Milling and Baking Test Results for Hard Winter Wheat

Harvested in 2024

75th 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, as well as private wheat breeding companies including Syngenta (AgriPro Wheat), Bayer (WestBred), Limagrain and other collaborators from milling, baking, grain trade, other firms and academic 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 and other wheat end-use quality tests. Trade names, if used, are used to identify products only. 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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2024

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 2024 Testing Program

Founded in 1949, this is the **75th** 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 wheat growing region. This technical report includes GIPSA wheat market classification, physical grain testing, milling, analytical, rheological, and bread baking results.

Twenty-three composite entries this year were grown in two different Uniform Growout Systems (Northern and Southern) and Montana. The Northern has 6 composite entries including 1 check and 5 breeding lines from 3 breeding programs (ND, SD, and WB) and The Southern has 13 composite entries including 1 check and 12 breeding lines from 6 breeding programs (CO, OK, LM, KH, WB, and TX). The wheat samples were milled on the Miag Multomat mill in the Kansas State University Department of Grain Science and Industry (Methods, Appendix A). The flour was distributed to 18 cooperators (16 for bread baking, 1 for tortilla, and 1 for noodle) for end-product quality evaluation. The wheat physical and chemical tests, flour quality analysis, and dough rheological tests (Mixograph, Farinograph, Alveograph, Extensigraph and GlutoPeak) were conducted by the HWWQL.

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

2024 WQC HWW Entries & Breeding Programs

Breeding Programs	Entry Number	Sample Identification
SOUTHERN	24-2401	SY Monument_CK
	24-2402	XG4108_WB
	24-2403	WB4347_WB
	24-2404	WB4445CLP_WB
	24-2405	TX18DH287_TX
	24-2406	TX18DH313_TX
	24-2407	OK198417C_OK
	24-2408	OK20708_OK
	24-2409	KS20H124_KH
	24-2410	LCH21-9398_LM
	24-2411	LCH16ACC403-1_LM
	24-2412	CO19S129W_CO
	24-2413	CO19410R_CO
MONTANA	24-2414	SY Monument_CK
	24-2415	Yellowstone_CK
	24-2416	MTS2068_MT
	24-2417	MTV2164_MT
NORTHERN	24-2418	SY Monument_CK
	24-2419	23Nord-181_ND
	24-2420	23Nord-184_ND
	24-2421	SD20B088-2_SD
	24-2422	SD20D100-9_SD
	24-2423	XG4108_WB

CK=Check; CO=Colorado; OK=Oklahoma; LM=Limagrain; WB=Westbred (Bayer); TX=Texas; NE=Nebraska; KH= KSU-Hays; KM=KSU-Manhattan; MT=Montana; SD=South Dakota; ND=North Dakota.

2024 Wheat Classification Results from GIPSA

GIPSA Wheat Market Classification

ID	CL	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	GRADE
24-0002401	HRW	0.0	60.1	11.6	OK	0.0	0.2	0.0	0.4	0.6	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
24-0002402	HRW	0.2	62.1	11.6	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	U.S. NO. 1 HRW, DKG 0.2%
24-0002403	HRW	0.1	61.9	11.4	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S. NO. 1 HRW, DKG 0.1%
24-0002404	HRW	0.1	60.2	11.5	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	U.S. NO. 1 HRW, DKG 0.1%
24-0002405	HRW	0.1	61.5	11.4	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S. NO. 1 HRW, DKG 0.1%
24-0002406	HRW	0.2	60.5	11.4	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	U.S. NO. 1 HRW, DKG 0.2%
24-0002407	HRW	0.3	62.5	11.3	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S. NO. 1 HRW, DKG 0.3%
24-0002408	HRW	0.0	61.1	11.4	OK	0.0	0.3	0.0	0.2	0.5	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
24-0002409	HRW	0.0	61.7	11.3	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
24-0002410	HRW	0.0	60.0	11.2	OK	0.0	0.6	0.0	0.5	1.1	0.0	1.0	U.S. NO. 1 HRW, DKG 0.0%
24-0002411	HRW	0.0	60.3	11.3	OK	0.0	0.3	0.0	0.4	0.7	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
24-0002412	HDWH	0.1	59.5	11.2	OK	0.0	0.6	0.0	0.5	1.1	0.0	2.4	U.S. NO. 2 HDWH, DKG 0.1%
24-0002413	HRW	0.2	60.5	11.6	OK	0.0	0.7	0.0	0.8	1.5	0.0	0.0	U.S. NO. 1 HRW, DKG 0.2%
24-0002414	HRW	0.0	61.9	10.1	OK	0.0	0.0	0.0	1.1	1.1	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
24-0002415	HRW	0.0	61.8	10.7	OK	0.0	0.0	0.0	0.8	0.8	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
24-0002416	HRW	0.0	62.8	11.0	OK	0.0	0.0	0.0	0.9	0.9	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
24-0002417	HRW	0.0	62.5	11.0	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
24-0002418	HRW	0.3	59.0	12.2	OK	0.0	1.9	0.0	0.6	2.5	0.0	0.0	U.S. NO. 2 HRW, DKG 0.3%
24-0002419	HRW	0.1	56.3	12.1	OK	0.0	0.4	0.0	0.8	1.2	0.0	0.0	U.S. NO. 3 HRW, DKG 0.1%
24-0002420	HRW	0.1	57.9	12.2	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S. NO. 3 HRW, DKG 0.1%
24-0002421	HRW	1.0	60.3	12.0	OK	0.0	0.7	0.0	0.2	0.9	0.0	0.0	U.S. NO. 1 HRW, DKG 1.0%
24-0002422	HRW	0.2	60.4	12.1	OK	0.0	0.3	0.0	0.4	0.7	0.0	0.0	U.S NO. 1 HRW, DKG 0.2%
24-0002423	HRW	0.3	62.0	12.3	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S. NO. 1 HRW, DKG 0.3%

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

SOUTHERN GROWOUT

24-2401	SY Monument_CK
24-2402	XG4108_WB
24-2403	WB4347_WB
24-2404	WB4445CLP_WB
24-2405	TX18DH287_TX
24-2406	TX18DH313_TX
24-2407	OK198417C_OK
24-2408	OK20708_OK
24-2409	KS20H124_KH
24-2410	LCH21-9398_LM
24-2411	LCH16ACC403-1_LM
24-2412	CO19S129W_CO
24-2413	CO19410R_CO

CK=Check; LM=Limagrain; WB=Westbred (Bayer); OK=Oklahoma; KH=KSU Hays; KM=KSU Manhattan; CO=Colorado; TX=Texas A&M Bushland.

Description of Test Plots and Breeder Entries

Southern Growout:

There are 13 composited entries including one check from 6 breeding programs (CO, OK, LM, KH, WB and TX). The Southern growout consisted of more than 10 locations, but there were only 8 locations (AP, LM, OK, UM, KM, CO, WB, and TX) submitting wheat samples for the composites used for end-use quality testing.

BAYER (WESTBRED) by Adam Bray

Growing Location and Conditions

The 2024 Bayer Hard Winter Wheat Quality Council samples were grown in strips at Hale Center, TX under pivot irrigation. The field was planted 10/12/2023 after crop fallow. Pre-plant fertilizer (50#N, 40#P, 30#K, 10#S) was incorporated, with additional fertility (21#N, 52#P, 0#K, 10#S) applied in furrow at planting. In season fertilizer consisted of one application of 38# 32-0-0 through the center pivot, with a total season applied Nitrogen of 109 pounds. No diseases were observed. Plots received 2.5-inches rain from Oct- Dec 2023 and 3.85-inches rain from Jan-April 2024. Additionally, plots received 5.25-inches of irrigation. Plots were harvested on 6/07/2024 with a yield average of 67bu/ac and test weight average of 63.7 lbs/bu.

WB4347

WB4347 is a hard red winter wheat with medium-early maturity, good straw strength, and excellent dryland yield potential. It has good tillering potential and is well adapted to the western plains. It has good rust package with resistance to Stripe, Leaf, and Stem Rusts. It is moderately resistance to Wheat Streak Mosaic Virus potentially coming from curl mite resistance. Additionally, it has resistance to Hessian Fly. Internal quality testing indicates average protein and good test weight with above average functionality for hard red winter wheat class. WB4347 was released in 2024 targeting dryland acres across the central and western plains.

WB4445CLP

WB4445CLP is a Clearfield Plus hard red winter wheat with medium maturity, good straw strength, excellent quality, and high yield potential. It has good winterhardiness and is broadly adapted to the central and northern plains. It has resistance to Wheat Streak Mosaic Virus in addition to curl mite resistance. It has moderate resistance to Stripe, Leaf, and Stem Rusts. Internal quality testing indicates good protein content, good test weight, and excellent functionality. WB4445CLP was released in 2024 targeting dryland acres in the central and western plains. Yield performance in grower fields under high management condition exceeded expectations.

TEXAS A&M by Jackie C. Rudd and Shuyu Liu

Texas A&M AgriLife Research, Amarillo

The Texas southern growout of the Wheat Quality Council entries was at Bushland, TX (near Amarillo in the Texas Panhandle). Strips were planted adjacent to our intensively managed irrigated yield trials. We fertilized for a yield goal of 100 bu/a and harvested yield averaged 106 bu/a and testweight 60 lb/bu. The crop was irrigated with a linear at regular intervals from early March to early May. Crop development was normal for the Texas Panhandle.

TX18DH287

This hard red winter wheat line is a doubled haploid selection from an 8 parent cross [(TX1112-108/TAM 113)/(TAM 1112-20/Gallagher)]/[(TX12A001044/TAM114)/(Joe/TX12A001078)]. It is adapted throughout Texas and resistant to leaf rust, stripe rust, and stem rust. It is medium-early maturing and medium-tall height. It has an intermediate resistance to Hessian fly.

TX18DH313

This hard red winter wheat is a doubled haploid from CO11D1767/TX12V7229. Adapted throughout Texas. Resistant to leaf rust, stripe rust, and stem rust. Medium-early maturing and medium-tall height. Excellent stripe rust resistance – markers indicate *Yr5* but not *Yr15*. Weak mixogram and tendency to lodge.

OKLAHOMA by Brett Carver

Description of Test Plots and Breeder Entries

The North Central Agronomy Research Station at Lahoma (12 miles west of Enid) is the Oklahoma site for the southern uniform WQC growout. The WQC growout has occurred at this same location in a wheat-fallow rotation for more than 20 years. Grain yield in 2024 averaged 32 bu/ac across the entire field, including the growout. Yields were unprotected by fungicide and thus potentially impacted by prolonged, severe, overlapping infections of stripe rust and leaf rust. Surprisingly, test weight averaged 62.6 lb/bu. Wheat protein did not spike with the lower yields but averaged 12.5% across the field, which is the long-term expectation. Harvest occurred on June 14, 2024.

OK198417C

Doublestop CL Plus has been the leading planted variety across Oklahoma for the past three crop seasons. Finding an able successor has taken some blood, sweat and tears…which by the way, a band by that name could riff on a double stop back in the day. By pedigree, OK198417C is *effectively* a backcross derivative of Doublestop CL Plus. OK198417C was either directly derived from Doublestop CL Plus or from parentage that also produced Doublestop.

Three characteristics distinguish OK198417C from Doublestop CL Plus: grain yield (10-14% greater in OK198417C), a level of pre-adult to adult-plant stripe rust resistance that rarely exists in the OSU wheat breeding program, and presence of the glutenin subunit Dx2+Dy12. Test weight of OK198417C is as good as if not better than that of Doublestop CL Plus. Dough strength of OK198417C is inferior but acceptable, producing mixograph tolerance ratings averaging 3.4 ± 0.2 (n=17 site-years). Farinograph peak and stability times are approximately 6 and 10 minutes, respectively. Loaf volume has been acceptable to desirable.

OK198417C

Foundation seed of OK198417C is being produced this year for an expected commercial launch in spring 2025. It will be positioned for the same area currently serviced by Doublestop CL Plus.

Figure 1. Doublestop CL+ pictured left, OK198417C right, at Tipton, OK on 31 March 2024, during a severe infection of stripe rust on juvenile plants. Plots suffering the severest infection (second tier of plots) failed to produce 5 bu/ac yield in June.

OK20708

Following its first year of commercial seed production in 2018, Smith's Gold quickly rose to be a top-two planted variety across Oklahoma by 2020 and has since maintained similar status. It should be no surprise that the OSU wheat breeding program is stocked full of elite germplasm descended from Smith's Gold. We currently have eyes on three experimental lines for potential release, and one of those is OK20708 with the pedigree Miranda (from Romania)/Smith's Gold.

OK20708 has been a top-yielding experimental line in each year it was tested since 2020, except 2024. This could have reflected lesser protection against stripe rust in 2024 relative to Smith's Gold, but replicating Smith's Gold stripe rust reaction has not been as easy as one might expect if resistance was simply inherited. Still today, we do not know the genetic basis of stripe rust resistance in Smith's Gold. OK20708 has under-impressed (performed in the intermediate range) for dough and bake quality. Its kernel size and weight, however, are in the top echelon, with TKW usually between 35 and 40g. OK20708 would be positioned from the far eastern areas of the state to the far western panhandle.

KANSAS-HAYS by Guorong Zhang

Description of Test Plots and Breeder Entries

The 13 lines and SY Monument (check) were planted on Sept. 24, 2023 in a field at Hays experimental station with sandy-loam soil. The field was fertilized pre-planting with 60 lb/a N. The field had very limited soil moisture at planting and the plots did not have good stands. Plots were not irrigated and were not treated with fungicide. Plots were harvested, but they had low test weights with an average of 54.8 lb/bu. Therefore, samples were not submitted for testing.

KS20H124 (KS Homesteader CL+)

KS20H124 was released as KS Homesteader CL+ in August 2024. It is a hard red, two-gene Clearfield winter wheat with medium to medium-late maturity and medium to medium-tall height. KS20H124 has high grain yield potential and good drought tolerance. KS20H124 has a good disease resistance package for western Kansas, including resistance to wheat streak mosaic virus and stripe rust. KS20H124 has resistance to grain shattering, good straw strength and good winter hardiness. KS20H124 also has above average test weight and good baking qualities. KS20H124 can be used for dryland production in western Kansas and surrounding regions.

LIMAGRAIN by Marla Dale Barnett

Growing Location & Conditions

The 2024 hard winter Wheat Quality Council samples from Limagrain Cereal Seeds originated from strip increases grown in Benton, KS located in south central Kansas. The WQC strips were planted on November 17th, 2023 into dry conditions following a soybean crop. Emergence was good going into winter. The field received 100 lbs/acre actual N in March 2022 at Feekes growth stage 4. No fungicide was applied, and stripe rust was prevalent. The mean grain test weight of the 13 entries was 59.1 lbs/bushel with an average grain protein content of 12.4% (Table 1). Stripe rust was the most persistent stress factor. Temperatures ranged from -5°F on January 14th, 2024 to 102°F on June 24th, 2024 during the growing season at the location. The field received 18.98 inches of rainfall (not counting snowfall) from planting through harvest.

Table 1. Grain test weight and grain protein from thirteen winter wheat experimental entries and checks grown in Benton, KS 2024, Limagrain Cereal Seeds.

	Test Weight (lbs/bu)	Grain Protein (%)
SY Monument	55.0	12.1
XG4108	60.2	12.9
WB4347	59.7	12.7
WB4445CLP	58.7	11.1
TX18DH287	61.9	11.4
TX18DH313	61.2	11.7
OK198417C	61.9	13.5
OK20708	59.8	12.5
KS20H124	60.8	14.0
LCH21-9398	57.1	12.2
LCH16ACC403-1	58.8	12.0
CO19S129W	56.7	12.6
CO19410R	56.6	12.5
Mean	59.1	12.4

LCH21-9398

LCH21-9398 is a medium maturing, medium tall, hard red winter wheat adapted to both dryland and irrigated acres on the High Plains. The pedigree of LCH21-9398 is SY Monument / Joe. Tolerance to wheat streak mosaic virus via Wsm2, resistance to stem rust and soil-borne mosaic virus make this medium maturing line very attractive to growers in the High Plains. Moderate resistance to FHB is a nice addition that gives growers in higher rainfall areas some protection against damages from FHB if they also struggle with wheat streak mosaic virus. Straw strength and yield performance is excellent in both dryland and irrigated production. This line was tested in the 2023 Southern Regional Performance Nursery.

Milling and baking quality data from LCS show acceptable milling quality, dough properties and baking quality. Small pup (100g) loaf volumes are noted as very good, typically ranging from 975 cc to exceeding 1050 cc. Flour protein content and strength are noted as desirable with good mixograph water absorption.

LCH16ACC403-1

LCH16ACC403-1 is a medium maturing hard red winter wheat with two genes of tolerance to CoAXium brand herbicide. The pedigree of LCH16ACC403-1 is Antero / ACC845-6. High tillering ability thoughout the entire growing season combined with early spring greenup make LCH16ACC403-1 an excellent choice for winter grazing. Large biomass is notable as well as little to no grazing penalty in grain yield after cattle are removed and grain is harvested. Resistance to stem rust and wheat soil borne mosaic virus along with moderate Fusarium head blight resistance make this medium maturing line very attractive to growers in the central plains of Oklahoma and Kansas. Straw strength and yield performance is excellent in both dryland and irrigated production. Milling and baking quality data from LCS show desirable milling quality and desirable baking quality. Protein content is acceptable with very strong mixograph strength and tolerance. Small pup (100g) loaf volumes typically exceed 1000 cc.

COLORADO by Esten Mason

Growing Location & Conditions

The Wheat Quality Council samples from Colorado originated from strip increases grown under irrigated conditions at the Agricultural Research, Development and Education Center. The field with the strip increases, including adjacent breeding and extension trials, was fertilized with a pre-plant application of 130 lbs N/acre (applied as 46-0-0) and 45 lbs S/acre. The planting date was September 23, 2023 and the harvest date was July 19, 2024. The trial was planted into moisture with good stands and good fall growth. No diseases noted. The winter and spring were average precipitation. Irrigation started in late April with ~6" total applied.

CO19S129W

It is a hard white winter wheat CSU experimental line with the pedigree CO13D1638/Snowmass 2.0. It was first entered into the CSU Uniform Variety Performance Trials (UVPT) in 2023 and performed at 104% of the trial mean for yield in 2023. Over two years from 2023-2024 it was 101% of the trial mean. It contains *Wsm2* for resistance to WSMV and has good resistance to stripe rust. It has excellent milling and baking quality and confirmed presence of Bx7oe which confers strong mixing properties. It was targeted for potential release in 2025 but was dropped prior to planting in 2025 due to its performance compared to other released hard white winter wheat varieties.

CO19410R

It is a hard red winter wheat CSU experimental line with the pedigree Avery/CO07W722-F5//CO11D1316W. It was first entered into the CSU Uniform Variety Performance Trials (UVPT) in 2023. Over two years from 2023-2024, it was the highest yielding hard red winter wheat in the UVPT at 69.3 bu/A and 107% of the trial mean. It has medium maturity, similar to the CSU variety Avery. It is resistant to the wheat curl mite via Cmc4 which vectors the mosaic virus complex. Moderate susceptibility to stripe rust and good resistance to stem rust. Good milling and baking quality. It is currently on a 1 acre Pre-foundation increase for potential release in 2025 or 2026.

SYNGENTA (AGRIPRO) by Josh Coltrain

Northern and Southern uniform growout increase strips were planted on 10/9/23 at our location in Junction City, KS. The strips had good fall stand establishment. All increases had 80lbs of 11-52-0 applied with the planter with 70lbs of N applied prior to planting. An additional 70lbs of N and 20lbs of Sulfur were top-dressed in the spring prior to jointing. All strips were sprayed with a 13.7oz rate of Trivapro at flag leaf to ensure good quality seed. Growing conditions were fair to above average at the site which provided better yields than most of the growing region. The increase strips were harvested on June 18, 2024 with good yield levels.

USDA-MANHATTAN by Mary Guttieri

The 2024 winter Wheat Quality samples from USDA-ARS (Manhattan, KS) originated from 150-ft strip increases grown at the USDA-ARS Meat Animal Research Center near Clay Center, NE located in south-central Nebraska (40.5369, -98.1495). The soil type is a Hastings silt loam. The WQC strips were planted on September 28, 2023. The previous crop was soybeans. The field was conventionally tilled with a field cultivator and no fertilizer was applied pre-plant. There was good soil moisture at planting and a half inch of water was applied a week after planting by center pivot irrigation. Based on soil test results from samples collected in February 2023, liquid fertilizer was applied on April 4, 2024 at a rate of 130 lb N/A and 19 lb S/A. 32% UAN was applied at the flag leaf stage on May 14, 2024 at a rate of 10lbs of nitrogen per acre because the yield was expected to be high. Nexicor fungicide was applied on May 14, 2024 because stripe rust was observed on ~30% of the flag leaves in some genotypes. Miravis Ace fungicide was applied on June 6, 2024 because of concern for Fusarium head blight with cooler and wetter weather during flowering (average June min temperature 63.5 °F and 6 rain events from June 1 - Jun 19). Weeds were controlled by applying 3 oz/A Zidua SC herbicide on April 4, 2024 and 28.5 oz/A Prowl H2O on May 14, 2024. This region experienced severe drought in the Spring of 2024 and received adequate rainfall in May and June (1.14” in March, 1.95” in April, 3.95” in May, and 4.76” in June). The field was irrigated four times, primarily to incorporate/activate herbicides or fertilizer (4/20/24: 0.40”, 5/1/24: 0.40”, 5/20/24: 0.40”, 6/15/24: 0.40”). The growout was harvested on July 10, 2024 with average moisture of 11.7%. The harvested grain had a small percentage of cracked kernels from harvest; therefore grain was cleaned with an orbital seed sizer (Almaco SeedBoss) and a Carter Dockage Tester. Mean test weight was 58.3 lb/bu and average protein was 11.2% (12% mb). The mean yield for the growouts was 88.6 bu/A.

KANSAS-MANHATTAN by Allan Fritz

The Gypsum, KS growout was planted on October 12, 2023. It was planted no-till after a failed soybean crop. The trial had excellent fall stand establishment and growth. A late spring freeze event affected the site and yield data was not collected for most breeding trials at the site. The area of the field with the growouts was less affected and the plots were harvested on June 23. The trial was fertilized for an 80 bu/ac yield goal based on soil testing results. Plots were treated with fungicide at full flag leaf expansion for the majority of lines in the test.

Southern Growout: 2024 (Small-Scale) Samples

Test entry number	24-2401	24-2402	24-2403	24-2404
Sample identification	**SY Monument_CK**	**XG4108_WB**	**WB4347_WB**	**WB4445CLP_WB**
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	60.1	62.1	61.9	60.2
Hectoliter weight (kg/hl)	79.1	81.7	81.4	79.2
1000 kernel weight (gm)	32.3	34.1	32.9	35.1
Wheat kernel size (Rotap)				
Over 7 wire (%)	74.3	77.0	75.8	73.0
Over 9 wire (%)	25.0	22.7	23.7	26.5
Through 9 wire (%)	0.3	0.3	0.5	0.5
Single kernel (skcs)[a]				
Hardness (avg /s.d)	64.1/17.6	63.2/16.9	62.2/17.9	60.0/17.2
Weight (mg) (avg/s.d)	32.3/10.1	34.1/10.8	32.9/11.2	35.1/12.5
Diameter (mm)(avg/s.d)	2.72/0.41	2.78/0.38	2.70/0.42	2.72/0.40
Moisture (%) (avg/s.d)	11.5/0.5	11.0/0.6	62.2/17.9	11.5/0.5
SKCS distribution	03-12-32-53-01	03-13-24-60-01	05-15-26-54-01	05-15-29-51-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	13.3	13.5	12.9	13.3
Wheat ash (12% mb)	1.52	1.58	1.52	1.61
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	76.6	73.1	77.1	77.4
Quadrumat Sr. Mill	69.3	66.1	69.6	70.0
Flour moisture (%)	14.2	14.1	13.9	14.0
Flour protein (14% mb)	12.1	12.3	11.9	12.3
Flour ash (14% mb)	0.48	0.46	0.47	0.48
Rapid Visco-Analyser				
Peak time (min)	6.1	6.1	6.1	6.1
Peak viscosity (RVU)	204.2	190.3	187.9	214.8
Breakdown (RVU)	79.4	70.6	70.3	90.1
Final viscosity at 13 min (RVU)	234.3	225.5	222.0	233.4
Minolta color meter				
L*	91.29	91.7	92.03	91.34
a*	-1.16	-1.12	-1.17	-1.33
b*	8.87	8.50	8.21	9.33
PPO	0.282	0.570	0.540	0.521
Falling number (sec)	420	438	429	435
Damaged Starch				
(AI%)	96.1	96.6	96.9	95.1
(AACC76-31)	8.0	8.6	8.9	7.0

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

Southern Growout: 2024 (Small-Scale) Samples (continued)

Test entry number	24-2405	24-2406	24-2407	24-2408
Sample identification	**TX18DH287_TX**	**TX18DH313_TX**	**OK198417C_OK**	**OK20708_OK**
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	61.5	60.5	62.5	61.1
Hectoliter weight (kg/hl)	80.9	79.6	82.2	80.4
1000 kernel weight (gm)	35.1	32.6	36.9	36.9
Wheat kernel size (Rotap)				
Over 7 wire (%)	83.7	76.3	86.5	88.7
Over 9 wire (%)	16.1	23.5	13.5	11.3
Through 9 wire (%)	0.3	0.3	0.0	0.0
Single kernel (skcs)[a]				
Hardness (avg /s.d)	67.1/18.0	59.8/16.7	59.3/19.4	70.1/18.7
Weight (mg) (avg/s.d)	35.1/11.2	32.6/11.6	36.9/10.8	36.9/10.7
Diameter (mm)(avg/s.d)	2.77/0.40	2.70/0.41	2.92/0.36	2.86/0.39
Moisture (%) (avg/s.d)	11.5/0.5	11.0/0.7	11.2/0.6	11.4/0.5
SKCS distribution	03-09-24-64-01	08-13-24-55-01	11-16-23-50-03	02-09-18-71-01
Classification	Hard	Hard	Mixed	Hard
Wheat protein (12% mb)	12.2	12.4	13.8	12.8
Wheat ash (12% mb)	1.47	1.51	1.73	1.50
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	75.7	76.4	76.6	75.8
Quadrumat Sr. Mill	66.5	66.9	67.6	66.8
Flour moisture (%)	13.8	13.7	13.9	13.9
Flour protein (14% mb)	11.0	11.1	12.7	11.6
Flour ash (14% mb)	0.49	0.52	0.56	0.53
Rapid Visco-Analyser				
Peak time (min)	6.2	6.1	6.3	6.1
Peak viscosity (RVU)	205.1	191.5	198.9	192.2
Breakdown (RVU)	83.6	68.8	70.8	75.3
Final viscosity at 13 min (RVU)	219.5	234.9	228.8	212.9
Minolta color meter				
L*	91.18	91.49	91.38	91.19
a*	-1.43	-1.46	-1.13	-1.24
b*	10.07	9.96	8.78	9.59
PPO	0.497	0.631	0.541	0.471
Falling number (sec)	424	444	398	404
Damaged Starch				
(AI%)	95.9	96.5	95.5	96.7
(AACC76-31)	7.8	8.5	7.4	8.7

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

Southern Growout: 2024 (Small-Scale) Samples (continued)

Test entry number	24-2409	24-2410	24-2411
Sample identification	**KS20H124_KH**	**LCH21-9398_LM**	**LCH16ACC403-1_LM**
Wheat Data			
GIPSA classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	61.7	60.0	60.3
Hectoliter weight (kg/hl)	81.1	78.9	79.3
1000 kernel weight (gm)	36.2	32.1	34.3
Wheat kernel size (Rotap)			
Over 7 wire (%)	80.6	75.8	72.2
Over 9 wire (%)	19.3	23.6	27.3
Through 9 wire (%)	0.2	0.7	0.6
Single kernel (skcs)[a]			
Hardness (avg /s.d)	74.9/15.5	57.6/17.1	48.6/16.9
Weight (mg) (avg/s.d)	36.2/10.4	32.1/10.4	34.3/11.8
Diameter (mm)(avg/s.d)	2.83/0.34	2.69/0.40	2.75/0.42
Moisture (%) (avg/s.d)	11.2/0.5	11.5/0.6	10.7/0.8
SKCS distribution	01-02-14-83-01	07-21-29-43-01	19-24-31-26-03
Classification	Hard	Hard	Mixed
Wheat protein (12% mb)	13.6	12.7	12.7
Wheat ash (12% mb)	1.60	1.58	1.62
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	74.0	71.1	73.2
Quadrumat Sr. Mill	66.7	67.0	67.4
Flour moisture (%)	13.9	14.7	14.4
Flour protein (14% mb)	12.7	11.2	11.7
Flour ash (14% mb)	0.55	0.47	0.52
Rapid Visco-Analyser			
Peak time (min)	6.3	6.0	6.0
Peak viscosity (RVU)	243.3	178.4	174.6
Breakdown (RVU)	100.3	76.6	79.3
Final viscosity at 13 min (RVU)	238.3	202.1	188.7
Minolta color meter			
L*	91.59	92.02	92.32
a*	-1.39	-1.29	-1.32
b*	9.41	8.63	8.46
PPO	0.581	0.518	0.530
Falling number (sec)	441	392	371
Damaged Starch			
(AI%)	96.4	96.3	96.0
(AACC76-31)	8.3	8.2	8.0

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

Southern Growout: 2024 (Small-Scale) Samples (continued)

Test entry number	24-2412	24-2413
Sample identification	**CO19S129W_CO**	**CO19410R_CO**
Wheat Data		
GIPSA classification	2 HDWH	1 HRW
Test weight (lb/bu)	59.5	60.5
Hectoliter weight (kg/hl)	78.3	79.6
1000 kernel weight (gm)	31.7	29.4
Wheat kernel size (Rotap)		
Over 7 wire (%)	69.6	63.2
Over 9 wire (%)	29.8	35.7
Through 9 wire (%)	0.7	1.1
Single kernel (skcs)[a]		
Hardness (avg /s.d)	61.4/19.1	57.0/17.5
Weight (mg) (avg/s.d)	31.7/10.5	29.4/10.3
Diameter (mm)(avg/s.d)	2.74/0.40	2.55/0.37
Moisture (%) (avg/s.d)	10.5/1.0	10.8/1.0
SKCS distribution	06-14-24-56-01	09-18-27-46-01
Classification	Hard	Hard
Wheat protein (12% mb)	12.7	12.6
Wheat ash (12% mb)	1.64	1.59
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	72.9	73.5
Quadrumat Sr. Mill	63.9	67.4
Flour moisture (%)	14.0	14.6
Flour protein (14% mb)	11.4	11.5
Flour ash (14% mb)	0.54	0.49
Rapid Visco-Analyser		
Peak time (min)	6.2	6.3
Peak viscosity (RVU)	183.4	231.9
Breakdown (RVU)	79.2	91.9
Final viscosity at 13 min (RVU)	193.8	242.2
Minolta color meter		
L*	91.89	92.04
a*	-1.43	-1.21
b*	9.16	8.11
PPO	0.312	0.525
Falling number (sec)	393	443
Damaged Starch		
(AI%)	96.3	95.9
(AACC76-31)	8.3	7.8

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

Southern Growout: Physical Dough Tests and Gluten Analysis 2024 (Small-Scale) Samples

Test Entry Number	**24-2401**	**24-2402**	**24-2403**	**24-2404**
Sample Identification	**SY Monument_CK**	**XG4108_WB**	**WB4347_WB**	**WB4445CLP_WB**
MIXOGRAPH				
Flour Abs (% as-is)	66.9	67.3	67.4	66.2
Flour Abs (14% mb)	67.2	67.4	67.3	66.2
Mix Time (min)	8.5	5.5	5.3	6.0
Mix tolerance (0-6)	6	5	4	5
FARINOGRAPH				
Flour Abs (% as-is)	63.0	67.6	66.4	61.3
Flour Abs (14% mb)	63.3	67.8	66.5	61.4
Peak time (min)	7.1	9.9	8.8	4.9
Mix stability (min)	23.1	30.6	27.9	18.9
Mix Tolerance Index (FU)	15	12	4	12
Breakdown time (min)	24.8	32.0	30.0	16.6
ALVEOGRAPH				
P(mm): Tenacity	154	190	157	112
L(mm): Extensibility	63	42	70	91
G(mm): Swelling index	17.6	14.4	18.6	21.4
W(10^{-4} J): strength (curve area)	403	346	426	388
P/L: curve configuration ratio	2.44	4.52	2.24	1.20
Ie(P_{200}/P): elasticity index	65.3	59.0	61.1	64.2
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	689/1167/1268	572/700/784	463/722/776	513/943/1080
Extensibility (mm at 45/90/135 min)	116/88/84	128/115/105	136/128/110	139/137/110
Energy (cm^2 at 45/90/135 min)	124/126/125	122/125/120	109/152/127	123/212/163
Resist $_{max}$ (BU at 45/90/135min)	866/1297/1383	763/908/979	632/1000/1006	707/1355/1288
Ratio (at 45/90/135 min)	5.9/13.3/15.1	4.5/6.1/7.5	3.4/5.6/7.1	3.7/6.9/9.9
PROTEIN ANALYSIS				
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+8, 5+10	2*, 7+8, 5+10	2*, 7+8, 5+10
TPP/TMP	1.05	0.98	0.93	0.98
SEDIMENTATION TEST				
Volume (ml)	68.2	67.1	63.9	67.0

Southern Growout: Physical Dough Tests and Gluten Analysis 2024 (Small-Scale) Samples (continued)

Test Entry Number	**24-2405**	**24-2406**	**24-2407**	**24-2408**
Sample Identification	**TX18DH287_TX**	**TX18DH313_TX**	**OK198417C_OK**	**OK20708_OK**
MIXOGRAPH				
Flour Abs (% as-is)	65.0	65.3	65.2	64.3
Flour Abs (14% mb)	64.7	65.0	65.0	64.2
Mix Time (min)	3.5	3.1	2.3	2.5
Mix tolerance (0-6)	3	3	2	3
FARINOGRAPH				
Flour Abs (% as-is)	63.5	64.2	65.9	69.8
Flour Abs (14% mb)	63.4	64.0	65.9	69.9
Peak time (min)	4.7	4.4	4.8	5.3
Mix stability (min)	10.0	8.0	5.7	7.9
Mix Tolerance Index (FU)	27	30	33	35
Breakdown time (min)	10.5	8.9	9.3	9.9
ALVEOGRAPH				
P(mm): Tenacity	114	116	91	159
L(mm): Extensibility	90	97	109	53
G(mm): Swelling index	21.1	21.9	23.2	16.2
W(10^{-4} J): strength (curve area)	337	345	268	317
P/L: curve configuration ratio	1.27	1.20	0.83	3.0
Ie(P_{200}/P): elasticity index	53.8	52.3	48.7	48.5
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	363/409/501	292/356/418	197/228/246	289/299/307
Extensibility (mm at 45/90/135 min)	154/169/153	169/170/159	171/192/193	150/166/165
Energy (cm^2 at 45/90/135 min)	105/138/138	96/119/126	63/85/91	77/96/97
Resist $_{max}$ (BU at 45/90/135min)	527/631/703	433/533/603	268/315/339	380/430/433
Ratio (at 45/90/135 min)	2.4/2.4/3.3	1.7/2.1/2.6	1.2/1.2/1.3	1.9/1.8/1.9
PROTEIN ANALYSIS				
HMW-GS Composition	2*, 7+8, 5+10	2*, 17+18, 2+12	2*, 7+9, 2+12	2*,7+8,5+10
TPP/TMP	1.15	1.08	1.05	1.05
SEDIMENTATION TEST				
Volume (ml)	48.9	51.8	56.9	49.5

Southern Growout: Physical Dough Tests and Gluten Analysis 2024 (Small-Scale) Samples (continued)

Test Entry Number	24-2409	24-2410	24-2411
Sample Identification	KS20H124_KH	LCH21-9398_LM	LCH16ACC403-1_LM
MIXOGRAPH			
Flour Abs (% as-is)	66.8	62.7	63.9
Flour Abs (14% mb)	66.7	63.5	64.3
Mix Time (min)	5.8	3.5	4.3
Mix tolerance (0-6)	5	3	4
FARINOGRAPH			
Flour Abs (% as-is)	67.1	61.3	61.5
Flour Abs (14% mb)	67.1	62.1	62.2
Peak time (min)	9.2	5.1	9.5
Mix stability (min)	28.5	10.2	19.5
Mix Tolerance Index (FU)	16	21	11
Breakdown time (min)	31.5	11.3	21.0
ALVEOGRAPH			
P(mm): Tenacity	143	98	110
L(mm): Extensibility	76	82	94
G(mm): Swelling index	19.4	20.1	21.5
W(10^{-4} J): strength (curve area)	427	264	353
P/L: curve configuration ratio	1.88	1.20	1.17
Ie(P_{200}/P): elasticity index	64.1	52.5	58.3
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	503/612/669	278/351/383	380/485/536
Extensibility (mm at 45/90/135 min)	146/132/130	149/160/160	154/162/143
Energy (cm^2 at 45/90/135 min)	132/140/154	76/110/114	113/155/140
Resist $_{max}$ (BU at 45/90/135min)	716/886/1018	370/529/546	580/768/781
Ratio (at 45/90/135 min)	3.54.6/5.1	1.9/2.2/2.4	2.5/3.0/3.8
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9, 5+10	2*, 7+9, 5+10
TPP/TMP	0.80	1.06	0.90
SEDIMENTATION TEST			
Volume (ml)	61.4	52.4	55.2

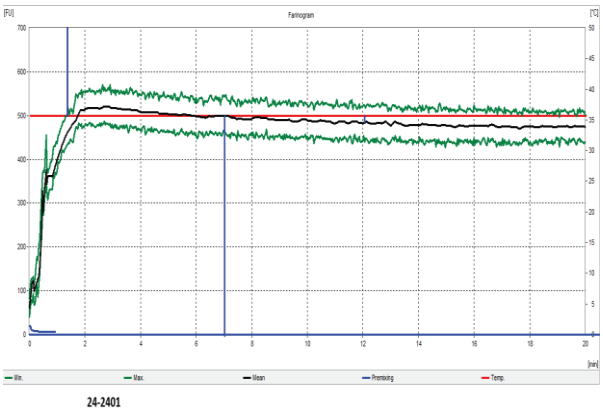
Southern Growout: Physical Dough Tests and Gluten Analysis 2024 (Small-Scale) Samples (continued)

Test Entry Number	24-2412	24-2413
Sample Identification	CO19S129W_CO	CO19410R_CO
MIXOGRAPH		
Flour Abs (% as-is)	65.8	65.3
Flour Abs (14% mb)	65.8	66.0
Mix Time (min)	8.5	6.3
Mix tolerance (0-6)	6	6
FARINOGRAPH		
Flour Abs (% as-is)	64.6	62.5
Flour Abs (14% mb)	64.7	63.4
Peak time (min)	9.3	9.0
Mix stability (min)	33.6	33.3
Mix Tolerance Index (FU)	12	12
Breakdown time (min)	34.5	34.5
ALVEOGRAPH		
P(mm): Tenacity	189	126
L(mm): Extensibility	29	89
G(mm): Swelling index	12.0	20.9
W(10^{-4} J): strength (curve area)	250	414
P/L: curve configuration ratio	6.52	1.42
Ie(P_{200}/P): elasticity index	0.0	61.8
EXTENSIGRAPH		
Resist (BU at 45/90/135 min)	666/1086/536	560/829/940
Extensibility (mm at 45/90/135 min)	117/84/86	132/125/119
Energy (cm^2 at 45/90/135 min)	124/108/136	124/174/174
Resist $_{max}$ (BU at 45/90/135min)	855/1174/1410	724/1187/1232
Ratio (at 45/90/135 min)	5.7/13.0/15.4	4.2/6.6/7.9
PROTEIN ANALYSIS		
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9, 5+10
TPP/TMP	0.88	0.96
SEDIMENTATION TEST		
Volume (ml)	54.0	56.4

Physical Dough Tests – Farino and Mixo

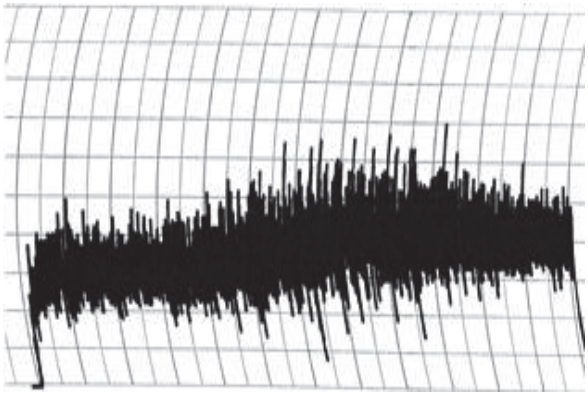
2024 (Small Scale) Samples – Southern Growout

Farinograms



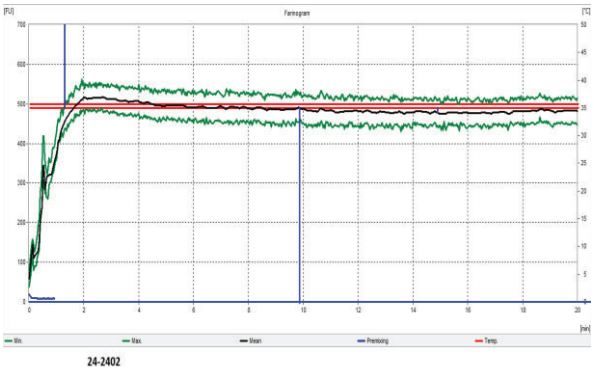
Water abs = 63.3%, Peak time = 7.1 min,
Mix stab = 23.1 min, MTI = 15 FU

Mixograms

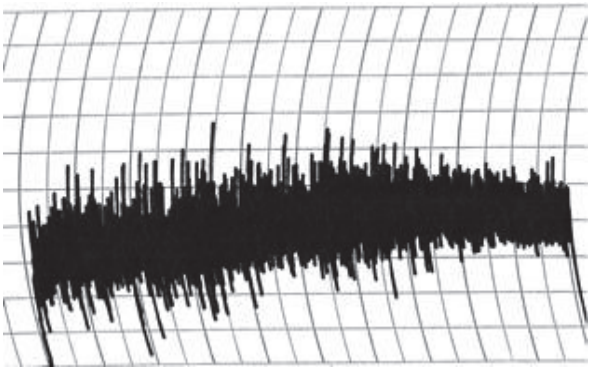


Water abs = 67.2%
Mix time = 8.5 min

24-2401, SY Monument_CK



Water abs = 67.8%, Peak time = 9.9 min,
Mix stab = 30.6 min, MTI = 12 FU



Water abs = 67.4%
Mix time = 5.5 min

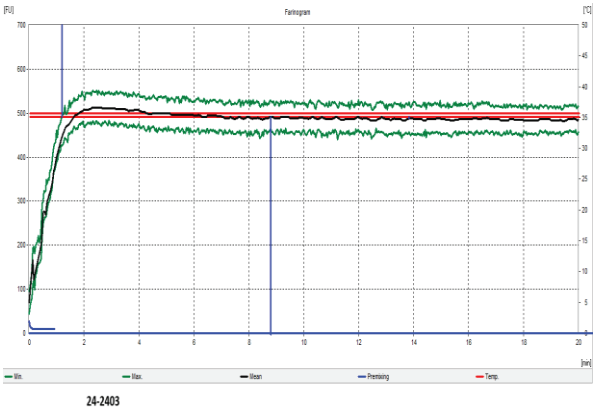
24-2402, XG4108_WB

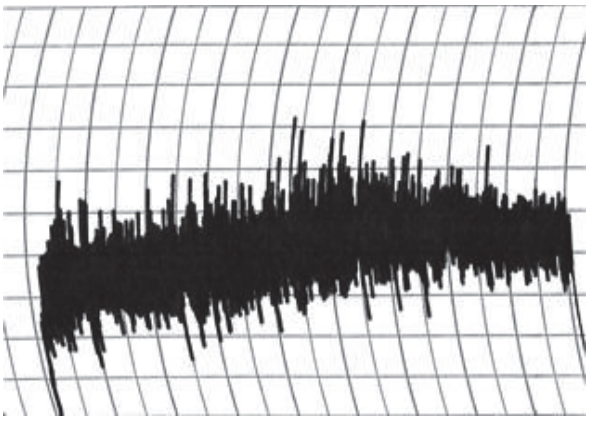
Physical Dough Tests – Farino and Mixo

2024 (Small Scale) Samples – Southern Growout (Continued)

Farinograms

Mixograms

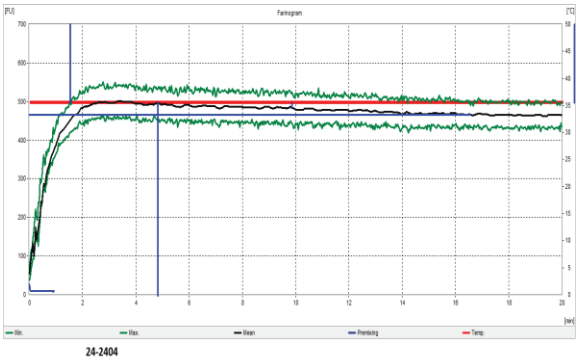


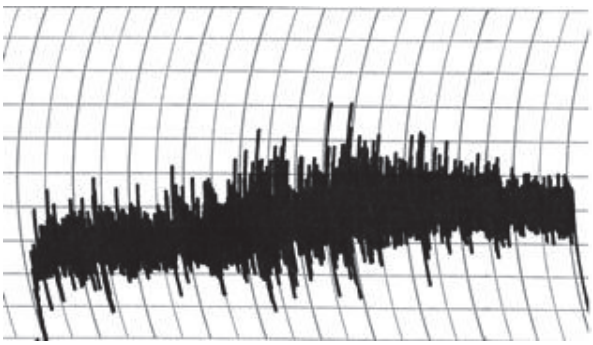


Water abs = 66.5%, Peak time = 8.8 min,
Mix stab = 27.9 min, MTI = 4 FU

Water abs = 67.3%
Mix time = 5.3 min

24-2403, WB4347_WB





Water abs = 61.4%, Peak time = 4.9 min,
Mix stab = 18.9 min, MTI = 12 FU

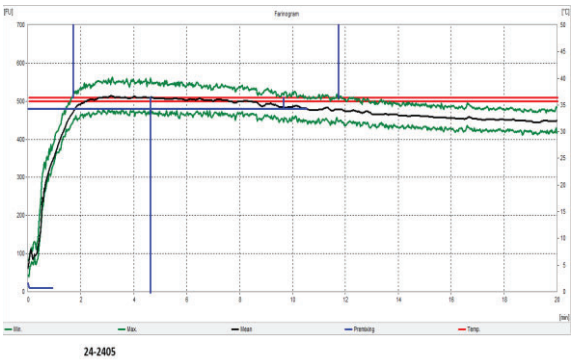
Water abs = 66.2%
Mix time = 6.0 min

24-2404, WB4445CLP_WB

Physical Dough Tests – Farino and Mixo

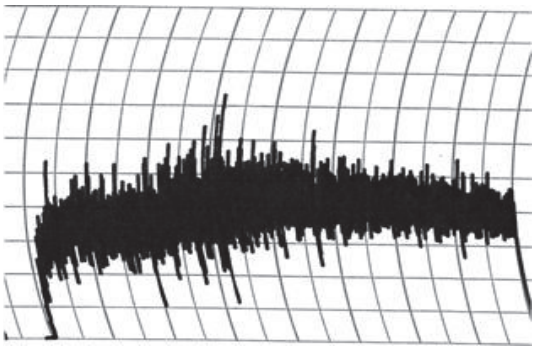
2024 (Small Scale) Samples – Southern Growout (Continued)

Farinograms



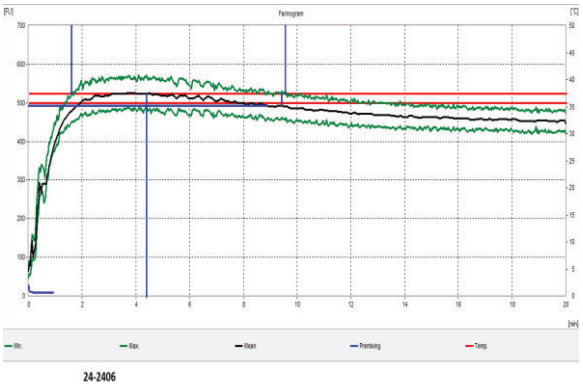
Water abs = 63.5%, Peak time = 4.7 min,
Mix stab = 10.0 min, MTI = 27 FU

Mixograms

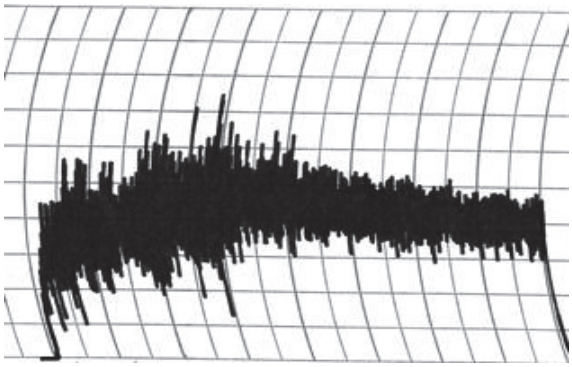


Water abs = 64.7%
Mix time = 3.5 min

24-2405, TX18DH287_TX



Water abs = 64.0%, Peak time = 4.4 min,
Mix stab = 8.0 min, MTI = 30 FU



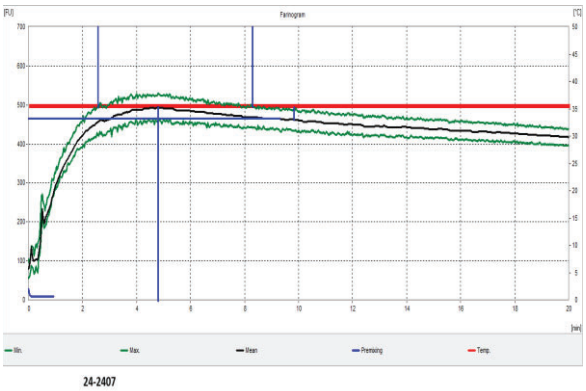
Water abs = 65.0%
Mix time = 3.1 min

24-2406, TX18DH313_TX

Physical Dough Tests – Farino and Mixo

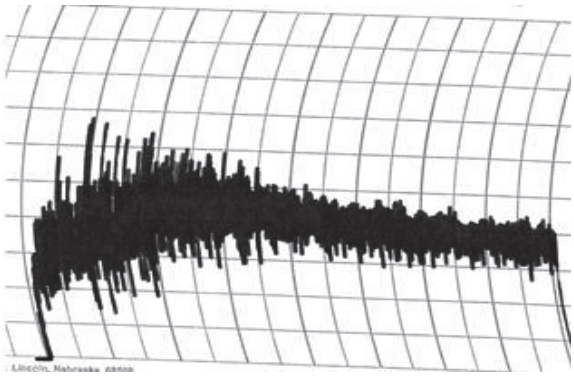
2024 (Small Scale) Samples – Southern Growout (Continued)

Farinograms



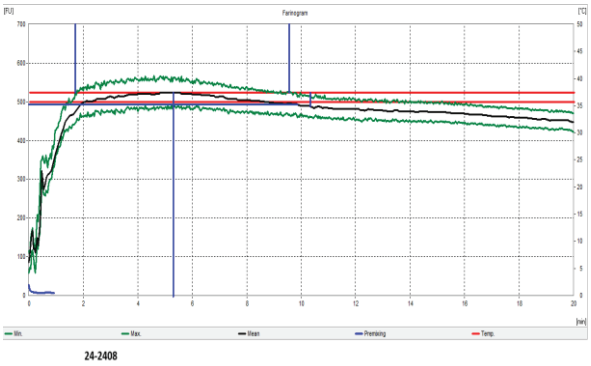
Water abs = 65.9%, Peak time = 4.8 min,
Mix stab = 5.7 min, MTI = 33 FU

Mixograms

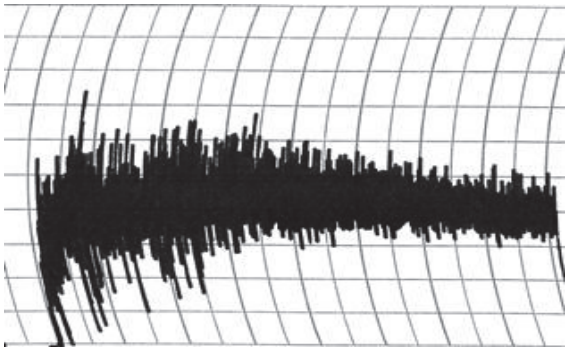


Water abs = 65.0%
Mix time = 2.3 min

24-2407, OK198417C_OK



Water abs = 69.9%, Peak time = 5.3 min,
Mix stab = 7.9 min, MTI = 35 FU

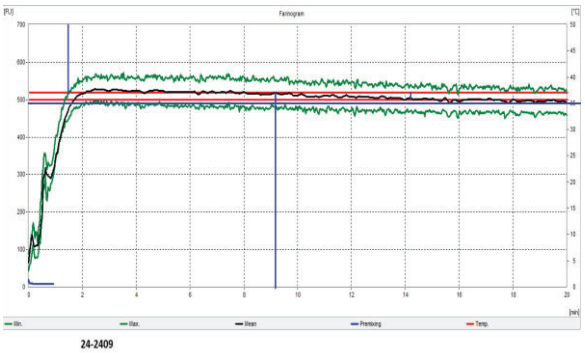


Water abs = 64.2%
Mix time = 2.5 min

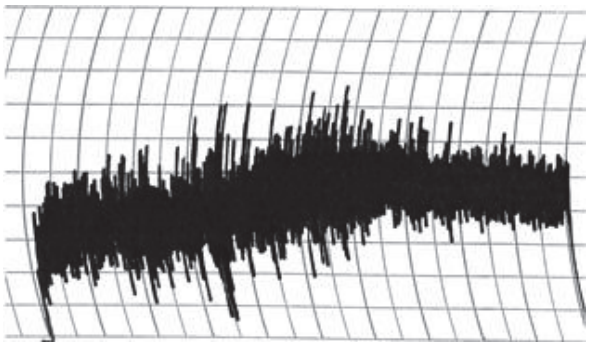
24-2408, OK20708_OK

Physical Dough Tests – Farino and Mixo

2024 (Small Scale) Samples – Southern Growout (Continued)

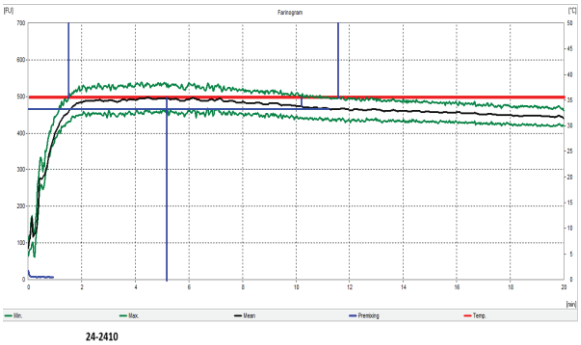


Water abs = 67.1%, Peak time = 9.2 min,
Mix stab = 28.5 min, MTI = 16 FU

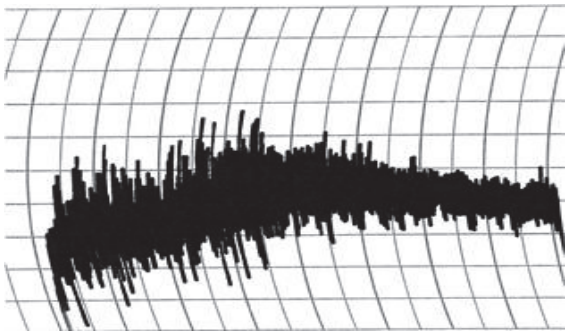


Water abs = 66.7%
Mix time = 5.8 min

24-2409, KS20H124_KH



Water abs = 62.1%, Peak time = 5.1 min,
Mix stab = 10.2 min, MTI = 21 FU

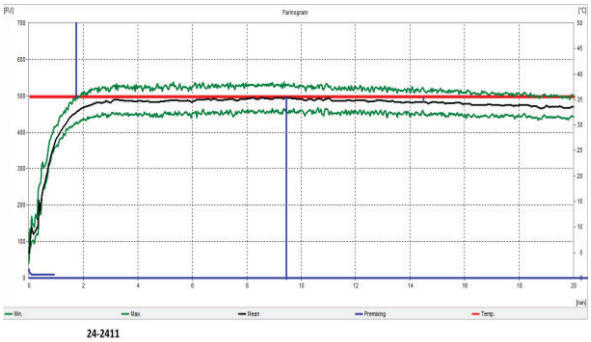


Water abs = 63.5%
Mix time = 3.5 min

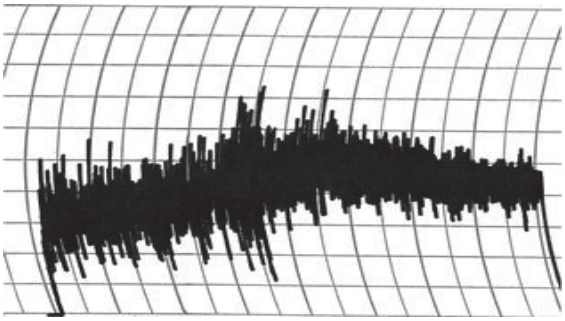
24-2410, LCH21-9398_LM

Physical Dough Tests – Farino and Mixo

2024 (Small Scale) Samples – Southern Growout (Continued)

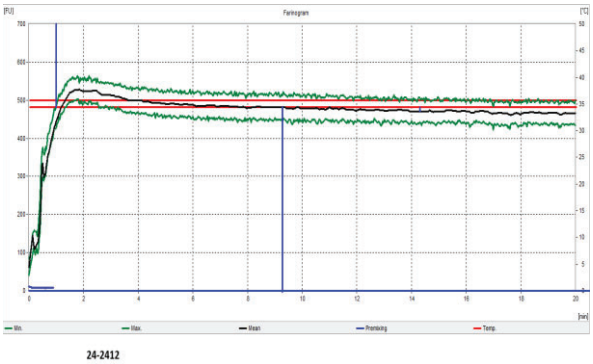


Water abs = 62.2%, Peak time = 9.5 min,
Mix stab = 19.5 min, MTI = 11 FU

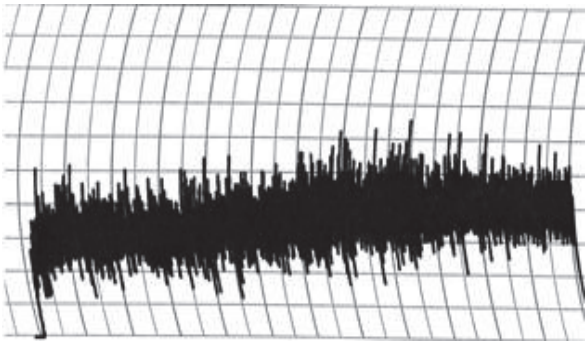


Water abs = 64.3%
Mix time = 4.3 min

24-2411, LCH16ACC403-1_LM



Water abs = 64.7%, Peak time = 9.3 min,
Mix stab = 33.6 min, MTI = 12 FU

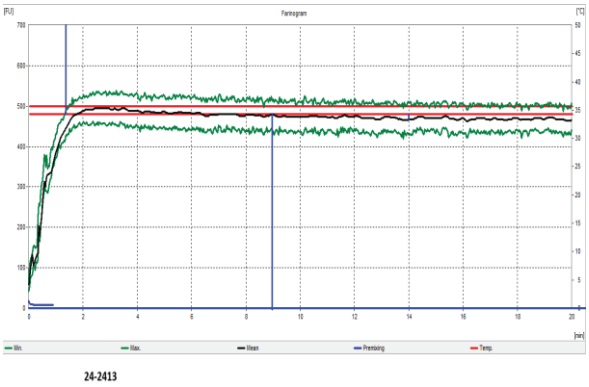


Water abs = 65.8%
Mix time = 8.5 min

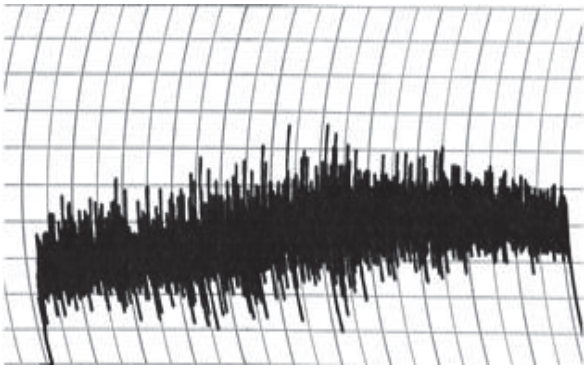
24-2412, CO19S129W_CO

Physical Dough Tests – Farino and Mixo

2024 (Small Scale) Samples – Southern Growout (Continued)



