SOFT WHEAT QUALITY LABORATORY

63ND ANNUAL RESEARCH REVIEW

2017 ANNUAL REPORT

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USDA - AGRICULTURAL RESEARCH SERVICE

CORN, SOYBEAN AND WHEAT QUALITY RESEARCH UNIT

SOFT WHEAT QUALITY LABORATORY

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AGRICULTURAL RESEARCH SERVICE VISION AND MISSION

The ARS vision is to lead America towards a better future through agricultural research and information.

ARS conducts research to develop and transfer solutions to agricultural problems of high national priority and provide information access and dissemination to:

- ensure high-quality, safe food, and other agricultural products
- assess the nutritional needs of Americans
- sustain a competitive agricultural economy
- enhance the natural resource base and the environment
- provide economic opportunities for rural citizens, communities and society as a whole

National Program 306: Quality and Utilization of Agricultural Products

Mission Statement

Enhance the marketability of agricultural products, increase the availability of healthful foods, develop value-added food and nonfood products, and enable commercially-preferred technologies for post-harvest processing.

Program Vision

Research is focused on developing knowledge and enabling commercially-viable technologies to (1) measure and maintain/enhance post-harvest product quality, (2) harvest and process agricultural materials and (3) create new value-added products.

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SOFT WHEAT QUALITY LABORATORY

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
Corn, Soybean and Wheat Quality Research Unit
1680 Madison Ave., Wooster, Ohio

MISSION

- Improve END-USE QUALITY and VALUE of soft wheat produced in the eastern U.S. for the domestic milling and baking industries and for export trade, through contribution to the development of wheat varieties of superior quality.
- Lead scientific research on end-use quality traits of soft wheat and their genetic connections, and develop efficient and reliable test methods for estimation of the milling and baking qualities of wheat.
- Contribute to the improvement in HUMAN NUTRITION and HEALTH, in collaboration with wheat foods processors and eastern U.S. wheat breeding programs, through identifying and deploying traits for greater food quality and nutrition.

BACKGROUND

Wheat is the world's largest crop used for direct human consumption. Approximately half of the wheat in the U.S. is milled in the eastern region served by the USDA-ARS Soft Wheat Quality Laboratory (SWQL), Wooster, OH. Since the 1930s, the SWQL has conducted the end-use quality evaluation of soft wheat breeding lines and scientific research on wheat quality through long-established coordinated research with state land-grant universities and private breeding programs in the eastern U.S. for the purpose of improving the milling and baking quality of soft wheat produced in the region. It is one of the few laboratories in the world that develops methods for testing the quality of soft wheat, the major wheat type grown in the eastern U.S.

Today, the SWQL evaluates in excess of 5,000 breeding lines and varieties submitted by 17 public and private breeding programs in 13 eastern states annually for end-use quality potentials for the development of wheat varieties possessing desirable quality. The SWQL also plays a pivotal role in the variety evaluation under the uniform regional variety testing programs, and the Wheat Quality Council project for testing end-use quality potentials of newly released varieties in cooperation with eastern soft wheat breeders, the Wheat Quality Council and the regional milling and baking companies.

Since its establishment, the SWQL has enjoyed strong, continuous support from the regional milling and baking industries and in return has made significant contributions to the overall improvement in the quality of soft wheat that is produced in the region. No doubt, the solid cooperation from wheat breeding programs and milling and baking industries has been and will continue to be essential for the prosperity of the SWQL.

The SWQL critically evaluates nearly all wheat cultivars marketed from Missouri to the Atlantic seaboard. It also develops and publishes new methods, and conducts research in the areas of milling and flour quality. Research findings are shared with breeders, millers and food processors through the annual SWQL Research Review, annual Soft Wheat Quality Council Meeting, publications in refereed journals and presentations at international conferences. Our website makes SWQL data, protocols, cultivar descriptions and research news publicly available.

CURRENT FUNDING & STAFF

Current base funding supports two scientists, a support scientist, and five full-time and one part-time technicians. Two post-doctoral research associates joined the lab in 2014, and have been supported mainly from research grant funds received from the wheat industry; they will continue to work in the SWQL for a fourth year. A visiting scholar from the Rural Development Administration (RDA) in Korea joined the lab in December 2016, and is working on a funded cooperative research project until September 2017. A visiting student joined us in March 2016 from Chonbuk National University in Korea and another from the same university in April 2017 to work on a collaborative research project. The four full-time and one part-time technical support staff members are responsible for the quality evaluation of breeding lines and varieties. Two full-time research technicians, two post-doctoral research associates and two visiting scholars work with two scientists to conduct research projects.

The laboratory continues to improve the efficiency and reliability of the quality evaluations of breeding lines and varieties under declining discretionary funds. Renovations to the flour milling facilities and mills are ongoing and will continue as funding permits. The renovated HVAC system in the milling room provides better control of humidity and temperature conditions.

NEW IN 2016

The 62nd SWQL Annual Research Review Conference was held jointly with the Soft Wheat Quality Council Meeting on March 1-2, 2016, in Cincinnati, Ohio. The meeting was attended by five guest speakers, four SWQL presenters and 67 registered attendees from wheat breeding programs, universities, state wheat growers associations, foundation seed programs and milling and baking industries. The 2016 Conference was productive and well-received by the attendees, as evaluations of the meeting were predominantly positive with a few individual suggestions.

Bryan Penning joined the lab in March 2016 as the new Research Scientist/Plant Geneticist, and has successfully developed his research plan. Dr. Moonseok Kang, a visiting scholar from the Rural Development Administration (RDA)-Korea, completed his scholarship for two years in the lab with significant accomplishments in the study examining the changes in end-use quality traits, falling number and α-amylase activity of wheat grain during the grain-filling period. Another RDA scientist, Dr. Yuyoung Lee, joined the lab in December 2016, will be with us for ten months and works on an international cooperative research project investigating ways to improve the quality attributes and sensory acceptance of whole grain soft wheat products including pancakes, biscuits, noodles and steamed bread.

From the ARS equipment funds, an Illumina NeoPrep machine was purchased and has been used for preparation of RNA libraries. A new flour sifter was purchased for re-sieving of Miag-milled flour to further remove bran particles.

Thus far, we have received approximately 5,897 breeding lines and varieties grown in the 2016 crop year from 18 private and public breeding programs, as well as state and regional uniform variety testing programs, for quality evaluation. End-use quality evaluation for the variety testing program samples from the states of Illinois, Maryland, Michigan, New York, Ohio and Virginia, and seven uniform regional nursery samples, has been completed and the summarized test results distributed. Our quality evaluation of wheat breeding lines produced in the 2016 crop year is in progress and has been completed for over 80% of the test samples.

For the 2016 crop Soft Wheat Quality Council (SWQC) project, seven entries grown in Custar, Ohio, by the Northwest Agricultural Research Station-Ohio Agricultural Research & Development Center and six entries grown in Atlanta, Indiana, were obtained and evaluated for end-use quality potentials by eleven cooperators from the regional wheat breeding, milling and baking companies as well as private and government wheat quality testing laboratories. Wheat grain was cleaned, tested for grain characteristics, milled and sent out to collaborators for processing and baking quality evaluation. Based on the quality evaluation data obtained from the SWQL and collaborators, we published the 2016 WQC project report.

With the 2015 crop Overseas Varietal Analysis (OVA) project, we have collected the grain and flour characteristics of ten entries from the SWQL, and end-product quality evaluation results from the overseas cooperators, analyzed and assembled the data, and published the 2015 crop OVA report. The U.S. Wheat Associates have decided to end their sponsorship of the OVA project after the 2015 crop. No further evaluation of eastern soft winter wheat varieties by overseas buyers for milling and baking quality will be carried out.

Our research projects include: 1) development of a cake baking test procedure for non-chlorinated flour and batter viscosity of flour for estimation of cake baking quality; 2) pre-harvest sprouting resistance (PHS) profile of soft red winter (SRW) wheat varieties and grain characteristics related to PHS resistance; 3) quality characteristics of eastern soft wheat required for making biscuits; 4) characteristics of SRW wheat bran related to the quality attributes of whole wheat grain biscuits; and 5) three sucrose synthase alleles and their effect on milling quality.

We secured extramural research funds from Mondeléz International Company ($33,000) and the Rural Development Administration (RDA)-Korea ($60,000).

We published the '2017 Annual Research Review Report', 'Overseas Varietal Analysis Report for Crop Year 2015', and 'Milling and Baking Test Results for Eastern Soft Wheats Harvested in 2016'. Dr. Baik was the corresponding author of seven, and co-author of two, refereed journal articles published in 2016. Dr. Baik was co-author of a soft red winter wheat variety registration. Dr. Baik and three other SWQL members were the authors of four poster presentations at the American Association of Cereal Chemists International Meeting in Savannah, Georgia, in 2016. Dr. Penning and one other SWQL member were authors of a poster at Plant and Animal Genome in San Diego,

CA in 2017. Dr. Baik gave a presentation on soft red winter wheat quality, value and access as an invited speaker at the Latin American & Caribbean Wheat Buyers Conference sponsored by the Wheat Associates on June 21-24, 2016, in Portland, Oregon. Dr. Baik delivered presentations on the crop quality of 2016 soft red winter and Pacific North West (PNW) soft white wheat as an invited speaker at the Central America and Caribbean Crop Quality Seminars on November 2-12, 2016, in Mexico, Guatemala, Costa Rica, Panama, and the Dominican Republic.

The ARS laboratory was recognized as winner of the best protein and pH analyses, and was first runner-up in overall quality analysis in 2016 among the 50 institutions competing in the American Association of Cereal Chemists International (AACCI) Cincinnati Section check sample evaluation.

2016 SOFT WHEAT QUALITY LAB RESEARCH

SWQL RESEARCH PROJECTS

The SWQL research team, composed of a plant molecular biologist/lead scientist, a plant geneticist, a research support scientist, two post-doctoral research associates, two visiting scholars, and a technician, has made significant progress in a number of research projects including quality evaluation method development, identification of the biochemical characteristics of wheat grain related to milling and baking quality, exploration of the potential uses of eastern soft wheat and whole grain wheat for extended food products, and genetics of milling and baking quality traits. Following the newly approved SWQL five-year project plan, we have continued research on: 1) development of a cake baking test procedure for non-chlorinated flour and batter viscosity of flour for estimation of cake baking quality; 2) PHS profile of SRW wheat varieties and grain characteristics related to PHS resistance; 3) quality characteristics of eastern soft wheat required for making biscuits; 4) characteristics of SRW wheat bran related to the quality attributes of whole wheat grain biscuits; and 5) chromosome 2B type 2 sucrose synthase (*TaSus2-2B*) alleles and their effect on milling quality in wheat.

We have continued collaborative research on the effects of nitrogen fertilizer application rate on wheat grain characteristics related to milling and baking quality with two Ohio State University faculty members, Drs. Laura Lindsey and Ed Lentz. We have continued our cooperative research with the following eastern soft wheat breeders: Dr. Carl Griffey at Virginia Tech University for identification of genes, quantitative trait loci (QTL) and diagnostic markers associated with specific end-use quality traits in SRW wheat, Dr. Dave Van Sanford at the University of Kentucky for the quality assessment of eastern U.S.-grown wheat for making baguettes, Dr. Fred Kolb at the University of Illinois for the identification of QTLs for milling and baking traits, and Dr. Wade Thomason at Virginia Tech University for the milling and baking quality evaluation of early-harvested soft wheat grain.

The results we have obtained from the research projects, including: 1) Nitrogen fertilizer application rate on grain, milling and baking quality characteristics of soft red winter wheat; 2) Volatile organic compound profile of whole grain soft winter wheat; 3) Harvest time of wheat for maximum grain yield and falling number in soft wheat; and 4) Quality characteristics of Chinese steamed bread made from soft red winter wheat flours with waxy wheat flour substitution, were shared with the national and international audience at the American Association of Cereal Chemists International (AACCI) Annual Meeting in October of 2016 in Savannah, Georgia.

The SWQL current research projects are described below.

1. **Development of a cake baking test procedure for non-chlorinated flour and batter viscosity of flour for estimation of cake baking quality**

   An experimental high ratio cake baking method for non-chlorinated flour was established with optimization of the formula (including the proportions of water, sugar and shortening) from the AACCI 10-90 method for chlorinated flour with consideration of cake volume and contour. The volume of cakes prepared from non-chlorinated flour using the new method exhibited significant correlation with the volume of cakes baked from chlorinated flour using the AACCI 10-90 method. We observed that the RVA viscosity of both flour-water and flour-sucrose-water batters determined without heating showed significant correlations with both the volume of the cakes prepared from chlorinated flours using the AACCI 10-90 method and that of the cakes prepared from non-chlorinated flours using the new method. The RVA viscosity measurement of flour-water batter can be used to estimate the cake baking potential of wheat flour.

2. **Qualitative effect of added gluten on dough properties and quality of Chinese steamed bread**

   Both protein content and gluten protein strength of wheat flour are known to significantly affect Chinese steamed bread (CSB) making quality. Previous reports show conflicting results on the nature of the relationships (positive vs. negative) of these two flour characteristics on CSB quality attributes. We attempted to determine the influence of gluten strength, alone, on dough properties and CSB quality by adding gluten of varying strengths to a base flour with controlled overall protein content. Glutens of different strengths isolated from 15 soft red winter (SRW) wheat varieties were incorporated into a base wheat flour to prepare wheat flour blends of similar protein content, but varying in gluten strength. We found that CSB made from flours containing added strong glutens exhibited a smoother surface, better crumb structure and higher total score than CSB made from flours containing added weak glutens. In addition, significantly positive relationships of gluten strength with CSB specific volume and stress relaxation were observed with the gluten-added flours. A quantitative increase in gluten protein, regardless of strength, resulted in improved dough mixing properties with little effect on dough extensibility, and increased CSB specific volume and crumb structure scores without affecting surface smoothness, stress relaxation and total score of CSB. Our results indicate that consideration of gluten protein strength in the evaluation and selection of wheat varieties is necessary for the production of high quality CSB. It is evident that SRW wheat varieties producing grain with relatively high protein content and specifically, high gluten strength, would be suitable for the production of CSB.

3. **Grain and flour characteristics of eastern soft winter wheat required for making baking powder biscuits**

   The quality characteristics of eastern soft wheat grain and flour important for making baking powder biscuits have not been clearly identified, and consequently no known target value for each characteristic is available. We determined comprehensive grain and flour characteristics of thirteen red and two white varieties and related them to the quality attributes of biscuits including height, specific volume, shape factor (SF, ratio of the highest height to the lowest

height) and crumb hardness. We found that protein content, SDSS volume as a measure of protein strength, starch damage and water SRC showed relationships with biscuit quality attributes.

4. **Varietal variations in wheat bran characteristics and their association with whole wheat Chinese steamed bread**

   Wheat bran obtained from milling can differ widely in compositional, nutritional, physical and biochemical characteristics among the sources of grain and varieties, affecting the product quality and sensory acceptance of whole wheat foods. We obtained brans by milling the grains of 17 soft red winter wheat varieties and determined their composition including protein, dietary fiber, arabinoxylan and phenolic acid contents. Bran from each variety was blended with the same flour to prepare 17 different preparations of whole wheat flour for the determination of dough properties and whole wheat steamed bread quality evaluation. We observed that bran composition varied widely among wheat varieties, and that the bound and total phenolic acid, water-soluble arabinoxylan and insoluble dietary fiber contents of bran significantly affected the quality attributes of Chinese steamed bread.

5. **Varietal differences in falling number of wheat grain under sprouting conditions and influences of grain characteristics**

   Pre-harvest sprouting (PHS) accompanies an increase in α-amylase activity and consequently lowers falling number (FN) of wheat grain, which negatively affects end-use quality and leads to price reduction. To establish a PHS resistance profile of wheat varieties (which would help wheat growers select varieties for planting with improved FN), we screened soft red and soft white wheat varieties for their resistance to PHS under sprouting conditions in the field and also in a growth chamber by determination of FN and α-amylase activity, and visual examination. We also determined the characteristics of wheat grain produced under non-sprouting conditions, and compared them to the FN and α-amylase activity of grain produced under sprouting conditions to identify the relationship between the genetically controlled grain characteristics and PHS resistance. Wheat varieties exhibited large differences in PHS resistance as evidenced by a large range in FN values of wheat grain subjected to sprouting conditions both in the field and in a growth chamber. Even under severe sprouting conditions in the field, 14 cultivars produced wheat grain with FNs greater than 300, indicating evident differences in PHS resistance among wheat varieties. We also observed that soft red winter wheat and awn-less varieties tended to produce grain with higher FN compared to soft white winter wheat and awned varieties, respectively, when subjected to sprouting conditions. The test weight of wheat grain produced under non-sprouting conditions showed a significant positive relationship with the FN of wheat grain subjected to sprouting conditions.

6. **Evaluation of chromosome 2B type 2 sucrose synthase (*TaSus2-2B*) alleles and their effect on milling quality in wheat**

   Recent genetic mapping studies identified quantitative trait loci (QTL) affecting milling quality present on chromosome 2B of wheat (*Identification of milling and baking quality QTL in multiple*

soft wheat mapping populations, Antonio Cabrera, Theor Appl Genet 2015 Nov). These milling QTL are located very near the gene (*TaSus2-2B)* encoding one form of a sucrose synthase expressed in the endosperm. Sucrose synthase catalyzes the conversion of sucrose to produce the precursor for starch synthesis, UDP-glucose. The SWQL has developed triple backcrossed, near-isogenic lines containing three different *TaSus2-2B* alleles in several elite soft red wheat cultivar backgrounds. Preliminary studies using quantitative real-time PCR (qRT-PCR) indicate that these alleles may be expressed in different amounts. No difference in copy number was detected between the *TaSus2-2B* alleles, and sequencing evidence indicates allelic variation in the upstream region of the gene on 2B. A 35 base pair insertion/deletion site has been discovered in the region with strong similarity to a rice promoter motif known to increase seed expression of genes. Near-isogenic, homozygous lines (NILs) are being tested for *TaSus2-2B* expression and grown in the field for milling quality evaluation. We have shown that the preferred allele is underrepresented in U.S. eastern soft wheats. Our goal is to incorporate the favored allele, reportedly associated with increased kernel weight (*Global Selection on Sucrose Synthase Haplotypes during a Century of Wheat Breeding,* Hou, et al, Plant Physiology, April 2014, Vol. 164, pp. 1918–1929), into eastern soft wheat germplasm, potentially affecting milling yield and quality in these lines.

END-USE QUALITY EVALUATION OF WHEAT BREEDING LINES AND VARIETIES

Twenty-one cooperators, including public and private breeding programs of the eastern soft winter wheat and the state variety testing programs, have thus far submitted approximately 5,897 samples harvested in the 2016 crop year for end-use quality evaluation. Analyses for approximately 85% of the samples received were completed by the end of April, 2017. Milling and baking quality evaluation for the samples from six state variety performance test trials and seven uniform regional cooperative testing trials in the 2016 crop year has been completed. The test results have been summarized and provided to the breeding programs by the SWQL. We expect to complete all tests of breeding lines and varieties by the end of May, 2017.

As implemented beginning with the 2013 crop year, breeding lines submitted to the SWQL for quality evaluation by the breeding programs are classified into 'Preliminary', 'Intermediate' or 'Advanced' groups, considering breeding stage and screening requests. Grain characteristics (test weight, kernel hardness and protein content) and quadrumat test milling properties are determined for all of the wheat breeding lines submitted to the SWQL. Intermediate and advanced group samples are further tested for flour composition (protein and moisture) and sodium carbonate and lactic acid SRCs. Only advanced group samples undergo the sugar-snap cookie baking test.

Quality evaluation data have been reported to the breeding programs along with a t-score (which is the number of standard deviations away from the check variety for each quality parameter), and a total t-score is calculated and included in the report. The total t-score is the sum of the t-scores of test weight, kernel hardness, flour yield, softness equivalence and sodium carbonate SRC, with different weights of 0.15, 0.10, 0.4, 0.15 and 0.2, respectively. Each breeding line is assigned a specific grade (A, B, C, D, or F) based on its flour yield compared to the flour yield distribution of wheat breeding lines and varieties tested in the SWQL between 2009 and 2015. The wheat breeding lines that fall in the top 15% receive a grade 'A', in the next 20% a 'B', in the next 30% a 'C', in the next 20% a 'D' and in the bottom 15% an 'F'.

The SWQL coordinates the Soft Wheat Quality Council (SWQC) in collaboration with the Wheat Quality Council. We obtained wheat grain, milled it and shipped the flour to cooperators in the domestic milling and baking industries for end-users' evaluations of flour quality and baking performance. In 2016, 13 entries for the SWQC were processed and distributed to cooperators.

VARIETY DESCRIPTIONS – NEW WHEAT CULTIVARS

The Soft Wheat Quality Laboratory solicits newly released varieties and advanced breeding lines for yearly grow out and evaluation in Wooster alongside known standards. Each cultivar is grown for a minimum of three years in the soft wheat quality nursery to produce a reliable profile of current regional soft winter wheat varieties. In this report we present descriptions of new lines submitted for testing between 2014 and 2017. The SWQL thanks each of the cooperating breeders for their collaboration and contributions of seed and variety descriptions.

Collaborating institutions and breeders are listed below followed by breeder's descriptions of their contributed cultivars. A more complete list of descriptions for cultivars grown at the SWQL is available on the SWQL website.

Beck's Hybrids - Trek Murray

Beck 88AA

Beck 88AA is an awnless, medium height soft red winter wheat with excellent winter hardiness. Beck 88 is blue-green before maturity, extremely early maturing (heads 3 days earlier than Clark) and recommended for double cropping. It has tremendous standability and excellent Fusarium head blight tolerance. Beck 88 is best suited for growth in Missouri, Illinois, Indiana, Ohio and Kentucky and shows resistance to Fusarium head blight and Septoria leaf blotch, tolerance to Septoria Glume Blotch, Leaf Rust, Barley yellow dwarf virus and soilborne wheat mosaic virus.

Beck 88AA is an exciting double crop performer for Beck's marketing area. This extremely early product adds yield while maintaining standability, winter hardiness, test weight, and Fusarium head blight tolerance. Beck 88 opens new opportunities for double crop in Beck's northern market area. Beck 88AA was evaluated for the 2016 Wheat Quality Council.

Beck 114

Beck 114 is an awnless, medium height, early maturing soft red winter wheat with outstanding test weight and consistent yield. Beck 114 has excellent yield potential, standability, winter hardiness and disease resistance. Beck 114 is highly resistant to soilborne wheat mosaic virus and Septoria leaf blotch and has good resistance to Septoria glume blotch, FHB (head scab) and barley yellow dwarf virus with tolerance to powdery mildew and leaf rust. Maturing plants are medium green in color. Beck 114 was evaluated for the 2016 Wheat Quality Council.

Beck 123

Beck 123 is an awned, medium tall soft red winter wheat with excellent yield potential and stability, test weight and plant health. Beck 123 has good resistance to Septoria leaf blotch and glume blotch, leaf rust, FHB (head scab) and barley yellow dwarf virus. It is resistant to soilborne wheat mosaic virus. Beck 123 has excellent standability, tiller production winter hardiness, uniformity, straw yield and fall growth are all excellent. Maturing plants are medium green in color.

Beck 123 is a tremendous bin busting yielder. This medium-early variety was the pre-commercial trial champion in 2015. Beck 123 brings a nice plant health package complemented with a gorgeous harvest appearance. Beck 123 will be an exciting variety for years to come. Beck 123 was evaluated for the 2016 Wheat Quality Council.

Beck 125

Beck 125 is an awned, medium tall soft red winter wheat with outstanding yield, test weight, winter hardiness and standability released in 2014. Beck 125 is medium-early maturing (3 days later than Clark) and shows resistance to Septoria leaf blotch, scab, powdery mildew and barley yellow dwarf virus with good tolerance to Septoria Glume Blotch and soilborne wheat mosaic virus. Beck 125 is medium green before maturity. Beck 125 is a dominant yielder in Beck's entire market area. Winning the precommercial trial each of the last two years it has combined yield, test weight, health and standability. Beck 125 is a broadly adapted, medium early farmer favorite. Beck 125 was evaluated for the 2016 Wheat Quality Council.

Beck 128

Beck 128 is an awned, medium tall, soft red winter wheat with outstanding yield potential and excellent standability, winter hardiness, test weight and plant health. Beck 128 is resistant to FHB (head scab) and has good resistance to Septoria glume blotch. Beck 128 is tolerant to Septoria leaf blotch, barley yellow dwarf virus and soilborne wheat mosaic virus and shows some tolerance to powdery mildew and leaf rust. Maturing plants are medium green in color.

Beck 128 is a tremendous medium-late variety for better soils. With the FHB1 gene, it has a superior tolerance to head scab. Beck 128 maximizes yield potential through good tillering and aggressive early growth. Beck 128 will compete in every corner of Beck's marketing area.
Beck 128 was evaluated for the 2016 Wheat Quality Council.

Beck 120

Beck 120 is an awned, medium short soft red winter wheat with superior yield, excellent test weight, winter hardiness and standability. Beck 120 is medium-early maturing (2 days later than Clark) and shows resistance to Septoria Glume Blotch and barley yellow dwarf virus, with tolerance to Septoria leaf blotch, scab, powdery mildew and soilborne wheat mosaic virus. Beck 120 is dark green before maturity. Beck 120 was released in 2012.

Beck 120 is a high performing variety that delivers bin-busting yields in a medium early maturity. This awned variety offers excellent standability to perform great under high management with higher rates of nitrogen. Beck 120 is a broadly adapted medium early farmer favorite. Beck 120 was evaluated as a check variety for the 2016 Wheat Quality Council.

Descriptions by Trek Murray, 2017

KWS Seed – Jana Murche

KWS077 – NEW 2017

KWS077 is an awnletted, medium-tall, soft red winter wheat with consistently high yields, a good test weight and well-rounded disease resistance package. It expresses good standing ability at a medium-tall height and is scheduled for release in fall 2018.

KWS077 shows excellent resistance to stripe rust, leaf rust, Xanthomonas and soilborne mosaic virus. Additionally it has a good resistance level to Fusarium Head Blight, Septoria leaf and glume blotch. A fungicide application is advised in regions, where powdery mildew occurs frequently.

Description by Jana Murche, 2017

Rupp Seed – John King

RS 902 – NEW 2017

RS 902 is an awned, soft red winter wheat with average head size and white chaff at maturity. RS 902 is tolerant/resistant to Scab, powdery Mildew and Glume Blotch. It has excellent winter hardiness and straw strength for standability. RS 902 is medium height with medium late maturity, medium seed size and excellent test weight. Flag leaf orientation is upright and prior to maturity, plant color is green.

RS 911 – NEW 2017

RS 911 is an awnless, soft red winter wheat of average head size. Chaff color at maturity is white. RS 911 is tolerant or resistant to Scab, Powdery Mildew, and Glume Blotch. It has excellent winter hardiness and straw strength/standability. RS 911 is a medium maturing, medium tall plant with medium seed size and very good test weight. Flag leaf orientation is upright and prior to maturity, plant color is green.

RS 910

RS 910 is an awned, soft red winter wheat, with average head size and white chaff at maturity. RS 910 is resistant or tolerant to Scab, Powdery Mildew and Glume Blotch. It has very good winter hardiness and excellent straw strength/standability. RS 910 is a medium late maturing line of medium height that produces medium sized grain and excellent test weight. Flag leaf orientation is upright and prior to maturity, plant color is green.

Rupp RS972

RS972 is an awnless, soft red winter wheat with white chaff. Disease tolerance is very good for leaf and stripe rusts, powdery mildew, Septoria leaf blotch and fusarium head blight. Test weight is very good from this medium to late heading, medium height plant with very good winter hardiness and excellent straw strength.

Rupp RS979

RS979 is an awnless, soft red winter wheat with white chaff. Disease tolerance is very good for leaf and stripe rusts, powdery mildew, Septoria leaf blotch and fusarium head blight. Test weight is very good from this medium heading, medium height plant with very good winter hardiness and excellent straw strength.

Rupp 9xp367

Experimental line 9xp367 is an awned, soft red winter wheat with white chaff. Disease tolerance is very good for leaf and stripe rusts, powdery mildew, Septoria leaf blotch and good to average for fusarium head blight. Test weight is very good from this medium heading (Patterson +1-2, similar to Pioneer 25R47), medium height plant with very good winter hardiness and excellent straw strength. The green stage plant is green in color with a recurved, not twisted, flag leaf orientation.

RS935

RS935 is a medium early heading soft red winter wheat variety that has established a multi-year yield record. It works well on all soil types and exhibits good head scab tolerance. RS935 is medium short, awned with excellent standability, very good winter hardiness and average test weight. It is moderately resistant to head scab (FHB), powdery mildew and Septoria glume blotch.

