# SOFT WHEAT QUALITY LABORATORY

## 62ND ANNUAL RESEARCH REVIEW

## 2016 ANNUAL REPORT

**Dr. Byung-Kee Baik, Director**
**Anne Sturbaum, Molecular Biologist**

**March 1, 2016**

## USDA - AGRICULTURAL RESEARCH SERVICE

***CORN, SOYBEAN AND WHEAT QUALITY RESEARCH UNIT***

# SOFT WHEAT QUALITY LABORATORY

**1680 Madison Avenue**
**Wooster, OH 44691**
**United States Department of Agriculture**
**Agricultural Research Service**
**Corn, Soybean and Wheat Quality Research Unit (CSWQRU)**


**http://ars.usda.gov/Main/Docs.htm?docid=3032**

**Dr. Peg Redinbaugh, CSWQRU Research Leader** Peg.Redinbaugh@ars.usda.gov
**Dr. Byung-Kee Baik, SWQL Director** ByungKee.Baik@ars.usda.gov

**Soft Wheat Quality Laboratory (SWQL) Staff:**

| | |
|---|---|
| Scott Beil | scott.Beil@ars.usda.gov |
| Amy Bugaj | amy.Bugaj@ars.usda.gov |
| Sharon Croskey | croskey.6@osu.edu |
| Tom Donelson | thomas.Donelson@ars.usda.gov |
| Cindy Hampton | cindy.Hampton@ars.usda.gov |
| Taehyun Ji | taehyun.Ji@ars.usda.gov |
| Anthony Karcher | anthony.Karcher@ars.usda.gov |
| Fengyun Ma | ma.1036@osu.edu |
| Paul Nemes | nemes.1@osu.edu |
| Anne Sturbaum | anne.Sturbaum@ars.usda.gov |

**Visiting Scholar**

| | |
|---|---|
| Moonseok Kang | moonseok.kang@ars.usda.gov |

### *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.

# Contents

# FIGURES AND TABLES

# 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 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 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 12 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, the Wheat Quality Council project for testing end-use quality potentials of newly released varieties, and the Overseas Varietal Analysis project for popularly grown wheat varieties for overseas users, in cooperation with the eastern soft wheat breeders, the Wheat Quality Council and U.S. Wheat Associates, respectively.

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 the 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 meetings, 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 ($816,023) supports a lead scientist, a post-doctoral research associate, and a scientific support staff composed of six full-time and two part-time members.

Two additional post-docs joined the SWQL in March and April of 2014. They were paid mainly from grant funds and funds received from the wheat industry. One post-doc left the program upon completion of the project in December 2014, while the other continues working in the SWQL for a second year. A visiting scholar from the Rural Development Administration (RDA) in Korea joined the lab in September 2014, and is expected to work on a cooperative research project until July 2016.

There are four full-time and two part-time technical support staff members carrying out the quality evaluation of breeding lines and varieties. Two full-time research technicians, two post-doctoral research associates and one visiting scholar perform 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. Renovation of the HVAC system in the milling facility was completed in October 2015 to provide better control of humidity and temperature conditions.

## *NEW IN 2015*

The 61st SWQL Annual Research Review Conference, which was jointly held with the Soft Wheat Quality Council meeting for the first time, was successfully conducted on March 3-4, 2015, in Indianapolis, Indiana, with five guest speakers, four SWQL presenters and 73 registered attendees from wheat breeding programs, universities, state wheat growers associations, foundation seed programs and milling and baking industries. This year's Conference was well received and favored by the attendees. The attendees' evaluations of the meeting were predominantly positive with a few individual suggestions.

With much effort and direction from Dr. Peg Redinbaugh, the Research Leader of the Corn, Soybean and Wheat Quality Research Unit, we have successfully completed the candidate interviews for the Research Geneticist/Molecular Biologist/Chemist position. The administrative appointment process is currently under way. We expect that the new scientist will join the SWQL by March 2016. Dr. Moonseok Kang, a visiting scholar from the RDA-Korea (equivalent to the USDA-ARS), has continued his scholarship for a second year and conducted research on changes in falling number and α-amylase activity of wheat grain during the grain-filling period.

After a long delay and many missteps, HVAC renovation of the milling room has finally been completed to provide constant and controlled temperature and humidity conditions, which are critical for obtaining a reliable milling quality evaluation of wheat breeding lines. From the ARS equipment funds, a minus 20°C walk-in freezer was constructed in the wheat grain sample receiving room to replace the hazardous fumigation room, which employed the use of a toxic gas for insect control of wheat grain coming from the breeders. With help from Lonnie Andrews, the former milling specialist in the SWQL, a Quadrumat break roll unit was refurbished with new sets of rolls to be used as a backup for the existing 30+ year-old unit. Two units of the thermal gravitational analyzer have been installed, and it is being optimized for the automated determination of grain and flour ash contents. We plan to have the ash content assay of flour considered as one of the routine quality evaluation tests for wheat breeding lines.

Thus far, we have received approximately 4,800 breeding lines and varieties grown in the 2015 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 Michigan, Ohio and Virginia, and eight uniform regional nursery samples, has been completed, and the summarized test results distributed. Our quality evaluation of wheat breeding lines produced in the 2015 crop year is in fair progress and has been completed for over 50% of the test samples.