Water abs = 63.4%, Peak time = 9.0 min,
Mix stab = 33.3 min, MTI = 12 FU

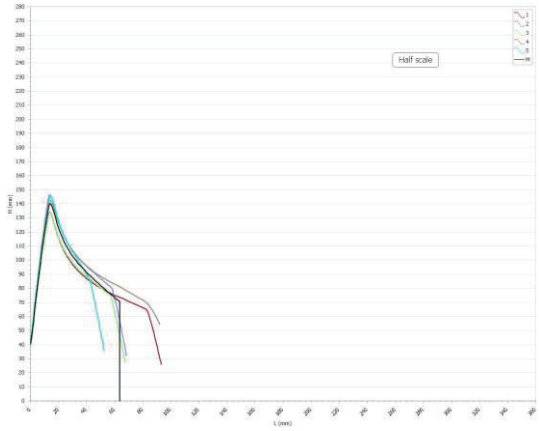


Water abs = 66.0%
Mix time = 6.3 min

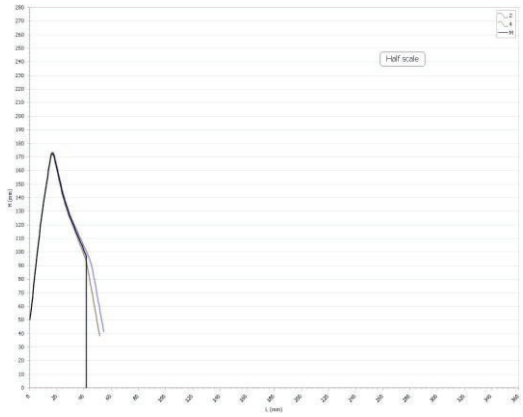
24-2413, CO19410R_CO

Physical Dough Tests - Alveograms

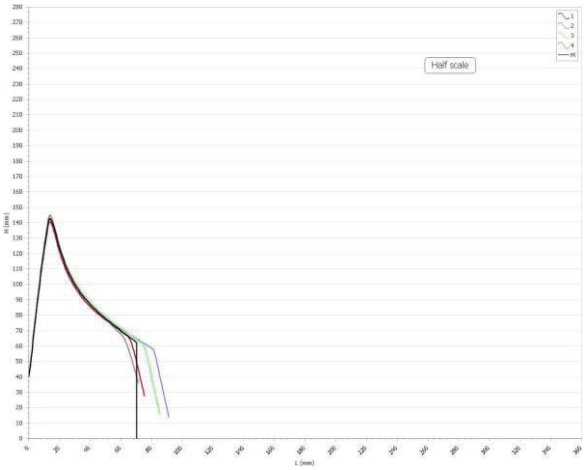
2024 (Small Scale) Samples – Southern Growout



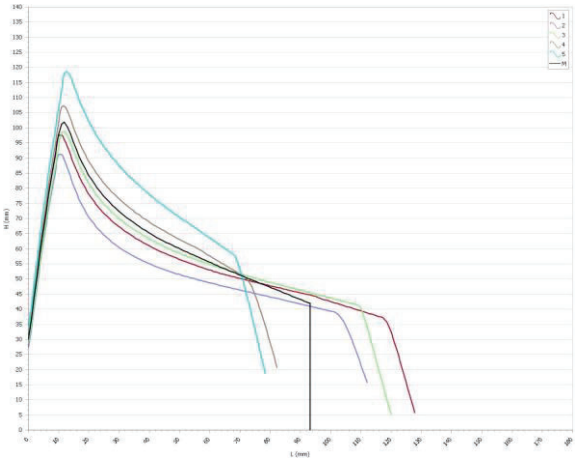
24-2401, SY Monument_CK
P(mm H_20) =154, L(mm) = 63, W($10E^{-4}$ J) = 403



24-2402, XG4108_WB
P(mm H_20) =190, L(mm) = 42, W($10E^{-4}$ J) = 346



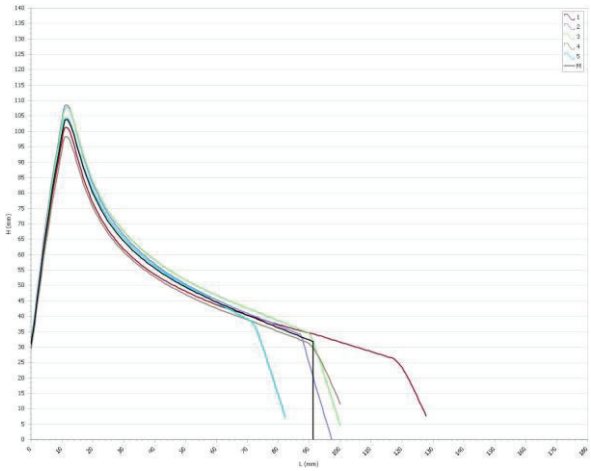
24-2403, WB4347_WB
P(mm H_20) = 157, L(mm) = 70, W($10E^{-4}$ J) = 426



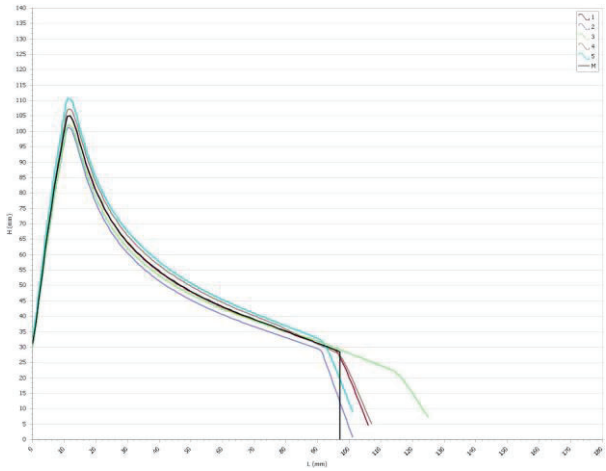
24-2404, WB4445CLP_WB
P(mm H_20) =112, L(mm) = 91, W($10E^{-4}$ J) = 338

Physical Dough Tests - Alveograms

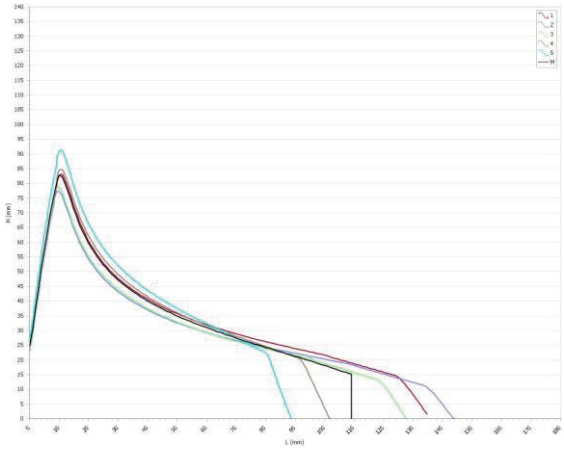
2024 (Small Scale) Samples – Southern Growout (Continued)



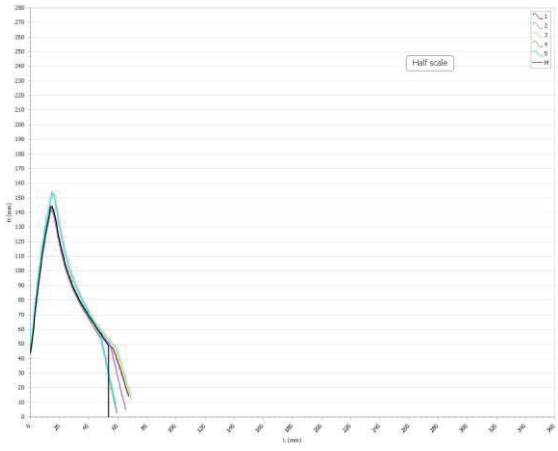
24-2405, TX18DH287_TX
P(mm H_20) = 114, L(mm) = 90, W($10E^{-4}$ J) = 337



24-2406, TX18DH313_TX
P(mm H_20) = 116, L(mm) = 97, W($10E^{-4}$ J) = 345



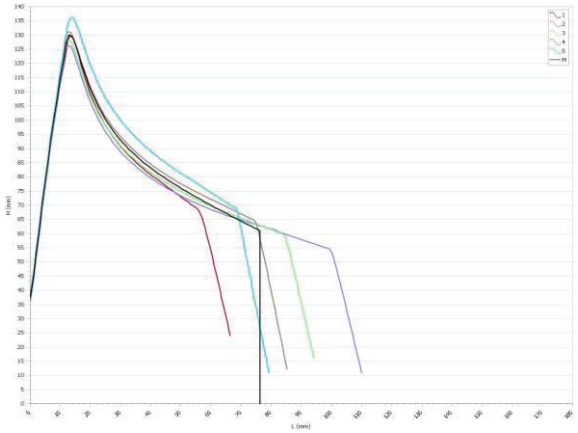
24-2407, OK198417C_OK
P(mm H_20) = 91, L(mm) = 109, W($10E^{-4}$ J) = 268



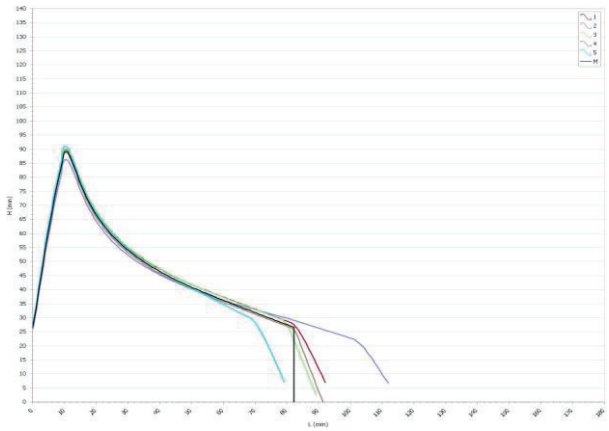
24-2408, OK20708_OK
P(mm H_20) = 159, L(mm) = 53, W($10E^{-4}$ J) = 317

Physical Dough Tests - Alveograms

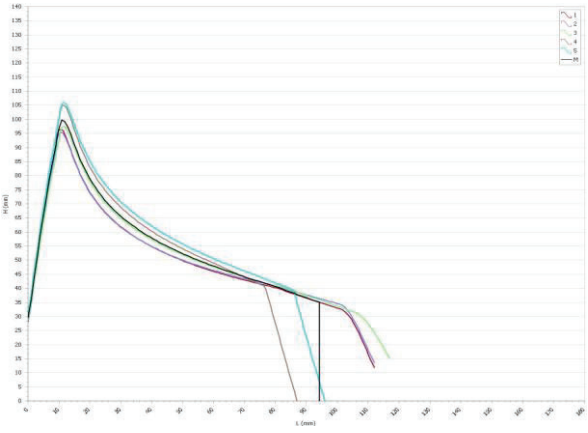
2024 (Small Scale) Samples – Southern Growout (Continued)



24-2409, KS20H124_KH
P(mm H_20) = 143, L(mm) = 76, W($10E^{-4}$ J) = 427



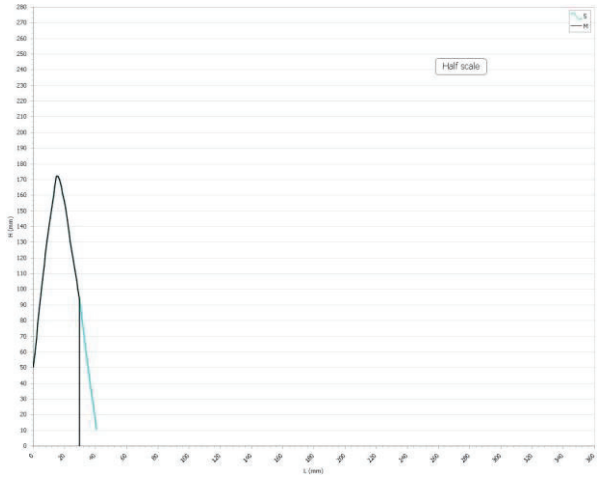
24-2410, LCH21-9398_LM
P(mm H_20) = 98, L(mm) = 82, W($10E^{-4}$ J) = 264



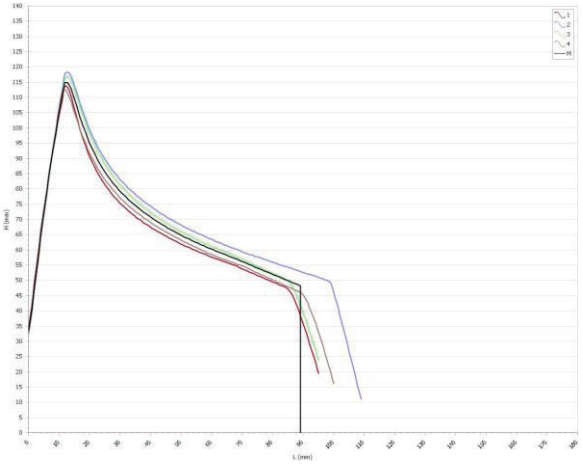
24-2411, LCH16ACC403-1_LM
P(mm H_20) = 110, L(mm) = 94, W($10E^{-4}$ J) = 353

Physical Dough Tests - Alveograms

2024 (Small Scale) Samples – Southern Growout (Continued)



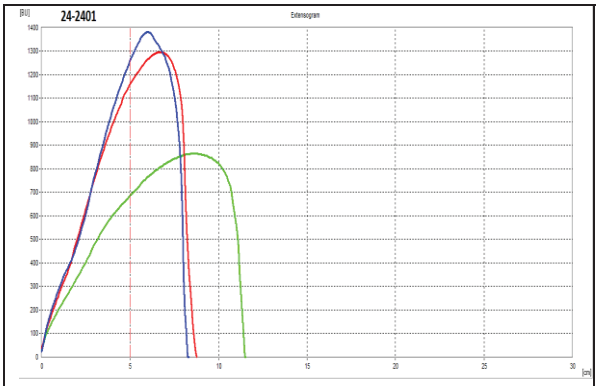
24-2412, CO19S129W_CO
P(mm H_20) = 189, L(mm) = 29, W($10E^{-4}$ J) = 250



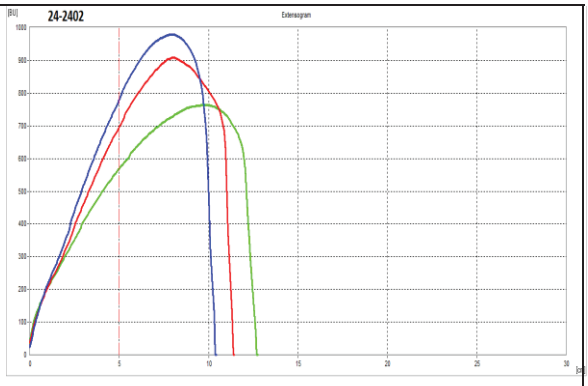
24-2413, CO19410R_CO
P(mm H_20) = 126, L(mm) = 89, W($10E^{-4}$ J) = 414

Physical Dough Tests - Extensigrams

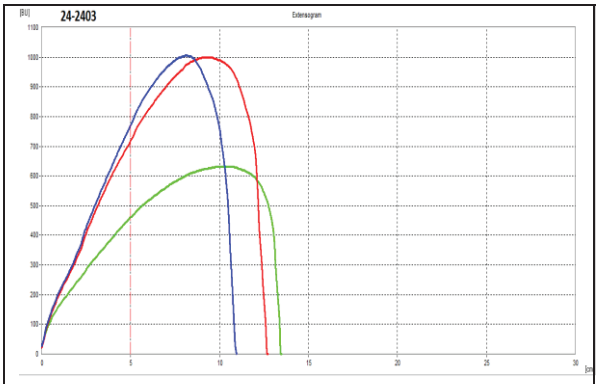
2024 (Small Scale) Samples – Southern Growout



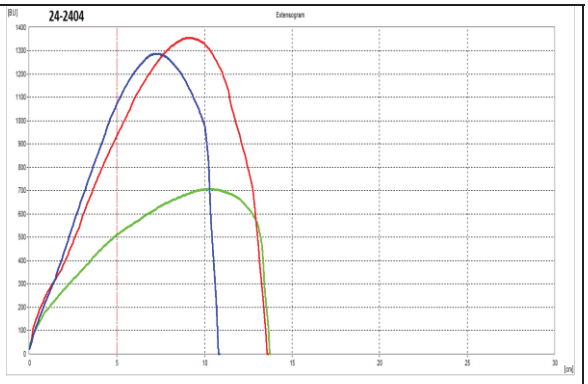
24-2401, SY Monument_CK
R (BU) = 1167, E (mm) = 88, W (cm^2) = 126
Rmax (BU) = 1297, Ratio = 13.3 at 90 min



24-2402, XG4108_WB
R (BU) = 700, E (mm) = 115, W (cm^2) = 125
Rmax (BU) = 908, Ratio = 6.1 at 90 min



24-2403, WB4347_WB
R (BU) = 722, E (mm) = 128, W (cm^2) = 152
Rmax (BU) = 1000, Ratio = 5.6 at 90 min

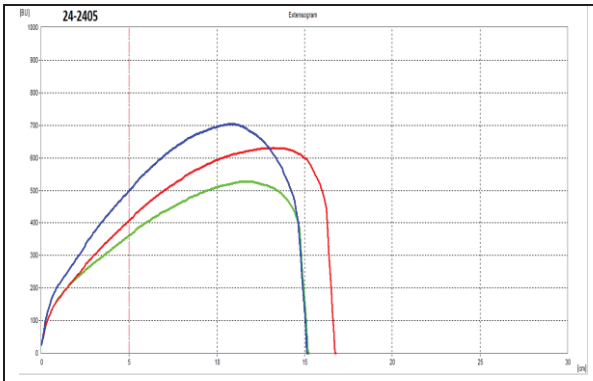


24-2404, WB4445CLP_WB
R (BU) = 943, E (mm) = 137, W (cm^2) = 212
Rmax (BU) = 1355, Ratio = 6.9 at 90 min

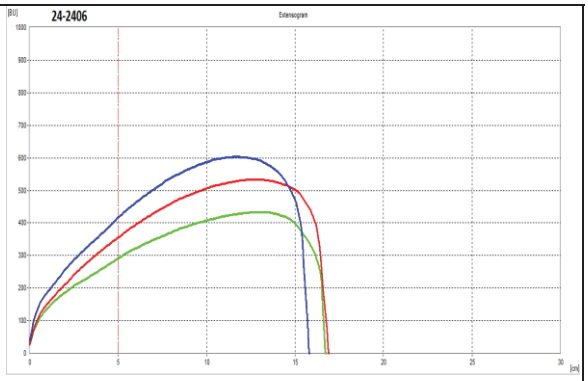
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigrams

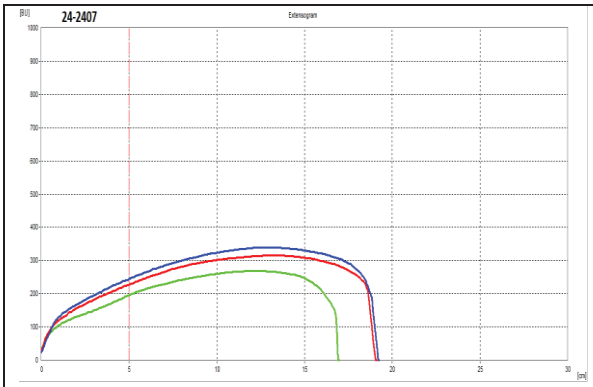
2024 (Small Scale) Samples – Southern Growout (Continued)



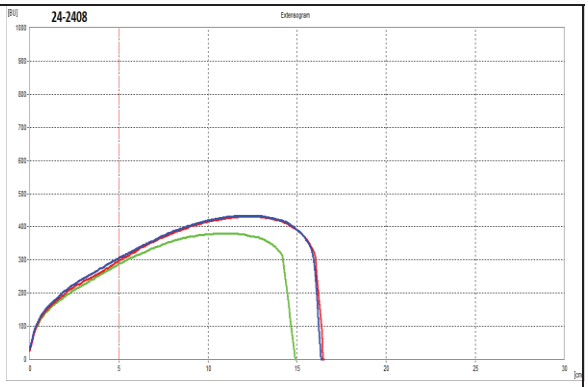
24-2405, TX18DH287_TX
R (BU) = 409, E (mm) = 169, W (cm^2) = 137
Rmax (BU) = 631, Ratio = 2.4 at 90 min



24-2406, TX18DH313_TX
R (BU) = 356, E (mm) = 170, W (cm^2) = 119
Rmax (BU) = 533, Ratio = 2.1 at 90 min



24-2407, OK198417C_OK
R (BU) = 228, E (mm) = 192, W (cm^2) = 85
Rmax (BU) = 315, Ratio = 1.2 at 90 min

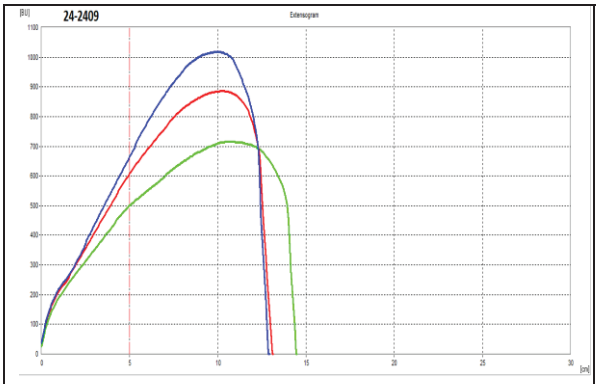


24-2408, OK20708_OK
R (BU) = 299, E (mm) = 166, W (cm^2) = 96
Rmax (BU) = 430, Ratio = 1.8 at 90 min

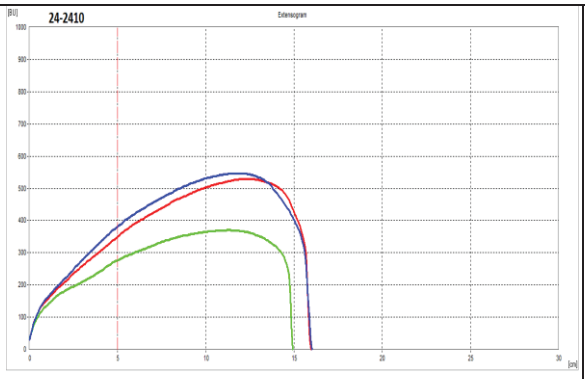
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigrams

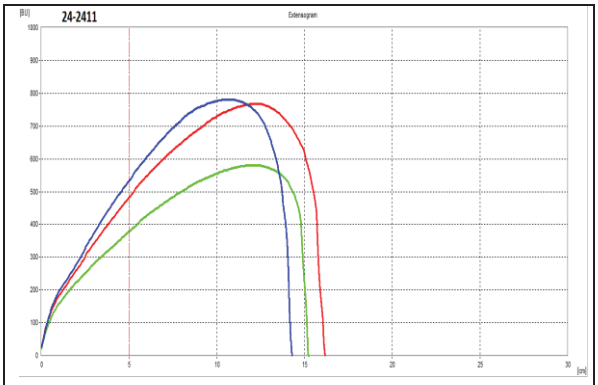
2024 (Small Scale) Samples – Southern Growout (Continued)



24-2409, KS20H124_KH
R (BU) = 612, E (mm) = 132, W (cm^2) = 140
Rmax (BU) = 886, Ratio = 4.6 at 90 min



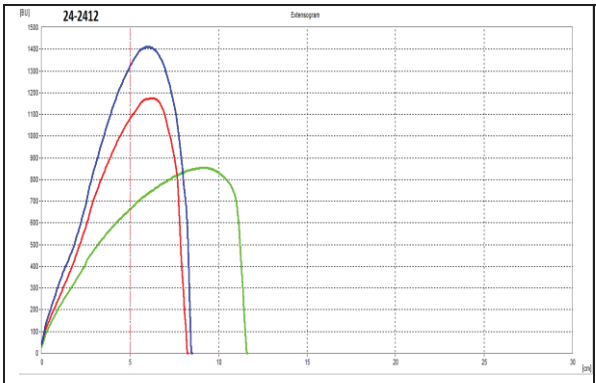
24-2410, LCH21-9398_LM
R (BU) = 351, E (mm) = 160, W (cm^2) = 110
Rmax (BU) = 529, Ratio = 2.2 at 90 min



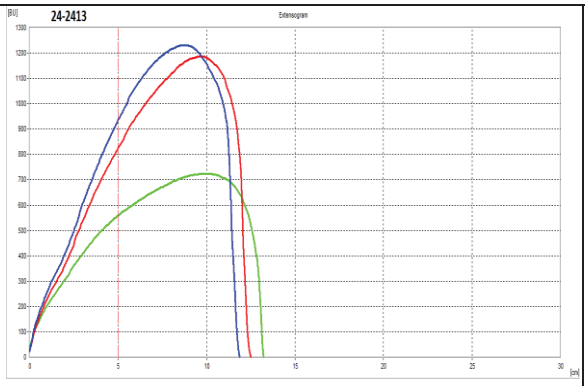
24-2411, LCH16ACC403-1_LM
R (BU) = 485, E (mm) = 162, W (cm^2) = 155
Rmax (BU) = 768, Ratio = 3.0 at 90 min

Physical Dough Tests - Extensigrams

2024 (Small Scale) Samples – Southern Growout (Continued)

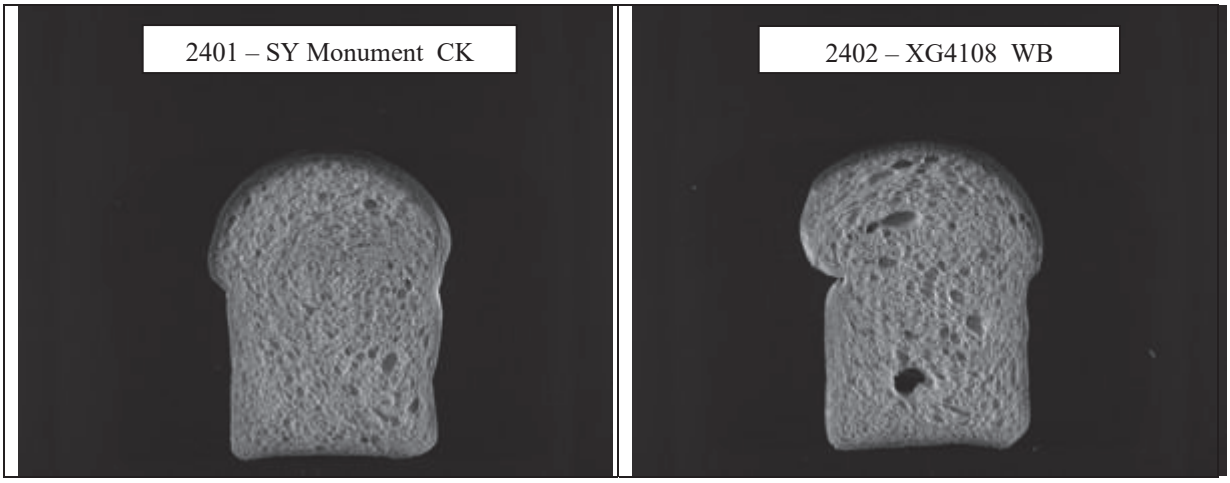


24-2412, CO19S129W_CO
R (BU) = 1086, E (mm) = 84, W (cm^2) = 108
Rmax (BU) = 1174, Ratio = 13.0 at 90 min

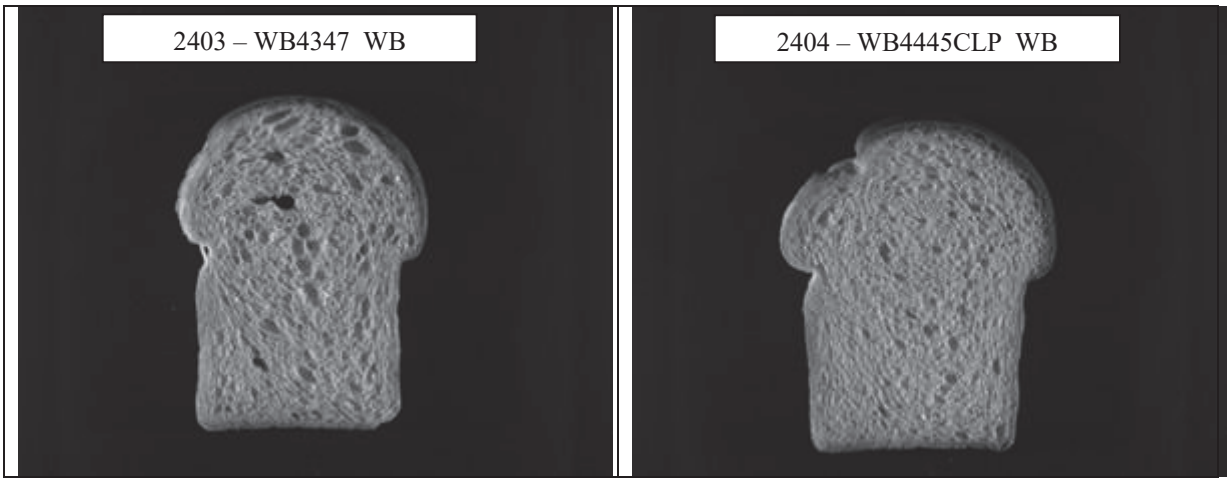


24-2413, CO19410R_CO
R (BU) = 829, E (mm) = 125, W (cm^2) = 174
Rmax (BU) = 1187, Ratio = 6.6 at 90 min

Southern Growout: C-Cell Bread Images and Analysis
2024 (Small-Scale) Samples

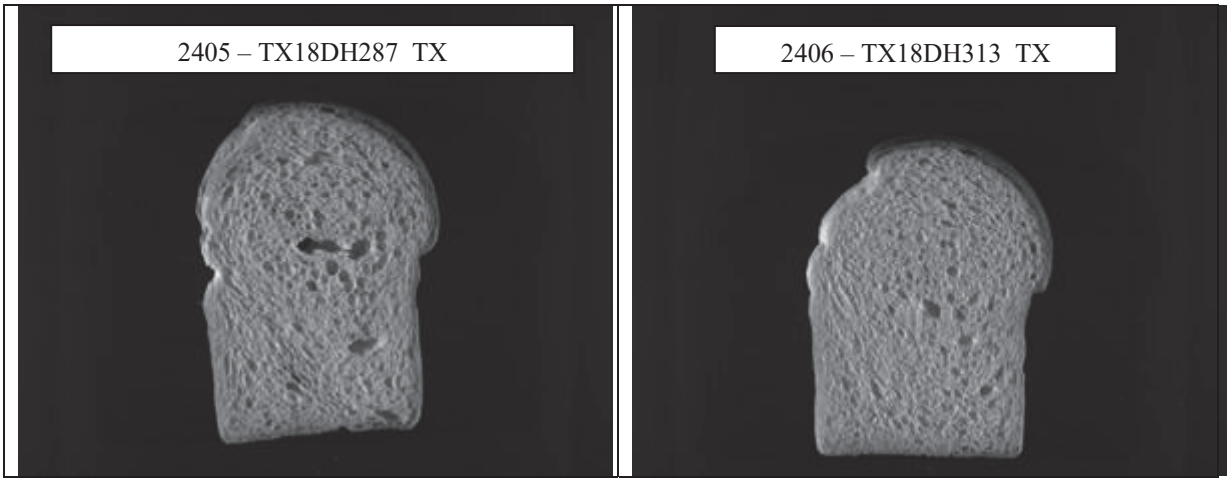


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2401	6325	119	3728	0.418	1.955	4.633	1.843	-0.33
2402	5874	114	3513	0.425	1.945	3.430	1.775	-5.90

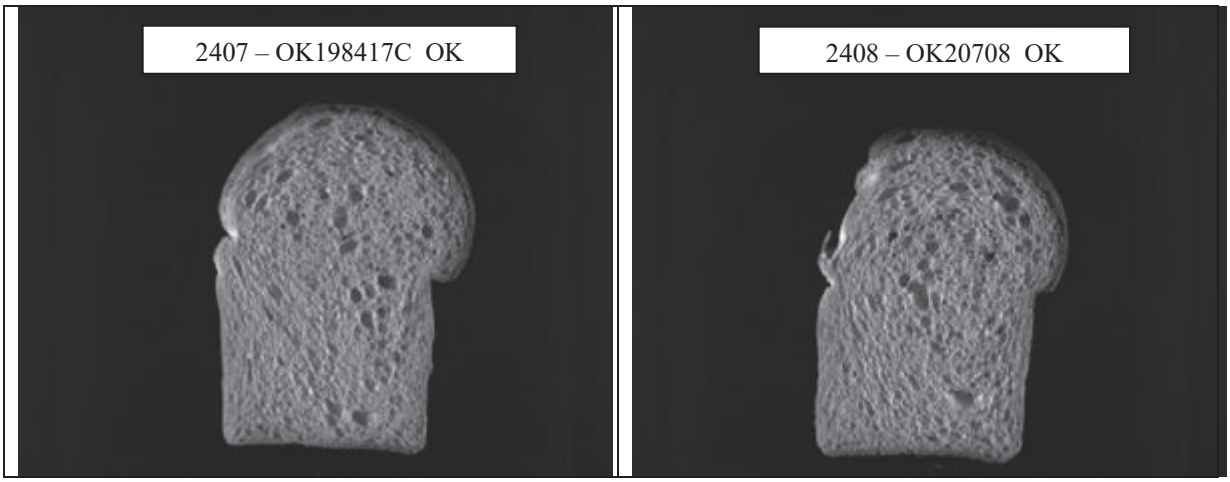


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	6156	116	3544	0.430	2.058	7.658	1.775	-5.83
2404	6943	119	4157	0.415	2.005	3.935	1.805	-9.35

Southern Growout: C-Cell Bread Images and Analysis
2024 (Small-Scale) Samples (Continued)

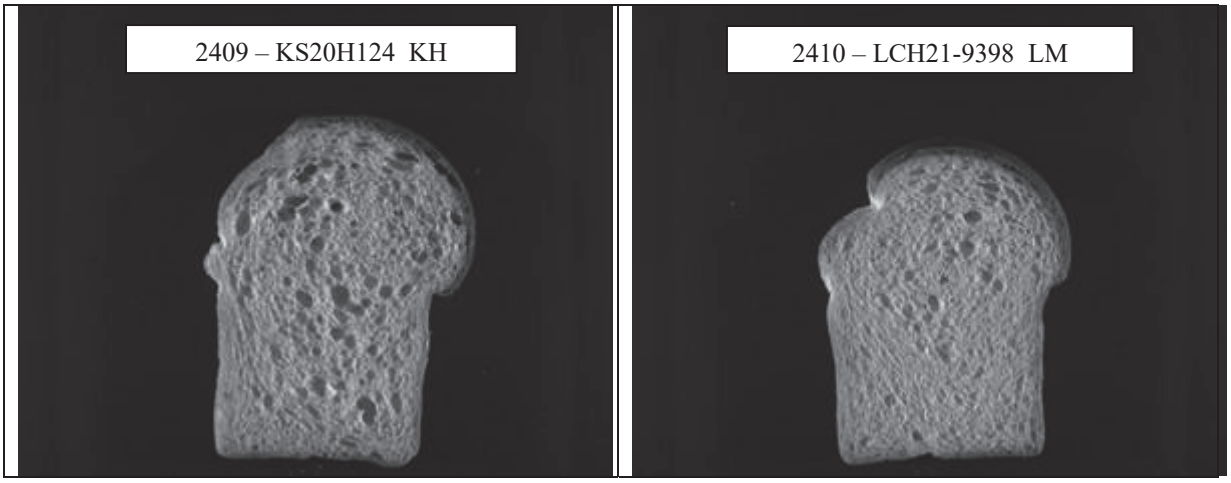


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2405	6457	117	3923	0.425	1.975	8.045	1.775	-5.20
2406	6200	123	3979	0.415	1.935	1.075	1.815	-9.30



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2407	7019	118	4270	0.420	2.105	1.750	1.770	-8.35
2408	6451	116	3505	0.435	2.255	1.615	1.795	-4.75

Southern Growout: C-Cell Bread Images and Analysis
2024 (Small-Scale) Samples (Continued)

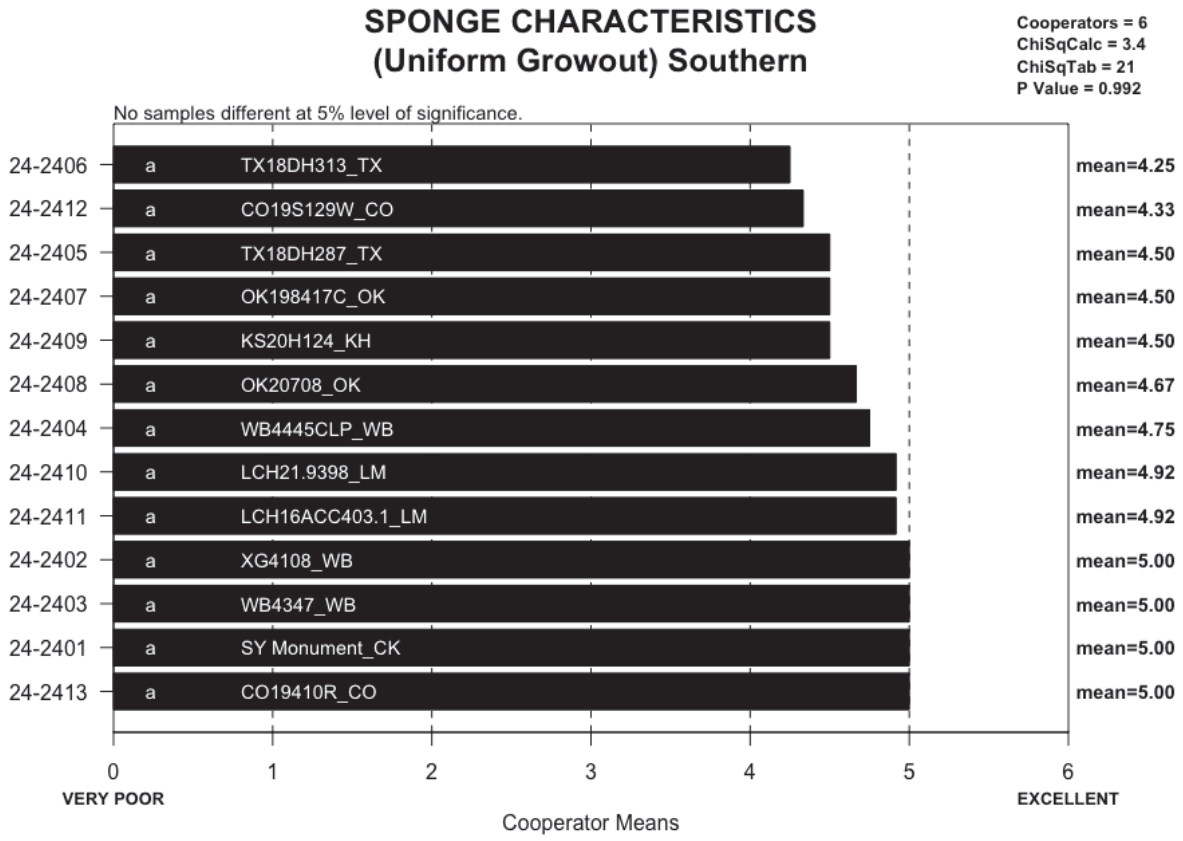


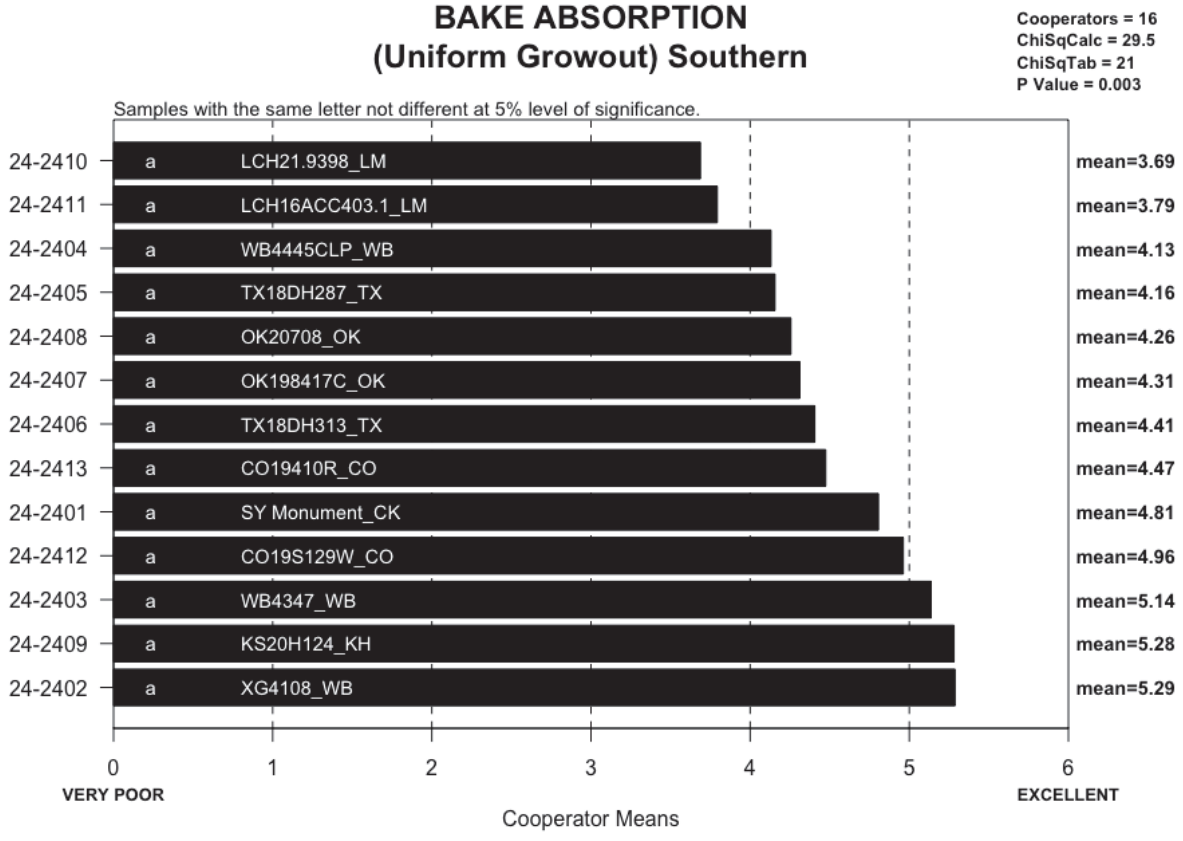
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2409	6978	114	3714	0.440	2.365	2.245	1.780	-7.70
2410	6232	122	3802	0.420	1.995	5.430	1.800	-7.05

Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2411	6523	121	3907	0.430	2.080	1.700	1.785	-8.45

Southern Growout: C-Cell Bread Images and Analysis
2024 (Small-Scale) Samples (Continued)

Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2412	6473	120	3754	0.425	2.000	4.705	1.755	-2.20
2413	6539	117	3825	0.425	2.125	10.095	1.755	-7.50


SPONGE CHARACTERISTICS
(Uniform Growout) Southern
Cooperators = 6
ChiSqCalc = 3.4
ChiSqTab = 21
P Value = 0.992
No samples different at 5% level of significance.
24-2406 a TX18DH313_TX mean=4.25
24-2412 a CO19S129W_CO mean=4.33
24-2405 a TX18DH287_TX mean=4.50
24-2407 a OK198417C_OK mean=4.50
24-2409 a KS20H124_KH mean=4.50
24-2408 a OK20708_OK mean=4.67
24-2404 a WB4445CLP_WB mean=4.75
24-2410 a LCH21.9398_LM mean=4.92
24-2411 a LCH16ACC403.1_LM mean=4.92
24-2402 a XG4108_WB mean=5.00
24-2403 a WB4347_WB mean=5.00
24-2401 a SY Monument_CK mean=5.00
24-2413 a CO19410R_CO mean=5.00
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

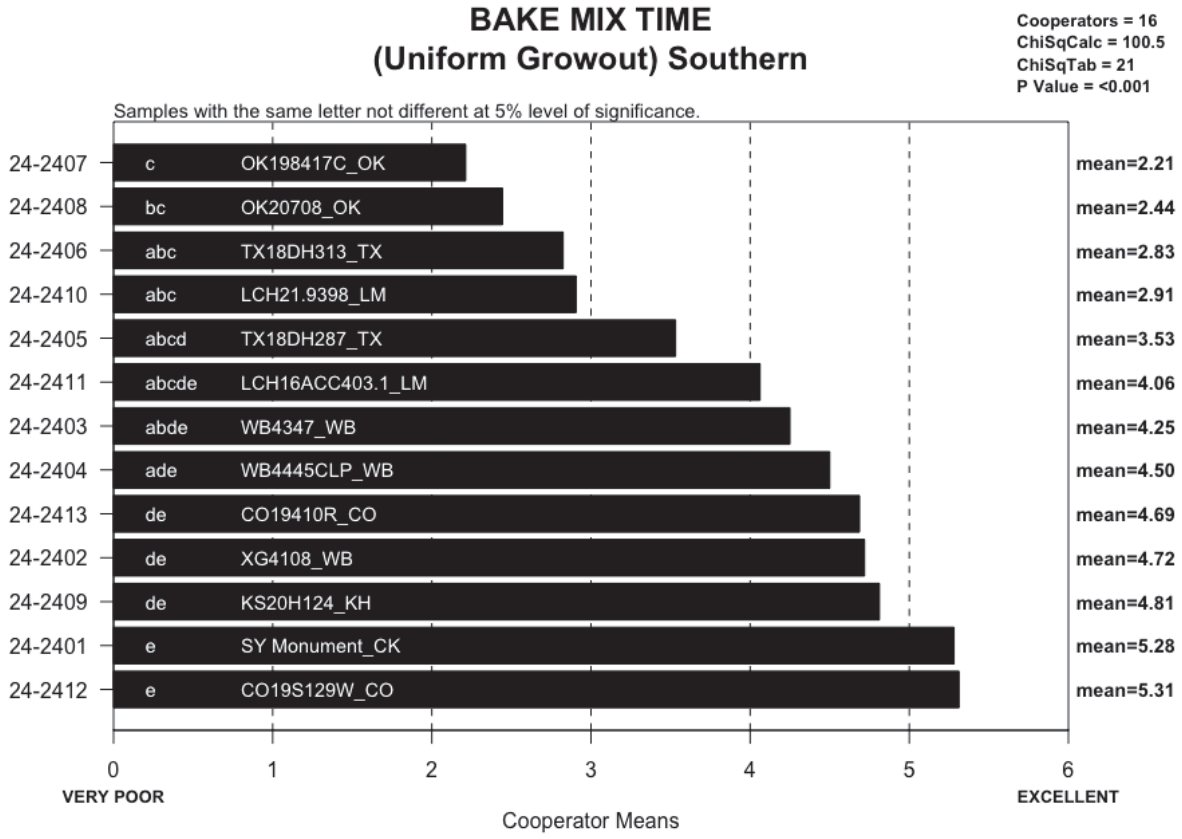

BAKE ABSORPTION
(Uniform Growout) Southern
Cooperators = 16
ChiSqCalc = 29.5
ChiSqTab = 21
P Value = 0.003
Samples with the same letter not different at 5% level of significance.
24-2410 a LCH21.9398_LM mean=3.69
24-2411 a LCH16ACC403.1_LM mean=3.79
24-2404 a WB4445CLP_WB mean=4.13
24-2405 a TX18DH287_TX mean=4.16
24-2408 a OK20708_OK mean=4.26
24-2407 a OK198417C_OK mean=4.31
24-2406 a TX18DH313_TX mean=4.41
24-2413 a CO19410R_CO mean=4.47
24-2401 a SY Monument_CK mean=4.81
24-2412 a CO19S129W_CO mean=4.96
24-2403 a WB4347_WB mean=5.14
24-2409 a KS20H124_KH mean=5.28
24-2402 a XG4108_WB mean=5.29
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

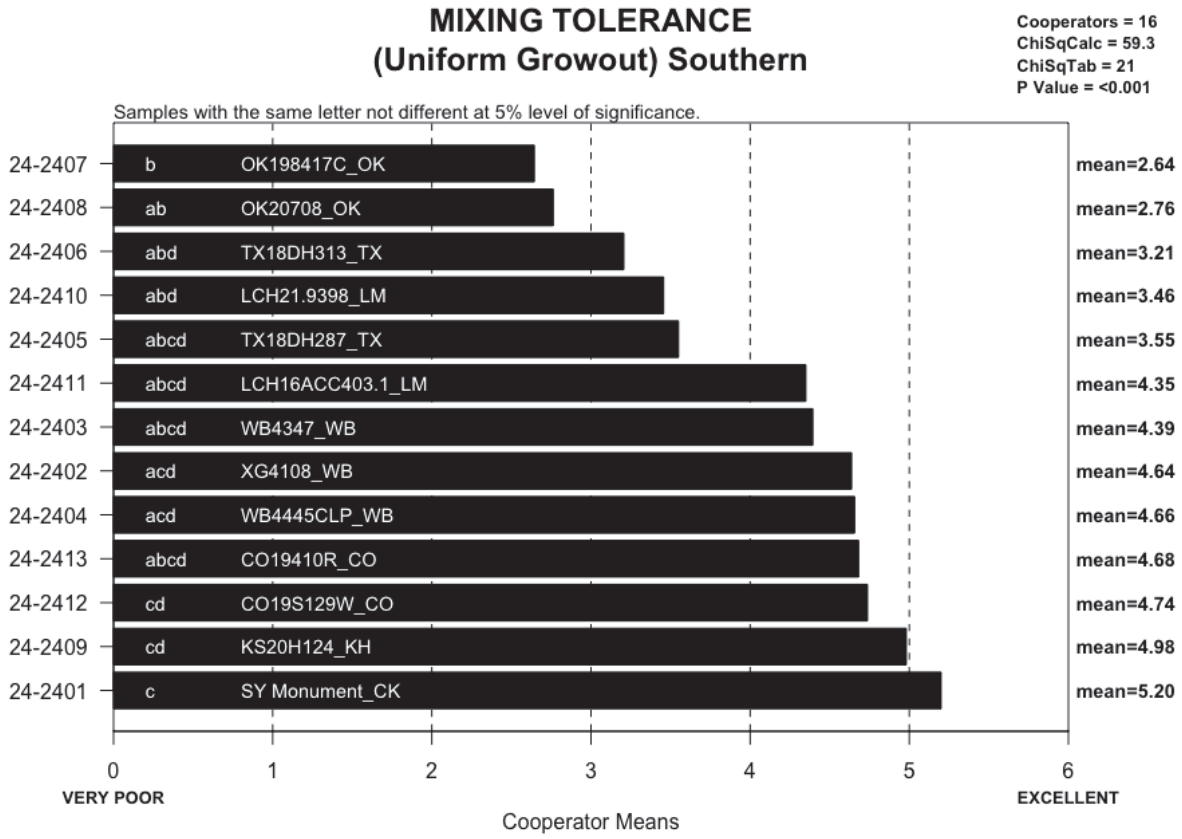
BAKE ABSORPTION, ACTUAL (14% MB)
(Uniform Growout) Southern
Cooperators A – P

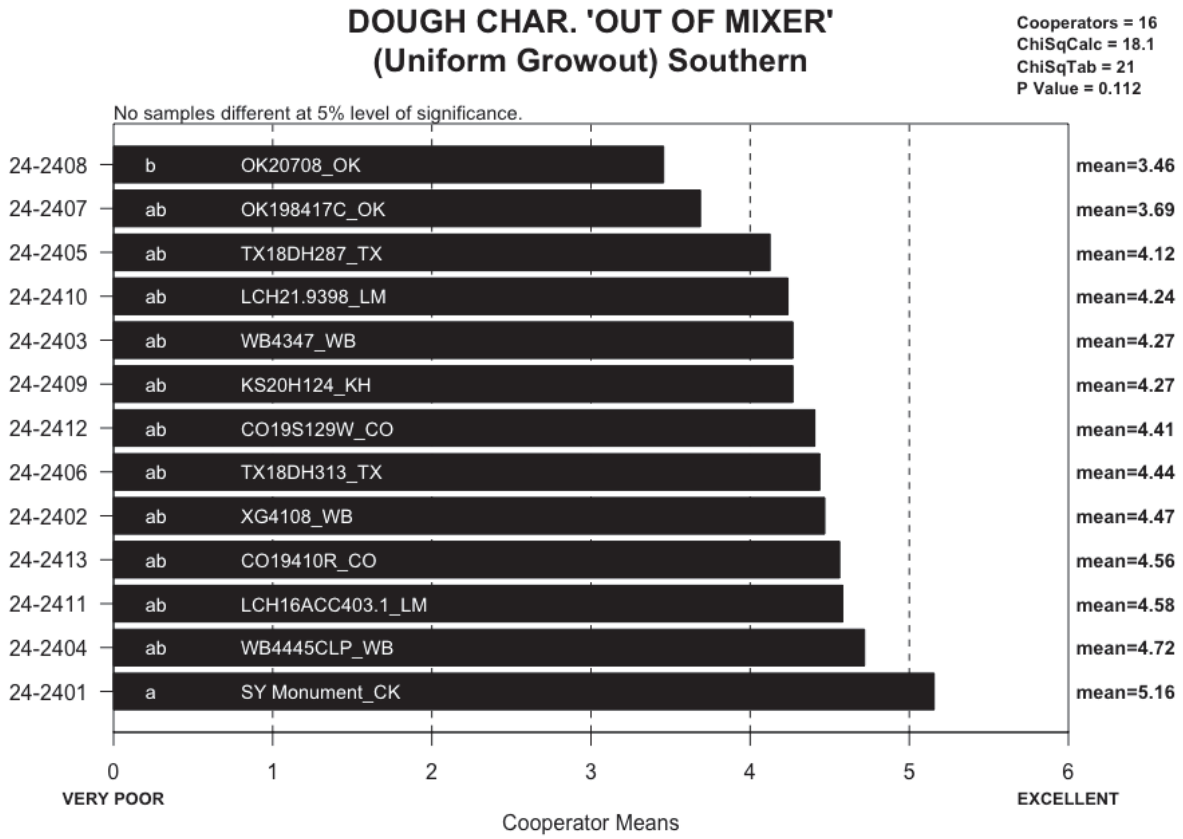
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2401	SY Monument_CK	61	67.0	67.7	63.3	62.9	66.9	67.0	63.3	63.8	67.3	63	65.3	63.3	63	66.0	65.1
24-2402	XG4108_WB	61	68.5	67.7	67.8	63.6	66.8	67.9	65.2	69.9	67.4	67	69.8	67.8	62	70.6	66.0
24-2403	WB4347_WB	61	67.5	67.4	66.5	63.2	65.6	67.8	65.1	69.4	67.1	66	68.5	66.5	62	69.4	65.0
24-2404	WB4445CLP_WB	59	66.5	66.5	61.4	62.1	66.8	66.4	61.2	64.2	66.0	61	63.4	61.4	62	64.3	64.0
24-2405	TX18DH287_TX	58	65.0	66.0	63.4	62.0	65.2	64.5	62.8	67.1	64.7	63	65.4	63.4	60	66.5	62.5
24-2406	TX18DH313_TX	58	65.0	65.0	64.0	63.0	65.6	65.5	62.8	66.8	65.2	63	66.0	64.0	60	67.2	63.1
24-2407	OK198417C_OK	59	65.5	64.4	65.9	63.0	67.1	65.2	61.0	68.0	65.2	63	67.9	65.9	62	68.9	66.0
24-2408	OK20708_OK	59	65.5	65.3	69.9	62.6	65.1	64.8	64.1	73.3	64.1	63	71.9	69.9	61	72.8	64.7
24-2409	KS20H124_KH	61	69.0	68.2	67.1	64.5	66.1	66.7	65.0	69.1	66.6	67	69.1	67.1	63	70.1	66.9
24-2410	LCH21.9398_LM	58	63.0	62.6	62.1	63.5	65.0	63.5	62.8	63.2	63.5	62	64.1	62.1	60	64.3	62.5
24-2411	LCH16ACC403.1_LM	60	64.0	65.3	62.2	62.7	65.5	64.3	62.6	63.6	64.2	62	64.2	62.2	61	64.5	62.5
24-2412	CO19S129W_CO	59	67.0	67.8	64.7	62.4	65.4	65.9	65.2	67.0	66.0	65	66.7	64.7	60	67.6	65.0
24-2413	CO19410R_CO	60	66.5	67.9	63.4	62.6	65.7	66.6	63.9	64.4	66.0	63	65.4	63.4	61	65.5	63.7

BAKE MIX TIME, ACTUAL
(Uniform Growout) Southern Cooperators A – P

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2401	SY Monument_CK	15	6.8	6.5	18	9.5	6.5	10.0	13	5.0	9.0	35	20	8	5.8	9	7.5
24-2402	XG4108_WB	8	5.3	5.3	17	9.6	4.8	8.5	8	5.0	6.9	33	17	12	4.6	8	6.5
24-2403	WB4347_WB	7	5.0	4.5	15	6.6	4.0	6.5	6	5.0	5.8	15	18	10	4.7	7	5.5
24-2404	WB4445CLP_WB	9	5.5	5.3	12	8.2	5.8	8.3	10	5.0	7.5	25	20	6	5.0	6	6.5
24-2405	TX18DH287_TX	5	3.6	4.0	15	6.0	4.3	5.8	6	4.8	5.0	8	16	6	3.3	5	4.5
24-2406	TX18DH313_TX	5	3.0	3.5	11	4.7	3.3	4.9	4	4.8	4.2	11	14	6	2.9	5	4.0
24-2407	OK198417C_OK	4	2.8	2.8	7	3.4	2.8	3.3	3	4.3	2.8	8	9	6	2.3	6	3.3
24-2408	OK20708_OK	4	3.0	3.3	7	4.1	3.0	4.3	4	4.3	3.8	8	8	6	3.4	5	3.5
24-2409	KS20H124_KH	9	6.1	6.0	14	10.5	6.8	8.5	9	5.5	6.8	35	20	10	5.5	9	7.5
24-2410	LCH21.9398_LM	5	3.7	3.5	14	5.5	4.0	4.3	4	3.8	3.9	8	9	6	3.5	5	4.0
24-2411	LCH16ACC403.1_LM	7	4.6	4.5	12	7.3	4.0	5.5	9	4.8	5.3	18	18	10	4.3	6	5.0
24-2412	CO19S129W_CO	9	8.1	7.5	14	13.0	6.5	12.0	9	5.5	8.8	35	20	10	6.7	10	10.0
24-2413	CO19410R_CO	5	6.2	5.8	12	9.9	5.3	8.0	9	5.3	6.8	35	20	10	5.5	7	6.5

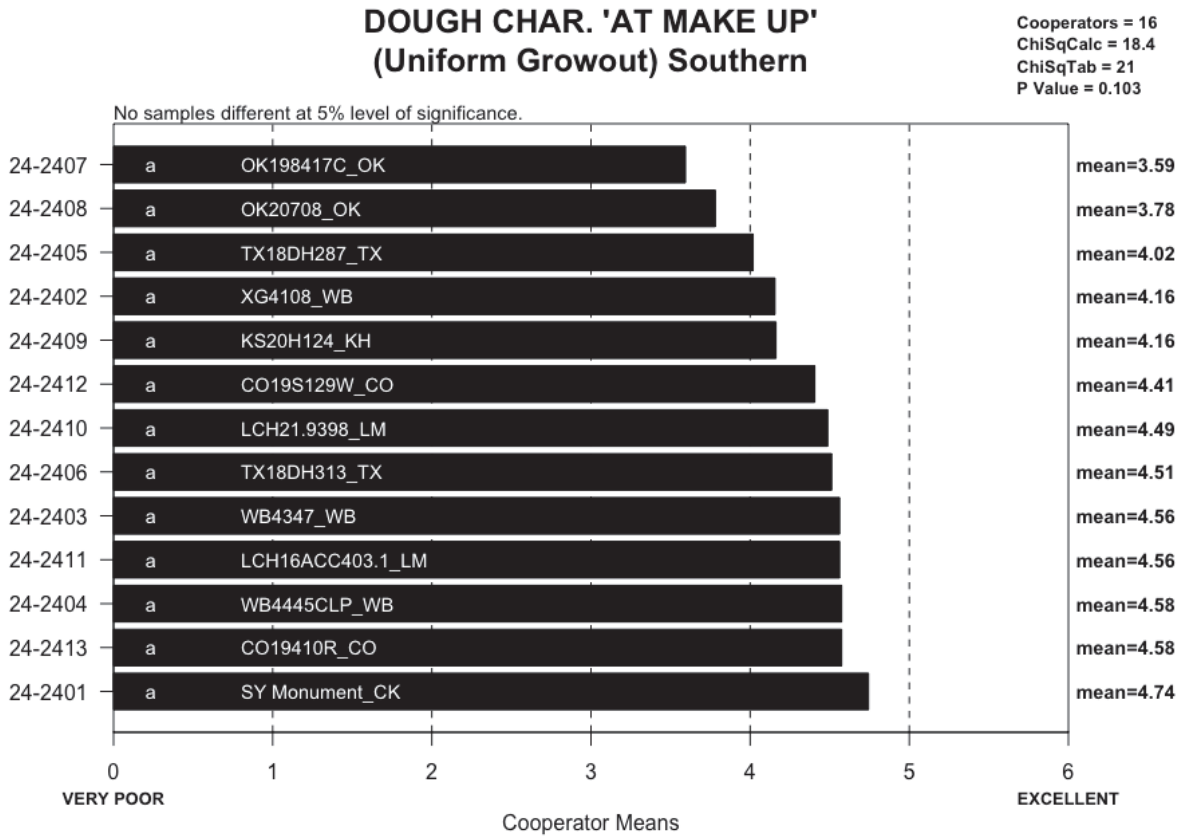

BAKE MIX TIME
(Uniform Growout) Southern
Cooperators = 16
ChiSqCalc = 100.5
ChiSqTab = 21
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
24-2407 c OK198417C_OK mean=2.21
24-2408 bc OK20708_OK mean=2.44
24-2406 abc TX18DH313_TX mean=2.83
24-2410 abc LCH21.9398_LM mean=2.91
24-2405 abcd TX18DH287_TX mean=3.53
24-2411 abcde LCH16ACC403.1_LM mean=4.06
24-2403 abde WB4347_WB mean=4.25
24-2404 ade WB4445CLP_WB mean=4.50
24-2413 de CO19410R_CO mean=4.69
24-2402 de XG4108_WB mean=4.72
24-2409 de KS20H124_KH mean=4.81
24-2401 e SY Monument_CK mean=5.28
24-2412 e CO19S129W_CO mean=5.31
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Uniform Growout) Southern
Cooperators = 16
ChiSqCalc = 59.3
ChiSqTab = 21
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
24-2407 b OK198417C_OK mean=2.64
24-2408 ab OK20708_OK mean=2.76
24-2406 abd TX18DH313_TX mean=3.21
24-2410 abd LCH21.9398_LM mean=3.46
24-2405 abcd TX18DH287_TX mean=3.55
24-2411 abcd LCH16ACC403.1_LM mean=4.35
24-2403 abcd WB4347_WB mean=4.39
24-2402 acd XG4108_WB mean=4.64
24-2404 acd WB4445CLP_WB mean=4.66
24-2413 abcd CO19410R_CO mean=4.68
24-2412 cd CO19S129W_CO mean=4.74
24-2409 cd KS20H124_KH mean=4.98
24-2401 c SY Monument_CK mean=5.20
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means