RS967

RS967 is a line that has tremendous yield potential. RS967 is a medium maturing variety with good test weight, stiff straw and scab resistance as its defining characteristics. RS967 is a soft red winter wheat of medium height, awned, with excellent standability and very good test weight and winter hardiness. RS967 is resistant to head scab (FHB), moderately resistant to powdery mildew and Septoria glume blotch.
Descriptions by John King, Rupp Seeds, 2017

Seed Consultants – Bill Mullen

SC 13S26

SC 13S26 is a soft red winter wheat with strong early growth and good early tillering. This medium height and medium maturing line has high yield with very good winter hardiness test weight. SC13S26 has Fhb1 type II scab resistance, good tolerance to leaf rust and very good tolerance to Septoria leaf and glume blotch. Tolerance to stripe rust and powdery mildew is average, fungicide is recommended to control powdery mildew. SC 13S26 is best positioned from central Kentucky and north into Michigan. SC 13S26 is being produced in 2016 for sale in fall 2016.

SC EXP142

SC EXP142 is an awned, soft red winter wheat with high yield, very good test weight and winter hardiness. SC EXP142 has very good early tillering and fuller head size with medium maturity due to longer grain fill period. SC EXP142 is a high yielding wheat variety with type II scab resistance, very good tolerance to Septoria leaf and glume blotch and powdery mildew. SC EXP142 is best positioned in central Kentucky and into the southern wheat growing area and responds well to

intensive wheat management programs. SC EXP142 is being produced in 2016 and will be renamed for sale in fall 2016.

SC 1315-15™ brand

SC 1315-15 is a medium-early maturity, bearded, soft red winter wheat, ideal for double crop. SC1315 produced 105% of yield mean in 2014 SCI Wheat Testing at 8 test locations. The cultivar is medium height, with excellent standability and heavy bucket weight, and is a widely adapted variety throughout the SCI sales area. SC1315-15 has a very good disease package including FHB (head scab) and leaf blotch tolerance.
Spring top dress N of 85 to 100 pound actual N under high management and nice companion variety with SC 1325-15™ in early, high yield environments.

SC 1325-15™ brand

SC 1325-15 is a bearded, medium maturing soft red winter wheat with high yield potential, adapted throughout OH, IN, KY and MI. SC 1325-15 is an Ideal choice for planting double crop soybeans after wheat. SC 1325-15 is a medium maturity line that works well in intensive wheat management programs. SC 1325-15 has very good plant health, good test weight and winter hardiness. The cultivar has excellent standability with very good tolerance to glume blotch and FHB (head scab). SC 1325-15 topped 2014 OSU Wheat Trials at 113.4 bpa/110% of plot mean of 87 entries and 2014 UKY Wheat Test SC 1325-15™ yielded 102 bushel, #10 out of 102 entries, 106% of plot mean. This cultivar adapts to a high wheat management environment—90 to 100# N spring top dress. Where Powdery Mildew is an issue, a fungicide is recommended for control.

SC 1335-15™ brand

SC 1335-15 is a medium late maturing, bearded variety adapted well to all environments throughout the SCI sales area. SC 1335-15 has excellent standability, test weight and winter hardiness with excellent tolerance to powdery mildew and glume blotch and very good tolerance to FHB (head scab).

SC 1335-15 is a high yield potential variety, works well before double crop soybeans.
SC 1335-15 yielded 103% of the plot mean in 2014 KY Wheat Trials, #37 out of 112 entries at 98.7 bushel with 59.8 test weight and 103% of plot mean in 2014 OSU Wheat Trials, #24 out of 87 entries at 106 bushel with a 59.7 test weight. Spring top dress N of 80 to 95 pounds helps this variety to excel in yield. With fall seeding rate of 1.6 to 1.8 million seeds per acre, this cultivar is a great companion for SC 1342™

Steyer Seed – Brenna Finnegan

Ackley

Ackley is an awnless, medium short, soft red winter wheat with very early maturity and tremendous test weight. It is widely adapted, with very good winter hardiness. Ackley has very good standability and has excellent resistance to leaf rust, Septoria glume blotch, Septoria leaf blotch, barley yellow dwarf virus and Fusarium head scab. Ackley has very good resistance to soil-borne mosaic virus and good resistance to stem rust, powdery mildew and Hessian fly. Akley had a very limited release in 2015 and is Seimer milling approved.

Dowell

Dowell is an awnless soft red winter wheat with solid overall disease package with exciting yield potential and outstanding head scab tolerance. Dowell has excellent yield potential, handles wet conditions very well and has excellent scab tolerance. Dowell is a medium maturing, medium height wheat with excellent resistance to lodging and very good test weight. It has excellent winter hardiness and very good resistance to stem and leaf rusts. Dowell has excellent resistance to powdery mildew and barley yellow dwarf, with very good resistance to Septoria glume and leaf blotch, good resistance to soil-borne mosaic virus and Hessian fly.

Evans

Evans is an awned, medium height soft red winter wheat with consistent high yields. It is widely adapted, with outstanding winter hardiness. Evans has very good test weight, excellent winter hardiness and standability. Evans has excellent resistance to stem rust, very good resistance to powdery mildew and Septoria glume blotch and good resistance to leaf rust, Septoria leaf blotch, scab and Hessian fly.

Morrin

Morrin is an awnless, medium short, widely adapted soft red winter wheat with excellent yield potential and stripe rust resistance. Morrin has excellent winter hardiness and standability and responds to high management STEX 146. With tremendous test weight and very early maturity, Morrin is a great double crop choice. Morrin has excellent resistance to leaf rust, Septoria leaf blotch and Hessian fly, very good resistance to soil-borne mosaic virus and barley yellow dwarf virus, good resistance to powdery mildew, Septoria glume blotch and scab. Morrin is Seimer milling approved.

Sebree

Seebree is a soft red, awned winter wheat of medium height and very early maturity and high yield. It has excellent winter hardiness very good test weight and good resistance to lodging. Disease resistance is excellent against Septoria glume and leaf blotch as well as soil-borne mosaic virus and barley yellow dwarf virus. Seebree has very good resistance to stem and leaf rusts, powdery mildew, and Hessian fly. The cultivar is extremely early and high yielding, works well in North and South and has excellent double-crop potential.

Syngenta Seeds, Inc. Barton Fogelman, Allen Becker, Jennifer Vonderwell

SY Viper

This soft red winter wheat variety has a medium-early maturity and broad adaptability, equating to better yields in more environments. SY Viper has a strong disease package, showing very good stripe rust tolerance and good Metribuzin tolerance in testing. This variety has a very good test weight and showed high yields across the Mid-South and East Coast growing regions.
SY Viper is a medium to medium-tall height, semidwarf variety bred by Syngenta Seeds, Inc. It has white chaff and has a heading date almost three and one-half days earlier than "Oakes". SY Viper has shown moderate resistance to the current races of powdery mildew and moderate susceptibility to the current races of leaf rust in the growing areas. Milling and baking characteristics are equivalent to those of soft wheat variety, Jamestown. SY Viper is intended for grain production.

SY 100

SY 100 (formerly M10-1100) is a soft red winter wheat bred by Syngenta Seeds, Inc. for grain production. SY 100 is a medium tall semi-dwarf variety and has white chaff at maturity. It has medium maturity and its heading is a day later than W1104. SY 100 has shown above average test weight, moderate resistance to fusarium head blight, moderate resistance to all prevalent leaf diseases in the Midwest and mid-Atlantic including current races of powdery mildew, leaf rust and stripe rusts. It has tested moderately susceptible to septoria leaf blight. It has above average milling and cookie qualities and is an above average broad adaptation end use market variety. SY 100 appears to be best adapted for grain production in the states of Illinois, Indiana, Missouri, Michigan, Ohio, Wisconsin, Delaware, Maryland, North Carolina, Pennsylvania, and Virginia. SY 100 was evaluated for the 2016 Wheat Quality Council.

M11-2024# (SR5111)

M11-2024# is an awnless soft red winter wheat bred by Syngenta. It is a medium short height semi-dwarf variety with medium-early maturity heading the same as Branson. M11-2024# has shown above average test weight, moderate resistance to BYD, Soilborne virus, powdery mildew, leaf rust and stripe rust. It has shown very good milling with average cookie baking properties. M11-2024# was evaluated for the 2016 Wheat Quality Council.

M11*3144CS (SY 944) – NEW 2017

SY 944: This soft white winter wheat variety delivers excellent milling and baking qualities due to its durable test weight and high grain yield. This medium-late maturity variety offers a strong agronomic package with excellent mildew and soil virus resistance. With good pre-harvest sprouting tolerance and winter survival, SY 944 is hardy and well-suited for the northern growing regions in Michigan and New York. M11*3144CS was evaluated for the 2016 Wheat Quality Council.

Branson

Branson is a soft red winter wheat, bred and developed by AgriPro Wheat. Branson is a medium height semi dwarf variety with good straw strength. Branson is moderately resistant to Septoria Leaf Blotch and Stripe rust and Powdery Mildew. Intermediate resistance to Soilborne Mosaic virus and Leaf rust. Primary adaptation is the wheat growing regions of Missouri, Illinois, Indiana, Michigan, and Ohio. Juvenile growth habit is semi erect. Plant color at boot stage is dark green. Flag leaf at boot stage is erect and twisted. Waxy bloom is present on the head, stem and flag leaf sheath. Anther color is yellow. Head shape is strap, mid-dense and awnletted. Glumes are glabrous, narrow in width and long in length with oblique shoulders and obtuse beaks. Seed shape is ovate. Brush hairs are mid-long in length and occupy a large area of the seed tip. Seed crease depth is shallow and width is narrow. Seed cheeks are rounded. Branson has been uniform and stable since 2003. Less than 0.8% of the plants were rouged from the Breeders Seed increase in 2004. Approximately 90% of the rouged variant plants were taller height wheat plants (8 to 15 cm) and 10% were awned plants. AgriPro Wheat maintains seed stock and certified classes of Foundation, Registered and Certified. Certified seed stocks of Branson will be available in the fall of 2005. Certified acreage is not to be published by AOSCA and certifying agencies. Plant Variety Protection is anticipated and Branson may only be sold as a class of certified seed. Branson was evaluated as a check for the 2016 Wheat Quality Council.

SY Cypress – formerly B08*0313

SY Cypress (aka B08*0313) is a soft red winter wheat, bred and developed by Syngenta Seeds, Inc. SY Cypress is of medium-short height, a semi-dwarf variety with white chaff at maturity. It has early maturity heading about one day earlier than USG 3120 and three days earlier than AGS 2035. SY Cypress has shown best adaptation to the wheat growing areas of Louisiana, southern Georgia and eastern South Carolina. It has shown moderate resistance to the races of powdery mildew and leaf rust in these areas. It has shown a moderate resistance/moderate susceptibility reaction to the current race of stripe rust in Louisiana. It is likely also well adapted to south Mississippi and south Alabama.

Milling and baking characteristics are good and this variety is intended for grain production. Syngenta Seeds, Inc. maintains seed stock and certified classes of Foundation, Registered and Certified. Limited amounts of certified seed stocks of SY Cypress will be available in the fall of 2014. Certified acreage is not to be published by AOSCA and certifying agencies.

Juvenile growth habit of SY Cypress is erect. Plant color at boot stage is blue green, anther color is yellow and auricle anthocyanin is absent. Flag leaf at boot stage is erect and twisted and wax is present. Head shape is tapering and awned. Glumes are mid-long in length. Glume shoulder shape is elevated with an acuminate beak. Chaff color is white at maturity. Seed shape is ovate. Brush hairs on the seed are mid-long in length and occupy a medium area of the seed tip. Seed cheeks are rounded.

Syngenta Seeds, Inc. maintains seed stock and certified classes of Foundation, Registered and Certified. Certified acreage is not to be published by AOSCA and certifying agencies. SY Cypress may only be sold as a class of certified seed and all seed sales are royalty bearing.

B09-2950

B09-2950 is a very promising experimental line that has shown very good adaptation to the Delta region and to the Carolinas. It is medium short height and medium to medium early heading and maturity. It has shown a good level of resistance/tolerance to the current field races of powdery mildew, leaf & stripe rust, and barley yellow dwarf virus.

Coker 9553

Syngenta Seeds produced this very large kernelled soft wheat cultivar. The heads are awned, and the plant is medium tall with very good standability and winter survival. Test weight is excellent. Coker 9553 has resistance to stripe rust and tolerance to leaf rust, powdery mildew and Septoria leaf blotch. Coker 9553 has potential for double cropping due to early maturity. It will likely be a very soft granulating cultivar similar to Coker 9184, Hopewell and Pioneer 25R47. Cookie spread may be slightly smaller than the average soft wheat but certainly within the soft wheat range. The lactic acid SRC of 105% would suggest medium-strong gluten.

Syngenta Seeds (Northern Soft Region)

SY 912 – NEW 2017

SY 912 is an awnless soft white winter wheat bred by Syngenta and is planted for sale as foundation seed in fall of 2017. SY 912 is a medium height wheat and is medium early maturity with height similar to and heading two days earlier than W1062. SY 912 has shown above average test weight. It has shown above average resistance to Fusarium head blight, current races of powdery mildew, stripe and leaf rust in all testing. It is average to soilborne, and susceptible to septoria and glume blotch. SY 912 has shown best adaptation to the primary white wheat growing areas of Michigan and northwest Ohio but also has performed well in all areas north of US 30 in the Midwest. SY 912 has shown acceptable milling and good cookie & cereal baking properties and is entered as a newly released variety.

M13-4009# - NEW 2017

M13-4009# is an awnless soft red winter wheat bred by Syngenta and is in breeder's seed production this year. M13-4009# is a medium short semi-dwarf variety with medium maturity heading the same time as SY 483. It has shown above average test weight and great standability. It has tested above average resistance to stripe rust, leaf rust, Fusarium head blight, septoria and powdery mildew. It is moderately susceptible to wheat spindle streak mosaic and soilborne mosaic. M13-4009# has shown above average milling flour yields and acceptable cookie baking properties.

M13-4038# - NEW 2017

M13-4038# is an awnless soft red winter wheat bred by Syngenta and is in breeders' seed production this year. M13-4038# is a medium short semi-dwarf variety with medium early maturity heading a day earlier than Branson. M13-4038# has shown average test weight and very good standability. It has tested above average resistance to Fusarium head blight, stripe rust, and soilborne virus. It is moderately susceptible to leaf rust and septoria. It has shown average milling flour yields and good cookie baking properties with a high softness equivalence.

M12-2020# - NEW 2017

M12-2020# is an awnless soft red winter wheat bred and developed by Syngenta. M12-2020# is a medium tall semi-dwarf variety with medium maturity heading the same time as SY 483. M12-2020# has shown a wide adaptation with above average check yield performance in the Great Lakes Region, Midwest, North East and Mid-Atlantic. M12-2020# has tested above average resistance to Fusarium head blight, powdery mildew, stripe rust, septoria and Hessian fly biotypes L & O. It has tested average tolerance to leaf rust and wheat spindle streak, and is known to be susceptible to soilborne. M12-2020# has shown average milling flour yields and acceptable cookie baking properties.

W1104

W1104 is an awnless soft red winter wheat bred by Syngenta that began certified sales in 2011. W1104 is relatively short heighted wheat with medium maturity. Height and heading date are both similar to Cooper. W1104 has shown resistance to soil-borne and spindle-streak viruses. It is moderately resistant to barley yellow dwarf, Septoria, and powdery mildew. W1104 has shown its best yield response to standard levels of nitrogen fertilizer and does not appear to benefit from very high fertility levels. W1104 has shown acceptable milling and cookie baking properties and is entered as a newer known check.

SY 483

SY 483 is an awnless soft red winter wheat bred by Syngenta that began certified sales in 2013. SY 483 is a medium tall, semi-dwarf variety with medium maturity heading the same time as W1377. It has shown moderate resistance to soil-borne, spindle streak, and barley yellow dwarf viruses and powdery mildew. It is moderately susceptible to Fusarium, leaf rust, and Septoria. SY 483 has shown above average milling flour yields and acceptable cookie baking properties.

SY 474

SY 474 is an awnless soft red winter wheat bred by Syngenta that began certified sales in 2014. SY 474 is a medium tall, semi-dwarf variety with medium maturity heading a day earlier than W1377. SY 474 has shown above average test weight, and has moderate resistance to fusarium head blight, powdery mildew, and to the races of leaf rust and stripe rust in this area. SY 474 has susceptibility to soil-borne mosaic virus. It has tested resistant to Hessian fly biotype B. It has above average gluten strength and is an above average broad adaptation end use market variety.

M10-1277

M10-1277 is an awnless soft red winter wheat bred by Syngenta. It is a medium short height semi-dwarf variety with medium-early maturity heading the same as Branson. SY 100 has shown average test weight, moderate resistance leaf rust and stripe rust. It has tested moderately susceptible to powdery mildew. It has shown acceptable milling and cookie baking properties.

M09-9513

M09-9513 is a soft red winter wheat bred by Syngenta Seeds, Inc. for grain production. M09-9513 is a medium tall semi-dwarf variety and has white chaff at maturity. It has medium-early maturity and its heading is a similar to Branson. It has tested above average winter survival over the last 4 years. M09-9513 has shown average test weight, moderate resistance to fusarium head blight, and moderate susceptibility to leaf rust and stripe rusts, and Septoria leaf blight. It has average milling and cookie qualities and is an average broad adaptation end use market variety. M09-9513 has tested well and appears to be best adapted for grain production in the states of Illinois, Indiana, Missouri, Kentucky, Michigan, Ohio, Wisconsin, Delaware, Maryland, North Carolina, Pennsylvania, and Virginia.

SY 547 (formerly M09L-9547)

SY 547 is a soft red winter wheat, bred and developed by Syngenta Seeds, Inc. SY 547 was selected for height, maturity, appearance, and kernel soundness using a modified bulk breeding method that originated with a single cross made in February of 2003. SY 547 is a medium tall semi-dwarf variety and has white chaff at maturity. It has medium maturity and its heading is a half day earlier than SY 474, and about a day later than Branson. SY 547 has shown a wide adaptation with above average check yield performance in the Great Lakes Region, Midwest, Mid-South, North East and Mid-Atlantic. The highest yield advantage has been in the double crop region of Southern IL. SY 547 is moderately resistant to powdery mildew, soil-borne virus and fungal leaf blights. It has tested average tolerance to current races of stripe & leaf rust and Fusarium head blight, and is known to be moderately susceptible to barley yellow dwarf virus.
Syngenta Seeds, Inc. maintains seed stock and certified classes of Foundation, Registered and Certified. Certified seed stocks of SY 547 will be available in the fall of 2015. Certified acreage is not to be published by AOSCA and certifying agencies and SY 547 may only be sold as a class of certified seed.

Descriptions prepared by Jen Vonderwell, Breeder

University of Tennessee – Dennis West

TN 1102 (Charlie)

TN 1102 (pedigree KY90C-292-4-1/TX91-57//(Saluda/Becker)-F6/VA94W-158) is an experimental, fully awned, soft red winter wheat variety. TN1102 has medium heading date and medium height, both similar to Bess. Disease resistance in this line is moderate to Septoria glume blotch and leaf blight, moderate to powdery mildew. TN1102 was a top 5 yielding variety in

Tennessee Variety trials from 2011 to 2013. In the 2010-2011 Uniform Eastern Wheat nursery TN1102 had above average flour yield (72.3%) and above average milling and baking qualities.

TN 1201

TN 1201, (Pioneer2552//FRX304)-F6/Dozier///VA94W-158//(FFR555/Madison)-F6/NC98-26192, is an experimental soft red winter wheat, fully awned with medium heading date, like Bess and medium height, 4 inches shorter than Bess. TN 1201 has moderate sease resistance to Septoria glume blotch and leaf blight and moderate resistance to powdery mildew. TN 1201 performed in the top third of Tennessee yield trials from 2012-2014, with 69.3% flour yield, average milling and good baking qualities as evaluated in the 2011-2012 Uniform Eastern Wheat nursery. The expected release date for TN 1201 is 2016.

TN 1202

TN 1202, pedigree (Coker747/ABI90-8369-718)-F6/KY90C-292-4-1//Tribute/(Verne/Pioneer2580)-F6, is an experimental line of soft red winter wheat. The head is awnletted and the plant is medium height (three inches taller than Shirley) with medium heading date (the same as Shirley). Disease resistance is moderate to Septoria glume blotch and leaf blight. This variety tested below average in the Tennessee grain yield trials from 2012 to 2014 with above average flour yield (72.3%) and above average milling and baking qualities as tested in the 2011-2012 Uniform Eastern Wheat nursery. TN 1202 is expected to be released in 2016.

Virginia Tech, Carl Griffey

VA11W-279

The soft red winter wheat line VA11W-279 was derived from the cross NC00-15389 (GA85240-6 / NC96BGTA5) / GF951079-2E31 (PI 644020) // 'USG 3555' (PI 654454). The parentage of GA951079-2E31 is GA881130 / 'Gore'. VA11W-279 was derived as a bulk of an F4:5 headrow selected in 2010 and has been evaluated over two years (2014 and 2015) in Virginia's State Variety Trials and throughout most of the soft red winter (SRW) wheat region in the 2015 USDA-ARS Uniform Southern Soft Red Winter Wheat Nursery (USSRWWN).

VA11W-279 is a high yielding, awnletted, moderately early heading, short height semi-dwarf (Rht2) wheat variety that is adapted to the southern and mid-Atlantic SRW wheat regions. In the 2015 USSRWWN, average head emergence of VA11W-279 (116 d) was most similar to USG 3555 and 2 d later than 'USG 3120'. Average mature plant height of VA11W-279 (30 inch) is similar to USG 3555 and about 5 inches shorter than USG 3120. Straw strength (0=erect to 9=completely lodged) of VA11W-279 (1.3) is also similar to USG 3555. In the USSRWWN, winter kill (0 – 9 scale) and freeze survival (%) scores for VA11W-279 (6.5 and 77.5%) respectively were higher and lower than those of USG 3120 (3.8 and 87.5%).

VA11W-279 was evaluated at 16 locations in the 2015 USSRWWN, and ranked seventh among 30 entries for grain yield (74.7 Bu/ac). Average test weight of VA11W-279 (56.4 Lb/Bu) over 15 locations was most similar to that of USG 3120 and 1.4 Lb/Bu higher than that of USG 3555.

Grain samples of VA11W-279 produced in three crop environments (2014 and 2015) were evaluated for end use quality by the USDA-ARS Soft Wheat Quality Lab. VA11W-279 has exhibited milling and baking qualities that are similar to those of 'Jamestown'. Comparison of average milling and baking quality attributes over three different environments for VA11W-279 versus Jamestown include: softness equivalent (54.5 vs. 57.7%), flour yield (67.7 vs. 67.4%), flour protein (8.7 vs. 8.6%), gluten strength (lactic acid SRC 118.3 vs. 114.5%), sodium carbonate SRC (70.0 vs. 71.8%) and cookie spread diameter (18.4 vs. 18.1 cm).

VA11W-279 is resistant Hessian fly biotypes B, C, D, O, and L and expresses moderate to high levels of resistance to other diseases prevalent in the SRW wheat region. These include leaf, stripe and stem rusts, powdery mildew, Fusarium head blight, Septoria tritici leaf blotch, Stagonospora nodorum glume blotch and leaf blotch, bacterial leaf blight (Xanthomonas campestris), barley and cereal yellow dwarf viruses, and wheat soilborne mosaic virus.
Description Carl Griffey, VA Tech, 2016

VA10W-119 (SH 7200)

The soft red winter (SRW) wheat line VA10W-119 was developed and released by the Virginia Agricultural Experiment Station in May 2016. It was derived from the cross **KY97C-0540-04** / **GA951079-2E31** (PI 644020). The pedigree of KY97C-0540-04 is 'Coker 9803' (PI 548845) / L910097 // Pioneer Brand '2552' (PI 566924). Parentage of L910097 is Coker 9803 / 'Coker 983' (PI 601076). The parentage of GA951079-2E31 is GA881130 / 'GA-Gore' (PI 561842). VA10W-119 was derived as a bulk of an $F_{4:5}$ headrow selected in 2009. It was evaluated over six years (2011 – 2016) in Virginia's Official Variety Trials and throughout most of the SRW wheat region in the 2012 and 2013 USDA-ARS Uniform Southern SRW Wheat Nurseries. VA10W119 will be marketed by Meherrin, 4020 Wake Forest Rd., Suite 110, Raleigh, NC under the Southern Harvest brand name as variety 'SH 7200' and was evaluated for the 2016 Wheat Quality Council.

VA10W-119 is a broadly adapted, high yielding, early heading, and medium height (*Rht*2 semi-dwarf) SRW wheat. Foliage and spike color of VA10W-119 is blue-green and spikes are awned and slightly tapering to strap in shape. Average head emergence of VA10W-119 in the southern SRW wheat region varied from 95 d in 2012 to 119 d in 2013 and was 1 to 2 d earlier than 'USG 3555' and 2 to 4 d later than 'Jamestown'. Mature plant height of VA10W-119 has varied from 34 to 38 inches on average and is similar in height to 'Hilliard' and 3 inches taller than Jamestown. In the 2012 Uniform Southern Nursery, the mean lodging score for VA10W-119 (0.7) was similar to Pioneer Brand '26R61' (1.1) and significantly ($P \leq 0.05$) lower than those of the other three check varieties (2 – 3). In the 2013 Uniform Southern Nursery, the mean lodging score of VA10W-119 (3.3) was similar to those of USG 3555 (2.4) and AGS 2000 (3.4). Winter hardiness of VA10W-119 is good and better than that of 'AGS 2000'.

VA10W-119 was evaluated at 21 and 18 locations, respectively, in the 2012 and 2013 USDA-ARS Uniform Southern SRW Wheat Nurseries. In the 2012 nursery, VA10W-119 ranked second among 29 entries for grain yield (69.3 bu/ac) with a mean test weight of 57.8 lb/bu. In the 2013 nursery,

VA10W-119 ranked third among 33 entries for grain yield (76 bu/ac) with a mean test weight of 57.1 lb/bu.

Grain samples of VA10W-119 produced in six crop environments (2011 and 2015) were evaluated for end use quality by the USDA-ARS Soft Wheat Quality Lab. VA10W-119 has exhibited milling and baking qualities that are intermediate to those of 'Shirley' (weak gluten strength) and Jamestown (moderate gluten). Comparisons of milling and baking quality attributes over three to five crop environments for VA10W-119 versus Shirley and Jamestown include: milling quality score (**72.0** vs. 69.6 and 60.4), baking quality score (**50.3** vs. 72.8 and 52.3), softness equivalent score (**59.6** vs. 72.4 and 64.4), flour yield (**70.6%** vs. 69.9% and 68.1%), flour protein (**8.4%** vs. 7.6% and 8.1%), gluten strength (lactic acid retention capacity **114.3%** vs. 90.2% and 109.9%), and cookie spread diameter (**18.3** vs. 18.8 and 18.1 cm). Flour of VA10W-119 likely would be more suitable than that of Shirley for making crackers and other products requiring strong gluten strength.

VA10W-119 is a widely adapted, early heading, Hessian fly resistant (gene *H13*) wheat variety that has high grain yield potential, high test weight, good milling and baking quality, and has performed well in SRW wheat production areas of the southeastern and mid-Atlantic regions. VA10W-119 expresses intermediate to high levels of resistance to diseases prevalent in the SRW wheat region. These include Hessian fly, leaf and stripe rusts, powdery mildew, Fusarium head blight, *Septoria tritici* leaf blotch, *Stagonospora nodorum* leaf and glume blotch, *Barley and Cereal Yellow Dwarf Viruses*, and *Wheat Soilborne Mosaic Virus*.

VA11W-106 (L11550)

Soft red winter (SRW) wheat line VA11W-106 was developed and released by the Virginia Agricultural Experiment Station in May 2016. It was derived from the cross Pioneer Brand '25R47' (PI 631473) / 'Jamestown' (PI 653731). VA11W-106 was derived as a bulk of an $F_{5:6}$ headrows selected in 2010 and has been evaluated over four years (2013 – 2016) in Virginia's Official Variety Trials. It also was evaluated throughout the SRW wheat region in the 2014 USDA-ARS Uniform Southern and the 2015 Uniform Eastern SRW Wheat Nurseries and the 2016 Wheat Quality Council. VA11W-106 will be marketed by Limagrain Cereal Seeds as variety 'L11550'.

VA11W-106 is a broadly adapted, high yielding, full-season, medium height, semi-dwarf (gene *Rht*2) SRW wheat. In the southern SRW wheat region, head emergence of VA11W-106 (123 d) in 2014 on average was 4.3 d later than Jamestown. In the eastern SRW wheat region, average head emergence of VA11W-106 (132 d) in 2015 was similar to that of 'Shirley'. In the Uniform Southern and Uniform Eastern nurseries, plant height of VA11W-106 (33 and 32 inches, respectively) was 3 inches shorter than checks 'AGS 2000' and MO-080104. Straw strength of VA11W-106 (1.4 – 2.1) is good and was similar to that of the checks in both the Uniform Southern and Uniform Eastern nurseries. In the 2014 Uniform Southern nursery, winter kill (0 = no injury to 9 = severe injury) of VA11W-106 (2.9) was significantly ($P \leq 0.05$) lower than that of the four check varieties (5.4 – 6.5). In the 2015 Uniform Eastern nursery, winter hardiness of VA11W-106 (1.0) was similar to that of the checks (1.0 – 1.4).

