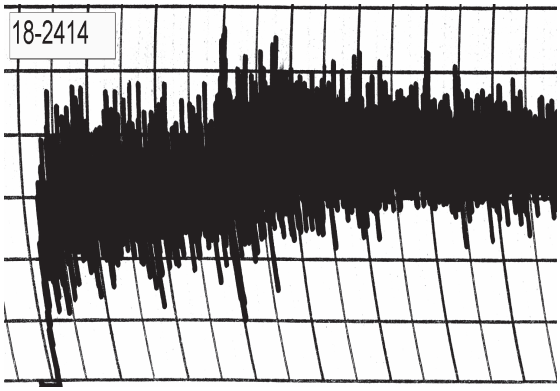
2018 (Small Scale) Samples – Syngenta (Agripro)

Farinograms



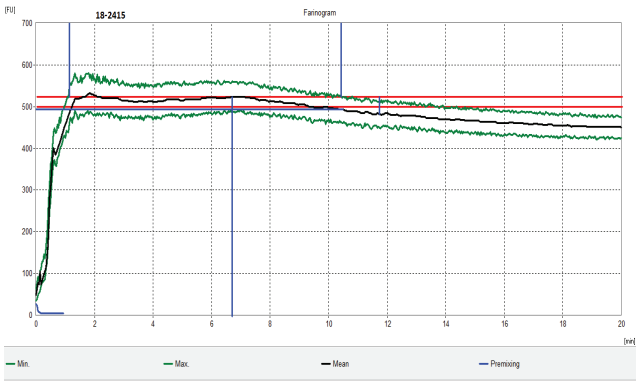
Water abs = 60.6%, Peak time = 4.4 min
Mix stab = 11.1 min, MTI = 19 FU

Mixograms

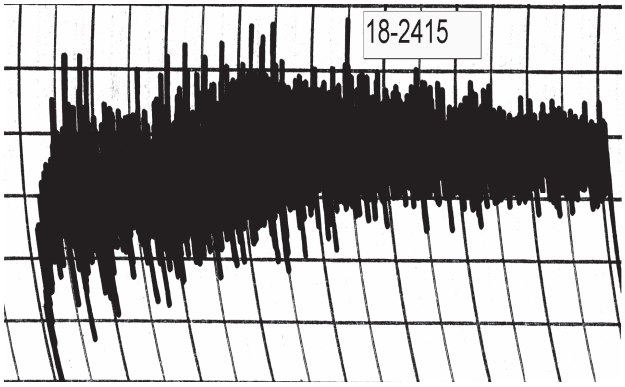


Water abs = 63.9%
Mix time = 3.9 min

18-2414, Jagalene (CC05)



Water abs = 60.5%, Peak time = 6.7 min,
Mix stab = 9.3 min, MTI = 41 FU



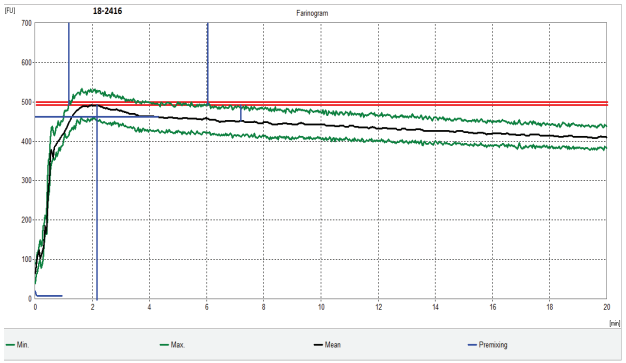
Water abs = 61.0%
Mix time = 3.3 min

18-2415, 10BC107#115

Physical Dough Tests

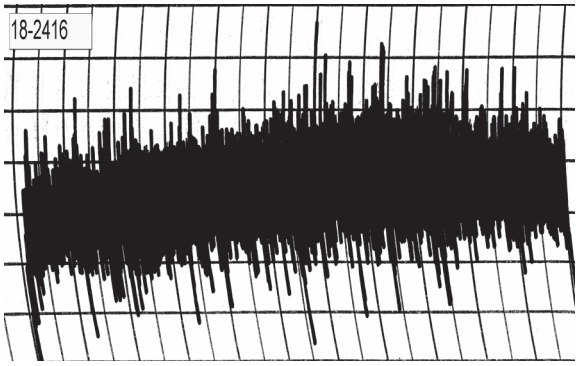
2018 (Small Scale) Samples – Syngenta (continued)

Farinograms



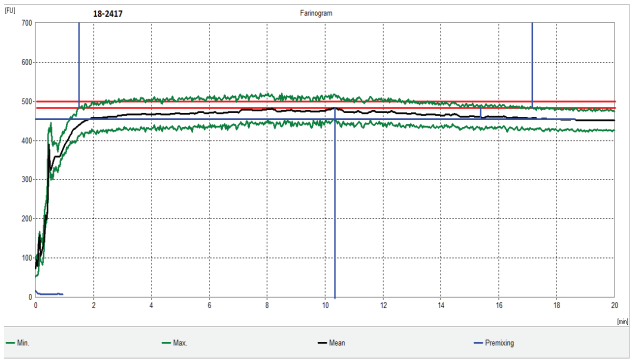
Water abs. = 61.4%, Peak time = 2.2 min,
Mix stab = 4.9 min, MTI = 41 FU

Mixograms

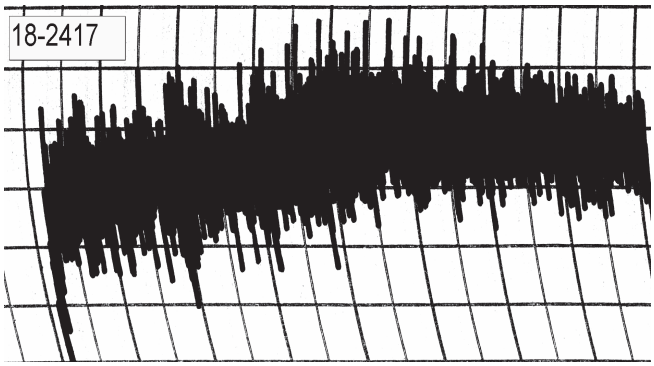


Water abs = 62.8%
Mix time = 7.3 min

18-2416, SY Monument



Water abs. = 60.3%, Peak time = 10.4 min,
Mix stab = 15.7 min, MTI = 23 FU

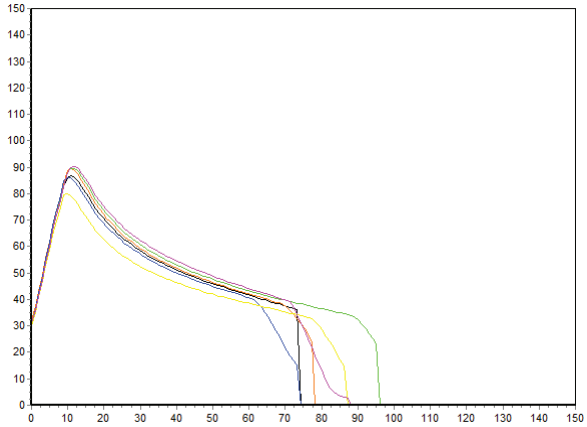


Water abs = 61.4%
Mix time = 4.3 min

18-2417, 08BC379-40-1

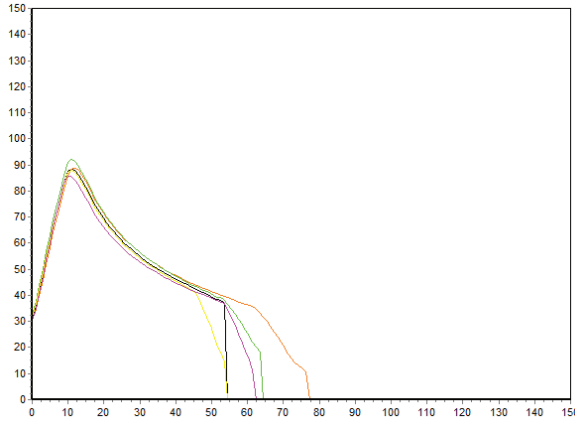
Physical Dough Tests - Alveograph

2018 (Small Scale) Samples – Syngenta (Agripro)