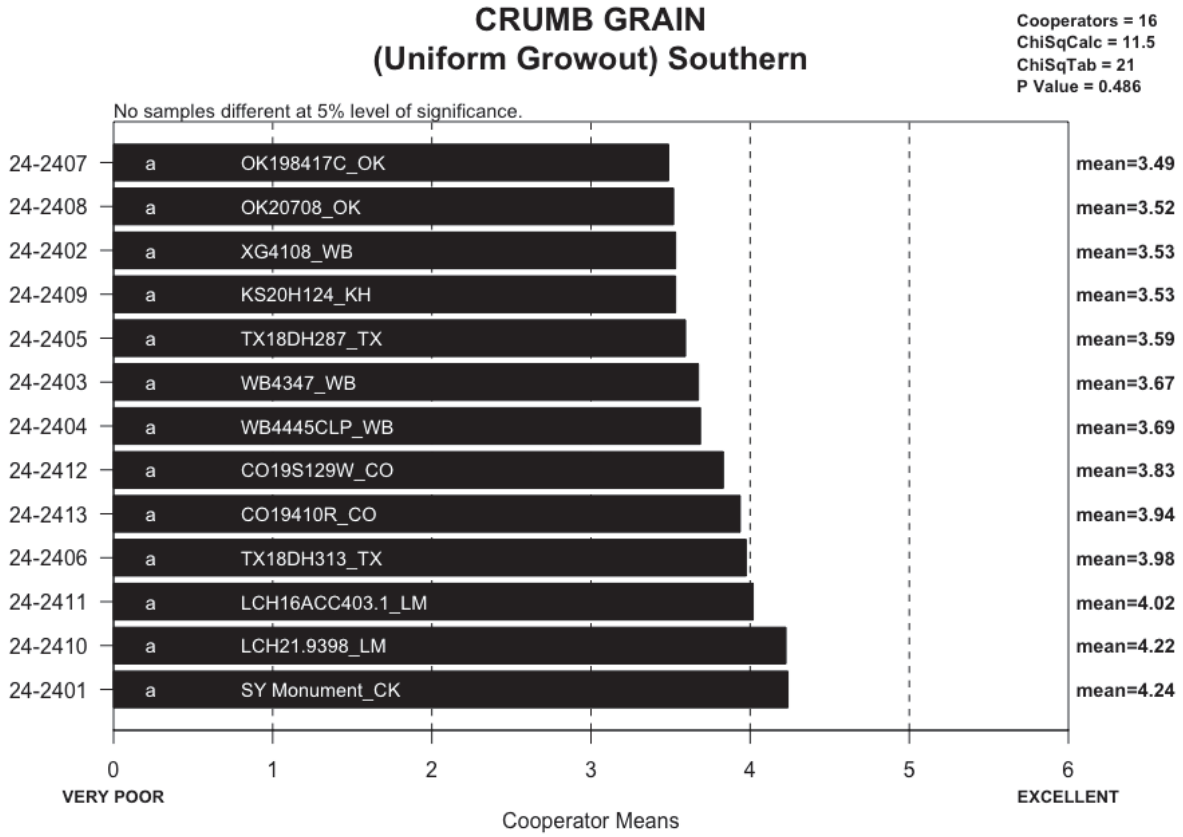
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Uniform Growout) Southern

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
24-2401	SY Monument_CK	1	0	2	5	8
24-2402	XG4108_WB	1	1	3	8	3
24-2403	WB4347_WB	3	1	3	5	4
24-2404	WB4445CLP_WB	2	0	2	6	6
24-2405	TX18DH287_TX	4	0	1	8	3
24-2406	TX18DH313_TX	2	0	2	9	3
24-2407	OK198417C_OK	8	0	0	5	3
24-2408	OK20708_OK	7	1	4	2	2
24-2409	KS20H124_KH	4	0	2	8	2
24-2410	LCH21.9398_LM	5	0	1	7	3
24-2411	LCH16ACC403.1_LM	3	0	1	10	2
24-2412	CO19S129W_CO	2	0	4	7	3
24-2413	CO19410R_CO	2	0	4	6	4



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Uniform Growout) Southern

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
24-2401	SY Monument_CK	1	0	4	8	3
24-2402	XG4108_WB	0	1	7	5	3
24-2403	WB4347_WB	2	0	3	8	3
24-2404	WB4445CLP_WB	0	1	4	8	3
24-2405	TX18DH287_TX	3	1	3	7	2
24-2406	TX18DH313_TX	2	2	0	8	4
24-2407	OK198417C_OK	5	5	1	3	2
24-2408	OK20708_OK	6	1	3	5	1
24-2409	KS20H124_KH	1	0	7	7	1
24-2410	LCH21.9398_LM	4	2	1	4	5
24-2411	LCH16ACC403.1_LM	1	1	3	7	4
24-2412	CO19S129W_CO	1	0	6	5	4
24-2413	CO19410R_CO	2	1	4	5	4

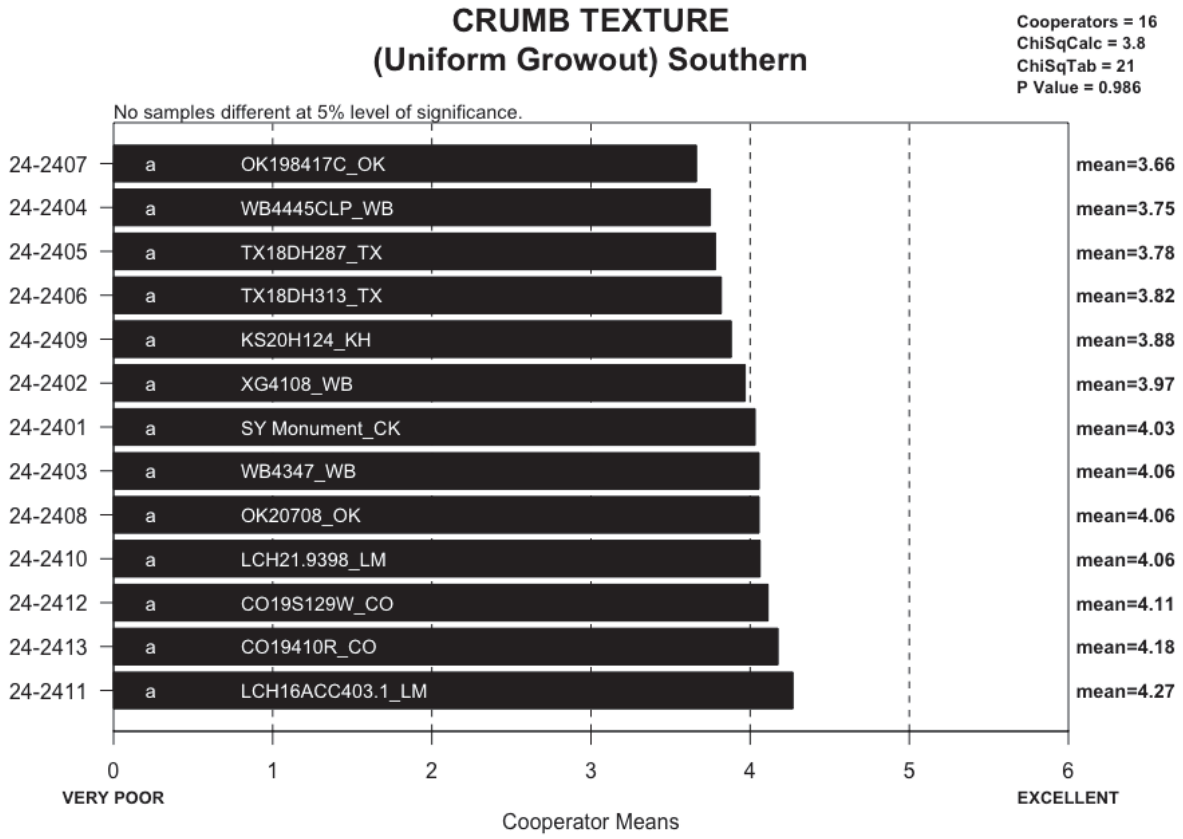


CRUMB GRAIN, DESCRIBED
(Uniform Growout) Southern

IDCODE	ID	Open	Fine	Dense
24-2401	SY Monument_CK	7	8	1
24-2402	XG4108_WB	9	5	2
24-2403	WB4347_WB	10	4	2
24-2404	WB4445CLP_WB	11	5	0
24-2405	TX18DH287_TX	10	4	2
24-2406	TX18DH313_TX	9	4	3
24-2407	OK198417C_OK	9	4	3
24-2408	OK20708_OK	9	5	2
24-2409	KS20H124_KH	14	2	0
24-2410	LCH21.9398_LM	6	8	2
24-2411	LCH16ACC403.1_LM	7	7	2
24-2412	CO19S129W_CO	8	6	2
24-2413	CO19410R_CO	8	7	1

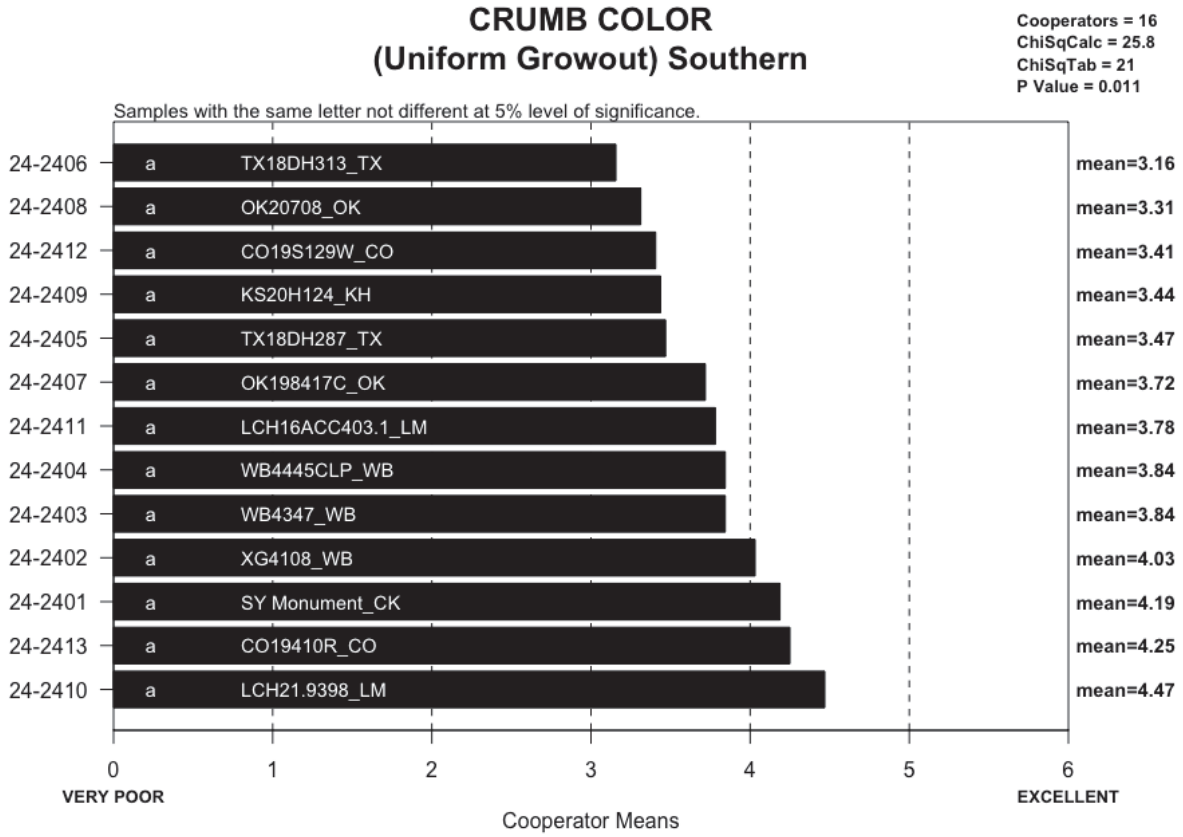
CELL SHAPE, DESCRIBED
(Uniform Growout) Southern

IDCODE	ID	Round	Irregular	Elongated
24-2401	SY Monument_CK	6	8	2
24-2402	XG4108_WB	6	8	2
24-2403	WB4347_WB	5	6	5
24-2404	WB4445CLP_WB	5	8	3
24-2405	TX18DH287_TX	8	4	4
24-2406	TX18DH313_TX	6	7	3
24-2407	OK198417C_OK	5	7	4
24-2408	OK20708_OK	4	6	6
24-2409	KS20H124_KH	8	6	2
24-2410	LCH21.9398_LM	6	6	4
24-2411	LCH16ACC403.1_LM	4	8	4
24-2412	CO19S129W_CO	4	8	4
24-2413	CO19410R_CO	5	8	3



CRUMB TEXTURE, DESCRIBED
(Uniform Growout) Southern

IDCODE	ID	Harsh	Smooth	Silky
24-2401	SY Monument_CK	3	10	3
24-2402	XG4108_WB	3	11	2
24-2403	WB4347_WB	1	13	2
24-2404	WB4445CLP_WB	4	11	1
24-2405	TX18DH287_TX	5	8	3
24-2406	TX18DH313_TX	4	9	3
24-2407	OK198417C_OK	4	10	2
24-2408	OK20708_OK	2	12	2
24-2409	KS20H124_KH	3	11	2
24-2410	LCH21.9398_LM	3	10	3
24-2411	LCH16ACC403.1_LM	1	11	4
24-2412	CO19S129W_CO	2	11	3
24-2413	CO19410R_CO	1	12	3



CRUMB COLOR, DESCRIBED
(Uniform Growout) Southern

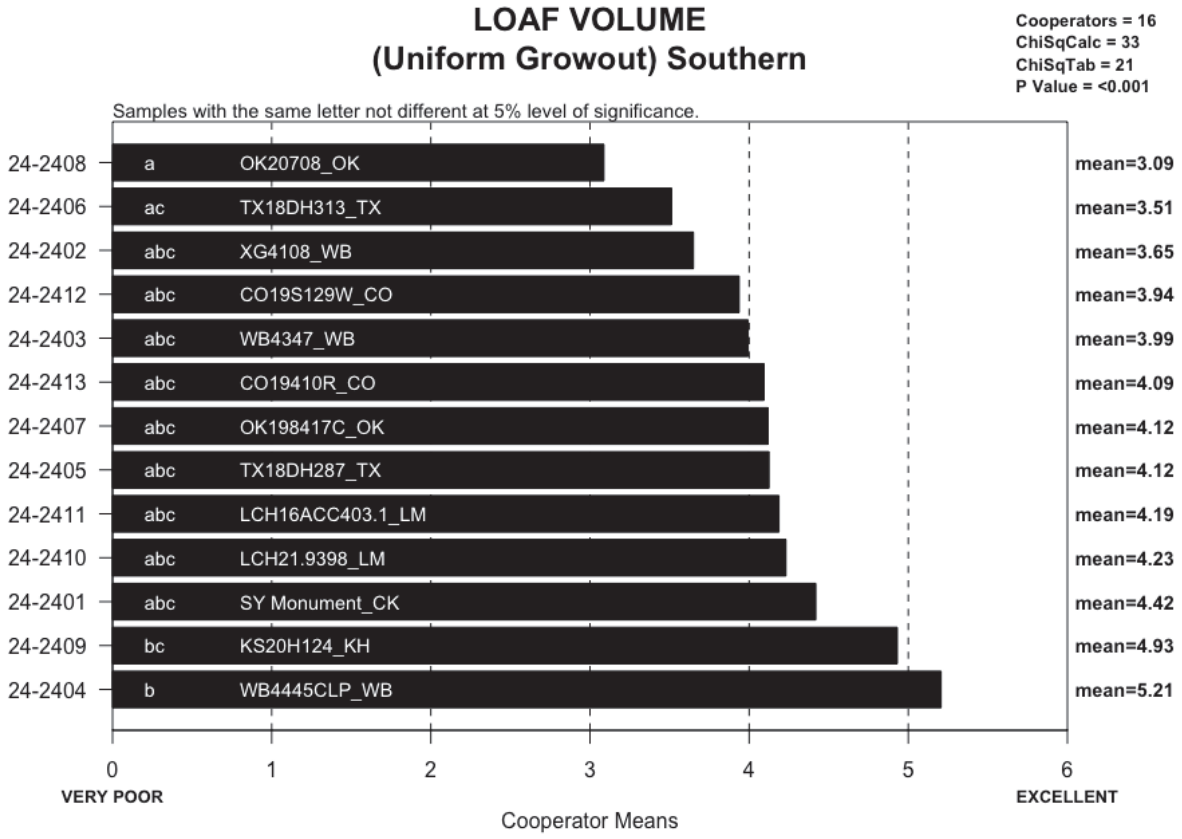
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
24-2401	SY Monument_CK	0	0	1	1	10	4	0
24-2402	XG4108_WB	0	0	1	3	9	3	0
24-2403	WB4347_WB	0	0	4	1	9	2	0
24-2404	WB4445CLP_WB	0	0	3	1	8	4	0
24-2405	TX18DH287_TX	0	2	3	2	7	1	1
24-2406	TX18DH313_TX	0	1	4	4	5	2	0
24-2407	OK198417C_OK	0	0	3	2	7	4	0
24-2408	OK20708_OK	0	0	4	4	6	1	1
24-2409	KS20H124_KH	0	0	3	4	7	2	0
24-2410	LCH21.9398_LM	0	0	0	0	9	5	2
24-2411	LCH16ACC403.1_LM	0	0	3	3	6	2	2
24-2412	CO19S129W_CO	0	1	3	4	3	5	0
24-2413	CO19410R_CO	0	0	1	1	6	6	2

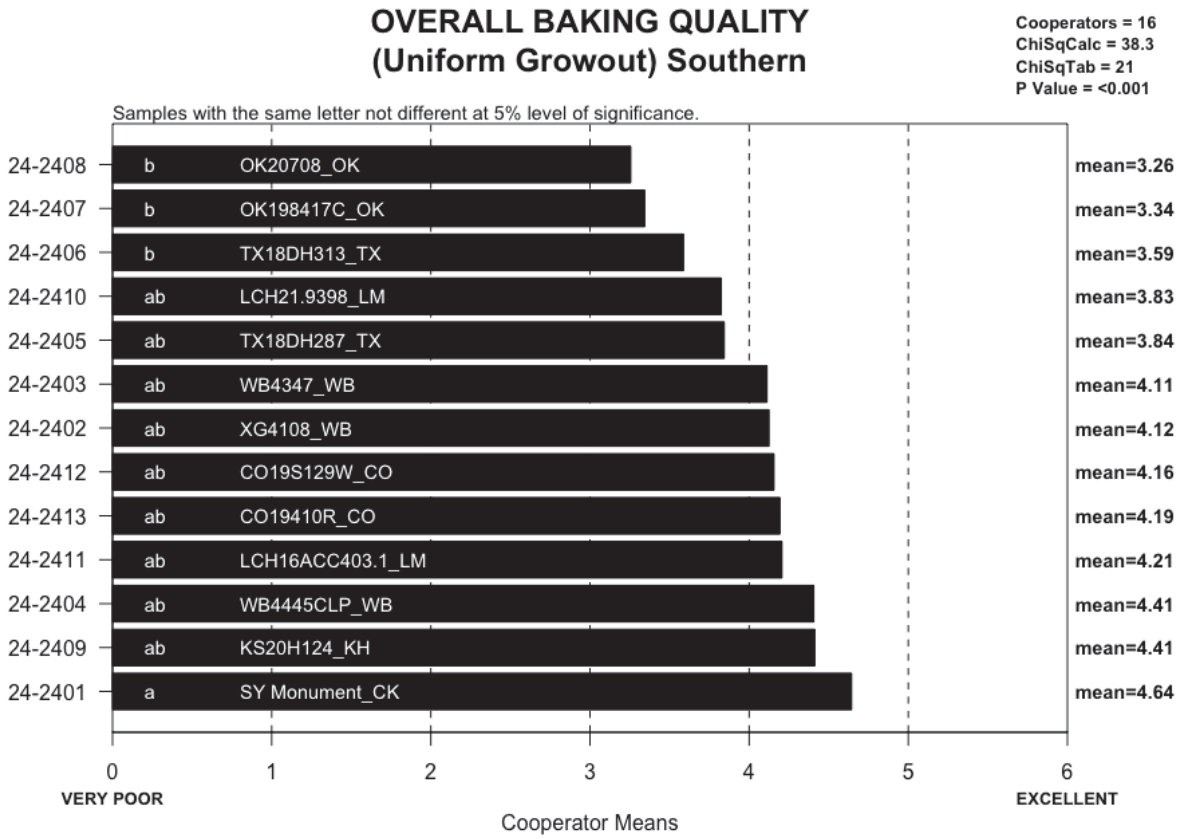
LOAF WEIGHT, ACTUAL
(Uniform Growout) Southern
Cooperators A – P

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2401	SY Monument_CK	412	140.6	141.5	455.0	142.1	154.2	152.4	474.8	132.6	138.6	472.8	429.0	452	143.9	439	143.5
24-2402	XG4108_WB	411	143.8	142.9	452.0	134.0	153.1	152.4	474.5	136.7	140.0	473.3	426.1	453	141.1	436	144.9
24-2403	WB4347_WB	409	139.5	145.5	454.5	140.9	155.6	152.3	477.2	134.1	139.3	470.5	424.3	454	140.9	434	142.4
24-2404	WB4445CLP_WB	413	138.3	143.2	452.5	143.1	152.5	150.2	479.4	130.0	137.4	471.0	423.0	458	138.1	433	141.6
24-2405	TX18DH287_TX	410	137.7	143.7	462.5	140.1	148.1	151.7	478.4	133.2	137.4	465.4	424.5	454	137.9	435	140.5
24-2406	TX18DH313_TX	414	140.2	143.8	460.0	138.1	154.1	153.5	481.4	135.2	140.1	469.6	429.2	455	137.1	434	143.3
24-2407	OK198417C_OK	414	138.0	144.4	448.0	138.6	155.4	150.9	475.6	135.4	138.4	468.8	428.1	453	140.4	433	143.7
24-2408	OK20708_OK	412	142.1	144.4	452.0	140.0	153.9	149.9	471.9	138.4	138.8	468.4	420.5	451	141.3	428	141.8
24-2409	KS20H124_KH	413	144.3	145.5	458.5	138.7	149.6	149.0	479.2	129.8	137.2	467.9	422.2	456	140.1	437	142.7
24-2410	LCH21.9398_LM	414	135.8	141.6	457.0	139.8	153.6	149.2	481.8	131.4	139.1	468.7	424.6	458	138.2	437	141.0
24-2411	LCH16ACC403.1_LM	417	137.4	141.9	455.5	138.9	152.5	150.9	479.2	132.6	138.0	470.8	431.3	465	140.3	436	137.8
24-2412	CO19S129W_CO	415	140.7	145.2	451.5	134.7	150.2	151.7	476.0	136.9	137.8	476.1	430.2	463	139.4	434	141.5
24-2413	CO19410R_CO	412	141.1	144.2	456.5	135.1	150.8	151.0	483.2	133.2	137.0	477.4	433.0	464	142.7	437	142.7

LOAF VOLUME, ACTUAL
(Uniform Growout) Southern
Cooperators A – P

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2401	SY Monument_CK	2725	1060	1080	2110	870	901	925	2425	895	860	3000	2825	2560	1075	2206	765
24-2402	XG4108_WB	2800	955	1045	2150	885	802	800	2525	923	774	2883	2725	2400	975	2202	770
24-2403	WB4347_WB	3100	980	1055	2147	886	867	915	2450	900	819	2853	2800	2386	1025	2239	795
24-2404	WB4445CLP_WB	3000	1110	1080	2092	883	965	1000	2538	1040	947	2885	2900	2658	1100	2289	890
24-2405	TX18DH287_TX	2900	915	985	2144	895	731	905	2475	885	878	2817	2825	2665	1025	2193	900
24-2406	TX18DH313_TX	2650	830	835	2045	874	857	850	2500	840	834	2773	2725	2518	950	2212	815
24-2407	OK198417C_OK	2725	1000	955	2125	989	905	965	2488	895	944	2457	2700	2580	1050	2194	950
24-2408	OK20708_OK	2675	805	845	1992	894	794	885	2500	908	811	2582	2675	2383	900	2091	860
24-2409	KS20H124_KH	2925	1020	1045	2038	940	932	975	2663	1000	914	2809	2900	2610	1075	2400	860
24-2410	LCH21.9398_LM	2725	1000	935	2165	918	873	885	2488	925	865	2618	2800	2606	1000	2188	855
24-2411	LCH16ACC403.1_LM	2725	955	1035	2170	1004	887	920	2450	870	862	2795	2625	2568	1025	2549	930
24-2412	CO19S129W_CO	2850	965	1015	2220	900	767	865	2463	843	811	2986	2850	2445	875	2168	720
24-2413	CO19410R_CO	2825	1015	995	2130	900	869	915	2400	903	902	2964	2675	2483	975	2093	795


LOAF VOLUME
(Uniform Growout) Southern
Cooperators = 16
ChiSqCalc = 33
ChiSqTab = 21
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
24-2408 a OK20708_OK mean=3.09
24-2406 ac TX18DH313_TX mean=3.51
24-2402 abc XG4108_WB mean=3.65
24-2412 abc CO19S129W_CO mean=3.94
24-2403 abc WB4347_WB mean=3.99
24-2413 abc CO19410R_CO mean=4.09
24-2407 abc OK198417C_OK mean=4.12
24-2405 abc TX18DH287_TX mean=4.12
24-2411 abc LCH16ACC403.1_LM mean=4.19
24-2410 abc LCH21.9398_LM mean=4.23
24-2401 abc SY Monument_CK mean=4.42
24-2409 bc KS20H124_KH mean=4.93
24-2404 b WB4445CLP_WB mean=5.21
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Uniform Growout) Southern
Cooperators = 16
ChiSqCalc = 38.3
ChiSqTab = 21
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
24-2408 b OK20708_OK mean=3.26
24-2407 b OK198417C_OK mean=3.34
24-2406 b TX18DH313_TX mean=3.59
24-2410 ab LCH21.9398_LM mean=3.83
24-2405 ab TX18DH287_TX mean=3.84
24-2403 ab WB4347_WB mean=4.11
24-2402 ab XG4108_WB mean=4.12
24-2412 ab CO19S129W_CO mean=4.16
24-2413 ab CO19410R_CO mean=4.19
24-2411 ab LCH16ACC403.1_LM mean=4.21
24-2404 ab WB4445CLP_WB mean=4.41
24-2409 ab KS20H124_KH mean=4.41
24-2401 a SY Monument_CK mean=4.64
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – P

24-2401	**SY Monument_CK**
A	Long mix time Good out of mixer and make up Lower loaf volume
B	Longer mix time than prefered, stronger mixograph, good dough feel, and an excellent bake
C	excellent loaf externals
D	No comment
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Creamy Crumb Grain, Fine Elongate Cells, Good Resilient & Silky Texture
F	No comment
G	Long mix time, high absorption & grain. Tough dough throughout. Good volume. Excellent mixing tolerance.
H	High absorp, longest mix time, sticky dough, fine, nice creamy colored grain, low volume. Excellent mixing toler.
I	No comment
J	No comment
K	Excellent absorption, long mix, excellent volume
L	Good protein and volume. High mix time, absorption and stability.
M	No comment
N	No comment
O	No comment
P	No comment
24-2402	**XG4108_WB**
A	Good overall
B	High protein, higher bake absorption relative to the set, ok loaf volume but internal grain was more open than desireable
C	nice loaf externals
D	No comment
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Slightly Yellow Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Long mix time, high absorption, tough dough throughout resulting in dense grain & low volume. Good mix toler.
H	Very high absorp. Avg mix time & volume. Good dough at make up. Finest cream colored grain. Good mix toler.
I	No comment
J	No comment
K	Excellent absorption, long mix, good volume
L	Good protein, mix time and volume. High absorption and stability.
M	No comment
N	No comment
O	No comment
P	No comment

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – P

24-2403	**WB4347_WB**
A	Excellent Volume Average mix time
B	Ok loaf volume but internal crumb grain was open amd less than desirable
C	excellent loaf externals
D	No comment
E	High Water Abs, Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Long mix time, high absorption, tough dough throughout resulting in open, round grain. Good volume & mix toler.
H	Very high absorption. Avg mix time & tolerance. Sticky dough. Avg dense crumb grain. Low volume.
I	No comment
J	No comment
K	Excellent absorption, good mix, good volume
L	Good protein and mix time. High absorption, stability and volume.
M	No comment
N	No comment
O	No comment
P	No comment
24-2404	**WB4445CLP_WB**
A	Excellent Volume Average mix time
B	High protein, ok mix time,excellent dough feel, excellent loaf volume, crumb grain was open and less than desirable
C	Left and Right break
D	No comment
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Creamy Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Long mix time, avg absorption. Fine, elongated grain with smooth texture, Excellent volume. Good mixing toler.
H	Avg absorption & volume. Good dough at make up. Avg open, round crumb grain harsh texture. Good mix toler.
I	No comment
J	No comment
K	Average absorption, long mix, average volume; could have taken higher absorption
L	Good protein and stability. High mix time, absorption and volume.
M	No comment
N	No comment
O	No comment
P	No comment

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – P

24-2405	**TX18DH287_TX**
A	Short mix time Good volume Nice interior
B	Low protein, lower bake absorption relative to the set, good overall bake despite low protein
C	Left and Right break
D	No comment
E	High Water Abs, Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Creamy Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Lower mix time & absorption. Avg mixing tolerance. Open, round dark yellow crumb grain. Good volume though.
H	High absorp. Avg mix time. Sticky wet dough. Dense, dark yellow crumb grain. Low volume & mix toler.
I	No comment
J	No comment
K	Overall average sample; could have used slightly lower absorption to optimize
L	Fair protein and stability. High mix time, absorption and volume.
M	nice loaf shape, looks like spring wheat
N	No comment
O	No comment
P	No comment
24-2406	**TX18DH313_TX**
A	Short mix time Low volume Nice interior
B	Weak and short mixing, yellow flour, poor bake and lower volume relative to protein
C	Left and Right break
D	No comment
E	High Water Abs, Medium MT, Slight Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Slightly Open Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Shorter mix time. Avg absorption. Good dough at make up. Fine, irregular grain.Ragged, break & shred. Avg volume.
H	High absorp. Very short mix time. Open, dark yellow crumb grain, harsh textured. Avg volume. Very low mix toler.
I	No comment
J	No comment
K	Went down 1% on absorption to accommodate shortstability; mixed to optimum development; low to average volume
L	Low stability. Fair mix time and protein. High absorption. Good volume.
M	No comment
N	No comment
O	No comment
P	No comment

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – P

24-2407	**OK198417C_OK**
A	Higher protein Soft dough Short mix
B	Concerned about short mixing and weak, ok bake, good color
C	weak dough, nice loaf externals
D	No comment
E	High Water Abs, Short MT, Slight Sticky & Strong Dough, Very High Loaf Volume, Yellow Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Short mix time. Avg absorption. Wet dough at make up. Although open, good grain. Good volume. Low mix toler.
H	Avg absorption. Shortest mix time. Sticky wet dough. Open round crumb grain. Low volume. Very low mix toler.
I	No comment
J	No comment
K	Went down 2% on absorption to accommodate short stability; dough sticky at handling; could cut additional 2%absorption. Too slack . Low volume.
L	Low mix time and stability. High protein and absorption. Good volume. Negative bench comment (DO NOT RECOMMEND)
M	No comment
N	No comment
O	No comment
P	No comment
24-2408	**OK20708_OK**
A	Soft dough Lower volume
B	Weak and short mixing, dull color, poor bake and low loaf volume relative to protein
C	tough dough, nice loaf externals
D	No comment
E	High Water Abs, Medium MT, Slight Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Lower mix time & absorption. Avg mixing tolerance. Open, round crumb grain. Avg volume.
H	High absorp. Very short mix time. Good dough at make up. Open, round poorest rated crumb grain. Very low mix toler.
I	No comment
J	No comment
K	Went down 4% on absorption to accommodate short stability: dough sticky at handling; could cut additional 3% absorption. Too slack. Low volume.
L	Low mix time and stability. High absorption. Fair protein and volume.
M	No comment
N	No comment
O	No comment
P	No comment

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – P

24-2409	**KS20H124_KH**
A	Good volume Good overall
B	High protein and good bake absorption
C	long time to pick up, nice loaf externals
D	No comment
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Open Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Long mix time, avg absorption. Tough dough throughout. Open, round grain.Excellent volume. Good mix toler.
H	Shrunken sides due to very high absorp. Tough dough at make up. One of the highest volumed loaves.
I	No comment
J	No comment
K	Excellent absorption, long mix, good volume
L	High protein, stability, absorption, mix time and volume.
M	No comment
N	No comment
O	No comment
P	No comment
24-2410	**LCH21-9398_LM**
A	Short mix soft dough
B	Low protein, lowest bake absorption of the set but still relatively high bake absorption for low protien, excellent dough feel, ok crumb grain and ecellent loaf volume for protein
C	No comment
D	No comment
E	High Water Abs, Medium MT, Slight Sticky & Strong Dough, High Loaf Volume, Creamy Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Shorter mix time. Low absorption. Wet dough at make up. Fine, irregular creamy colored grain. Avg volume.
H	Very short mix time, sticky dough. Avg open round,creamy colored grain. Low volume & mix toler.
I	No comment
J	No comment
K	Average absorption, shorter stability / mix time, low volume. Sticky dough with harsh/open resulting crumb indicatates cut-back on absorption.
L	Low mix time. Fair protein and stability. High absorption and volume.
M	No comment
N	No comment
O	No comment
P	No comment

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – P

24-2411	**LCH16ACC403-1_LM**
A	Soft dough Average mix
B	Low bake absorption relative to the set, excellent dough feel, good bake
C	excellent loaf externals
D	No comment
E	High Water Abs, Long MT, Slight Sticky & Strong Dough, Very High Loaf Volume, Yellow Crumb Grain, Open Irregular Cells, Good Resilient & Slightly Harsh Texture
F	No comment
G	Good mix time. Low absorp. Average open grain. Good dough at make up. Good volume & mix tolerance.
H	High absorption. Sticky dough. Avg open crumb grain. Low volume. Good mix tolerance.
I	No comment
J	No comment
K	Average absorption with good mix time; average volume. Slightly tight dough - could have taken additional 1-2% absorption.
L	Good protein, mix time and stability. High absorption. Fair volume.
M	No comment
N	No comment
O	No comment
P	No comment
24-2412	**CO19S129W_CO**
A	Average volume Good overall
B	Longer mix time than prefered, yellow flour, good loaf volume relative to protein
C	rough break
D	some larger holes
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Fine Elongate Cells, Good Resilient & Very Smooth Texture
F	No comment
G	Long mix time, avg absorption. Avg open, dark yellow crumb grain. Avg volume. Excellent mix tolerance.
H	Very high absorption. Avg open crumb grain. Low volume. Good mix tolerance.
I	No comment
J	No comment
K	Excellent absorption, long mix, good volume
L	Good protein. High absorption, stability, mix time and volume. (RECOMMEND)
M	No comment
N	No comment
O	No comment
P	No comment

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – P

24-2413	CO19410R_CO
A	Soft dough short mix good volume
B	Open grain but excellent loaf volume relative to set, excellent dough feel, baked well
C	white dough, excellent loaf externals
D	multiple large holes
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Creamy Crumb Grain, Fine Elongate Cells, Good Resilient & Very Smooth Texture
F	No comment
G	Long mix time, avg absorption. Avg open grain. Good volume. Excellent mix tolerance.
H	Good dough throughout. Average open, creamy colored crumb grain. Low volume. Good mix toler.
I	No comment
J	No comment
K	Overall excellent - could have taken additional 1-2%absorption
L	Good protein. High absorption, stability and mix time. Fair volume.
M	off flavor
N	No comment
O	No comment
P	No comment

SOUTHERN MICRO-QUALITY ANALYSIS

1. LOCATIONS AND ENTRIES

Entry_Code	Entry_ID	Entry_No	Breeding Programs	Locations*
24-WB2401	SY Monument	2401	CHECK	WB
24-WB2402	XG4108	2402	Bayer/WestBred	WB
24-WB2403	WB4347	2403	Bayer/WestBred	WB
24-WB2404	WB4445CLP	2404	Bayer/WestBred	WB
24-WB2405	TX18DH287	2405	Texas A&M AgriLife	WB
24-WB2406	TX18DH313	2406	Texas A&M AgriLife	WB
24-WB2407	OK198417C	2407	OSU	WB
24-WB2408	OK20708	2408	OSU	WB
24-WB2409	KS20H124	2409	KSU-Hays	WB
24-WB2410	LCH21-9398	2410	LCS	WB
24-WB2411	LCH16ACC403-1	2411	LCS	WB
24-WB2412	CO19S129W	2412	CSU	WB
24-WB2413	CO19410R	2413	CSU	WB
24-AP2401	SY Monument	2401	CHECK	AP
24-AP2402	XG4108	2402	Bayer/WestBred	AP
24-AP2403	WB4347	2403	Bayer/WestBred	AP
24-AP2404	WB4445CLP	2404	Bayer/WestBred	AP
24-AP2405	TX18DH287	2405	Texas A&M AgriLife	AP
24-AP2406	TX18DH313	2406	Texas A&M AgriLife	AP
24-AP2407	OK198417C	2407	OSU	AP
24-AP2408	OK20708	2408	OSU	AP
24-AP2409	KS20H124	2409	KSU-Hays	AP
24-AP2410	LCH21-9398	2410	LCS	AP
24-AP2411	LCH16ACC403-1	2411	LCS	AP
24-AP2412	CO19S129W	2412	CSU	AP
24-AP2413	CO19410R	2413	CSU	AP
24-LM2401	SY Monument	2401	CHECK	LM
24-LM2402	XG4108	2402	Bayer/WestBred	LM
24-LM2403	WB4347	2403	Bayer/WestBred	LM
24-LM2404	WB4445CLP	2404	Bayer/WestBred	LM
24-LM2405	TX18DH287	2405	Texas A&M AgriLife	LM
24-LM2406	TX18DH313	2406	Texas A&M AgriLife	LM
24-LM2407	OK198417C	2407	OSU	LM
24-LM2408	OK20708	2408	OSU	LM
24-LM2409	KS20H124	2409	KSU-Hays	LM
24-LM2410	LCH21-9398	2410	LCS	LM
24-LM2411	LCH16ACC403-1	2411	LCS	LM
24-LM2412	CO19S129W	2412	CSU	LM
24-LM2413	CO19410R	2413	CSU	LM
24-UM2401	SY Monument	2401	CHECK	UM
24-UM2402	XG4108	2402	Bayer/WestBred	UM
24-UM2403	WB4347	2403	Bayer/WestBred	UM
24-UM2404	WB4445CLP	2404	Bayer/WestBred	UM
24-UM2405	TX18DH287	2405	Texas A&M AgriLife	UM
24-UM2406	TX18DH313	2406	Texas A&M AgriLife	UM
24-UM2407	OK198417C	2407	OSU	UM
24-UM2408	OK20708	2408	OSU	UM
24-UM2409	KS20H124	2409	KSU-Hays	UM
24-UM2410	LCH21-9398	2410	LCS	UM
24-UM2411	LCH16ACC403-1	2411	LCS	UM
24-UM2412	CO19S129W	2412	CSU	UM
24-UM2413	CO19410R	2413	CSU	UM

24-OK2401	SY Monument	2401	CHECK	OK
24-OK2402	XG4108	2402	Bayer/WestBred	OK
24-OK2403	WB4347	2403	Bayer/WestBred	OK
24-OK2404	WB4445CLP	2404	Bayer/WestBred	OK
24-OK2405	TX18DH287	2405	Texas A&M AgriLife	OK
24-OK2406	TX18DH313	2406	Texas A&M AgriLife	OK
24-OK2407	OK198417C	2407	OSU	OK
24-OK2408	OK20708	2408	OSU	OK
24-OK2409	KS20H124	2409	KSU-Hays	OK
24-OK2410	LCH21-9398	2410	LCS	OK
24-OK2411	LCH16ACC403-1	2411	LCS	OK
24-OK2412	CO19S129W	2412	CSU	OK
24-OK2413	CO19410R	2413	CSU	OK
24-CO2401	SY Monument	2401	CHECK	CO
24-CO2402	XG4108	2402	Bayer/WestBred	CO
24-CO2403	WB4347	2403	Bayer/WestBred	CO
24-CO2404	WB4445CLP	2404	Bayer/WestBred	CO
24-CO2405	TX18DH287	2405	Texas A&M AgriLife	CO
24-CO2406	TX18DH313	2406	Texas A&M AgriLife	CO
24-CO2407	OK198417C	2407	OSU	CO
24-CO2408	OK20708	2408	OSU	CO
24-CO2409	KS20H124	2409	KSU-Hays	CO
24-CO2410	LCH21-9398	2410	LCS	CO
24-CO2411	LCH16ACC403-1	2411	LCS	CO
24-CO2412	CO19S129W	2412	CSU	CO
24-CO2413	CO19410R	2413	CSU	CO
24-KM2401	SY Monument	2401	CHECK	KM
24-KM2402	XG4108	2402	Bayer/WestBred	KM
24-KM2403	WB4347	2403	Bayer/WestBred	KM
24-KM2404	WB4445CLP	2404	Bayer/WestBred	KM
24-KM2405	TX18DH287	2405	Texas A&M AgriLife	KM
24-KM2406	TX18DH313	2406	Texas A&M AgriLife	KM
24-KM2407	OK198417C	2407	OSU	KM
24-KM2408	OK20708	2408	OSU	KM
24-KM2409	KS20H124	2409	KSU-Hays	KM
24-KM2410	LCH21-9398	2410	LCS	KM
24-KM2411	LCH16ACC403-1	2411	LCS	KM
24-KM2412	CO19S129W	2412	CSU	KM
24-KM2413	CO19410R	2413	CSU	KM
24-TX2401	SY Monument	2401	CHECK	TX
24-TX2402	XG4108	2402	Bayer/WestBred	TX
24-TX2403	WB4347	2403	Bayer/WestBred	TX
24-TX2404	WB4445CLP	2404	Bayer/WestBred	TX
24-TX2405	TX18DH287	2405	Texas A&M AgriLife	TX
24-TX2406	TX18DH313	2406	Texas A&M AgriLife	TX
24-TX2407	OK198417C	2407	OSU	TX
24-TX2408	OK20708	2408	OSU	TX
24-TX2409	KS20H124	2409	KSU-Hays	TX
24-TX2410	LCH21-9398	2410	LCS	TX
24-TX2411	LCH16ACC403-1	2411	LCS	TX
24-TX2412	CO19S129W	2412	CSU	TX
24-TX2413	CO19410R	2413	CSU	TX

* WB = Westbred, AP=Agripro, LM=Limagrain, UM=USDA Manhattan, KM=Kansas Manhattan.

A. There are 8 locations:

Westbred = WB;

Agripro = AP;

Limagrain = LM;

USDA Manhhattan =UM;

Oklahoma = OK;

Colorado = CO;

Kansas Manhattan = KM;

Texas A&M = TX.

B. There are 13 entries grown in each of the locations:

SY Monument (CK) = 2401

XG4108 (Westbred) = 2402

WB4347 (Westbred) = 2403

WB4445CLP (Westbred) = 2404

TX18DH287 (Texas) =2405

TX18DH313 (Texas) = 2406

OK198417C (Oklahoma) = 2407

OK20708 (Oklahoma) = 2408

KS20H124 (Kansas Hays) = 2409

LCH21-9398 (Limagrain) =2410

LCH16ACC403-1 (Limagrain) = 2411

CO19S129W (Colorado) = 2412

CO19410R (Colorado) = 2413.

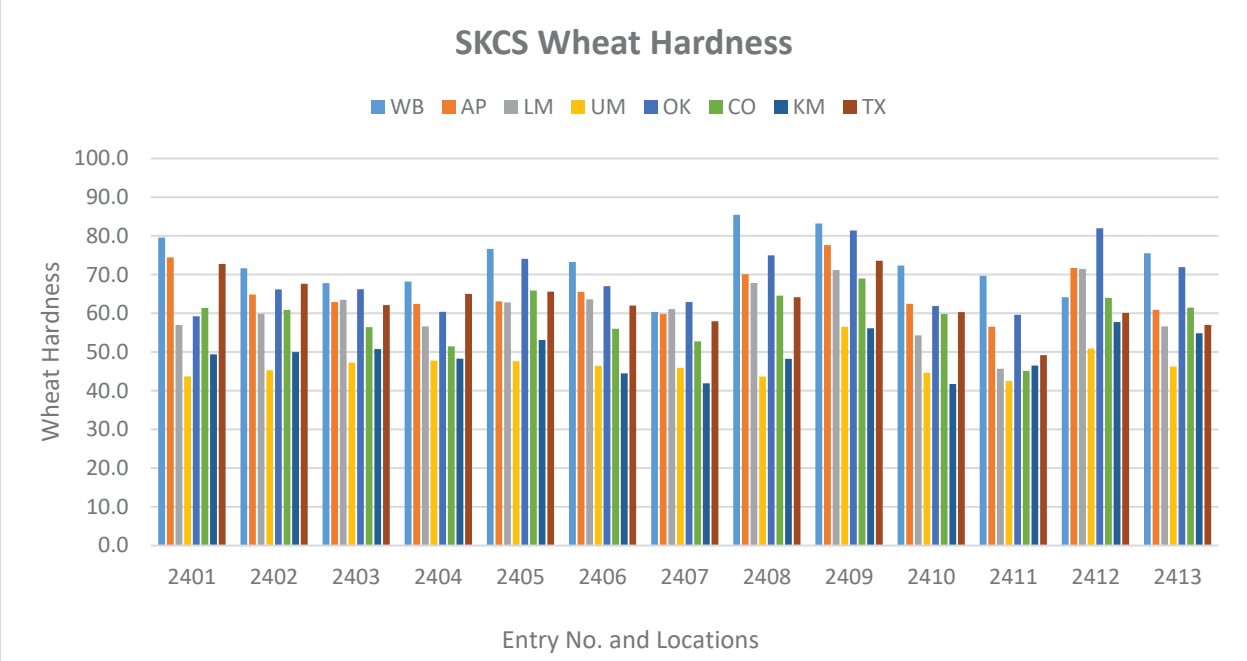
2. SKCS SINGLE KERNEL INFORMATION

A. Kernel Hardness

SKCS Wheat Kernel Hardness

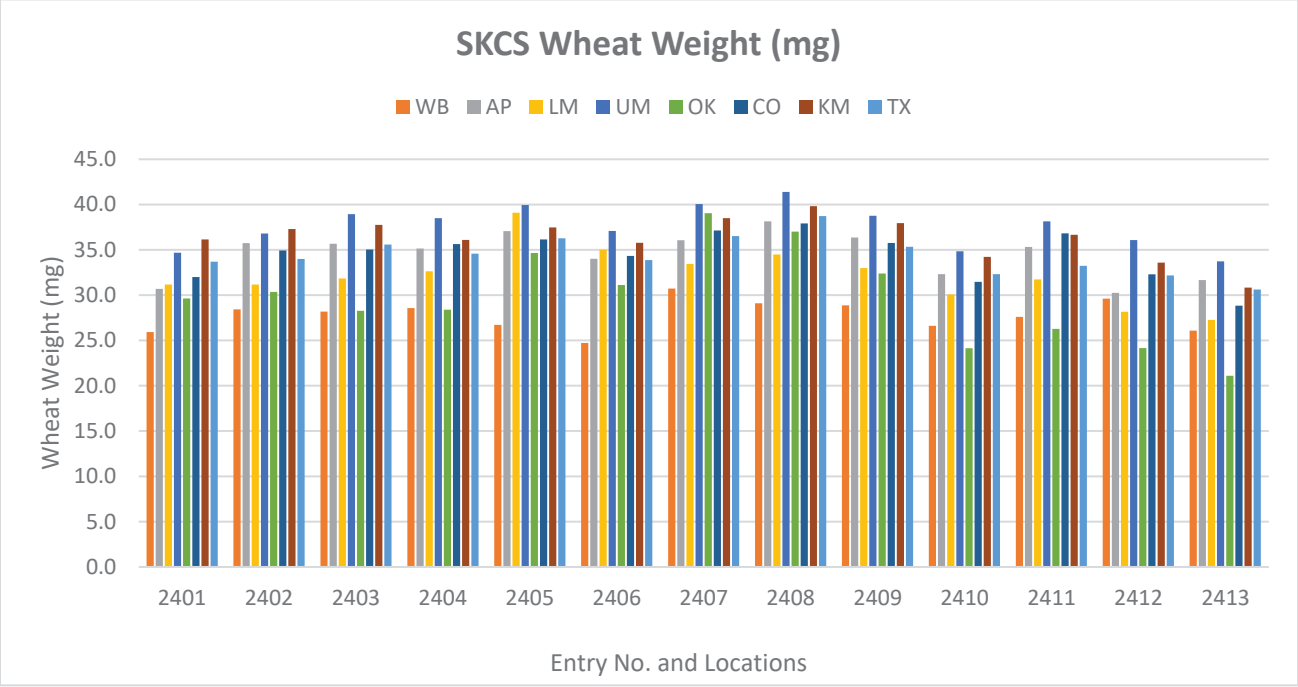
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	79.6	74.4	57.0	43.7	59.2	61.4	49.4	72.7	62.2	12.57
2402	71.6	64.8	59.8	45.3	66.2	60.9	50.0	67.6	60.8	9.01
2403	67.8	62.9	63.5	47.2	66.2	56.4	50.7	62.1	59.6	7.41
2404	68.2	62.4	56.6	47.8	60.4	51.4	48.3	65.0	57.5	7.75
2405	76.6	63.1	62.8	47.6	74.1	65.9	53.1	65.6	63.6	9.67
2406	73.3	65.6	63.6	46.4	67.0	56.0	44.5	62.0	59.8	10.10
2407	60.4	59.8	61.1	45.9	62.9	52.7	41.9	57.9	55.3	7.74
2408	85.4	70.1	67.8	43.6	75.0	64.6	48.2	64.1	64.9	13.57
2409	83.2	77.6	71.2	56.5	81.4	69.0	56.1	73.6	71.1	10.30
2410	72.3	62.5	54.3	44.6	61.9	59.8	41.7	60.3	57.2	10.01
2411	69.7	56.5	45.7	42.5	59.6	45.1	46.5	49.2	51.9	9.32
2412	64.2	71.7	71.5	50.9	82.0	64.0	57.8	60.1	65.2	9.66
2413	75.5	60.9	56.6	46.2	71.9	61.5	54.8	57.0	60.6	9.40
Avg.	72.9	65.6	60.9	46.8	68.3	59.1	49.5	62.9		
Std	7.21	6.14	7.14	3.64	7.91	6.60	5.09	6.52		

AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred



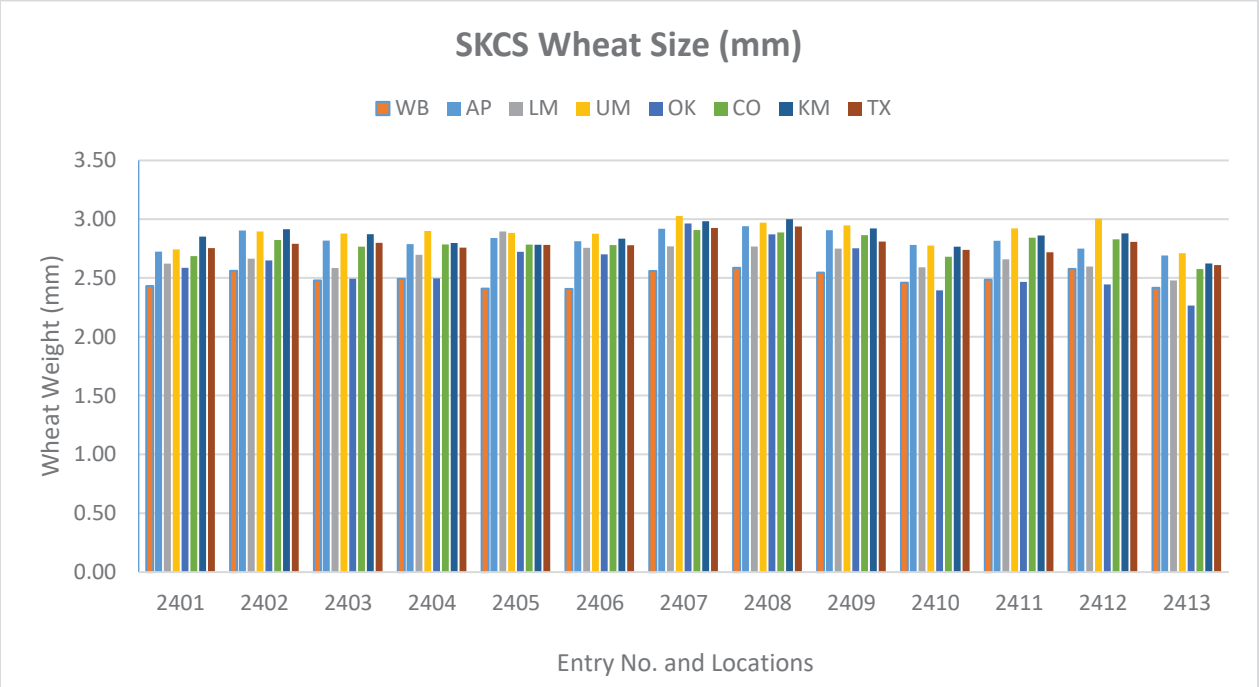
B. Kernel Weight (mg)

SKCS Wheat Kernel Weight (mg)										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	25.9	30.7	31.2	34.7	29.6	32.0	36.2	33.7	31.7	3.20
2402	28.4	35.7	31.2	36.8	30.4	34.9	37.3	34.0	33.6	3.24
2403	28.2	35.7	31.8	38.9	28.3	35.0	37.7	35.6	33.9	4.07
2404	28.6	35.1	32.6	38.5	28.4	35.6	36.1	34.6	33.7	3.60
2405	26.7	37.1	39.1	39.9	34.7	36.1	37.5	36.3	35.9	4.08
2406	24.7	34.0	35.0	37.1	31.1	34.3	35.8	33.9	33.2	3.85
2407	30.7	36.1	33.4	40.0	39.0	37.1	38.5	36.5	36.4	3.08
2408	29.1	38.2	34.5	41.4	37.0	37.9	39.8	38.7	37.1	3.80
2409	28.9	36.4	33.0	38.8	32.4	35.8	37.9	35.3	34.8	3.24
2410	26.6	32.3	30.1	34.8	24.1	31.5	34.2	32.3	30.7	3.70
2411	27.6	35.3	31.7	38.2	26.3	36.8	36.7	33.2	33.2	4.40
2412	29.6	30.2	28.2	36.1	24.2	32.3	33.6	32.2	30.8	3.64
2413	26.1	31.7	27.3	33.7	21.1	28.8	30.8	30.6	28.8	3.95
Avg.	27.8	34.5	32.2	37.6	29.7	34.5	36.3	34.4		
Std	1.69	2.51	3.04	2.32	5.21	2.62	2.36	2.14		
AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred										



C. Kernel Size

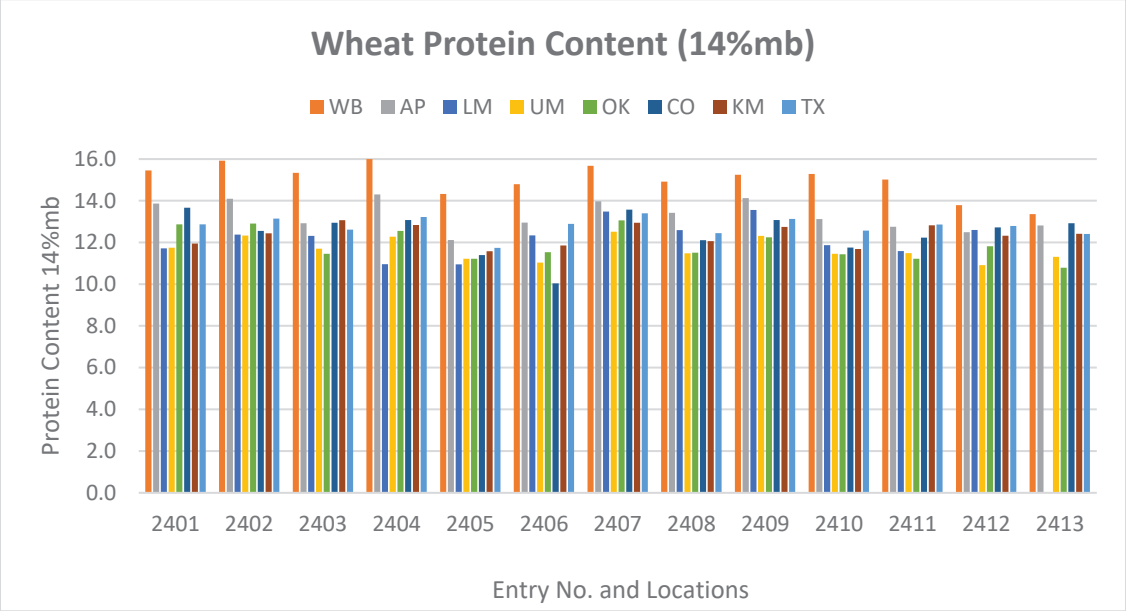
SKCS Wheat Kernel Size (mm)										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	2.43	2.72	2.62	2.74	2.59	2.69	2.85	2.75	2.67	0.13
2402	2.56	2.90	2.66	2.90	2.65	2.82	2.91	2.79	2.77	0.13
2403	2.48	2.82	2.58	2.88	2.49	2.77	2.87	2.80	2.71	0.17
2404	2.49	2.79	2.70	2.90	2.50	2.78	2.80	2.76	2.71	0.15
2405	2.41	2.84	2.90	2.88	2.72	2.78	2.78	2.78	2.76	0.15
2406	2.41	2.81	2.76	2.88	2.70	2.78	2.83	2.78	2.74	0.15
2407	2.56	2.92	2.77	3.03	2.96	2.91	2.98	2.92	2.88	0.15
2408	2.59	2.94	2.77	2.97	2.87	2.89	3.00	2.94	2.87	0.14
2409	2.55	2.91	2.75	2.95	2.75	2.86	2.92	2.81	2.81	0.13
2410	2.46	2.78	2.59	2.78	2.39	2.68	2.77	2.74	2.65	0.15
2411	2.49	2.82	2.66	2.92	2.47	2.84	2.86	2.72	2.72	0.17
2412	2.58	2.75	2.60	3.00	2.45	2.83	2.88	2.81	2.74	0.18
2413	2.42	2.69	2.48	2.71	2.26	2.58	2.62	2.61	2.55	0.15
Avg.	2.49	2.82	2.68	2.89	2.60	2.79	2.85	2.78		
Std	0.07	0.08	0.11	0.10	0.20	0.09	0.10	0.08		
AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred										