VA11W-106 was evaluated at 21 locations in the 2014 USDA-ARS Uniform Southern SRW Wheat Nursery and ranked fourth among 33 entries for grain yield (81 bu/ac). Average test weight of VA11W-106 (56.2 lb/bu) was similar to the overall trial mean and significantly ($P \leq 0.05$) higher than that of 'USG 3555' (54.4 lb/bu). VA11W-106 also was evaluated at 24 locations in the 2015 USDA-ARS Uniform Eastern SRW Wheat Nursery, and ranked fourth in grain yield (79 lb/bu) among 31 entries. Average test weight of VA11W-106 (55.9 lb/bu) was similar to the overall trial mean, and higher ($P \leq 0.05$) than those of 'Branson' (54.7 lb/bu) and Shirley (53.5 lb/bu).
In quality tests conducted by the USDA-ARS Soft Wheat Quality Lab, VA11W-106 has exhibited milling and baking qualities that are most similar to those of Jamestown and better than those of 'Yorktown'. Comparisons of mean milling and baking quality attributes over three crop environments for **VA11W-106**, Jamestown, and Yorktown include: softness equivalent values of **60.2** versus 57.5 and 58.8%; flour yields of **68.1** versus 68.0 and 66.4%; flour protein concentrations of **7.6** versus 8.1 and 8.1%; gluten strength (lactic acid SRC) of **110** versus 114 and 123%; and cookie spread diameters of **18.4** versus 18.0 and 17.5 cm.

With the exception of stem rust and Hessian fly, VA11W-106 has expressed moderate to high levels of resistance to diseases prevalent in the SRW wheat region. These include powdery mildew, leaf rust, stripe rust, leaf and glume blotch, bacterial leaf streak, *Barley and Cereal Yellow Dwarf Viruses*, and Fusarium head blight.

Hilliard

Soft red winter (SRW) wheat cultivar Hilliard (tested as VA11W-108) was developed and released by the Virginia Agricultural Experiment Station in May 2015. It was derived from the cross Pioneer Brand '25R47' (PI 631473) / 'Jamestown' (PI 653731). Hilliard was derived as a bulk of an F5:6 headrow selected in 2010 and was evaluated over three years (2013 – 2015) in Virginia's State Variety Trials and throughout the soft red winter (SRW) wheat region in the 2014 USDA-ARS Uniform Southern and Uniform Eastern Soft Red Winter Wheat Nurseries and for the 2016 Wheat Quality Council.

Hilliard is a broadly adapted, high yielding, mid-season, medium height, semi-dwarf (gene Rht2) SRW wheat. Plant stem and spike color of Hilliard are green, and its spikes are awned. In the southern SRW wheat region, head emergence of Hilliard (121 d) has been similar to that of 'USG 3555' and 3 days later than Jamestown. In the eastern SRW wheat region, head emergence of Hilliard (136 d) was 1 day later than 'Branson' and 1.5 d earlier than 'Shirley'. Average mature plant height of Hilliard throughout the SRW wheat region has varied from 34 to 38 inches. In the Uniform Southern and Uniform Eastern nurseries, plant height of Hilliard (34 inches) was 2 inches shorter than checks 'AGS 2000' and MO-080104 and 2.5 to 3.5 inches taller than Shirley. Straw strength (0=erect to 9=completely lodged) of Hilliard (0.2 – 2.3) is very good and similar to that of Shirley (0.6 – 2.5). In the Uniform Eastern Nursery, winter hardiness (0 = no injury to 9 = severe injury) of Hilliard (2.2) was similar to that of the checks (1.8 – 2.9), while in the Uniform Southern Nursery, its winter injury (4.0) was less than that of the checks (5.4 – 6.5).

Hilliard was evaluated at 21 sites in the 2014 USDA-ARS Uniform Southern SRW Wheat Nursery and ranked second among 33 entries for grain yield (84 bu/ac). Average test weight of Hilliard (55.8 lb/bu) was similar to the overall trial mean and significantly ($P < 0.05$) higher than that of USG 3555 (54.4 lb/bu). Hilliard also was evaluated at 21 locations in the 2014 USDA-ARS Uniform Eastern SRW Wheat Nursery, and ranked first in grain yield within the eastern wheat region (87.6 lb/bu) and second overall test sites (86.9 lb/bu). Average test weight of Hilliard (56.9 lb/bu) was similar to the overall trial mean, and significantly ($P < 0.05$) higher than those of Branson (55.8 lb/bu) and Shirley (54.7 lb/bu).

Grain samples of Hilliard produced in five crop environments (2012 – 2014) were evaluated for end use quality by the USDA-ARS Soft Wheat Quality Lab. Hilliard has exhibited milling and baking qualities that are intermediate between those of Jamestown and USG 3555. Jamestown has better milling quality attributes than Hilliard or USG 3555, while both Jamestown and Hilliard have superior baking quality compared to USG 3555. While flour of Hilliard has the lowest grain protein content, it has slightly stronger gluten strength than Jamestown or USG 3555.

Hilliard is a widely adapted, mid-season wheat variety with good winter hardiness. It has high grain yield potential, good straw strength, and has performed well over most of the eastern SRW wheat production areas. With the exception of stem rust, Hilliard has expressed moderate to high levels of resistance to diseases prevalent in the SRW wheat region. These include powdery mildew, leaf rust, stripe rust, leaf and glume blotch, bacterial leaf streak, Soilborne Mosaic Virus, Barley and Cereal Yellow Dwarf Viruses, Fusarium head blight, and Hessian fly.

Initial Breeder seed of Hilliard, derived in 2013 from a 225 ft2 F9 seed increase block from which visible variant plants were removed prior to harvest, was grown on 0.25 ac at the Virginia Crop Improvement Association's (VCIA) Foundation seed farm and produced 10 units (50 lbs / unit) of seed. In fall 2014, this seed was planted on 7.6 ac at the Foundation seed farm and to produce additional Foundation seed. A purer source of Hilliard Breeder seed was developed upon evaluation of plots derived from 89 selected breeder seed headrows having yellow anther and white coleoptile color. Remnant seed (34 lbs) from these headrows was planted on 0.6 acre at VCIA's Foundation Seed Farm during fall 2014 to produce a purer source of Hilliard breeder seed.

VA13W-38 SOFT RED WINTER WHEAT – NEW 2017

Soft red winter wheat line VA13W-38 was derived from the cross IL99-15867 (IL93-2879 / P881705A-1-X-60) / 'Jamestown'. VA13W-38 was derived as a bulk of an F5:6 headrow selected in 2012 and has been evaluated over two years (2015 and 2016) in Virginia's State Variety Trials and throughout most of the soft red winter (SRW) wheat region in the 2016 USDA-ARS Uniform Southern Soft Red Winter Wheat Nursery. Release of VA13W-38 as a replacement for Jamestown is proposed for 2018 contingent on its performance in 2017.

VA13W-38 is a high yielding, awned, early heading, short height, semi-dwarf (Rht1) that is resistant to Fusarium head blight and adapted to the southern and mid-Atlantic SRW wheat regions. In the 2016 Uniform Southern nursery, average head emergence of VA13W-38 (107 d) was 4 d later than

Jamestown and 6 d earlier than 'Hilliard'. Plant height and straw strength (0 – 9) of VA13W-38 (34 inch and 1.7) are similar to those of Jamestown (33 inch and 1.4). In the 2016 Uniform Southern nursery, winter kill (0 = no injury to 9 = severe injury) of VA13W-38 (4.0) was lower than those of Jamestown (4.8) and 'AGS 2000' (6.1).

VA13W-38 was evaluated at 23 locations in the 2016 Uniform Southern SRW Wheat Nursery and had a mean yield (64.8 bu/ac) that was similar to Jamestown and test weight (56.6 lb/bu) that was significantly ($P < 0.05$) higher than that of Hilliard (55.7 lb/bu). VA13W-38 has better resistance to leaf rust, stem rust, Septoria tritici, and Bacterial Leaf Streak than Jamestown.

A grain sample composite (AL, AR, GA, and VA) from the 2016 Uniform Southern Nursery was evaluated for end use quality by the USDA-ARS Soft Wheat Quality Lab. VA13W-38 has exhibited milling and baking qualities that are better than those of Jamestown. Comparisons of mean milling and baking quality attributes for VA13W-38 versus Jamestown include: softness equivalent values of 54.8% versus 57.4%; flour yields of 69.2% versus 66.2%; flour protein concentrations of 8.8% versus 8.8%; gluten strength (lactic acid retention capacities) of 107.2% versus 123.0%; cookie spread diameters of 18.5 cm versus 17.3 cm; and cookie top grade scores (0-9) of 4 versus 1. In summary VA13W-38 has higher flour yields, lower Solvent Retention Capacity (SRC) for Sodium Carbonate, and produces cookies of larger diameter and better top grain than those of Jamestown.

VA13W-38 expresses moderate to high levels of resistance to diseases prevalent in the SRW wheat region. These include Fusarium head blight, leaf rust, stem rust, powdery mildew, Septoria tritici leaf blotch, Stagonospora nodorum glume blotch, Bacterial Leaf Streak, Barley and Cereal Yellow Dwarf Viruses, and Wheat Soilborne Mosaic Virus.

VA12W-72 SOFT RED WINTER WHEAT

The soft red winter wheat line VA12W-72 was derived from the cross Pioneer Brand '25R47' (PI 631473) / GF951079-2E31 (PI 644020) // 'USG 3555' (PI 654454). The parentage of GA951079-2E31 is GA881130 / 'Gore'. VA12W-72 was derived as a bulk of an F5:6 headrow selected in 2011 and has been evaluated over three years (2014 – 2016) in Virginia's State Variety Trials and throughout most of the soft red winter (SRW) wheat region in the 2015 and 2016 USDA-ARS Uniform Southern Soft Red Winter Wheat Nursery. VA12W-72 was released by VAES March 15, 2017.

VA12W-72 is a high yielding, awned, moderately early heading, short height, semi-dwarf (Rht2) wheat variety with gene H13 for Hessian fly [Mayetiola destructor (Say)] resistance that is well-adapted to the southern and mid-Atlantic SRW wheat regions. In regional and uniform nurseries, average head emergence of VA12W-72 (109 – 128 d) has been 2 to 6 d later than 'Jamestown' and 3 to 5 d earlier than 'Shirley'. In 2015 and 2016 Uniform Southern nurseries, plant height of VA12W-72 (32 and 34 inches) was consistently 1 inch taller than Jamestown, while straw strength of VA12W-72 (0.8 and 1.0) was similar to that of Jamestown (0.4 and 1.4). In the 2015 and 2016 Uniform Southern nurseries, winter kill ratings (0 = no injury to 9 = severe injury) of VA12W-72

(2.5 and 3.3) were consistently lower than those of Jamestown (3.3 and 4.8) and 'AGS 2000' (3.8 and 6.1).

VA12W-72 was evaluated at 16 locations in the 2015 USDA-ARS Uniform Southern SRW Wheat Nursery and ranked 1st in grain yield (78.5 bu/ac) among 30 entries. Average test weight of VA12W-72 (55.9 lb/bu) was the same as the overall trial average. VA12W-72 also was evaluated at 23 locations in the 2016 Uniform Southern SRW Wheat Nursery and ranked 3rd among 30 entries for grain yield. VA12W-72 had a mean yield (74.7 lb/bu) and test weight (55.5 lb/bu) that did not differ significantly ($P \geq 0.05$) from those of the highest yielding entry 'Hilliard' (76.5 bu/ac and 55.7 lb/bu).

Grain samples of VA12W-72 produced in six crop environments (2014 – 2016) were evaluated for end use quality by the USDA-ARS Soft Wheat Quality Lab. VA12W-72 has exhibited milling and baking qualities that are most similar to those of Jamestown. Comparisons of mean milling and baking quality attributes over five crop environments (Table 13) for VA12W-72 versus Jamestown include: softness equivalent values of 55.5% versus 56.0%; flour yields of 66.5% versus 66.6%; flour protein concentrations of 8.8% versus 8.4%; gluten strength (lactic acid retention capacities) of 105.0% versus 114.2%; cookie spread diameters of 18.6 cm versus 17.8 cm; and cookie top grade scores (0-9) of 3.0 versus 2.8. Flour of VA12W-72 has lower Solvent Retention Capacity (SRC) for Sodium Carbonate (68.1%) than that of Jamestown (73.4%) and also produces cookies of larger diameter (18.6 cm) than those of Jamestown (17.8 cm). Flour of VA12W-72 has higher Lactic Acid SRC (105%) and therefore stronger gluten strength than that of Shirley (89%), and would be more suitable in production of crackers and other products requiring stronger gluten strength.

VA12W-72 is resistant to Hessian fly biotypes B, C, D, O, and L, and expresses moderate to high levels of resistance to other diseases prevalent in the SRW wheat region. These include leaf, stripe and stem rusts, powdery mildew, Septoria tritici leaf blotch, Stagonospora nodorum glume blotch and leaf blotch, Barley and Cereal Yellow Dwarf Viruses, and Wheat Soilborne Mosaic Virus.

VA11W-313

The soft red winter wheat line VA11W-313 was derived from the cross Pioneer Brand '25R47' (PI 631473) / GF951079-2E31 (PI 644020) // 'USG 3555' (PI 654454). The parentage of GA951079-2E31 is GA881130 / 'Gore'.

VA11W-313 is a high yielding, awned, early heading, short height semi-dwarf (Rht2) wheat variety that is adapted to the southern and mid-Atlantic SRW wheat regions. VA11W-313 was evaluated at 16 locations in the 2015 USSRWWN, and ranked fourth among 30 entries for grain yield (75.8 Bu/ac). Average test weight of VA11W-313 (54.6 Lb/Bu) over 15 locations was most similar to that of USG 3555 (55.0 Lb/Bu).

VA11W-313 has exhibited milling and baking qualities that are similar to those of 'Jamestown'. VA11W-313 is heterogeneous for resistance to Hessian fly biotypes B, C, D, O, and L. It expresses moderate to high levels of resistance to leaf and stripe rusts, powdery mildew, Fusarium head

blight, Septoria tritici leaf blotch, Stagonospora nodorum glume blotch and leaf blotch, bacterial leaf blight (Xanthomonas campestris), barley and cereal yellow dwarf viruses, and wheat soil-borne mosaic virus.

VA10W-21 (AgriMAXX 462)

Soft red winter wheat line VA10W-21 was developed and released by the Virginia Agricultural Experiment Station in May 2015 and will be marketed as variety AgriMAXX 462. It was derived from the cross Z00-5018 / VA01W-158. Wheat line Z00-5018 was developed and derived from the cross U90-1A // ZX90-2C1 / Pioneer Brand '2580' (PI 561198) by Western Plant Breeders and was selected as a parent from the 2002 – 2003 Uniform Eastern SRW Wheat Nursery. Parental line VA01W-158 was developed at Virginia Tech from the cross Pioneer Brand '2643' (PI583739) / VA94-54-331.

VA10W-21 is a broadly adapted, high yielding, mid-season, short height, semi-dwarf (gene Rht2). Plant stem and spike color of VA10W-21 are blue green, and spikes are strap shaped with short apical tip awns. VA10W-21 has exhibited milling qualities that are intermediate between those of Jamestown and USG 3555. Overall Jamestown has superior milling and baking quality to VA10W-21, which in turn has better milling quality but poorer baking quality than USG 3555.

VA10W-21 is a widely adapted wheat variety with good winter hardiness. It has high grain yield potential, high test weight, and has performed well in most of the eastern SRW wheat production areas including the mid-South, mid-Atlantic and Corn-belt regions. With the exception of stem rust, stripe rust, and possibly Hessian fly, VA10W-21 expresses moderate to high levels of resistance to powdery mildew, leaf rust, leaf and glume blotch, soil-borne mosaic virus, barley and cereal yellow dwarf viruses, and most notably Fusarium head blight.
AgriMAXX462 was evaluated for the 2016 Soft Wheat Quality Council.

VA 258

The soft red winter wheat cultivar VA258 was derived from the three-way cross VA98W-130 // 'Coker 9835' / '38158' (PI 619052= SS520). Parentage of VA98W-130 is 'Savannah' / VA87-54-558 // VA88-54-328 / 'GA-Gore'. Parentage of VA87-54-558 is 'Massey' / 'Holley' and parentage of VA88-54-328 is 'Lovrin 29' / 'Tyler' // 'Redcoat' *2 / 'Gaines'.

The soft red winter wheat line VA258 is broadly adapted, high yielding, full-season maturity, and a standard height semi-dwarf (Rht2). Spikes and straw of VA258 are white to creamy in color at maturity, and the tapering spikes are awnletted. VA258 produced yields that were similar to or significantly higher than the test averages at 16 locations. VA258 has exhibited milling and baking qualities that are most similar to those of the strong gluten cultivars Featherstone 176, Jamestown, and Tribute.

VA10W-96

The soft red winter (SRW) wheat line VA10W-96 was derived from the cross FG 95195 / 'Jamestown' (PI 653731). The pedigree of FG 95195 is SWN6828-6AP / 'Coker 9766' (PI 601429) // 'Mason' (PI 594044) /3/ 'Morey' (PI 591428) sib.

VA10W-96 is a high yielding, early heading, and medium height (Rht2 semi-dwarf) SRW wheat. In the 2014 Uniform Southern SRW Wheat Nursery, VA10W-96 had a mean grain yield (76.0 Bu/ac) that was similar to that of the highest yielding check 'USG 3120' (77.4 Bu/ac). In Virginia's state test (2013-15), VA10W-96 had a test weight mean (58.5 Lb/Bu) that was significantly higher than the overall trial average (56.7 Lb/Bu).

VA10W-96 has milling and baking quality characteristics that overall are intermediate to those of Jamestown and 'Yorktown'. VA10W-96 expresses moderate to high levels of resistance to leaf and stripe rusts, powdery mildew, Fusarium head blight, bacterial leaf streak (Xanthomonas translucens), glume blotch (Stagonospora nodorum), barley and cereal yellow dwarf viruses, and wheat soil-borne mosaic virus.

VA10W-123

The soft red winter wheat line VA10W-123 was derived from the cross Pioneer Brand '25R47' (PI 631473) / GA951079-2E31 (PI 644020). The parentage of GA951079-2E31 is GA881130 / 'Gore'.

VA10W-123 is an early heading, medium height, semi-dwarf (Rht2) wheat that is broadly adapted and high yielding. Spikes of VA10W-123 are slightly tapering to strap in shape and have short tip awns. VA10W-123 was evaluated at 19 locations in the 2013 USDA-ARS Uniform Southern SRW Wheat Nursery, and ranked second among 33 entries for grain yield (76.9 Bu/ac) over 18 locations. Average test weight of VA10W-123 (56.7 Lb/Bu) over 18 locations was similar to the overall nursery mean (56.4 Lb/Bu) and to those of check cultivars (56.0 – 57.0 Lb/Bu), with the exception of Jamestown (58.7 Lb/Bu).

VA10W-123 has exhibited milling and baking qualities that are intermediate to those of Shirley (weak gluten) and Pioneer Brand 26R15 (strong gluten) and superior to that of USG 3555. VA10W-123 is a widely adapted, moderately early heading, wheat cultivar that has high grain yield potential, good milling and baking quality, and has performed well in SRW wheat production areas of the Deep South and mid-Atlantic regions. With the possible exceptions of Wheat Spindle Streak Mosaic Virus and Hessian fly, VA10W-123 expresses moderate to high levels of resistance to leaf, stripe and stem rusts, powdery mildew, Fusarium head blight, Septoria tritici leaf blotch, Stagonospora nodorum glume blotch and leaf blotch, barley and cereal yellow dwarf viruses, and wheat soil-borne mosaic virus.

MCIA Venus (formerly VA09W-188WS)

The soft white winter wheat line VA09W-188WS was developed by the Virginia Agricultural Experiment Station and released in March 2013 as cultivar 'MCIA Venus'. It was derived from the cross Pioneer Brand '25W60' (PI 607579) // Pioneer Brand '25W33' (PI 599197) / VAN98W-

170WS. The pedigree of VAN98W-170WS is 'FFR 555W' (PI 560318) / 'GA-Gore' (PI 561842) // 'Coker 9803' (PI 548845) / VA87-54-636.

VA09W-188WS is a broadly adapted, high yielding, early heading, medium height semi-dwarf (gene Rht2). At maturity, VA09W-188WS has yellow colored straw and spikes with the latter being slightly recurved, tapering in shape, and awned. VA09W-188WS was evaluated at 5 locations (MI, NY, VA, and Ontario Canada) in the 2012 Uniform Eastern Soft White Winter Wheat Nursery and ranked in the third highest yield group over locations for grain yield (77 Bu/ac) among 29 entries. It also was evaluated in this nursery in 2011 at 7 locations (IN, OH, MI, NY, VA, and Ontario) and ranked second for grain yield (80 Bu/ac). In these two nursery years, average test weights of VA09W-188WS (57.1 and 57.4 Lb/Bu) were similar to or significantly ($P < 0.05$) higher than those of Caledonia (57.0 and 55.7 Lb/Bu).

Over all four environments, VA09W-188WS had an average milling quality score (77.5) and flour yield (71.7%) that exceed those of Shirley (68.5 and 69.9%), Branson (65.0 and 69.2%), and Pioneer Brand '25R15' (69.3 and 70.1%). On average, baking quality score of VA09W-188WS (63.3) was higher than that of Pioneer Brand 25R15 (57.5), but lower than those of Shirley (74.1) and Branson (67.9). Like Shirley, flour of VA09W-188WS is most suitable for pastry products, but also may be suitable for manufacturing breakfast cereals and other whole grain products due to its white grain color.

VA09W-188WS has performed well in eastern soft white winter wheat regions of the U.S. and Ontario as well as in the mid-Atlantic region. With the exception of stem rust, glume blotch (Stagonospora nodorum), and potentially Wheat Spindle Streak Mosaic Virus, VA09W-188WS expresses moderate to high levels of resistance to leaf and stripe rusts, powdery mildew, Septoria tritici leaf blotch, Fusarium head blight, barley yellow dwarf virus, wheat soil-borne mosaic virus, and Hessian fly.

Variety descriptions by Carl Griffey, 2017

USDA-ARS 2016 SWQL GRAIN AND FLOUR EVALUATIONS

Long-term relationships established between the SWQL and cooperative nursery programs, the Wheat Quality Council and U.S. Wheat Associates depend on the reliable milling and baking evaluations performed in the USDA-ARS SWQL in Wooster, Ohio. The SWQL performs quality evaluations for three main collaborative projects: Soft Wheat Quality Council, Overseas Variety Analysis and Regional Cooperative Nurseries.

2016 CROP SOFT WHEAT QUALITY COUNCIL

The SWQL coordinates and participates in the Soft Wheat Quality Council (SWQC) annual evaluation of new varieties and advanced breeding lines by milling grain, distributing flour to collaborators, performing quality trait evaluations and preparing a report that collates quality evaluations among the collaborators for presentation at the annual SWQC meeting. Uniform milling and reliable quality trait testing, as performed at the SWQL, provide data critical for collaborators to compare quality evaluations of the new varieties presented each year.

In the 2016 crop year, a total of 13 entries of SRW wheat, including three check varieties, were submitted for the WQC project from three wheat breeding programs. The SWQL milled the wheat grain of the submitted entries using a Miag Multomat mill and distributed the flour to the twelve cooperators for determination of flour composition, solvent retention capacity, dough rheological properties and baking quality. The test results of the entries by the SWQL and cooperators were pooled, analyzed and used for preparation of the report, which is available at the WQC web site (http://www.wheatqualitycouncil.org/). The director of the SWQL will lead the discussion on quality potentials of the entries with the cooperators during the Joint Meeting of the SWQL Annual Research Review & Soft WQC on May 1, 2017, in West Lafayette, Indiana.

CONTRIBUTING SOFT WHEAT BREEDING PROGRAMS AND TEST LINES

New variety/breeding line descriptions are found in the New Wheat Cultivars section of this report.

Carl Griffey, Virginia Polytechnic Institute and State University

VA10W-119
VA11W-106
Hilliard*

Jennifer Vonderwell, AgriPro/Syngenta

SY 100
M11-2024#
M11*3144CW
Branson*

Trek Murray, Beck's Hybrids

Beck 88AA
Beck 114
Beck 123
Beck 125
Beck 128
Beck 120*

*Check varieties.

MILLING AND BAKING RESULTS OF 2016 CROP SWQC ENTRIES REPORTED BY COLLABORATORS AND THE SWQL

Table 1. Miag Multomat Mill Stream Yields of the 2016 crop SWQC Entries by SWQL

Mill Stream	VA10W-119	VA11W-106	Hilliard	SY 100	M11-2024#	M11*31 44CW	Branson	Beck 88AA	Beck 114	Beck 123	Beck 125	Beck 128	Beck 120
1st Break	8.4	9.8	9.7	11.0	6.1	10.7	10.2	8.0	8.1	10.3	7.7	12.4	7.6
2nd Break	6.6	7.8	8.5	9.9	7.2	7.5	9.7	8.7	8.0	8.6	8.8	11.3	8.9
Grader	3.4	4.0	3.7	4.8	3.0	4.2	4.2	3.7	3.7	4.3	3.4	4.4	3.8
3rd Break	11.3	10.8	11.3	10.1	7.8	10.7	10.5	8.2	9.1	9.5	8.8	9.1	7.8
Total Brk	29.8	32.3	33.3	35.8	24.0	33.2	34.7	28.6	28.9	32.7	28.7	37.2	28.1
1st Middlings	11.7	9.0	10.1	9.8	11.0	10.9	10.8	9.9	8.3	9.1	9.0	10.4	10.7
2nd Middlings	14.4	12.1	11.9	12.1	17.5	13.0	12.5	15.2	14.3	13.0	15.5	11.8	16.9
3rd Middlings	7.0	6.4	5.9	5.5	7.6	5.9	5.2	6.8	8.0	5.9	6.9	5.1	7.4
Re-Dust	6.9	5.2	5.2	5.6	7.3	6.5	6.2	6.2	5.4	5.5	5.3	4.9	7.1
4th Middlings	3.0	3.6	3.0	2.8	4.1	2.7	2.5	4.4	4.9	3.8	4.5	2.9	3.7
5th Middlings	0.9	1.1	1.0	1.0	1.3	0.8	0.9	1.6	1.7	1.3	1.7	1.1	1.1
Total Middlings	43.9	37.5	37.0	36.8	48.8	39.8	38.1	44.0	42.7	38.6	43.0	36.2	46.9
Straight Grade	73.7	69.8	70.3	72.5	72.8	72.9	72.7	72.6	71.6	71.3	71.7	73.4	75.0
Break Shorts	6.2	7.0	7.9	6.7	6.8	5.8	7.2	8.0	8.3	8.6	7.5	6.8	6.8
Red Dog	0.7	0.8	0.9	0.8	0.8	0.5	0.7	1.2	1.2	1.0	1.4	1.0	0.9
Tail Shorts	0.2	0.2	0.3	0.2	0.3	0.2	0.3	0.5	0.4	0.4	0.4	0.2	0.3
Bran	18.7	21.9	20.3	19.4	18.8	20.1	18.6	17.5	18.1	18.4	18.5	18.2	17.0
Total Byproduct	25.8	30.0	29.3	27.2	26.7	26.6	26.9	27.1	28.1	28.4	27.9	26.3	25.0

*Check varieties.

WHEAT GRAIN AND FLOUR CHARACTERISTICS OF 2016 CROP SWQC ENTRIES

Table 2. Grain characteristics, SKCS test parameters of the 2016 entries by USDA-ARS Soft Wheat Quality Laboratory

Group	Entry	Test Weight (lb/bu)	Grain Protein (%, 12% mb)	Grain Falling Number	SKCS Parameter		
					Hardness	Kernel Weight (mg)	Kernel Diameter (mm)
1	VA10W-119	60.5	9.3	361	20.0	38.0	2.8
1	VA11W-106	60.3	9.0	366	5.8	32.8	2.6
1	Hilliard*	59.5	9.0	369	15.5	32.4	2.6
2	SY 100	58.3	8.4	338	2.5	37.2	2.6
2	M11-2024#	62.8	10.2	362	29.4	37.7	2.9
2	M11*3144CW	60.2	9.75	329	5.7	40.7	2.8
2	Branson*	59.2	8.94	368	1.3	34.8	2.6
3	Beck 88AA	61.4	8.9	369	11.9	41.0	2.9
3	Beck 114	61.7	8.78	374	14.1	34.9	2.7
3	Beck 123	60.1	8.42	344	5.3	37.9	2.8
3	Beck 125	60.8	8.99	345	26.0	30.7	2.5
3	Beck 128	59.0	7.95	335	1.4	35.7	2.7
3	Beck 120*	60.6	8.75	359	22.4	33.9	2.6

*Check varieties.

Table 3. Miag and Quadrumat Milling parameters of the 2016 entries by USDA-ARS Soft Wheat Quality Laboratory.