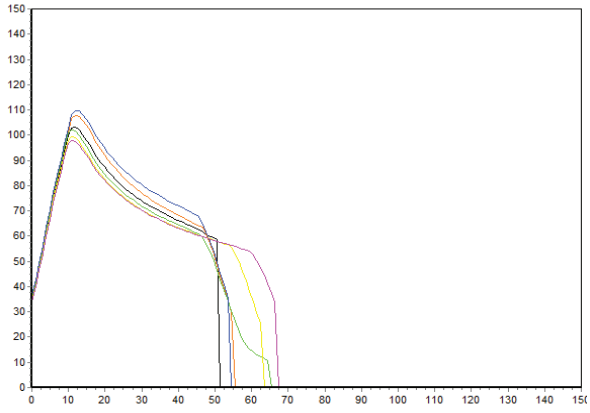
18-2414, Jagalene (CC05)

P (mm H_20) = 96, L (mm) = 74, W ($10E^{-4}J$) = 263



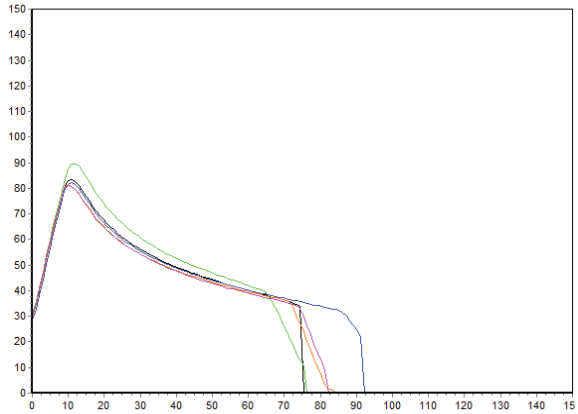
18-2415, 10BC107#115

P (mm H_20) = 97, L (mm) = 54, W ($10E^{-4}J$) = 202



18-2416, SY Monument

P (mm H_20) = 114, L (mm) = 51, W ($10E^{-4}J$) = 247

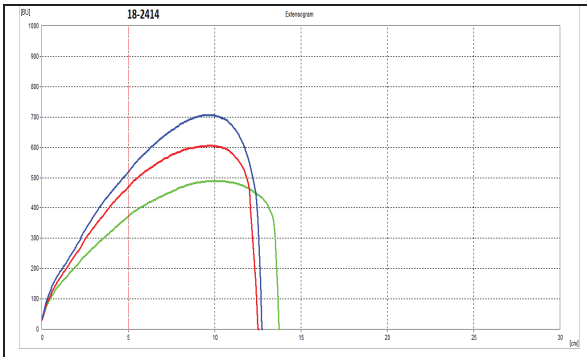


18-2417, 08BC379-40-1

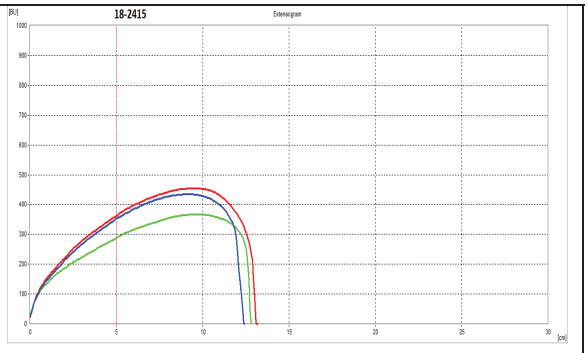
P (mm H_20) = 92, L (mm) = 74, W ($10E^{-4}J$) = 255

Physical Dough Tests - Extensigraph

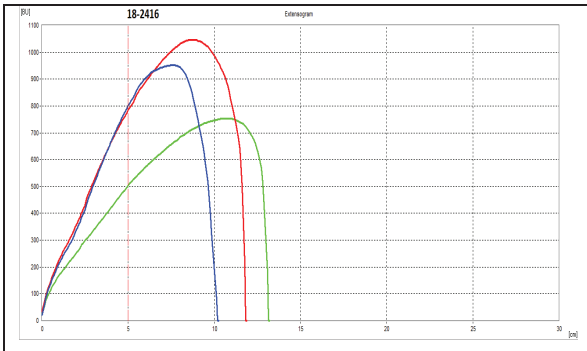
2018 (Small Scale) Samples – Syngenta (Agripro)



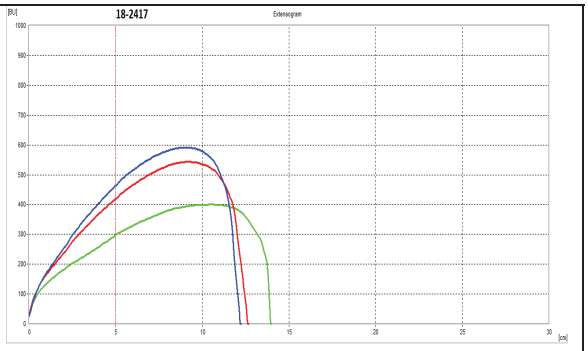
18-2414, Jagalene (CC05)
R (BU) = 471, E (mm) = 127, W (cm^2) = 98
Rmax (BU) = 605, Ratio = 3.7 at 90 min



18-2415, 10BC107#115
R (BU) = 363, E (mm) = 133, W (cm^2) = 79
Rmax (BU) = 455, Ratio = 2.7 at 90 min



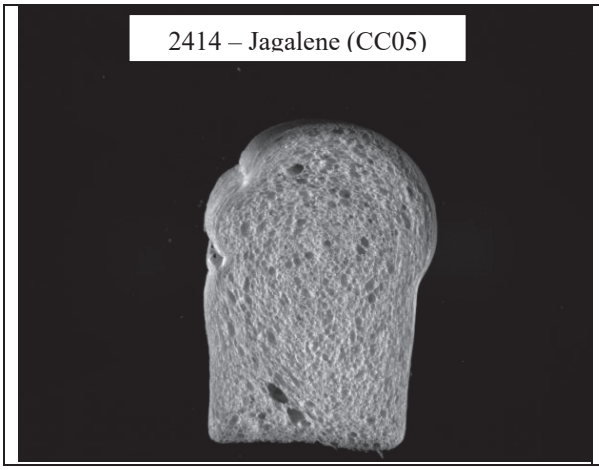
18-2416, SY Monument
R (BU) = 787, E (mm) = 120, W (cm^2) = 150
Rmax (BU) = 1046, Ratio = 6.6 at 90 min



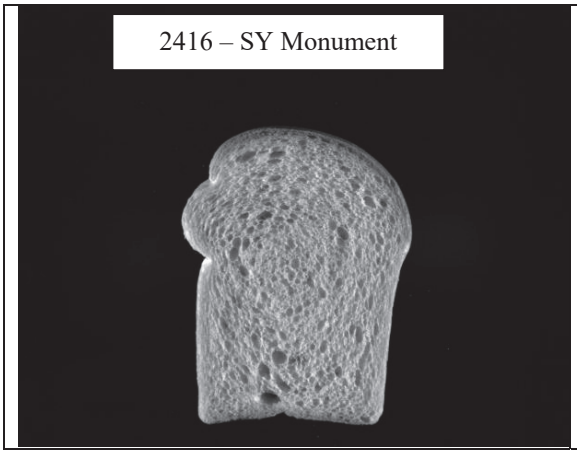
18-2417, 08BC379-40-1
R (BU) = 421, E (mm) = 127, W (cm^2) = 87
Rmax (BU) = 543, Ratio = 3.3 at 90 min

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.