3. PROTEN CONTENT

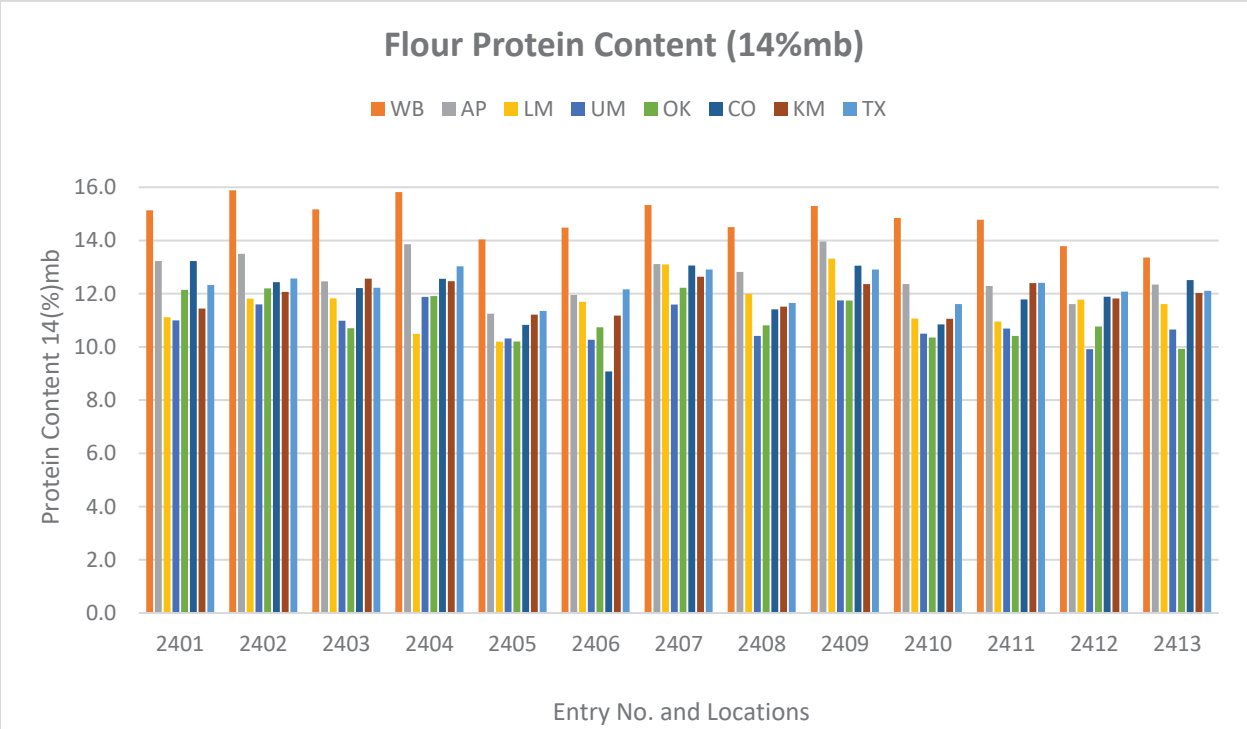
A. Wheat Protein

Wheat Protein Content (14%mb)										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	15.5	13.9	11.7	11.7	12.9	13.7	11.9	12.9	13.0	1.29
2402	15.9	14.1	12.4	12.3	12.9	12.5	12.4	13.1	13.2	1.24
2403	15.3	12.9	12.3	11.7	11.5	12.9	13.1	12.6	12.8	1.19
2404	16.0	14.3	11.0	12.3	12.6	13.1	12.8	13.2	13.2	1.49
2405	14.3	12.1	10.9	11.2	11.2	11.4	11.6	11.7	11.8	1.07
2406	14.8	13.0	12.3	11.0	11.5	10.0	11.9	12.9	12.2	1.43
2407	15.7	14.0	13.5	12.5	13.1	13.6	12.9	13.4	13.6	0.96
2408	14.9	13.4	12.6	11.5	11.5	12.1	12.1	12.4	12.6	1.14
2409	15.2	14.1	13.6	12.3	12.2	13.1	12.7	13.1	13.3	1.00
2410	15.3	13.1	11.9	11.5	11.4	11.8	11.7	12.6	12.4	1.30
2411	15.0	12.8	11.6	11.5	11.2	12.2	12.8	12.9	12.5	1.21
2412	13.8	12.5	12.6	10.9	11.8	12.7	12.3	12.8	12.4	0.83
2413	13.4	12.8	12.1	11.3	10.8	12.9	12.4	12.4	12.3	0.85
Avg.	15.0	13.3	12.2	11.7	11.9	12.5	12.4	12.8		
Std	0.79	0.71	0.80	0.53	0.75	0.98	0.50	0.43		
AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred										



B. Flour Protein

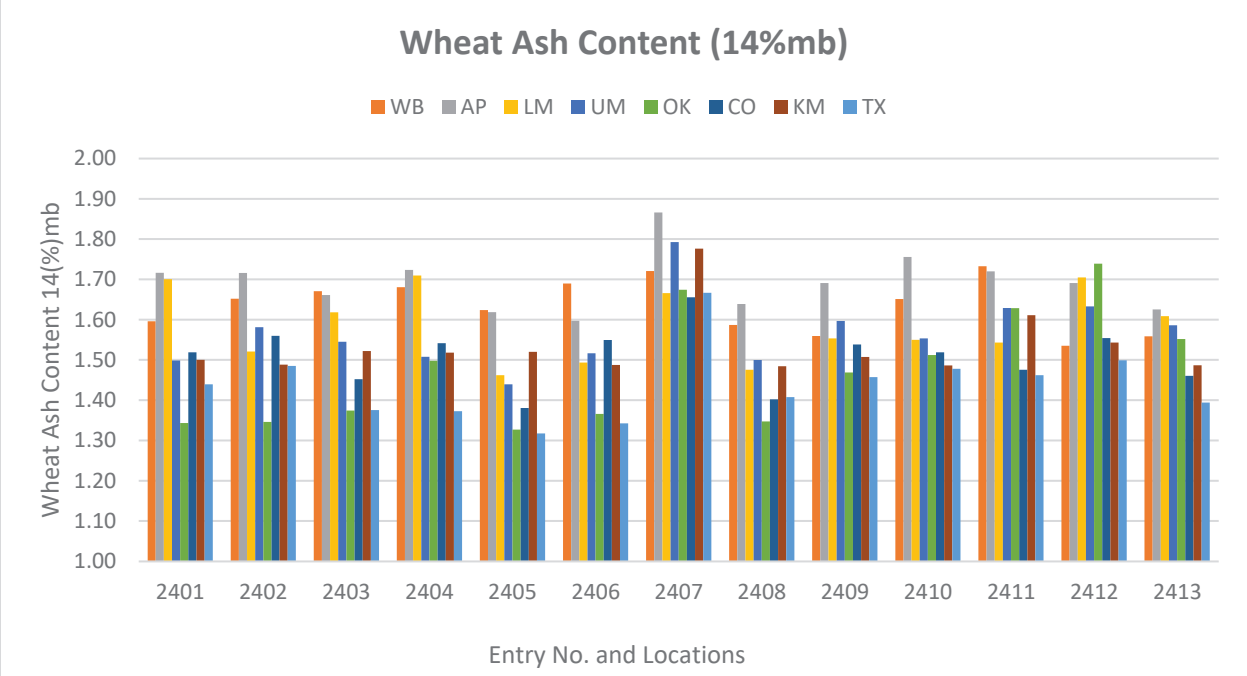
Flour Protein Content (14%)										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	15.1	13.2	11.1	11.0	12.1	13.2	11.4	12.3	12.5	1.39
2402	15.9	13.5	11.8	11.6	12.2	12.4	12.1	12.6	12.8	1.39
2403	15.2	12.5	11.8	11.0	10.7	12.2	12.6	12.2	12.3	1.35
2404	15.8	13.9	10.5	11.9	11.9	12.6	12.5	13.0	12.8	1.58
2405	14.0	11.2	10.2	10.3	10.2	10.8	11.2	11.4	11.2	1.25
2406	14.5	12.0	11.7	10.3	10.7	9.1	11.2	12.2	11.4	1.59
2407	15.3	13.1	13.1	11.6	12.2	13.1	12.6	12.9	13.0	1.08
2408	14.5	12.8	12.0	10.4	10.8	11.4	11.5	11.7	11.9	1.28
2409	15.3	14.0	13.3	11.7	11.7	13.1	12.4	12.9	13.0	1.19
2410	14.8	12.4	11.1	10.5	10.4	10.8	11.1	11.6	11.6	1.47
2411	14.8	12.3	11.0	10.7	10.4	11.8	12.4	12.4	12.0	1.39
2412	13.8	11.6	11.8	9.9	10.8	11.9	11.8	12.1	11.7	1.11
2413	13.4	12.3	11.6	10.7	9.9	12.5	12.0	12.1	11.8	1.08
Avg.	14.8	12.7	11.6	10.9	11.1	11.9	11.9	12.3		
Std	0.76	0.83	0.90	0.64	0.83	1.16	0.57	0.52		
AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred										



4. WHEAT ASH

Wheat Ash Content (14%)										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	1.60	1.72	1.70	1.50	1.34	1.52	1.50	1.44	1.54	0.13
2402	1.65	1.72	1.52	1.58	1.35	1.56	1.49	1.49	1.54	0.11
2403	1.67	1.66	1.62	1.55	1.37	1.45	1.52	1.38	1.53	0.12
2404	1.68	1.72	1.71	1.51	1.50	1.54	1.52	1.37	1.57	0.12
2405	1.62	1.62	1.46	1.44	1.33	1.38	1.52	1.32	1.46	0.12
2406	1.69	1.60	1.49	1.52	1.37	1.55	1.49	1.34	1.51	0.11
2407	1.72	1.87	1.67	1.79	1.67	1.66	1.78	1.67	1.73	0.08
2408	1.59	1.64	1.48	1.50	1.35	1.40	1.48	1.41	1.48	0.10
2409	1.56	1.69	1.55	1.60	1.47	1.54	1.51	1.46	1.55	0.07
2410	1.65	1.76	1.55	1.55	1.51	1.52	1.49	1.48	1.56	0.09
2411	1.73	1.72	1.54	1.63	1.63	1.48	1.61	1.46	1.60	0.10
2412	1.54	1.69	1.70	1.63	1.74	1.55	1.54	1.50	1.61	0.09
2413	1.56	1.63	1.61	1.59	1.55	1.46	1.49	1.39	1.53	0.08
Avg.	1.64	1.69	1.59	1.57	1.48	1.51	1.53	1.44		
Std	0.06	0.07	0.09	0.09	0.14	0.07	0.08	0.09		

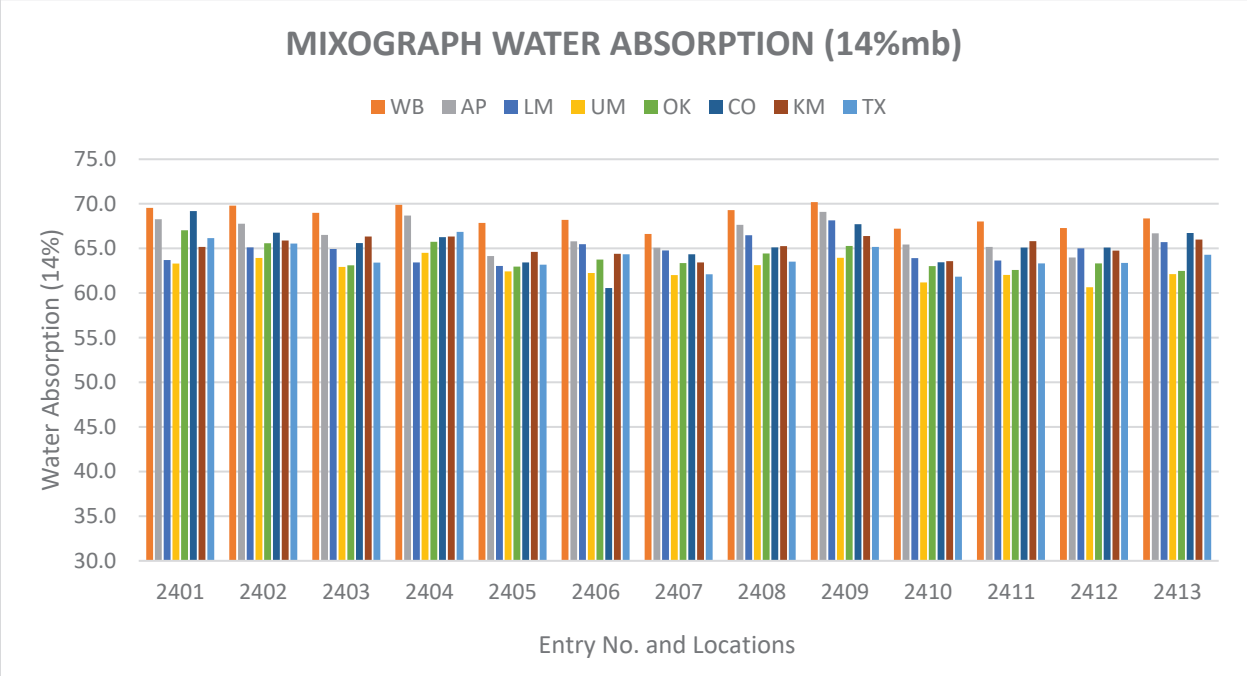
AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred



5. MIXOGRAPH TEST RESULTS

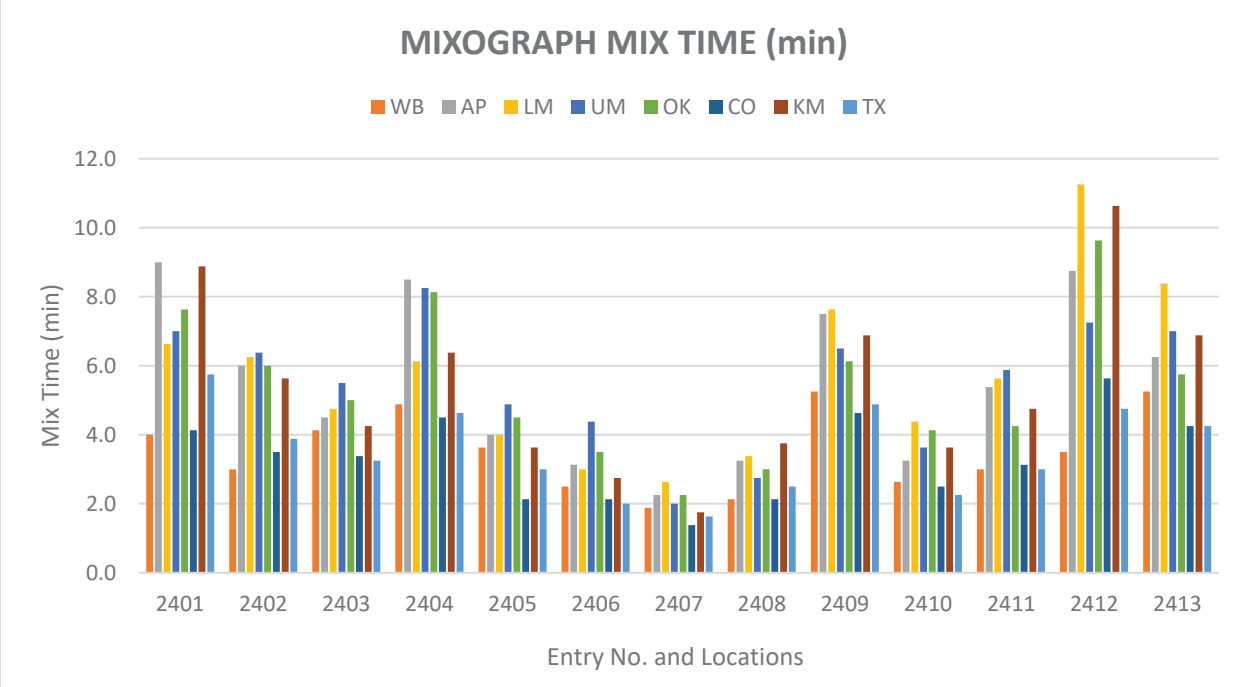
A. Mixograph Water Absorption

Mixograph Water Absorption (14%mb)										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	69.5	68.3	63.7	63.3	67.0	69.2	65.2	66.2	66.5	2.38
2402	69.8	67.8	65.1	63.9	65.6	66.7	65.9	65.5	66.3	1.81
2403	69.0	66.5	64.9	62.9	63.1	65.6	66.3	63.4	65.2	2.08
2404	69.9	68.7	63.4	64.5	65.7	66.2	66.3	66.8	66.5	2.08
2405	67.9	64.1	63.0	62.4	63.0	63.4	64.6	63.2	64.0	1.72
2406	68.2	65.8	65.5	62.2	63.8	60.6	64.4	64.3	64.3	2.31
2407	66.6	65.1	64.8	62.0	63.4	64.3	63.4	62.1	64.0	1.56
2408	69.3	67.6	66.5	63.1	64.4	65.1	65.3	63.5	65.6	2.09
2409	70.2	69.1	68.1	63.9	65.3	67.7	66.4	65.2	67.0	2.15
2410	67.2	65.4	63.9	61.2	63.0	63.4	63.6	61.8	63.7	1.92
2411	68.0	65.2	63.6	62.0	62.6	65.1	65.8	63.3	64.5	1.96
2412	67.3	64.0	65.0	60.6	63.3	65.1	64.7	63.4	64.2	1.91
2413	68.4	66.7	65.7	62.1	62.5	66.7	66.0	64.3	65.3	2.17
Avg.	68.5	66.5	64.9	62.6	64.0	65.3	65.2	64.1		
Std	1.14	1.70	1.40	1.12	1.43	2.17	1.02	1.50		
AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred										



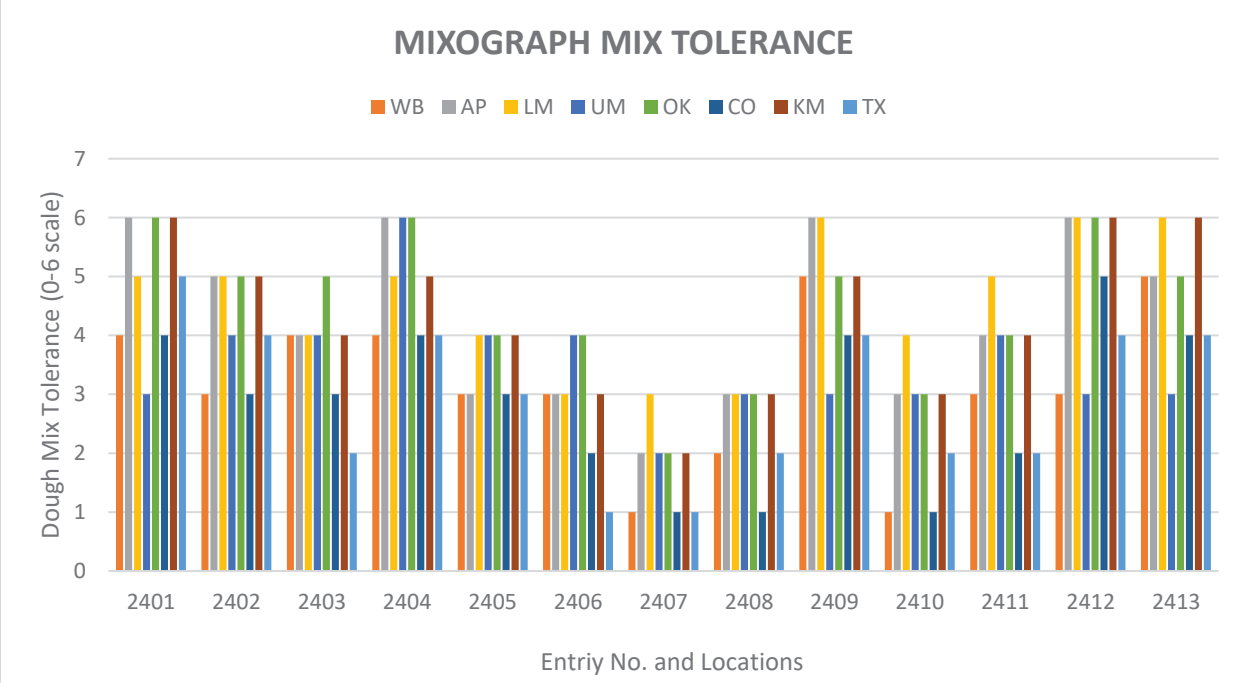
B. Mixograph Mix Time

Mixograph Mix Time (min)										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	4.0	9.0	6.6	7.0	7.6	4.1	8.9	5.8	6.6	1.92
2402	3.0	6.0	6.3	6.4	6.0	3.5	5.6	3.9	5.1	1.38
2403	4.1	4.5	4.8	5.5	5.0	3.4	4.3	3.3	4.3	0.77
2404	4.9	8.5	6.1	8.3	8.1	4.5	6.4	4.6	6.4	1.69
2405	3.6	4.0	4.0	4.9	4.5	2.1	3.6	3.0	3.7	0.86
2406	2.5	3.1	3.0	4.4	3.5	2.1	2.8	2.0	2.9	0.77
2407	1.9	2.3	2.6	2.0	2.3	1.4	1.8	1.6	2.0	0.40
2408	2.1	3.3	3.4	2.8	3.0	2.1	3.8	2.5	2.9	0.59
2409	5.3	7.5	7.6	6.5	6.1	4.6	6.9	4.9	6.2	1.16
2410	2.6	3.3	4.4	3.6	4.1	2.5	3.6	2.3	3.3	0.78
2411	3.0	5.4	5.6	5.9	4.3	3.1	4.8	3.0	4.4	1.22
2412	3.5	8.8	11.3	7.3	9.6	5.6	10.6	4.8	7.7	2.85
2413	5.3	6.3	8.4	7.0	5.8	4.3	6.9	4.3	6.0	1.43
Avg.	3.5	5.5	5.7	5.5	5.4	3.3	5.4	3.5		
Std	1.13	2.35	2.43	1.87	2.13	1.25	2.52	1.27		
AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred										



C. Mixograph Mix Tolerance

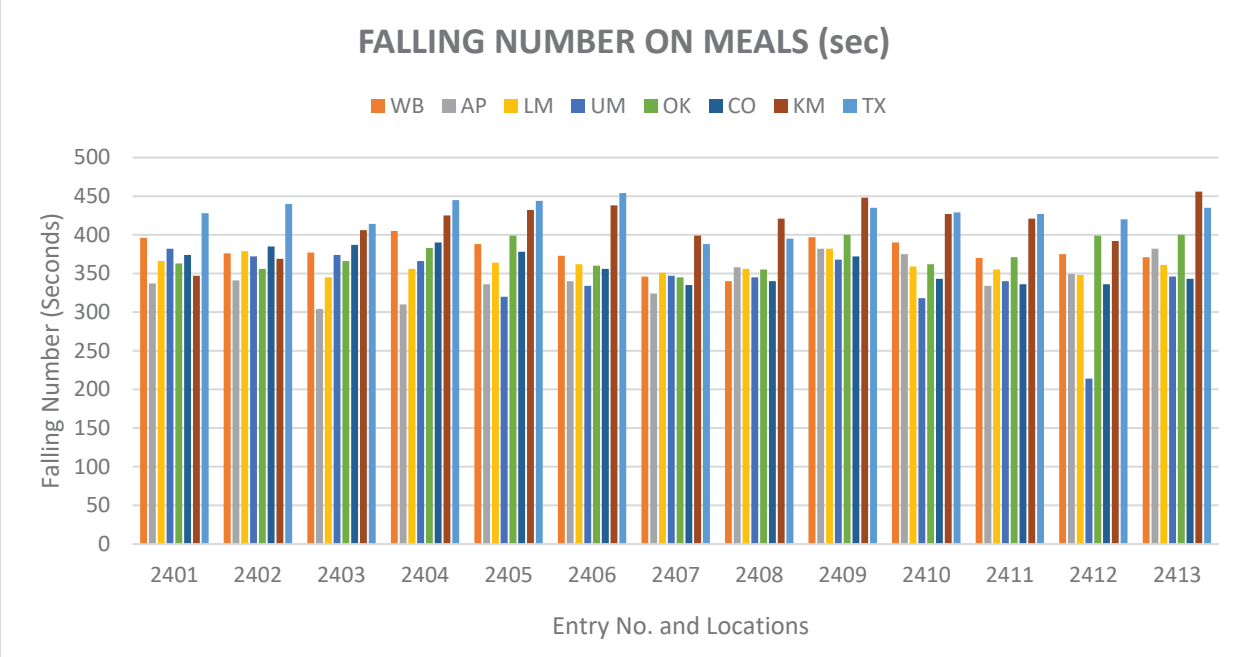
Mixograph Mix Tolerance										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	4	6	5	3	6	4	6	5	4.9	1.1
2402	3	5	5	4	5	3	5	4	4.3	0.9
2403	4	4	4	4	5	3	4	2	3.8	0.9
2404	4	6	5	6	6	4	5	4	5.0	0.9
2405	3	3	4	4	4	3	4	3	3.5	0.5
2406	3	3	3	4	4	2	3	1	2.9	1.0
2407	1	2	3	2	2	1	2	1	1.8	0.7
2408	2	3	3	3	3	1	3	2	2.5	0.8
2409	5	6	6	3	5	4	5	4	4.8	1.0
2410	1	3	4	3	3	1	3	2	2.5	1.1
2411	3	4	5	4	4	2	4	2	3.5	1.1
2412	3	6	6	3	6	5	6	4	4.9	1.4
2413	5	5	6	3	5	4	6	4	4.8	1.0
Avg.	3.2	4.3	4.5	3.5	4.5	2.8	4.3	2.9		
Std	1.28	1.44	1.13	0.97	1.27	1.34	1.32	1.32		
AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred										



6. FALLING NUMBER TEST

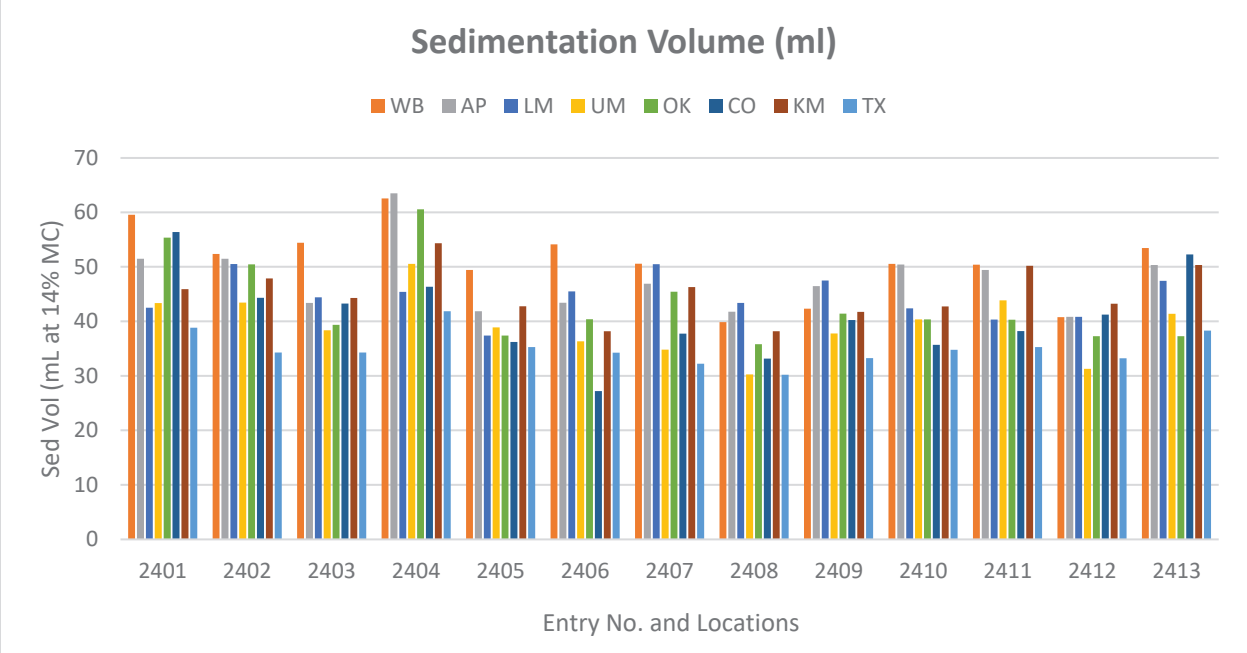
Falling Number on Meals (sec)										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	396	337	366	382	363	374	347	428	374	29
2402	376	341	379	372	356	385	369	440	377	29
2403	377	304	345	374	366	387	406	414	372	35
2404	405	310	356	366	383	390	425	445	385	42
2405	388	336	364	320	399	378	432	444	383	43
2406	373	340	362	334	360	356	438	454	377	44
2407	346	324	351	347	345	335	399	388	354	26
2408	340	358	356	345	355	340	421	395	364	29
2409	397	382	382	368	400	372	448	435	398	29
2410	390	375	359	318	362	343	427	429	375	39
2411	370	334	355	340	371	336	421	427	369	37
2412	375	349	348	214	399	336	392	420	354	64
2413	371	382	361	346	400	343	456	435	387	41
Avg.	377	344	360	340	374	360	414	427		
Std	19	25	11	43	20	22	31	19		

AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred



7. SEDIMENTATION TEST

Sedimentation Volume (ml)										
	LOCATIONS									
Entry No.	WB	AP	LM	UM	OK	CO	KM	TX	Avg	Std
2401	59.5	51.5	42.5	43.3	55.3	56.4	45.9	38.8	49.2	7.55
2402	52.4	51.5	50.5	43.4	50.4	44.3	47.9	34.3	46.8	6.04
2403	54.4	43.4	44.4	38.3	39.4	43.3	44.3	34.3	42.7	5.91
2404	62.5	63.5	45.4	50.6	60.6	46.3	54.3	41.9	53.1	8.38
2405	49.4	41.8	37.4	38.9	37.4	36.2	42.8	35.3	39.9	4.65
2406	54.1	43.4	45.5	36.3	40.4	27.2	38.2	34.3	39.9	8.06
2407	50.6	46.9	50.5	34.8	45.4	37.7	46.3	32.2	43.1	7.13
2408	39.9	41.8	43.4	30.2	35.8	33.2	38.2	30.2	36.6	5.06
2409	42.3	46.5	47.5	37.8	41.4	40.2	41.7	33.3	41.3	4.54
2410	50.6	50.4	42.4	40.4	40.4	35.7	42.7	34.8	42.2	5.88
2411	50.4	49.4	40.3	43.9	40.3	38.2	50.2	35.3	43.5	5.90
2412	40.8	40.8	40.8	31.3	37.3	41.2	43.2	33.2	38.6	4.26
2413	53.5	50.3	47.4	41.4	37.3	52.3	50.3	38.3	46.3	6.44
Avg.	50.8	47.8	44.5	39.3	43.2	40.9	45.1	35.1		
Std	6.72	6.13	3.90	5.51	7.68	7.80	4.75	3.05		
AP=Agripro; UM=USDA-Manhattan; LM=Limagrain; OK=OSU; TX=Texas A&M; KM=Kansas Manhattan; WB=Westbred										



MONTANA

24-2414	SY Monument_CK
24-2415	Yellowstone_CK
24-2416	MTS2068_MT
24-2417	MTV2164_MT

Description of Test Plots and Breeder Entries

Montana – Suchismita (Sue) Mondal

MTS2068- Released as MT Meadowlark, is a solid stem hard red winter wheat line developed from a composite cross of MTS0819//08x350-A6/Warhorse and Spur//08x350-A6/Warhorse. One of the parent varieties "Warhorse" is a popular solid stem variety grown in Montana. It does not have the issue of physiological leaf spotting which has been a concern in the past years as Bobcat gained acreage in Montana. It has low PPO and thus maybe suitable for the Asian noodle market. It has excellent stripe rust resistance though susceptible to stem and leaf rust. MTS2068 combines high yield, test weight, low PPO with excellent stripe rust resistance and resistance to sawfly by low stem cutting.

MTV2164 – it is a hollow stem hard red winter wheat line derived from a cross of MT1265*2/Joe, MT265 carries Wsmv1 gene while Joe has Wsmv2 gene for resistance to wheat streak mosaic virus. The breeding line MTV2164 carries only Wsmv 2 gene and shows moderate resistance to wheat streak mosaic virus in field testing conditions at Bozeman, MT. MTV2164 has excellent yield potential across the winter wheat regions in Montana in the 3 years of multi-location testing.

Montana: 2024 (Small-Scale) Samples

Test entry number	24-2414	24-2415	24-2416	24-2417
Sample identification	**SY Monument_CK**	**Yellowstone_CK**	**MTS2068_MT**	**MTV2164-MT**
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	61.9	61.8	62.8	62.5
Hectoliter weight (kg/hl)	81.4	81.3	82.6	82.2
1000 kernel weight (gm)	31.9	33.9	31.0	39.4
Wheat kernel size (Rotap)				
Over 7 wire (%)	65.9	75.5	56.7	91.4
Over 9 wire (%)	33.5	24.2	43.3	8.5
Through 9 wire (%)	0.7	0.3	0.0	0.1
Single kernel (skcs)[a]				
Hardness (avg /s.d)	74.1/20.6	67.6/15.0	81.8/14.3	62.0/14.1
Weight (mg) (avg/s.d)	31.9/9.9	33.9/9.7	31.0/10.0	39.4/9.3
Diameter (mm)(avg/s.d)	2.64/0.39	2.65/0.37	2.53/0.34	2.82/0.38
Moisture (%) (avg/s.d)	9.7/1.1	10.4/0.3	11.0/0.3	10.5/0.4
SKCS distribution	03-08-14-75-01	01-08-18-73-01	00-01-06-93-01	03-10-29-58-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	13.2	13.5	14.2	12.4
Wheat ash (12% mb)	1.38	1.55	1.33	1.52
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	74.7	75.0	74.0	75.4
Quadrumat Sr. Mill	67.5	68.3	65.2	66.5
Flour moisture (%)	14.3	14.2	13.6	12.6
Flour protein (14% mb)	12.0	12.6	13.1	11.4
Flour ash (14% mb)	0.44	0.47	0.46	0.46
Rapid Visco-Analyser				
Peak Time (min)	6.2	6.4	6.4	6.3
Peak Viscosity (RVU)	196.3	216.9	199.4	192.4
Breakdown (RVU)	55.5	63.6	38.7	54.8
Final Viscosity at 13 min (RVU)	256.0	260.1	279.0	240.3
Minolta color meter				
L*	91.71	91.60	91.25	91.74
a*	-1.29	-1.14	-1.56	-1.13
b*	9.28	8.86	11.35	8.65
PPO	0.256	0.390	0.201	0.478
Falling number (sec)	452	472	492	423
Damaged Starch				
(AI%)	96.5	96.2	96.5	96.7
(AACC76-31)	8.5	8.2	8.5	8.7

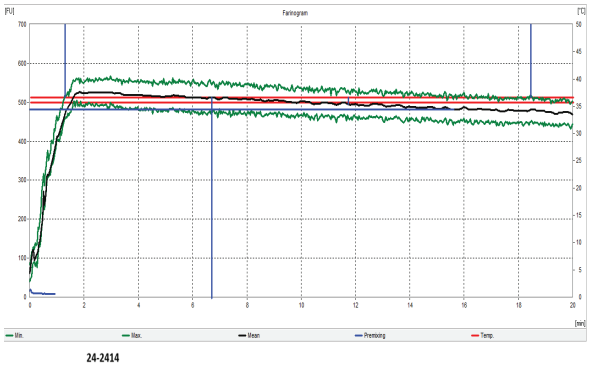
[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Montana: Physical Dough Tests and Gluten Analysis
2024 (Small-Scale) Samples

Test Entry Number	24-2414	24-2415	24-2416	24-2417
Sample Identification	SY Monument_CK	Yellowstone_CK	MTS2068_MT	MTV2164_MT
MIXOGRAPH				
Flour Abs (% as-is)	65.6	65.6	68.2	66.1
Flour Abs (14% mb)	65.9	65.9	67.7	64.4
Mix Time (min)	7.0	7.8	5.8	6.0
Mix tolerance (0-6)	5	6	5	5
FARINOGRAPH				
Flour Abs (% as-is)	65.5	63.8	66.7	68.1
Flour Abs (14% mb)	66.0	64.1	66.3	66.6
Peak time (min)	6.7	5.7	7.0	3.5
Mix stability (min)	17.2	10.1	15.0	6.3
Mix Tolerance Index (FU)	17	22	14	35
Breakdown time (min)	15.6	12.3	17.2	7.1
ALVEOGRAPH				
P(mm): Tenacity	161	125	162	136
L(mm): Extensibility	59	73	64	58
G(mm): Swelling index	17.1	19.0	17.8	16.9
W(10^{-4} J): strength (curve area)	403	381	424	323
P/L: curve configuration ratio	2.73	1.71	2.53	2.34
Ie(P_{200}/P): elasticity index	65.4	68.4	64.6	61.2
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	645/913/1008	738/993/1055	565/953/1015	464/551/421
Extensibility (mm at 45/90/135 min)	134/127/112	108/109/86	122/108/102	131/135/125
Energy (cm^2 at 45/90/135 min)	144/192/166	115/150/111	108/150/137	103/129/94
Resist $_{max}$ (BU at 45/90/135 min)	842/1298/1292	856/1164/1181	726/1184/1146	635/787/650
Ratio (at 45/90/135 min)	4.8/7.2/9.0	6.8/9.1/12.2	4.7/8.8/10.0	3.6/4.1/3.4
PROTEIN ANALYSIS				
HMW-GS Composition	2*, 7+9, 5+10	1, 7+8, 5+10	1, 7+8, 5+10	1, 7+8, 5+10
TPP/TMP	1.00	0.98	1.04	0.98
SEDIMENTATION TEST				
Volume (ml)	70.2	71.2	71.7	66.9

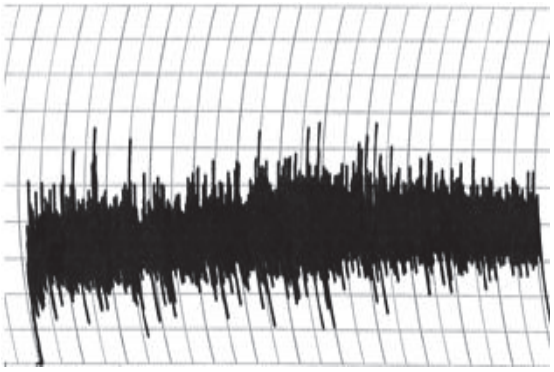
Physical Dough Tests
2024 (Small Scale) Samples – Montana

Farinograms



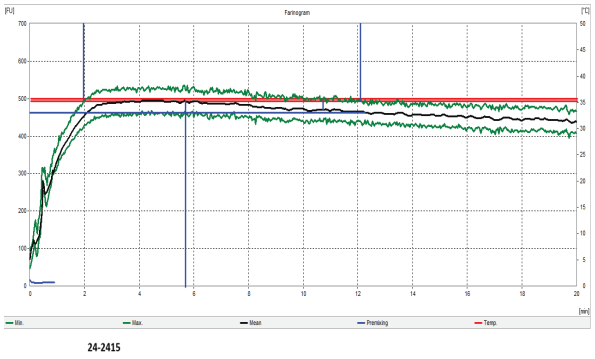
Water abs = 66.0%, Peak time = 6.7 min
Mix stab = 17.2 min, MTI = 17 FU

Mixograms

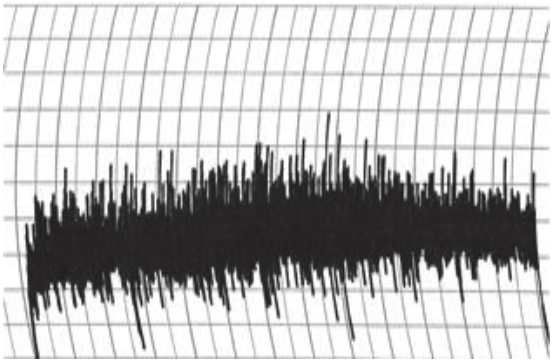


Water abs = 65.9%
Mix time = 7.0 min

24-2414, SY Monument_CK



Water abs = 64.1%, Peak time = 5.7 min,
Mix stab = 10.1 min, MTI = 22 FU



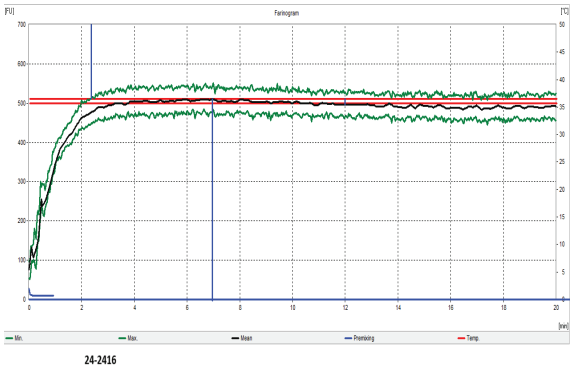
Water abs = 65.9%
Mix time = 7.8 min

24-2415, Yellowstone_CK

Physical Dough Tests

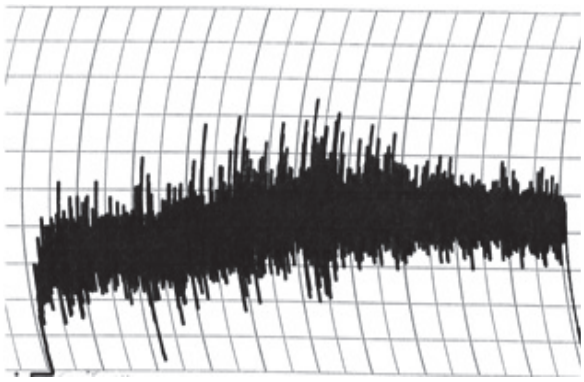
2024 (Small Scale) Samples – Montana (continued)

Farinograms



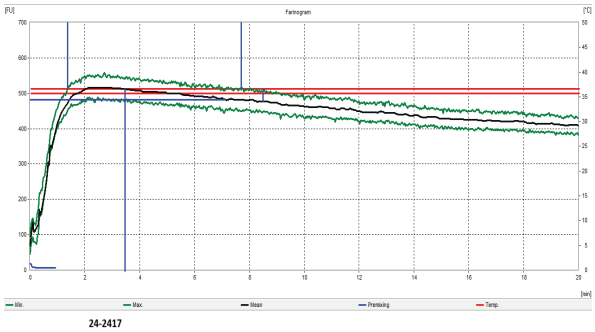
Water abs. = 66.3%, Peak time = 7.0 min,
Mix stab = 15.0 min, MTI = 14 FU

Mixograms

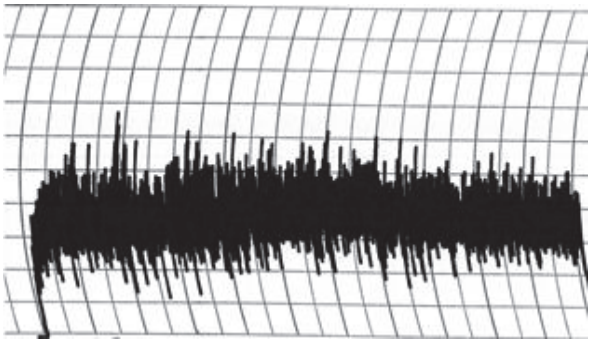


Water abs = 67.7%
Mix time = 5.8 min

24-2416, MTS2068_MT



Water abs. = 66.6%, Peak time = 3.5 min,
Mix stab = 6.3 min, MTI = 35 FU

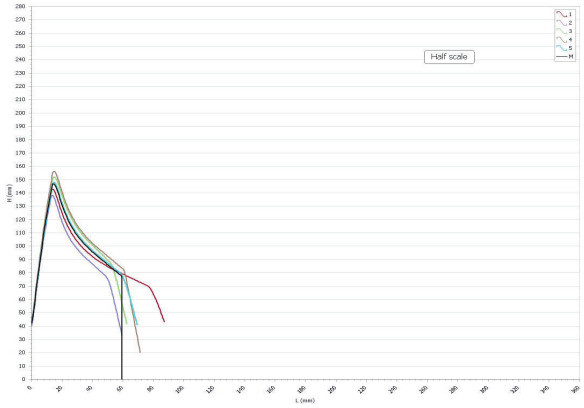


Water abs = 64.4%
Mix time = 6.0 min

24-2417, MTV2164_MT

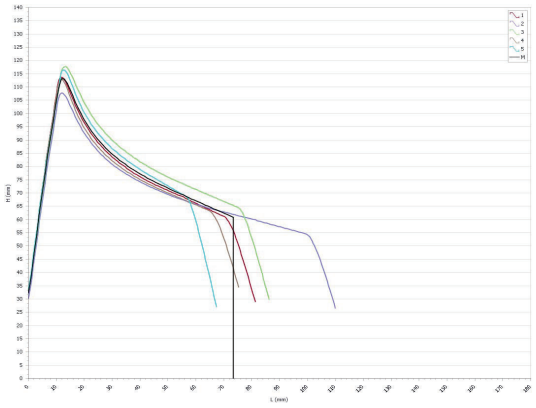
Physical Dough Tests - Alveograph

2024 (Small Scale) Samples – Montana



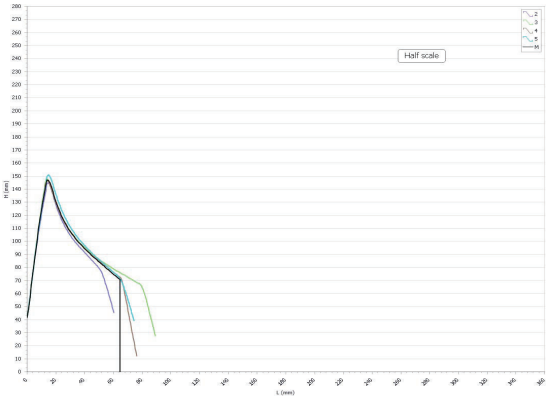
24-2414, SY Monument_CK

P (mm H_20) = 161, L (mm) = 59, W ($10E^{-4}J$) = 403



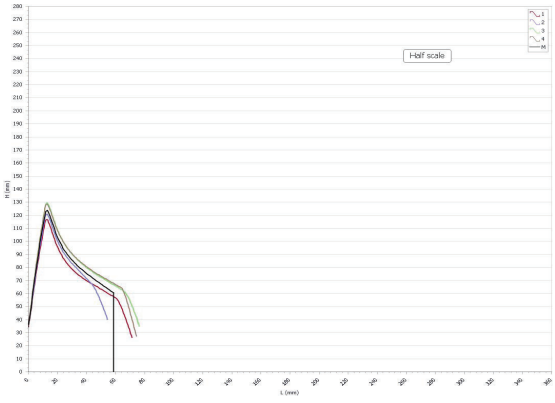
24-2415, Yellowstone_CK

P (mm H_20) = 125, L (mm) = 73, W ($10E^{-4}J$) = 381



24-2416, MTS2068_MT

P (mm H_20) = 162, L (mm) = 64, W ($10E^{-4}J$) = 424

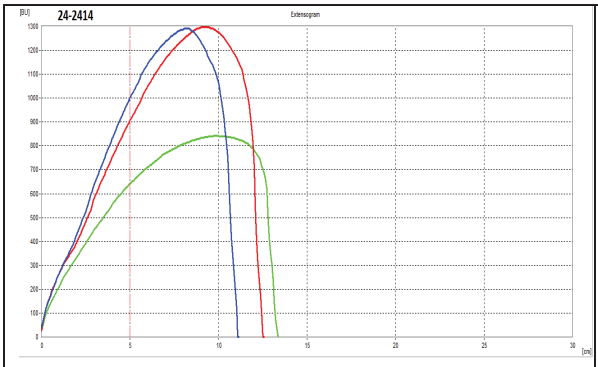


24-2417, MTV2164_MT

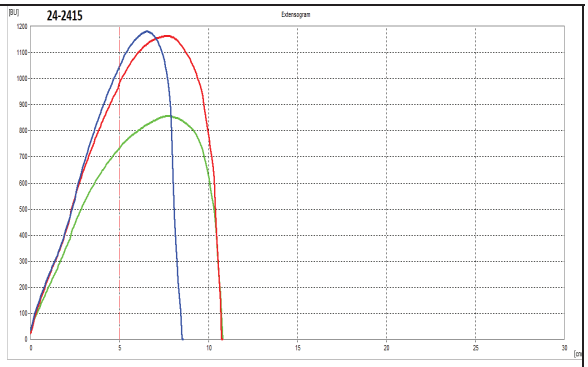
P (mm H_20) = 136, L (mm) = 58, W ($10E^{-4}J$) = 323

Physical Dough Tests - Extensigraph

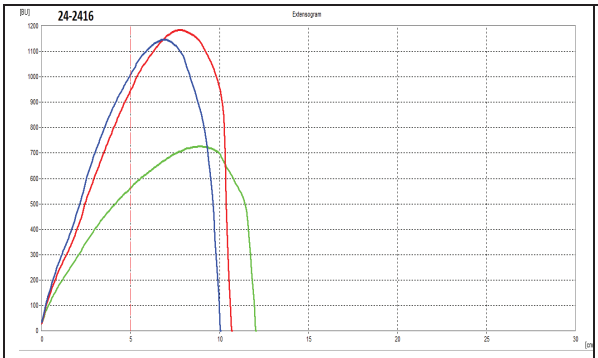
2024 (Small Scale) Samples – Montana



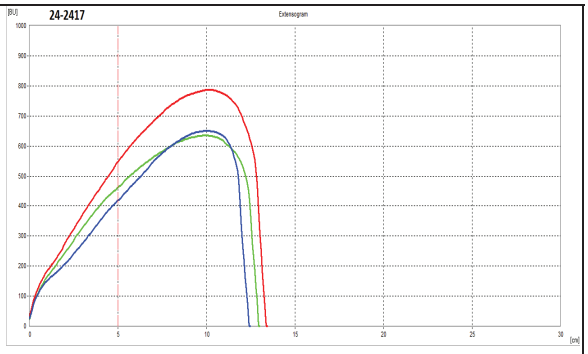
24-2414, SY Monument_CK
R (BU) = 913, E (mm) = 127, W (cm^2) = 192
Rmax (BU) = 1298, Ratio = 7.2 at 90 min



24-2415, Yellowstone_CK
R (BU) = 993, E (mm) = 109, W (cm^2) = 150
Rmax (BU) = 1164, Ratio = 9.1 at 90 min



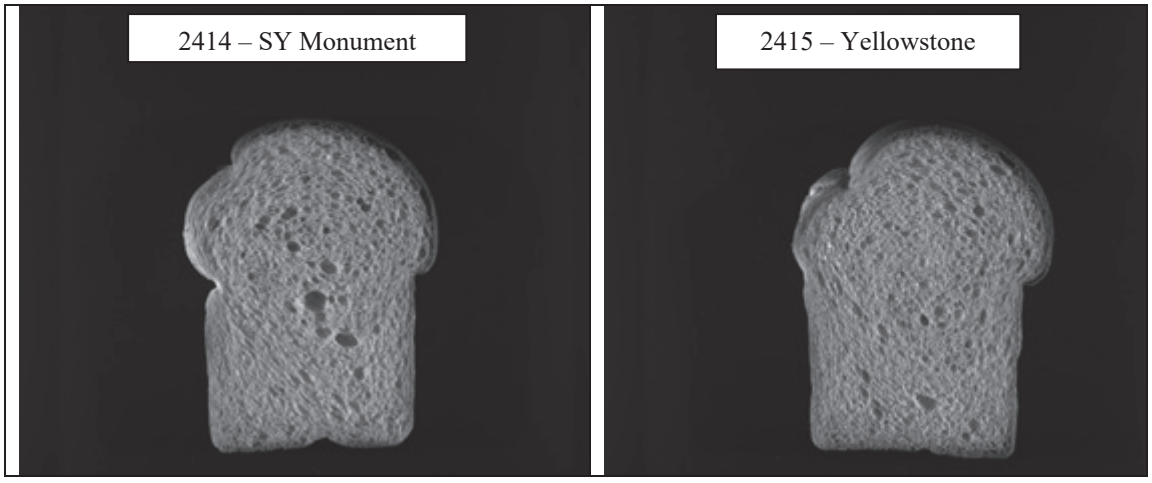
24-2416, MTS2068_MT
R (BU) = 953, E (mm) = 108, W (cm^2) = 150
Rmax (BU) = 1184, Ratio = 8.8 at 90 min



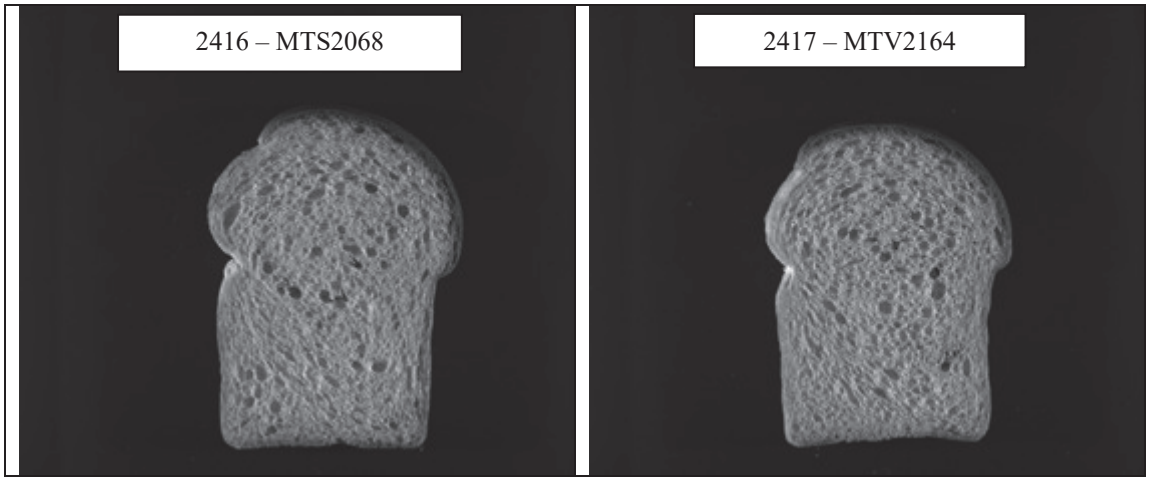
24-2417, MTV2164_MT
R (BU) = 551, E (mm) = 135, W (cm^2) = 129
Rmax (BU) = 787, Ratio = 4.1 at 90 min

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.