Group	Entry	Miag Milling Quality		Quadrumat Milling Quality	
		Break Flour Yield (%)	Straight Grade Flour Yield (%)	Flour Yield (%)	Softness Equivalent (%)
1	VA10W-119	29.8	73.7	72.0	61.7
1	VA11W-106	32.3	69.8	69.0	64.6
1	Hilliard*	33.3	70.3	68.9	65.7
2	SY 100	35.8	72.5	68.8	67.3
2	M11-2024#	24.0	72.8	74.9	47.4
2	M11*3144CW	33.2	72.9	73.7	66.4
2	Branson*	34.7	72.7	71.1	67.7
3	Beck 88AA	28.6	72.6	69.6	56.8
3	Beck 114	28.9	71.6	69.1	59.1
3	Beck 123	32.7	71.3	69.0	65.9
3	Beck 125	28.7	71.7	69.0	60.5
3	Beck 128	37.2	73.4	72.4	69.3
3	Beck 120*	28.1	75.0	72.2	59.4

*Check varieties.

Table 4. Flour quality parameters of the 2016 entries by USDA-ARS Soft Wheat Quality Laboratory

Group	Entry	Moisture (%)	Protein (%, 14% mb)	pH	α-amylase Activity	Starch Damage (%)	Flour Ash (%, 14% mb)
1	VA10W-119	13.5	8.1	6.06	0.018	3.86	0.39
1	VA11W-106	13.5	7.4	6.06	0.021	2.42	0.36
1	Hilliard*	13.8	7.1	6.08	0.025	3.29	0.36
2	SY 100	13.8	6.3	6.11	0.019	1.99	0.34
2	M11-2024#	14.1	8.2	5.90	0.012	3.33	0.34
2	M11*3144CW	13.8	7.6	6.03	0.011	1.24	0.33
2	Branson*	13.6	7.3	6.07	0.019	1.71	0.35
3	Beck 88AA	13.7	7.5	6.07	0.016	2.03	0.35
3	Beck 114	13.6	7.3	6.02	0.012	3.41	0.35
3	Beck 123	13.8	7.0	6.10	0.017	1.93	0.36
3	Beck 125	13.8	7.7	5.97	0.017	3.78	0.33
3	Beck 128	13.7	5.8	6.09	0.015	1.72	0.35
3	Beck 120*	13.7	7.2	6.02	0.019	4.42	0.32

*Check varieties.

SUMMARIES AND STATISTICS OF COMBINED COOPERATOR TEST PARAMETERS OF 2016 CROP SWQC ENTRIES

Table 5. Mean SRC test parameters and overall flour quality scores by ten cooperators (n=10)[a]

Group	Entry	Solvent Retention Capacity (%)*			
		Water	Sodium Carbonate	Sucrose	Lactic Acid
1	VA10W-119	55.3 a	73.7 a	95.4 a	111.9 a
1	VA11W-106	53.9 a	75.1 a	99.6 a	110.0 a
1	Hilliard*	55.4 a	76.2 a	99.0 a	113.9 a
2	SY 100	50.9 b	69.0 a	85.3 bc	97.6 c
2	M11-2024#	53.9 a	70.8 ab	92.0 a	82.6 d
2	M11*3144CW	50.4 b	66.0 b	83.1 c	105.0 b
2	Branson*	52.4 ab	71.6 a	90.4 ab	112.5 a
3	Beck 88AA	52.0 b	69.8 bc	88.1 bcd	106.1 ab
3	Beck 114	55.6 a	75.1 a	100.0 a	109.4 a
3	Beck 123	53.2 ab	69.3 bc	89.1 bc	104.8 b
3	Beck 125	55.4 a	73.2 ab	93.7 ab	106.0 ab
3	Beck 128	53.7 ab	67.8 c	81.6 d	81.3 d
3	Beck 120*	51.9 b	68.8 c	85.9 cd	91.4 c

*Check varieties.

[a]Means with different letters within the same group are significantly different at $P<0.05$.

Table 6. Mean Alveograph test parameters by three collaborators (n=3)

Group	Entry	Alveograph			
		P	L	P/L Ratio	W
1	VA10W-119	67.3 a	61.0 a	1.11 a	142.4 a
1	VA11W-106	50.4 a	71.8 a	0.73 a	108.9 a
1	Hilliard*	63.0 a	49.2 a	1.37 a	107.6 a
2	SY 100	35.3 a	62.4 b	0.56 b	73.9 a
2	M11-2024#	45.9 a	51.5 b	0.89 a	69.2 a
2	M11*3144CW	29.4 a	94.6 a	0.31 c	77.5 a
2	Branson*	36.7 a	98.1 a	0.39 bc	89.7 a
3	Beck 88AA	37.2 ab	93.3 a	0.39 b	92.0 a
3	Beck 114	67.8 a	51.2 b	1.32 a	122.1 a
3	Beck 123	50.2 ab	48.2 b	1.02 a	103.6 a
3	Beck 125	61.2 a	58.4 b	1.04 a	121.2 a
3	Beck 128	22.6 b	60.3 b	0.38 b	38.1 a
3	Beck 120*	28.1 b	88.5 a	0.32 b	62.0 a

*Check varieties.

Table 7. Mean Farinograph test parameters by two collaborators (n=2)[a]

Group	Entry	Farinograph (n=2)*			
		Water Absorption (%)	Development Time (min)	Stability (min)	Mixing Tolerance Index (BU)
1	VA10W-119	53.9 a	1.1 a	2.0	97 a
1	VA11W-106	51.5 a	1.1 a	2.3 a	94 a
1	Hilliard*	52.8 a	1.0 a	1.6 a	105 a
2	SY 100	49.6 b	0.7 ab	1.1 b	158 a
2	M11-2024#	55.1 a	1.5 a	2.5 a	126 ab
2	M11*3144CW	50.4 b	0.6 b	1.5 ab	112 ab
2	Branson*	50.5 b	0.5 b	2.5 a	95 b
3	Beck 88AA	51.6 ab	0.9 a	1.9 a	105 bc
3	Beck 114	54.0 a	1.0 a	1.9 a	110 bc
3	Beck 123	51.4 ab	0.8 a	1.3 a	143 ab
3	Beck 125	55.1 a	0.8 a	2.0 a	91 c
3	Beck 128	49.3 b	0.7 a	1.0 a	162 a
3	Beck 120*	52.4 ab	0.7 a	1.4 a	134 abc

*Check varieties.
[a]Means with different letters within the same group are significantly different at $P<0.05$.

Table 8. Mean (n=4) Rapid Visco-Analyzer (RVA) test parameters[a]

Group	Entry	Rapid Visco-Analyzer							
		Peak Time (min)	Peak (cP)	Trough (cP)	Break-down (cP)	Setback (cP)	Final (cP)	Pasting Temperature (°C)	Peak/Final Ratio
1	VA10W-119	6 a	3060 b	2002 b	1058 a	1357 a	3551 b	80.5 a	0.86 a
1	VA11W-106	6 a	3113 b	2063 b	1050 a	1467 a	3741 b	76.9 a	0.83 b
1	Hilliard*	6 a	3324 a	2292 a	1033 a	1510 a	4041 a	79.3 a	0.82 c
2	SY 100	6 a	3259 ab	2017 ab	1244 a	1426 a	3606 ab	78.2 a	0.91 a
2	M11-2024#	6 a	3005 bc	2086 a	920 b	1343 a	3643 a	79.9 a	0.82 c
2	M11*3144CW	6 a	2832 c	1842 b	992 b	1307 a	3301 b	80.3 a	0.86 b
2	Branson*	6 a	3407 a	2137 a	1273 a	1457 a	3762 a	79.2 a	0.91 a
3	Beck 88AA	6 a	3388 a	1974 a	1416 a	1409 a	3492 a	74.4 a	0.97 a
3	Beck 114	6 a	3061 bc	1879 ab	1182 cd	1331 a	3351 a	75.3 a	0.92 b
3	Beck 123	6 a	3250 ab	1930 ab	1318 b	1281 a	3325 ab	75.9 a	0.98 a
3	Beck 125	6 a	2795 d	1664 d	1132 d	1334 a	3132 b	79.2 a	0.89 c
3	Beck 128	6 a	3029 c	1794 cd	1235 bc	1418 a	3361 a	68.9 a	0.90 bc
3	Beck 120*	6 a	2904 cd	1835 bc	1087 d	1404 a	3383 a	78.8 a	0.86 d

*Check varieties.
[a]Means with different letters within the same group are significantly different at $P<0.05$.

Table 9. Mean sugar-snap cookie test (AACCI Approved method 10-50D (n=3) & 10-52 (n=4)) parameters[a]

Group	Entry	Sugar-Snap Cookie (10-50D)				Sugar-Snap Cookie (10-52)
		Width (mm)	Thickness (mm)	W/T Ratio (mm)	Spread Factor	Width (cm)
1	VA10W-119	478 a	56.5 a	8.6 a	79.7 b	17.7 b
1	VA11W-106	501 a	52.0 a	9.7 a	90.7 a	18.5 a
1	Hilliard*	499 a	53.3 a	9.5 a	89.0 a	18.2 ab
2	SY 100	523 a	46.8 b	11.3 a	102.3 a	19.1 a
2	M11-2024#	481 b	57.5 a	8.5 b	70.0 b	17.7 b
2	M11*3144CW	511 a	50.0 ab	10.3 a	97.0 a	18.9 a
2	Branson*	508 a	50.3 ab	10.3 a	95.7 a	18.7 a
3	Beck 88AA	513 a	48.3 b	10.7 a	100.3 a	18.6 ab
3	Beck 114	483 b	55.0 ab	9.0 bc	84.3 cd	17.7 c
3	Beck 123	508 ab	51.0 ab	10.1 ab	94.0 ab	18.7 ab
3	Beck 125	482 b	58.3 a	8.4 c	78.3 d	18.0 bc
3	Beck 128	524 a	48.5 ab	10.9 a	101.3 a	19.3 a
3	Beck 120*	506 ab	53.8 ab	9.6 abc	90.0 bc	18.8 ab

*Check varieties.

[a]Means with different letters within the same group are significantly different at $P<0.05$.

Table 10. Mean (n=2) sponge cake baking test parameters[a]

Group	Entry	Sponge Cake	
		Volume (mL)	Texture Score
1	VA10W-119	1251 a	39 a
1	VA11W-106	1305 a	40 a
1	Hilliard*	1314 a	39 a
2	SY 100	1345 a	39 a
2	M11-2024#	1305 a	40 a
2	M11*3144CW	1336 a	40 a
2	Branson*	1321 a	39 a
3	Beck 88AA	1327 a	39 a
3	Beck 114	1266 a	39 a
3	Beck 123	1320 a	39 a
3	Beck 125	1265 a	39 a
3	Beck 128	1332 a	37 a
3	Beck 120*	1278 a	38 a
1	VA10W-119	1251 a	39 a

*Check varieties.
[a]Means with different letters within the same group are significantly different at $P<0$.

GENOTYPING FOR QUALITY TRAITS: 2016 SOFT WHEAT QUALITY COUNCIL

Anne Sturbaum, January, 2017

Genotyping for traits associated with quality, physiology and disease resistance was done at the Regional Small Grains Genotyping Laboratory (RSGGL) in Raleigh, N.C. and in Wooster for the thirteen WQC entries, Beck 88A, Beck 114, Beck 120, Beck 123, Beck 125, Beck 128, M11*3144CW, M11-2024#, SY 100, VA11W-106 and VA10W-119 with Branson and Hilliard as checks for this set.

Quality

High molecular weight glutenins, especially the alleles for *Dx5 (*"*5+10*") at *GluD1*, the over expressed *Bx7* subunit at *GluB1* and *Ax2** at the *GluA1* loci are useful for selecting preferential milling and baking quality. These alleles correlate with strong gluten and dough strength (Ma et al., 2003). We report on the *GluA1, GluB1* and *GluD1* loci involved in selecting for varieties with specific dough quality.

Amplification for high molecular weight glutenins at the *GluA1* locus, adapted from the marker *umn19* (Liu et al., 2008a) identified the *Ax2** genotype in the WQC entries Beck 114, Beck 120, Beck 125, Beck 128 M11*3144CW, M11-2024#, VA11W-106. VA10W-119, and the two check entries, Branson and Hilliard. Beck 123, Beck 88A and SY100 have the *Ax1* allele at the *GluA* locus.

M11*3144CW, M11-2024# and SY100 have the overexpressing the *GluB1* allele, *Bx7OE*, as tested by primers diagnostic for a 45 base pair insertion specific to the *Bx7* over-expressing *GluB1* allele (Guttieri et al., 2008).

Primers specific for *GluD1* alleles *Dx5* and *Dx2* generated a PCR product corresponding to the "5+10" strong gluten allele for Beck 88A, Beck 114, Beck 123, Beck 125 and "2+12" for all other varieties as well as the checks, Branson and Hilliard. SR 5111 was heterozygous for "2+12+ and "5+10" at the *GluD1* locus. (Wan et al., 2005).

A translocation from chromosome 1 of rye, *Secale cereale L* (1RS), onto wheat chromosome 1B or 1A provides multiple resistances to powdery mildew, stem rust, leaf rust and stripe rust. Amplification products with scm9F primers are specific for rye ω-secalin using the Scm9 marker pair (Saal and Wricke, 1999). The only cultivar bearing the 1B:1R translocation was SR 5111.

Physiology

Mutations in the homeologous photoperiod genes *Ppd-A1*, *Ppd-B1* and *Ppd-D1* of chromosome 2, confer photoperiod insensitivity or day neutral growth in wheat permitting early flowering. Mutations in the *Ppd-D1* allele (Beales et al., 2007), copy number variations in *Ppd-B1* (Díaz et al., 2012) and insertions and deletions in *Ppd-A1* (Nishida et al., 2013) each influence the plant's flowering time allowing early maturation thus lowering the risk of high temperature exposure during grain fill and allowing for early harvest.

All WQC varieties with the exception of M11*3144CW lack photoperiod sensitivity through one or more of the mutant photoperiod alleles described above. Beck 88A and Beck 114 are insensitive

through the *Ppd-A1* locus alone, Beck 123 and Branson have both the *Ppd-A1* and *PpdD1* mutant loci, and the remainder of the cultivars are insensitive through only the *Ppd-D1* gene (*Ppd-D1a*).

Dwarfing genes were tested using markers specific for reduced height genes *Rht-B1* and *RhtD1* (formerly *Rht1 and Rht2).* The mutant alleles, *Rht-B1b* and *Rht-D1b* confer dwarfing traits to reduce plant height, increase yield and improve resistance to lodging (Zhang et al., 2006). WQC varieties M11*3144CW, SR 5111, SY 100, Va11W-106, VA10W-119 and Hilliard were homozygous for the single dwarfing allele, *Rht-D1b*. Beck 88A, Beck 114, Beck 120, Beck 123, Beck 125, Beck 88 and Branson each achieve dwarfing through the *Rht-B1b* locus.

Sr36, Stem Rust Resistance was assayed at the RSGGL for WQC varieties with none of the cultivars bearing the resistant allele. Markers, protocols and references for the disease resistance loci can be found on the MASWheat website: http://maswheat.ucdavis.edu/protocols/index.htm.

The preferred haplotype for sucrose synthase (*HapH* for high grain weight) was observed in Beck 114 and as heterozygous in VA10W-119.

Table 11. Genotypes 2016 WQC cultivars.
Preferred allele is presented in bold type.

Cultivar	Dwarfing	Photoperiod Insensitivity	High Molecular Weight Glutenins*			1RS RyeTL	Sucrose Synthase HapH	Stem Rust Resistance (*Sr36*)
			*GluA1 Ax2**	*GluB1 Bx7OE*	*GluD1 5+10*			
VA10W-119	***Rht-D1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	HET	no
VA11W-106	***Rht-D1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	no	no
Hilliard	***Rht-D1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	no	no
SY 100	***Rht-D1b***	***Ppd-D1a***	1	**YES**	2+12	non-1RS	no	no
M11-2024#	***Rht-D1b***	***Ppd-D1a***	**2***	**YES**	HET	**1B:1R**	no	no
M11*3144CW	***Rht-D1b***	*sensitive*	**2***	**YES**	2+12	non-1RS	no	no
Branson	***Rht-B1b***	***Ppd-D1a/A1a.1***	**2***	no	2+12	non-1RS	no	no
Beck 88A	***Rht-B1b***	***Ppd-A1a.1***	1	no	**5+10**	non-1RS	**YES**	no
Beck 114	***Rht-B1b***	***Ppd-A1a.1***	**2***	no	**5+10**	non-1RS	no	no
Beck 123	***Rht-B1b***	***Ppd-D1a/A1a.1***	1	no	**5+10**	non-1RS	no	no
Beck 125	***Rht-B1b***	***Ppd-D1a***	**2***	no	**5+10**	non-1RS	no	no
Beck 128	***Rht-B1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	no	no
Beck 120	***Rht-B1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	no	no

*Assays for high molecular weight glutenins test for the specific allele indicated.

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OVERSEAS VARIETAL ANALYSIS OF 2015 CROP ENTRIES

EXECUTIVE SUMMARY OF INTERNATIONAL COOPERATORS' RESULTS

Wheat Sources and Characteristics

The 2015 U.S. Wheat Associates Overseas Varietal Analysis project evaluated ten soft red winter wheat (SRW) varieties: WB-196 from Ohio; USG 3120, USG 3201 and USG 3895 from North Carolina; LA 754 and TV 8848 from Louisiana; Charlie from Tennessee; and USG 3251, USG 3404 and USG 3833 from Virginia. The grains of USG 3120 and TV 8848 were graded U.S. #1, with test weights greater than or equal to 61.2 lb/bu. WB-196, USG 3201, LA 754, USG 3251 and USG 3833 were graded U.S. #2, with test weights ranging from 58.7 to 60.4 lb/bu and damaged kernel percentages ranging from 1.0 to 2.5%. USG 3895, Charlie and USG 3404 received a U.S. #3 grade with test weights less than or equal to than 57.3 lb/bu, even though their damaged kernel percentages were less than 1.6%. Overall, the majority of grain samples exhibited signs of weathering and mild pre-harvest sprouting, which lowered their grade. Wheat grain samples were evaluated for grain characteristics, milled using a Miag Multomat pilot mill, and assessed for flour composition, solvent absorption characteristics, mixograph dough mixing properties, rapid visco-analyzer hot pasting properties and sugar-snap cookie baking quality by the Soft Wheat Quality Laboratory. Evaluations of the farinograph and alveograph tests of flour samples were conducted by the Wheat Marketing Center in Portland, Oregon. Flour samples were further tested by nine overseas cooperators from the Dominican Republic, Indonesia, Malaysia, the Philippines, Thailand and Vietnam for making cookies, sponge cakes, and chiffon cakes.

The ten OVA varieties ranged from 56.2 to 61.8 lb/bu in test weight, 29.9 to 40.6 g in 1000 kernel weight, 8.6 to 11.1% in grain protein content (12% moisture basis) and -2.1 to 18.6 in single kernel characterization system (SKCS) kernel hardness. Falling number of grain ranged from 272 in USG 3201 to 390 in USG 3895. Flour yield of the ten entries determined using a Miag Multomat mill ranged from 70.6 to 75.6%, with a flour ash content (14% moisture basis) range of 0.35 to 0.46%. All ten entries exhibited excellent milling properties as indicated by no to slow increase in flour ash content until around 60% flour extraction. Flour protein content (14% moisture basis) was lowest in Charlie (7.0%) and highest in TV 8848 and LA 754 (9.1%). Charlie exhibited a considerably higher flour ash content, damaged starch content, water solvent retention capacity (SRC) and sodium carbonate SRC than other varieties. LA 754 contained the strongest gluten protein as indicated by its highest SDS sedimentation volume and highest lactic acid SRC, whereas both protein strength tests failed to show a significant relationship. Water and sodium carbonate SRCs of the ten varieties ranged from 53.1 to 59.0% and 69.0 to 84.2%, respectively. The ten varieties showed relatively small differences in sucrose and lactic acid SRC values, which ranged from 82.5 to 93.7% and 91.2 to 117.9%, respectively. USG 3833 exhibited an unusually long farinograph dough development time of 3.4 min, which could not be explained by flour protein content or lactic acid SRC value. LA 754 showed the highest farinograph dough stability of 5.2 min and second longest dough development time of 1.4 min, corresponding to its highest SDS sedimentation volume (32 mL) and lactic acid SRC (117.9%) among the ten varieties. LA 754 and USG 3120 exhibited the

highest alveograph W values, followed by USG 3201 and TV 8848. The highest alveograph P value was observed with USG 3120. USG 3251, USG 3404 and USG 3201 produced sugar-snap cookies with diameters equal to or greater than 18.0 cm, followed by WB-196, USG 3895 and TV 8848 with cookie diameters of 17.9 cm. Charlie produced the smallest sugar-snap cookies (16.8 cm diameter), probably due to its much higher damaged starch content and consequently higher water and sodium carbonate SRCs than other varieties.

The summary that follows is primarily based on the preference rankings in Table 16. Among cooperators, the relative ranks of SRW varieties exhibited the greatest variation for sponge cakes (with an average standard deviation (STD) of 3.0), less variation for cookies (2.6 average STD) and the least variation for chiffon cakes (1.4 average STD), possibly due to differences in formulas, baking procedures and preferences.

Product Preferences

1) Among all cooperators that evaluated the entries for baking cookies, USG 3404 was ranked highest with an average ranking of 2.1, followed by USG 3251, WB-196, USG 3120, TV 8848 and USG 3895, all of which were rated higher than the average ranking of the cooperator standard flours (controls). USG 3833 showed the lowest average ranking of 8.9 for baking cookies, and followed by Charlie with 8.0 average ranking. The excellent performance of USG 3404 for making cookies was expected from its lowest kernel hardness, second lowest damaged starch content and much lower water, sodium carbonate and sucrose SRC values than the other nine varieties. The poor performance of USG 3833 for baking cookie was not apparent, although it had much higher farinograph dough development time than other entries and the second highest farinograph dough stability. Charlie's poor ranking was probably due to its much higher damaged starch content, water SRC and sodium carbonate SRC compared to others.
2) For baking sponge cakes, USG 3404 again exhibited the highest average ranking of 3.8, and was closely followed by LA 754 and USG 3120 with average rankings of 4.0 and 4.5, respectively. The remaining seven OVA varieties were ranked lower than the cooperator standard flours. WB-196 was ranked lowest for making sponge cakes with an average ranking of 8.5, closely followed by USG 3985 with 8.0.
3) USG 3120 performed best for baking chiffon cakes among the OVA varieties with an average ranking of 2.3, followed by USG 3833 with an average ranking of 2.7. The other eight OVA varieties exhibited average rankings of less than 5.0, much lower than the cooperator standard flours which had an average ranking of 1.7.
4) No significant relationships were observed between the rankings of SRW wheat flours for baking cookies, sponge cakes and chiffon cakes, indicating the considerable differences in flour characteristics preferred for each product.

USG 3404 exhibited the highest overall average ranking (3.8) followed by USG 3120 (4.1), mainly due to their top performance in making cookies and sponge cakes for the former and chiffon cakes for the latter. USG 3201, USG 3895, Charlie and WB-196 had relatively low overall average rankings, largely due to their poor performance for making cookies, sponge cakes and/or chiffon cakes.

Summary of Cultivars

This summary is primarily based on the grain characteristics, flour composition, solvent retention capacities, dough rheological properties and sugar-snap cookie baking tests analyzed/performed by the SWQL (Table 13,Table 14 & 15), and the rankings and desirability scores for making cookies, sponge cakes and chiffon cakes (TablesTable 16, Table 17, Table 18,Table 19, Table 20Table 21).

WB-196 (1501) exhibited a very low kernel hardness (2.7) and a relatively low falling number (286), indicating mild pre-harvest sprout damage; near average grain and flour protein contents, straight grade flour yield and SDS sedimentation volume; and lower damaged starch content, and water and sodium carbonate SRC values; a uniquely higher rapid visco-analyzer pasting temperature than the other nine OVA varieties; and intermediate dough strength and sugar-snap cookie diameter. WB-196 was ranked high for making cookies with an average ranking of 4.3, but poorly for making sponge cakes and chiffon cakes with average rankings of 8.5 and 8.7, respectively. WB-196 appears to be better fit for making cookies than cakes.

USG 3120 (1502) was characterized by intermediate kernel hardness, high falling number, intermediate flour yield, below average flour protein content, the second lowest lactic acid SRC, and a close to average sugar-snap cookie diameter.

USG 3120 was rated intermediate for making cookies and above average for making sponge cakes by the cooperators, but highest for making chiffon cakes. It exhibited relatively high desirability scores for flour, dough and batter properties for making cookies, sponge cakes and chiffon cakes.

USG 3201 exhibited a below average grain protein content, relatively high kernel hardness, and the lowest falling number of 272. It had an above average protein strength as shown by SDS sedimentation volume and lactic acid SRC, and intermediate water, sodium carbonate and sucrose SRC values, but produced sugar-snap cookies of relatively large diameter.

USG 3201 was ranked below the average of the entries for making cookies, average for making sponge cakes and lowest for making chiffon cakes. USG 3201 exhibited average or below average desirability scores for flour characteristics, cookie dough and cake batter properties, and for cookie and sponge cake quality.

USG 3895 exhibited a test weight that was 1.8 lb/bu lower than that of the average of the ten OVA varieties; was highest in kernel hardness with the lowest kernel weight and diameter; and was intermediate in grain protein content, flour yield, sedimentation volume, water and sucrose SRC test values, farinograph, and sugar-snap cookie diameter among the OVA varieties.

USG 3895 ranked slightly lower than the median of the entries for making cookies, second lowest for making sponge cakes and ranked near the middle for making chiffon cakes. The desirability scores for flour characteristics, dough properties and product quality for making cookies were higher than the median of the OVA varieties.

LA 754 exhibited a relatively high grain protein content, a quite low kernel hardness, an excellent flour yield, the highest SDS sedimentation volume and lactic acid SRC, and intermediate water, sodium carbonate and sucrose SRC values. It produced a dough of the highest farinograph stability and alveograph W values, and sugar-snap cookies of relatively small diameter. LA 754 ranked below the median of the OVA varieties for baking cookies, second highest for making sponge cakes and intermediate for making chiffon cakes.

TV 8848 had the second highest grain protein content, a slightly above average kernel hardness, an average flour milling yield, the second highest SDS-sedimentation volume but a below average lactic acid SRC, and slightly below average water, sodium carbonate and sucrose SRC values.

It ranked slightly above the median for making cookies and chiffon cakes and below the median for making sponge cakes among the OVA varieties. The desirability scores for flour characteristics and overall desirability scores for making cookies, sponge cakes and chiffon cakes were slightly above intermediate.

Charlie had the lowest test weight, protein content and flour milling yield among the ten entries, a comparatively high kernel hardness score and lowest SDS sedimentation volume. It exhibited the highest damaged starch content and consequently the highest water and sodium carbonate, and the second highest sucrose SRC value, which all contributed to the production of sugar-snap cookies of the smallest diameter. Charlie ranked near the bottom for making cookies and sponge cakes, but intermediate for chiffon cakes. Charlie was rated below the average of the entries in flour characteristics and overall desirability scores.

USG 3251 had an average test weight and grain protein content, and a low kernel hardness. It exhibited a slightly below average flour yield, protein strength and damaged starch content, and average water, sodium carbonate and sucrose SRC values. The farinograph and alveograph dough strength parameters of USG 3251 were intermediate or slightly below average. It produced sugar-snap cookies of the largest diameter, ranked second highest for making cookies, and ranked intermediate for making sponge and chiffon cakes. The desirability scores of USG 3251 for flour characteristics were above average for making cookies and sponge cakes, but below average for making chiffon cakes.

USG 3404 was 1.9 lb/bu lower in test weight than the average of the entries, low in grain protein content and lowest in kernel hardness. Nevertheless, it exhibited the highest flour milling yield and second lowest damaged starch content, which probably contributed to the lowest water, sodium carbonate and sucrose SRC values. USG 3404 contained intermediate strength protein as evidenced by SDS sedimentation volume, lactic acid SRC and farinograph and alveograph dough strengths parameters. USG 3404 produced sugar-snap cookies of the second largest diameter, and received the best ranking for baking cookies and sponge cakes, and an above average ranking for baking chiffon cakes. The desirability scores of USG 3404 were always greater than the averages in flour characteristics for making cookies.

USG 3833 had an intermediate test weight, the highest grain protein content, a relatively low kernel hardness, an average flour yield, and slightly lower water, sodium carbonate and sucrose SRC values compared to the average. It exhibited higher than average dough strength and baked the second smallest sugar-snap cookies; consequently, it ranked lowest for making cookies, intermediate for making sponge-cakes, but near the top for making chiffon cakes without evident reason.