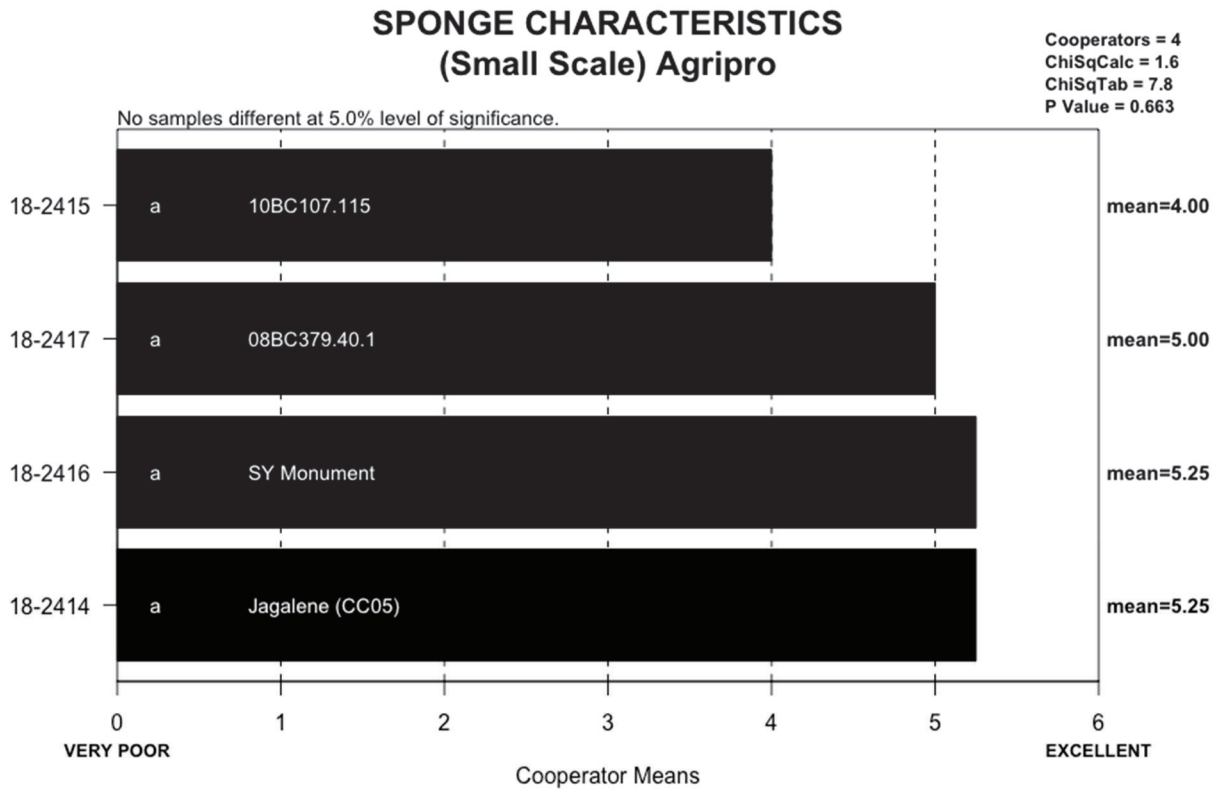
Syngenta: C-Cell Bread Images and Analysis
2018 (Small-Scale) Samples

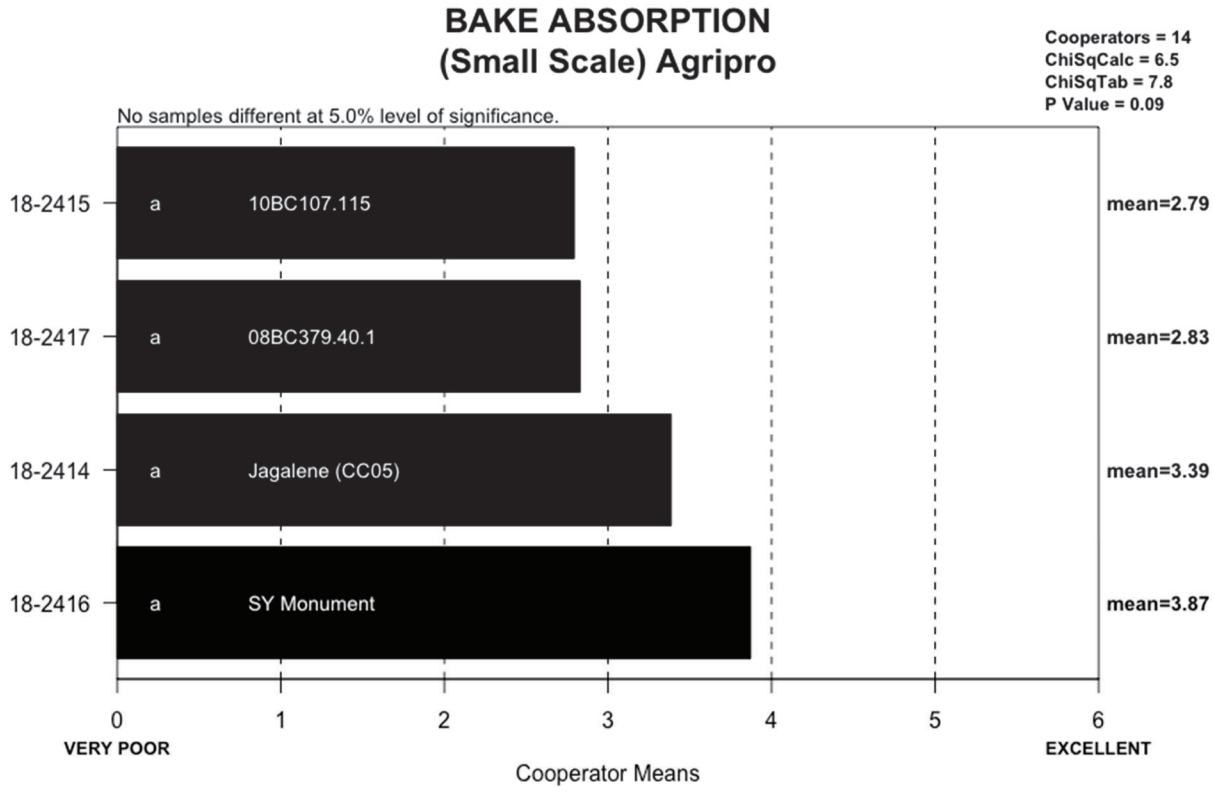


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2414	6479	139	4032	0.436	1.978	0.858	1.720	-13.35
2415	6125	144	3848	0.440	1.948	0.686	1.730	-9.85



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	6194	141	3855	0.439	1.974	1.943	1.778	-7.68
2417	6221	148	3974	0.437	1.959	0.661	1.675	-13.35


SPONGE CHARACTERISTICS
(Small Scale) Agripro
Cooperators = 4
ChiSqCalc = 1.6
ChiSqTab = 7.8
P Value = 0.663
No samples different at 5.0% level of significance.
18-2415
a
10BC107.115
mean=4.00
18-2417
a
08BC379.40.1
mean=5.00
18-2416
a
SY Monument
mean=5.25
18-2414
a
Jagalene (CC05)
mean=5.25
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