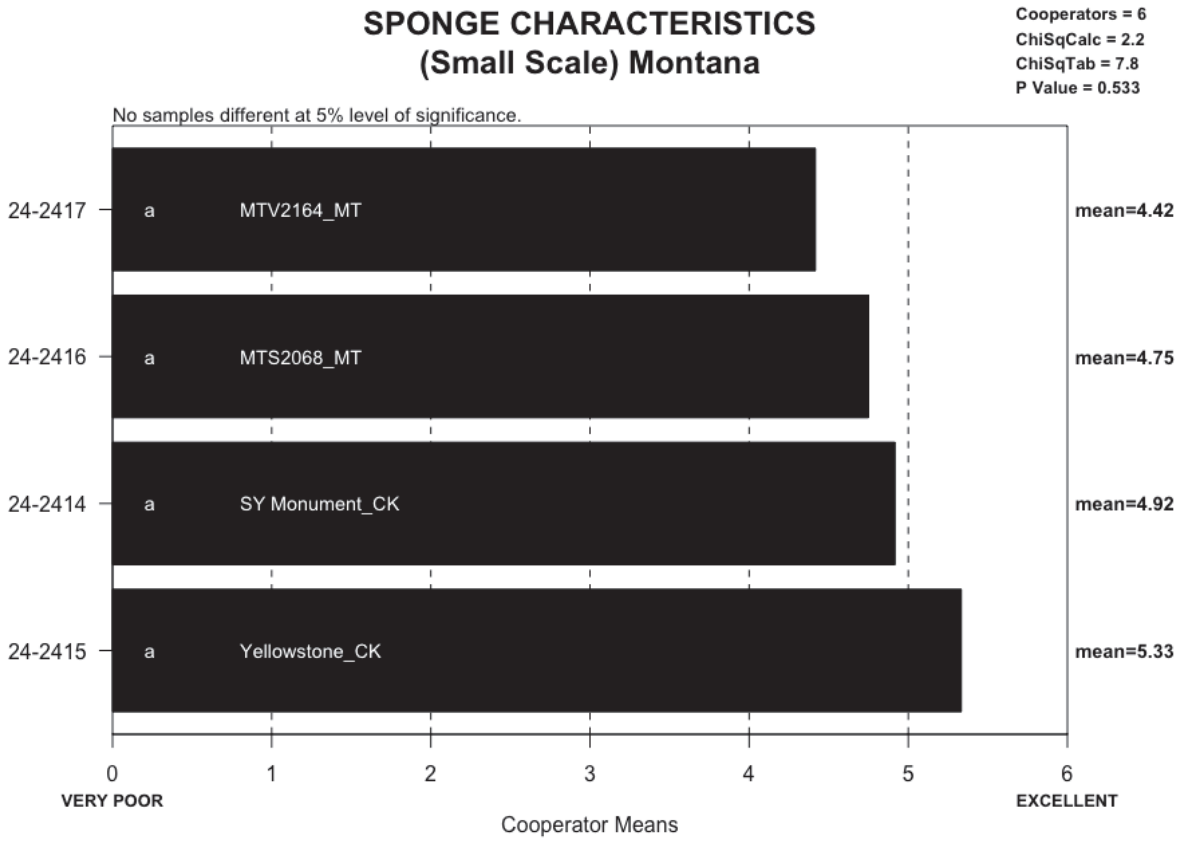
Montana: C-Cell Bread Images and Analysis
2024 (Small-Scale) Samples

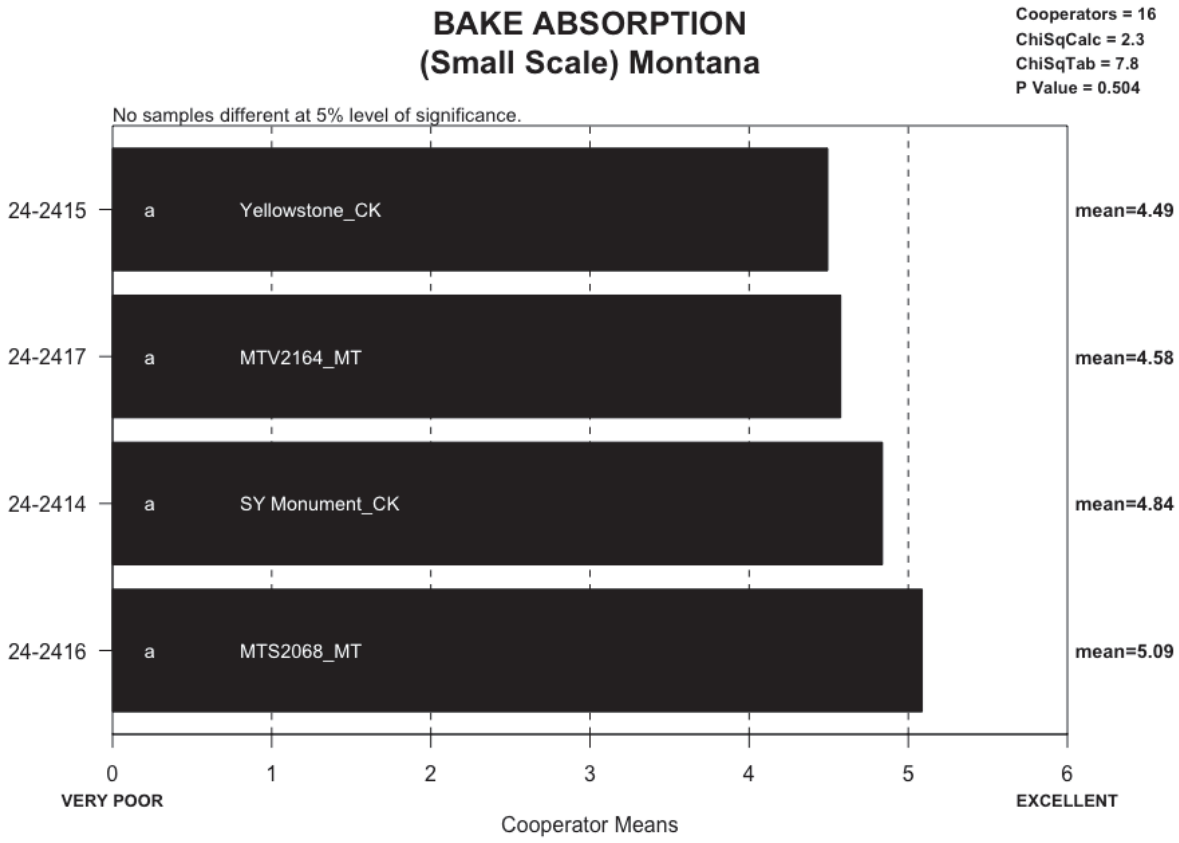


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2414	6434	121	3958	0.420	1.980	2.355	1.790	-7.25
2415	6732	120	4312	0.405	1.920	5.210	1.785	-8.90



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2416	6751	114	4050	0.415	2.005	6.385	1.770	-7.50
2417	6181	118	3770	0.423	1.953	1.638	1.733	-5.28


SPONGE CHARACTERISTICS
(Small Scale) Montana
Cooperators = 6
ChiSqCalc = 2.2
ChiSqTab = 7.8
P Value = 0.533
No samples different at 5% level of significance.
24-2417
a
MTV2164_MT
mean=4.42
24-2416
a
MTS2068_MT
mean=4.75
24-2414
a
SY Monument_CK
mean=4.92
24-2415
a
Yellowstone_CK
mean=5.33
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

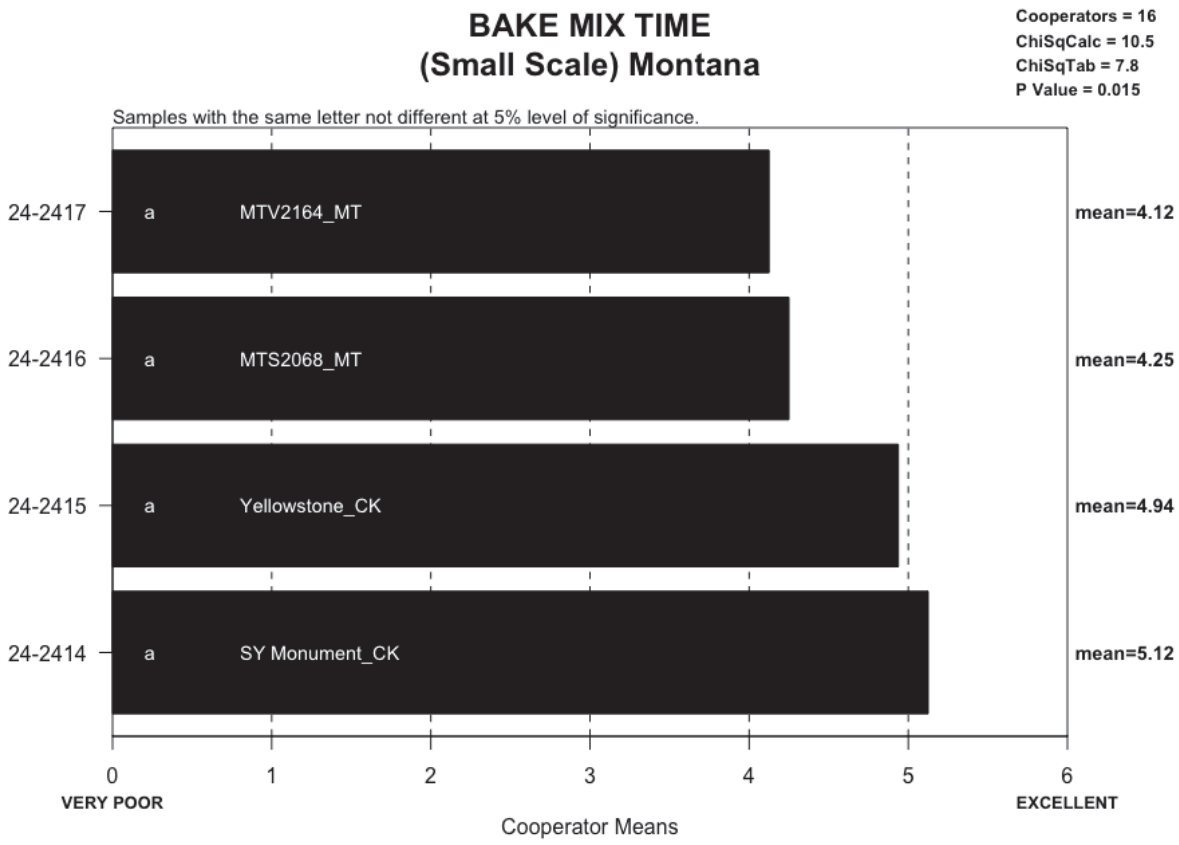

BAKE ABSORPTION
(Small Scale) Montana
Cooperators = 16
ChiSqCalc = 2.3
ChiSqTab = 7.8
P Value = 0.504
No samples different at 5% level of significance.
24-2415
a
Yellowstone_CK
mean=4.49
24-2417
a
MTV2164_MT
mean=4.58
24-2414
a
SY Monument_CK
mean=4.84
24-2416
a
MTS2068_MT
mean=5.09
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

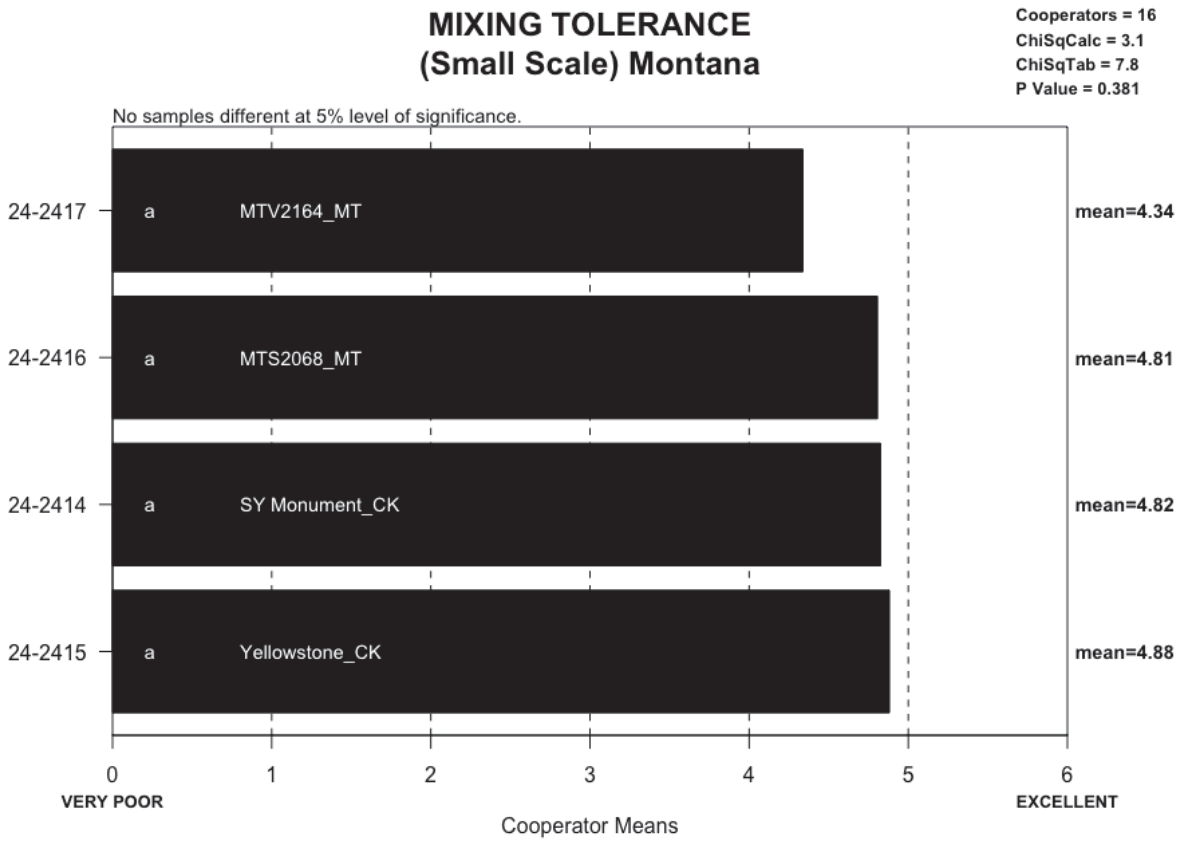
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Montana
Cooperators A – P

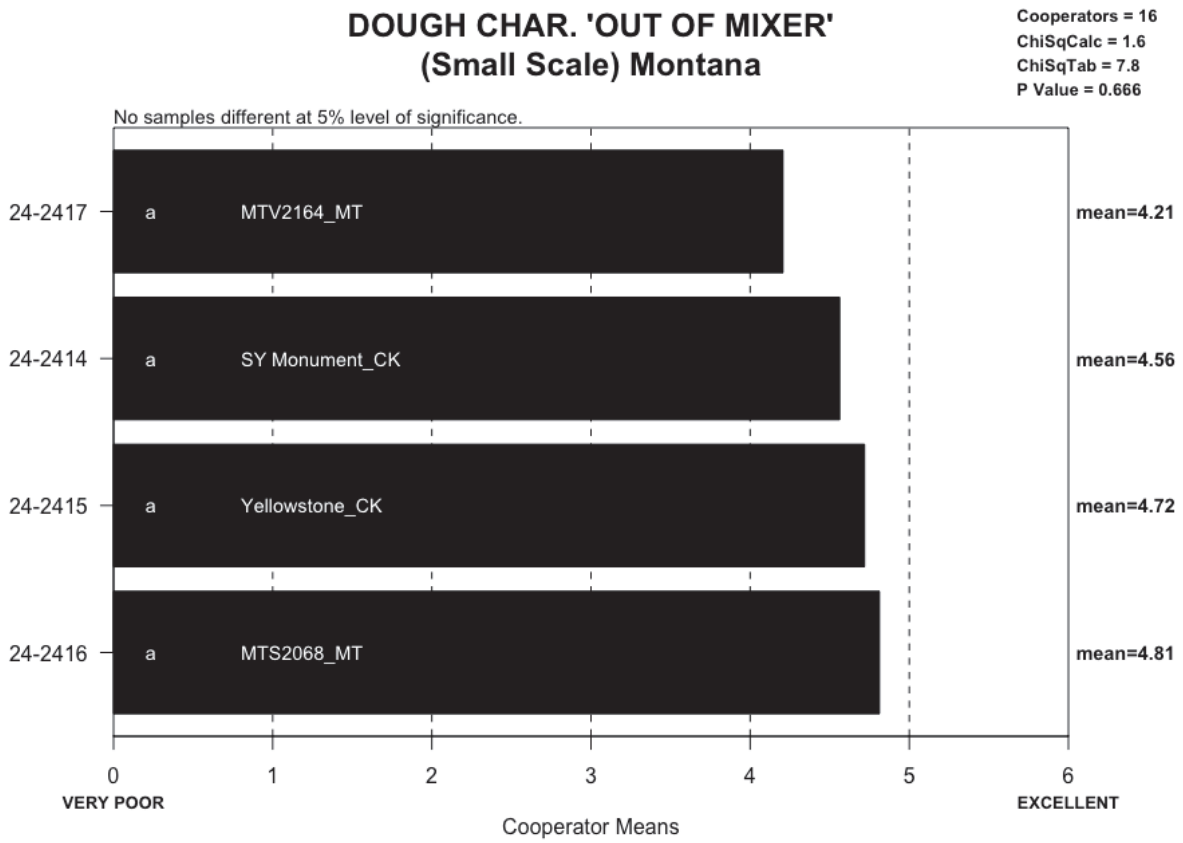
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2414	SY Monument_CK	60	66	68.2	66.0	62.4	66.3	66.2	64.5	66.7	65.8	66	68.0	66.0	62	68.5	65.8
24-2415	Yellowstone_CK	61	66	67.9	64.1	62.9	65.5	66.0	63.3	63.1	65.8	64	66.1	64.1	62	66.8	64.5
24-2416	MTS2068_MT	61	68	67.6	66.3	64.4	65.9	67.8	63.6	66.4	67.8	66	68.3	66.3	63	69.7	66.0
24-2417	MTV2164_MT	57	66	66.2	66.6	63.2	63.1	66.2	60.5	68.6	64.5	65	68.6	66.6	60	71.1	66.0

BAKE MIX TIME, ACTUAL
(Small Scale) Montana
Cooperators A – P

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2414	SY Monument_CK	7	6.9	6.5	18	10.5	5.8	10.5	9	5.5	7.5	25	20	7.5	6.5	8	8.0
24-2415	Yellowstone_CK	7	6.0	6.8	14	9.3	5.8	9.1	10	5.3	6.8	20	20	6.0	5.2	12	7.3
24-2416	MTS2068_MT	7	5.2	4.8	12	6.6	4.5	7.8	9	5.3	5.5	17	17	7.0	5.2	8	6.0
24-2417	MTV2164_MT	7	5.6	5.8	12	9.9	5.2	14.0	9	5.5	7.1	8	11	5.0	5.0	7	8.0

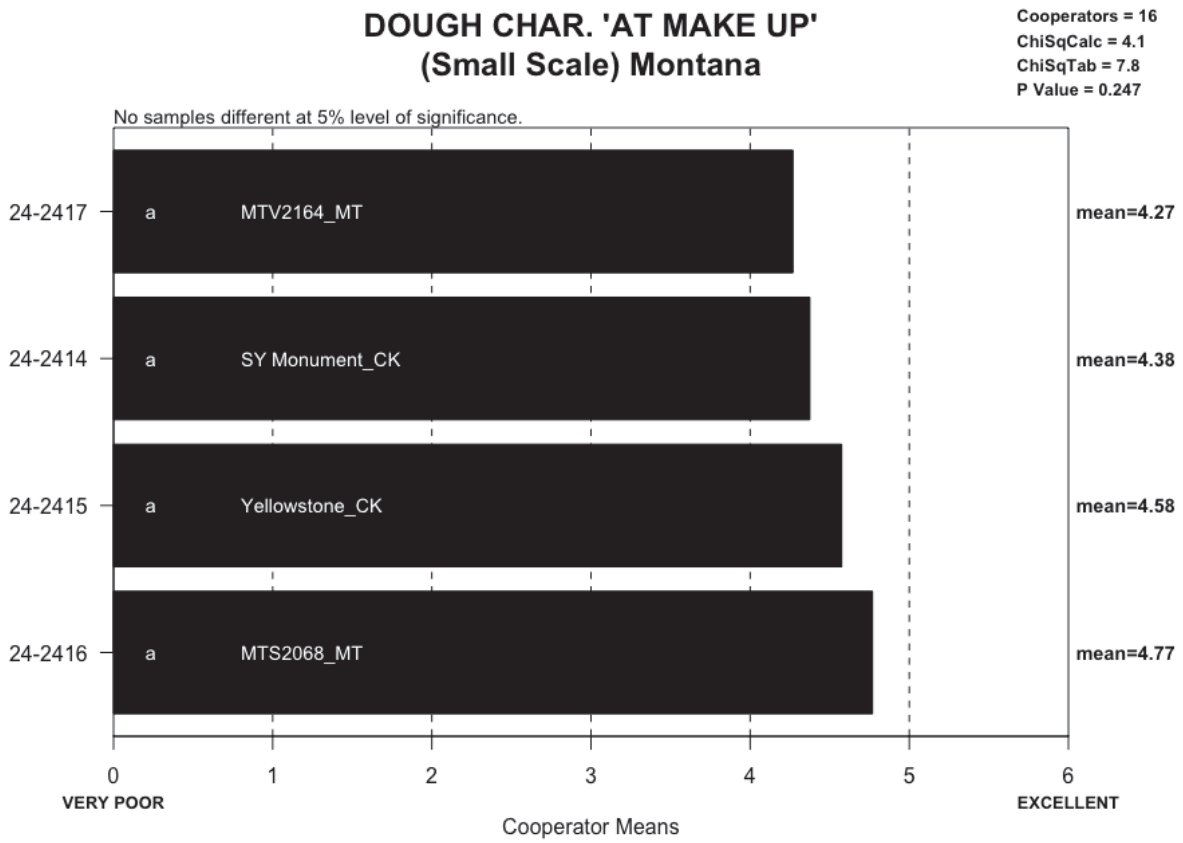

BAKE MIX TIME
(Small Scale) Montana
Cooperators = 16
ChiSqCalc = 10.5
ChiSqTab = 7.8
P Value = 0.015
Samples with the same letter not different at 5% level of significance.
24-2417
a
MTV2164_MT
mean=4.12
24-2416
a
MTS2068_MT
mean=4.25
24-2415
a
Yellowstone_CK
mean=4.94
24-2414
a
SY Monument_CK
mean=5.12
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Montana
Cooperators = 16
ChiSqCalc = 3.1
ChiSqTab = 7.8
P Value = 0.381
No samples different at 5% level of significance.
24-2417
a
MTV2164_MT
mean=4.34
24-2416
a
MTS2068_MT
mean=4.81
24-2414
a
SY Monument_CK
mean=4.82
24-2415
a
Yellowstone_CK
mean=4.88
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means



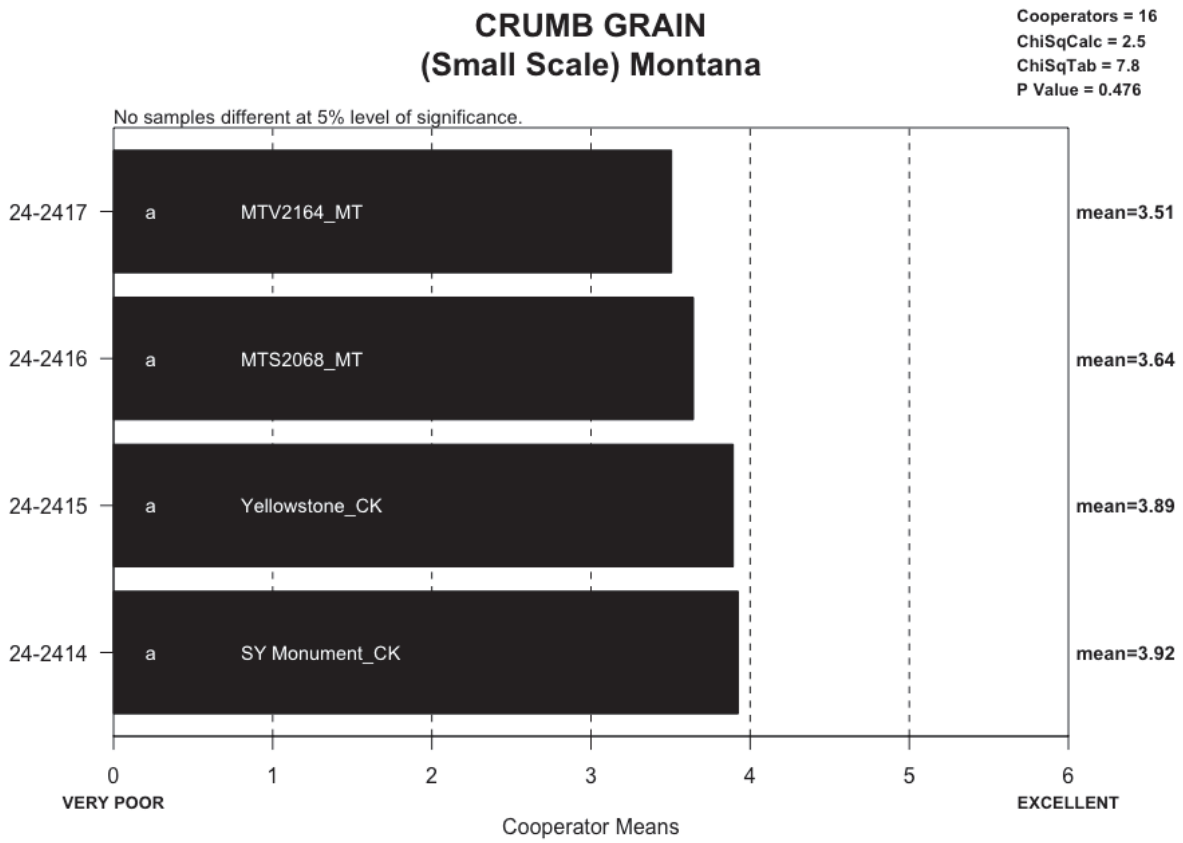
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Montana

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
24-2414	SY Monument_CK	2	0	4	7	3
24-2415	Yellowstone_CK	0	0	3	8	5
24-2416	MTS2068_MT	3	0	3	5	5
24-2417	MTV2164_MT	4	0	5	6	1



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

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
24-2414	SY Monument_CK	0	0	6	9	1
24-2415	Yellowstone_CK	0	0	6	6	4
24-2416	MTS2068_MT	0	0	3	8	5
24-2417	MTV2164_MT	2	1	4	8	1

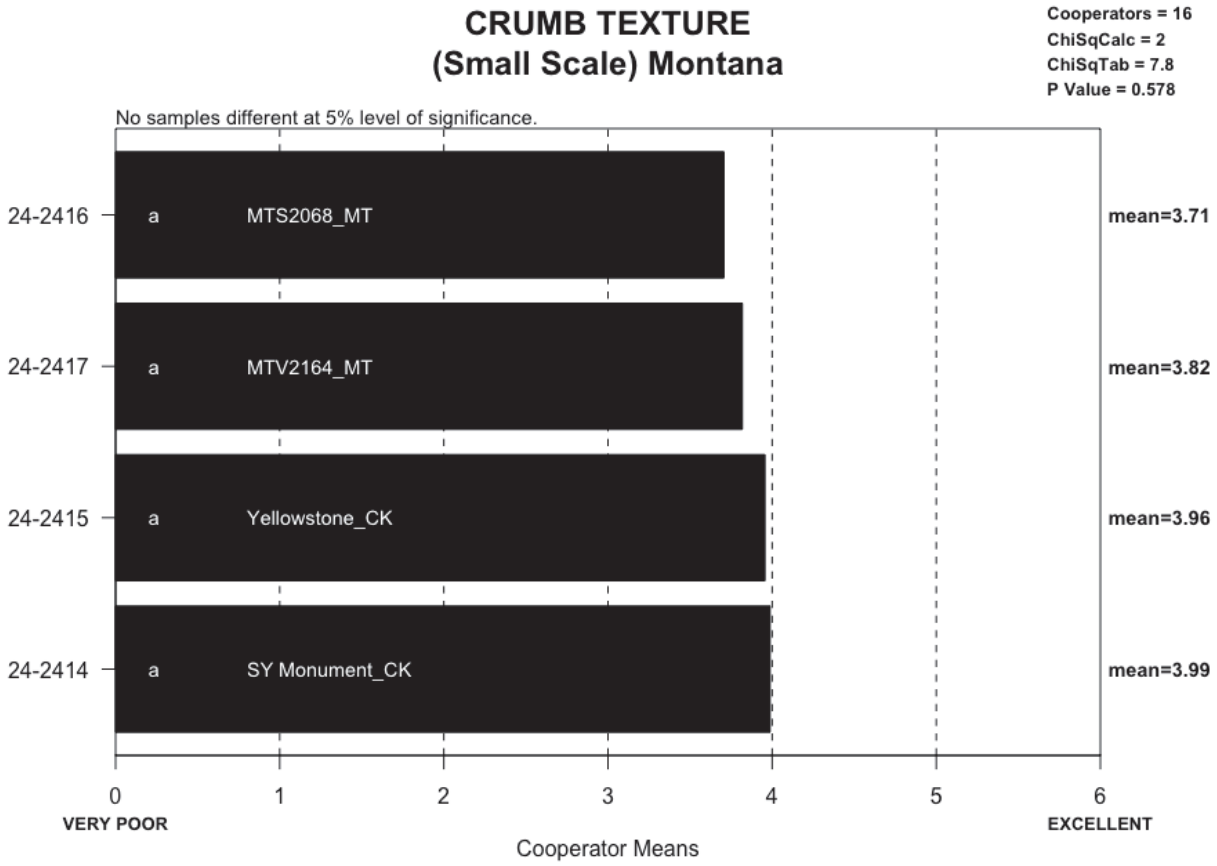


CRUMB GRAIN, DESCRIBED
(Small Scale) Montana

IDCODE	ID	Open	Fine	Dense
24-2414	SY Monument_CK	5	6	5
24-2415	Yellowstone_CK	6	10	0
24-2416	MTS2068_MT	9	6	1
24-2417	MTV2164_MT	8	4	4

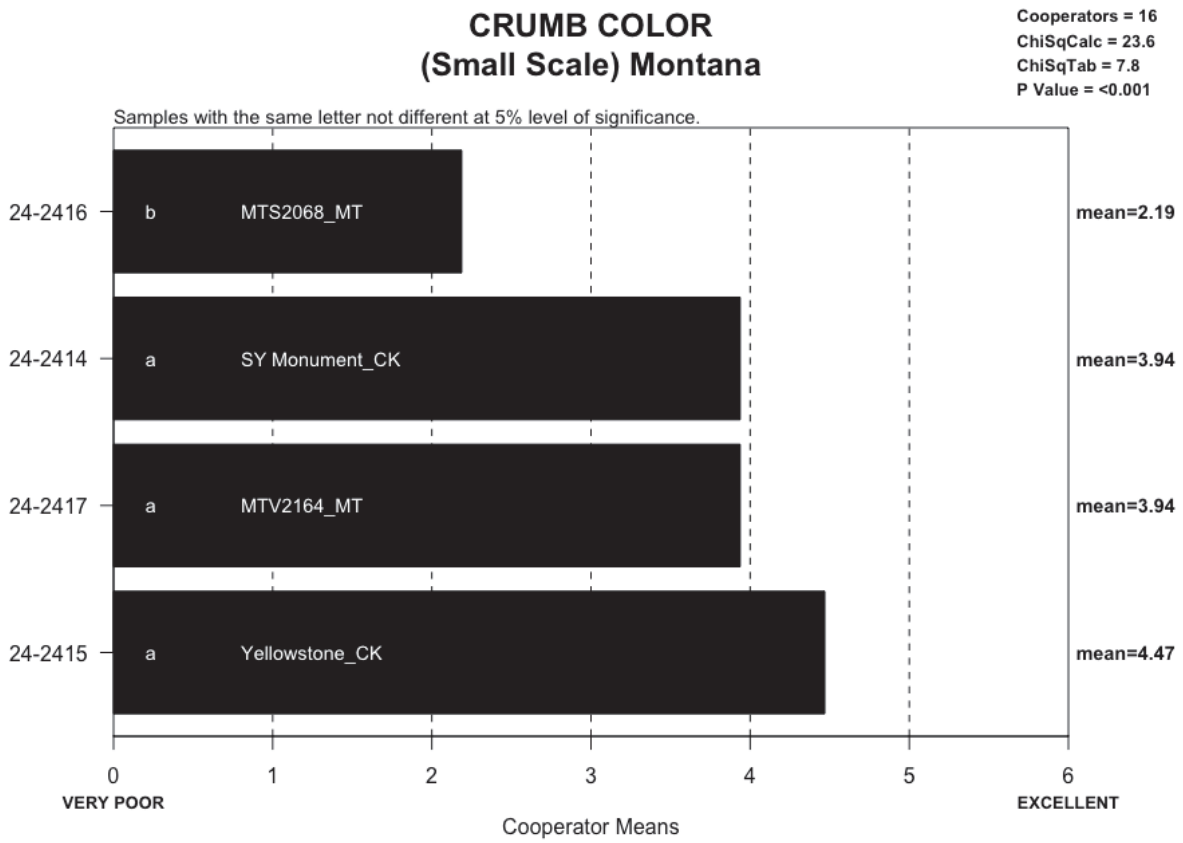
CELL SHAPE, DESCRIBED
(Small Scale) Montana

IDCODE	ID	Round	Irregular	Elongated
24-2414	SY Monument_CK	6	5	5
24-2415	Yellowstone_CK	6	5	5
24-2416	MTS2068_MT	7	5	4
24-2417	MTV2164_MT	5	6	5



CRUMB TEXTURE, DESCRIBED
(Small Scale) Montana

IDCODE	ID	Harsh	Smooth	Silky
24-2414	SY Monument_CK	3	10	3
24-2415	Yellowstone_CK	1	13	2
24-2416	MTS2068_MT	4	10	2
24-2417	MTV2164_MT	4	9	3



CRUMB COLOR, DESCRIBED
(Small Scale) Montana

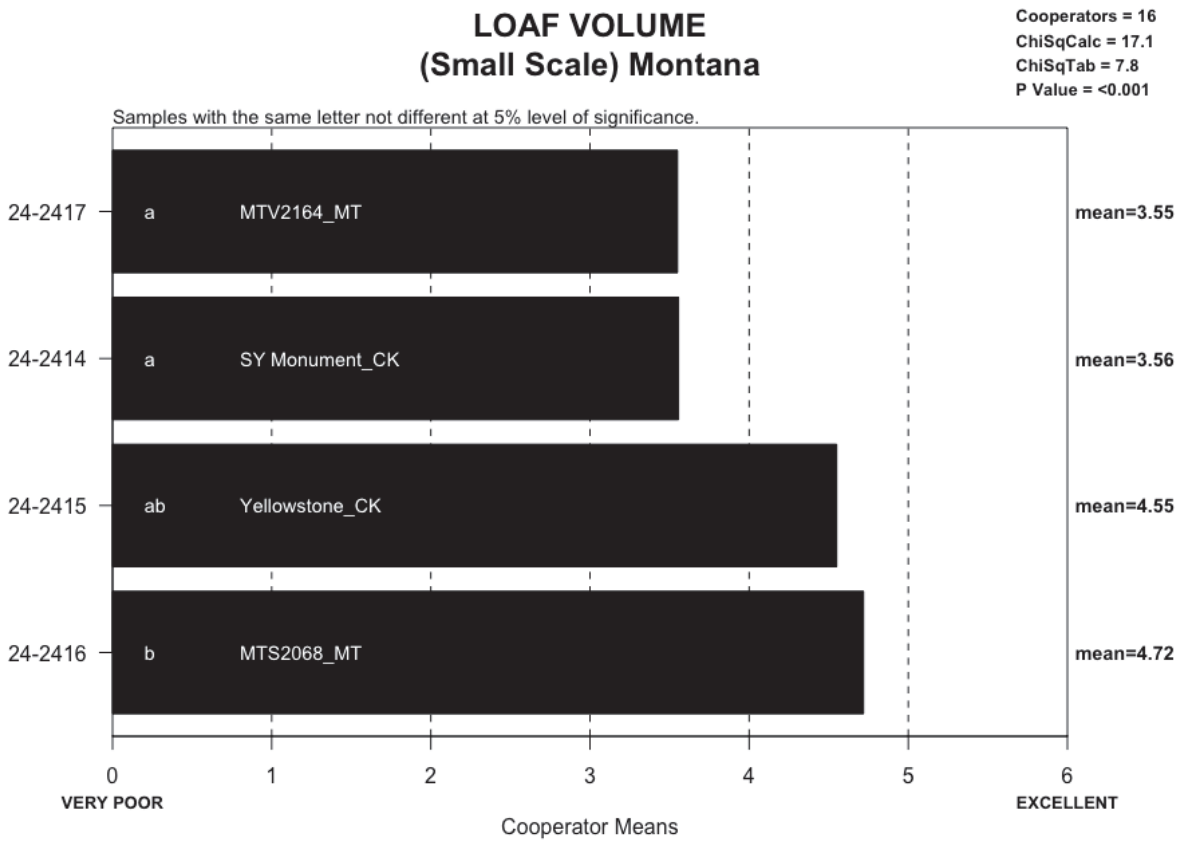
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
24-2414	SY Monument_CK	0	0	2	3	7	4	0
24-2415	Yellowstone_CK	0	0	1	1	5	8	1
24-2416	MTS2068_MT	0	4	8	1	2	1	0
24-2417	MTV2164_MT	0	0	2	2	8	4	0

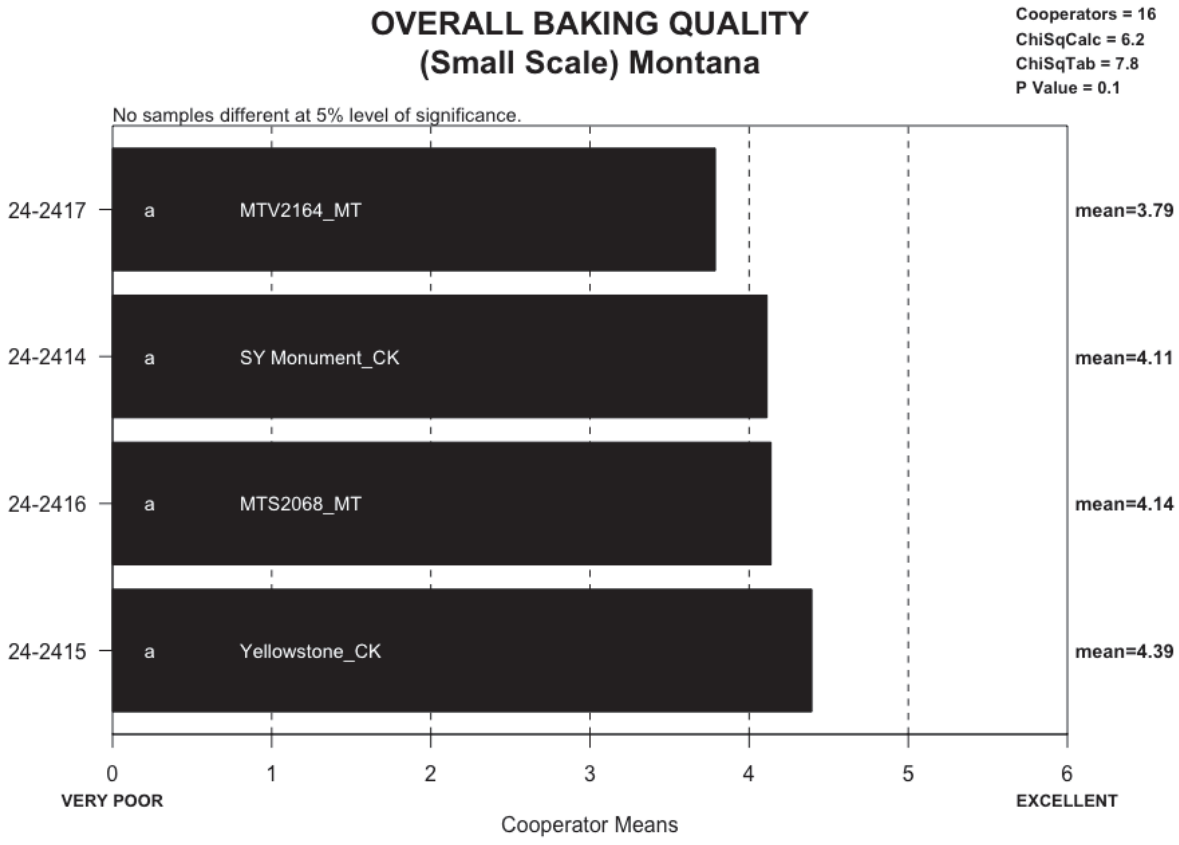
LOAF WEIGHT, ACTUAL
(Small Scale) Montana
Cooperators A – P

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2414	SY Monument_CK	413	141.7	145.2	456	139.5	153.4	153.3	478.3	136.6	138.4	472.2	428.6	456	141.9	438	141.7
24-2415	Yellowstone_CK	414	139.2	142.8	466	141.0	151.2	150.4	484.2	132.5	138.5	474.7	426.9	454	140.7	440	141.1
24-2416	MTS2068_MT	410	140.9	143.6	458	140.7	150.6	150.7	480.4	132.0	138.2	474.4	428.8	454	142.1	440	143.5
24-2417	MTV2164_MT	414	140.7	142.8	448	137.9	151.3	150.0	485.9	132.0	139.3	470.3	425.4	458	140.5	435	141.6

LOAF VOLUME, ACTUAL
(Small Scale) Montana
Cooperators A – P

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2414	SY Monument_CK	2875	965	1055	2111	888	828	865	2463	823	813	2883	2700	2387	925	2084	745
24-2415	Yellowstone_CK	3000	985	1055	2136	978	944	960	2488	943	936	2927	2750	2499	925	2161	865
24-2416	MTS2068_MT	2925	1000	1030	2191	948	961	950	2663	900	904	2898	2700	2556	950	2242	905
24-2417	MTV2164_MT	2725	870	900	2156	880	867	860	2488	890	857	2890	2600	2345	850	2173	855


LOAF VOLUME
(Small Scale) Montana
Cooperators = 16
ChiSqCalc = 17.1
ChiSqTab = 7.8
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
24-2417
a
MTV2164_MT
mean=3.55
24-2414
a
SY Monument_CK
mean=3.56
24-2415
ab
Yellowstone_CK
mean=4.55
24-2416
b
MTS2068_MT
mean=4.72
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Small Scale) Montana
Cooperators = 16
ChiSqCalc = 6.2
ChiSqTab = 7.8
P Value = 0.1
No samples different at 5% level of significance.
24-2417
a
MTV2164_MT
mean=3.79
24-2414
a
SY Monument_CK
mean=4.11
24-2416
a
MTS2068_MT
mean=4.14
24-2415
a
Yellowstone_CK
mean=4.39
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Small Scale) Montana
Cooperators A – P

24-2414	**SY Monument_CK**
A	Very open grain Average overall
B	Slightly longer bake mix time than prefered, excellent dough feel, ok bake
C	tough dough, slight cap
D	No comment
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Fine Elongate Cells, Good Resilient & Very Smooth Texture
F	No comment
G	Long mix time, avg absorption. Average open grain and average volume. Good mix tolerance.
H	Higher absoprtion, tough dough. Good although open, creamy colored crumb grain. Low volume. Good mix toler.
I	No comment
J	No comment
K	Overall very good - target
L	High absorption, stability and mix time. Good protein and volume.
M	No comment
N	No comment
O	No comment
P	No comment
24-2415	**Yellowstone_CK**
A	Very open grain Good volume
B	Good dough feel, good crumb grain and bright white flour, ok bake
C	excellent loaf externals
D	No comment
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, Very High Loaf Volume, Creamy Crumb Grain, Fine Elongate Cells, Good Resilient & Very Smooth Texture
F	No comment
G	Long mix time, avg absorption. Fine, irregular, cream colored grain. Good volume. Excellent mix tolerance.
H	High absorption, tough dough. Good although open, creamy colored crumb grain. Low volume.
I	No comment
J	No comment
K	Overall very good
L	Low stability. High absorption, mix time and protein. Good volume.
M	No comment
N	No comment
O	No comment
P	No comment

COOPERATOR'S COMMENTS
(Small Scale) Montana
Cooperators A – P

24-2416	MTS2068_MT
A	Good overall Very open grain
B	High protein, high bake absorption relative to set, good dough feel, ok crumb grain but dark yellow color, ok bake volume relative to protein
C	yellow flour and dough, excellent loaf externals
D	No comment
E	Very High Water Abs, Long MT, Slight Sticky & Strong Dough, Very High Loaf Volume, Yellow Crumb Grain, Fine Elongate Cells, Good Resilient & Very Smooth Texture
F	No comment
G	Long mix time, highest absorption. Open round dark yellow crumb grain. Good volume & mix tolerance.
H	Tough dough. Average open, round, very dark yellow crumb grain. One of the highest volume. Good mix toler.
I	No comment
J	No comment
K	Excellent absorption, good mix time, good volume
L	High protein and absorption. Good mix time, stability and volume. Slight yellow color.
M	No comment
N	No comment
O	No comment
P	No comment
24-2417	**MTV2164_MT**
A	Lower volume Bright interior Average mix
B	Lowest protein of the set, weak out of mixer dough but dough feel greatly improved at make up, good crumb grain with white color, ok loaf volume for protein
C	white dough, rough break
D	some larger holes
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Open Round Cells, Good Resilient & Slightly Harsh Texture
F	No comment
G	Very long mix time, avg absorption. Open, round, harsh textured crumb grain. Average volume. Good mix tolerance.
H	Average absorp. & mix toler. Tough dough. Average open although creamy colored crumb grain. Low volume.
I	No comment
J	No comment
K	Went down 2% on absorption to accommodate short stability; dough sticky at handling; Good volume.
L	Low stability. High absorption. Good protein. Fair mix time and volume. Negative bench comments.
M	No comment
N	No comment
O	No comment
P	No comment

NORTHERN GROWOUT

24-2418	SY Mounment_CK
24-2419	21Nord-181_ND
24-2420	23Nord-184_ND
24-2421	SD20B088-2_SD
24-2422	SD20D100-9_SD
24-2423	XG4108_WB

CK=Check; ND=North Dakota; SD=South Dakota; WB =Westbred (Bayer); NE=Nebraska.

Description of Test Plots and Breeder Entries

Northern Growout:

There are 6 composited entries including one control and 5 breeding lines from 3 breeding programs (ND, SD, and WB). The Northern growout consisted of 5 locations (ND, SD, NE, UM, and AP), but 3 locations (ND, SD, and AP) submitted the entries for the composites used for end-use quality testing.

NORTH DAKOTA by Francois Marais and Bradley Bisek

Growing Location & Conditions

The NDSU WQC grow-outs were located at the NDSU Agronomy Seed Farm (ASF) in Casselton, ND, approximately 20 miles west of Fargo. The grow-out strips (4' x 120') were seeded on Sept. 19th, 2023, into un-tilled soybean stubble. Urea was applied at a rate of 260 lbs/A (120 lbs N) by the ASF in the fall on October 25th, 2023.The fall provided ample moisture for germination and good plant establishment. The winter months were very moderate, with above average day-time temperatures and only few cold-snap periods. However, with warmer temperatures little to no snow cover was produced to insulate the winter wheat seedlings during extreme cold episodes. Fortunately, there appeared to be very minimal winter kill to the WQC grow-outs, and the strips recorded robust yields. Another factor leading to high yields was the abundant rainfall and moderate temperatures that continued in the spring and early summer. The intense summer heat did not begin to take effect until later in the season, after the plants had begun grain filling (July). The pesticide Wolverine Advanced was sprayed (via Airplane) on May 31st at the wheat jointing stage, to control weed growth. The WQC strips were harvested on August 2nd, 2024. Seed quality appeared to be adequate among the entries, except for the presence of common bunt found in lines NE18435, NE19619, and NHH19668. It was determined that seed treatment should be used in future grow-outs for better control of the smut and bunt diseases. Below are the yields for the harvested strips at Casselton, ND.

Entry Name	Yield (lbs)
SY Monument	83.8
23NORD-181	90.9
23NORD-184	85.5
SD20B088-2	90
SD20D100-9	88.3
XG4108	92.1
23NORD-187 - excluded	86.6
SD20D009-9 - excluded	92.5
NE18435 - excluded	91.6
NE19619 - excluded	96.1
NHH19668 - excluded	87

23NORD-181

23NORD-181 is a NDSU single-seed-descent (SSD) experimental line derived from a winter wheat project cross (18K287-23-2, Pedigree: Norstar-Fhb1,Sr50/Monument/3/Norstar-Fhb1/Jerry//13RGON-13 (= U3556-3-1-1/Deliver)). 23NORD-181 has shown to be significantly shorter than the cultivar Jerry, and has shown to have generally good standability. 23NORD-181 has performed competitively in grain yield in North Dakota. In the NDSU winter wheat project disease screenings, 23NORD-181 has shown to have adequate resistance to leaf rust, with the inclusion of *Lr16* and *Lr21*. 23NORD-181 has also been found to contain the *Almt1* marker, and has displayed superior tolerance to aluminum toxicity in western ND trials. In 2025, 23NORD-181 is included in the NDSU Elite trial, as well as a first-year entry to the 2025 NRPN trial.

23NORD-184

23NORD-184 is a NDSU doubled-haploid (DH) experimental line derived from a winter wheat project cross (18K287, Pedigree: Norstar-Fhb1,Sr50/Monument/3/Norstar-Fhb1/Jerry//13RGON-13 (= U3556-3-1-1/Deliver)). 23NORD-184 is closely related to 23NORD-181 (same original cross), and has equivalent characteristics in height, maturity, and *Lr* & *Sr* rust resistance scores/markers (*Lr16, Lr21*). Where 23NORD-184 differs, is in it's slightly higher yield totals, better *Yr* resistance scores, and the lack of the *Almt1* gene (and corresponding poor soil acidity tolerance). In 2025, 23NORD-184 is included in the NDSU Variety and Elite trials, as well as the NRPN trial.

SOUTH DAKOTA by Sunish Sehgal

Growing Location and Conditions

A total of 10 entries with one check (SY Monument) were evaluated under the 2024 Northern Wheat Quality Council (WQC) grow-outs. At Brookings (SD), all entries were timely planted in good moisture on October 8, 2023, as 200' long and 5' wide strips (7-rows) in oat stubble (no-till). A starter fertilizer 10-34-0 (10 gallons/ac) was applied at seeding. All entries had good emergence and decent growth going into winter. In spring 2024 no visible winter kill was observed, 28-0-0 (35 gallons/acre) fertilizer was stream-bar applied at Feekes 5 and the strips were also sprayed with 1.5 pt/acre Bison and 24 oz Prowl H2O. The early spring was dry, but rains picked up after April 15. All entries were sprayed with Prosaro at the anthesis. The grow-out trial was harvested on July 26, 2024, with total grain weight for entries ranging from 59 lbs to 98 lbs. The grain protein content ranged from 11.6% to 14.4% and the test weight ranged from 54.3 lb/bu to 60.2 lb/bu among the 11 entries.

SD20B088-2

SD20B088-2 was developed from a cross SYWolf/Ruth and it has a medium-tall height (Rht-B1b) with medium late maturity. It is a high-yielding line with good test weight and grain protein content. SD20B088-2 has been evaluated for 42-year location trials to date. Overall, in the last 2 years at 23 South Dakota CPT locations, SD20B088-2 ranked 4th in eastern SD (8 locations), 1st in central SD (10 locations), and 1st in western SD (5 locations) among 28 varieties. Additionally, in 2023 USDA North Regional Performance Nursery (NRPN), SD20B088-2 ranked 9th among 48 entries evaluated across 12 locations. It was rated moderately resistant to stem rust, tan spot, and hessian fly (GP type). SD20B088-2 was rated overall good milling and baking quality in USDA, and SDSU evaluations. Across multiple trial locations (2023), its milling quality parameters (average flour yield 67.5 %), mixograph mix time (mins) of 5.1, and mix tolerance of 4.5 and baking quality parameters (average loaf volume 955 cm^3 and specific volume 6.4 cc/g) were comparable to Winner (average flour yield 65.4%, mix time 4.4 and mix tolerance 4.4, average loaf volume 977 cm^3, and specific volume 6.5 cc/g).

SD20D100-9

SD20D100-9 was developed from a cross SYWolf/Ruth and it has a medium-tall height (Rht-B1b) with medium late maturity. It is a high-yielding line with good test weight and good grain protein content. Overall, in the last 2 years at 23 South Dakota CPT locations, SD20D100-9 ranked 10th in eastern SD (8 locations), 7th in central SD (10 locations), and 8th in western SD (5 locations) among 28 varieties. Additionally, in 2023 USDA North Regional Performance Nursery (NRPN), SD20D100-9 ranked 24th among 48 entries evaluated across 12 locations. It has demonstrated above-average FHB tolerance. SD20D100-9 was rated overall good to excellent milling and baking quality in USDA, and SDSU evaluations. Across multiple trial locations (2023), its milling quality parameters (average flour yield 66.8 %), mixograph mix time of 5.5 and mix.

SYNGENTA by Josh Coltrain

SYNGENTA-AGRIPRO WQC Description

Northern and Southern uniform growout increase strips were planted on 10/9/23 at our location in Junction City, KS. The strips had good fall stand establishment. All increases had 80lbs of 11-52-0 applied with the planter with 70lbs of N applied prior to planting. An additional 70lbs of N and 20lbs of Sulfur were top-dressed in the spring prior to jointing. All strips were sprayed with a 13.7oz rate of Trivapro at flag leaf to ensure good quality seed. Growing conditions were fair to above average at the site which provided better yields than most of the growing region. The increase strips were harvested on June 18, 2024 with good yield levels.

NEBRASKA by Katherine Frels

The Northern uniform growout was planted in Lincoln, NE on 10/10/23 into dry conditions. The field was prepared with Finesse (0.3 oz/a + Liberty (43oz/a) and 60lb/a N on 9/1/2023. Timely rains allowed good fall stand establishment, and good snow cover prevented winter damage during the coldest temperatures. The crop progressed normally during the winter and had excellent moisture during the spring. Prowl H2O + 2,4-D and 80lb/a N were applied in the spring. Trivapro was applied at flag leaf, and Miravis Ace was applied at heading to prevent stripe rust and FHB which were observed in nearby fields. Hot and dry conditions at the end of grain fill accelerated maturity and the strips were harvested on 07/10/24 prior to significant rainfall and humidity.

BAYER (WESTBRED) by Adam Bray

Growing Location and Conditions

The 2024 Bayer Hard Winter Wheat Quality Council samples were grown in strips at Hale Center, TX under pivot irrigation. The field was planted 10/12/2023 after crop fallow. Pre-plant fertilizer (50#N, 40#P, 30#K, 10#S) was incorporated, with additional fertility (21#N, 52#P, 0#K, 10#S) applied in furrow at planting. In season fertilizer consisted of one application of 38# 32-0-0 through the center pivot, with a total season applied Nitrogen of 109 pounds. No diseases were observed. Plots received 2.5-inches rain from Oct- Dec 2023 and 3.85-inches rain from Jan-April 2024. Additionally, plots received 5.25-inches of irrigation. Plots were harvested on 6/07/2024 with a yield average of 67bu/ac and test weight average of 63.7 lbs/bu.

XG4108 - N and S WQC Trial

XG4108 is a hard red winter wheat with medium maturity, great straw strength, and excellent test weight. It is a broadly adapted line with improved yield and disease traits compared to

WB4699. It has resistance to Soil-borne Mosaic Virus and Leaf Rust, and moderate resistance to FHB and Stripe Rust. Internal quality testing indicates above average protein with above average functionality. XG4108 is targeted for release in 2025 as a high yielding replacement for WB4699 across the Central and Northern Plains.

Northern Growout: 2024 (Small-Scale) Samples

Test entry number	24-2418	24-2419	24-2420
Sample identification	**SY Monument_CK**	**23Nord-181_ND**	**23Nord-184_ND**
Wheat Data			
GIPSA classification	2 HRW	3 HRW	3 HRW
Test weight (lb/bu)	59.0	56.3	57.9
Hectoliter weight (kg/hl)	77.6	74.2	76.2
1000 kernel weight (gm)	30.5	28.9	32.2
Wheat kernel size (Rotap)			
Over 7 wire (%)	77.1	70.0	74.5
Over 9 wire (%)	22.3	29.4	25.2
Through 9 wire (%)	0.7	0.7	0.3
Single kernel (skcs)[a]			
Hardness (avg /s.d)	64.9/20.4	56.2/20.9	52.7/17.8
Weight (mg) (avg/s.d)	30.5/11.4	28.9/11.0	32.2/11.6
Diameter (mm)(avg/s.d)	2.63/0.48	2.61/0.46	2.71/0.42
Moisture (%) (avg/s.d)	12.0/0.6	12.1/0.7	12.0/0.6
SKCS distribution	05-11-23-61-01	14-21-23-42-03	13-24-30-33-03
Classification	Hard	Mixed	Mixed
Wheat protein (12% mb)	12.4	11.8	12.2
Wheat ash (12% mb)	1.53	1.61	1.53
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	76.2	75.4	75.7
Quadrumat Sr. Mill	68.0	66.8	66.0
Flour moisture (%)	12.9	12.7	12.8
Flour protein (14% mb)	11.2	10.6	11.0
Flour ash (14% mb)	0.50	0.53	0.52
Rapid Visco-Analyser			
Peak time (min)	5.9	5.9	5.9
Peak viscosity (RVU)	180.6	173.9	181.0
Breakdown (RVU)	80.3	76.8	82.4
Final viscosity at 13 min (RVU)	200.7	194.3	192.2
Minolta color meter			
L*	91.08	91.48	91.39
a*	-1.08	-1.64	-1.31
b*	8.74	10.40	9.48
PPO	0.289	0.520	0.243
Falling number (sec)	408	382	390
Damaged Starch			
(AI%)	96.9	96.3	95.7
(AACC76-31)	8.9	8.2	7.6

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

Northern Growout: 2024 (Small-Scale) Samples (continued)

Test entry number	24-2421	23-2422	23-2423
Sample identification	**SD20B088-2_SD**	**SD20D100-9_SD**	**XG4108_WB**
Wheat Data			
GIPSA classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	60.3	60.4	62.0
Hectoliter weight (kg/hl)	79.3	79.5	81.5
1000 kernel weight (gm)	33.1	32.6	34.2
Wheat kernel size (Rotap)			
Over 7 wire (%)	76.3	80.0	84.0
Over 9 wire (%)	23.7	19.7	15.9
Through 9 wire (%)	0.0	0.3	0.1
Single kernel (skcs)[a]			
Hardness (avg /s.d)	64.3/18.8	64.0/21.4	57.8/18.0
Weight (mg) (avg/s.d)	33.1/9.9	32.6/9.6	34.2/9.2
Diameter (mm)(avg/s.d)	2.74/0.38	2.75/0.40	2.83/0.41
Moisture (%) (avg/s.d)	12.0/0.6	12.3/0.7	11.7/0.7
SKCS distribution	04-13-26-57-01	06-17-20-57-01	09-22-23-46-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	12.4	12.3	12.2
Wheat ash (12% mb)	1.61	1.57	1.56
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	75.4	76.6	74.4
Quadrumat Sr. Mill	66.1	66.8	65.6
Flour moisture (%)	12.9	12.9	12.8
Flour protein (14% mb)	11.4	11.2	11.0
Flour ash (14% mb)	0.62	0.56	0.49
Rapid Visco-Analyser			
Peak time (min)	5.9	5.9	6.0
Peak viscosity (RVU)	128.1	144.3	185.9
Breakdown (RVU)	54.2	66.1	81.7
Final viscosity at 13 min (RVU)	152.9	161.9	205.8
Minolta color meter			
L*	90.82	90.86	91.25
a*	-1.01	-0.89	-1.15
b*	9.17	8.32	8.57
PPO	0.541	0.503	0.517
Falling number (sec)	393	378	410
Damaged Starch			
(AI%)	96.2	96.6	96.2
(AACC76-31)	8.2	8.6	8.2

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100. *89%HDWH11%HRW

Northern Growout: Physical Dough Tests and Gluten Analysis 2024 (Small-Scale) Samples

Test Entry Number	24-2418	24-2419	24-2420
Sample Identification	SY Monument_CK	23Nord-181_ND	23Nord-184_ND
MIXOGRAPH			
Flour Abs (% as-is)	66.4	64.0	64.8
Flour Abs (14% mb)	65.1	62.5	63.4
Mix Time (min)	10.0	4.5	6.0
Mix tolerance (0-6)	6	4	5
FARINOGRAPH			
Flour Abs (% as-is)	65.5	61.1	62.8
Flour Abs (14% mb)	64.5	59.8	61.6
Peak time (min)	7.1	6.6	4.3
Mix stability (min)	14.1	14.9	9.8
Mix Tolerance Index (FU)	21	11	28
Breakdown time (min)	14.1	14.6	9.7
ALVEOGRAPH			
P(mm): Tenacity	146	108	112
L(mm): Extensibility	40	71	77
G(mm): Swelling index	14.0	18.7	19.5
W(10^{-4} J): strength (curve area)	248	275	313
P/L: curve configuration ratio	3.65	1.52	1.45
Ie(P_{200}/P): elasticity index	45.7	55.1	57.7
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	688/1139/1205	401/518/500	424/586/671
Extensibility (mm at 45/90/135 min)	130/92/87	154/161/147	147/132/147
Energy (cm^2 at 45/90/135 min)	157/142/123	115/159/134	116/139/175
Resist $_{max}$ (BU at 45/90/135min)	993/1456/1281	585/796/765	633/862/971
Ratio (at 45/90/135 min)	5.3/12.4/13.9	2.6/3.2/3.4	2.9/4.4/4.6
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9, 5+10	2*, 7+9, 5+10
TPP/TMP	1.04	1.20	1.20
SEDIMENTATION TEST			
Volume (ml)	66.6	52.7	59.1

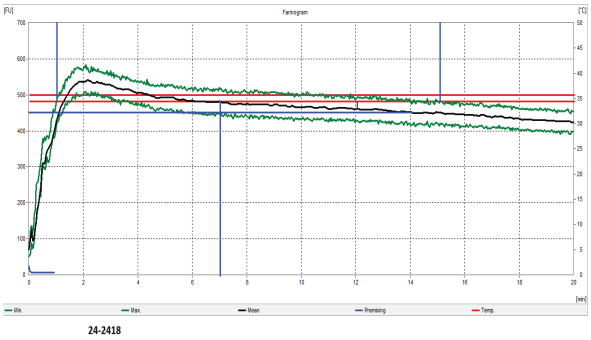
Northern Growout: Physical Dough Tests and Gluten Analysis 2024 (Small-Scale) Samples (continued)

Test Entry Number	24-2421	24-2422	24-2423
Sample Identification	SD20B088-2_SD	SD20D100-9_SD	XG4108_WB
MIXOGRAPH			
Flour Abs (% as-is)	65.2	65.0	65.0
Flour Abs (14% mb)	63.9	63.7	63.6
Mix Time (min)	3.6	4.8	6.0
Mix tolerance (0-6)	3	4	5
FARINOGRAPH			
Flour Abs (% as-is)	63.9	63.1	64.2
Flour Abs (14% mb)	62.9	61.9	63.0
Peak time (min)	6.1	4.9	5.2
Mix stability (min)	10.9	11.2	10.0
Mix Tolerance Index (FU)	20	22	26
Breakdown time (min)	12.2	12.1	11.1
ALVEOGRAPH			
P(mm): Tenacity	113	112	150
L(mm): Extensibility	85	70	34
G(mm): Swelling index	20.5	18.6	12.9
W(10^{-4} J): strength (curve area)	325	298	228
P/L: curve configuration ratio	1.33	1.60	4.41
Ie(P_{200}/P): elasticity index	55.0	58.0	0.0
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	310/360/377	414/543/581	529/727/694
Extensibility (mm at 45/90/135 min)	168/166/170	145/145/140	128/120/110
Energy (cm^2 at 45/90/135 min)	102/121/129	114/145/140	114/140/117
Resist $_{max}$ (BU at 45/90/135min)	457/570/595	630/799/823	723/959/924
Ratio (at 45/90/135 min)	1.8/2.2/2.2	2.9/3.7/4.2	4.1/6.1/6.3
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	1, 7+9, 5+10	2*, 7+8, 5+10
TPP/TMP	1.05	1.10	0.95
SEDIMENTATION TEST			
Volume (ml)	49.4	51.3	56.2

Physical Dough Tests – Farino and Mixo

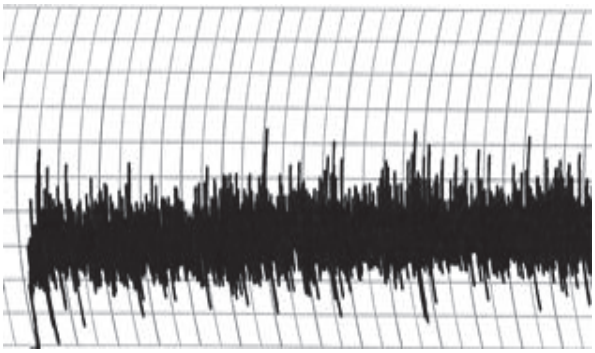
2024 (Small Scale) Samples – Northern Growout

Farinograms



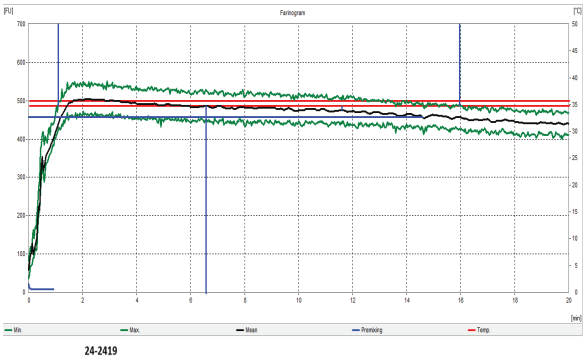
Water abs = 64.5%, Peak time = 7.1 min,
Mix stab = 14.1 min, MTI = 21 FU

Mixograms

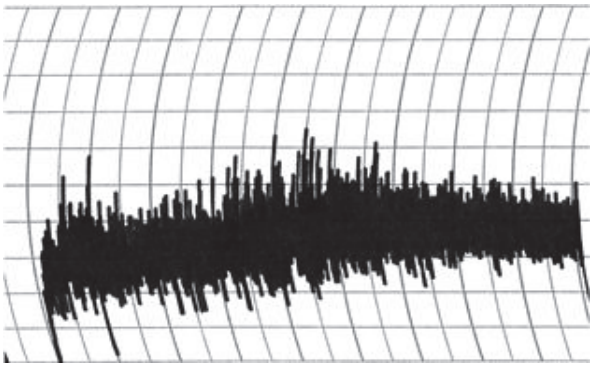


Water abs = 65.1%
Mix time = 10.0 min

24-2418, SY Mounment_CK



Water abs = 59.8%, Peak time = 6.6 min,
Mix stab = 14.9 min, MTI = 11 FU



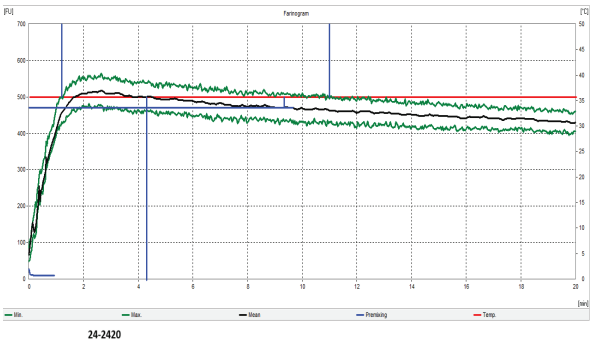
Water abs = 62.5%
Mix time = 4.5 min

24-2419, 23Nord-181_ND

Physical Dough Tests – Farino and Mixo

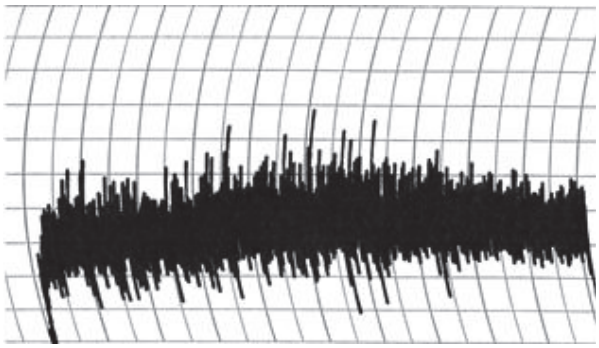
2024 (Small Scale) Samples – Northern Growout (Continued)

Farinograms



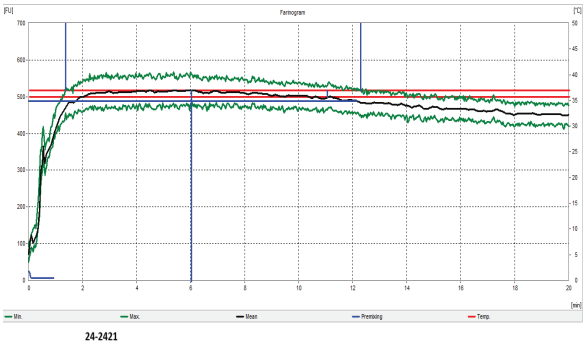
Water abs = 61.6%, Peak time = 4.3 min,
Mix stab = 9.8 min, MTI = 28 FU