Recommendations for Class

This year's OVA entries included three varieties showing test weights equal to or below 57.3 lb/bu, and three varieties with falling numbers ranging from 278 to 298. Other grain and flour characteristics were in the range of typical SRW wheat, with grain protein content ranging from 8.6 to 11.1%, kernel hardness from -2.1 to 18.6, and flour yield from 70.6 to 75.6%. The OVA varieties exhibited small differences in protein strength estimated by SDS sedimentation volume and lactic acid SRC tests. With the exception of one variety, damaged starch content and the associated water, sodium carbonate and sucrose SRC values showed relatively small differences among the entries. Charlie, on the other hand, exhibited the highest damaged starch content and much higher solvent retention capacities than other flours. Based on grain and flour characteristics as well as sugar-snap cookie baking performance, all the entries (with exception of Charlie, LA 754 and USG 3833) appear to be suitable for making cookies. The strong protein for LA 754, a high solvent retention capacity for Charlie and no evident cause for USG 3833 seem to negatively affect the cookie making quality potentials. With kernel hardness scores less than or equal to 18.6, break flour yields equal to or greater than 29.4%, and flour protein contents less than or equal to 9.1%, all of the OVA entries would make decent quality sponge cakes and chiffon cakes, with evident varietal differences in performance. The three top-ranked varieties by the cooperators were USG 3404, USG 3251 and WB-196 for baking cookies, USG 3404, LA 754 and USG 3120 for baking sponge cakes, and USG 3120, USG 3833 and TV 8848 for baking chiffon cakes. Compared to the cooperator standard flours, six OVA entries performed better for baking cookies, three for baking sponge cakes, but none for baking chiffon cakes.

The cooperators' preference rankings of the ten varieties for making cookies, sponge cakes and chiffon cakes widely differed in the assigned ranking of each entry for baking each product. The large differences in cooperators' preferences of the ten varieties for baking each product proved a challenge in the selection of universally satisfactory varieties. Nevertheless, USG 3404 received the highest average ranking for baking cookies and sponge cakes, as was expected from its relatively low protein content and kernel hardness, and lowest solvent retention capacities. Due to its comparatively high kernel hardness score and consequent highest damaged starch content and quite high solvent retention capacities (which are all known to be unfavorable for the production of sugar-snap cookies), Charlie ranked lowest for making cookies and near-lowest for sponge cakes.

Table 12. Yield of flour mill streams of ten 2015 OVA soft red winter wheat varieties

	1501	1502	1503	1504	1505	1506	1507	1508	1509	1510			
Flour Stream	WB-196	USG 3120	USG 3201	USG 3895	LA 754	TV 8848	Charlie	USG 3251	USG 3404	USG 3833	Mean	Min	Max
1st Bk	11.0	9.3	9.3	10.0	8.7	8.1	8.8	11.0	10.3	8.7	9.5	8.1	11.0
2nd Bk	9.8	8.4	10.6	10.1	8.4	7.4	8.7	11.2	11.1	8.0	9.4	7.4	11.2
Grader	5.0	3.9	4.2	4.2	4.4	3.6	5.2	5.0	5.0	4.1	4.5	3.6	5.2
3rd Bk	8.6	10.3	9.3	8.9	9.5	10.1	7.3	9.1	9.6	12.5	9.5	7.3	12.5
Total Break	**34.4**	**31.9**	**33.4**	**33.1**	**31.0**	**29.4**	**30.0**	**36.3**	**36.0**	**33.3**	**32.9**	**29.4**	**36.3**
1st Mids	10.3	10.5	10.6	10.2	11.7	9.4	8.9	9.2	10.8	9.6	10.1	8.9	11.7
2nd Mids	12.1	13.4	14.0	14.9	13.5	12.9	13.1	13.0	14.3	12.3	13.4	12.1	14.9
3rd Mids	5.1	6.5	5.2	4.8	6.0	9.4	5.7	4.2	4.4	7.4	5.9	4.2	9.4
Redust	6.3	6.4	7.0	6.4	7.2	6.3	5.4	5.3	6.5	5.7	6.2	5.3	7.2
4th Mids	3.4	3.4	2.5	2.6	4.3	4.3	5.4	3.2	2.7	4.1	3.6	2.5	5.4
5th Mids	1.3	1.1	0.9	1.0	1.2	1.4	2.2	1.2	0.9	1.4	1.2	0.9	2.2
Total Mids	**38.5**	**41.2**	**40.2**	**39.9**	**43.9**	**43.6**	**40.6**	**36.1**	**39.6**	**40.6**	**40.4**	**36.1**	**43.9**
Total Flour	**72.9**	**73.1**	**73.6**	**73.0**	**74.9**	**73.0**	**70.6**	**72.4**	**75.6**	**73.9**	**73.3**	**70.6**	**75.6**
Bk Shorts	6.3	6.3	6.8	6.5	6.3	8.2	7.0	7.7	6.1	7.0	6.8	6.1	8.2
Red Dog	2.0	0.7	0.7	0.7	0.9	1.0	1.7	1.1	0.6	1.0	1.0	0.6	2.0
Tail Shorts	0.4	0.3	0.4	0.3	0.6	0.4	0.7	0.3	0.3	0.4	0.4	0.3	0.7
Bran	18.4	19.2	18.5	19.4	17.0	17.1	19.8	18.2	17.0	17.5	18.2	17.0	19.8
Total Byproduct	**27.0**	**26.6**	**26.3**	**26.9**	**24.8**	**26.7**	**29.1**	**27.3**	**23.9**	**25.9**	**26.4**	**23.9**	**29.1**

Table 13. Grain Characteristics of 2015 crop OVA SRW Wheat Varieties

Variety	Test Weight (lb/bu)	Protein (%, 12% m.b.)	SKCS Kernel Hardness	Kernel Weight (mg)	Kernel Diameter (mm)	Falling Number (sec)
WB-196	59.0	9.8	2.7	36.2	2.7	286
USG 3120	61.2	9.5	15.0	35.9	2.7	373
USG 3201	60.4	9.6	16.1	31.0	2.6	272
USG 3895	57.3	10.0	18.6	29.9	2.5	390
LA 754	58.7	10.8	1.1	40.6	2.9	371
TV 8848	61.8	11.0	13.2	38.6	2.8	278
Charlie	56.2	8.6	18.0	34.9	2.8	298
USG 3251	59.7	9.7	4.5	36.7	2.7	340
USG 3404	57.2	9.7	-2.1	32.7	2.6	349
USG 3833	59.2	11.1	7.2	33.0	2.7	373

Table 14. Milling Yield, Composition, Falling Number and Solvent Retention Capacities of 2015 crop OVA SRW Wheat Flours

Variety	Miag Milling		Protein (%)	Ash (%)	SDS Sed. Volume (mL)	Flour Color (L*)	Alpha-Amylase (CU/g)	Starch Damage (%)	Solvent Retention Capacity (%)			
	Break Flour Yield (%)	Straight Grade Flour Yield (%)							Water (%)	Sodium Carbonate (%)	Sucrose (%)	Lactic Acid (%)
WB-196	34.4	72.9	8.0	0.350	19	93.0	0.072	1.56	53.9	72.8	91.0	106.7
USG 3120	31.9	73.1	7.9	0.375	21	92.0	0.032	3.28	57.4	73.6	93.7	91.4
USG 3201	33.4	73.6	8.0	0.350	25	93.0	0.072	2.82	54.7	74.1	92.8	107.4
USG 3895	33.1	73.0	8.0	0.353	20	92.9	0.028	2.61	55.8	72.3	87.7	91.2
LA 754	31.0	74.9	9.1	0.417	32	93.0	0.047	2.11	54.3	73.2	89.1	117.9
TV 8848	29.4	73.0	9.1	0.401	28	92.6	0.064	2.24	55.1	72.7	85.5	95.3
Charlie	30.0	70.6	7.0	0.456	14	92.8	0.061	3.92	59.0	84.2	92.9	100.2
USG 3251	36.3	72.4	7.7	0.369	17	93.3	0.036	2.22	55.8	73.9	87.9	95.6
USG 3404	36.0	75.6	7.9	0.409	22	93.2	0.022	1.91	53.1	69.0	82.5	95.9
USG 3833	33.3	73.9	9.0	0.395	26	92.5	0.034	2.44	54.9	72.0	88.7	93.7

Table 15. Dough Rheological Characteristics and Sugar Snap cookie Diameter of 2015 crop OVA SRW Wheat Flours

Variety	Farinograph			Alveograph				Sugar-snap Cookie Diameter (cm)
	Abs. (%)	Dev. Time (min)	Stability (min)	P (mm)	L (mm)	P/L	W (10^{-4} joules)	
WB-196	50.7	1.2	1.4	25	158	0.16	97	17.9
USG 3120	52.1	1.0	1.9	44	94	0.47	124	17.6
USG 3201	50.6	1.2	1.5	34	127	0.27	115	18.0
USG 3895	51.4	1.2	1.6	32	100	0.32	81	17.9
LA 754	50.9	1.4	5.2	32	132	0.24	124	17.2
TV 8848	51.8	1.3	1.7	34	107	0.32	110	17.9
Charlie	51.0	1.2	0.9	37	79	0.47	82	16.8
USG 3251	51	1.0	1.1	32	116	0.28	90	18.2
USG 3404	48.6	1.2	2.0	25	125	0.2	90	18.0
USG 3833	50.8	3.4	4.5	31	139	0.22	107	17.2

COOPERATORS' RANKINGS AND SCORES BY PRODUCT 2015 CROP OVA

Introduction

The cooperators compared the flours of ten SRW wheat varieties to their own standard flours for suitability in making cookies, sponge cakes, and chiffon cakes. The varieties were ranked from 1 (for most preferred) to 9 (for least preferred). The cooperators were also asked to respond to four questions addressing overall flour quality, dough or batter handling performance, end-product performance and overall acceptability. Scores were assigned to each sample in response to these questions. The scores were reported on a scale of 1 to 9, with the preferred varieties receiving the higher scores.

Cookies (Tables Table 16, Table 17,Table 18, Table 19Table 20)

The preference ranking of each variety fluctuated largely among the eight cooperators, indicating that there are large differences in the preferred quality attributes of cookies and consequently in flour quality requirements among cooperators. USG 3404 was the most preferred variety for baking cookies with an average ranking of 2.1 (and with little difference in its ranking among cooperators), followed by USG 3251 and WB-196 with average rankings of 4.0 and 4.3, respectively. USG 3201, LA 754, Charlie and USG 3833 received lower average rankings compared to that of the cooperator standard flours (controls).

The desirability scores for flour and dough characteristics showed slight variations among the varieties. Despite achieving the highest ranking for baking cookies, USG 3404 received similar desirability scores to USG 3120 and USG 3251 in flour quality, and an even lower desirability score than USG 3833, which received the lowest baking preference ranking, indicating the discrepancies between desirability scores for flour characteristics and the preference ranking for baking cookies. Similar observations were made for dough characteristics. The average desirability score for the dough of USG 3404 was lower than those of other nine varieties. The desirability scores for cookie quality and overall desirability scores, on the other hand, were generally in agreement with the preference rankings.

The average rankings of the OVA varieties failed to show significant relationships with flour composition, SRC test values and dough rheological properties, but exhibited significant correlations with break flour yield and sugar-snap cookie diameter with coefficients of -0.60 (P<0.05) and -0.69 (P<0.05). On the other hand, the average desirability scores for flour quality exhibited a significant relationship only with sodium carbonate SRC (r=-0.65, P<0.05), indicating some discrepancy between the overall preference ranking and desirability scores for flour characteristics by the cooperators.

Sponge cakes (Tables Table 16, Table 17,Table 18, Table 19Table 20)

The quality ranking and desirability scores of the OVA varieties for baking sponge cakes were evaluated by six cooperators. For baking sponge cakes, USG 3404 (ranked best for baking sugar-snap cookies) again received the highest average ranking of 3.8, followed by LA 754 and USG 3120

with average rankings of 4.0 and 4.5, respectively. The other seven varieties received lower average rankings than that of the cooperator standard flours (5.2). As with sugar-snap cookies, the average preference rankings and desirability scores did not agree. The best ranked variety, USG 3404, received a relatively low average desirability score for flour characteristics. Still, the relatively poorly ranked varieties (including WB-196, USG 3895 and Charlie) received low desirability scores for flour characteristics.

The desirability scores for batter and sponge cakes exhibited relatively small differences among varieties and consequently poor differentiating capabilities. Neither the average quality rankings for making sponge cakes nor the average desirability scores for flours showed significant relationships with flour composition, protein strength parameters or SRC test parameters, indicating the difficulty in predicting the sponge cake baking potential of wheat flour. No significant correlation was observed between the average rankings for making cookies and those for making sponge cakes, indicating that the preferred flours for making each product are quite different. The average preference ranking of the varieties for baking sponge cakes showed no significant relationships with the desirability scores for flour characteristics, sponge cake quality, or the overall desirability score.

Chiffon cakes (Tables Table 16, Table 17,Table 18, Table 19Table 20)

Three cooperators from the Philippines determined the quality rankings and desirability scores of the OVA varieties for baking chiffon cakes. The cooperator standard flours received the highest average ranking of 1.7 for making chiffon cakes, followed closely by USG 3120 and USG 3833 with average rankings of 2.3 and 2.7, respectively. USG 3201 and LA 754 were preferred least for baking chiffon cakes, receiving average rankings of 9.7 and 9.3, respectively.

The average ranking of the varieties for baking chiffon cakes failed to show any significant relationships with the desirability scores for flour and chiffon cake batter characteristics, but exhibited a significant correlation with the desirability score for chiffon cake quality. The average ranking of the OVA varieties for baking chiffon cakes showed no relationships with grain and flour composition and water, sodium carbonate and sucrose SRC test values, but was significantly correlated with lactic acid SRC, indicating the importance of protein characteristics for making chiffon cakes.

Summary

Six out of ten OVA SRW wheat varieties received higher ratings than the cooperator standard flours for making cookies. The highest ranked variety, USG 3404, had the lowest kernel hardness, second lowest damaged starch content, and the lowest water, sodium carbonate and sucrose SRC values, and a relatively low flour protein content with intermediate protein strength. However, no apparent differences between the varieties that ranked higher than the cooperator standard flours and those that ranked lower could be identified, making it difficult to determine conclusively the flour quality characteristics preferred by cooperators for making cookies. The average rankings of the OVA varieties for baking cookies showed a significant relationship only with break flour yield, indicating the importance of kernel hardness and flour particle size for making cookies.

For baking sponge cakes, three OVA varieties (USG 3404, LA 754 and USG 3120) were ranked higher than the cooperator standard flours with no apparent common flour characteristics. Flour characteristics, including composition, solvent retention capacity and protein strength, failed to show any relationship with the average preference ranking for making sponge cakes, thus making apparent the challenges in predicting the cake baking potential of wheat flour. For baking chiffon cakes, USG 3120 and USG 3833 closely followed the cooperator standard flours in preference ranking with a difference equal to or less than 1.0, whereas the rankings of the remaining eight varieties were much lower and ranged from 5.0 to 9.7. Similar to sponge cakes, the grain and flour characteristics that dominantly influence processing and product quality are not apparent, which makes it difficult to estimate the quality potential of flour for making chiffon cakes.

Table 16. Rankings of 10 Soft Red Winter Wheat Varieties for Making Cookies, Sponge Cakes, and Chiffon Cakes*

Product	Cooperator	Control**	WB-196	USG 3120	USG 3201	USG 3895	LA 754	TV 8848	Charlie	USG 3251	USG 3404	USG 3833
Cookie	Indonesia-1	7	11	6	8	4	1	5	10	2	3	9
Cookie	Indonesia-2	10	1	7	6	5	8	4	9	3	2	11
Cookie	Malaysia	5	2	4	3	11	6	7	8	10	1	9
Cookie	Philippines-1	7	10	8	11	2	6	4	9	5	3	1
Cookie	Philippines-2	6	5	1	4	9	11	7	8	2	3	10
Cookie	Philippines-3	5	3	2	10	8	6	7	11	4	1	9
Cookie	Thailand	9	1	6	8	7	10	5	4	3	2	11
Cookie	Vietnam	4	1	9	8	6	10	7	5	3	2	11
	Average	**6.6**	**4.3**	**5.4**	**7.3**	**6.5**	**7.3**	**5.8**	**8.0**	**4.0**	**2.1**	**8.9**
Sponge Cake	Dominican Rep.	5	4	1	10	6	8	3	11	9	7	2
Sponge Cake	Indonesia-1	4	11	7	3	8	2	5	10	6	1	9
Sponge Cake	Indonesia-2	6	10	2	5	9	4	11	7	3	1	8
Sponge Cake	Malaysia	11	5	4	3	7	1	9	2	10	8	6
Sponge Cake	Thailand	1	10	6	7	9	4	8	5	2	3	11
Sponge Cake	Vietnam	4	11	7	8	9	5	2	10	6	3	1
	Average	**5.2**	**8.5**	**4.5**	**6.0**	**8.0**	**4.0**	**6.3**	**7.5**	**6.0**	**3.8**	**6.2**
Chiffon Cake	Philippines-1	2	10	1	9	8	6	7	3	11	4	5
Chiffon Cake	Philippines-2	2	7	3	10	8	11	4	6	9	5	1
Chiffon Cake	Philippines-3	1	9	3	10	6	11	4	8	5	7	2
	Average	**1.7**	**8.7**	**2.3**	**9.7**	**7.3**	**9.3**	**5.0**	**5.7**	**8.3**	**5.3**	**2.7**
	Overall Average	**4.5**	**7.1**	**4.1**	**7.6**	**7.3**	**6.9**	**5.7**	**7.1**	**6.1**	**3.8**	**5.9**

* 1 = Best/ 11 = Poorest; **Local flour.

Table 17. Desirability Scores of 10 Soft Red Winter Wheat Flours for Making Cookies, Sponge Cakes and Chiffon Cakes*

Product	Cooperator	Control**	WB-196	USG 3120	USG 3201	USG 3895	LA 754	TV 8848	Charlie	USG 3251	USG 3404	USG 3833
Cookie	Indonesia-1	9.0	6.5	7.5	7.5	7.5	8.0	7.5	7.0	7.5	8.0	7.0
Cookie	Indonesia-2	7.0	4.0	7.0	4.0	7.0	3.5	6.5	3.5	7.0	7.0	7.8
Cookie	Malaysia	7.0	5.0	6.0	6.7	6.6	7.1	6.9	6.5	7.1	6.8	7.2
Cookie	Philippines-1	8.5	8.0	8.0	8.0	8.0	7.0	7.0	7.5	7.5	7.5	7.0
Cookie	Philippines-2	7.0	6.5	6.5	6.5	6.5	7.0	8.0	6.0	6.0	6.0	7.5
Cookie	Philippines-3	7.0	6.8	6.9	6.8	5.5	6.5	6.6	6.4	6.5	7.8	7.3
Cookie	Thailand	7.0	4.5	5.5	6.0	6.0	6.5	6.8	4.0	6.0	6.0	6.5
Cookie	Vietnam	7.0	8.0	9.0	8.0	8.5	7.0	8.0	8.0	9.0	8.0	
	Mean	**7.4**	**6.2**	**7.1**	**6.7**	**7.0**	**6.6**	**7.2**	**6.1**	**7.1**	**7.1**	**7.2**
Sponge Cake	Indonesia-1	8.0	6.5	7.5	7.5	7.5	8.0	7.5	7.0	7.5	8.0	7.0
Sponge Cake	Indonesia-2	7.0	4.0	7.0	4.0	7.0	3.5	6.5	3.5	7.0	7.0	
Sponge Cake	Malaysia	7.0	5.0	6.0	6.7	6.6	7.1	6.9	6.5	7.1	6.8	7.2
Sponge Cake	Thailand	7.0	4.5	5.5	6.0	6.0	6.5	6.8	4.0	6.0	6.0	6.5
Sponge Cake	Vietnam	7.0	8.0	9.0	8.0	9.0	7.0	8.0	8.0	9.0	8.0	8.0
Sponge Cake	Dominican Rep.		5.5	7.5	7.5	4.0	5.0	6.5	3.0	6.5	4.0	6.0
	Mean	**7.2**	**5.6**	**7.1**	**6.6**	**6.7**	**6.2**	**7.0**	**5.3**	**7.2**	**6.6**	**6.9**
Chiffon Cake	Philippines-1	8.5	6.5	6.5	6.5	6.5	6.5	6.5	6.0	6.5	5.0	5.0
Chiffon Cake	Philippines-2	7.0	7.0	8.5	8.0	8.0	7.0	7.0	6.5	6.5	7.0	6.5
Chiffon Cake	Philippines-3	7.0	4.4	5.2	4.7	4.2	5.0	5.0	4.2	4.8	4.2	5.2
	Mean	**7.5**	**6.0**	**6.7**	**6.4**	**6.2**	**6.2**	**6.2**	**5.6**	**5.9**	**5.4**	**5.6**
	Overall Mean	**7.4**	**5.9**	**7.0**	**6.6**	**6.6**	**6.3**	**6.8**	**5.7**	**6.7**	**6.4**	**6.6**

* 1 = Very poor/ 9 = Excellent; **Local flour.

Table 18. Desirability Scores for Dough of 10 Soft Red Winter Wheat Flours for Making Cookies*

Product	Cooperator	Control**	WB-196	USG 3120	USG 3201	USG 3895	LA 754	TV 8848	Charlie	USG 3251	USG 3404	USG 3833
Cookie	Indonesia-1	8.0	7.0	8.0	7.0	8.0	8.0	8.0	7.0	8.0	7.0	7.5
Cookie	Indonesia-2	7.0	4.0	7.0	4.0	7.0	4.0	7.0	4.0	7.0	4.0	7.0
Cookie	Malaysia	7.0	6.9	7.3	7.2	6.8	7.1	7.1	6.8	7.1	6.9	6.8
Cookie	Philippines-1	6.0	5.0	8.0	6.0	8.0	8.0	8.0	6.0	8.0	6.0	7.0
Cookie	Philippines-2	7.0	6.5	7.0	6.5	7.0	7.0	7.0	6.5	7.0	6.5	7.0
Cookie	Philippines-3	7.0	7.5	8.0	7.5	8.0	8.0	8.0	7.5	8.0	7.0	7.5
Cookie	Thailand	7.0	5.5	5.5	5..0	5.5	5.5	5.5	5.5	5.5	4.0	5.0
Cookie	Vietnam	7.0	7.0	8.0	7.0	8.0	8.0	8.0	7.0	8.0	7.0	8.0
	Mean	**7.0**	**6.2**	**7.4**	**6.5**	**7.3**	**7.0**	**7.3**	**6.3**	**7.3**	**6.1**	**7.0**

* 1 = Very poor/ 9 = Excellent; **Local flour.

Table 19. Desirability Scores for Batter of 10 Soft Red Winter Wheat Flours for Making Sponge Cakes and Chiffon Cakes*

Product	Cooperator	Control**	WB-196	USG 3120	USG 3201	USG 3895	LA 754	TV 8848	Charlie	USG 3251	USG 3404	USG 3833
Sponge Cake	Indonesia-1	7.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7.5	7.5
Sponge Cake	Indonesia-2	7.0	7.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Sponge Cake	Malaysia	7.0	6.8	7.4	7.5	6.8	7.3	7.1	7.4	7.1	7.2	7.2
Sponge Cake	Thailand	7.0		5.5	5.0	5.5	5.5	5.5	5.5	5.5	4.0	5.0
Sponge Cake	Vietnam	7.0	5.0	7.0	6.0	5.0	5.0	5.0	6.0	6.0	7.5	7.5
Sponge Cake	Dominican Rep.	8.0	6.5	8.5	8.0	7.0	7.5	8.5	6.0	6.5	6.0	8.0
	Mean	**7.3**	**6.4**	**6.8**	**6.5**	**6.1**	**6.3**	**6.4**	**6.2**	**6.3**	**6.4**	**6.9**
Chiffon Cake	Philippines-1	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Chiffon Cake	Philippines-2	7.0	7.0	6.5	6.0	7.0	6.5	7.0	6.5	7.0	6.5	6.5
Chiffon Cake	Philippines-3	7.0	6.5	6.0	5.5	7.5	6.0	6.5	6.0	7.0	6.5	6.0
	Mean	**7.0**	**6.8**	**6.5**	**6.2**	**7.2**	**6.5**	**6.8**	**6.5**	**7.0**	**6.7**	**6.5**
	Overall Mean	**7.1**	**6.6**	**6.7**	**6.3**	**6.7**	**6.4**	**6.6**	**6.4**	**6.6**	**6.5**	**6.7**

* 1 = Very poor/ 9 = Excellent; **Local flour.

Table 20. Desirability Scores for Quality of Cookies, Sponge Cakes and Chiffon Cakes of 10 Soft Red Winter Wheat Flours*

Product	Cooperator	Control**	WB-196	USG 3120	USG 3201	USG 3895	LA 754	TV 8848	Charlie	USG 3251	USG 3404	USG 3833
Cookie	Indonesia-1	5.0	8.5	7.5	8.0	8.0	8.0	8.0	8.5	8.5	8.5	7.0
Cookie	Indonesia-2	7.0	8.0	5.0	8.0	8.0	4.0	8.0	4.0	8.0	8.0	5.0
Cookie	Malaysia	7.0	7.3	7.2	7.3	6.7	6.9	6.9	6.9	6.7	7.3	6.9
Cookie	Philippines-1	6.0	3.0	7.0	6.0	7.0	3.0	5.0	5.0	6.5	6.5	4.0
Cookie	Philippines-2	7.0	8.0	7.5	7.5	7.5	6.5	7.5	6.0	7.5	7.0	7.0
Cookie	Philippines-3	7.0	7.6	7.1	5.4	6.5	5.9	6.3	5.1	6.6	8.4	5.0
Cookie	Thailand	7.0	8.5	7.8	7.5	7.8	6.8	7.8	8.0	8.5	8.5	6.8
Cookie	Vietnam	6.0	9.0	8.0	8.0	7.0	7.0	7.0	5.0	8.0	8.0	5.0
	Mean	**6.5**	**7.5**	**7.1**	**7.2**	**7.3**	**6.0**	**7.1**	**6.1**	**7.5**	**7.8**	**5.8**
Sponge Cake	Indonesia-1	8.5	7.0	7.5	8.5	7.5	8.5	8.5	8.0	8.5	8.0	7.5
Sponge Cake	Indonesia-2	7.0	7.0	7.0	7.0	7.0	7.0	8.0	8.0	8.0	6.0	6.0
Sponge Cake	Malaysia	7.0	7.2	7.4	7.6	7.1	8.0	6.8	8.0	6.8	6.9	7.1
Sponge Cake	Thailand	7.0	4.5	5.3	5.5	5.0	6.0	5.0	6.0	6.7	6.0	4.0
Sponge Cake	Vietnam	7.0	7.0	7.0	6.0	6.5	6.5	6.5	6.0	5.5	5.0	6.0
Sponge Cake	Dominican Rep.	6.5	6.5	6.5	6.0	8.0	8.0	7.0	8.0	7.0	8.5	8.5
	Mean	**7.2**	**6.5**	**6.8**	**6.8**	**6.9**	**7.3**	**7.0**	**7.3**	**7.1**	**6.7**	**6.5**
Chiffon Cake	Philippines-1	7.0	4.0	7.5	4.0	5.0	5.5	5.5	6.5	3.0	6.0	6.0
Chiffon Cake	Philippines-2	7.0	7.0	6.0	6.0	6.0	6.0	6.5	6.0	6.0	6.5	6.5
Chiffon Cake	Philippines-3	7.0	5.6	6.5	6.0	5.0	5.0	5.8	6.4	5.0	5.9	6.7
	Mean	**7.0**	**5.5**	**6.7**	**5.3**	**5.3**	**5.5**	**5.9**	**6.3**	**4.7**	**6.1**	**6.4**
	Overall Mean	**6.9**	**6.5**	**6.9**	**6.4**	**6.5**	**6.3**	**6.7**	**6.6**	**6.4**	**6.9**	**6.3**

* 1 = Very poor/ 9 = Excellent; **Local flour.