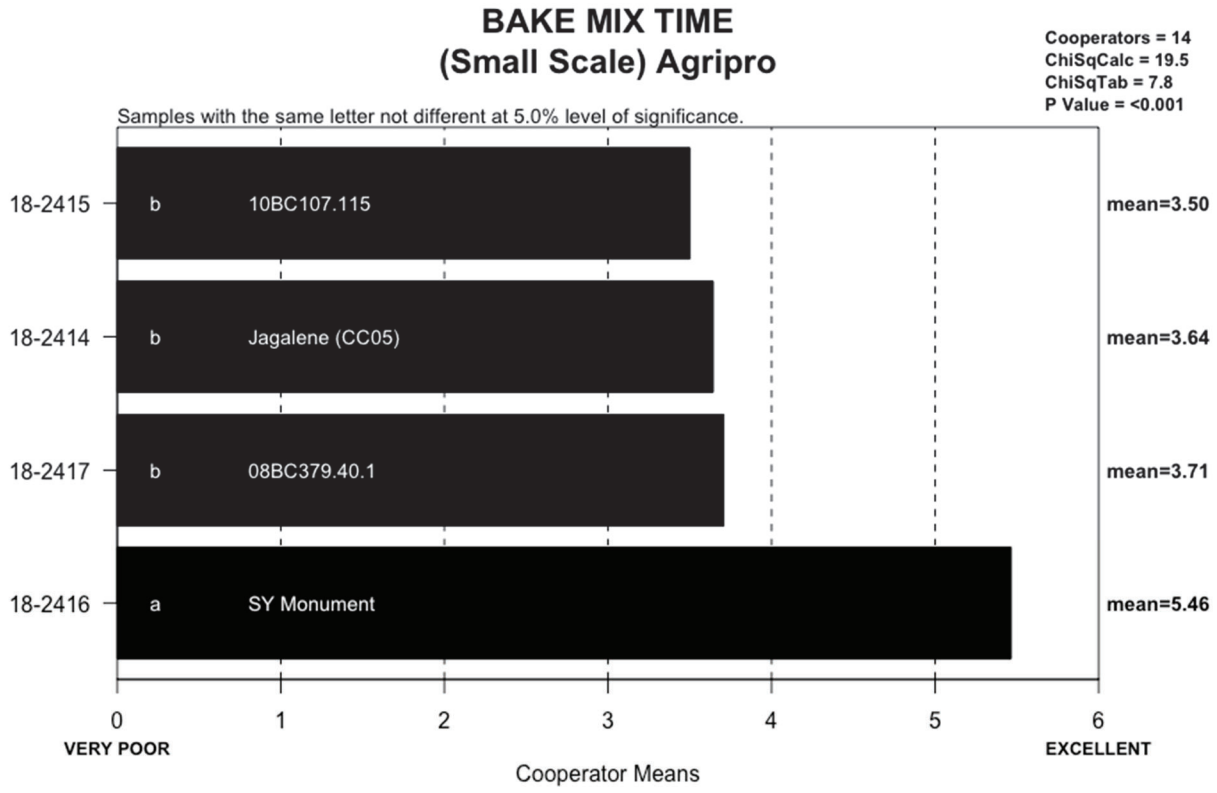

BAKE ABSORPTION
(Small Scale) Agripro
Cooperators = 14
ChiSqCalc = 6.5
ChiSqTab = 7.8
P Value = 0.09
No samples different at 5.0% level of significance.
18-2415
a
10BC107.115
mean=2.79
18-2417
a
08BC379.40.1
mean=2.83
18-2414
a
Jagalene (CC05)
mean=3.39
18-2416
a
SY Monument
mean=3.87
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

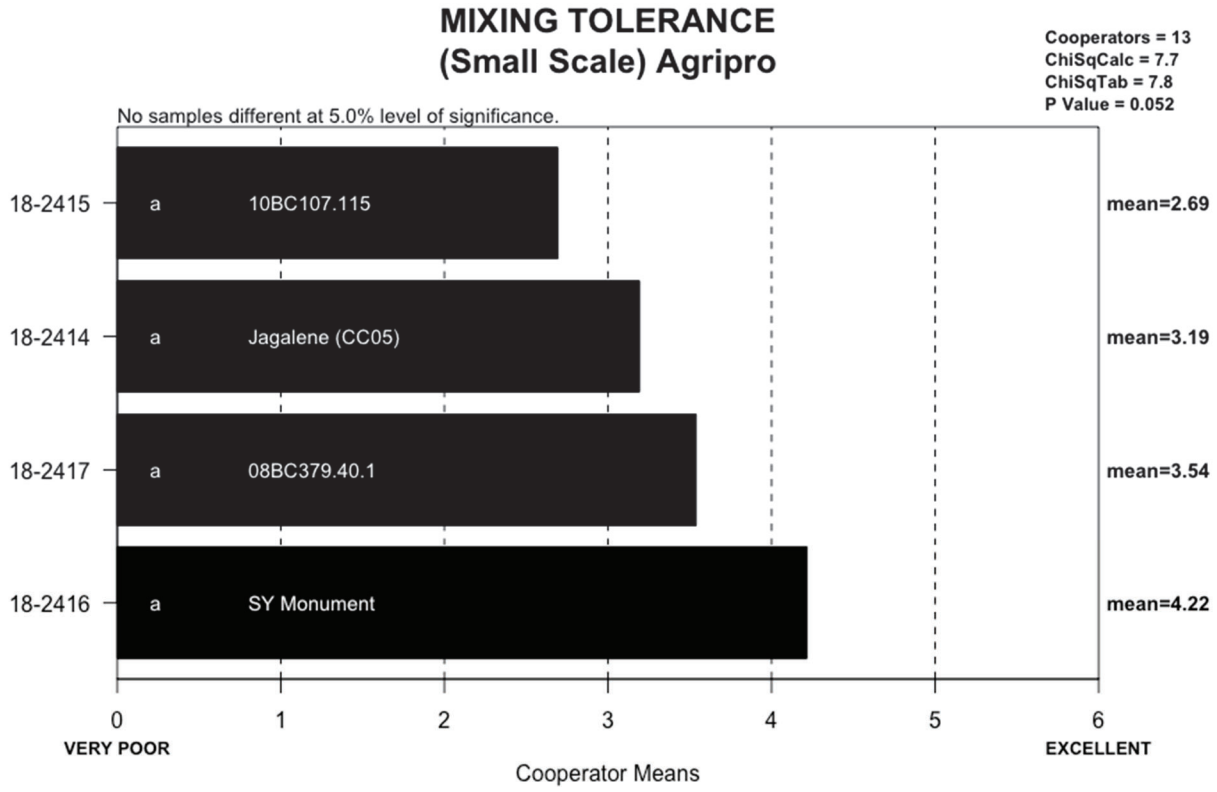
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Agripro
Cooperators A – N