Mixograms

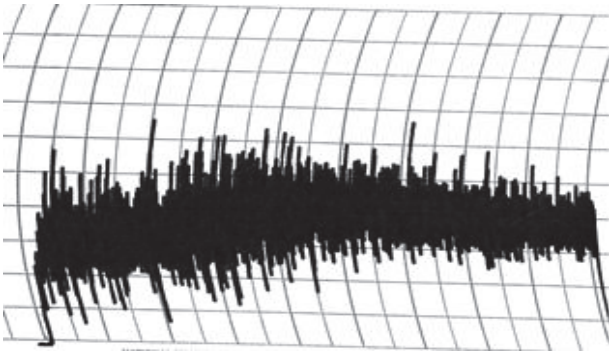


Water abs = 63.4%
Mix time = 6.0 min

24-2420, 23Nord-184_ND



Water abs = 62.9%, Peak time = 6.1 min,
Mix stab = 10.9 min, MTI = 20 FU



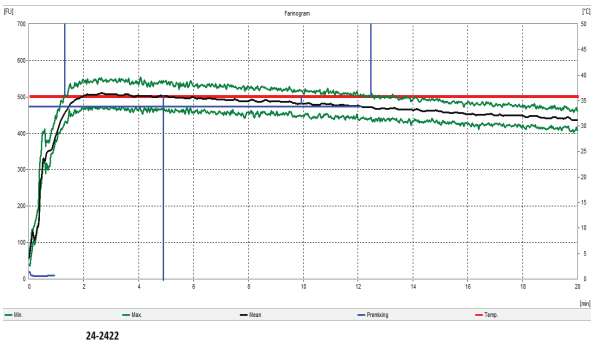
Water abs = 63.9%
Mix time = 3.6 min

24-2421, SD20B088-2_SD

Physical Dough Tests - Farino and Mixo

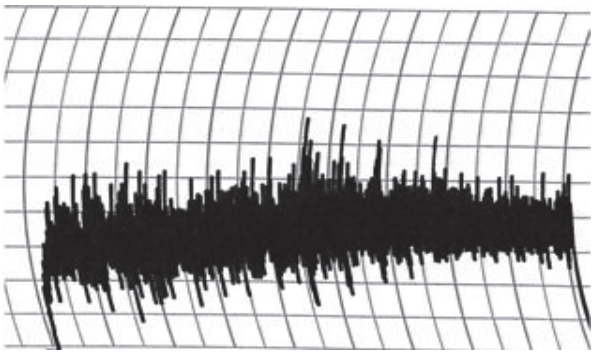
2024 (Small Scale) Samples – Northern Growout (Continued)

Farinograms



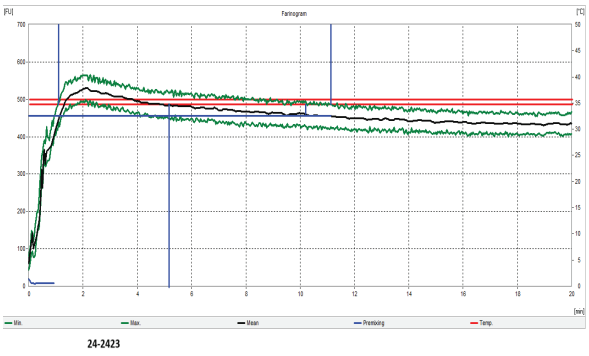
Water abs = 61.9%, Peak time = 4.9 min,
Mix stab = 11.2 min, MTI = 22 FU

Mixograms

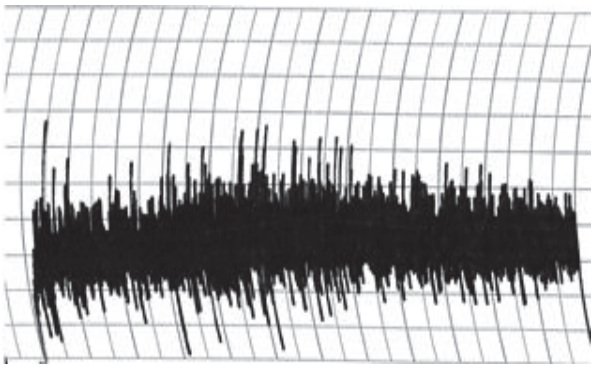


Water abs = 63.7%
Mix time = 4.8 min

24-2422, SD20D100-9_SD



Water abs = 63.0%, Peak time = 5.2 min,
Mix stab = 10.0 min, MTI = 26 FU

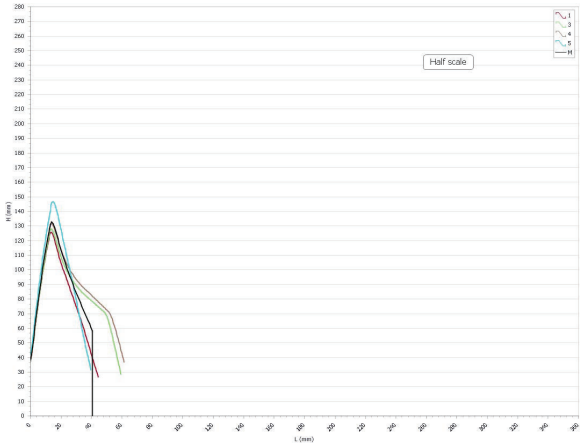


Water abs = 63.6%
Mix time = 6.0 min

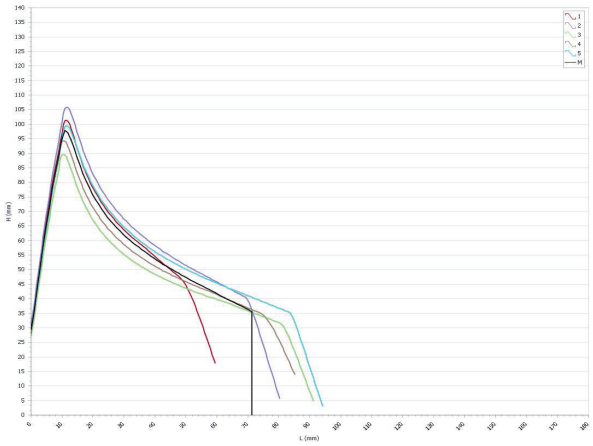
24-2423, XG4108_WB

Physical Dough Tests - Alveograms

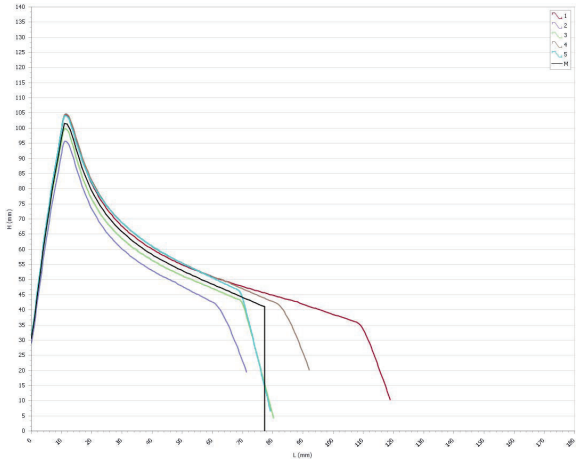
2024 (Small Scale) Samples – Northern Growout



24-2418, SY Monument_CK
P(mm H_20) = 146, L(mm) = 40, W($10E^{-4}$ J) = 248



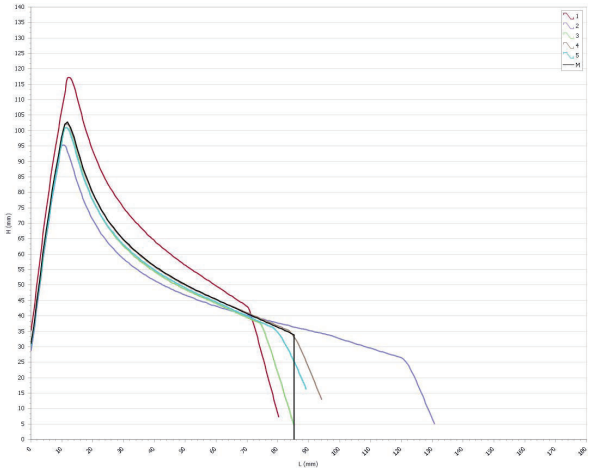
24-2419, 23Nord-181_ND
P(mm H_20) = 108, L(mm) = 71, W($10E^{-4}$ J) = 275



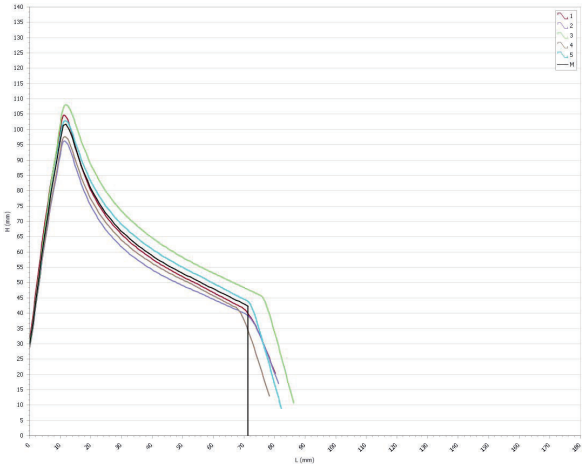
24-2420, 23Nord-184_ND
P(mm H_20) = 112, L(mm) = 77, W($10E^{-4}$ J) = 313

Physical Dough Tests - Alveograms

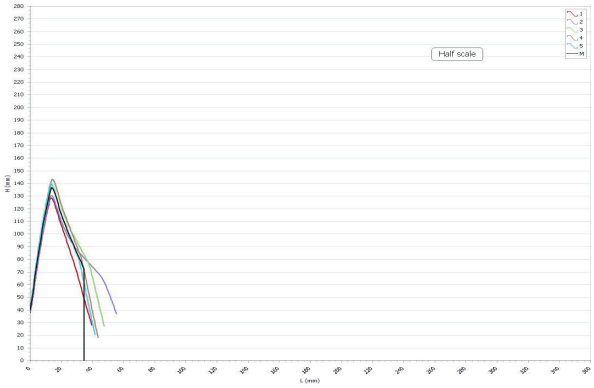
2024 (Small Scale) Samples – Northern Growout (Continued)



24-2421, SD20B088-2_SD
P(mm H_20) = 133, L(mm) = 85, W($10E^{-4}$ J) = 325



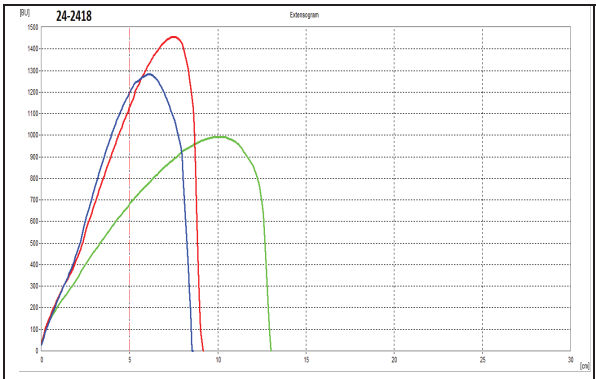
24-2422, SD20D100-9_SD
P(mm H_20) = 112, L(mm) = 70, W($10E^{-4}$ J) = 298



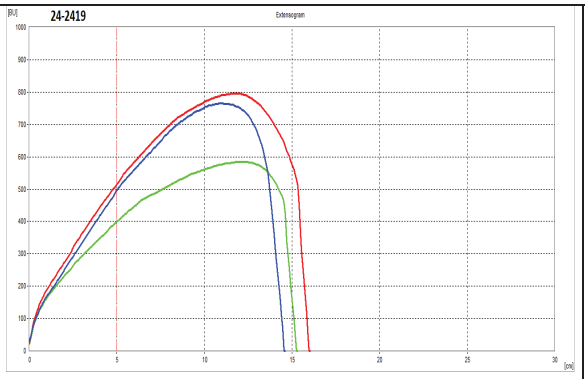
24-2423, XG4108_WB
P(mm H_20) = 150, L(mm) = 34, W($10E^{-4}$ J) = 228

Physical Dough Tests - Extensigrams

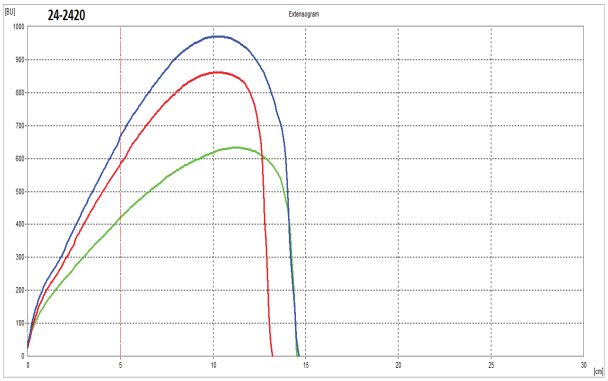
2024 (Small Scale) Samples – Northern Growout



24-2418, SY Monument_CK
R (BU) =1139, E (mm) = 92, W (cm^2) = 142
Rmax (BU) = 1456, Ratio = 12.4 at 90 min



24-2419, 23Nord-181_ND
R (BU) = 518, E (mm) = 161, W (cm^2) = 160
Rmax (BU) = 796, Ratio = 3.2 at 90 min

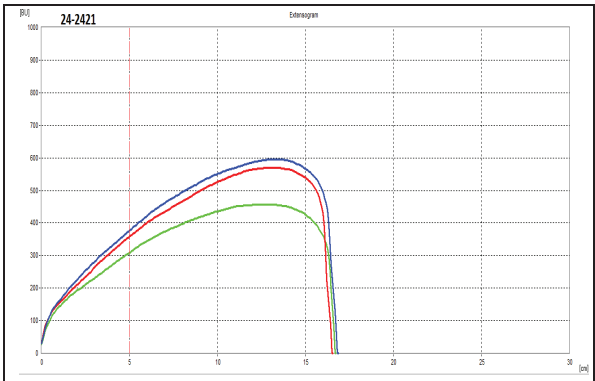


24-2420, 23Nord-184_ND
R (BU) = 586, E (mm) = 132, W (cm^2) = 139
Rmax (BU) = 862, Ratio = 4.4 at 90 min

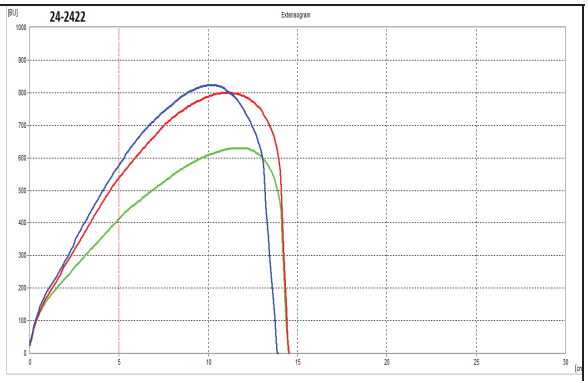
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigrams

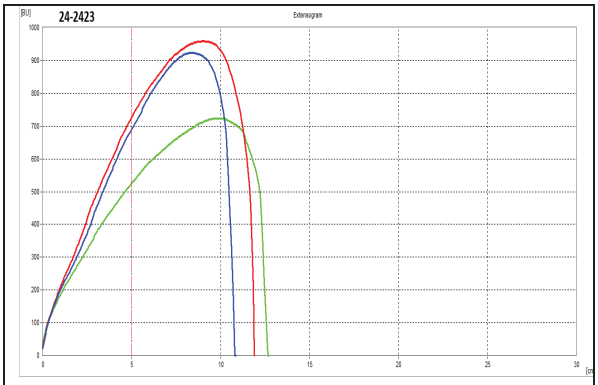
2024 (Small Scale) Samples – Northern Growout (Continued)



24-2421, SD20B088_SD
R (BU) = 360, E (mm) = 166, W (cm^2) = 121
Rmax (BU) = 570, Ratio = 3.4 at 90 min



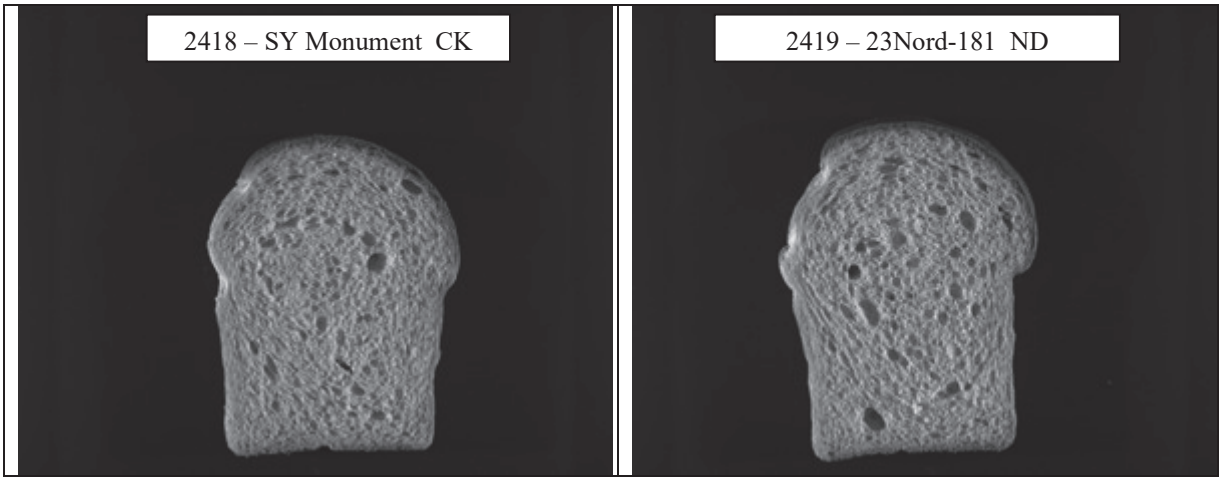
24-2422, SD20D100-9_SD
R (BU) = 543, E (mm) = 145, W (cm^2) = 145
Rmax (BU) = 799, Ratio = 3.7 at 90 min



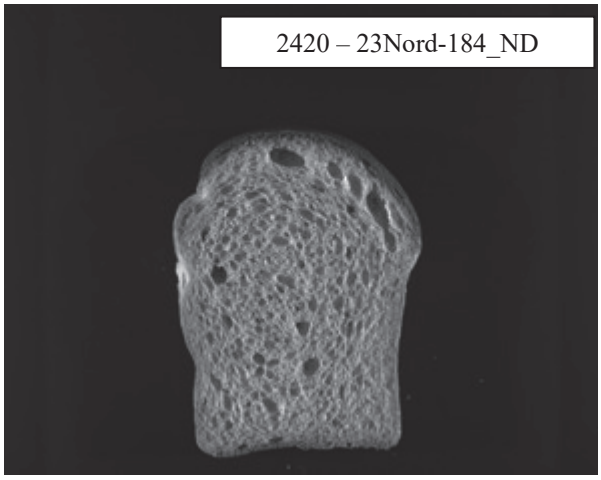
24-2423, XG4108_WB
R (BU) = 727, E (mm) = 120, W (cm^2) = 140
Rmax (BU) = 959, Ratio = 6.1 at 90 min

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.

Northern Growout: C-Cell Bread Images and Analysis
2024 (Small-Scale) Samples

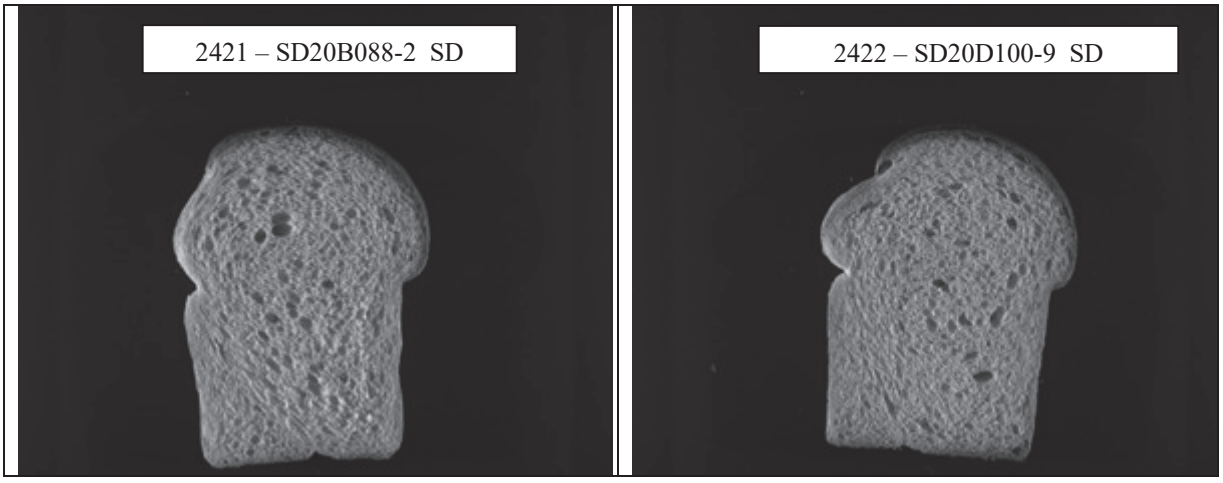


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2418	6277	116	3721	0.430	2.025	1.315	1.755	-4.70
2419	6682	118	3520	0.445	2.305	3.895	1.780	-5.45



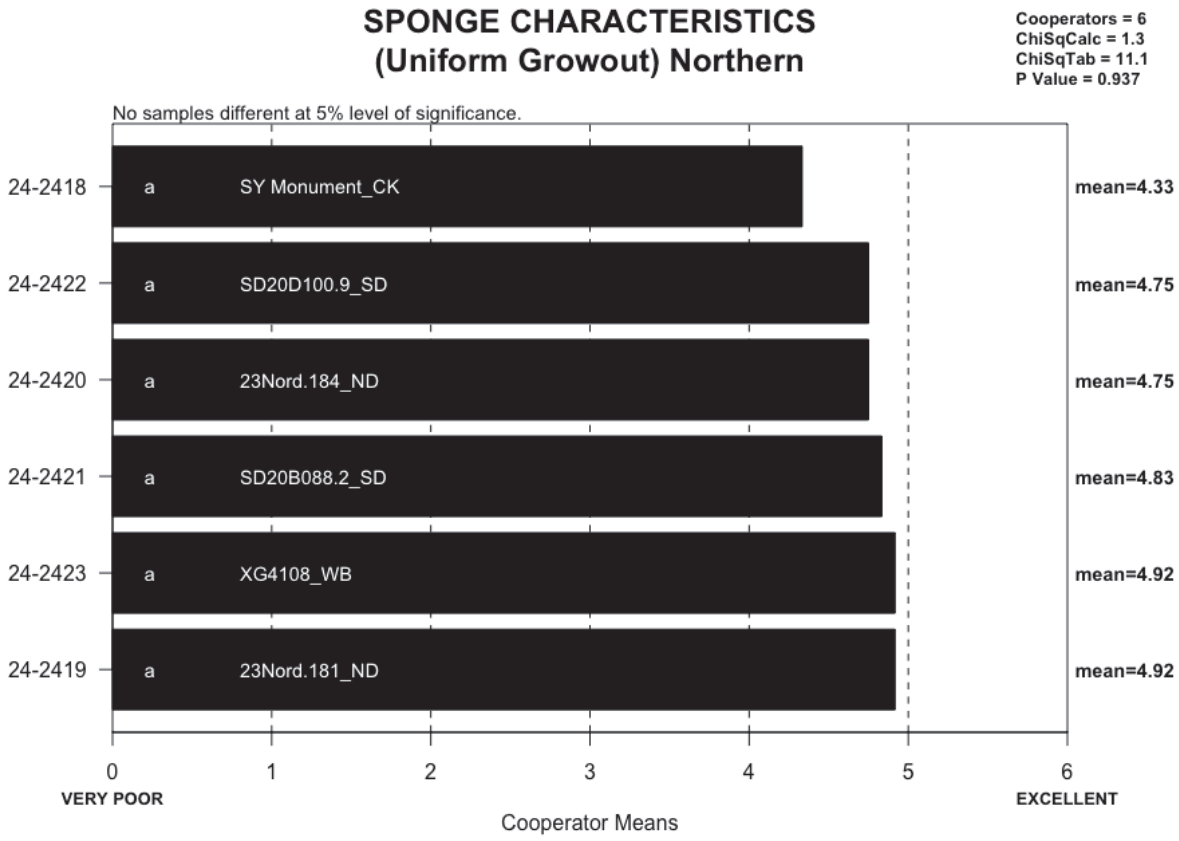
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2420	6352	114	3447	0.435	2.185	3.235	1.830	0.45

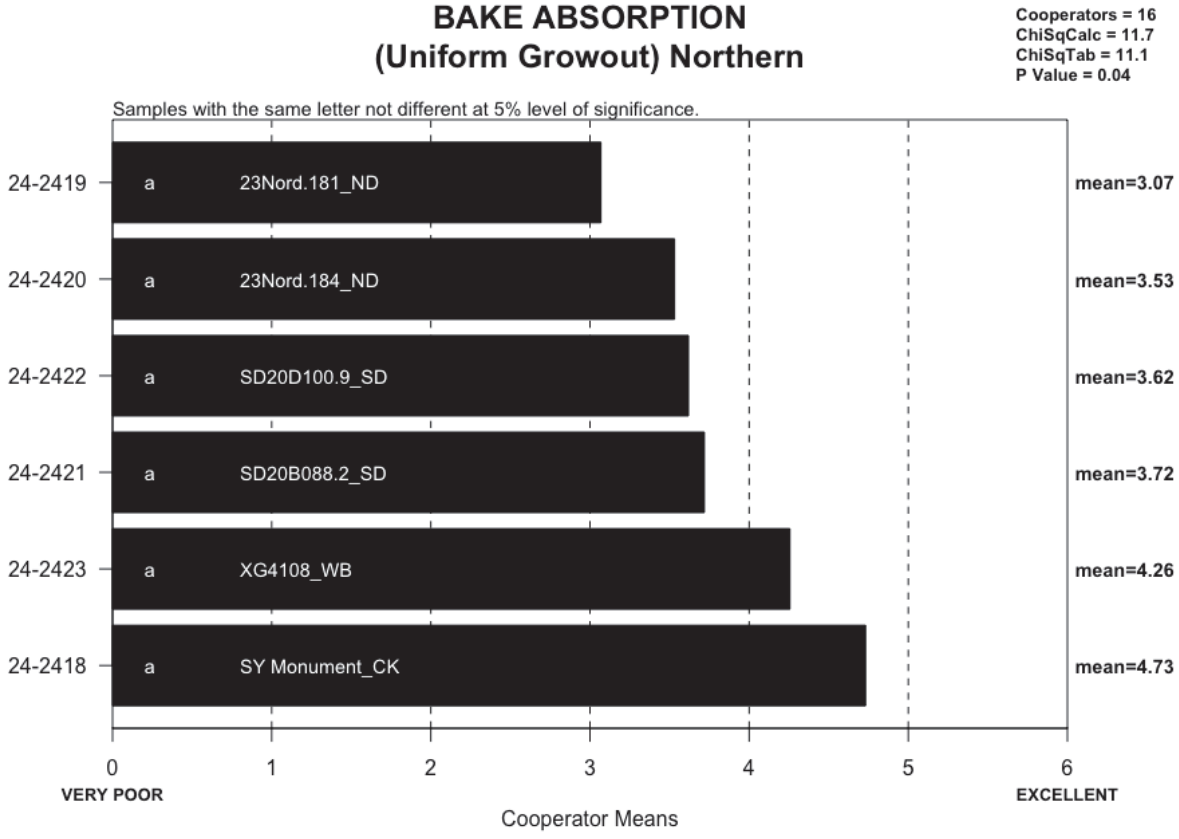
Northern Growout: C-Cell Bread Images and Analysis
2024 (Small-Scale) Samples (Continued)



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})
2421	6681	118	3736	0.435	2.205	4.330	1.755	-6.50
2422	6498	116	4134	0.410	1.870	2.355	1.825	-6.00

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})
2423	5707	116	3669	0.415	1.800	0.995	1.780	-6.15


SPONGE CHARACTERISTICS
(Uniform Growout) Northern
Cooperators = 6
ChiSqCalc = 1.3
ChiSqTab = 11.1
P Value = 0.937
No samples different at 5% level of significance.
24-2418 a SY Monument_CK mean=4.33
24-2422 a SD20D100.9_SD mean=4.75
24-2420 a 23Nord.184_ND mean=4.75
24-2421 a SD20B088.2_SD mean=4.83
24-2423 a XG4108_WB mean=4.92
24-2419 a 23Nord.181_ND mean=4.92
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

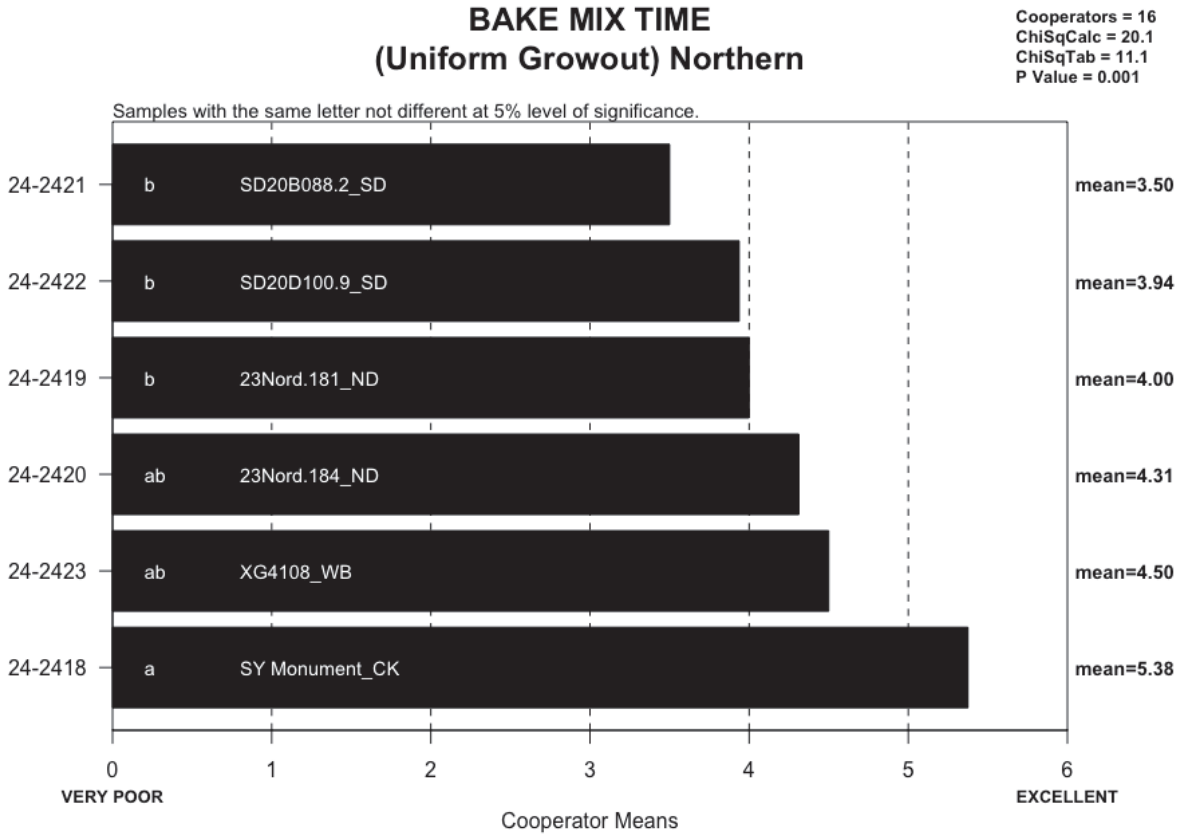

BAKE ABSORPTION
(Uniform Growout) Northern
Cooperators = 16
ChiSqCalc = 11.7
ChiSqTab = 11.1
P Value = 0.04
Samples with the same letter not different at 5% level of significance.
24-2419 a 23Nord.181_ND mean=3.07
24-2420 a 23Nord.184_ND mean=3.53
24-2422 a SD20D100.9_SD mean=3.62
24-2421 a SD20B088.2_SD mean=3.72
24-2423 a XG4108_WB mean=4.26
24-2418 a SY Monument_CK mean=4.73
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

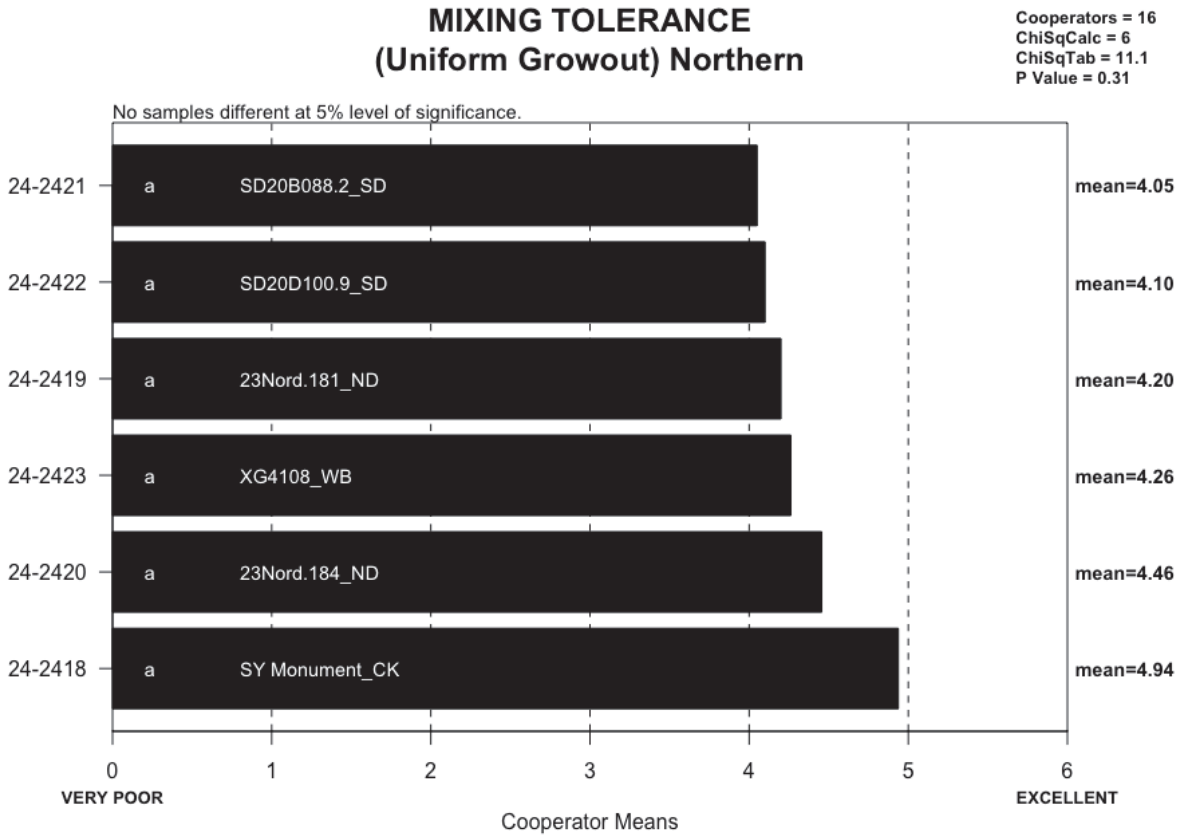
BAKE ABSORPTION, ACTUAL (14% MB)
(Uniform Growout) Northern
Cooperators A – P

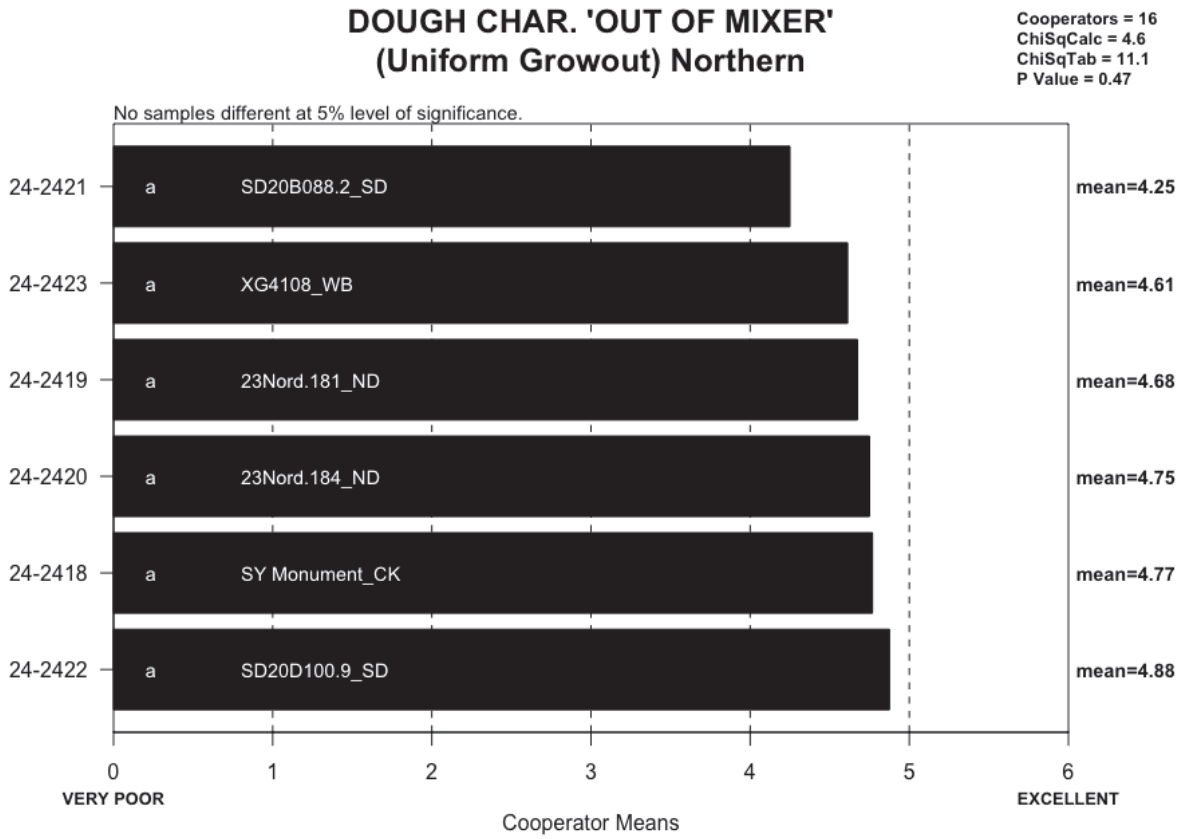
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2418	SY Monument_CK	58	68.0	69.4	64.5	62.7	62.4	65.6	61.9	68.8	65.3	65	66.5	64.5	61	68.5	64.6
24-2419	23Nord.181_ND	57	66.0	63.3	59.8	61.6	62.4	62.4	58.7	63.4	62.4	60	61.8	59.8	59	64.1	61.0
24-2420	23Nord.184_ND	58	65.0	66.1	61.6	62.0	63.1	63.6	60.9	65.1	63.4	62	63.6	61.6	60	65.8	61.6
24-2421	SD20B088.2_SD	58	65.5	65.8	62.9	62.0	62.8	64.1	61.9	64.1	63.8	63	64.9	62.9	61	66.9	62.0
24-2422	SD20D100.9_SD	58	65.0	65.2	61.9	62.4	62.8	63.5	60.8	66.3	63.8	62	63.9	61.9	61	66.1	62.1
24-2423	XG4108_WB	58	69.0	66.3	63.0	62.1	62.2	63.5	61.8	67.5	63.4	63	65.0	63.0	60	67.2	63.0

BAKE MIX TIME, ACTUAL
(Uniform Growout) Northern
Cooperators A – P

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2418	SY Monument_CK	10	8.5	8.8	18	11.3	7.8	14.5	10	6.0	9.5	14	20	8	8.2	7	10
24-2419	23Nord.181_ND	6	5.4	5.0	12	7.4	5.0	7.5	5	5.0	5.6	14	13	8	4.3	7	6
24-2420	23Nord.184_ND	6	5.6	5.5	12	8.2	5.3	9.5	6	5.5	6.5	17	20	5	5.2	7	6
24-2421	SD20B088.2_SD	5	4.3	4.5	12	6.2	4.0	6.0	4	5.0	4.8	10	11	7	4.1	6	5
24-2422	SD20D100.9_SD	6	5.0	5.0	16	6.9	4.8	7.5	5	5.3	5.5	12	15	6	4.5	7	6
24-2423	XG4108_WB	6	6.1	6.3	13	8.5	5.7	10.8	4	5.8	7.5	15	20	6	5.3	8	7

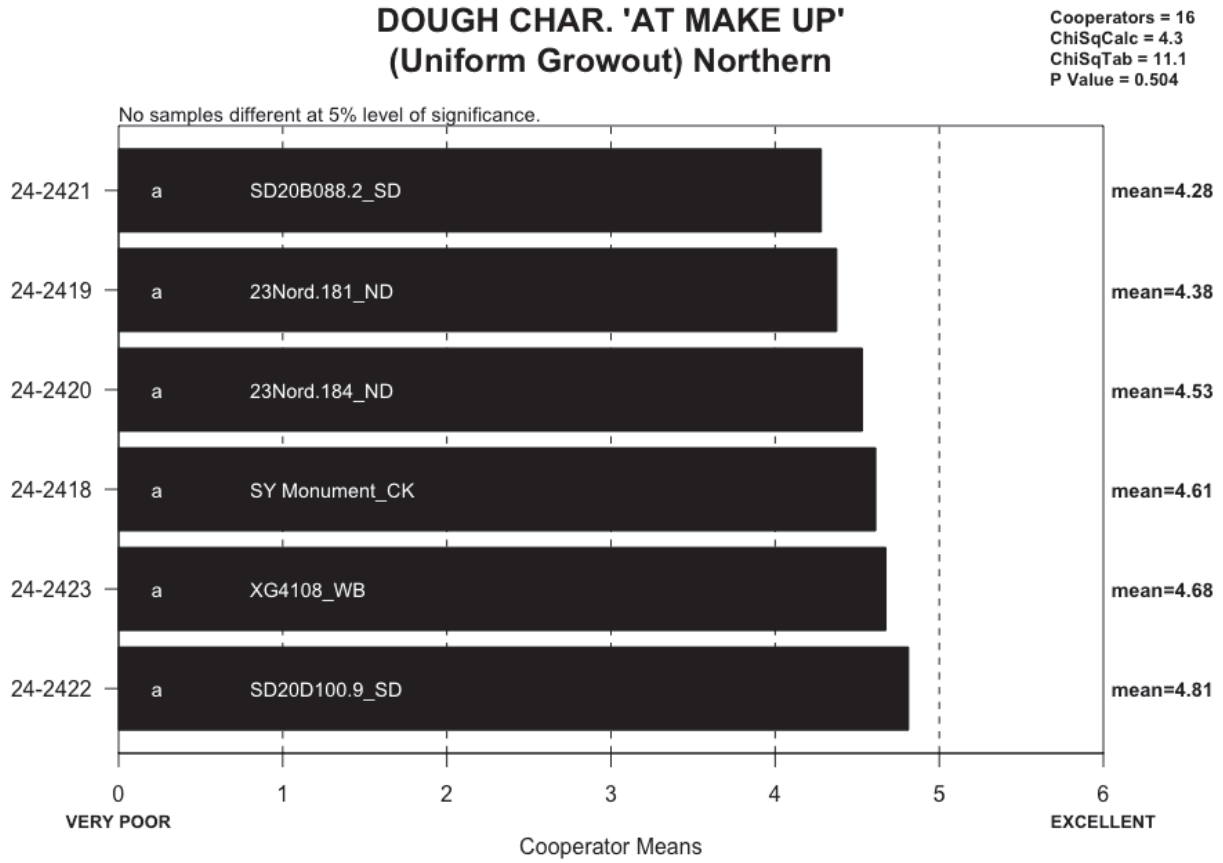

BAKE MIX TIME
(Uniform Growout) Northern
Cooperators = 16
ChiSqCalc = 20.1
ChiSqTab = 11.1
P Value = 0.001
Samples with the same letter not different at 5% level of significance.
24-2421
b
SD20B088.2_SD
mean=3.50
24-2422
b
SD20D100.9_SD
mean=3.94
24-2419
b
23Nord.181_ND
mean=4.00
24-2420
ab
23Nord.184_ND
mean=4.31
24-2423
ab
XG4108_WB
mean=4.50
24-2418
a
SY Monument_CK
mean=5.38
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Uniform Growout) Northern
Cooperators = 16
ChiSqCalc = 6
ChiSqTab = 11.1
P Value = 0.31
No samples different at 5% level of significance.
24-2421
a
SD20B088.2_SD
mean=4.05
24-2422
a
SD20D100.9_SD
mean=4.10
24-2419
a
23Nord.181_ND
mean=4.20
24-2423
a
XG4108_WB
mean=4.26
24-2420
a
23Nord.184_ND
mean=4.46
24-2418
a
SY Monument_CK
mean=4.94
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means



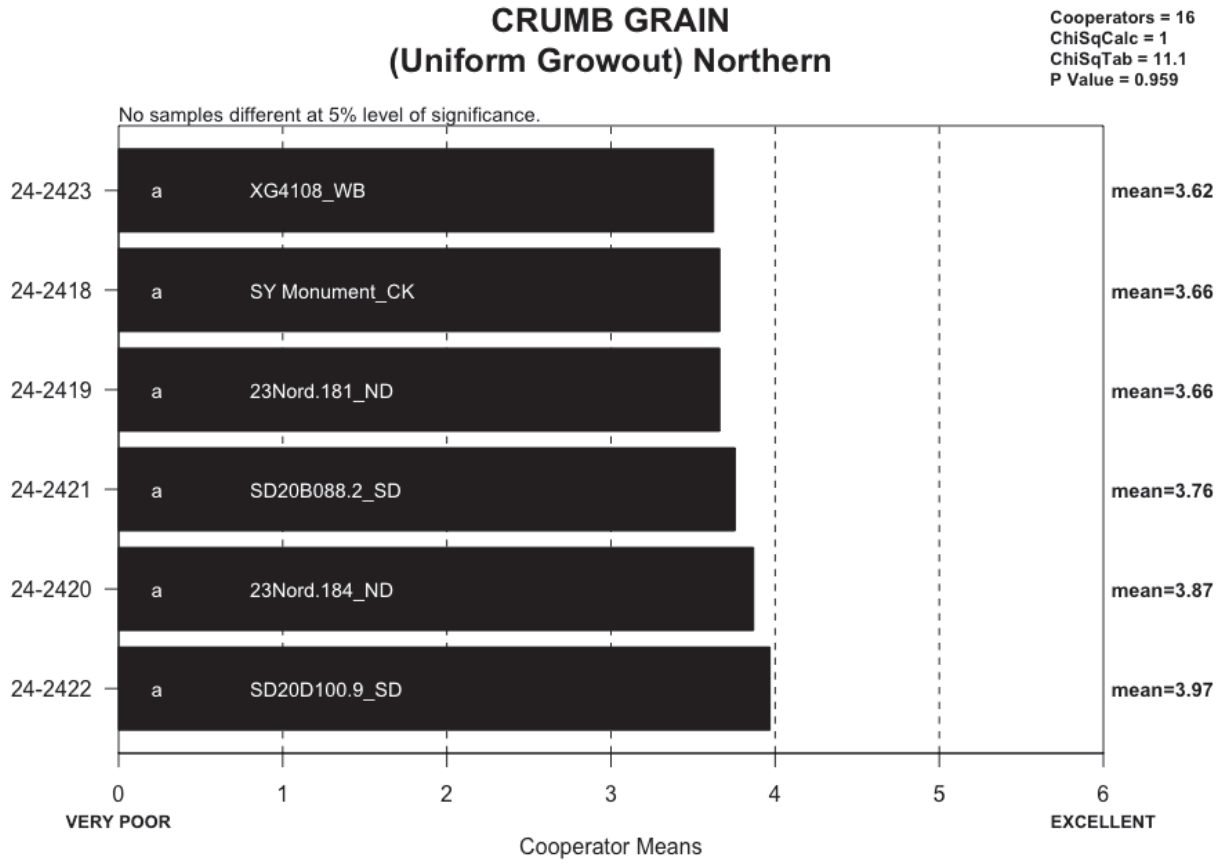
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Uniform Growout) Northern

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
24-2418	SY Monument_CK	2	0	2	10	2
24-2419	23Nord.181_ND	1	1	3	9	2
24-2420	23Nord.184_ND	1	0	2	10	3
24-2421	SD20B088.2_SD	4	2	1	8	1
24-2422	SD20D100.9_SD	1	1	1	7	6
24-2423	XG4108_WB	1	1	2	8	4



DOUGH CHAR. 'AT MAKE UP', DESCRIBED (Uniform Growout) Northern

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
24-2418	SY Monument_CK	0	1	4	7	4
24-2419	23Nord.181_ND	1	1	3	10	1
24-2420	23Nord.184_ND	1	1	4	7	3
24-2421	SD20B088.2_SD	3	3	1	5	4
24-2422	SD20D100.9_SD	1	0	1	9	5
24-2423	XG4108_WB	1	0	3	8	4

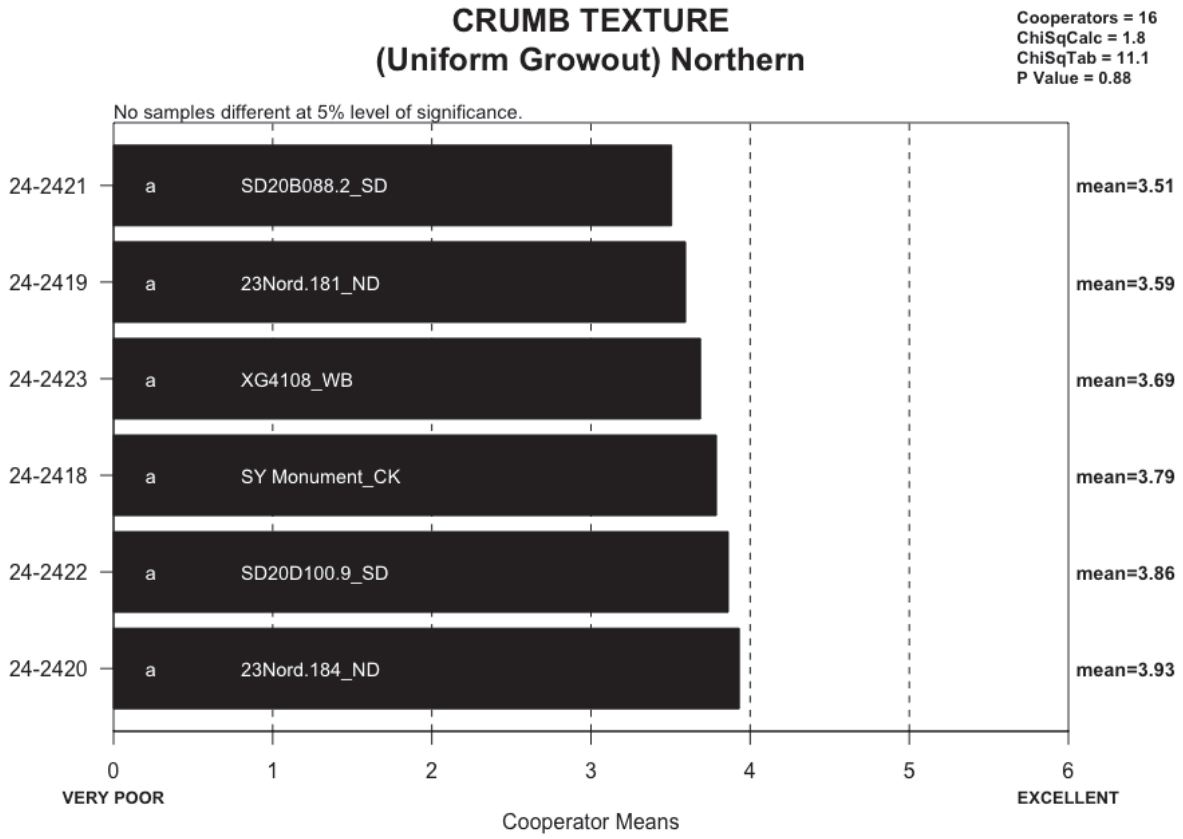


CRUMB GRAIN, DESCRIBED
(Uniform Growout) Northern

IDCODE	ID	Open	Fine	Dense
24-2418	SY Monument_CK	6	4	6
24-2419	23Nord.181_ND	10	4	2
24-2420	23Nord.184_ND	6	7	3
24-2421	SD20B088.2_SD	10	3	3
24-2422	SD20D100.9_SD	9	4	3
24-2423	XG4108_WB	10	4	2

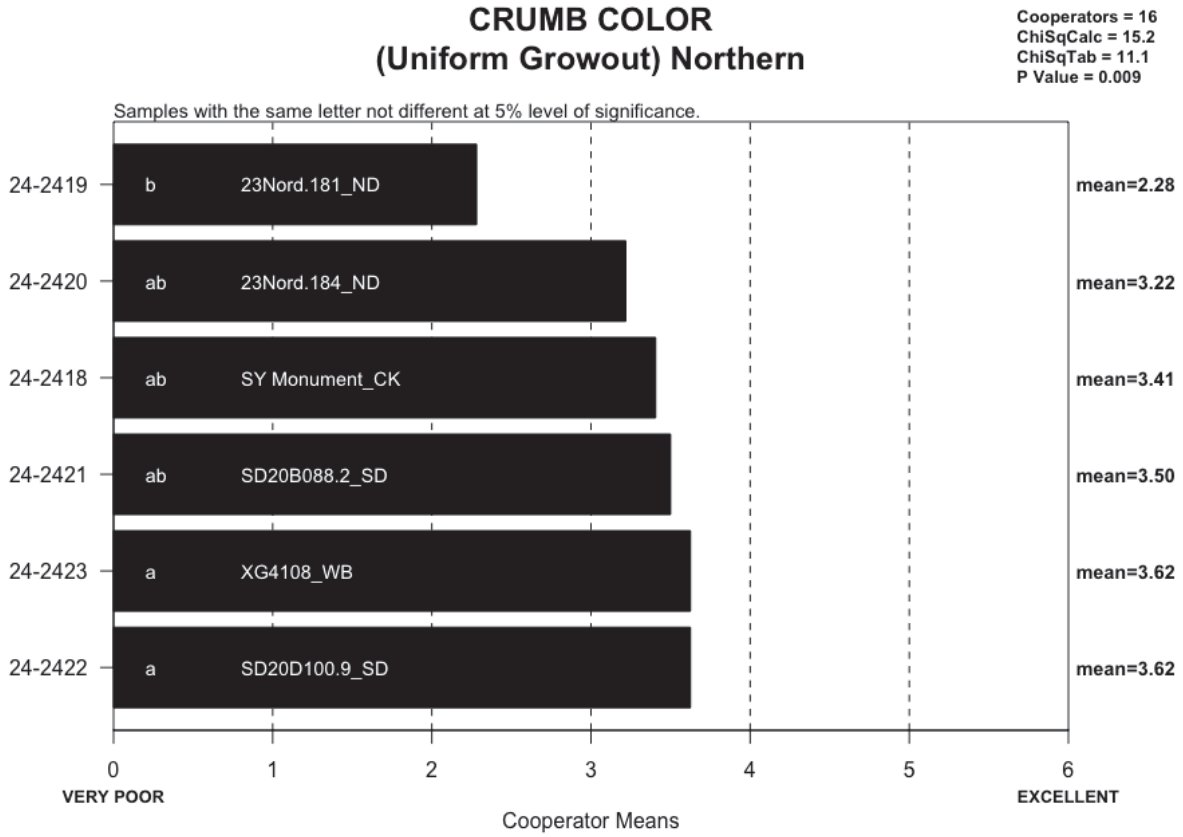
CELL SHAPE, DESCRIBED
(Uniform Growout) Northern

IDCODE	ID	Round	Irregular	Elongated
24-2418	SY Monument_CK	8	3	5
24-2419	23Nord.181_ND	7	7	2
24-2420	23Nord.184_ND	7	7	2
24-2421	SD20B088.2_SD	9	4	3
24-2422	SD20D100.9_SD	4	7	5
24-2423	XG4108_WB	7	4	5



CRUMB TEXTURE, DESCRIBED
(Uniform Growout) Northern

IDCODE	ID	Harsh	Smooth	Silky
24-2418	SY Monument_CK	6	7	3
24-2419	23Nord.181_ND	6	9	1
24-2420	23Nord.184_ND	2	12	2
24-2421	SD20B088.2_SD	7	6	3
24-2422	SD20D100.9_SD	4	11	1
24-2423	XG4108_WB	5	10	1



CRUMB COLOR, DESCRIBED
(Uniform Growout) Northern

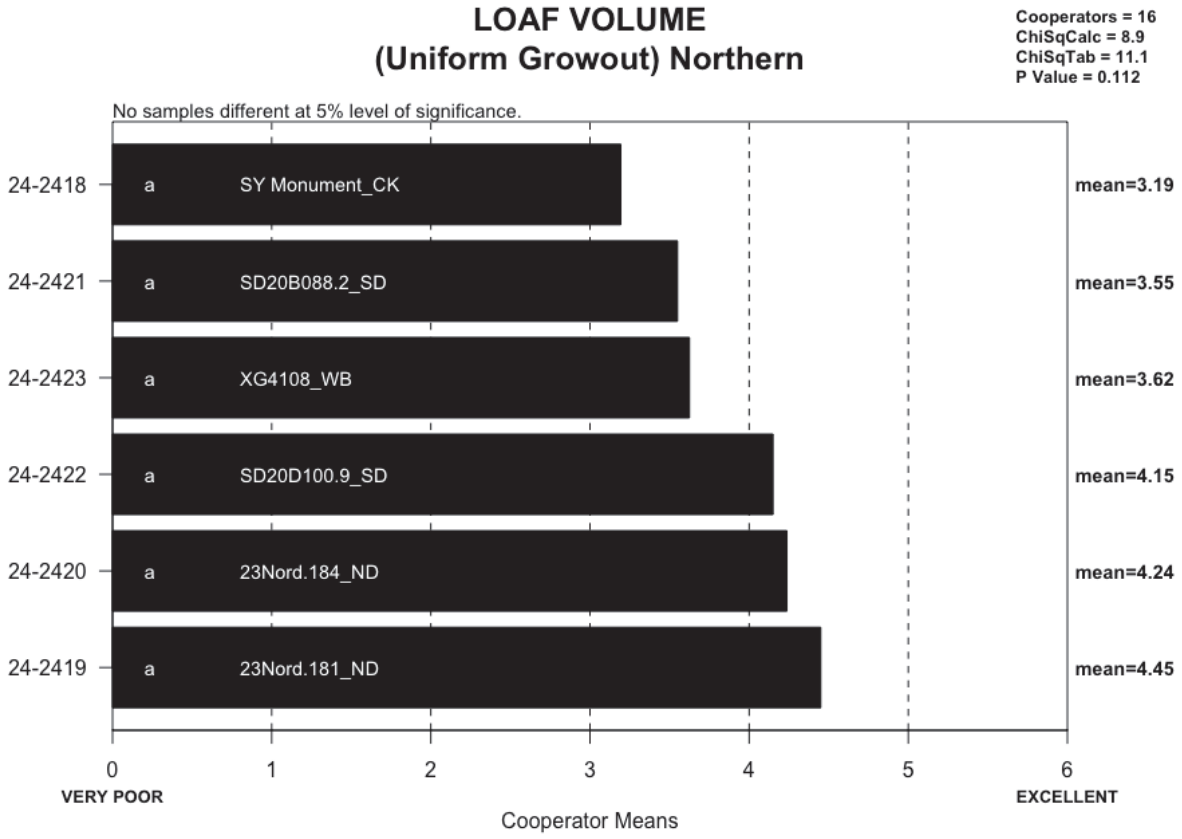
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright_White
24-2418	SY Monument_CK	1	0	2	6	4	3	0
24-2419	23Nord.181_ND	0	2	10	1	3	0	0
24-2420	23Nord.184_ND	0	1	3	5	7	0	0
24-2421	SD20B088.2_SD	0	0	3	3	7	3	0
24-2422	SD20D100.9_SD	0	0	3	4	4	5	0
24-2423	XG4108_WB	0	0	2	6	3	5	0