Table 21. Overall Desirability Scores of 10 Soft Red Winter Wheat Flours for Making Cookies, Sponge Cakes and Chiffon Cakes*

Product	Cooperator	Control**	WB-196	USG 3120	USG 3201	USG 3895	LA 754	TV 8848	Charlie	USG 3251	USG 3404	USG 3833
Cookie	Indonesia-1	7.0	5.5	6.5	6.5	6.5	7.0	6.5	6.0	6.5	7.0	7.5
Cookie	Indonesia-2	7.0	5.3	6.3	5.3	7.3	3.8	7.2	3.8	7.3	6.3	6.6
Cookie	Malaysia	7.0	6.4	6.8	7.2	6.7	6.8	6.8	6.7	6.6	7.1	7.0
Cookie	Philippines-1	6.8	5.3	7.7	6.7	7.7	6.0	6.7	6.2	7.3	6.7	6.0
Cookie	Philippines-2	7.0	8.0	7.5	7.5	7.5	6.5	7.5	6.0	7.5	7.0	7.0
Cookie	Philippines-3	7.0	7.3	7.3	6.6	6.7	6.8	7.0	6.3	7.0	7.7	6.6
Cookie	Thailand	7.0	8.5	7.8	7.5	7.8	6.8	7.8	8.0	8.5	8.5	6.8
Cookie	Vietnam	5.0	7.9	7.5	7.7	6.5	6.0	7.0	5.5	8.5	8.0	5.2
	Mean	**6.7**	**6.8**	**7.2**	**6.9**	**7.1**	**6.2**	**7.0**	**6.1**	**7.4**	**7.3**	**6.6**
Sponge Cake	Indonesia-1	7.0	5.5	6.5	6.5	6.5	7.0	6.5	6.0	6.5	7.0	6.0
Sponge Cake	Indonesia-2	7.0	6.0	6.7	5.7	6.7	5.5	6.8	5.8	7.0	6.3	4.0
Sponge Cake	Malaysia	7.0	6.0	6.9	7.3	6.8	7.5	6.8	7.3	6.7	6.8	7.2
Sponge Cake	Thailand	7.0	4.5	5.3	5.5	5.0	6.0	5.0	6.0	6.7	6.0	4.0
Sponge Cake	Vietnam	7.0	6.2	5.4	5.7	5.0	6.0	5.5	5.8	5.3	5.6	6.5
Sponge Cake	Dominican Rep.	7.0	6.5	8.0	4.5	7.5	4.5	7.0	4.0	5.0	7.5	7.0
	Mean	**7.0**	**5.8**	**6.5**	**5.9**	**6.2**	**6.1**	**6.3**	**5.8**	**6.2**	**6.5**	**5.8**
Chiffon Cake	Philippines-1	7.5	5.8	7.0	5.8	6.2	6.3	6.3	6.5	5.5	6.0	6.0
Chiffon Cake	Philippines-2	7.0	6.0	6.0	6.0	7.0		7.5	6.0	7.5	6.0	6.0
Chiffon Cake	Philippines-3	7.0	5.5	5.9	5.2	5.6	5.3	5.8	5.5	5.6	5.5	6.0
	Mean	**7.2**	**5.8**	**6.3**	**5.7**	**6.2**	**5.8**	**6.5**	**6.0**	**6.2**	**5.8**	**6.0**
	Overall Mean	**7.0**	**6.1**	**6.6**	**6.1**	**6.5**	**6.0**	**6.6**	**6.0**	**6.6**	**6.6**	**6.1**

* 1 = Very poor/ 9 = Excellent; **Local flour

REGIONAL AND STATE PERFORMANCE NURSERIES – 2016 CROP

QUALITY CHARACTERISTICS OF REGIONAL NURSERY ENTRIES

2016 Crop Evaluations

Each year, wheat breeders submit elite breeding materials to cooperative yield trials known as regional nurseries, which are then grown throughout the target production region. Grain samples from these nurseries are evaluated each year for end-use quality by the SWQL, and this information is provided to breeders in the regional nursery reports, as well as being posted on the SWQL website, **http://www.ars.usda.gov/Main/docs.htm?docid=3032**.

Narratives describing recent quality evaluations of these uniform performance testing nurseries and data summary tables are provided below. The goal of this project is to provide consistent and complete information on the milling and baking performances of advanced breeding lines and varieties.

General Comments on Evaluation Parameters

Flour Yield

Of the characteristics of quality we measure at the Soft Wheat Quality Laboratory, flour yield is one, and perhaps the most important, of the highly reproducible quality traits, since it is directly related to economic return for the flour millers. Flour yield is determined by an experimental milling test using the modified Quadrumat Senior milling system.

Softness Equivalence

Softness equivalence (SE) has high heritability and is an important predictor of flour particle size, grain hardness and damaged starch content. Larger values are preferred for most soft wheat products, particularly cakes and other high-sugar baked products. SE is the percentage of break flour weight over total flour weight.

Solvent Retention Capacity (SRC)

Sucrose SRC is largely influenced by pentosan (arabinoxylan) content. Lactic acid SRC is associated with gluten protein characteristics, and sodium carbonate SRC is related to damaged starch. Water SRC is influenced by all water absorbing components in flour. The combined pattern of these flour SRC results establishes a practical flour quality and functionality profile that is useful in predicting baking performance.

Lactic acid SRC estimates gluten protein strength and correlates to flour protein content. High sodium carbonate SRC absorption indicates increased damaged starch content during milling. Lower sodium carbonate and water SRC values are desired for cookies, cakes and crackers.

REGIONAL COLLABORATING NURSERIES AND COORDINATORS

GULF ATLANTIC WHEAT NURSERY	*Carl Griffey, Virginia Polytechnic Institute and State University*
MASON-DIXON REGIONAL NURSERY	*Carl Griffey, Virginia Polytechnic Institute and State University*
NORTHERN UNIFORM WINTER WHEAT SCAB NURSERY	*Carl Griffey, Virginia Polytechnic Institute and State University*
PRELIMINARY NORTHERN UNIFORM WINTER WHEAT SCAB NURSERY	*Carl Griffey, Virginia Polytechnic Institute and State University*
SOUTHERN UNIFORM WINTER WHEAT SCAB NURSERY	*Carl Griffey, Virginia Polytechnic Institute and State University*
UNIFORM EASTERN SOFT RED WINTER WHEAT NURSERY	*Eric Olson, Michigan State University*
UNIFORM EASTERN SOFT WHITE WINTER WHEAT NURSERY	*Mark Sorrells, Cornell University*
UNIFORM SOUTHERN SOFT RED WINTER WHEAT NURSERY	*Esten Mason, University of Arkansas*

GULF ATLANTIC WHEAT NURSERY

Carl Griffey, Virginia Polytechnic Institute and State University

Forty-five breeding lines and varieties were analyzed for test weight, grain protein content, hardness, kernel weight, kernel size, flour yield, SE, flour protein content, sodium carbonate SRC, lactic acid SRC and sugar-snap cookie baking quality. Letter grades (A, B, C, D or F) for flour yield were assigned to each entry based on the flour yield range of wheat breeding lines and varieties the SWQL tested in 2009-2015. Those entries that fell in the top 15% range of lines and varieties for flour yield received an 'A', the next 20% a 'B', the next 30% a 'C', the next 20% a 'D', and the bottom 15% an 'F'.

Overall, the entries are characterized by their generally higher flour protein contents and lactic acid SRC values, and lower softness equivalence values, compared to typical SRW wheat, thus producing smaller sugar-snap cookies.

Nine out of 45 entries exhibited kernel hardness values greater than 25. LA08218C-57 showed a kernel hardness score (57.9) similar to hard wheat. High kernel hardness tends to lower softness equivalence and increase sodium carbonate SRC. Two entries, DH11SRW070-14 and LA08218C-57, exhibited flour yields of 72.0 and 73.5%, respectively, thus receiving an "A" grade for flour yield.

Table 22. Gulf Atlantic Wheat Nursery wheat variety trial 2016 crop quality data

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Cookie Diameter (cm)	Top Grade (0-9)	Flour Yield % Grade
LA06146E-P4	58.4	11.3	25.6	3.0	39.9	65.3	49.1	9.5	122.4	75.5	16.7	2	F
TX13D5137	57.7	11.2	13.9	2.9	35.5	65.5	54.7	9.7	141.1	74.8	17.2	2	F
TX13D5161	60.5	11.1	20.0	3.0	42.0	69.0	54.0	9.0	98.9	73.5	17.2	3	C
TX13D5169	59.2	11.0	18.2	2.9	39.7	68.4	55.0	9.3	118.0	71.0	17.7	3	C
TX13D5217	58.3	10.9	9.2	2.8	32.1	69.8	55.1	9.1	132.8	64.0	18.2	3	B
TX13D5234	60.1	10.7	9.5	2.9	36.9	68.4	58.3	8.9	125.0	68.8	18.4	4	C
TX13D5237	58.8	10.5	12.6	2.8	32.8	67.7	61.9	8.6	124.7	72.4	17.8	2	D
LA08095C-37	62.3	11.8	14.1	3.0	39.8	69.1	53.8	9.5	135.1	67.9	17.7	3	C
LA08218C-57	61.0	10.5	57.9	3.0	39.9	73.5	40.2	9.7	101.7	80.7	16.1	1	A
LA08265C-50	60.5	10.7	18.1	2.9	37.0	68.2	54.9	8.9	134.7	67.1	17.5	3	D
LA09225C-33	60.2	10.6	6.7	2.9	40.2	70.2	55.4	8.9	117.0	66.4	17.9	3	B
LA09264C-P2	59.6	11.9	16.3	3.0	45.4	65.7	50.2	10.2	142.6	76.3	16.8	2	F
LA09264C-P5	59.6	11.7	18.4	2.9	37.2	68.0	50.9	9.9	116.3	70.8	17.8	2	D
SS8641	59.7	11.0	25.0	2.8	34.7	67.4	51.6	9.7	133.5	68.0	17.4	2	D
GA061096-14E3	60.6	10.8	17.6	3.0	42.6	67.1	51.5	9.3	121.1	69.6	17.3	2	D
GA07192-14E9	61.0	10.6	17.4	2.8	37.5	68.5	56.1	9.0	129.9	71.9	17.7	2	C
GA061158-14LE11	59.3	12.3	26.2	2.9	35.2	66.9	47.8	10.6	146.5	71.4	16.9	2	D
GA07169-14LE24	58.6	9.9	25.3	2.9	37.9	69.8	52.6	8.7	129.2	73.3	17.3	3	B
GA061086-14LE23	61.0	12.4	21.2	2.9	37.4	67.3	55.3	10.3	127.6	73.2	17.1	2	D
GA06112-13EE16	61.6	11.7	14.3	3.1	45.6	68.8	47.7	10.0	109.3	70.6	17.6	2	C
AR06017-6-2	57.8	10.7	14.0	2.7	29.9	69.8	58.1	8.4	102.6	67.2	18.1	3	B
AR06037-17-2	59.2	10.2	18.7	2.6	30.4	68.1	55.8	8.3	116.0	68.8	17.8	3	D
AR06046-10-3	57.5	10.5	8.9	2.7	34.2	67.2	56.7	8.7	95.9	69.8	17.9	3	D
AR06050-7-2	58.7	10.5	22.0	2.7	34.1	64.7	54.3	9.2	111.9	73.3	17.7	2	F
Pioneer 26R41	57.0	9.9	12.4	2.7	34.1	69.0	62.7	8.3	115.5	70.5	18.1	3	C
NC13-20539	60.6	11.1	28.7	2.8	35.7	70.2	52.1	9.4	108.0	71.0	17.3	3	B
NC13-20332	59.5	11.2	21.6	2.8	34.3	67.4	55.0	9.2	105.5	67.8	17.7	3	D
NC13-22649	58.6	10.6	22.4	2.7	32.4	66.8	53.1	9.1	116.3	71.2	17.4	3	F
NC13-20278	58.9	10.5	17.0	2.8	33.2	68.5	56.3	9.0	110.0	69.7	17.8	3	C
NC10034-50	59.6	10.8	11.9	2.8	37.9	68.5	56.6	8.6	126.7	73.4	17.6	2	C
NC13-21987	60.9	10.9	30.2	2.7	31.9	67.6	54.6	8.9	131.0	73.3	17.3	2	D
NC13-23443	60.2	10.8	15.6	2.7	30.8	70.0	58.0	9.1	117.3	66.5	18.1	2	B
NC13-21213	59.6	10.9	29.9	2.7	31.3	65.9	55.0	8.8	128.1	77.0	17.0	2	F
NC10034-47	58.1	10.7	13.2	2.7	30.7	67.4	59.4	8.9	115.4	70.7	17.9	2	D
Hilliard	59.5	10.4	15.6	2.8	34.6	67.4	60.2	8.5	120.8	70.4	17.7	3	D

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Cookie Diameter (cm)	Top Grade (0-9)	Flour Yield % Grade
VA14W-29	60.4	9.5	18.7	2.7	33.0	66.7	58.4	7.9	122.2	73.4	18.0	3	F
DH11SRW070-14	59.2	10.0	8.2	2.9	35.0	72.0	55.8	8.1	96.0	64.8	17.8	3	A
DH11SRW070-28	58.8	10.7	11.0	3.0	38.8	70.3	56.7	8.6	95.7	70.6	18.1	3	B
VA07MAS3-7304-3-1-2-3	59.8	9.7	17.6	2.9	37.5	70.3	52.6	8.5	108.1	70.4	17.7	4	B
VA07MAS3-7304-3-2-4-3	58.5	10.4	13.3	2.8	36.2	69.6	55.2	8.5	111.8	70.4	18.2	3	C
VA09MAS1-12-8-4	61.0	9.9	22.5	2.8	34.9	69.5	56.3	8.3	105.3	68.4	18.2	4	C
VA09MAS6-122-7-1	59.6	10.8	10.7	2.8	35.8	69.5	57.8	8.8	111.9	66.1	18.3	4	C
VA09MAS7-61-2-1	59.7	9.6	27.4	2.8	34.6	70.2	51.6	8.4	100.5	74.0	17.3	3	B
VA14FHB-28	60.8	10.0	16.0	2.9	41.9	70.4	55.4	8.5	105.0	74.1	17.2	3	B
VA08MAS1-188-6-4-1	59.2	11.7	7.9	2.7	33.5	67.4	53.2	9.4	105.2	72.5	17.7	2	D
Average	59.6	10.8	18.3	2.8	36.1	68.4	54.6	9.0	117.6	70.9	17.6	2.6	
Std Dev	1.1	0.7	8.6	0.1	3.8	1.8	3.9	0.6	13.1	3.3	0.5	0.7	

MASON-DIXON REGIONAL NURSERY

Carl Griffey, Virginia Polytechnic Institute and State University

Seventy-one advanced breeding lines and varieties of SRW wheat were analyzed for test weight, NIR grain protein content, kernel hardness, kernel weight, kernel size, flour yield, softness equivalence, flour protein content, sodium carbonate SRC, lactic acid SRC and sugar-snap cookie baking quality. Letter grades (A, B, C, D or F) for flour yield were assigned to each entry based on the flour yield range of wheat breeding lines and varieties the SWQL tested in 2009-2015. Those entries that fell in the top 15% range of lines and varieties for flour yield received an 'A', the next 20% a 'B', the next 30% a 'C', the next 20% a 'D', and the bottom 15% an 'F'.

The entries exhibited relatively small variations in test weight, grain protein content and flour yield with standard deviations of 1.4, 0.7 and 1.7, respectively. The entries exhibited evident differences in kernel hardness, sodium carbonate SRC and lactic acid SRC values, which ranged from 2.2 to 32.1, 63.7 to 83.8% and 82.7 to 137.8%, respectively. The flour yields of the entries were generally lower than that of the typical eastern soft wheat, with an average of 67.1%. Only two entries out of 71 exhibited flour yield greater than 70%.

Table 23. Mason-Dixon Regional Nursery wheat variety trial 2016 crop quality data

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Cookie Diameter (cm)	Top Grade (0-9)	Flour Yield % Grade
SHIRLEY	57.5	10.9	4.7	2.7	36.3	68.7	57.9	8.5	88.2	67.9	18.8	4	C
HILLIARD	60.5	10.8	13.4	2.7	35.0	67.3	59.9	8.4	116.2	69.8	18.5	2	D
BESS	58.7	10.6	13.1	2.6	31.6	66.7	57.0	8.6	97.6	68.2	18.3	5	F
Pioneer 26R10	57.8	10.3	9.1	2.8	38.2	68.7	66.0	8.4	100.0	70.6	18.7	2	C
VA12W-101	57.5	10.8	9.7	2.6	27.8	68.0	60.4	8.7	115.5	65.4	18.7	5	D
VA13W-174	58.7	10.4	22.7	2.8	33.4	66.2	54.1	8.4	111.0	74.4	17.5	3	F
07MAS4-7416-5-4-2	58.6	10.5	18.6	2.8	33.1	67.9	56.3	8.6	117.7	70.0	18.1	2	D
VA13FHB-26	59.1	11.7	20.5	2.8	34.4	67.2	56.0	9.5	121.3	70.0	17.6	1	D
VA14W-6	58.6	11.9	16.5	2.9	36.7	67.5	51.8	9.4	101.4	69.4	18.4	4	D
VA14W-29	60.3	9.8	18.4	2.7	33.4	66.1	59.2	7.8	121.2	75.3	18.4	1	F
VA14W-59	59.0	9.6	14.0	2.7	32.2	68.1	63.3	7.6	110.0	68.9	18.1	6	D
DH11SRW070-14	59.0	10.7	7.5	2.9	35.4	71.0	55.8	8.6	94.9	65.0	18.4	4	A
DH11SRW070-28	58.1	10.5	10.1	3.0	39.6	69.9	57.8	7.9	91.9	72.2	18.4	2	B
VA07MAS3-7304-3-1-2-3	60.0	10.5	16.4	2.9	39.9	70.1	52.8	8.5	109.3	70.0	17.7	6	B
VA07MAS3-7304-3-2-4-3	58.1	10.8	12.9	2.8	36.6	68.7	56.2	8.7	110.3	70.5	17.8	6	C
VA07MAS4-7463-6-2-2-2	58.5	10.5	8.5	2.8	37.0	67.2	58.4	8.2	91.6	71.6	18.2	3	D
VA07MAS4-7463-6-2-2-4	58.3	10.8	10.8	2.8	37.0	67.5	57.5	8.2	94.2	72.1	17.8	3	D
VA09MAS1-12-8-4	60.9	10.6	24.0	2.8	37.6	68.9	54.9	8.7	106.7	68.8	18.5	5	C
VA09MAS6-122-7-1	59.1	10.7	9.1	2.8	36.5	68.9	58.9	8.4	113.4	66.1	18.7	6	C
VA09MAS7-61-2-1	59.0	10.0	25.2	2.8	36.3	69.5	52.3	8.4	103.9	75.5	17.4	6	C
VA14FHB-14	60.9	11.4	7.9	2.8	34.4	67.9	59.1	9.0	123.9	73.0	17.8	2	D
VA14FHB-28	60.5	10.8	15.5	3.0	43.5	69.1	54.8	8.7	106.7	75.2	17.5	2	C
VA08MAS1-188-6-4-1	59.1	12.4	6.5	2.7	35.2	66.7	52.9	9.6	104.6	73.1	17.5	1	F
VA11W-108PA	59.6	11.1	16.0	2.7	34.8	66.8	58.4	8.9	119.1	70.6	17.9	2	F
ARS11-0229	59.9	11.4	12.7	2.9	38.4	67.3	61.2	9.0	89.9	70.8	18.4	1	D
ARS12-024	56.9	9.8	19.9	2.7	29.6	64.5	60.8	8.0	101.5	72.8	17.9	1	F
ARS12-026	57.1	10.3	18.0	2.7	29.4	63.4	58.9	8.3	109.3	71.6	17.6	1	F
ARS12-093	60.3	12.2	18.0	2.9	38.4	66.4	58.1	10.0	98.9	72.3	18.3	1	F
ARS12-105	56.8	12.3	6.1	2.7	29.2	66.1	56.5	9.8	137.8	72.8	17.9	4	F
ARS12-201	60.7	12.7	14.7	2.9	36.5	69.7	53.8	10.2	102.1	63.7	17.9	2	B
ARS13-053	57.8	12.2	25.2	2.8	32.1	64.3	52.0	10.0	124.3	72.2	17.5	0	F
ARS13-232	54.7	11.5	20.3	2.7	32.5	64.6	53.6	9.3	115.9	71.9	17.6	2	F
ARS13-233	54.7	10.9	21.1	2.7	31.5	64.8	55.4	9.1	119.9	71.3	17.7	3	F
ARS13-258	61.0	11.1	9.2	2.7	34.9	67.1	59.8	9.1	100.6	71.8	18.2	5	D
ARS13-262	59.2	11.1	13.1	2.7	36.1	66.7	58.3	8.8	122.8	71.2	17.9	3	F
ARS13-471	56.7	11.8	14.2	2.8	34.1	65.0	56.0	9.3	108.7	68.0	17.8	2	F
KY09C-1024-96-1-3	56.8	11.0	19.1	2.8	33.3	66.7	57.3	8.9	86.8	66.5	18.6	5	F

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Cookie Diameter (cm)	Top Grade (0-9)	Flour Yield % Grade
KY09C-0601-39-8-1	61.9	12.8	22.8	2.8	35.4	69.1	50.2	10.3	87.8	63.8	18.4	3	C
KY09C-0128-72-2-1	59.4	11.8	24.4	2.8	34.2	69.5	52.9	9.6	86.4	65.6	18.3	2	C
X08C-1232-30-6-3	61.1	11.1	26.7	2.8	35.2	68.9	55.3	9.2	96.4	69.8	18.2	3	C
X08C-1108-20-4-5	57.9	10.4	10.6	2.8	35.7	67.0	61.6	8.6	104.2	70.0	17.9	3	D
KY09C-1021-36-20-3	57.9	10.4	17.4	2.7	31.1	65.8	59.2	8.0	85.6	64.6	18.9	6	F
KY09C-1021-35-17-3	58.0	10.5	8.5	2.8	34.6	68.7	63.3	8.3	112.8	65.6	19.1	5	C
X08C-1299-43-4-3	60.5	11.4	22.3	2.9	40.3	66.6	53.6	9.6	124.9	70.5	17.4	3	F
KY07C-1285-109-8-3	57.4	10.6	5.6	2.8	38.8	67.4	58.9	8.9	97.6	69.0	18.0	1	D
KY09C-2023-99-1-1	59.8	10.5	19.1	2.8	35.6	66.0	59.4	8.5	112.5	77.9	17.1	2	F
X08C-1077-11-18-3	58.3	11.9	24.3	2.8	35.3	64.4	52.8	9.4	93.6	76.4	17.4	3	F
X09-0503-99-11-3	59.6	11.0	18.3	2.7	31.8	66.2	59.5	9.4	112.3	71.5	17.8	2	F
X10-0225-28-10-3	59.0	10.6	18.8	2.8	35.1	68.7	55.2	9.0	91.5	70.1	18.3	3	C
X08C-1070-75-20-1	57.0	12.0	23.3	2.8	33.6	65.4	51.2	9.5	117.9	67.8	18.0	3	F
KY07C-1145-94-12-5	60.5	9.8	2.2	2.6	30.4	67.6	64.5	8.0	89.4	69.3	18.5	4	D
KY09C-0128-71-18-1	58.2	10.5	20.5	2.8	36.1	68.0	52.4	8.6	128.0	71.7	17.4	5	D
KY09C-1021-36-15-5	56.9	10.8	13.6	2.8	34.4	66.8	57.6	8.7	96.4	65.8	18.8	6	F
X10-0196-25-6-3	59.4	11.3	17.1	2.9	36.8	67.2	57.9	9.3	103.7	72.2	18.4	5	D
KY09C-1021-37-2-3	57.5	10.0	15.0	2.7	30.2	66.5	63.3	8.1	95.4	68.1	18.6	5	F
X10-0040-1-7-1	58.0	11.1	11.4	2.7	29.6	66.3	57.2	8.9	84.9	66.7	18.9	5	F
MD08W48-14-1	59.8	10.9	17.3	2.7	28.8	67.9	56.6	8.8	110.5	66.6	18.4	2	D
MD272-6-14-2	60.4	12.2	13.6	2.8	34.5	67.2	54.3	9.8	107.8	70.6	18.0	1	D
MD07W494-14-1	59.6	11.7	25.7	2.8	35.7	66.7	52.9	9.8	124.8	73.5	17.1	2	F
MD07W481-14-1	60.6	11.2	28.9	2.6	28.4	65.4	52.8	9.2	82.7	68.9	18.0	3	F
MD07W481-14-2	59.5	11.0	22.8	2.7	32.1	65.6	54.9	8.8	111.4	77.0	16.9	2	F
MD07W478-14-1	58.4	10.4	17.3	2.9	35.6	67.5	51.5	8.8	95.8	74.6	17.3	6	D
MD07W478-14-2	60.0	11.7	11.6	2.8	33.6	67.1	54.7	9.5	104.4	75.8	17.0	1	D
MD07W478-14-3	58.6	11.2	19.2	2.9	34.7	69.4	56.8	9.0	107.2	72.1	17.4	1	C
MD07W478-14-4	59.9	10.6	20.2	2.9	34.4	67.0	55.9	8.6	105.5	77.3	17.0	1	D
MD07W478-14-6	58.3	10.8	14.1	2.8	33.8	68.4	56.1	8.7	112.1	73.0	17.2	2	C
MD83-18-2-14-1	59.1	11.7	7.1	2.7	33.4	63.9	57.8	9.4	127.9	82.5	17.0	0	F
MD83-18-2-14-5	59.3	10.7	5.7	2.7	32.9	64.9	61.8	8.7	125.2	81.9	17.9	0	F
MD83-18-2-14-6	58.8	11.1	8.4	2.7	33.3	63.6	59.4	9.0	126.3	83.8	16.9	0	F
MD272-8-4-14-2	58.0	12.7	14.9	2.7	33.6	64.9	57.7	10.1	111.8	75.6	17.6	1	F
MD272-8-4-14-4	60.7	12.1	32.1	2.6	28.8	64.7	50.6	9.7	84.1	69.8	18.2	2	F
Average	58.9	11.0	15.8	2.8	34.4	67.1	56.8	8.9	106.3	71.1	18.0	2.9	
Std Dev	1.4	0.7	6.5	0.1	3.1	1.7	3.5	0.6	13.0	4.1	0.5	1.8	

NORTHERN UNIFORM WINTER WHEAT SCAB NURSERY

Carl Griffey, Virginia Polytechnic Institute and State University

A total of 566 entries were analyzed for test weight, grain protein content, kernel hardness, kernel weight, kernel size, flour yield, softness equivalence (SE), flour protein content, sodium carbonate SRC and lactic acid SRC. Letter grades (A, B, C, D or F) for flour yield were assigned to each entry based on the flour yield range of wheat breeding lines and varieties the SWQL tested in 2009-2015. Those entries that fell in the top 15% range of lines and varieties for flour yield received an 'A', the next 20% a 'B', the next 30% a 'C', the next 20% a 'D', and the bottom 15% an 'F'.

OH10-219-65, ES14-0937 and NI12702W exhibited visual signs of sprouting damage. The kernel hardness values of eight entries were higher than 30.1, with five of them showing kernel hardness in the range of hard wheat (50.9 to 79.0). Overall, the entries exhibited relatively lower flour yields than typical soft red winter wheat. Flour yields of the entries ranged from 62.9 to 72.6%, with only four entries showing yields higher than 70.0%. There were 12 entries showing lactic acid SRC values greater than 120, despite having flour protein contents lower than 8.9%, indicating the presence of relatively strong gluten protein.