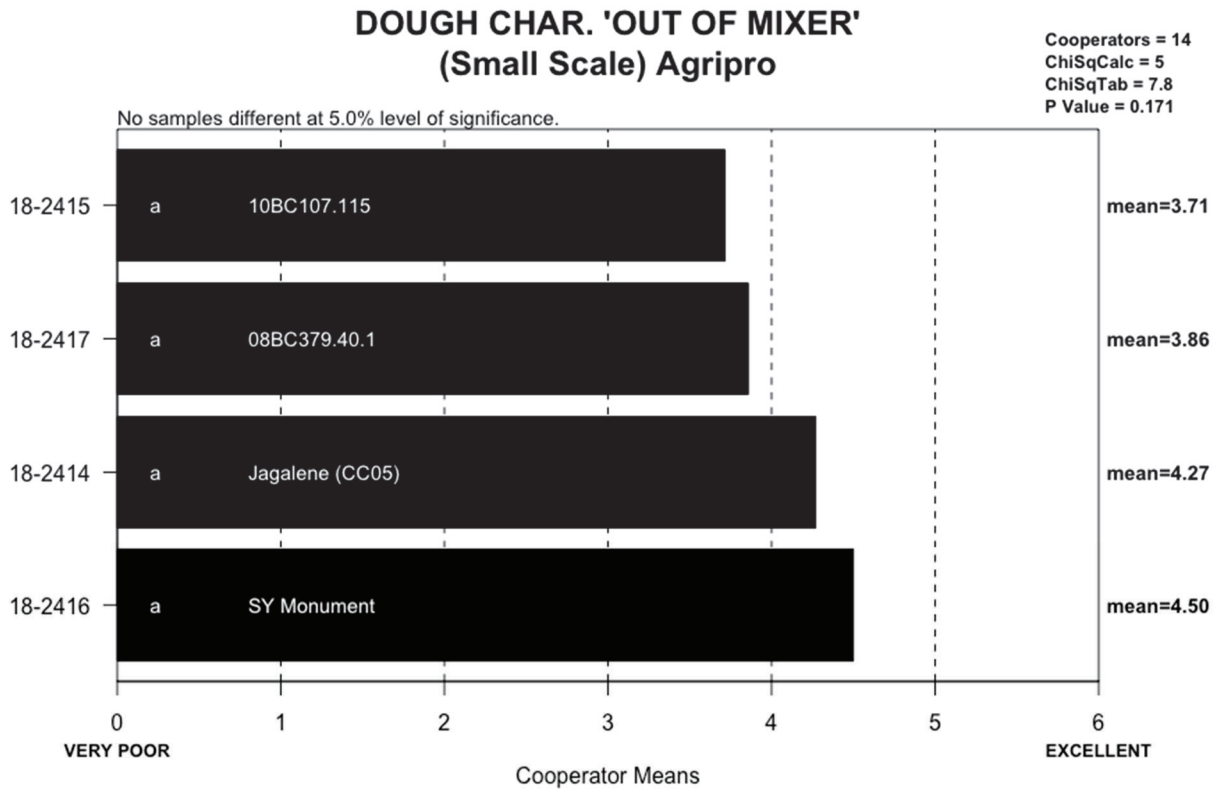
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2414	Jagalene (CC05)	61	60.7	63.8	64.9	58	60.6	60.1	70.1	64.2	63.0	63.0	65.4	57	63.5
18-2415	10BC107.115	60	59.8	62.5	63.6	58	60.5	59.1	67.3	63.7	61.0	62.4	65.3	57	60.5
18-2416	SY Monument	64	60.8	64.8	62.2	58	61.4	59.5	69.7	65.0	66.0	63.0	65.4	57	64.3
18-2417	08BC379.40.1	61	60.7	62.2	62.6	58	60.3	60.0	69.0	63.8	62.5	62.6	62.3	56	61.4

BAKE MIX TIME, ACTUAL
(Small Scale) Agripro
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2414	Jagalene (CC05)	4.5	4.3	4.0	6.6	5	4	3.5	5.0	3.8	3.4	14	3.6	20	6
18-2415	10BC107.115	4.0	3.8	4.6	6.3	5	5	4.1	4.5	3.5	3.3	9	3.6	11	5
18-2416	SY Monument	8.0	7.0	6.2	7.6	11	8	6.5	6.0	6.3	5.6	22	6.9	25	10
18-2417	08BC379-40-1	4.3	4.5	4.8	5.4	5	8	5.5	4.5	3.8	3.3	8	3.3	14	5

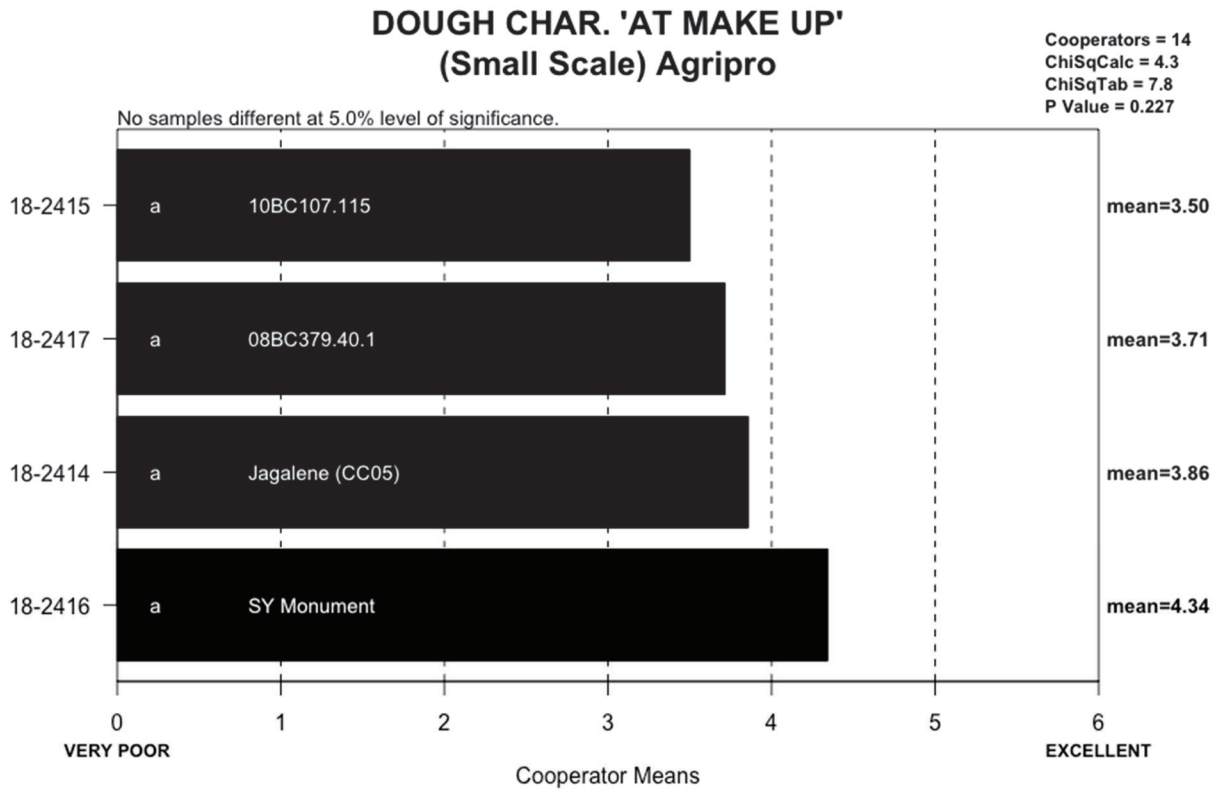

BAKE MIX TIME
(Small Scale) Agripro
Cooperators = 14
ChiSqCalc = 19.5
ChiSqTab = 7.8
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2415
b
10BC107.115
mean=3.50
18-2414
b
Jagalene (CC05)
mean=3.64
18-2417
b
08BC379.40.1
mean=3.71
18-2416
a
SY Monument
mean=5.46
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Agripro
Cooperators = 13
ChiSqCalc = 7.7
ChiSqTab = 7.8
P Value = 0.052
No samples different at 5.0% level of significance.
18-2415
a
10BC107.115
mean=2.69
18-2414
a
Jagalene (CC05)
mean=3.19
18-2417
a
08BC379.40.1
mean=3.54
18-2416
a
SY Monument
mean=4.22
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means