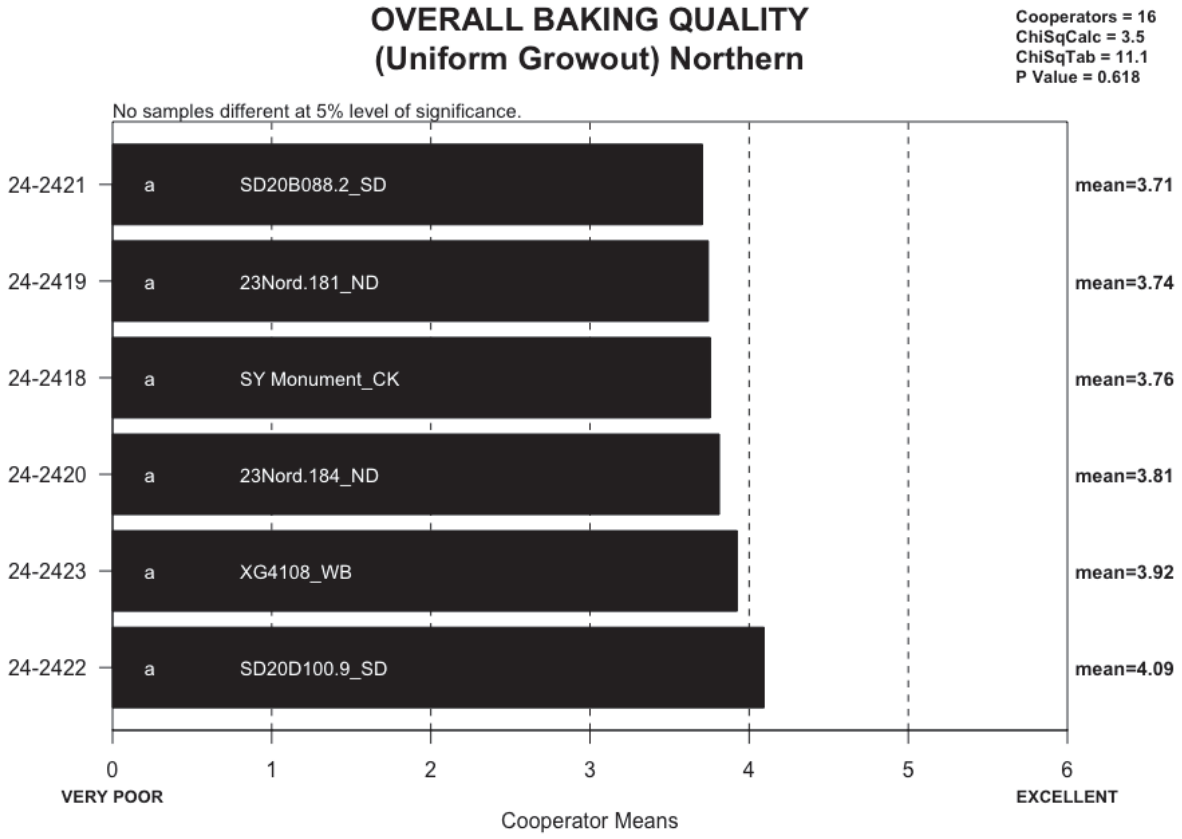
LOAF WEIGHT, ACTUAL
(Uniform Growout) Northern
Cooperators A – P

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2418	SY Monument_CK	411	145.9	145.8	459.0	139.0	149.9	151.0	481.0	135.8	139.9	473.9	431.0	460	140.7	437	140.8
24-2419	23Nord.181_ND	413	138.0	143.5	460.5	138.6	142.8	148.4	475.2	131.5	140.0	472.3	432.1	462	138.4	436	139.0
24-2420	23Nord.184_ND	412	139.3	143.6	456.0	139.6	153.1	147.9	481.9	130.9	140.0	469.9	433.0	458	138.6	432	139.4
24-2421	SD20B088.2_SD	417	138.4	144.3	452.5	139.3	155.0	148.0	484.9	130.8	139.2	471.1	432.6	458	139.3	434	136.6
24-2422	SD20D100.9_SD	409	137.5	143.1	458.5	139.5	153.4	149.1	481.3	129.3	138.2	475.9	430.9	458	138.2	433	135.9
24-2423	XG4108_WB	410	144.7	141.8	459.5	141.7	150.6	148.7	481.3	132.8	140.8	472.9	432.6	464	140.7	432	138.1

LOAF VOLUME, ACTUAL
(Uniform Growout) Northern
Cooperators A – P

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
24-2418	SY Monument_CK	2875	950	935	1931	863	820	795	2388	760	823	2817	2525	2464	825	2147	730
24-2419	23Nord.181_ND	2925	995	965	2059	965	864	895	2488	915	896	3001	2900	2604	925	2327	795
24-2420	23Nord.184_ND	2875	935	960	2109	925	912	840	2450	905	842	3022	2775	2531	925	2398	790
24-2421	SD20B088.2_SD	2625	905	890	2178	980	870	905	2350	865	855	2780	2550	2536	950	2268	905
24-2422	SD20D100.9_SD	2750	950	965	2023	990	869	910	2338	885	881	2927	2700	2536	975	2360	850
24-2423	XG4108_WB	2750	1030	980	2170	854	824	745	2438	870	777	3015	2800	2395	800	2410	745


LOAF VOLUME
(Uniform Growout) Northern
Cooperators = 16
ChiSqCalc = 8.9
ChiSqTab = 11.1
P Value = 0.112
No samples different at 5% level of significance.
24-2418 a SY Monument_CK mean=3.19
24-2421 a SD20B088.2_SD mean=3.55
24-2423 a XG4108_WB mean=3.62
24-2422 a SD20D100.9_SD mean=4.15
24-2420 a 23Nord.184_ND mean=4.24
24-2419 a 23Nord.181_ND mean=4.45
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Uniform Growout) Northern
Cooperators = 16
ChiSqCalc = 3.5
ChiSqTab = 11.1
P Value = 0.618
No samples different at 5% level of significance.
24-2421 a SD20B088.2_SD mean=3.71
24-2419 a 23Nord.181_ND mean=3.74
24-2418 a SY Monument_CK mean=3.76
24-2420 a 23Nord.184_ND mean=3.81
24-2423 a XG4108_WB mean=3.92
24-2422 a SD20D100.9_SD mean=4.09
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Uniform Growout) Northern
Cooperators A – P

24-2418	**SY Monument_CK**
A	Good overall
B	High bake absorption for lower protein, long bake mix time, dough feel improved at make up from good to excellent, good crumb grain with good loaf volume relative to protein
C	long time to pick up, rough break
D	No comment
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, High Loaf Volume, Dull Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Longest mix time, avg absorption. Dense, round, harsh textured crumb grain. Very low volume. Excellent mix toler.
H	Average absorption. Good dough at make up. Dense round, harsh textured crumb grain. Very low volume.
I	No comment
J	No comment
K	High absorption; good stability and mix time - was sticky at handling; volume ok.
L	High mix time and absorption. Good stability. Fair protein. Low volume. Negative bench comments.
M	No comment
N	No comment
O	No comment
P	No comment
24-2419	**23Nord-181_ND**
A	Short mix good volume
B	Lowest protein of set, higher bake absorption for low protein, great dough feel, ok crumb grain but dark yellow color, high loaf volume relative to protein
C	dull flour and dough
D	No comment
E	Medium Water Abs, Long MT, Slight Sticky & Strong Dough, Very High Loaf Volume, Yellow Crumb Grain, Slightly Open Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Long mix time, lowest absorp. Good dough throughout. Open, round, very dark yellow crumb grain.Avg volume.
H	Lowest absorption. Short mix time. Tough dough. Open, dark yellow colored crumb grain. Low volume.
I	No comment
J	No comment
K	Good other than yellow crumb color and slightly lower absorption. Had excellent volume.
L	Low protein. Good stability, absorption, mix time and volume. Slight yellow color.*
M	No comment
N	No comment
O	No comment
P	No comment

COOPERATOR'S COMMENTS
(Uniform Growout) Northern
Cooperators A – P

24-2420	**23Nord-184_ND**
A	Short mix good volume
B	Good dough feel, good crumb grain but dull color, good loaf volume relative to protein
C	nice loaf externals
D	No comment
E	High Water Abs, Long MT, Slight Sticky & Strong Dough, Very High Loaf Volume, Yellow Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Long mix time, lower absorption. Open, round, dark yellow crumb grain.Low volume. Good mix tolerance.
H	Average absorption & mix time. Open crumb grain. Low volume & mix toler.
I	No comment
J	No comment
K	Overall very good.
L	High absorption and mix time. Good protein and volume. Low stability.
M	No comment
N	No comment
O	No comment
P	No comment
24-2421	**SD20B088-2_SD**
A	Short mix Lower volume Slightly soft dough
B	Open crumb grain but ok color, ok loaf volume relative to protein
C	No comment
D	No comment
E	High Water Abs, Long MT, Slight Sticky & Strong Dough, Very High Loaf Volume, Yellow Crumb Grain, Slightly Open Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Good mix time. Low absorp. Tough dough throughout. Average open grain. Good volume.
H	Average absorption, very short mix time. Open round, harsh textured crumb grain. Very low volume. Low mix toler.
I	No comment
J	No comment
K	Shorter stability / mix time; sticky at handling; low to average volume.
L	High absorption. Fair mix time and stability. Low volume. Good protein.
M	No comment
N	No comment
O	No comment
P	No comment

COOPERATOR'S COMMENTS
(Uniform Growout) Northern
Cooperators A – P

24-2422	**SD20D100-9_SD**
A	Good out of mixer Lower volume Open grain
B	Good dough feel, good crumb grain and white color, good loaf volume relative to protein
C	nice loaf externals
D	No comment
E	High Water Abs, Long MT, Slight Sticky & Strong Dough, Very High Loaf Volume, Yellow Crumb Grain, Fine Elongate Cells, Good Resilient & Very Smooth Texture
F	No comment
G	Long mix time, lower absoprtion. Avg open grain, but smooth textured. Good volume and mix tolerance.
H	Short mix time. Good dough at make up. Open harsh textured crumb grain. Very low volume. Low mix toler.
I	No comment
J	No comment
K	Overall very good. Excellent dough handling.
L	High absorption. Good protein mix time, and volume. Fair stability.
M	No comment
N	No comment
O	No comment
P	No comment
24-2423	**XG4108_WB**
A	Good out of mixer Lower volume Open grain
B	Highest bake absorption in set, good dough feel, ok crumb grain and white color, excellent loaf volume relative to protein
C	excellent loaf externals
D	No comment
E	High Water Abs, Very Long MT, Slight Sticky & Strong Dough, Medium Loaf Volume, Dull Crumb Grain, Fine Elongate Cells, Good Resilient & Smooth Texture
F	No comment
G	Long mix time, lower absoprtion. Dense, round grain. Tough dough throughout. Lowest volume. Good mix toler.
H	Very short mix time. Good dough at make up. Open, harsh textured crumb grain. Low volume. Very low mix toler.
I	No comment
J	No comment
K	Overall very good. Excellent dough handling.
L	High absorption, mix time and volume. Fair stability. Good protein.
M	No comment
N	No comment
O	No comment
P	No comment

NORTHERN MICRO-QUALITY ANALYSIS

Entry_Code	Entry_ID	Entry_No	Breeding Program	Locations*
24-UM2418	SY Monument	2418	SY Monument	UM
24-UM2419	23Nord-181	2419	23Nord-181	UM
24-UM2420	23Nord-184	2420	23Nord-184	UM
24-UM2421	SD20B088-2	2421	SD20B088-2	UM
24-UM2422	SD20D100-9	2422	SD20D100-9	UM
24-UM2423	XG4108	2423	XG4108	UM
24-AP2418	SY Monument	2418	SY Monument	AP
24-AP2419	23Nord-181	2419	23Nord-181	AP
24-AP2420	23Nord-184	2420	23Nord-184	AP
24-AP2421	SD20B088-2	2421	SD20B088-2	AP
24-AP2422	SD20D100-9	2422	SD20D100-9	AP
24-AP2423	XG4108	2423	XG4108	AP
24-SD2418	SY Monument	2418	SY Monument	SD
24-SD2419	23Nord-181	2419	23Nord-181	SD
24-SD2420	23Nord-184	2420	23Nord-184	SD
24-SD2421	SD20B088-2	2421	SD20B088-2	SD
24-SD2422	SD20D100-9	2422	SD20D100-9	SD
24-SD2423	XG4108	2423	XG4108	SD
24-ND2418	SY Monument	2418	SY Monument	ND
24-ND2419	23Nord-181	2419	23Nord-181	ND
24-ND2420	23Nord-184	2420	23Nord-184	ND
24-ND2421	SD20B088-2	2421	SD20B088-2	ND
24-ND2422	SD20D100-9	2422	SD20D100-9	ND
24-ND2423	XG4108	2423	XG4108	ND
24-NE2418	SY Monument	2418	SY Monument	NE
24-NE2419	23Nord-181	2419	23Nord-181	NE
24-NE2420	23Nord-184	2420	23Nord-184	NE
24-NE2421	SD20B088-2	2421	SD20B088-2	NE
24-NE2422	SD20D100-9	2422	SD20D100-9	NE
24-NE2423	XG4108	2423	XG4108	NE
*SD=South Dakota State Univeristy; UM=USDA Manhattan;				
ND=North Dakota State University; AP=Agripro.				

1. LOCATIONS AND ENTRIES

A. There are 5 locations:

USDA Manhattan = UM;

Agripro = AP;

South Dakota = SD;

North Dakota = ND;

Nebraska = NE.

B. There are 6 entries grown in each of the locations:

SY Monument (Check) = 2418

23Nord-181 (NDSU) = 2419

23Nord-184 (NDSU) = 2420

SD20B088 (SDSU) = 2421

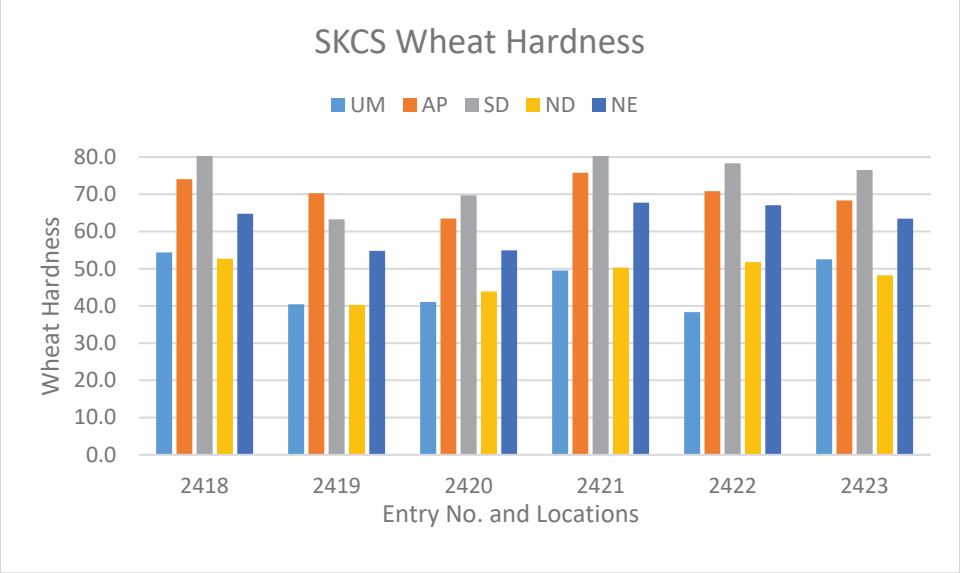
SD20D100-9 (SDSU) = 2422

XG4108 (Westbred) = 2423

2. SKCS SINGLE KERNEL INFORMATION

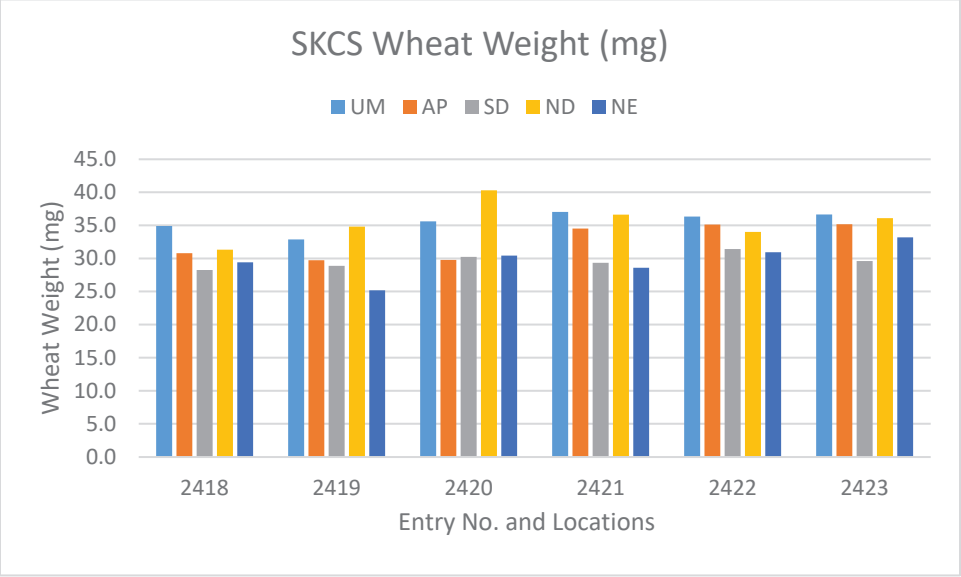
A. Kernel Hardness

SKCS Wheat Kernel Hardness							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	54.4	74.1	80.5	52.7	64.8	65.3	12.13
2419	40.4	70.3	63.3	40.3	54.8	53.8	13.45
2420	41.0	63.5	69.7	43.9	54.9	54.6	12.32
2421	49.5	75.8	81.1	50.3	67.7	64.9	14.49
2422	38.3	70.8	78.3	51.7	67.0	61.2	16.07
2423	52.5	68.3	76.5	48.2	63.4	61.8	11.54
Avg.	46.0	70.5	74.9	47.8	62.1		
Std	6.92	4.35	7.03	4.85	5.84		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



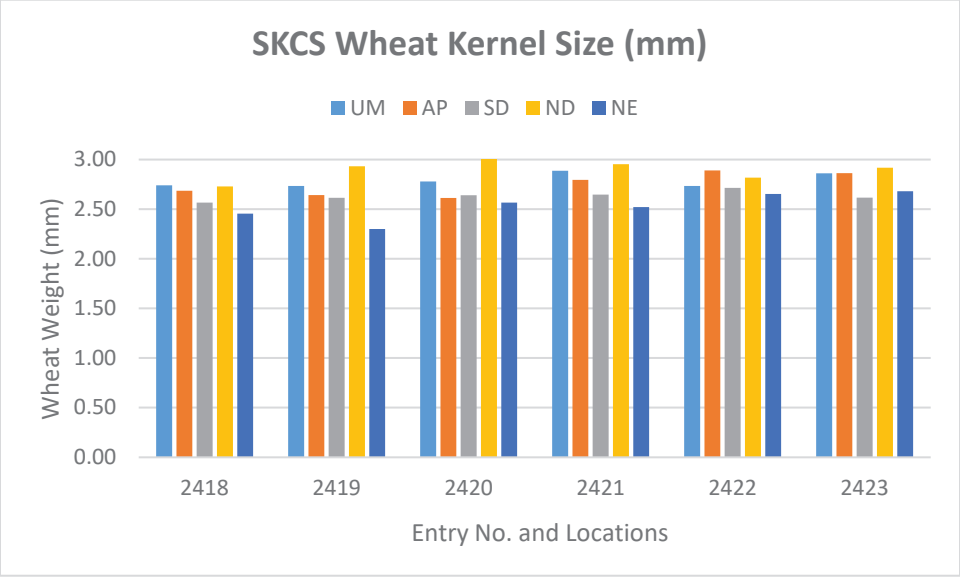
B. Kernel Weight (mg)

SKCS Wheat Kernel Weight (mg)							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	34.9	30.8	28.2	31.3	29.4	30.9	2.53
2419	32.9	29.7	28.9	34.8	25.2	30.3	3.72
2420	35.6	29.8	30.2	40.3	30.4	33.3	4.59
2421	37.0	34.5	29.3	36.6	28.6	33.2	4.01
2422	36.3	35.1	31.4	34.0	30.9	33.6	2.33
2423	36.6	35.2	29.6	36.1	33.2	34.1	2.86
Avg.	35.6	32.5	29.6	35.5	29.6		
Std	1.52	2.69	1.11	2.99	2.68		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



C. Kernel Size

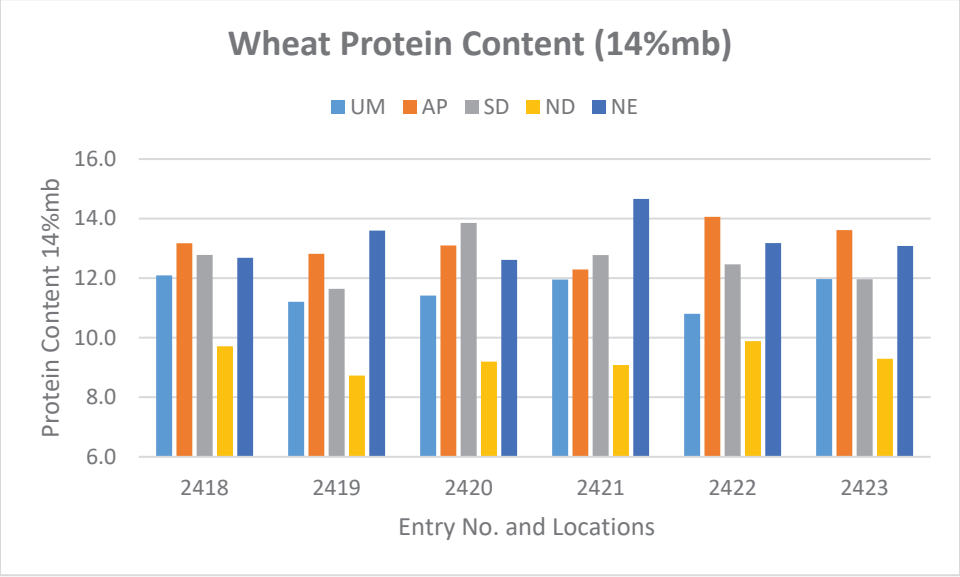
SKCS Wheat Kernel Size (mm)							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	2.74	2.69	2.57	2.73	2.45	2.63	0.12
2419	2.73	2.64	2.61	2.93	2.30	2.64	0.23
2420	2.78	2.61	2.64	3.11	2.57	2.74	0.22
2421	2.89	2.79	2.65	2.95	2.52	2.76	0.18
2422	2.73	2.89	2.71	2.82	2.65	2.76	0.09
2423	2.86	2.86	2.62	2.92	2.68	2.79	0.13
Avg.	2.79	2.75	2.63	2.91	2.53		
Std	0.07	0.12	0.05	0.13	0.14		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



3. PROTEN CONTENT

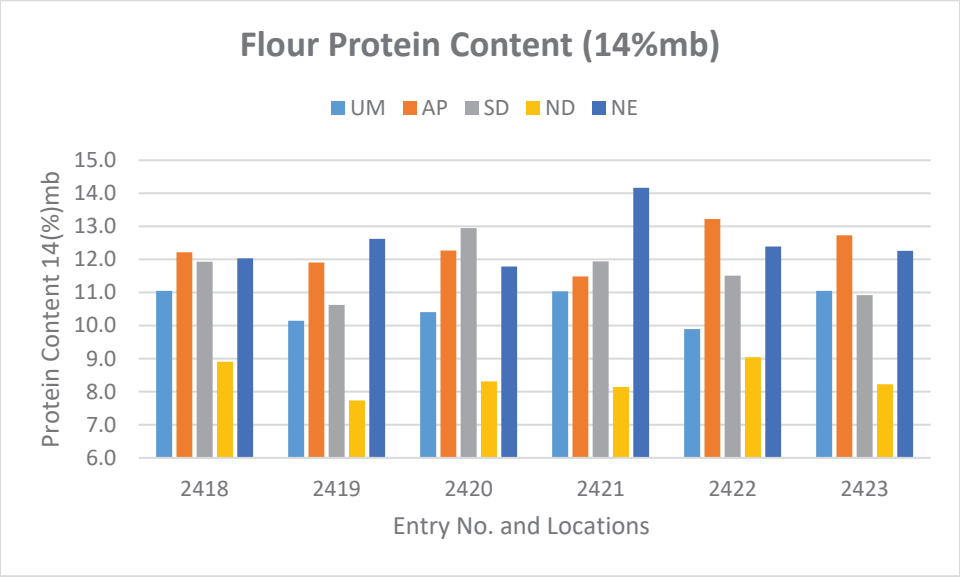
A. Wheat Protein

Wheat Protein Content (14%mb)							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	12.1	13.2	12.8	9.7	12.7	12.1	1.38
2419	11.2	12.8	11.6	8.7	13.6	11.6	1.86
2420	11.4	13.1	13.9	9.2	12.6	12.0	1.82
2421	12.0	12.3	12.8	9.1	14.7	12.2	2.01
2422	10.8	14.1	12.5	9.9	13.2	12.1	1.71
2423	12.0	13.6	12.0	9.3	13.1	12.0	1.67
Avg.	11.6	13.2	12.6	9.3	13.3		
Std	0.5	0.6	0.8	0.4	0.8		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



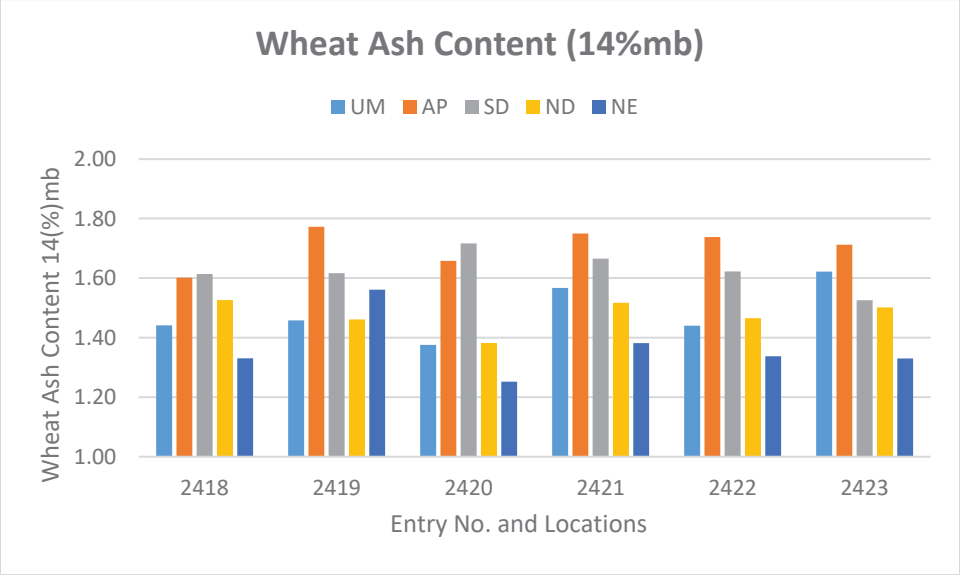
B. Flour Protein

Flour Protein Content (14%)							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	11.0	12.2	11.9	8.9	12.0	11.2	1.37
2419	10.1	11.9	10.6	7.7	12.6	10.6	1.89
2420	10.4	12.3	12.9	8.3	11.8	11.1	1.83
2421	11.0	11.5	11.9	8.1	14.2	11.4	2.16
2422	9.9	13.2	11.5	9.0	12.4	11.2	1.73
2423	11.0	12.7	10.9	8.2	12.3	11.0	1.75
Avg.	10.6	12.3	11.6	8.4	12.5		
Std	0.52	0.61	0.83	0.49	0.85		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



4. WHEAT ASH

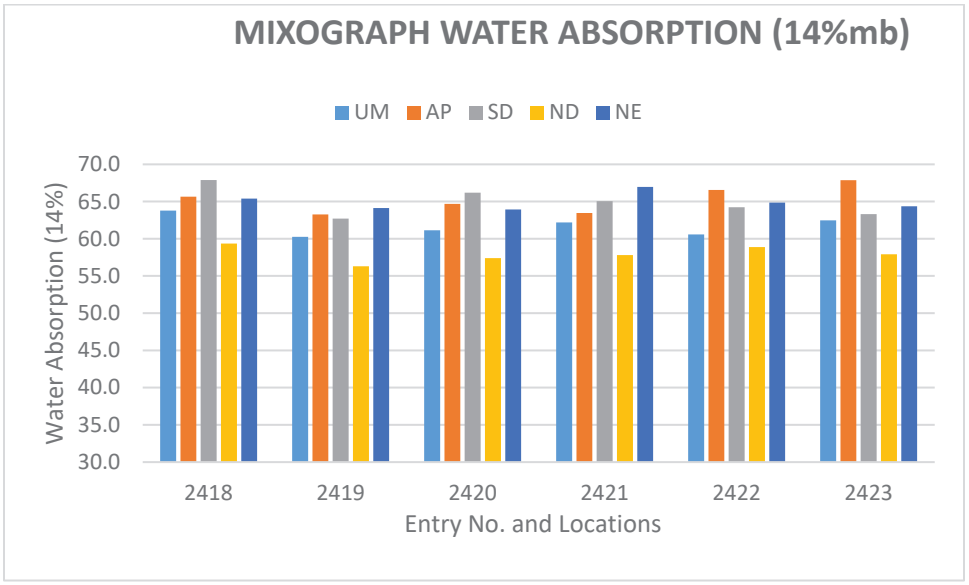
Wheat Ash Content (14%)							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	1.44	1.60	1.61	1.53	1.33	1.50	0.12
2419	1.46	1.77	1.62	1.46	1.56	1.57	0.13
2420	1.38	1.66	1.72	1.38	1.25	1.48	0.20
2421	1.57	1.75	1.67	1.52	1.38	1.58	0.14
2422	1.44	1.74	1.62	1.47	1.34	1.52	0.16
2423	1.62	1.71	1.53	1.50	1.33	1.54	0.14
Avg.	1.48	1.71	1.63	1.48	1.37		
Std	0.09	0.06	0.06	0.05	0.10		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



5. MIXOGRAPH TEST RESULTS

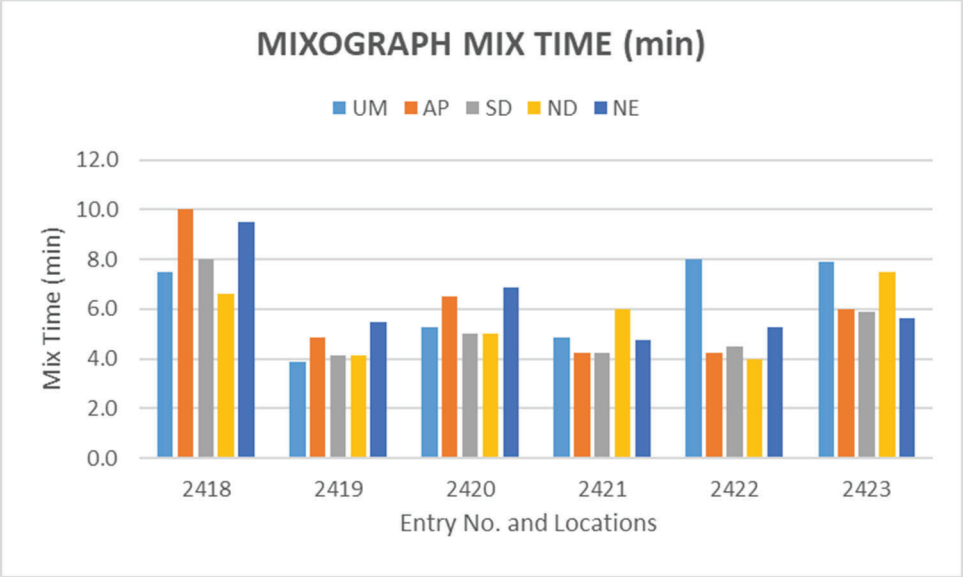
A. Mixograph Water Absorption

Mixograph Water Absorption (14%mb)							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	63.8	65.6	67.9	59.4	65.4	64.4	3.18
2419	60.2	63.3	62.7	56.3	64.1	61.3	3.16
2420	61.1	64.7	66.2	57.4	63.9	62.7	3.47
2421	62.2	63.5	65.0	57.8	67.0	63.1	3.46
2422	60.6	66.6	64.2	58.9	64.9	63.0	3.18
2423	62.5	67.9	63.3	57.9	64.4	63.2	3.59
Avg.	61.7	65.2	64.9	57.9	64.9		
Std	1.33	1.80	1.92	1.09	1.13		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



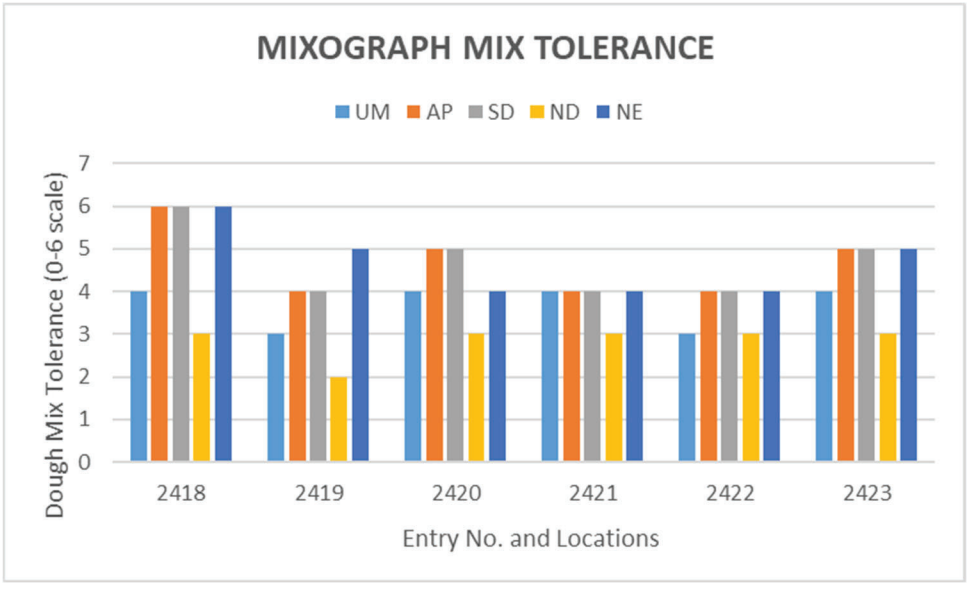
B. Mixograph Mix Time

Mixograph Mix Time (min)							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	7.5	10.0	8.0	6.6	9.5	8.3	1.40
2419	3.9	4.9	4.1	4.1	5.5	4.5	0.67
2420	5.3	6.5	5.0	5.0	6.9	5.7	0.90
2421	4.9	4.3	4.3	6.0	4.8	4.8	0.72
2422	8.0	4.3	4.5	4.0	5.3	5.2	1.63
2423	7.9	6.0	5.9	7.5	5.6	6.6	1.03
Avg.	6.2	6.0	5.3	5.5	6.3		
Std	1.78	2.17	1.47	1.41	1.74		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



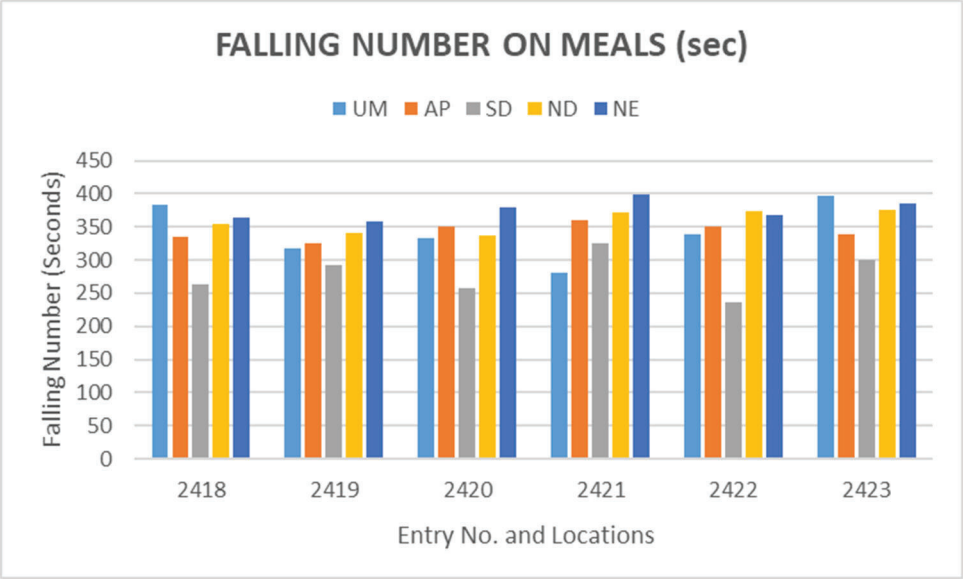
C. Mixograph Mix Tolerance

Mixograph Mix Tolerance							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	4	6	6	3	6	5.0	1.41
2419	3	4	4	2	5	3.6	1.14
2420	4	5	5	3	4	4.2	0.84
2421	4	4	4	3	4	3.8	0.45
2422	3	4	4	3	4	3.6	0.55
2423	4	5	5	3	5	4.4	0.89
Avg.	3.7	4.7	4.7	2.8	4.7		
Std	0.52	0.82	0.82	0.41	0.82		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



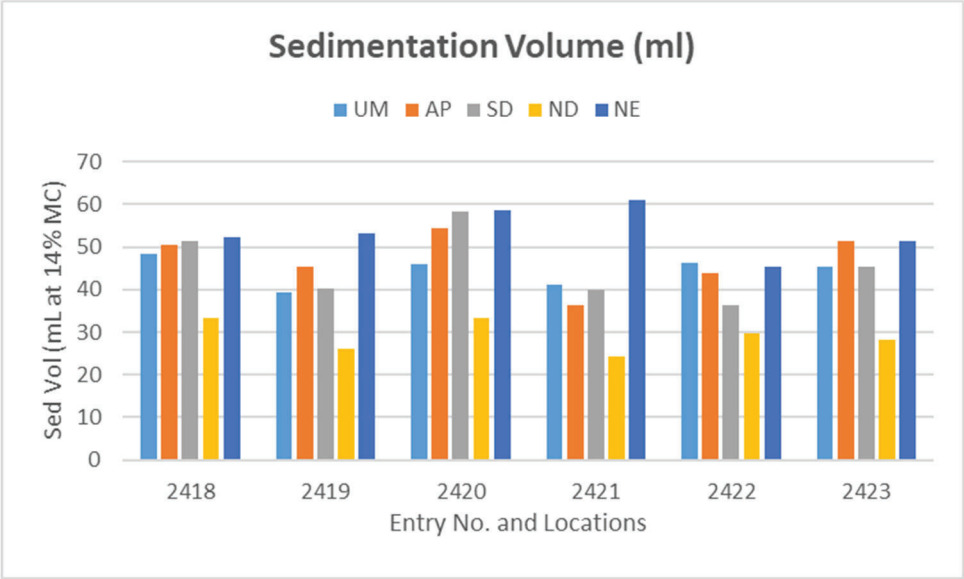
6. FALLING NUMBER TEST

Falling Number on Meals (sec)							
	LOCATIONS*						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	383	334	263	355	363	340	46
2419	318	325	292	341	358	327	25
2420	333	350	258	336	380	331	45
2421	280	360	325	371	399	347	46
2422	338	351	236	373	368	333	56
2423	396	339	301	376	385	359	39
Avg.	341	343	279	359	376		
Std	43	13	33	17	15		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							



7. SEDIMENTATION TEST

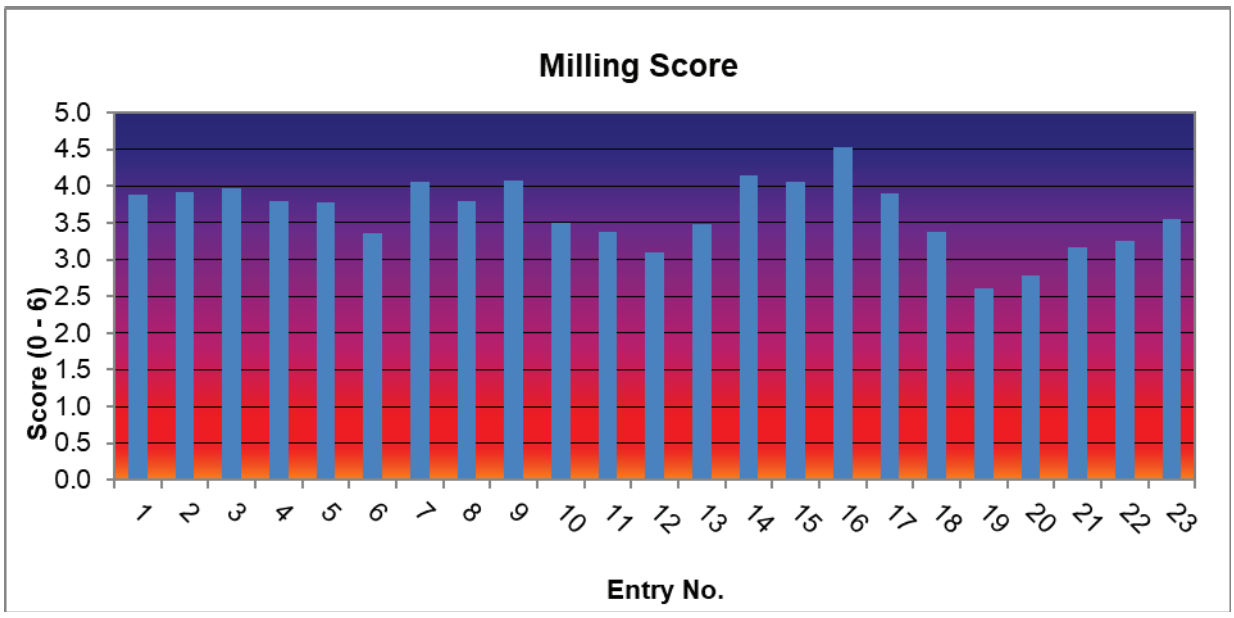
Sedimentation Volume (ml)							
	LOCATIONS						
Entry No.	UM	AP	SD	ND	NE	Avg	Std
2418	48.3	50.4	51.3	33.3	52.4	47.2	7.88
2419	39.2	45.3	40.2	26.2	53.3	40.8	9.91
2420	45.8	54.4	58.4	33.3	58.5	50.1	10.70
2421	41.3	36.3	39.8	24.2	61.0	40.5	13.26
2422	46.4	43.7	36.3	29.7	45.4	40.3	7.10
2423	45.3	51.3	45.4	28.2	51.4	44.3	9.50
Avg.	44.4	46.9	45.2	29.2	53.7		
Std	3.43	6.53	8.30	3.71	5.51		
*SD=South Dakota State Univeristy; UM=USDA Manhattan;							
ND=North Dakota State University; AP=Agripro.							

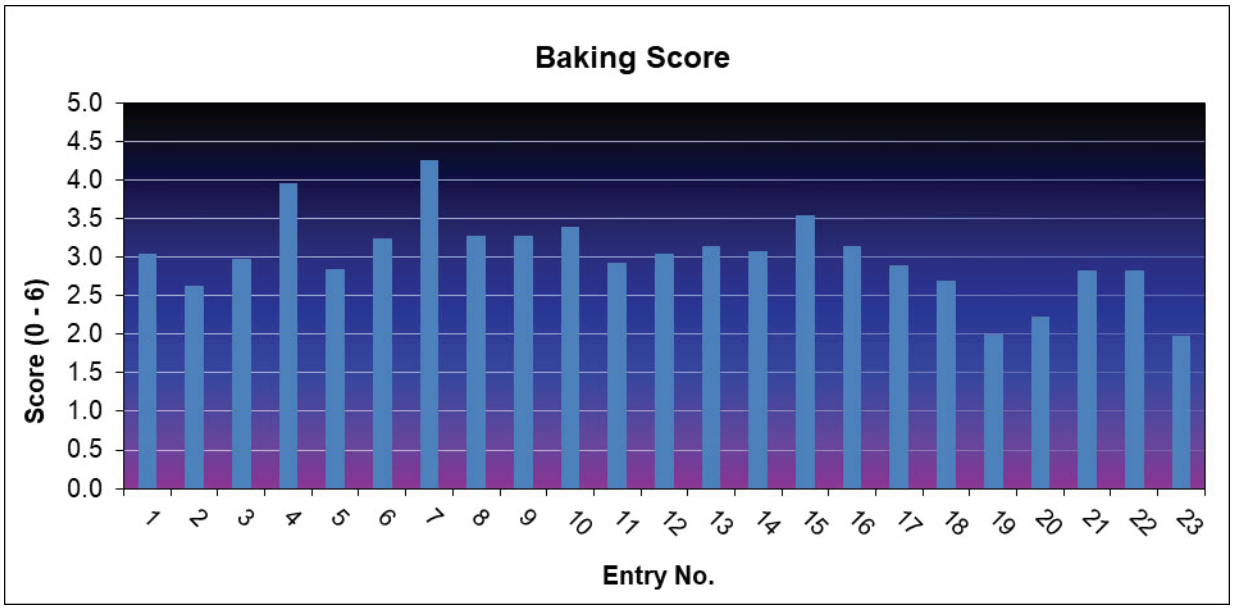


2024 WQC Milling and Baking Marketing Scores

2024 WQC Milling & Baking Marketing Scores

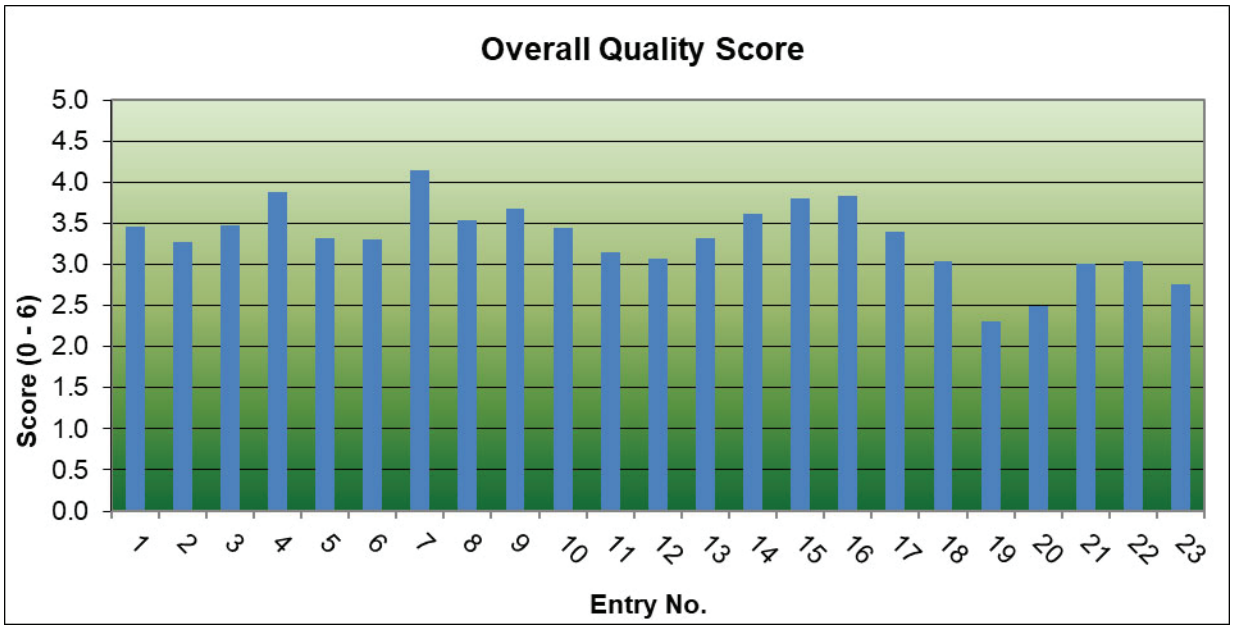
(Based upon HWWQL Quality Data and KSU Milling Data)





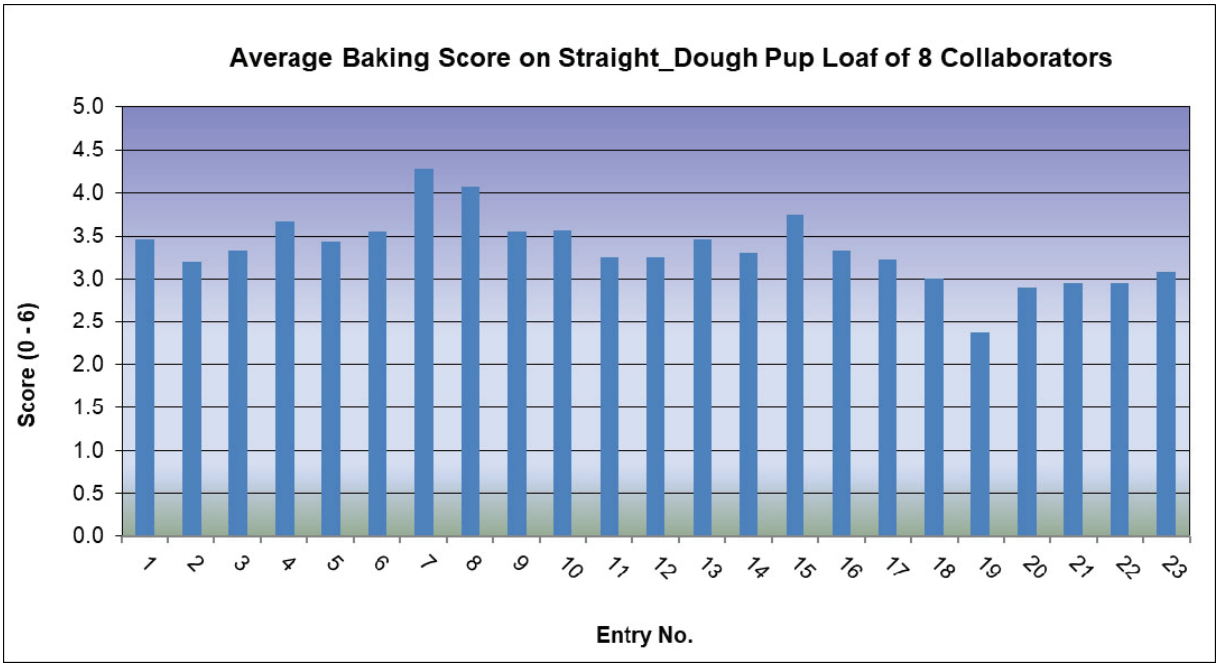
2024 WQC Milling & Baking Marketing Scores

(Based upon HWWQL Quality Data and KSU Milling Data)



2024 WQC Baking Marketing Scores

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



Marketing Scores

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

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

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

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

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

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

Alkaline Noodle Quality Tests

Of

2024 WQC Hard Winter Wheat Entries

USDA-ARS Hard Winter Wheat Quality Laboratory

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Manhattan, KS 66502

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Alkaline Noodle Quality Report

Objectives: Evaluate alkaline noodle color and cooking characteristics.

Materials: 23 WQC hard winter wheat samples harvested in 2024.

Methods:

PPO (Polyphenol Oxidase) Test:

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

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

Noodle Making:

Formulation:

Alkaline noodle was made with 100 g flour, 1 g Na_2CO_3, and 35 mL of water (fixed).

Procedure:

1. 100 g flour with 1 g Na_2CO_3 + 35 mL water.
2. Mix at medium speed for 10 min (100 g Micro Mixer – no pins in the bowl, National MFG. Co., Lincoln, NE)
3. Rest for 30 min in a plastic bag.
4. Plug roll gap with plastic tubing and pour mixed dough.
5. Sheeting: roll gaps 4 (2x), 3, 2.3, 1.75, 1.35, 1.1 (mm).
6. Measure color at 0 and 24 hr.
7. Cutting

Measurement of Noodle Dough Color:

Noodle dough color (L*, lightness; a*, redness-greenness; b*, yellowness-blueness) was measured by Minolta Chroma Meter CR-410 at 0 and 24 hr.

Cooking Noodles:

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

Measurement of Cooking Loss and Water Uptake:

Cooking Loss:

1. Pre-weigh 500 mL beaker to 0.01 g.
2. Quantitatively transfer cooking/rinse water to beaker.
3. Evaporate to dryness (constant weight) in air oven at 95±5^{0}C. Drying time is about 20 hr.
4. Cool beakers and weigh to 0.01 g. For 25 g sample, multiply by 4 > % cooking loss.

Water Uptake:

Water Uptake (%) = (Cooked noodle weight – Raw noodle weight)/Raw noodle weight x100.

Texture Profile Analysis (TPA) of Noodle:

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

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

- **Resilience (ratio)**: measurement of how the sample recovers from deformation both in terms of speed and forces derived.

- **Cohesiveness (ratio)**: ratio of the positive force area during the second compression to that during the first compression.

Results:

The top 3 samples showing desirable properties were selected in each category.

Table I shows the following:

Noodle Color (L value, Higher is better) **at 0 hr.,** 2412 (79.20), 2414 (78.52), 2417 (78.48).

Noodle Color (L value, Higher is better) **at 24 hr.,** 2417 (66.92), 2414 (66.59), 2420 (66.17).

Delta L (Change of L value, lower absolute value is better).

2420 (-11.21), 2416 (-11.29), 2415 (-11.36)

PPO (Lower is better): 2416 (0.201), 2420 (0.243), 2414 (0.256).

Table II shows the following:

Hardness: 2420 (2.727), 2416 (2.633), 2405 (2.582).

Springiness: 2411 (0.919), 2404 (0.917), 2414 (0.915).

Chewiness: 2416 (1.656), 2405 (1.600), 2420 (1.593).

Resilience: 2401 (0.464), 2409 (0.458), 2414 (0.448).

Cohesiveness: 2401 (0.710), 2409 (0.704), 2411 (0.702).

Water Uptake: 2405 (92.80), 2407 (92.00), 2409 (92.00).

Cooking Loss: 2405 (5.20), 2407 (5.60), 2409 (6.00).

Discussion

The sample 2414 had the second highest L-value (brightness) at both 0 and 24 hrs.; the third lowest PPO value and higher b-value at 24 hrs. This sample also had the third highest springiness and resilience in texture after cooking. Bright noodle color 24 hrs. after production and a firmer texture following cooking are considered desirable

characteristics for alkaline noodles. Thus, the sample 2414 would be considered the most favorable variety overall for alkaline noodle quality.

The sample 2420 has the third highest L-value (brightness) at 24 hrs.; the lowest Delta L-value and the second lowest PPO value. The sample 2420 also had the highest hardness and the third highest chewiness after cooking.

The sample 2417 had the highest L-value (brightness) at 24 hrs. and the third highest L-value (brightness) at 0 hrs. This sample also had lower hardness and chewiness after cooking. Therefore, the sample 2417 would be considered the most favorable variety overall for white salted noodles quality (Japanese Udon-type), which are preferred to have a bright, creamy white color, smooth, and soft texture.

Table I. Noodle Color and PPO Level

Sample ID	*L** @ 0	*L** @ 24	*a** @ 0	*a** @ 24	*b** @ 0	*b** @ 24	delta *L**	delta *a**	delta *b**	PPO
2401	78.14	65.84	-0.55	1.07	21.89	24.33	-12.30	1.62	2.44	0.282
2402	77.63	64.23	-0.41	1.57	21.62	24.49	-13.40	1.98	2.87	0.570
2403	77.85	63.80	-0.33	1.46	20.95	23.54	-14.05	1.79	2.59	0.540
2404	76.19	62.86	-0.39	1.76	22.96	24.98	-13.33	2.14	2.02	0.521
2405	77.74	64.85	-0.82	1.43	24.21	27.57	-12.90	2.25	3.36	0.497
2406	78.35	64.01	-0.99	1.47	21.91	26.29	-14.34	2.46	4.38	0.631
2407	74.98	60.64	-0.19	1.87	22.33	22.81	-14.35	2.05	0.48	0.541
2408	75.98	62.79	-0.49	1.85	24.20	25.28	-13.19	2.33	1.08	0.471
2409	77.08	62.80	-0.75	1.60	23.08	24.51	-14.28	2.35	1.43	0.581
2410	78.17	65.50	-0.93	1.19	21.38	24.39	-12.67	2.12	3.01	0.518
2411	76.85	64.29	-0.91	1.20	23.83	24.37	-12.56	2.11	0.54	0.530
2412	79.20	65.02	-1.34	0.58	22.71	24.94	-14.18	1.92	2.24	0.312
2413	78.16	65.94	-0.81	1.30	22.71	25.15	-12.22	2.11	2.44	0.525
2414	78.52	66.59	-0.64	1.31	24.76	26.11	-11.94	1.95	1.36	0.256
2415	76.73	65.37	-0.05	2.12	23.04	25.54	-11.36	2.17	2.50	0.390
2416	75.70	64.41	-0.35	1.72	28.71	30.29	-11.29	2.07	1.59	0.201
2417	78.48	66.92	-0.39	2.08	20.96	25.21	-11.57	2.46	4.25	0.478
2418	78.47	65.99	-0.36	1.68	19.62	23.38	-12.48	2.04	3.76	0.289
2419	77.10	64.32	-0.69	1.49	24.33	26.84	-12.78	2.18	2.51	0.520
2420	77.37	66.17	-0.41	1.86	23.74	28.32	-11.21	2.27	4.58	0.243
2421	75.91	61.52	-0.54	2.16	24.24	25.53	-14.39	2.69	1.29	0.541
2422	77.13	62.49	-0.61	2.09	20.75	23.86	-14.64	2.70	3.11	0.503
2423	78.47	66.08	-0.90	1.39	20.80	24.93	-12.39	2.28	4.14	0.517
Avg	77.40	64.45	-0.60	1.57	22.81	25.33	-12.95	2.17	2.52	0.454

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

Sample ID	Hardness	Springiness	Chewiness	Resilience	Cohesiveness	Water Uptake (%)	Cooking Loss (%)
2401	2.297	0.909	1.482	0.464	0.710	78.80	6.40
2402	2.337	0.907	1.486	0.436	0.701	81.20	6.40
2403	2.307	0.900	1.441	0.426	0.694	78.80	7.60
2404	2.479	0.917	1.593	0.441	0.701	80.00	6.40
2405	2.582	0.905	1.600	0.443	0.685	92.80	5.20
2406	2.541	0.894	1.520	0.413	0.669	86.40	7.20
2407	2.422	0.884	1.440	0.407	0.673	92.00	5.60
2408	2.391	0.894	1.446	0.414	0.676	85.60	7.20
2409	2.255	0.911	1.446	0.458	0.704	92.00	6.00
2410	2.414	0.892	1.443	0.401	0.670	86.00	7.20
2411	2.263	0.919	1.459	0.445	0.702	86.80	6.00
2412	2.288	0.896	1.400	0.431	0.683	85.20	8.00
2413	2.263	0.911	1.431	0.435	0.695	82.40	7.20
2414	2.489	0.915	1.573	0.448	0.691	79.20	7.20
2415	2.489	0.900	1.563	0.440	0.698	75.60	7.20
2416	2.633	0.909	1.656	0.432	0.692	82.00	6.80
2417	2.386	0.902	1.473	0.424	0.684	77.60	8.00
2418	2.369	0.911	1.481	0.422	0.686	81.60	7.60
2419	2.485	0.900	1.450	0.379	0.648	87.20	8.00
2420	2.727	0.896	1.593	0.383	0.651	84.00	8.40
2421	2.555	0.888	1.499	0.412	0.661	87.20	7.20
2422	2.497	0.894	1.486	0.399	0.665	84.00	7.20
2423	2.555	0.900	1.549	0.413	0.673	84.80	8.00
Avg	2.436	0.902	1.500	0.425	0.683	83.97	7.04

TORTILLA BAKING TEST RESULTS OF 2024 WQC SAMPLES

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(January 2025)

SUMMARY

This report includes the production and evaluation methods of wheat flour tortillas and data for the 2024 WQC samples. The report contains tortilla quality data for 23 samples (24-2401-24-2423). The production and fresh tortilla evaluation was carried out over two days with an internal control sample baked on both days.

Samples 24-2404, 2407, 2414, 2415, and 2417 gave tortillas that were rated as "Excellent," based on their final diameter (≥14.0 cm) and subjective rollability score (>4.5 - very little cracking when rolled 16 days after baking). These samples also had good dough handling properties. Higher diameter and rollability scores suggest flour that is moderately strong with good extensibility characteristics, resulting in tortillas with longer shelf life.

Samples 24-2408, 2412, 2418, 2419, 2422 and 2423 were rated as "poor," based primarily on their rollability scores (<3 on day 16). The dough samples were strong and greatly limited extensibility on hot-pressing, which resulted in easily cracking tortillas. Sample 2419 specifically had higher diameter (15.25 cm), but the rollability score was too low (2.5).

The remaining samples had a general rating of “good” with rollability score ranges between 3.5 and 4.0 and mostly lower diameters than the ones with “excellent” rating. Some of the samples (e.g. 2401, 2405, 2409, 2410, 20411, 2420, and 2421) had good diameters but their rollability score was not as high.