Table 24. Northern Uniform Winter Wheat Scab Nursery wheat variety trial 2016 crop quality data

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Adjusted Flour Yield % Grade
TRUMAN	59.2	10.2	14.7	2.6	33.4	66.0	56.7	8.2	100.2	67.6	F
FREEDOM	57.1	10.8	17.0	2.7	32.4	66.3	55.6	8.3	93.4	66.2	F
ERNIE	57.8	11.1	7.4	2.9	37.2	65.8	54.8	8.6	115.9	69.5	F
PIONEER 2545											
OH10-219-65	58.7	10.6	9.9	2.7	33.3	66.3	58.2	8.3	100.0	68.3	F
OH09-207-68	58.5	9.7	7.1	2.8	36.4	68.8	58.3	7.9	110.2	71.4	C
OH08-206-69	61.5	11.1	13.7	2.9	37.4	69.8	53.2	9.3	113.3	65.7	B
OH11-118-18	61.8	10.6	30.5	2.7	33.6	65.5	52.8	8.9	110.2	70.0	F
KWS060	58.1	9.4	5.1	2.8	34.9	68.6	61.7	7.5	107.5	67.0	C
KWS072	60.6	10.7	22.3	3.0	41.5	65.8	49.9	8.6	124.9	79.8	F
KWS074	58.5	9.7	8.7	2.7	30.7	65.2	61.9	7.8	118.9	71.5	F
KWS078	59.5	10.9	10.9	2.9	37.7	69.1	57.1	8.5	124.2	68.5	C
JAMESTOWN	60.2	11.1	15.4	2.9	36.3	65.5	52.8	8.6	126.3	77.2	F
KY09C-0052-26-12-3	60.7	9.8	18.5	2.8	34.7	70.0	59.4	8.0	113.3	68.6	B
X08C-1070-73-18-1	59.3	11.4	30.1	2.9	36.9	65.8	46.3	9.2	120.8	69.1	F
X09-0187-112-14-1	60.6	10.3	15.2	3.0	40.9	68.0	56.2	8.5	138.0	66.6	D
KY09C-1024-96-1-3	57.6	10.3	18.3	2.8	34.1	66.3	56.3	8.4	96.1	66.5	F
KY09C-0601-39-8-1	61.6	11.3	19.2	2.8	36.1	68.9	51.4	9.0	103.1	63.8	C
NY05158-833	57.7	10.8	13.8	2.8	32.0	64.7	60.3	8.5	86.7	66.8	F
NY05158-864	58.2	10.9	13.4	2.8	33.5	65.0	59.0	8.4	88.7	67.4	F
NY05158-841	57.7	10.7	13.2	2.8	33.1	64.3	59.9	8.4	82.7	66.9	F
NY05158-859	58.1	11.0	14.1	2.8	33.7	64.7	59.1	8.5	89.3	67.6	F
NY99069-352	57.4	9.7	10.6	2.7	31.7	67.9	58.0	7.8	88.5	64.2	D
TRIBUTE	61.9	10.8	29.1	2.8	35.2	66.9	53.1	8.9	124.3	73.6	D
VA14W-6	58.2	11.3	17.8	2.9	36.3	66.0	51.6	8.9	101.1	69.6	F
VA10W-21BSR124	59.0	9.2	45.6	2.8	34.1	70.5	49.7	7.4	119.5	80.4	B
VA14FHB-22	60.5	10.4	23.6	2.8	35.5	67.2	56.7	8.4	116.1	73.0	D
VA14FHB-31	60.0	10.7	18.0	2.9	36.7	65.5	53.7	8.1	125.8	76.8	F
MI14R0233	58.2	12.2	15.2	2.8	33.9	65.8	53.5	9.7	117.5	66.7	F
MI14R0082	58.7	11.6	29.2	2.8	32.2	62.9	51.5	9.5	80.5	72.7	F
MI14W0217	58.9	10.3	12.1	2.7	34.2	66.5	58.1	8.4	104.5	68.0	F
MI14R0080	58.3	10.1	9.8	2.7	29.9	65.7	60.4	8.0	110.9	68.0	F
MI14R0109	59.3	10.4	14.0	2.8	31.0	64.3	57.4	8.2	95.9	70.2	F

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Adjusted Flour Yield % Grade
PIONEER 26R10	58.0	10.3	9.5	2.8	37.1	67.4	65.0	8.1	106.7	71.7	D
0762A1-2-8	57.3	9.6	12.7	2.9	36.1	66.2	57.3	8.1	100.7	68.6	F
05247A1-7-3-108-2	59.3	10.9	24.5	2.8	34.2	65.9	55.4	8.9	112.7	73.3	F
0566A1-3-1-52	56.5	10.7	20.2	2.8	32.0	64.5	58.6	8.8	113.1	73.3	F
05247A1-7-3-120	59.2	10.7	20.3	2.7	33.0	66.3	55.9	8.5	104.8	74.5	F
04620A1-1-7-4-17	58.4	10.9	20.5	2.8	34.7	63.2	54.9	8.3	100.5	73.4	F
ES14-0937	58.8	10.3	5.8	2.7	33.8	66.0	59.2	8.6	123.5	67.6	F
ES14-1398	59.2	10.2	19.8	2.8	35.6	66.5	51.8	8.2	127.9	71.4	F
ES14-1860	60.4	10.8	18.2	2.7	31.3	67.4	57.2	9.0	124.4	68.8	D
ES14-1847	58.6	10.2	9.5	2.8	33.6	65.2	60.6	8.5	83.0	70.2	F
BRANSON	58.4	10.4	7.9	2.7	34.3	67.4	59.5	8.4	122.0	68.6	D
IL10-21934	59.2	9.6	12.3	2.8	36.5	66.1	52.4	8.2	121.2	69.3	F
IL10-21937	59.1	9.7	18.8	2.9	37.3	64.8	48.8	8.4	121.6	72.5	F
IL11-6543	61.3	10.4	10.8	2.8	34.0	66.2	56.9	8.8	116.5	65.7	F
IL11-28222	60.0	10.2	23.2	2.7	28.1	66.9	56.7	8.2	110.8	68.0	D
IL12-5110	59.8	10.5	7.4	2.7	31.4	66.5	57.8	8.8	118.1	64.0	F
NE13625	60.1	10.1	53.8	2.8	34.6	70.6	47.6	9.3	124.7	70.5	B
NE13515	60.0	11.5	62.1	2.7	32.4	68.8	45.1	10.4	130.5	82.1	C
NE05548	58.3	11.6	50.9	2.7	32.6	72.6	47.6	10.3	122.5	70.6	A
NE13604	59.7	11.3	69.4	2.9	36.2	68.3	40.4	9.9	122.1	80.1	C
NI12702W	62.1	11.5	79.0	2.8	35.4	65.4	33.1	10.1	125.3	92.9	F
HILLIARD	59.5	10.1	12.9	2.7	34.7	67.5	60.3	8.1	124.3	73.0	D
SHIRLEY	57.4	10.2	3.9	2.7	35.8	68.2	58.6	7.9	93.3	70.3	D
Average	59.2	10.5	20.7	2.8	34.5	66.7	55.0	8.6	111.3	70.9	
Std Dev	1.3	0.6	15.9	0.1	2.5	1.9	5.6	0.6	14.1	5.1	F

PRELIMINARY NORTHERN UNIFORM WINTER WHEAT SCAB NURSERY

Carl Griffey, Virginia Polytechnic Institute and State University

Forty-five advanced breeding lines and varieties were analyzed for test weight, grain protein content, SKCS hardness, kernel weight, kernel size, flour yield, softness equivalence, flour protein content, sodium carbonate SRC and lactic acid SRC. Letter grades (A, B, C, D or F) for flour yield were assigned to each entry based on the flour yield range of wheat breeding lines and varieties the SWQL tested in 2009-2015. Those entries that fell in the top 15% range of lines and varieties for flour yield received an 'A', the next 20% a 'B', the next 30% a 'C', the next 20% a 'D', and the bottom 15% an 'F'.

Jamestown and MI14W0604 exhibited visual signs of pre-harvest sprouting. The majority of breeding lines exhibited lower test weights and flour yields compared to typical SRW wheat. The test weights and flour yields of 45 entries ranged from 55.2 to 61.5 lb/bu and 63.0 to 71.1%, respectively. KWS083 exhibited the highest SKCS kernel hardness value of 30.0, the lowest flour yield of 63.0% and the second highest sodium carbonate SRC of 76.9%. The average lactic acid SRC value of 45 entries was 109.5%, and eight entries exhibited lactic acid SRC values greater than 125.2%, indicating the presence of strong gluten protein.

Table 25. Preliminary Northern Uniform Winter Wheat Nursery wheat variety trial 2016 crop quality data

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Adjusted Flour Yield % Grade
TRUMAN	58.3	9.6	10.7	2.5	31.8	65.9	58.4	7.7	103.1	68.5	F
FREEDOM	56.7	10.3	13.1	2.7	31.0	66.4	57.7	8.0	92.7	66.5	F
ERNIE	57.8	10.5	3.2	2.9	36.7	66.2	56.5	8.4	114.7	70.2	F
PIONEER2545	58.0	10.0	5.6	2.8	37.8	67.7	65.7	8.0	107.4	71.9	D
OH10-316-20	58.5	9.8	18.6	2.8	36.7	67.0	57.4	7.9	120.1	72.6	D
OH12-263-1	58.5	10.3	10.7	2.6	30.5	64.6	56.4	8.4	102.5	67.3	F
OH12-195-22	57.0	10.0	9.3	2.7	32.5	64.1	59.3	8.5	96.9	76.1	F
OH12-223-12	60.6	10.9	5.2	2.8	36.5	70.7	58.3	8.7	126.4	65.9	B
OH12-319-13	58.1	10.3	17.7	2.8	36.8	66.8	53.8	8.3	103.9	68.8	F
OH12-140-13	57.4	10.2	9.3	2.7	33.7	67.0	56.3	8.1	91.8	69.4	D
JAMESTOWN	59.9	10.7	16.9	2.8	35.2	65.2	53.7	8.4	129.8	77.2	F
KWS081	56.8	9.8	6.7	2.5	31.0	66.4	60.9	7.9	112.8	69.5	F
KWS083	60.9	10.9	30.0	2.7	33.6	63.0	55.2	9.0	115.1	76.9	F
KWS085	58.4	9.8	25.4	2.7	31.9	64.6	58.5	7.5	106.5	71.9	F
KWS087	57.5	10.2	6.8	2.8	37.4	67.6	57.2	8.2	93.8	70.2	D
KWS086	57.6	10.2	2.6	2.9	38.5	69.2	60.4	8.0	107.1	65.9	C
KY09C-0128-72-2-1	59.3	10.4	20.8	2.8	33.2	69.0	52.3	8.7	90.6	66.1	C
X08C-1232-30-6-3	61.5	10.6	25.6	2.8	35.6	68.6	53.1	8.9	102.9	70.1	C
X08C-1108-20-4-5	57.9	9.9	8.8	2.8	35.0	66.6	60.5	8.3	112.8	71.0	F
KY09C-1021-36-20-3	58.2	10.0	14.5	2.7	31.5	65.9	58.2	7.8	89.3	65.1	F
KY09C-1024-97-9-5	57.1	10.1	12.5	2.8	31.9	65.6	58.4	8.1	106.2	71.0	F
TRIBUTE	60.9	10.3	26.2	2.8	35.0	67.2	54.4	8.4	125.4	75.3	D
VA14W-41	59.9	10.5	17.5	2.9	36.2	67.7	53.8	8.5	125.9	72.8	D
DH11SRW063-14	60.2	10.1	15.4	2.8	39.4	71.1	56.0	8.2	132.1	69.0	A
VA15FHB-11	61.2	9.8	15.1	2.7	34.6	68.4	57.7	8.3	113.3	71.3	C
VAMD10422-98	60.8	10.9	17.3	2.7	33.3	67.3	57.8	9.1	120.7	71.5	D
13VA-FHB-DH131	60.6	11.2	18.5	2.9	38.2	67.7	51.3	9.2	113.7	69.4	D
13VA-FHB-DH192	59.8	11.4	13.5	2.8	37.3	68.4	56.4	9.4	127.0	69.5	C
MI14R0180	60.6	10.7	18.0	2.8	33.8	65.0	55.3	8.6	115.4	70.9	F
MI14R0235	58.8	12.2	17.0	2.8	34.0	65.6	51.9	9.7	122.3	68.9	F
MI14W0447	55.6	10.1	19.8	2.7	34.1	66.0	57.2	8.5	102.0	70.5	F
MI14W0604	56.5	11.1	3.9	2.7	36.1	66.5	58.0	8.9	79.5	66.3	F
MI14R0112	59.0	11.0	8.6	2.8	37.2	65.9	57.3	9.1	111.1	71.0	F
MI14W0464	55.2	9.7	6.0	2.6	34.0	70.2	62.2	7.8	78.7	65.6	B

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Adjusted Flour Yield % Grade
PIONEER 26R10	57.9	9.8	8.4	2.8	38.8	67.1	64.2	8.2	106.6	72.9	D
0527A1-9-14-4-3-1-1	59.6	10.5	18.7	2.8	35.4	65.3	57.2	8.3	99.4	71.1	F
0566A1-3-1-6	57.5	10.7	19.6	2.7	32.3	64.7	58.7	9.0	114.4	70.3	F
05247A1-7-3-120	59.0	11.3	19.7	2.7	32.9	65.7	56.0	8.8	106.4	75.9	F
0566A1-3-1-51	57.3	11.0	23.8	2.8	33.7	64.1	57.3	9.0	119.4	75.0	F
05247A1-7-3-114	58.7	11.4	27.1	2.7	33.0	65.0	52.9	9.1	103.6	74.9	F
IL12-8545	59.7	11.2	8.3	2.7	33.1	67.3	56.4	8.9	119.4	65.8	D
IL12-13746	58.5	10.2	14.2	2.7	32.5	67.3	58.5	8.6	125.2	68.4	D
IL12-14179	59.6	11.0	28.0	2.7	30.9	66.9	53.7	9.1	102.9	70.1	F
IL12-26448	58.1	11.4	21.5	2.6	30.5	67.7	52.5	9.6	109.4	65.3	D
IL12-30879	58.6	10.0	10.2	2.7	32.9	66.1	59.7	8.3	125.8	72.9	F
Average	58.7	10.5	14.9	2.7	34.4	66.7	57.0	8.5	109.5	70.4	
Std Dev	1.5	0.6	7.2	0.1	2.4	1.7	3.1	0.5	13.0	3.2	

*Check variety.

SOUTHERN UNIFORM WINTER WHEAT SCAB NURSERY

Carl Griffey, Virginia Polytechnic Institute and State University

Fifty-nine advanced breeding lines and varieties were analyzed for test weight, grain protein content, kernel hardness, kernel weight, kernel size, flour yield, softness equivalence, flour protein content, sodium carbonate SRC and lactic acid SRC. Letter grades (A, B, C, D or F) for flour yield were assigned to each entry based on the flour yield range of wheat breeding lines and varieties the SWQL tested in 2009-2015. Those entries that fell in the top 15% range of lines and varieties for flour yield received an 'A', the next 20% a 'B', the next 30% a 'C', the next 20% a 'D', and the bottom 15% an 'F'.

ERNIE, AR07010-7-1, AR07053-13-1, GANC9337-15ES27 and NC10435-11 exhibited visual signs of pre-harvest sprouting. Overall, the entries exhibited slightly higher grain and flour protein contents than the SWQL SRW wheat averages, and lower flour yields, which ranged from 62.5 to 71.1%. Six entries with kernel hardness values ranging from 30.2 to 58.1 exhibited lower flour yields and softness equivalence values, and higher sodium carbonate SRCs (with the exception of ARS 10-389). Despite having the highest kernel hardness value of 58.1, ARS 10-389 showed the highest flour yield among 59 entries. There were ten entries showing lactic acid SRCs ranging from 125.2 to 148.3%, indicating their strong gluten protein.

Table 26. Southern Uniform Winter Wheat Scab Nursery wheat variety trial 2016 crop quality data

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Adjusted Flour Yield % Grade
ERNIE	55.5	11.2	7.1	2.9	36.5	63.4	52.2	8.4	115.1	73.6	F
COKER9835	58.0	10.1	9.9	2.7	33.3	66.3	59.5	8.2	103.3	74.5	F
BESS	58.8	10.2	14.6	2.6	32.4	65.1	54.4	8.3	101.6	69.7	F
JAMESTOWN	59.5	10.3	15.9	2.9	34.9	65.1	53.7	8.0	121.4	76.9	F
AR06024-7-2	61.5	11.7	21.1	2.8	30.8	64.5	55.4	9.3	108.0	69.8	F
ARS10-389	58.0	11.4	58.1	2.8	30.8	71.1	39.4	10.4	111.3	75.6	A
AR07010-7-1	58.0	11.3	29.3	2.6	28.9	66.1	52.0	8.8	99.4	68.6	F
AR07053-13-1	58.5	11.1	21.5	2.7	32.4	65.7	54.2	9.2	94.3	67.8	F
AR07078-7-4	58.7	10.9	28.4	2.7	31.7	67.5	54.2	8.7	103.8	69.9	D
AR07108-6-1	59.4	11.2	18.3	2.8	34.9	66.9	54.8	9.1	101.6	70.6	F
ARLA06146E-20-1	60.0	11.7	15.1	2.8	33.1	64.9	56.1	9.1	114.4	70.9	F
ARLA07084C-10-1	59.2	10.7	13.4	2.7	33.0	66.7	59.5	8.2	101.0	73.0	F
ARS11-2086	58.9	12.5	16.7	2.8	35.0	67.7	53.1	10.1	106.8	65.0	D
ARS12-201	60.0	12.1	17.5	2.9	36.3	68.6	51.4	10.0	103.5	63.7	C
ARS13-159	57.4	10.8	10.0	2.6	30.8	68.3	61.1	9.0	108.3	66.9	C
ARS13-215	60.7	11.2	21.4	3.0	45.5	68.8	46.9	9.3	94.0	67.7	C
ARS14W1012	54.4	11.3	45.2	2.9	36.9	65.8	47.8	8.7	106.7	78.3	F
HILLIARD	60.0	10.6	16.0	2.7	34.6	66.7	58.8	8.5	118.2	70.9	F
SHIRLEY	57.4	10.9	6.2	2.7	34.8	67.5	56.0	8.3	95.0	68.8	D
ES14-0057	61.5	11.3	22.1	2.7	30.7	65.3	57.6	9.1	93.7	71.2	F
ES14-0528	57.9	10.3	24.4	2.8	32.9	69.9	54.4	8.3	93.9	68.1	B
ES14-1293	59.4	11.9	12.5	2.7	30.2	66.8	53.7	9.4	104.3	64.7	F
ES14-1350	60.2	11.2	30.2	2.7	29.2	66.0	47.0	9.2	117.8	71.6	F
GA08250-15ES14	62.2	10.9	17.8	2.7	33.5	68.8	55.3	8.7	120.6	68.5	C
GA08293-15ES3	58.5	10.9	35.9	2.9	35.7	62.5	46.5	8.6	117.1	79.8	F
GA09361-15ES38	61.0	10.4	14.0	2.9	42.2	69.6	52.4	8.5	125.2	69.4	C
GA091252-15ES35	61.9	10.9	22.7	2.9	38.0	69.8	52.9	8.7	119.9	68.4	B
GA08281-15ES1	61.4	11.0	19.2	2.9	37.4	67.3	54.5	9.2	131.2	71.4	D
GANC9337-15ES27	60.4	10.6	17.1	2.9	35.1	65.6	56.1	8.0	123.9	78.2	F
GA09343-15ES33	60.4	11.1	17.2	3.0	38.9	67.6	55.9	9.0	120.8	76.2	D
GANC 10014-15ES24	59.1	11.2	23.2	2.9	35.5	63.4	53.8	9.0	132.4	77.6	F
TRIBUTE	61.2	11.0	30.9	2.8	34.3	66.7	53.4	9.1	125.5	74.6	F
KWS 053	60.1	11.4	9.8	2.8	36.8	67.7	54.1	9.0	134.7	70.2	D
KWS 060	57.9	9.5	9.0	2.8	35.2	67.9	61.0	7.6	109.8	68.4	D

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Adjusted Flour Yield % Grade
KWS 074	58.8	10.3	11.9	2.7	31.7	65.3	61.5	8.1	122.4	71.6	F
KWS 081	57.4	10.2	7.4	2.5	31.7	66.9	59.6	8.3	113.6	68.0	D
KWS 083	61.6	11.4	34.3	2.7	35.2	62.9	54.8	9.4	119.1	78.6	F
KWS 087	58.0	11.1	10.2	2.8	36.8	67.3	56.5	8.6	97.4	68.6	D
LA06146E-P4	60.2	12.0	27.8	3.1	41.5	65.1	47.5	9.4	133.7	74.4	F
LA08090C-9-2	62.1	11.5	25.0	2.9	35.7	67.3	48.4	9.5	112.8	65.5	D
LA08265C-50	60.7	10.6	20.7	2.9	37.0	67.7	54.4	8.6	136.8	67.3	D
LA09011UB-2	60.0	11.1	20.7	2.9	36.4	67.5	51.3	9.0	122.5	73.0	D
LA09225C-33	60.2	10.9	10.8	2.9	39.9	68.8	53.8	9.0	121.2	67.2	C
PIONEER 26R10	58.5	9.8	8.8	2.8	38.2	68.0	65.4	8.0	106.8	70.0	D
NC10435-11	60.1	12.0	14.6	3.0	36.9	67.7	53.3	9.8	120.7	72.3	D
NC12-22225	59.2	11.3	22.2	2.6	30.3	65.5	53.4	9.0	124.1	68.0	F
NC13-20076	60.1	11.3	15.6	2.8	34.6	65.5	55.5	9.1	121.8	74.9	F
NC13-22350	59.6	10.7	18.1	2.7	31.3	66.1	56.4	8.5	137.3	70.9	F
NC13-23449	60.4	10.6	14.5	2.7	32.5	68.9	56.0	8.3	114.2	65.5	C
VA12W-68	58.8	11.6	12.4	3.1	45.8	66.1	53.1	9.8	113.4	66.9	F
VA13W-38	58.7	11.4	8.5	2.9	35.1	67.2	53.1	9.1	121.5	68.0	D
VA09MAS6-122-7-1	59.6	10.7	9.1	2.8	36.3	68.5	56.9	8.7	116.2	65.4	C
VA08MAS1-188-6-4-1	58.6	11.8	10.3	2.8	34.8	65.5	52.5	9.4	111.6	72.0	F
VA13FHB-26	59.0	10.8	19.9	2.8	34.4	65.4	54.8	9.1	121.5	69.9	F
VA14FHB-14	59.9	10.7	9.3	2.8	34.8	67.1	58.4	8.7	126.5	73.2	D
VA14FHB-13	59.5	10.7	12.6	2.9	36.4	66.4	54.9	8.9	148.3	74.3	F
VA14FHB-28	60.2	10.3	15.6	3.0	43.5	69.2	54.3	8.4	110.3	76.2	C
HILLIARD	59.9	10.9	15.9	2.8	34.7	66.3	58.2	8.5	122.3	72.2	F
SHIRLEY	57.5	10.7	5.8	2.7	36.3	67.8	56.8	8.4	94.4	69.0	D
Average	59.4	11.0	18.2	2.8	35.2	66.8	54.4	8.9	114.7	70.9	
Std Dev	1.5	0.6	9.6	0.1	3.6	1.7	4.2	0.6	12.5	3.9	F

UNIFORM EASTERN SOFT RED WINTER WHEAT NURSERY

Eric Olson, Michigan State University

Thirty-four SRW wheat breeding lines and varieties were analyzed for test weight, NIR grain protein content, kernel hardness, kernel weight, kernel size, flour yield, SE, flour protein content, sodium carbonate SRC, lactic acid SRC and sugar-snap cookie baking quality. Letter grades (A, B, C, D or F) for flour yield were assigned to each entry based on the flour yield range of wheat breeding lines and varieties the SWQL tested in 2009-2015. Those entries that fell in the top 15% range of lines and varieties for flour yield received an 'A', the next 20% a 'B', the next 30% a 'C', the next 20% a 'D', and the bottom 15% an 'F'.

The entries exhibited excellent test weights, which ranged from 60.8 to 65.3 lb/bu. There were four entries with kernel hardness values greater than 30.5. Overall, the flour yields of the entries were relatively lower than typical SRW wheat and ranged from 63.9 to 70.7%, resulting in no entry with an 'A' grade. IL11-28222 and IL11-6543 showed favorable test weight and sodium carbonate SRC values. Lactic acid SRCs of the entries ranged from 82.6 to 112.2, indicating the presence of relatively weak strength gluten protein. With the exception of two, the entries produced sugar-snap cookies with diameters greater than 18.0 cm.

Table 27. Uniform Eastern Soft Red Winter Wheat Nursery wheat variety trial 2016 crop quality data

Entry	Test Weight (LB/BU)	NIR Kernel Protein (at 12%)	SKCS Kernel Hardness	SKCS Kernel Diameter (mm)	SKCS Kernel Weight (mg)	Adjusted Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Cookie Diameter (cm)	Top Grade (0-9)	Flour Yield % Grade
Branson													
MO080104													
Hilliard													
Pioneer Brand 25R46													
0762A1-2-8	61.0	8.4	19.4	2.7	34.0	66.0	58.0	7.4	85.6	65.9	18.5	3	F
IL10-21934	62.9	8.4	16.6	2.7	33.8	67.8	57.8	7.3	97.4	64.1	18.3	3	D
TN1603	61.8	10.1	16.8	2.6	33.9	70.7	56.7	7.8	87.2	61.7	18.7	4	B
VA11W-279	63.3	8.7	30.6	2.8	38.3	67.1	54.2	7.8	98.3	69.9	18.4	4	D
VA11W-313	62.8	9.0	28.9	2.8	38.9	67.4	55.7	8.2	97.1	68.6	18.7	3	D
VA12W-31	62.3	9.0	24.3	2.6	29.5	66.4	57.8	7.7	100.8	66.0	18.7	5	F
KWS 072	64.3	9.1	24.8	2.8	40.1	67.3	54.0	7.9	92.9	70.8	18.6	3	D
KWS 074	62.1	9.0	18.8	2.5	30.4	67.5	64.8	7.4	110.5	69.3	19.1	4	D
KWS 078	63.4	8.8	12.7	2.8	38.5	70.0	59.8	7.7	107.8	66.4	18.7	6	B
KY06C-1178-16-10-3	61.3	8.8	6.5	2.8	38.3	69.3	61.1	7.5	112.2	65.8	18.3	4	C
KY06C-1195-37-2-5	62.0	7.7	8.2	2.8	35.7	67.8	62.8	7.1	90.3	67.4	18.6	4	D
KY06C-2067-16-7-1	62.3	9.0	11.8	2.7	36.2	68.6	59.2	7.5	82.6	66.4	18.4	5	C
IL11-28222	64.3	8.7	30.5	2.6	28.9	66.6	55.8	7.4	82.1	65.6	18.9	5	F
IL11-6543	65.3	10.0	19.6	2.7	33.9	66.5	56.7	8.6	107.3	64.9	18.2	2	F
OK11311F	65.0	9.7	36.0	2.8	37.0	67.0	52.8	8.4	108.3	68.3	18.1	3	D
DH11SRW8-59	62.1	8.7	16.6	2.6	36.1	68.2	62.0	7.3	103.4	67.1	18.8	3	C
DH11SRW41-26	62.5	9.6	25.6	2.7	37.5	68.6	56.1	8.1	79.9	65.5	19.0	5	C
AR06017-6-2	60.8	9.7	12.2	2.6	29.1	69.7	59.1	7.9	96.3	62.7	18.9	3	C
AR06050-7-2	63.9	9.4	29.2	2.7	34.9	64.1	56.9	8.1	92.5	67.8	18.5	3	F
MD09W272-8-4-13-3-15	64.4	9.9	31.9	2.6	33.4	63.9	55.6	8.3	83.9	70.4	17.7	3	F
MD09W272-8-4-14-6	62.8	9.7	26.0	2.5	32.1	65.3	60.2	8.4	87.9	73.4	18.4	3	F
MD09W272-8-4-14-8	62.6	9.8	24.7	2.5	31.4	65.4	61.2	8.5	92.4	74.4	18.0	3	F
OH10-219-65	61.8	8.6	18.2	2.6	33.8	67.7	58.5	7.4	82.6	67.3	18.5	4	D
OH09-207-68	62.8	8.8	11.5	2.7	34.9	70.1	60.8	7.4	94.1	68.8	18.7	6	B
04620A1-1-7-4-17	62.4	9.7	36.3	2.7	33.0	64.5	52.6	7.9	89.2	69.9	17.6	3	F
06497A1-7-3	63.5	10.1	23.1	2.6	35.8	65.5	53.9	8.5	75.3	69.0	18.2	2	F
Average	62.8	9.2	21.6	2.7	34.6	67.3	57.9	7.8	93.8	67.6	18.5	3.7	
Std Dev	1.2	0.6	8.3	0.1	3.1	1.9	3.2	0.4	10.2	2.9	0.4	1.1	

UNIFORM EASTERN SOFT WHITE WINTER WHEAT NURSERY

Mark Sorrells, Cornell University

Twelve eastern soft white winter wheat breeding lines and varieties were analyzed for test weight, NIR grain protein content, kernel hardness, kernel weight, kernel size, flour yield, SE, flour protein content, sodium carbonate SRC, lactic acid SRC and sugar-snap cookie baking quality. Letter grades (A, B, C, D or F) for flour yield were assigned to each entry based on the flour yield range of wheat breeding lines and varieties the SWQL tested in 2009-2015. Those entries that fell in the top 15% range of lines and varieties for flour yield received an 'A', the next 20% a 'B', the next 30% a 'C', the next 20% a 'D', and the bottom 15% an 'F'.

The entries exhibited excellent test weights, which ranged from 59.9 to 65.5 lb/bu. The kernel hardness values of NY05158-833, Venus and NY99056-161 were higher than 30.4, resulting in relatively lower softness equivalence and higher sodium carbonate SRC values. Ambassador and NY01016-AN exhibited higher flour yields than others (73.0 and 73.2%, respectively). The entries had lower flour protein contents than typical SWW wheat, with an average protein content of 7.5%. Sugar-snap cookies of excellent diameter ranging from 18.1 to 19.4 cm were produced from the entries. Ambassador, NY99069-249, NY01016-AN, Cayuga and NY99056-161 produced cookies with diameters greater than 19.0 cm.

Table 28. Uniform Eastern Soft White Winter Wheat Nursery wheat variety trial 2016 crop quality data

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Cookie Diameter (cm)	Top Grade (0-9)	Flour Yield % Grade
NY05158-833	63.8	9.5	37.6	2.8	33.4	68.1	53.7	8.1	74.5	70.7	18.2	4	D
Venus	61.7	8.6	31.1	2.7	34.4	72.5	55.9	7.1	81.3	72.2	18.6	5	C
Ambassador	61.2	8.7	9.4	2.9	43.8	73.2	58.1	6.9	76.4	64.2	19.4	5	A
NY99069-249	63.2	9.0	21.6	2.8	35.4	70.1	56.0	7.5	81.3	67.2	19.2	5	B
Caledonia	62.7	8.6	16.9	2.9	40.3	71.5	57.2	7.3	88.5	66.4	18.6	4	C
F1027	65.0	9.2	25.2	2.9	38.0	69.8	54.6	7.5	87.9	72.0	18.7	4	C
NY94025-136	63.4	9.0	21.7	2.8	36.1	71.7	59.1	7.3	91.0	68.7	18.8	4	C
NY01016-AN	62.6	9.3	17.4	3.0	42.4	73.0	57.0	7.5	106.5	66.6	19.1	5	B
KWS 086	62.8	9.3	19.9	3.0	41.3	72.4	57.2	7.6	93.6	68.6	18.5	4	C
F2016	59.9	8.8	13.6	2.8	38.1	71.3	60.2	7.1	101.9	71.6	18.1	4	D
Cayuga	65.5	10.2	25.4	2.9	39.5	69.3	55.7	8.2	101.6	70.4	19.1	5	B
NY99056-161	62.8	8.9	30.4	2.7	35.7	71.1	56.4	7.5	101.0	71.2	19.0	4	B
Average	62.9	9.1	22.5	2.9	38.2	71.2	56.8	7.5	90.5	69.1	18.8	4.4	
Std Dev	1.5	0.5	8.0	0.1	3.3	1.6	1.8	0.4	10.7	2.6	0.4	0.5	

UNIFORM SOUTHERN SOFT RED WINTER WHEAT NURSERY

Esten Mason, University of Arkansas

Thirty-three SRW wheat breeding lines and varieties were analyzed for test weight, NIR grain protein content, kernel hardness, kernel weight, kernel size, flour yield, SE, flour protein content, sodium carbonate SRC, lactic acid SRC and sugar-snap cookie baking quality. Letter grades (A, B, C, D or F) for flour yield were assigned to each entry based on the flour yield range of wheat breeding lines and varieties the SWQL tested in 2009-2015. Those entries that fell in the top 15% range of lines and varieties for flour yield received an 'A', the next 20% a 'B', the next 30% a 'C', the next 20% a 'D', and the bottom 15% an 'F'.