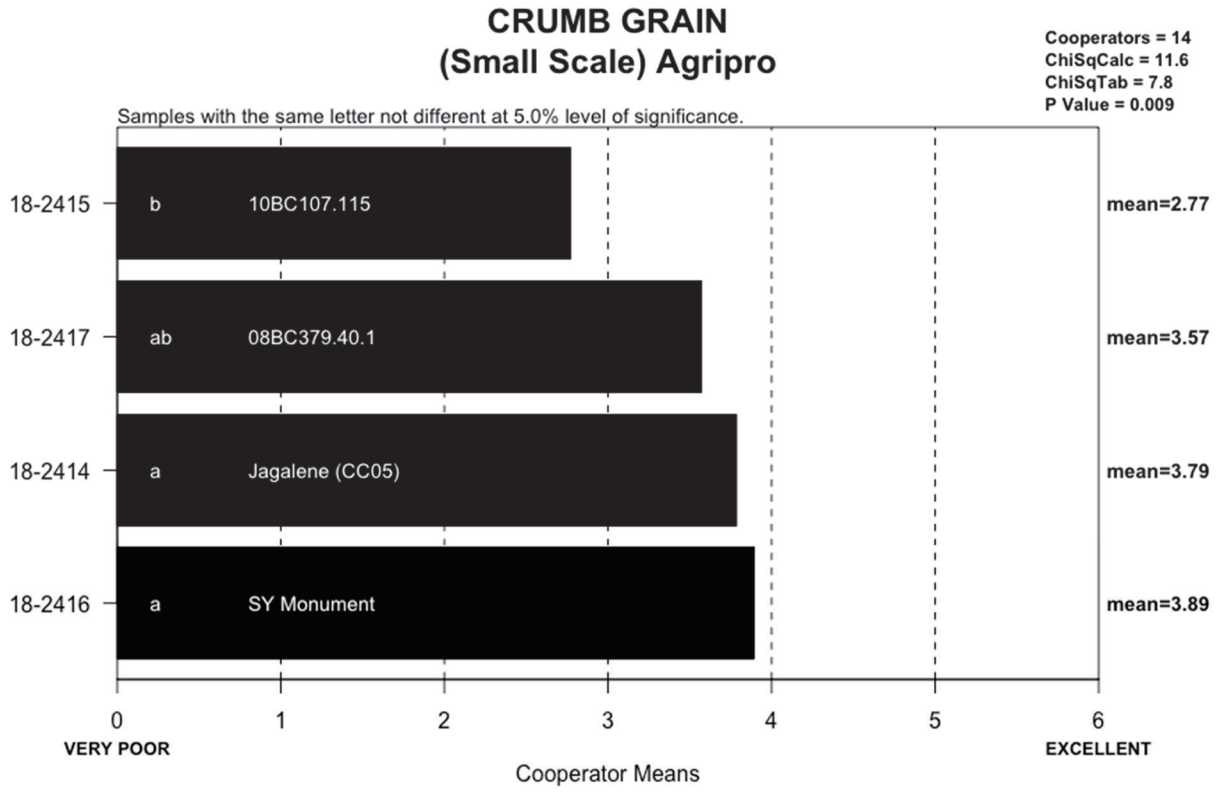
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Agripro

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2414	Jagalene (CC05)	2	0	3	7	1
18-2415	10BC107.115	2	1	4	7	0
18-2416	SY Monument	0	2	4	7	1
18-2417	08BC379-40-1	4	0	1	8	1



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Small Scale) Agripro

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2414	Jagalene (CC05)	1	3	1	9	0
18-2415	10BC107.115	1	1	4	8	0
18-2416	SY Monument	0	2	5	6	1
18-2417	08BC379-40-1	4	1	0	9	0

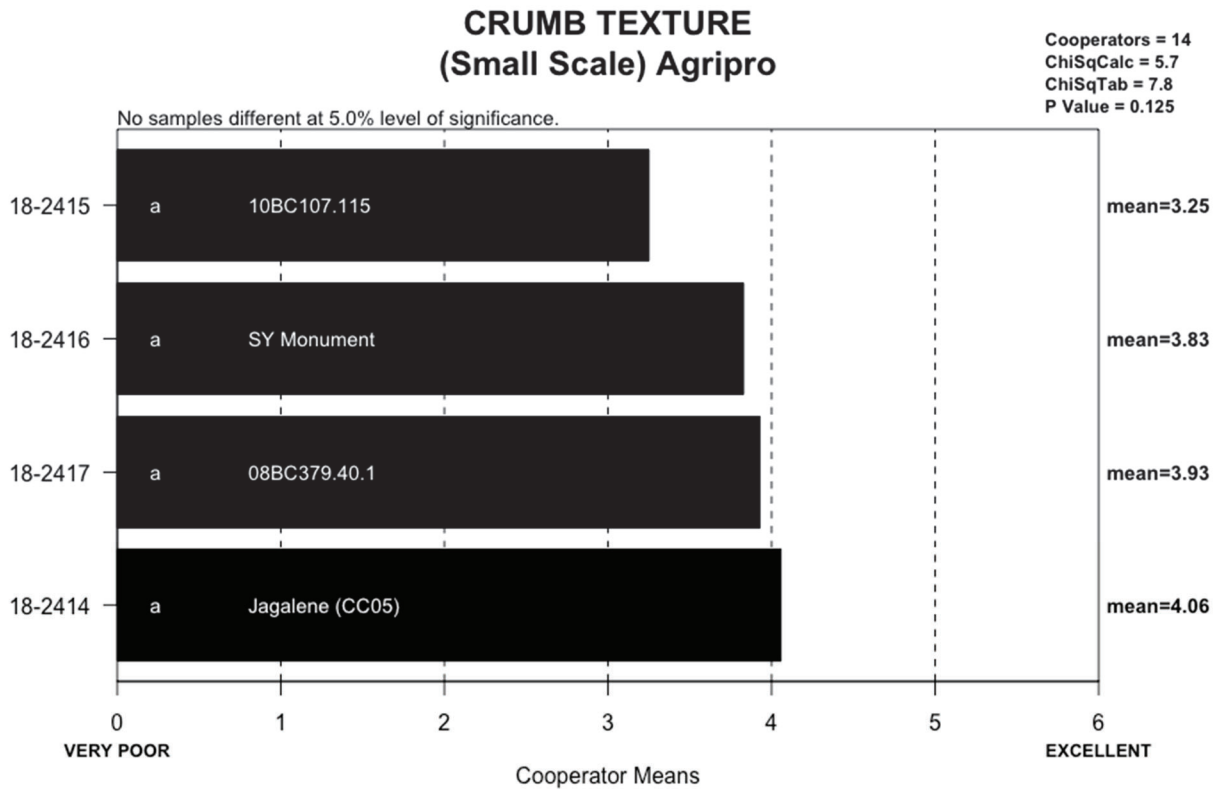


CRUMB GRAIN, DESCRIBED
(Small Scale) Agripro

IDCODE	ID	Open	Fine	Dense
18-2414	Jagalene (CC05)	5	6	3
18-2415	10BC107.115	7	3	4
18-2416	SY Monument	4	8	2
18-2417	08BC379-40-1	5	7	2