RESULTS

Sample ID	Total Moisture (%), n=2	Average Fresh Weight (g), n=10	Average Thickness (cm), n=10	Average Diameter (cm), n=10	Specific Volume (cm^3/g)	Lightness (L*), n=2 (back, front)	Rollability Day 8, n=2	Rollability Day 16, n=2	#Average Rating, n=2
24-2401	34.76	38.72	0.40	14.67	1.725	76.19	5	3.5	Good
24-2402	35.20	39.43	0.33	13.28	1.176	69.77	5	4	Good
24-2403	34.54	38.79	0.31	14.435	1.301	73.81	4.5	4	Good
24-2404	33.72	38.81	0.40	15.28	1.867	74.10	5	4.5	Excellent
24-2405	32.71	38.87	0.38	14.825	1.671	75.50	2.5	3.5	Good
24-2406	33.77	38.73	0.40	14.44	1.709	76.31	4.5	3.5	Good
24-2407	33.67	38.27	0.35	16.41	1.957	74.26	5	5	Excellent
24-2408	34.07	39.54	0.37	14.36	1.506	74.87	3.5	2.5	Poor
24-2409	34.51	38.9	0.39	14.585	1.689	75.20	4.5	4	Good
24-2410	33.66	38.92	0.37	15.08	1.695	76.65	4	3.5	Good
24-2411	33.80	38.62	0.37	15.16	1.737	75.35	5	4	Good
24-2412	34.70	38.66	0.39	14.46	1.641	74.83	3.5	2.5	Poor
24-2413	32.67	38.19	0.28	15.485	1.399	77.05	4	4	Good
24-2414	34.36	39.29	0.33	14.56	1.380	76.00	5	4.5	Excellent
24-2415	33.88	38.57	0.31	15.44	1.516	75.40	4.5	5	Excellent
24-2416	35.54	38.96	0.35	14.475	1.489	73.75	5	4	Good
24-2417	33.81	39.01	0.37	14.345	1.536	74.70	5	4.5	Excellent
24-2418	33.07	39.35	0.36	13.66	1.356	71.99	4	3	poor
24-2419	31.20	38.74	0.35	15.25	1.631	76.29	4	2.5	Poor
24-2420	32.30	38.97	0.36	14.81	1.587	75.36	4.5	4	Good
24-2421	31.25	38.97	0.34	15.14	1.551	74.93	5	4	Good
24-2422	31.86	39.98	0.36	14.995	1.581	75.80	5	3	Poor
24-2423	32.77	39.33	0.35	14.2	1.418	73.90	3.5	2.5	Poor

#Subjective rating based primarily on diameter and rollability. Excellent ≥4.5 on day 16, ≥14.0 cm diameter; Good: rollability score ≥3.5 on day 16, and any diameter. Poor: rollability score ≤3.0 on day 16, any for diameter.

PRODUCTION AND EVALUATION OF WHEAT FLOUR TORTILLAS

Tortilla Formulation

Ingredients	Amount
Wheat flour	100%
Salt	1.5%
Sodium Propionate	0.8%
Potassium Sorbate	0.4%
All-purpose Shortening	6.0%
Sodium Bicarbonate	0.6%
Fumaric Acid - encapsulated	0.5%
Sodium Aluminum Phosphate	0.82%
Water	53%

Tortilla Processing

MIX

→ **PROOF**
5 min, 32 °C, 70% RH →

DIVIDE and ROUND
Obtain 43-g dough balls.

←

PROOF
10 min, 32 °C, 70% RH ←

HOT-PRESS
Top and bottom of press plate = 360 °F

↙

BAKE
Oven temperature = 340 °F;
Oven residence time = 40 sec

→ **COOL and PACKAGE**

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

Evaluation of Tortilla Properties

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

1. Weight

An average of 10 tortillas weighed on a balance and the reading divided by 10 to estimate weight of a single tortilla.

2. Diameter

It is an average diameter of 10 tortillas, which is measured using a ruler in two opposite directions. This varied widely among wheat samples depending on flour quality; desired values are > 14.5 cm.

3. Thickness

This is the average height of 10 tortillas, which is measured using a digital caliper and then divided by 10 to estimate a value for a single tortilla.

4. Moisture

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

5. Color Values

The color values of lightness (L*), +a* (redness and greenness), and +b* (yellowness and blueness) of tortillas were determined using a handheld colorimeter (model CR-300, Minolta Camera Co., Ltd., Chuo-Ku, Osaka, Japan). Only L*-values are included in the report as this correlates with opacity and are usually greater than 70.

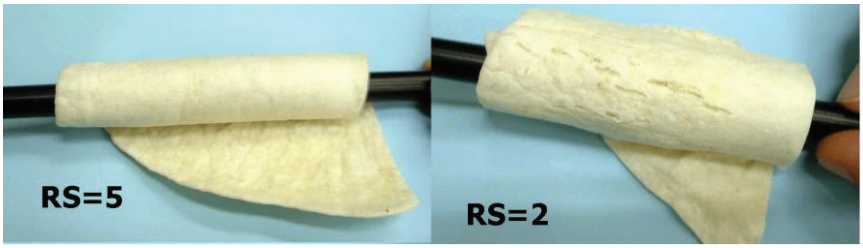
6. Specific Volume

$Specific\ volume\ \left[\frac{cm^3}{g}\right] = \frac{*(\frac{Diameter}{2})^2 * Height}{Weight}$; using the final values (estimates for single tortillas).

This corresponds to the fluffiness of the tortilla; the desired value is > 1.0 cm^3/g.

7. Tortilla Rollability Score

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



2024 WQC HARD WINTER WHEAT FLOUR PROTEIN ANALYSIS

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USDA, CGAHR, Manhattan, KS

Results of Flour Protein Analysis

Hard Winter Wheat WQC 2024 Crop Protein Analysis

	High Molecular Weight Glutenin Subunits			Polymeric/Monomeric protein ratio
	Glu-A1	**Glu-B1**	**Glu-D1**	
WQC 2024-01	2*	7 +9	5+10	1.05
WQC 2024-02	2*	7+8	5+ 10	0.98
WQC 2024-03	2*	7+8	5 + 10	0.93
WQC 2024-04	2*	7+8	5 + 10	0.98
WQC 2024-05	2*	7+8	5 + 10	1.15
WQC 2024-06	2*	17+18	2+12	1.08
WQC 2024-07	2*	7+9	2+12	1.05
WQC 2024-08	2*	7 +8	5+10	1.05
WQC 2024-09	2*	7 +9	5+10	0.80
WQC 2024-10	2*	7+9	5+10	1.06
WQC 2024-11	2*	7 +9	5+10	0.90
WQC 2024-12	2*	7+9	5+10	0.88
WQC 2024-13	2*	7 +9	5+10	0.96
WQC 2024-14	2*	7 +9	5+10	1.00
WQC 2024-15	1	7 +8	5+10	0.98
WQC 2024-16	1	7 +8	5+10	1.04
WQC 2024-17	1	7 +8	5+10	0.98
WQC 2024-18	2*	7 +9	5+10	1.04
WQC 2024-19	2*	7 +9	5+10	1.20
WQC 2024-20	2*	7 +9	5+10	1.20
WQC 2024-21	2*	7 +9	5+10	1.05
WQC 2024-22	1	7 +9	5+10	1.10
WQC 2024-23	2*	7+8	5+10	0.95

Procedure for the separation of glutenins for determination of HMW glutenin subunits on Agilent 2100 Lab-on-a -Chip- bioanalyzer

- Weight 100 mg of flour and add 1ml of 0.3 M Sodium Iodide solution containing 7.5 % isopropanol
- Include controls Karl 92 (1, 7+8, 5+10) and Chinese spring (null, 7+8, 2+12)
- Vortex shake for 15 min. and centrifuge for 5 min at 12,000 x g at room temp. Discard the supernatant.
- To the pellet add 1ml of deionized water, vortex shake for 5 min and centrifuge as above.
- Discard the supernatant.
- To the pellet add 1ml of 12.5 mM sodium borate buffer pH 10.0 + 2% SDS + 2% BME.
- Vortex shake for 30 minutes, centrifuge for 5 min. at 12,000 x g at room temp. and collect the supernatant (contains glutenins).

Determination of polymeric to monomeric protein ratio

Protein extraction

- Weight 10 mg flour and add 1 ml 0.05M Sodium phosphate buffer (Na_2HPO_4), pH 6.9, containing 0.5% SDS (w/v)
- Vortex the samples for 15 min.
- Sonicate the samples in ice for 15s at a power output of 6W. Collect the supernatant (contains total protein).
- Filter the supernatant in a 0.45 µm filter and analyze samples by size-exclusion HPLC (SE-HPLC).

SE-HPLC

- SE-HPLC was conducted using a 300.0 x 7.8 mm Yarra™ SEC-4000 column (Phenomenex, Torrance, CA) on an Agilent 1100 HPLC system, kept at 30°C, with a constant gradient composed of 50/50 ratio of HPLC grade water +

0.1% Trifluoroacetic acid (TFA) and Acetonitrile + 0.1% TFA flow rate of 0.50 ml/min during 30 min.

- The chromatograms were manually integrated. The area of the first peak corresponds to polymeric proteins and the area of the second peak to monomeric proteins. The ratio was determined using the areas of the chromatograms.

2024 WQC HARD WINTER WHEAT GLUTOPEAK ANALYSIS

Rhett Kaufman, Ph.D. and Michael Tilley, Ph.D.

USDA-ARS, CGAHR, Manhattan, KS

Objective:

Evaluation of Winter Wheat Samples by the GlutoPeak instrument with comparison to the WQC established functionality tests.

Materials and Methods:

Materials:
White flour produced by MIAG Multomat and Quadrumat Sr. mills from the wheat composites

Whole meal produced by a UDY Cyclone meal from the wheat composites

Methods:

There are many methods for analysis by the GlutoPeak instrument. There were two specific methods chosen for this set of testing.

Method 1. $CaCl_2$ Method (Chandi and Seetharaman, 2012)

8.5 grams of Flour or Whole Meal
9.5 grams of 0.5M $CaCl_2$ solution
1900 RPM paddle speed
34°C Bowl Temperature

Method 2. Distilled Water method (Wang et al, 2017)

9 grams of Flour
9 grams of Distilled Water solution
2700 RPM paddle speed
34°C Bowl Temperature

The liquid is weighed into the GlutoPeak bowl, then the flour/meal is added to the bowl. The bowl is placed in the machine and the procedure begins as soon as the paddle is lowered into the bowl.

Results:

The samples were analyzed using the standard and extended evaluation method from the GlutoPeak software. The measurements reported are:

PMT—Peak Mixing Time
BEM—Peak Torque

AM—Torque 15 seconds before Peak
PM—Torque 15 seconds after Peak
Peak Area—Area under curve between AM and PM (also called Aggregation Energy)
GSI—Calculated Index (BEM*Peak Area)/1000 (Wang et al., 2017)
GSI2—Calculated Index (BEM*PMT)/1000

Table 1. GlutoPeak Analysis of MIAG produced white flour analyzed by the $CaCl_2$ Method

	Sample	PMT	BEM	AM	PM	Peak Area	GSI	GSI2
Southern Growout	24-0002401	142	56	54	48	1572	88.0	223.2
	24-0002402	72	68	58	56	1855	126.1	133.6
	24-0002403	70	63	59	55	1803	113.6	126.2
	24-0002404	137	53	51	46	1506	79.8	206.3
	24-0002405	78	54	48	45	1535	82.9	119.8
	24-0002406	78	55	53	48	1574	86.6	122.8
	24-0002407	54	56	51	50	1621	90.8	87.5
	24-0002408	45	55	48	55	1591	87.5	71.6
	24-0002409	70	70	57	56	1843	129.0	129.0
	24-0002410	82	51	49	44	1416	72.2	116.1
	24-0002411	107	51	49	45	1435	73.2	153.6
	24-0002412	104	58	56	50	1651	95.8	171.7
	24-0002413	115	57	51	48	1546	88.1	177.8
Montana	24-0002414	96	61	55	51	1738	106.0	166.9
	24-0002415	72	63	58	54	1788	112.6	128.8
	24-0002416	64	68	57	56	1857	126.3	118.9
	24-0002417	70	65	52	50	1727	112.3	120.9
Northern Growout	24-0002418	95	63	58	53	1755	110.6	166.7
	24-0002419	103	50	33	48	1446	72.3	149.0
	24-0002420	113	51	48	48	1480	75.5	167.3
	24-0002421	81	56	53	46	1546	86.6	125.2
	24-0002422	81	57	54	48	1570	89.5	127.2
	24-0002423	83	56	52	46	1528	85.6	126.8

Table 2. GlutoPeak Analysis of Whole Meal analyzed by the $CaCl_2$ Method

		PMT	BEM	AM	PM	Peak Area	GSI	GSI2
Southern Growout	24-0002401	69	65	38	49	1615	105.0	111.4
	24-0002402	51	52	27	50	1309	68.1	66.8
	24-0002403	58	65	40	50	1700	110.5	98.6
	24-0002404	63	63	36	48	1490	93.9	93.9
	24-0002405	61	44	41	41	1252	55.1	76.4
	24-0002406	50	64	32	45	1514	96.9	75.7
	24-0002407	42	66	29	48	1593	105.1	66.9
	24-0002408	39	46	26	42	1174	54.0	45.8
	24-0002409	54	54	29	51	1397	75.4	75.4
	24-0002410	50	60	26	42	1384	83.0	69.2
	24-0002411	59	62	29	44	1521	94.3	89.7
	24-0002412	65	49	31	46	1354	66.3	88.0
	24-0002413	67	65	34	45	1597	103.8	107.0
Montana	24-0002414	56	54	31	50	1444	78.0	80.9
	24-0002415	58	57	31	50	1486	84.7	86.2
	24-0002416	60	48	38	43	1373	65.9	82.4
	24-0002417	55	49	29	46	1317	64.5	72.4
Northern Growout	24-0002418	68	51	30	48	1362	69.5	92.6
	24-0002419	66	54	30	40	1335	72.1	88.1
	24-0002420	62	51	28	44	1335	68.1	82.8
	24-0002421	52	53	28	46	1305	69.2	67.9
	24-0002422	59	55	32	44	1468	80.7	86.6
	24-0002423	73	49	37	42	1363	66.8	99.5

Table 3. GlutoPeak analysis of Quadrumat Sr. produced white flour analyzed using the Distilled water method.

		PMT	BEM	AM	PM	Peak Area	GSI	GSI2
Southern Growout	24-0002401	160	63	27	57	1638	103.2	262.1
	24-0002402	120	64	29	55	1700	108.8	204.0
	24-0002403	111	61	26	51	1567	95.6	174.0
	24-0002404	186	61	27	54	1596	97.4	296.9
	24-0002405	102	58	24	49	1446	83.9	147.5
	24-0002406	88	60	26	51	1567	94.0	137.9
	24-0002407	59	66	25	52	1667	110.0	98.4
	24-0002408	66	65	24	52	1543	100.3	101.9
	24-0002409	85	74	34	59	1903	140.8	161.8
	24-0002410	92	59	24	48	1489	87.9	137.0
	24-0002411	121	59	26	50	1564	92.3	189.2
	24-0002412	133	66	26	56	1633	107.8	217.2
	24-0002413	159	65	26	56	1636	106.3	260.1
Montana	24-0002414	81	70	28	57	1748	122.4	141.6
	24-0002415	151	68	30	56	1756	119.4	265.2
	24-0002416	57	74	32	58	1833	135.6	104.5
	24-0002417	189	61	28	49	1528	93.2	288.8
Northern Growout	24-0002418	256	62	25	54	1564	97.0	400.4
	24-0002419	200	52	22	43	1294	67.3	258.8
	24-0002420	197	56	27	48	1491	83.5	293.7
	24-0002421	135	60	23	50	1467	88.0	198.0
	24-0002422	147	58	25	47	1477	85.7	217.1
	24-0002423	186	56	28	50	1493	83.6	277.7

APPENDIX A
Credits and Methods

CREDITS

Milling, Sample Analysis, Ingredients and Report Preparation

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

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METHODS

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

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

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

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

Wheat and Flour Moisture - AACC Approved Method 44-15A. Wheat (ground in Falling Number 3303 burr-type mill to prevent drying before grinding) or flour is dried in a forced air oven at 130^0 C for one hour.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The time required for a Mixograph or Farinograph curve to reach the "peak" is an estimate of the amount of mixing required to properly develop the dough for handling and baking. The rate at which a curve falls and narrows after the peak and stability of

peak height on either side of the peak are indicators of mixing tolerance. Terms used to describe the Farinograph curve or "farinogram" include:

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

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

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

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

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

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

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

Cumulative Ash and Protein Curves

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

fact that endosperm has a lower mineral content than bran. Ash content is lowest in the center of the kernel and increases toward the outer parts because the bran layer contains several times more minerals than pure endosperm.

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

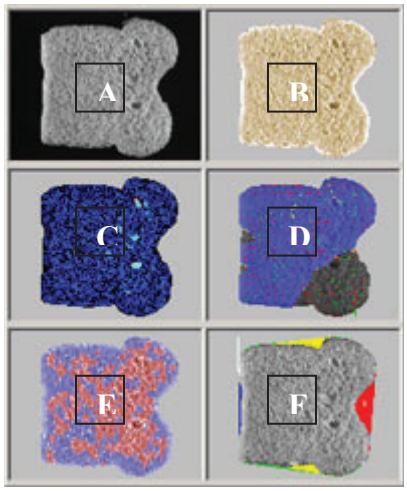
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein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

LI, Y. Z., and POSNER, E. S. 1987. The influence of kernel size on wheatmillability. Bull. Assoc. Operative Millers November: 5089-5098.
LI, Y. Z., and POSNER, E. S. 1989. An experimental milling techniquefor various flour extraction levels. Cereal Chem. 66:324-328.
LILLARD, D.W. and HERTSGAARD, D.M. 1983. Computer analysis and plotting of milling data: HRS wheat cumulative ash curves. Cereal Chem. 60:42-46.

C-Cell Image Analysis

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

Images:



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

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

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

Data:

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

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

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

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

Brightness: Sample brightness and cell contrast.

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

Slice Area: The total area of a product slice (mm^2).

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

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

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

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

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

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

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

Collaborators' Baking Test Profiles and Other Information

2024 WQC COLLABORATORS' BAKING TEST PROFILES AND OTHER INFORMATION

Coop	No.	Test Methods	Est. Flour and Dough Wt (g)	Mixing Tolerance	Fermentation time (min)	Oven Temp (F)	Baking Time (min)
A	1	Sponge and dough	600 g flour, 480 g dough	Other	240 min (sponge time) and 45 min (fermentation)	420	20
B	2	Pup-loaf straight dough	100 g	Mixograph	90 min	385	20
C	3	Pup-loaf straight dough	100 g, approx 170 g	Mixograph	90 min	400	25
D	4	Sponge and dough	700 g flour, 500 g dough	Farinograph	180 min (sponge) and 70 min (fermentation)	420	20
E	5	Pup-loaf straight dough	100 g flour, approx. 175 g dough	Farinograph and Mixograph	180 fermentation and 60 min proof time	400	25
F	6	Pup-loaf straight dough	100 g flour, approx 175 g dough	Mixograph	90 min	425	21
G	7	Pup-loaf straight dough	100 g flour, approx 170 g dough	Mixograph	120 min	420	18
H	8	Sponge and dough	700 g flour, 524 g dough	Farinograph with mixing evalu	240 min (sponge time) and 60 min (fermentation)	420	20
I	9	Pup-loaf straight dough	100 g flour, approx 160 g dough	Farinograph	120 min	425	20
J	10	Pup-loaf straight dough	200g, 170 g dough	Mixograph	180 min	419	24
K	11	Sponge and dough	675 g flour, 540 g dough	Mixing series	210 min	430	23
L	12	Sponge and dough	600 g flour, 160 g dough	Mixing series	240 min	425	16
M	13	Straight dough	700 g flour, 525 g dough	Mixing series	120 min	400	25
N	14	Pup-loaf straight dough	100 g	Mixograph	100 min	420	21
O	15	Sponge and dough	700 g flour, 500 g dough	Farinograph	240 Sponge time	425	25
P	16	Pup-loaf straight dough	100 g	Miograph	90 min	420	24

APPENDIX B

HWWQC Technical Board and Goals for HWW Breeders

Hard Winter Wheat Quality Council

2024 Technical Board Officers

CHAIR:	**Shawn Thiele,** Kansas State University
VICE CHAIR:	**Gang Guo,** Ardent Mills
SECRETARY:	**Kevin Kloberdanz,** Grain Craft
MEMBER:	**Scott Baker,** Bay State Milling
MEMBER:	**Rhett Kaufman,** USDA/ARS

Hard Winter Wheat Quality Council (HWWQC)

Charter
Revised and Approved (February 20, 2003)

Mission, Policy, and Operating Procedure

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

Objectives

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

Membership

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

HWWQC Technical Board

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

Duties of the Technical Board

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

Compensation

- Technical Board members shall serve without compensation.

Expenses

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

Hard Winter Wheat Quality Evaluation and Advisory Committee

Committee Purpose

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

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

Evaluation and Responsibilities

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

Sample/Locations

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

Annual Meeting

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

Finances and Budget

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

Amendments

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

Outlined Goals for Hard Winter Wheat Breeders

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

1. Adaptability. Varieties should be adaptable and retain their quality integrity over a large geographic area.

2. Varieties should be resistant to diseases, to insect infestation (including stored grain insects), and to sprouting.

3. Emphasize quality evaluation in earlier generations. Obtain milling and baking data before F7. Grain and Texture should be considered along with loaf volume, absorption, mixing, and dough properties when evaluating baking quality.
4. Kernel Characteristics:
   A. Visual Appearance typical of class.
   B. Hardness significantly greater than soft wheat, but not so hard that milling or flour properties are negatively influenced.
   C. Uniformly large, plump, vitreous.

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

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

Performance on KSU Pilot Mill

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

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

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

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

APPENDIX C

Hard Red Winter Wheat Quality Targets

RECOMMENDED* QUALITY TARGETS FOR HARD RED WINTER WHEAT

HWW Quality Targets Committee
Approved February, 2006

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

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

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APPENDIX D

Hard White Wheat Quality Targets
Adopted from PNW for Great Plains

Hard White Wheat Quality Targets

Dual Purpose -- Chinese Noodles and Western Pan Bread

Updated on March 1, 2002 at Hard White Wheat Quality Targets Meeting
Wheat Marketing Center, Portland, Oregon

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

Notes:

(1) Chinese raw, Chinese wet, Chinese instant fried, Philippine instant fried, Malaysia hokkien and Thai bamee noodles.

(2) Straight-grade flour of 12% protein wheat.

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

(4) Noodle formula: straight-grade flour, 100%; water, 28%; and sodium chloride, 1.2%.
Noodle sizes: 2.5 mm (width) x 1.2 mm (thickness).
Noodle textural measurement: cook 100 g noodles in 1000 ml deionized water for 5 min, rinse in 27^0C water and drain. Measure noodle texture on five noodle strands by compressing to 70% of noodle thickness with a 5-mm flat probe attached to TA.XT2 Texture Analyzer.

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

Wheat Marketing Center, Portland, Oregon

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

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

APPENDIX E

WQC Business Meeting Minutes
Feb. 22, 2024

Minutes for 2023 Hard Winter Wheat Quality Council

Wheat Quality Council
February 22, 2024
8:00 am, Embassy Suites Olathe Kansas

Meeting was called to order by chairman Mark Hodges.
Welcome and opening Comments given by Dave Green and Mark Hodges.
Review of the 2023 minutes and agenda items for 2024 meeting – Mark Hodges
Nomination and election of new members – Mark Hodges, Acting Chair – Michael Peters moved to elect the board as stated for 2024. Seconded by Brian Walker. Motion passed.
Dave Green spoke about the process of getting new individuals onto the boars and encouraged any interested parties to reach out to him for future consideration.
Announcing Board for 2024 - Mark Hodges

Chairman	Shawn Thiele	Kansas State University
Vice Chairman	Gang Guo	Ardent Mills
Secretary	Kevin Kloberdanz	Grain Craft
Member	Scott Baker	Bay State Milling
Member	Rhett Kaufman	USDA/ARS

Overview of Wheat Tours – Dave Green, WQC

- Hard Winter Wheat Tour will be held May 13-16, 2024.
- Comments provided about the wheat tour opportunities for new and young people in the industry to see wheat crops in the field and really understand what's happening. Wheat tours are also a great opportunity to network and learn from others in the industry.

Overview of Milling of Wheat Samples at KSU - Paul Blodgett, KSU Manhattan

- Milling started on October 16th, 2023, and finished on November 8th, 2024.
- Milled 28 samples
  - Average flour moisture was 13.2%
  - Average flour ash was 0.54%
  - Average flour protein was 12.13%
  - Questions and discussion on higher then expected starch damage on the samples.

Wheat Quality Council HRW Report for 2023 – Rhett Kaufman, USDA/ARS Manhattan

- Discussion on current and upcoming retirements through USDA and current structure of responsibilities.
- 28 entries across two grow-out locations in 2023.
- 14 Bake lab collaborators in 2023. USDA/ARS is always looking for more collaborators so please reach out if interested.

Review of 2023 Wheat Crop – Royce Schaneman, Plains Grains Inc.
Grow Out Program for Hard Winter Wheat – Marla Barnett, Limagrain
Soft Wheat Update – Dave Green, WQC.

- Byung-Kee Baik was unable to make the meeting this year. Dave announced the upcoming meeting in Wooster OH.

State Crop Reports 2023 Crop Conditions –

- Texas – Jackie Rudd – TX Wheat
- Oklahoma – Mike Schulte, Oklahoma Wheat Commission
- Kansas – Aaron harries, Kansas Wheat Commission
- Nebraska – Royce Schaneman, Nebraska Wheat Board
- Colorado – Brad Erker, Colorado Wheat
- South Dakota – Reid Christopherson, SD Wheat Commission
- Montana – Sam Anderson, Montana Wheat and Barley Committee

Financial Report – Dave Green, WQC

- No new money reported but enough in the budget for 2024.
- Hard Winter Wheat Budget is approved for this year.

Exhibitor Sessions:

- Short overview from each of the exhibitors in attendance this year.
- Midland Scientific, Perkin Elmer (soon to be Perten), Neo-Spectra, KPM Analytics, CW Brabender

Adjourned at 9:55 am

APPENDIX F

Past WQC Hard Winter
Wheat Entries
from 2001 to 2024

Past WQC Hard Winter Wheat Entries

2024

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
SY Monument	24-2401					Check
XG4108	24-2402					Westbred/Bayer
WB4347	24-2403					Westbred/Bayer
WB4445CLP	24-2404					Westbred/Bayer
TX18DH287	24-2405					TAMU
TX18DH313	24-2406					TAMU
OK198417C	24-2407					OSU
OK20708	24-2408					OSU
KS20H124	24-2409	HRW	Yes	KS Homesteader	2024	KSU-Hays
LCH21-9398	24-2410					Limagrain
LCH16ACC403-1	24-2411					Limagrain
CO19S129W	24-2412					CSU
CO19410R	24-2413					CSU
SY Monument	24-2414					Check
Yellowstone	24-2415					Check
MTS2068	24-2416	HRW	Yes	MT Meadowlark	2024	Montana
MTV2164	24-2417					Montana
SY Monument	24-2418					Check
23Nord-181	24-2419	HRW				NDSU
23Nord-184	24-2420	HRW				NDSU
SD20B088-2	24-2421					SDSU
SD20D100-9	24-2422					SDSU
XG4108	24-2423					Westbred/Bayer

2023

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
SY Monument	23-2401					Check
CO18035RA	23-2402					Colorado
CO18042RA	23-2403					Colorado
CO18D007W	23-2404					Colorado
OK15MASBx7 ARS 8-19-18-4	23-2405					Oklahoma
OK16107123-19-9	23-2406					Oklahoma
OK19225	23-2407					Oklahoma
LCH19DH-152-6	23-2408	HRW	yes	LCS Radar	2023	Limagrain
LCH16ACC421-64	23-2409	HRW	yes	LCS Warbird AX	2023	Limagrain
KS16DH0010-17	23-2410					KSU-Manhattan
KS19H10	23-2411	HRW	Yes	KS Bill Snyder	2023	KSU-Hays
XF4412	23-2412					Westbred (Bayer)
XF4402	23-2413					Westbred (Bayer)
WB4422	23-2414					Westbred (Bayer)
TX18A001119	23-2415					Texas AM
TX18A001132	23-2416					Texas AM
SY Monument	23-2417					Check

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
21Nord-160	23-2418	HRW	No			NDSU
XF4102	23-2419					Westbred (Bayer)
SD18B072-2	23-2420					SDSU
SD19B033-2	23-2421					SDSU
NE16562	23-2422					Nebraska
NW15443	23-2423					Nebraska
Yellowstone	23-2424					Check
SY Monument	23-2425					Check
MT2019	23-2426					Montana
MTCL2010	23-2427					Montana
MTF20189	23-2428	HRW	Yes	MT Cash	2023	Montana
2022						
Jagalene_CK	22-2401					Check
SY Monument_CK	22-2402					Check
19Nord-124_ND	22-2403	HRW	no			NSDU
SD15007-11_SD	22-2404					SDSU
SD18B025-8_SD	22-2405	HRW	Yes	SD Pheasant	2023	SDSU
NE17443_NE	22-2406					Nebraska
NE17441_NE	22-2407					Nebraska
WB4727_WB	22-2408					Westbred
SY Monument_CK	22-2409					Check
Jagalene_CK	22-2410					Check
LCH18-9027_LG	22-2411	HWW	yes	LCS White Lightning	2022	Limagrain
TX16M9216_TX	22-2412	HRW	yes	GO 9216H	2022	TAMU
BASF7_BF	22-2413					BASF
BASF12_BF	22-2414					BASF
WB4523_WB	22-2415					Westbred
WB0433004_WB	22-2416					Westbred
OK18510_OK	22-2417	HRW	yes	High Cotton	2023	Oklahoma
OK16107125C-17HR-2_OK	22-2418					Oklahoma
OKP17D101A666_OK	22-2419					Oklahoma
KS18H111-3_KH	22-2420	HRW	yes	KS Territory	2022	Kansas_Hays
CO16SF027_CO	22-2421					Colorado
CO18D297R_CO	22-2422					Colorado
KS13DH0041-35_KM	22-2423	HRW	yes	KS Providence	2022	Kansas_Manhattan
SY Monument_CK	22-2424					Check
Yellowstone_CK	22-2425					Check
MTFH1908_MT	22-2426					Montana
MTS1908_MT	22-2427					Montana
MTCL19151_MT	22-2428	HRW	yes	CS Bridger CLP	2023	Montana
2021						
Jagalene	21-2401					Check

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
19NORD122	21-2402	HRW	no			NDSU
19NORD127	21-2403	HRW	no			NDSU
10BC329-17-5	21-2404	HRW	yes	AP Bigfoot	2021	AgriPro(Syngenta)
NHH17450	21-2405	HRW	no			UNL
NHH17612	21-2406	HRW	no			UNL
SD12DHA01373	21-2407	HRW	yes	SD Midland	2021	SDSU
SD15035-2	21-2408					SDSU
LCH18-7071	21-2409	HRW	yes	LCS Steel AX	2021	Limagrain
SY Monument	21-2410					Check
Jagalene	21-2411					Check
LCH17-4196	21-2412	HRW	yes	LCS Runner	2021	Limagrain
SYMonument	21-2413					Check
OK15MASBx7 ARS 8-29	21-2414	HRW	yes	Paradox	2023	OSU
AP Roadrunner	21-2415	HRW	yes	AP Roadrunner	2020	AgriPro(Syngenta)
OK15DMASBx7 ARS 6-8	21-2416	HRW	yes	Firebox	2023	OSU
CO13007-F6R	21-2417					CSU
CO16D1487	21-2418					CSU
TX15M8024	21-2419	HRW	yes	Amigos	2021	Texas A&M
XE4101	21-2420					Westbred(Bayer)
WB4401	21-2421					Westbred(Bayer)

2020

Byrd	20-2401					Colorado
Jagalene (CC01)	20-2402					Colorado
CO14A055-258	20-2403	HRW	yes	Kivari AX	2020	Colorado
CO15D098R	20-2404	HRW	yes	Steamboat	2020	Colorado
CO16SF070	20-2405					Colorado
Jagalene (CC02)	20-2406					BASF
BASF1	20-2407					BASF
BASF2	20-2408					BASF
Jagalene (CC03)	20-2409					Limagrain
DH11HRW55-4	20-2410					Limagrain
LCH13DH-47-1675	20-2411	HRW	yes	LCSJULEP	2020	Limagrain
LCH15ACC-13-4	20-2412	HRW	yes	LCSPHOTONAX	2020	Limagrain
Jagalene (CC04)	20-2413					Kansas-Hays
Danby	20-2414					Kansas-Hays
KS15H137-2-2	20-2415	HRW	yes	KS Hamilton	2020	Kansas-Hays
Jagalene (CC05)	20-2416					Bayer
MODI4-6036	20-2417					Bayer
NEDI4-5064	20-2418					Bayer
Jagalene (CC06)	20-2419					Oklahoma
Baker's Ann	20-2420					Oklahoma
OK14124-2	20-2421	HRW	Yes	Butler's Gold	2020	Oklahoma
OK15MASBx7 ARS8-22	20-2422		not yet			Oklahoma

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
OK15818	20-2423	HRW	unofficiall	Gallagher Purific	2019	Oklahoma
OK12716W Comp I	20-2424		not yet			Oklahoma
Jagalene (CC07)	20-2425					Montana
Yellowstone	20-2426					Montana
MTCL1737	20-2427		no			Montana
MT1745	20-2428					Montana
Everest	20-2429					Kansas-Manhattan
Jagalene (CC08)	20-2430					Kansas-Manhattan
KS12DH0156-88	20-2431					Kansas-Manhattan
KS090616K-1	20-2432					Kansas-Manhattan
Jagalene (CC09)	20-2433					Northern States
17NORD-94	20-2434	HRW	no			North Dakota
17NORD-96	20-2435	HRW	Yes	ND Allison	203	North Dakota
NE14434	20-2436		no			Nebraska
NE14696	20-2437		no			Nebraska
PSB13NEDH-14-83W	20-2438		no			Nebraska
09BC308-14-16	20-2439	HRW	yes	AP EverRock		Syngenta
SD12DHA03282	20-2440	HRW	yes	SD Andes		South Dakota

2019

Byrd	19-2401	HRW	check			Colorado
Jagalene (CC01)	19-2402	HRW	check			Colorado
CO13D0787	19-2403	HRW	yes	Guardian	2019	Colorado
CO15SFD107	19-2404	HRW	yes	Fortify SF	2019	Colorado
CO15D098R	19-2405	HRW	yes	Steamboat	2020	Colorado
TAM 114	19-2406					Texas
TX14A001035	19-2407	HRW	yes	TAM 116	2021	Texas
TX14M7061	19-2408					Texas
Jagalene (CC02)	19-2409					Oklahoma
Ruby Lee	19-2410					Oklahoma
OK16D101089	19-2411	HRW	yes	Uncharted	2020	Oklahoma
OK168512	19-2412	HRW	yes	Breakthrough	2020	Oklahoma
OCW04S717T-6W	19-2413	HW	yes	Big Country	2020	Oklahoma
OK12912C-138407-2	19-2414	HRW	yes	Strad CL+	2020	Oklahoma
Jagalene (CC03)	19-2415					Limagrain
ERYTHR02420-2010	19-2416					Limagrain
Jagalene (CC04)	19-2417					Kansas-Hays
KS15H116-6-1	19-2418	HRW	yes	KS DALLAS	2019	Kansas-Hays
KS15H161-1-4	19-2419	HRW	yes	KS WESTERN	2019	Kansas-Hays
Danby	19-2420					Kansas-Hays
Jagalene (CC05)	19-2421					Monsanto
MODI4-5179	19-2422	HRW	yes	WB4505	2019	Monsanto

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
NEDI4-5304	19-2423	HRW	yes	WB4309	2019	Monsanto
Jagalene (CC06)	19-2424					Northern States
NW13493	19-2425	HWW	yes	NW13493	2021	Nebraska
NE14691	19-2426	HRW	no			Nebraska
SD14113-3	19-2427	HRW	yes	Draper	2019	South Dakota
MTCS1601R	19-2428	HRW	yes	StandClear CLP	2019	Montana
MT1683	19-2429					Montana

2018

Jagalene (CC01)	18-2401					Texas
TAM 111	18-2402					Texas
TX12V7415	18-2403	HRW	yes	TAM 205	2019	Texas
LINK	18-2404					Limagrain
Jagalene (CC02)	18-2405					Limagrain
DH11HRW53-34	18-2406					Limagrain
LCI13DH-22-22	18-2407					Limagrain
MOD14-4919	18-2408				TBD	Monsanto
Jagalene (CC03)	18-2409					Monsanto
H4N13-0253	18-2410	HRW	yes	N/A	2017	Monsanto
Danby	18-2411					Kansas-Hays
Jagalene (CC04)	18-2412					Kansas-Hays
KS14H180-4-63	18-2413		no			Kansas-Hays
Jagalene (CC05)	18-2414					Syngenta
10BC107#115	18-2415					Syngenta
SY Monument	18-2416					Syngenta
08BC379-40-1	18-2417					Syngenta
Jagalene (CC06)	18-2418					Oklahoma
Ruby Lee	18-2419					Oklahoma
OK12716-159319-13	18-2420	HRW	yes	Showdown	2018	Oklahoma
OK13621	18-2421	HRW	yes	Baker's Ann	2018	Oklahoma
OK12206-127206-2	18-2422	HRW	yes	OK Corral	2019	Oklahoma
OK1059018-129332-5	18-2423	HRW	no			Oklahoma
Jagalene (CC07)	18-2424					Northern States
NE10478-1	18-2425	HRW		LCS Valiant	2019	Nebraska
NHH144913-3	18-2426	SRW	no			Nebraska
MT1564	18-2427	HWW	yes	Flathead	2019	Montana
MTS1588	18-2428	HRW	yes	Bobcat	2019	Montana
NORD58	18-2429	HWW	no			North Dakota
NORD62	18-2430	HWW	no			North Dakota
SD09227	18-2431	HRW	yes	Thompson	2017	Sourth Dakota
SD14115-5	18-2432	HRW	yes	Winner	2019	Sourth Dakota

2017

SY Monument	17-2401	HRW				Syngenta

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
SY Achieve CL2	17-2402	XWHT	yes	SY Achieve CL2	2017	Syngenta
SY 517 CL2	17-2403	HRW	yes	S 517 CL2	2017	Syngenta
Jagalene (CC01)	17-2404	HRW				Syngenta
Jagalene (CC02)	17-2405	HRW				Texas
TAM 111	17-2406	HRW				Texas
TX11A001295	17-2407	HRW	yes	TAM 115	2019	Texas
TX12M4068	17-2408	HRW	no			Texas
Byrd	17-2409	HRW				Colorado
CO12D1770	17-2410	HRW	yes	Canvas	2018	Colorado
Jagalene (CC03)	17-2411	HRW				Colorado
CO13D1783	17-2412	HRW	yes	Whistler	2018	Colorado
CO12D2011	17-2413	HDWH	yes	Breck	2017	Colorado
Jagalene (CC04)	17-2414	HRW				Kansas-Hays
KS13HW92-3	17-2415	HDWH	yes	Venada	2018	Kansas-Hays
Danby	17-2416	HDWH				Kansas-Hays
KS14HW106-6-6	17-2417	HDWH	YES	KS SILVERADO	2019	Kansas-Hays
Yellowstone	17-2418	HRW				Montana
MT1465	17-2419	HRW	yes	FourOsix	2018	Montana
Jagalene (CC05)	17-2420	HRW				Montana
MTW1491	17-2421	HDWH	yes	Numont	2020	Montana
NI13706	17-2422	HRW	no			Nebraska
NE12561	17-2423	HRW	yes	Siege	2020	Nebraska
Jagalene (CC06)	17-2424	HRW				Nebraska
Jagalene (CC07)	17-2425	HRW				Monsanto
WB4623CLP	17-2426	HRW	yes	WB4623CLP	2014	Monsanto
WB4721	17-2427	HRW	yes	WB4721	2015	Monsanto
Ruby Lee	17-2428	HRW				Oklahoma
OK13621	17-2429	HRW	yes	Baker's Ann	2018	Oklahoma
OK12D22004-016	17-2430	HRW	no			Oklahoma
OCW04S7171T-6W	17-2431	HDWH	pending		2020	Oklahoma
Jagalene (CC08)	17-2432	HRW				Oklahoma

2016

LCH13-048	16-2401	HRW				Limagrain
LCH13NEDH-12-27	16-2402	HRW				Limagrain
Jagalene (CC01)	16-2403	HRW				Limagrain
PSB13NEDH-11-26	16-2404	HRW				Limagrain
LCI13-069	16-2405	HWW				Limagrain
PSB13NEDH-14-83	16-2406	HWW				Limagrain
KS1256-6-4	16-2407	HRW	yes	Tatanka	2016	Kansas-Hays
Danby	16-2408	HWW				Kansas-Hays
Jagalene (CC02)	16-2409	HRW				Kansas-Hays
LCH13NEDH-14-53	16-2410	HWW	no			Nebraska
Jagalene (CC03)	16-2411	HRW				Nebraska
LCHNEDH-4-16	16-2412	HWW	no			Nebraska
Postrock	16-2413	HRW				Syngenta

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Jagalene (CC04)	16-2414	HRW				Syngenta
AP11T2409	16-2415	HRW				Syngenta
Jagalene (CC05)	16-2416	HRW				Monsanto
HV9W10-0458	16-2417	HRW	yes	WB4515	2015	Monsanto
Jagalene (CC06)	16-2418	HRW				Oklahoma
Ruby Lee	16-2419	HRW				Oklahoma
OK10126	16-2420	HRW	yes	Spirit Rider	2017	Oklahoma
OK12D22004-016	16-2421	HRW	no			Oklahoma
OK12912C	16-2422	HRW	under Consideration			Oklahoma
OK13209	16-2423	HRW	yes	Green Hammer	2018	Oklahoma
Everest	16-2424	HRW				Kansas-Manhattan
Jagalene (CC07)	16-2425	HRW				Kansas-Manhattan
Larry	16-2426	HRW				Kansas-Manhattan
Zenda	16-2427	HRW				Kansas-Manhattan

2015

Jagalene (CC01)	15-2401	HRW				Kansas-Hays
Danby (IC)	15-2402	HRW				Kansas-Hays
KS11HW39-5	15-2403	HRW	yes	Joe	2015	Kansas-Hays
Jagalene (CC04)	15-2404	HRW				Nebraska
NE1059	15-2405	HRW	yes	Ruth	2016	Nebraska
Jagalene (CC06)	15-2406	HRW				Monsanto
BZ9W09-2075	15-2407	HWW	yes	WB4575	2015	Monsanto
HV9W10-1002	15-2408	HWW	yes	WB4303	2015	Monsanto
Jagalene (CC09)	15-2409	HRW				Colorado
Byrd (IC)	15-2410	HRW				Colorado
CO11D1397	15-2411	HRW				Colorado
CO11D1539	15-2412	HRW				Colorado
CO11D1767	15-2413	HRW				Colorado
Jagalene (CC14)	15-2414	HRW				Oklahoma
Gallagher (IC)	15-2415	HRW				Oklahoma
OK11D25056	15-2416	HRW	yes	Smith's Gold	2017	Oklahoma
OK13625	15-2417	HRW	yes	Skydance	2017	Oklahoma
OK10728W	15-2418	HWW	yes	Stardust	2017	Oklahoma
Jagalene (CC19)	15-2419	HRW				Montana
Yellowstone (IC)	15-2420	HRW				Montana
MTS1224	15-2421	HRW	yes	Loma	2016	Montana
MT1265	15-2422	HRW				Montana
Ideal (IC)	15-2423	HRW				South Dakota
SD10257-2	15-2424	HRW	yes	Oahe	2016	South Dakota
LCH13DH-20-87	15-2425	HRW	yes	LCS Chrome	2015	Limagrain

2014

Jagalene (CC01)	14-2401	HRW				Kansas_Hays

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Danby (IC)	14-2402	HWW				Kansas_Hays
KS11HW15-4	14-2403	HWW				Kansas_Hays
KS11W39-5	14-2404	HWW				Kansas_Hays
Jagalene (CC05)	14-2405	HRW				Texas_Amarillo
TAM 111 (IC)	14-2406	HRW				Texas_Amarillo
TX08A001249	14-2407	HRW				Texas_Amarillo
TX09A001194	14-2408	HRW				Texas_Amarillo
TX09D1172	14-2409	HRW				Texas_Amarillo
Jagalene (CC10)	14-2410	HRW				Colorado
Byrd (IC)	14-2411	HRW				Colorado
CO11D174	14-2412	HRW	yes	Avery	2015	Colorado
CO11D446	14-2413	HRW	yes	Langin	2016	Colorado
Jagalene (CC)	14-2414	HRW				Nebraska
Camelot (IC)	14-2415	HRW				Nebraska
NE07531	14-2416	HRW				Nebraska
NE09521	14-2417	HRW				Nebraska
Jagalene (CC18)	14-2418	HRW				Montana
Yellowstone (IC)	14-2419	HRW				Montana
MT1078	14-2420	HRW				Montana
MT1138	14-2421	HRW				Montana
Jagalene (CC22)	14-2422	HRW				Oklahoma
Ruby Lee (IC)	14-2423	HRW				Oklahoma
OK09125	14-2424	HRW	yes	Bentley	2015	Oklahoma
OK10126	14-2425	HRW	yes	Spirit Rider	2017	Oklahoma
Jagalene (CC26)	14-2426	HRW				Kansas_Manhattan
KanMark	14-2427	HRW				Kansas_Manhattan
06BC722#25	14-2428	HRW	yes	SY Flint	2015	Agripro
06BC796#68	14-2429	HRW	yes	SY Sunrise	2015	Agripro

2013

Check Blend (check)	13-2401	HRW				Limagrain
LCH08-80	13-2402	HRW				Limagrain
lCS Mint	13-2403	HRW	yes	LCS Mint	2012	Limagrain
Danby (check)	13-2404	HWW				Kansas-Hays
Oakley CL	13-2405	HRW	yes	Oakley CL	2013	Kansas-Hays
KS10HW78-1	13-2406	HWW				Kansas-Hays
Lyman (check)	13-2407	HRW				South Dakota
SD08200	13-2408	HRW				South Dakota
SD09192	13-2409	HRW				South Dakota
Postorock (check)	13-2410	HRW				Agripro
04BC574-2	13-2411	HRW	yes	SY Monument	2014	Agripro
Millennium (check)	13-2412	HRW				Nebraska
NE09521	13-2413	HRW				Nebraska
NE08499	13-2414	HRW				Nebraska
Yellowstone (check)	13-2415	HRW				Montana
MT1090	13-2416	HRW				Montana

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
MTW08168	13-2417	HWW	yes	WB3768	2013	Montana
Ruby Lee (check)	13-2418	HRW				Oklahoma
Doublestop CL+	13-2419	HRW	yes	Doublestop CL+	2013	Oklahoma
OK09125	13-2420	HRW	yes	Bentley	2015	Oklahoma

2012

WB-Stout (check)	12-2401	HRW				Westbred
HV9W07-1028	12-2402	HRW				Westbred
Millennium (check)	12-2403	HRW				Nebraska
NW07505	12-2404	HWW				Nebraska
NE06545	12-2405	HRW	yes	Freeman	2012	Nebraska
NE06607	12-2406	HRW				Nebraska
Byrd (check)	12-2407	HRW				Colorado
Snowmass (check)	12-2408	HWW				Colorado
CO07W245	12-2409	HWW	yes	Antero	2012	Colorado
CO07W722-F5	12-2410	HWW				Colorado
Billings (check)	12-2411	HRW				Oklahoma
Ruby Lee	12-2412	HRW				Oklahoma
Gallagher (OK07214)	12-2413	HRW	yes		2012	Oklahoma
Iba (OK07209)	12-2414	HRW	yes		2012	Oklahoma
OK09634	12-2415	HRW	no			Oklahoma
Lyman (check)	12-2416	HRW				South Dakota
SD08080	12-2417	HRW				South Dakota
SD06158	12-2418	HRW	yes	Redfield	2013	South Dakota
Yellowstone (check)	12-2419	HRW				Montana
MT08172	12-2420	HRW	yes	Colter	2012	Montana
MT0978	12-2421	HRW	yes	Northern	2015	Montana
TAM 111 (check)	12-2422	HRW				Texas
TX07A001505	12-2423	HRW				Texas
TX03A0563-07	12-2424	HRW				Texas

2011

Danby (check)	11-2401	HWW				Kansas-Hays
Tiger	11-2402	HWW	yes			Kansas-Hays
KS08HW35-1	11-2403	HWW	yes	Clara CL	2011	Kansas-Hays
PostRock (check)	11-2404	HRW				AgriPro
SY Wolf	11-2405	HRW	yes			AgriPro
Syngenta Exp 138-45	11-2406	HRW	yes	SY Southwind	2012	AgriPro
Fuller (check)	11-2407	HRW				Kansas-Manhattan
KS020319-7-3	11-2408	HRW	yes	1863	2012	Kansas-Manhattan
KS020633M-13	11-2409	HRW	no			Kansas-Manhattan
McGill (check)	11-2410	HRW				Nebraska
NE05496	11-2411	HRW	no			Nebraska
NE05548	11-2412	HRW	no			Nebraska

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
NI08708	11-2413	HRW	no			Nebraska
Jagalene (check)	11-2414	HRW				Westbred
HV9W06-509	11-2415	HWW	yes	WB-Grainfield	2012	Westbred
Yellowstone (check)	11-2416	HRW				Montana
MTS0808	11-2417	HRW	yes	Warhorse	2013	Montana
MT0871	11-2418	HRW	no			Montana
Lyman (check)	11-2419	HRW				South Dakota
SD06158	11-2420	HRW	yes	Redfield		South Dakota
SD07184	11-2421	HRW	no			South Dakota

2010

Lyman (check)	10-2401	HRW				SDSU
SD05118-1	10-2402	HRW	yes	Ideal	2011	SDSU
SD06158	10-2403	HRW	yes	Redfield		SDSU
Hatcher (check)	10-2404	HRW				CSU
CO050303-2	10-2405	HRW	yes	Denali	2011	CSU
CO06052	10-2406	HRW	yes	Brawl CL Plus	2011	CSU
CO06424	10-2407	HRW	yes	Byrd	2011	CSU
Millennium (check)	10-2408	HRW				NU
NE03490	10-2409	HRW	no			NU
NE04490	10-2410	HRW	no			NU
Billings (check)	10-2411	HRW				OSU
OK05526	10-2412	HRW	yes	Ruby Lee	2011	OSU
OK05212	10-2413	HRW	yes	Garrison	2011	OSU
OK07231	10-2414	HRW	no			OSU
Smoky Hill (check)	10-2415	HRW				Westbred
HV9W06-262R	10-2416	HRW	no			Westbred
HV9W06-218W	10-2417	HWW	no			Westbred
Yellowstone (check)	10-2418	HRW				MSU
MTS0721	10-2419	HRW	yes	Bearpaw	2011	MSU
TAM 111 (check)	10-2420	HRW				TAMU
TX05A001822	10-2421	HRW	no			TAMU
TX06A001263	10-2422	HRW	no			TAMU

2009

Smoky Hill (check)	09-2401	HRW				Westbred
Stout (HV9W03-539R)	09-2402	HRW	yes	WB-Stout	2009	Westbred
RonL (check)	09-2403	HWW				KSU-Hays
Tiger	09-2404	HWW	yes			KSU-Hays
Hatcher (check)	09-2405	HRW				CSU
CO04393	09-2406	HRW	no			CSU
CO04499	09-2407	HRW	no			CSU
OK Bullet (check)	09-2408	HRW				OSU
Billings	09-2409	HRW	yes			OSU

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
OK05526	09-2410	HRW	yes	Ruby Lee	2011	OSU
PostRock (check)	09-2411	HRW				AgriPro
CJ	09-2412	HRW	yes			AgriPro
SY Gold (AP00x0100-51)	09-2413	HRW	yes	SY Gold	2010	AgriPro
Yellowstone (check)	09-2414	HRW				MSU
MT06103	09-2415	HRW	no			MSU
MTS0713	09-2416	HRW	yes	Judee	2011	MSU
TAM 111 (check)	09-2417	HRW				TAMU
TX02A0252	09-2418	HRW	yes	TAM 113	2010	TAMU
Millennium (check)	09-2419	HRW				NU
NE01481	09-2420	HRW	yes	McGill	2010	NU
NI04421	09-2421	HRW	yes	Robidoux	2010	NU

2008

Jagalene (check)	08-2401	HRW				AgriPro
Art	08-2402	HRW	yes			AgriPro
Hawken	08-2403	HRW	yes			AgriPro
NuDakota	08-2404	HRW	yes			AgriPro
Hatcher (check)	08-2405	HRW				CSU
Thunder CL	08-2406	HWW	yes	Thunder CL	2008	CSU
CO03W054	08-2407	HWW	yes	Snowmass		CSU
CO03064	08-2408	HRW	no			CSU
Danby (check)	08-2409	HWW				KSU-Hays
Tiger	08-2410	HWW	yes			KSU-Hays
Karl 92 (check)	08-2411	HRW				KSU-Manhattan
KS970093-8-9-#1	08-2412	HRW	yes	Everest	2009	KSU-Manhattan
OK Bullet (check)	08-2413	HRW				OSU
OK03305	08-2414	HRW	yes	Pete	2009	OSU
OK03522	08-2415	HRW	yes	Billings	2009	OSU
OK03825-5403-6	08-2416	HRW				OSU
Tandem (check)	08-2417	HRW	yes	STARS0601W	2006	SDSU
SD05W030	08-2418	HWW	no			SDSU

2007

Hatcher (check)	07-2401	HRW				CSU
CO03W239	07-2402	HWW	yes	Thunder CL	2008	CSU
CO03W054	07-2403	HWW	yes	Snowmass		CSU
CO02W237	07-2404	HWW	no			CSU
Millennium (check)	07-2405	HRW				NU
NH03614	07-2406	HRW	yes	Settler CL	2008	NU
OK Bullet (check)	07-2407	HRW				OSU
OK00514-05806	07-2408	HRW	no			OSU
OK05737W	07-2409	HWW	no			OSU
OK03522	07-2410	HRW	yes	Billings	2009	OSU

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
OK02405	07-2411	HRW	no			OSU
Tandem (check)	07-2412	HRW				SDSU
SD98W175-1	07-2413	HRW	no			SDSU
SD01058	07-2414	HRW	no			SDSU
SD0111-9	07-2415	HRW	yes	Lyman	2008	SDSU
SD01273	07-2416	HRW	no			SDSU
Genou (check)	07-2417	HRW				MSU
MT0495	07-2418	HRW	no			MSU
MTS04114	07-2419	HRW	no			MSU

2006

Overley (check)	06-2401	HRW				KSU-Manhattan
Fuller	06-2402	HRW	yes			KSU-Manhattan
KS990498-3-&~2	06-2403	HRW	no			KSU-Manhattan
KS970274-14*9	06-2404	HRW	no			KSU-Manhattan
Overley (check)	06-2405	HRW				Westbred
Smoky Hill	06-2406	HRW	yes			Westbred
Aspen	06-2407	HRW	yes			Westbred
Millennium (check)	06-2408	HRW				NU
NW98S097	06-2409	HRW	yes	Anton	2008	NU
N02Y5117	06-2410	HRW	yes	Mace	2007	NU
NE01643	06-2411	HRW	yes	Overland	2007	NU
NE02584	06-2412	HRW	no			NU
OK Bullet (check)	06-2413	HRW				OSU
Duster	06-2414	HRW	yes			OSU
OK01420	06-2415	HRW	no			OSU
OK02405	06-2416	HRW	no			OSU
OK02522W	06-2417	HWW	yes	OK Rising	2008	OSU
Tandem (check)	06-2418	HRW				SDSU
SD96240-3-1	06-2419	HRW	no			SDSU
SD01122	06-2420	HRW	no			SDSU
SD01W065	06-2421	HWW	no			SDSU
TAM 111 (check)	06-2422	HRW				TAMU
TAM 112	06-2423	HRW	yes			TAMU
TX01A5936	06-2424	HRW	no			TAMU
TX01D3232	06-2425	HRW	yes	TAM 304	2006	TAMU
TX01V5314	06-2426	HRW	yes	TAM 203	2007	TAMU

2005

Akron (check)	05-2401	HRW				CSU
CO00016	05-2402	HRW	yes	Ripper	2006	CSU
Jagger (check)	05-2403	HRW				KSU-Hays
2137	05-2404	HRW	yes			KSU-Hays
KS03HW6-6	05-2405	HWW	no			KSU-Hays

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
KS03HW158-1	05-2406	HWW	yes	RonL		KSU-Hays
Jagger (check)	05-2407	HRW				AgriPro
Neosho	05-2408	HRW	yes			AgriPro
W03-20	05-2409	HRW	yes	Postrock	2005	AgriPro
Goodstreak (check)	05-2410	HRW				NU
Infinity CL	05-2411	HRW	yes			NU
OK Bullet (check)	05-2412	HRW				OSU
OK93p656H3299-2c04	05-2413	HRW	yes	Duster	2006	OSU
OK01307	05-2414	HRW	no			OSU
OK03918C	05-2415	HRW	yes	Centerfield	2006	OSU
OK00611W	05-2416	HWW	no			OSU
Tandem (check)	05-2417	HRW				SDSU
Crimson	05-2418	HRW	yes			SDSU
SD97059-2	05-2419	HRW	no			SDSU
SD01W064	05-2420	HWW	no			SDSU

2004

Jagger (check)	04-2401	HRW				KSU-Hays
2137	04-2402	HRW	yes			KSU-Hays
KS02HW34	04-2403	HWW	yes	Danby	2005	KSU-Hays
KS02HW35-5	04-2404	HWW	no			KSU-Hays
KS03HW158	04-2405	HWW	yes	RonL	2006	KSU-Hays
Antelope (check)	04-2406	HRW				NE-USDA-ARS
Arrowsmith	04-2407	HRW	yes			NE-USDA-ARS
NW99L7068	04-2408	HRW	no			NE-USDA-ARS
Millennium (check)	04-2409	HRW				NU
NE99495	04-2410	HRW	yes	NE99495	2005	NU
OK102 (check)	04-2411	HRW				OSU
OK00618W	04-2412	HWW	yes	Guymon	2005	OSU
OK99212	04-2413	HRW	no			OSU
OK00514	04-2414	HRW	yes	OK Bullet	2005	OSU
OK02909C	04-2415	HRW	yes	Okfield	2005	OSU
Tandem (check)	04-2416	HRW				SDSU
SD97W609	04-2417	HWW	yes	Alice	2006	SDSU
SD97538	04-2418	HRW	no			SDSU
SD98102	04-2419	HRW	yes	Darrell	2006	SDSU

2003

Akron (check)	03-2401	HRW				CSU
CO980607	03-2402	HRW	yes	Hatcher	2004	CSU
CO00D007	03-2403	HRW	yes	Bond CL	2004	CSU
Jagger (check)	03-2404	HRW				KSU-Hays
2137	03-2405	HRW	yes			KSU-Hays
KS01HW152-6	03-2406	HWW	no			KSU-Hays

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
KS01HW163-4	03-2407	HWW	no			KSU-Hays
KS02HW34	03-2408	HWW	yes	Danby	2005	KSU-Hays
Jagger (check)	03-2409	HRW				KSU-Manhattan
2137	03-2410	HRW	yes			KSU-Manhattan
Overley	03-2411	HRW	yes			KSU-Manhattan
KS940786-6-9	03-2412	HRW	no			KSU-Manhattan
OK 102 (check)	03-2413	HRW				OSU
OK94P549-11	03-2414	HRW	yes	Endurance	2004	OSU
OK98690	03-2415	HRW	yes	Deliver	2004	OSU
Crimson (check)	03-2416	HRW				SDSU
SD97W604	03-2417	HWW	yes	Wendy	2004	SDSU
SD92107-5	03-2418	HRW	no			SDSU

2002

Jagger (check)	02-2401	HRW				AgriPro
Cutter	02-2402	HRW	yes			AgriPro
Dumas	02-2403	HRW	yes			AgriPro
Jagalene	02-2404	HRW	yes			AgriPro
G1878 (check)	02-2405	HRW				Cargill
G980723	02-2406	HRW	no			Cargill
G970252W	02-2407	HWW	no			Cargill
Prowers (check)	02-2408	HRW				CSU
CO980376	02-2409	HRW	no			CSU
CO980607	02-2410	HRW	yes	Hatcher	2004	CSU
CO980630	02-2411	HRW	no			CSU
Jagger (check)	02-2412	HRW				KSU-Manhattan
KS940748-2-2	02-2413	HRW	no			KSU-Manhattan
KS940786-6-7	02-2414	HRW	yes	Overley	2003	KSU-Manhattan
KS940786-6-9	02-2415	HRW	no			KSU-Manhattan
Millennium (check)	02-2416	HRW				NU
NE97V121	02-2417	HRW	no			NU
NE98466	02-2418	HRW	no			NU
NE98471	02-2419	HRW	yes	Hallam	2004	NU
NI98439	02-2420	HRW	no			NU
2174 (check)	02-2421	HRW				OSU
OK102	02-2422	HRW	yes			OSU
OK95548-54	02-2423	HRW	no			OSU
OK95616-56	02-2424	HRW	no			OSU
OK96705-38	02-2425	HRW	no			OSU
OK98699	02-2426	HRW	no			OSU

2001

Jagger (check)	01-2401	HRW				Cargill
G970380A	01-2402	HRW	no			Cargill

Entry ID	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
G970209W	01-2403	HWW	no			Cargill
Prowers 99 (check)	01-2404	HRW				CSU
CO970547	01-2405	HRW	no			CSU
Millennium (check)	01-2406	HRW				NU
NE97426	01-2407	HRW	no			NU
NE97465	01-2408	HRW	yes	Goodstreak	2002	NU
NE97638	01-2409	HRW	yes	Empire	2002	NU
NE97669	01-2410	HRW	no			NU
NE97689	01-2411	HRW	yes	Harry	2002	NU
2174 (check)	01-2412	HRW				OSU
OK96717-99-6756	01-2413	HRW	no			OSU
OK97508	01-2414	HRW	yes	Ok102	2002	OSU

Thank you for reviewing this report of 2024 WQC Hard Winter Wheat milling and baking. Please let me know if you have any comments on this report. I can be reached at (785)776-2750 or by email, Richard.chen@usda.gov