Overall, the entries exhibited slightly lower test weights, but higher grain protein contents, than typical SRW wheat. KWS 083 showed the highest kernel hardness and consequently a low softness equivalence, a high sodium carbonate SRC and produced small sugar-snap cookies. The flour yields of the entries were mostly lower than typical SRW wheat, and ranged from 63.1 to 70.9%. TX-EL2 was the only entry receiving an 'A' grade for flour yield. Slightly higher protein contents and sodium carbonate SRCs of flour were observed for the entries, which resulted in the production of relatively small sugar-snap cookies. Only three entries (including NC10034-11, DH11SRW8-48 and KWS 081) produced sugar-snap cookies with a diameter of 18.6 cm, which is the average cookie diameter of typical SRW wheat.

Table 29. Uniform Southern Soft Red Winter Wheat Nursery wheat variety trial 2016 crop quality data

Entry	Test Weight (LB/BU)	Grain Protein (at 12%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalent (%)	Flour Protein (at 14%)	Lactic Acid SRC (%)	Sodium Carbonate SRC (%)	Cookie Diameter (cm)	Top Grade (0-9)	Flour Yield % Grade
AGS 2000	58.4	11.0	13.8	2.7	35.3	69.6	58.4	8.9	105.2	70.0	18.2	2	C
Jamestown	60.0	11.1	6.4	2.8	39.7	66.2	57.4	8.8	123.0	73.1	17.3	1	F
Hilliard	59.2	10.2	12.8	2.8	33.9	66.8	61.5	8.1	116.9	71.6	18.3	3	F
Pioneer 26R41	57.9	9.9	12.5	2.7	34.7	69.0	63.1	7.8	113.4	70.1	18.0	3	C
VA12W-72	58.8	10.9	9.0	3.0	45.1	66.6	57.2	9.1	105.4	66.8	18.1	3	F
NC11-22289	60.5	12.2	19.0	2.9	34.5	67.1	51.2	9.9	127.0	67.6	17.8	2	D
NC10034-11	59.6	11.0	13.6	2.5	28.6	67.6	59.3	8.7	114.0	67.5	18.6	3	D
TX12D4768	60.5	10.9	19.1	3.0	39.8	68.1	52.2	9.1	112.3	67.4	18.1	3	D
TX-EL2	60.0	9.9	11.5	2.9	41.1	70.9	57.6	8.4	109.9	69.4	18.1	3	A
GA071012-14E6	59.6	11.1	15.3	3.0	40.8	69.6	56.2	9.2	124.8	67.3	18.0	2	C
GA051207-14E53	59.9	10.4	20.4	2.9	39.1	69.8	56.5	9.0	122.7	68.0	18.1	3	B
GA07353-14E19	60.4	9.9	15.4	2.9	40.2	68.7	58.4	8.6	114.5	70.3	18.3	4	C
GAJT141-14E45	59.9	10.6	20.8	2.7	32.1	66.5	59.6	8.7	125.8	74.3	17.8	2	F
TN1601	57.4	11.1	13.1	2.8	36.0	65.7	55.8	8.8	100.0	74.8	18.0	2	F
TN1602	57.8	10.5	24.3	2.7	33.7	64.8	52.0	8.8	84.3	70.9	17.8	3	F
TN1604	58.6	10.0	13.4	2.7	35.4	68.9	57.6	7.9	92.1	66.5	18.5	4	C
VA12W-68	59.6	11.2	10.0	3.0	44.1	66.5	55.9	9.3	106.6	67.4	18.1	1	F
VA13W-38	59.3	11.0	2.8	2.8	34.2	69.2	54.8	8.8	107.2	64.8	18.5	4	C
VA13W-124	58.2	9.7	17.3	2.8	37.2	67.7	55.7	8.0	102.0	70.1	17.8	4	D
KWS 060	57.4	10.0	9.3	2.5	28.9	68.9	64.8	7.8	113.1	69.7	18.5	3	C
KWS 081	57.5	10.2	8.1	2.4	29.1	68.5	61.5	8.0	111.9	67.8	19.0	4	C
KWS 083	61.1	10.8	37.2	2.7	31.4	63.1	55.9	8.6	115.2	78.0	17.2	1	F
LA08090C-9-2	61.4	11.2	23.9	2.8	34.0	68.0	50.3	9.1	110.5	65.3	18.4	3	D
LA08115C-30	59.2	10.3	10.3	2.8	36.8	67.7	60.0	8.4	131.0	78.6	17.9	2	D
LA09011UB-2	60.3	10.8	21.7	2.8	35.8	68.6	54.5	8.7	114.5	69.3	18.0	3	C
DH11SRW8-48	58.8	10.7	1.3	2.7	36.2	69.0	64.0	8.2	116.8	67.6	18.9	3	C
ES14-0618	58.3	10.8	17.8	2.6	29.7	66.8	60.7	8.8	108.9	70.5	17.9	3	F
AR06473-9-4-4	60.9	11.7	17.9	2.8	36.2	68.3	54.9	9.5	124.2	66.6	18.1	2	C
AR06024-7-2	61.7	11.7	19.7	2.8	32.0	66.4	56.6	9.4	103.0	67.3	18.1	3	F
MD09W272-8-4-13-3-15	59.5	11.3	15.5	2.7	34.2	64.6	57.9	9.1	103.4	71.9	17.9	3	F
MD09W272-8-4-14-6	58.2	11.2	13.2	2.6	33.1	65.5	61.3	8.9	107.9	74.6	18.0	2	F
MD09W272-8-4-14-8	58.8	11.0	13.6	2.7	34.0	65.8	62.3	8.8	102.4	74.9	17.9	2	F
MD07W478-14-5	59.4	10.6	16.3	2.8	33.6	68.0	57.7	8.3	106.9	69.2	17.6	2	D
Average	59.3	10.7	15.0	2.8	35.5	67.5	57.7	8.7	111.4	70.0	18.1	2.7	
Std Dev	1.2	0.6	6.8	0.1	4.1	1.7	3.6	0.5	10.1	3.5	0.4	0.9	

MATERIALS AND METHODS 2017

QUADRUMAT MILLING TESTS – BREEDER SAMPLES

The Soft Wheat Quality Laboratory evaluates thousands of breeder wheat samples yearly. Table 30 summarizes the traits tested and reported to breeders by the SWQL. The SWQL milling methods are described below.

Table 30. Milling and baking measurements and calculations for evaluation of breeder samples

TRAIT	SYMBOL	DESCRIPTION / CALCULATION
Whole Grain Protein	WPRO	Percent protein of whole, untempered grain measured on DA7200 near infrared (NIR) analyzer
Whole Grain Hardness	Hard	Scale of 1-120, soft to hard. Whole, untempered grain measured using Single Kernel Characterization System
Grain Weight	GW	Weight of tempered, whole grain sample
Bran	Bran	Weight of milled product retained by 40-mesh* screen (over 40)
Mids	Mids	Weight of milled product retained by 94-mesh* screen (over 94)
Break Flour	BkFl	Weight of milled product passing through 94-mesh* screen (Grain weight – (bran + mids))
Percent Bran, Mids, Break Flour	%	Expressed as percent of grain weight (Bran Weight/GW) x 100
Total Flour	Flour	Break Flour + Mids
Flour Yield	FY	(Total Flour/GW) x 100
Softness Equivalence	SE	(BkFl/Total Flour) x 100
Flour Moisture	FMOIST	Percent moisture of wheat flour estimated by Unity NIR
Flour Protein	FPRO	% protein of wheat flour by Unity NIR
Cookie Diameter	Cookie Dia	Total diameter of 2 baked cookies (cm)
Cookie Top Grain	Cookie TopG	0-9 visual scale (0 worst, 9 best)
Solvent Retention Capacity Tests	SRC	Percentage of solvent retained by a flour/solvent slurry after centrifugation and draining
Lactic Acid Sodium Carbonate Sucrose Water	LA SC SU WA	((residue wt/ flour wt)-1) x (86/(100 - %FMOIST)) x 100 flour wt = weight of dry flour residue wt = weight of drained, saturated flour

* Mesh size is the number of openings in the SSBC screen per linear inch; smaller particles pass through higher mesh number.

MODIFIED QUADRUMAT MILLING METHOD

Tempering: Prior to milling, wheat grain is estimated for moisture content using a Perten NIR DA7200 whole grain analyzer and tempered to 15% moisture. Grain samples are tempered in glass jars by adding distilled water, sealing with silicon-free, screw-top lids and tumbling on a chain driven roller/conveyor (Lewco) until the water is absorbed, about 30 minutes. Tempered grain samples are kept sealed at room temperature for at least 24 hours prior to milling to allow moisture equilibration throughout the kernel.

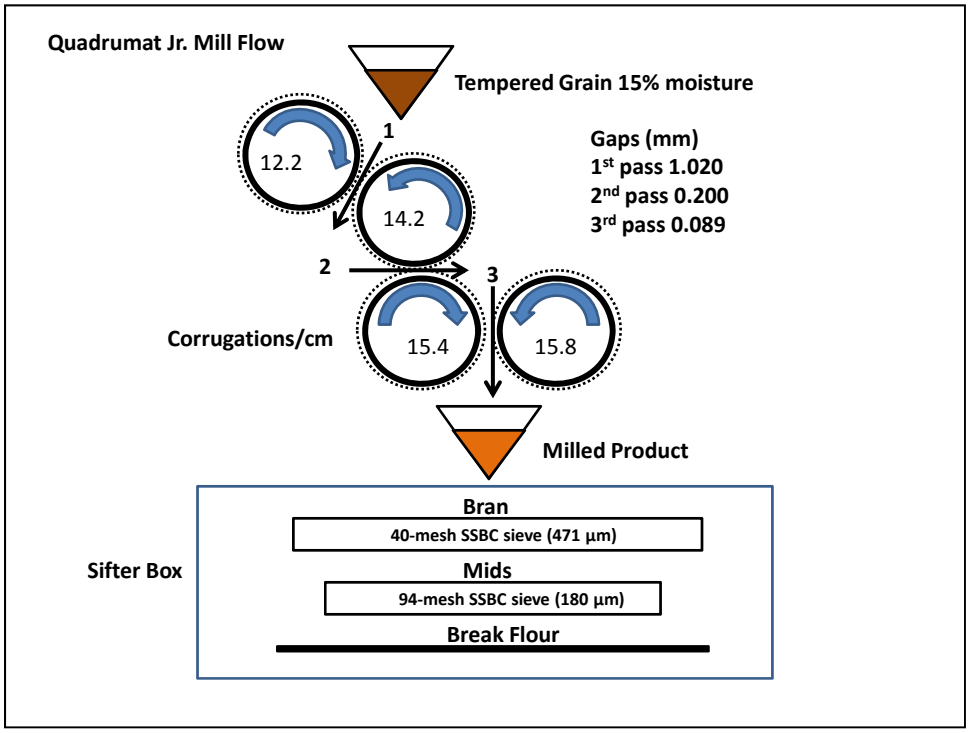
For the ***preliminary*** group samples, *tempered grain* is fed into the Quadrumat break roll unit and passed through three sets of milling rolls, each with increasing corrugations per centimeter and decreasing gaps to decrease particle size sequentially from grain to flour.

Milled product is sifted on a Great Western sifter box through sequential 40- and 94-mesh stainless steel bolting cloth (SSBC) screens, with 471 and 180 micron openings, respectively, to separate the milled product into three fractions: bran, mids and break flour. Bran is recovered above the 40-mesh screen, mids above the 94-mesh screen, and break flour passes through the 94-mesh screen. For ease of handling and accuracy, the bran and mids fractions are weighed as an indirect method for calculating flour yield (grain sample weight less bran as a percent of total grain weight) and softness equivalence (break flour as a percent of total flour).

For the ***intermediate*** group and ***advanced*** group grain samples, middlings are further passed through the Quadrumat reduction roll unit to obtain shorts and reduction flour. The milled fraction is sifted on an 84-mesh screen (213 micron openings) to yield shorts and reduction flour. Break and reduction flours are combined, blended to produce straight grade flour and used for composition, SRCs and cookie baking tests. Bran yield, break flour yield and total flour yield are determined the same ways as described for the preliminary group samples. All samples are milled under controlled temperature and humidity (19-21^{o}C and RH 58-62%). Mill temperature is equilibrated to 33 ± 1.0^{o}C by running the mill empty prior to sample milling.

Bran yield (%) is the percentage of bran retained by a 40-mesh SSBC screen (471 micron opening size) over the grain weight. Break Flour Yield (%) is the percentage by weight of the flour sifted through a 94-mesh SSBC screen (180 micron) over the grain weight. Mids (%) is the percentage middling stock (retained by the 94-mesch screen) over the grain weight. Potential Flour Yield (%) is the percentage by weight of the sum of break flour and middling stock over the grain weight.

Figure 1. Brabender Quadrumat break roll milling unit – adapted from Gaines, et al, 2000.



BREEDING SAMPLES

The SWQL treats samples as ***preliminary, intermediate*** or ***advanced*** group samples. The difference in treatment for each test type is summarized in Table 31.

Preliminary group testing is used for screening early generation selections, *intermediate* testing is used for intermediate generation samples and *advanced* testing is for advanced breeding lines. Milling scores produced for all three sample treatments are determined in the same way. *Intermediate* and *advanced* group testing add SRC and flour protein determinations, and *advanced* group testing includes sugar-snap cookie baking.

Preliminary group testing involves grain characteristics (TW, Grain NIR for protein and kernel hardness) and milling properties for breeders to screen early generation lines. Grain is milled using the Quadrumat break roll unit to obtain bran, middling and break flour. Flour yield and softness equivalence are calculated based on the equations described below in **Soft Wheat Quality Laboratory Testing Methods for Quality Traits** and summarized in Table 32. No further tests are performed using the break flour.

Intermediate and ***advanced*** group samples are milled using both the break and reduction roll units to produce break and reduction flours. The blend of break flour and reduction flour (straight grade flour) is used for flour quality tests. Grain characteristics and milling properties (TW, Grain NIR for protein and kernel hardness, flour yield and softness equivalence) are determined as for the preliminary groups. In addition, straight grade flour is tested for protein content and solvent retention capacity (SRC) of sodium carbonate and lactic acid. For ***advanced*** group samples, the straight grade flour is used for the sugar-snap cookie baking test.

Table 31. Differential processing of *Preliminary*, *Intermediate* and *Advanced* testing at SWQL

PROCEDURE	***Preliminary***	***Intermediate***	***Advanced***
Sample Size	80 g		200 g
Test weight	Whole grain		
Milling Method	Break Roll Unit Milling	Break and Reduction Roll Units Milling	
Flour Yield	Mids+Flour/Grain x 100		
Softness Equivalence	(Break Flour/Total Flour) x 100		
Kernel Hardness	Single Kernel Characterization System (SKCS)		
Whole Grain Protein & Moisture	DA7200 NIR		
Flour Test	NO	Straight Grade Flour (blend of break and reduction flours)	
Flour Moisture/Protein Content	NO	YES – Unity NIR	
Solvent Retention Capacity Tests (SRC)	NO	YES	
Sucrose	NO		YES upon request (5-g test)
Lactic Acid	NO	YES (1-g test)	
Water	NO		YES upon request (1-g test)
Sodium Carbonate	NO	YES (1-g test)	
Sugar-snap Cookie Diameter	NO		YES
Sugar-snap Cookie Top Grain	NO		YES

SOFT WHEAT QUALITY LABORATORY TESTING METHODS FOR QUALITY TRAITS

Traits included in the SWQL evaluation of breeding samples, the method used, the purpose of the measurement and measurement units are summarized in Table 31, below. Complete descriptions of the individual SWQL methods follow below.

Table 32. Traits measured at SWQL: methods, purpose and units

TRAIT	METHOD	INDICATES	UNITS
Test Weight	Modified AACC Method 55-10	Grain size, condition, packing efficiency	Estimated Pounds/bushel
Hardness (SKCS)	Perten Single Kernel Characterization System (SKCS) AACC Method 55-31.01	Grain hardness <40 is considered soft wheat	0-120
Whole Grain Protein & Moisture	Near Infra-Red (NIR) Perten DA7200	Whole grain Protein & Moisture content	0-100
			Percent
Falling Number	Perten Falling Number Tester AACC Method 56-81.03	Pre-harvest sprout damage	seconds
Flour Yield	mids + break flour as % of initial grain weight	Flour recovery	Percent
Softness Equivalence	Break flour weight as % of total flour weight (Finney, 1986)	Estimates grain hardness, flour particle size	Percent
Flour Ash	AACC Method 08-01	Inorganic residue after combustion	Percent
Flour Moisture	NIR Unity Spectra-Star	Flour moisture	Percent
Flour Protein		Flour protein content	Percent
Solvent Retention Capacity Profile (SRC)	AACC Method 56-11.02	Solvent affinity	Percent
	Lactic Acid	Gluten strength	
	Sodium Carbonate	Damaged starch	
	Sucrose	Pentosan Content (Arabinoxylans)	
	Water	Overall water affinity	
Sugar-snap Cookie Diameter	Baking Quality of Cookie Flour, Intermediate Method AACC Method 10-52	Cookie spread	Centimeters
Sugar-snap Cookie Top Grain		Visual quality cookie surface	1-10 higher is better

Whole Grain Moisture, Hardness and Protein

Whole grain moisture and protein are estimated using the NIR DA7200 Analyzer (Perten Instruments). Adjustment of calibrations was performed in Wooster, Ohio, for whole grain moisture and protein using values produced on the oven moistures (AACC Method 44-01.01) and nitrogen combustion analysis Rapid NIII Nitrogen Analyzer (Elementar), respectively.

Definitions:

Grain is the cleaned and tempered whole grain used for milling.

Break flour (BkFl) is milled product passing through the 94 mesh screen after a single pass through the Quadrumat break roll unit. Break flour is the smallest fraction of the milled product and has the finest particle size. Break flour weight is approximated by subtracting the weight of bran and mids from the original grain weight.

Mids (middlings) is the milled product passing through the 40 mesh screen but retained by the 94 mesh screen after a single pass through the Quadrumat break roll unit.

Bran is the milled product retained by the 40 mesh screen after a single pass through the Quadrumat break roll unit.

Reduction flour is the product passing through an 84 mesh screen after a second, reduction milling of the mids (from break roll unit) through the Quadrumat reduction roll unit.

Straight Grade Flour is a blend of break flour and reduction flour.

Flour Yield

Flour yield (FY) is calculated as the percent total flour weight (break flour + mids) of the sample grain weight (GW) from a single pass through the Quadrumat break roll unit. For calculation of flour yield, the difference between the grain weight (GW) and the bran weight (Bran) is used to estimate total flour (mids + break flour).

$$\mathbf{FY = ((GW\text{-}Bran)/GW) \times 100}$$

The formula is equivalent to: **(Total Flour/GW) x 100**

Softness Equivalence

Softness Equivalence (SE) is the percentage break flour (BkFl) passing through 94-mesh screen, of the total flour weight (break flour + mids). SE approximates grain softness and particle size of flour produced from a single pass through the Quadrumat break roll unit (*C.W. Brabender Instruments, Inc.*) and is analogous to break flour in a large-scale mill (Finney, 1986). Total flour weight is calculated by subtracting bran weight (remaining over the 40-mesh screen) from initial grain weight. Subtracting the weight of the mids (remaining over the 94-mesh screen) from the total flour gives the weight for break flour.

$$\mathbf{SE = \{(GW - (Bran + Mids))/(GW - Bran)\} \times 100}$$

This formula is equivalent to: **(BkFl/Total flour) x 100**

Flour Moisture and Protein

Flour moisture and protein are estimated using the SpectraStar NIR analyzer (Unity Scientific), calibrated yearly for protein by nitrogen combustion analysis using the Rapid NIII Nitrogen Analyzer (Elementar) and for moisture by the oven drying method (AACC method 44-01.01). Units are recorded in percent moisture or protein converted from nitrogen x 5.7 and expressed on a 14% moisture basis.

Solvent Retention Capacity

Solvent Retention Capacity (SRC) assays are performed as described in AACC Method 56-11.02, *Solvent Retention Capacity Profile*. The profile of SRCs in the four solvents (sucrose, lactic acid, sodium carbonate and water) is used to predict milling and baking quality. In general, lower SRCs are preferred for water, sodium carbonate and sucrose solvents (Kweon, Slade, & Levine, 2011).

Breeder samples processed by intermediate and advanced group testing use *straight grade flour* (blend of break and reduction flours) for SRC tests.

With the exception of sucrose, SRCs are performed using 1 gram of flour in glass test tubes with rubber stoppers. Sucrose SRCs are performed with 5 grams of flour in 50 mL disposable screw top centrifuge tubes, because the highly viscous sucrose solution impedes even distribution of solution in 1 gram flour tests, reducing the reliability of the small scale test.

The following descriptions of the biochemistry and correlations of SRCs with milling and baking traits were published in the Soft Wheat Quality Laboratory Annual Report 2011 (Souza, Kweon, & Sturbaum, 2011).

Water SRC is a global measure of the water affinity of the macro-polymers (starch, arabinoxylans, gluten, and gliadins). Lower water values are desired for cookies, cakes, and crackers, with target values below 51% on small experimental mills and 54% on commercial or long-flow experimental mills.

Sucrose SRC values are related to the content of arabinoxylans (also known as pentosans), which can strongly affect water absorption in baked products. Sucrose SRC is a good predictor of cookie quality and shows a negative correlation with wire-cut cookie diameter ($r = -0.66$, $p<0.0001$). The cross hydration of gliadins by sucrose also causes sucrose SRC values to be correlated to flour protein ($r = 0.52$) and lactic acid SRC ($r = 0.62$). The 95% target value can be exceeded in flour of high lactic acid SRC.

Sodium carbonate SRC takes advantage of the very alkaline solution to ionize the ends of starch polymers increasing the water binding capacity of the molecule. Sodium carbonate SRC increases as starch damage due to milling increases.

Lactic acid SRC predicts gluten strength of flour. Typical values are below 85% for "weak" protein soft wheat varieties and above 110% for "strong" protein soft wheat varieties. Lactic acid SRC results correlate to the SDS-sedimentation test. The lactic acid SRC is also correlated to flour protein concentration and dependent on genotypes and growing conditions.

Cookie Bakes (Sugar-Snap Cookies)

Two sugar-snap cookies are baked in the SWQL bake laboratory for each sample as described in AACC Method 10-52, *Baking Quality of Cookie Flour*. Cookies are baked exclusively for advanced group samples using straight grade flour (blend of break and reduction flours). Diameter of the two cookies is measured and recorded electronically using a Mitutoyo Absolute Digimatic Caliper. Cookies are graded visually for surface appearance, from worst to best on a scale of 1 to 10. Color is observed for bake quality but not evaluated.

Falling Number

The falling number test (AACC Method 56-81B) is performed using the Perten Falling Number instrument. A glass tube filled with a suspension of whole grain meal or milled flour is heated in a boiling water jacket to produce gelatinized starch. Immediately after heating, a weighted plunger is released into the suspension, and the travel time of the plunger is measured in seconds (falling number) as it falls from the top to bottom of the glass tube. The higher the viscosity of whole grain meal or flour paste in the glass tube, the longer the travel time of the plunger. The enzyme α-amylase, produced when grain sprouts, hydrolyzes starch molecules and lowers the viscosity of gelatinized starch, resulting in decreased travel time of the plunger (falling number). Alpha-amylase can be measured directly using a kit from Megazyme, International (AACC Method 22-02-01, *Measurement of alpha-Amylase in Plant and Microbial Materials Using the Ceralpha Method*). The SWQL uses a modified micro method of the Megazyme assay.

Flour Ash

Flour Ash is measured according to the AACC method 08-01 and detects residual inorganic materials after combustion. Since inorganic materials are higher in bran than in endosperm, flour ash is an indirect indicator of residual bran in the flour.

Materials and Methods References

Finney, P. A. (1986). Revised Microtesting for Soft wheat Quality Evaluation. *Cereal Chemistry* , 177-182.

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Kweon, M., Slade, L., & Levine, H. (2011). Solvent Retention Capacity (SRC) Testing of Wheat Flour: Principles and Value in Predicting Flour Functionality in Different Wheat-Based Food Processes and in Wheat Breeding—A Review. *Cereal Chemistry , 88*, 537-552.

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GENOTYPING FOR QUALITY TRAITS

DNA markers applied in marker assisted selection and genotyping are included below. For a complete bibliography, see the reference section for the 2016 Crop Wheat Quality Council genotyping. Besides in house genotyping, the SWQL sends samples to the Eastern Regional Small Grains Genotyping Laboratory for SNP genotyping.

http://www.ars.usda.gov/Main/docs.htm?docid=19522

Molecular markers and protocols are available at the University of California Davis website:

http://maswheat.ucdavis.edu/

References for PCR primers listed here are provided in the section **Genotyping for Quality Traits: 2016 Soft Wheat Quality Council**.

Quality Genotyping - Primer Sequences, Amplification Conditions and References

The molecular markers described below are the most commonly used markers at the SWQL. These are reliable and robust reactions that have been useful in assessing wheat quality. Primer sequences are given 5' to 3'.

High Molecular Weight Glutenins and γ-gliadin

Glu-A1

AxFwd	ATGACTAAGCGGTTGGTTCTT
Ax1 R	ACCTTGCTCCCCTTGTCCTG
Ax2* R	ACCTTGCTCCCCTTGTCTTT

Amplifies at 58°C, 1,200 bp product, present or absent using single forward primer, alternate reverse primers. (Ma et al., 2003), (Liu et al., 2008)

Glu-D1

DxL_151	AGGATTACGCCGATTACGTG
Dx2R ``2+12"	AGTATGAAACCTGCTGCGGAG
Dx5R ``5+10''	AGTATGAAACCTGCTGCGGAC

Amplifies 664 bp product, present or absent using single forward primer, alternate reverse primers, touchdown amplification. (Wan et al., 2005)

Glu-B1

Bx7oe_L1	GCGCGCTCAACTCTTCTAGT
Bx7oe_R1	CCTCCATAGACGACGCACTT

Amplifies at 64°C a 404 bp for wild-type or 447 bp product for over-expressing Bx7. (Lei et al., 2006)

γ-gliadin

GligDF1	AAGCGATTGCCAAGTGATGCG
GligDR1	GTTTGCAACACCAATGACGTA
GligDR2	GCAAGAGTTTGCAACAGCG

Amplifies at 56°C, a 264 bp product for gliadin 1.1 or 270 bp product for gliadin 1.2, using single forward primer, alternate reverse primers. (Zhang et al., 2003)

Translocations and Disease Resistance

1B/1R and 1A/1R – Chromosome 1B or 1A substituted with rye secalin

Tailed Reaction

SCM9_L_M13	CACGACGTTGTAAAACGACTGACAACCCCCTTTCCCTCGT
SCM9_R	TCATCGACGCTAAGGAGGACCC

Amplifies using a tailed reaction, 207 bp for 1B/1R or 203 bp for 1A/1R. (de Froidmont, 1998)

2B translocation - Sr 36 stem rust resistance

Stm773-F5	AAACGCCCCAACCACCTCTCTC
Stm773-R5	ATGGTTTGTTGTGTTGTGTGTAGG

Amplifies with 62/55°C touchdown program producing a 162 fragment indicative of the 2B translocation carrying Sr36 or 192 bp for wild type 2B. (Tsilo et al., 2008)

Sucrose Synthase type 2 Sus2

HapH	High grain weight associated with upstream 35 bp insertion
Sus2B_7.F	TCCTCGTTCTTTGTTCGTTCT
Sus2B_7.R	CACTTCGTGGTACTTTTCCT

The single 2-step assay replaces HapH and HapL SNP determination amplifying a 358 bp in HapH lines and 322 in HapL, haplotypes indicative of high or low grain weight, respectively. (Jiang et al., 2011).
PCR program uses 7 cycles at 62°C followed by 35 cycles at 55°C annealing.

Pre-harvest sprouting

Vp1BF	TGCTCCTTTCCCAATTGG
Vp1BR	ACCCTCCTGCAGCTCATTG

Amplifies at 62°C a 569 or 845 bp fragment for reported tolerance to preharvest sprouting.
(Yang et al., 2007)