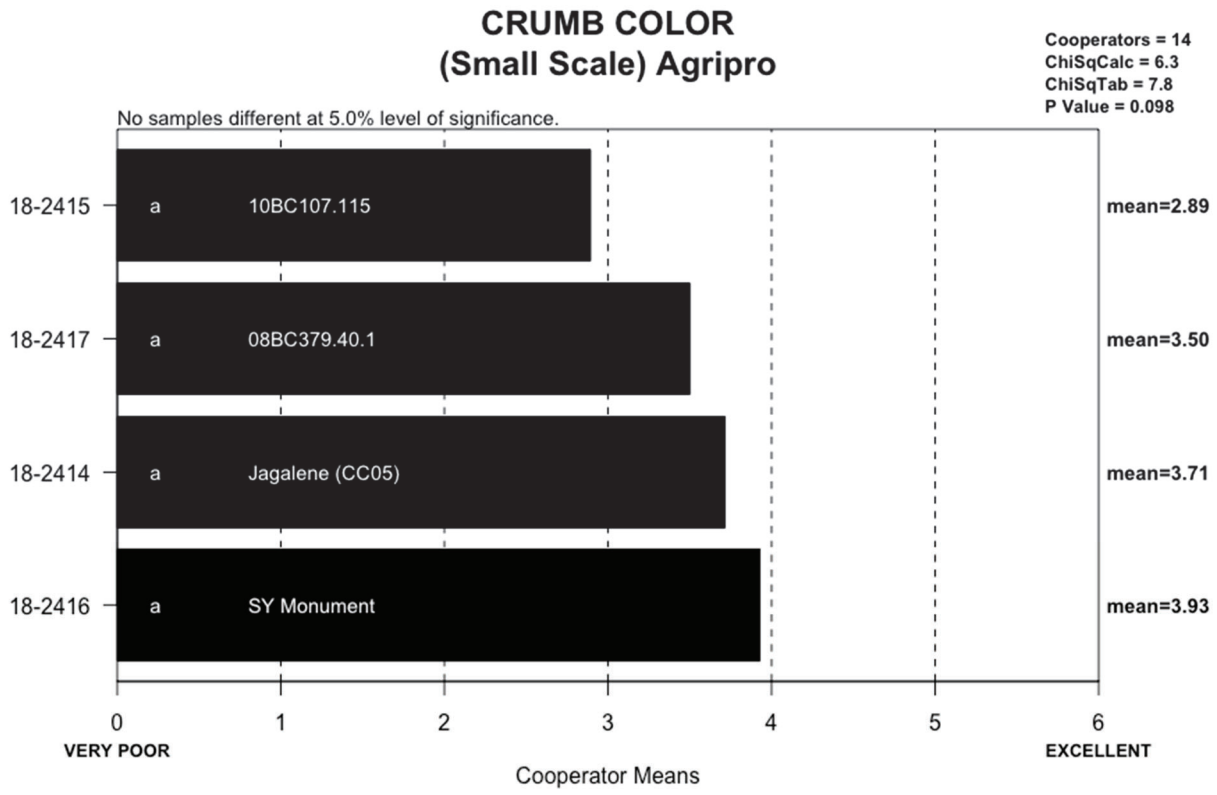
CELL SHAPE, DESCRIBED
(Small Scale) Agripro

IDCODE	ID	Round	Irregular	Elongated
18-2414	Jagalene (CC05)	3	4	7
18-2415	10BC107.115	8	3	3
18-2416	SY Monument	7	2	5
18-2417	08BC379-40-1	7	3	4



CRUMB TEXTURE, DESCRIBED
(Small Scale) Agripro

IDCODE	ID	Harsh	Smooth	Silky
18-2414	Jagalene (CC05)	3	7	4
18-2415	10BC107.115	5	8	1
18-2416	SY Monument	3	8	3
18-2417	08BC379-40-1	4	7	3



CRUMB COLOR, DESCRIBED
(Small Scale) Agripro

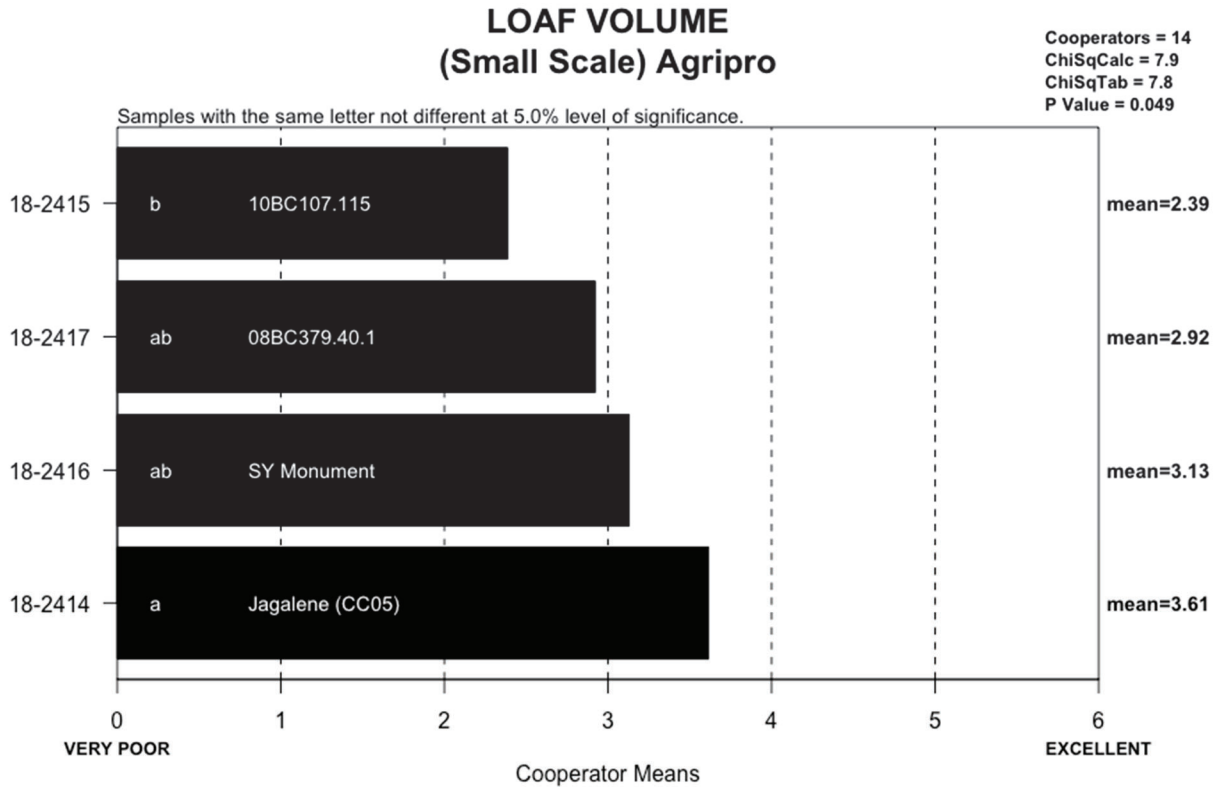
IDCODE	ID	Gray	DarkYellow	Yellow	Dull	Creamy	White	Bright White
18-2414	Jagalene (CC05)	0	0	3	1	9	1	0
18-2415	10BC107.115	1	0	3	4	6	0	0
18-2416	SY Monument	0	0	2	2	6	3	1
18-2417	08BC379-40-1	0	0	3	1	10	0	0

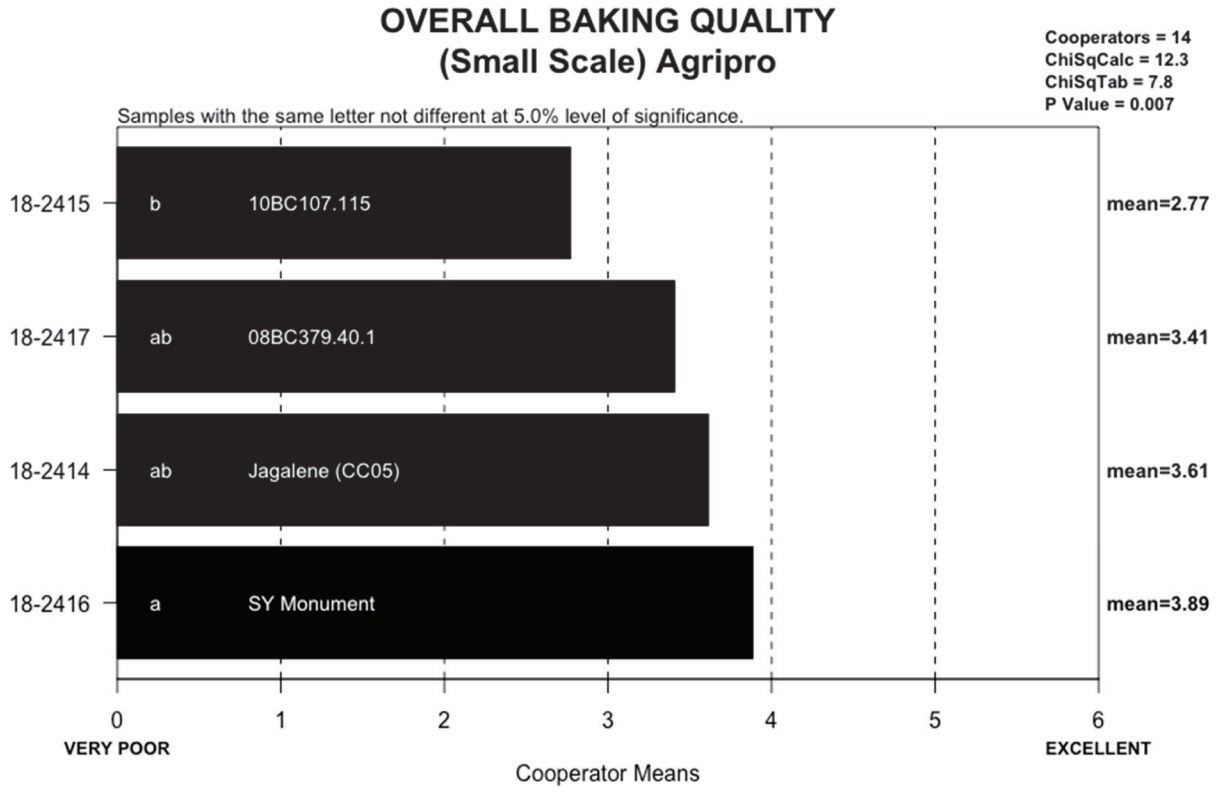
LOAF WEIGHT, ACTUAL
(Small Scale) Agripro
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2414	Jagalene (CC05)	137.4	141.1	151.9	141.6	418	463.3	132.9	134.3	133.7	143.2	443.5	138.9	466.7	149.5
18-2415	10BC107.115	138.2	144.4	155.7	139.0	413	466.2	130.7	133.8	133.3	143.3	440.5	141.7	484.4	149.8
18-2416	SY Monument	140.7	143.3	155.3	143.3	421	469.2	130.8	136.1	130.2	145.6	447.1	141.0	487.3	153.9
18-2417	08BC379-40-1	138.9	143.4	152.4	141.9	418	467.2	128.8	136.6	133.2	148.0	446.4	141.1	480.1	151.4

LOAF VOLUME, ACTUAL
(Small Scale) Agripro
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2414	Jagalene (CC05)	965	875	980	906	2850	2450	715	880	860	875	2700	842	2986	870
18-2415	10BC107.115	825	740	865	890	2800	2325	710	825	810	730	2425	745	2721	810
18-2416	SY Monument	935	910	850	725	2800	2250	720	930	910	940	2575	780	2809	810
18-2417	08BC379-40-1	875	745	808	888	2600	2275	810	865	905	845	2625	778	2809	875


LOAF VOLUME
(Small Scale) Agripro
Cooperators = 14
ChiSqCalc = 7.9
ChiSqTab = 7.8
P Value = 0.049
Samples with the same letter not different at 5.0% level of significance.
18-2415
b
10BC107.115
mean=2.39
18-2417
ab
08BC379.40.1
mean=2.92
18-2416
ab
SY Monument
mean=3.13
18-2414
a
Jagalene (CC05)
mean=3.61
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Small Scale) Agripro
Cooperators = 14
ChiSqCalc = 12.3
ChiSqTab = 7.8
P Value = 0.007
Samples with the same letter not different at 5.0% level of significance.
18-2415
b
10BC107.115
mean=2.77
18-2417
ab
08BC379.40.1
mean=3.41
18-2414
ab
Jagalene (CC05)
mean=3.61
18-2416
a
SY Monument
mean=3.89
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Small Scale) Syngenta (Agripro)

COOP. **18-2414 Jagalene (CC05)**

A. Loaf Volume better than protein predicted LV, low ABS.
B. Nice loaf externals.
C. Good dough strength but somewhat low tolerance to mixing. Good bread performance for protein level.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Weak Dough, Medium High Volume, Yellow Crumb, Open Elongated Cells with Keyhole, Resilient & Less Smooth Texture.
E. Soft doughs, short mix time.
F. No comment.
G. No comment.
H. No comment.
I. Light yellow crumb.
J. Decent grain, just average.
K. Average protein, dough notes, and characteristics. Good mixing tolerance. Great for Bread application.
L. No comment.
M. Low absorption, good mix strength and loaf volume.
N. Good grain, yellow crumb.

COOP. **18-2415 10BC107#115**

A. Low ABS.
B. No comment.
C. Low protein, dough strength promising. Good volume for protein level.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, High Volume, Yellow Crumb, Slight Open Elongated Cells, Resilient & Smooth Texture.
E. Open grain, Slightly creamy interior, average volume for protein.
F. No comment.
G. No comment.
H. Even crumb.
I. Crumb feels rough to the touch and is crumbly.
J. Lower protein/volume, small round cells.
K. Shorter mix time, gray in color, low mixing tolerance. Average protein. Good for blending.
L. No comment.
M. Low absorption and mix strength, low loaf volume. High ash.
N. Low absorption, poor grain, yellow crumb, low volume.

COOP. **18-2416 SY Monument**

A. Nice out of mixer, Loaf Volume better than protein predicted LV.
B. Excellent loaf externals.
C. Low protein, dough strength promising. Good volume for protein level.
D. Medium Protein, Normal Water Abs, Long MT, Slight Sticky & Weak Dough, Low Volume, Yellow Crumb, Dense Round Cells, Resilient & Harsh Texture.
E. Best of set. Good volume, Slightly creamy interior.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Lower protein but baked well.
K. Long mix time, high tolerance, and strong notes and dough characteristics. Slightly low protein. Great for blending.
L. No comment.
M. Low absorption, very good mix strength and slightly low loaf volume.
N. Yellow crumb, low volume, strong mixing tolerance.

COOP. **18-2417 08BC379-40-1**

A. Low ABS.
B. No comment.
C. Somewhat weaker dough type. Bread performance average.
D. Medium Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, Medium High Volume, Creamy Crumb, Fine Elongated Cells, Resilient & Smooth Texture.
E. Weak dough, Low loaf volume.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Yellow crumb color with ok crumb being silky, weaker dough throughout.
K. Good protein. Shorter mix time but good notes, characteristics, and volume. Great for bread application.
L. No comment.
M. Low absorption, fair mix strength and slightly low loaf volume.
N. Low absorption, yellow crumb.

Notes: **E, F, K and M** conducted sponge and dough bake tests