With significant pre-harvest sprout damage in 2015, all seven WQC entries grown in northwest Ohio showed grain falling numbers lower than 149, leaving no grain samples for the WQC cooperative quality evaluation. Just five entries from the advanced breeding lines and check varieties submitted by two different breeding programs were tested in the Soft WQC project in 2015. Ten soft red winter wheat varieties were selected for the 2015 OVA project. Wheat grain was obtained from a breeding program, state certified seed programs and seed companies. Wheat grain was cleaned, tested for grain characteristics, milled and sent out to domestic and overseas collaborators for processing and baking quality evaluation. Based on the quality evaluation data obtained from the SWQL and collaborators, we published the 2014 OVA and 2015 WQC project reports.

The research projects we are currently working on in the SWQL include: 1) development of a cake baking test procedure for non-chlorinated flour; 2) changes in falling number and $\alpha$-amylase activity of wheat grain during the grain-filling period; 3) volatile flavor compound profile of whole wheat grain; 4) quality characteristics of eastern soft wheat required for making steamed bread; 5) influences of nitrogen fertilizer application rate on quality characteristics of soft red winter wheat; 6) varietal variation in compositional characteristics of soft red winter wheat bran; and 7) novel sucrose synthase alleles and the effect on milling quality.

We secured additional research funds from the Maryland Grain Producers Association ($15,000), Mondeléz International Company ($33,000) and the Rural Development Administration (RDA)-Korea ($160,000) with a pending cooperative research agreement with the National Institute of Crop Science-RDA-Korea.

We published the '2015 Annual Research Review Report', 'Overseas Varietal Analysis Report for Crop Year 2014', and 'Milling and Baking Test Results for Eastern Soft Wheats Harvested in 2015'. Dr. Baik was the corresponding author of two, and co-author of four, refereed journal articles published in 2015. Dr. Baik and four other SWQL members were the authors of four poster presentations at the American Association of Cereal Chemists International Meeting in Minneapolis, Minnesota, in 2015.

The SWQL project plan for the next five years was approved by the Office of Scientific Quality Review. The new project plan includes four objectives which cover end-use quality test method development, expanded uses of eastern soft wheat for non-conventional and whole wheat foods, grain characteristics associated with flour yield and end-use quality evaluation of wheat breeding lines.

# 2015 SOFT WHEAT QUALITY LAB RESEARCH

## SWQL RESEARCH PROJECTS

The SWQL research team, composed of a lead scientist, two post-doctoral research associates, one visiting scholar, a research support scientist 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, and exploration of the potential uses of eastern soft wheat and whole grain wheat for extended food products. Following the newly approved SWQL five-year project plan, we have continued research on: 1) development of a cake baking test for non-chlorinated flour; 2) quality profiles of eastern soft wheat flour desirable for making steamed bread, 3) varietal variation in wheat bran characteristics and their association with whole wheat pancake and biscuit quality; 4) physical, biochemical and genetic factors associated with flour yield and 5) chromosome 2B type 2 sucrose synthase (*TaSus2-2B*) alleles and their effect on milling quality in wheat.

In collaboration with two Ohio State University faculty members, Drs. Laura Lindsey and Ed Lentz, we have investigated the effects of nitrogen fertilizer application rate on wheat grain characteristics related to milling and baking quality. Changes in grain falling number and α-amylase activity of wheat grain during the grain maturing period and establishing a volatile flavor compound profile of whole grain wheat are other research projects we have been working on since 2015.

We have also cooperatively worked with the following eastern soft wheat breeders: Dr. Jose Costa at the USDA-ARS for mapping soft wheat quality traits using a double haploid mapping population, 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) Quality Requirements of Soft Red Winter Wheat for Making Steamed Bread; 2) Storage Conditions Influence Increase in Falling Number of Wheat Grain; 3) Degree of Starchy Endosperm Separation from Bran as a Milling Quality Trait of Wheat Grain; and 4) Extraction of Soluble Dietary Fibers from Wheat Bran and Barley Grain Using Ultrasonication and Homogenization, were shared with the national and international audience at the American Association of Cereal Chemists International (AACCI) Annual Meeting in September of 2015 in Minneapolis, Minnesota.

The research projects we are currently working on in the SWQL are listed below.

1. **Development of a cake baking test procedure for non-chlorinated flour**
   We intend to develop an experimental cake baking test applicable to non-chlorinated flour. In the first year of the study, we determined that the volume and contour of cakes can be improved with proper selection of baking powder, reduction of sugar in the formula, batter pH reduction to 4.3-4.8 and with the addition of acids and heat treatment of flour. Based on the results, we identified the optimum formula for an experimental cake baking test using non-

chlorinated flour. The performance of this new cake baking test for non-chlorinated flour in differentiating flour quality for baking cakes has been compared to that of the AACCI 10-90 method for chlorinated flour.

2. **Starch amylose content of wheat flour influences the quality of steamed bread prepared from eastern soft red winter wheat**
   Starch constitutes more than 80% of wheat flour; thus its characteristics are believed to considerably influence the textural properties and shelf-life of wheat products. We intended to determine the effects of the starch amylose content of soft red winter (SRW) wheat flour on the quality attributes of steamed bread. SRW wheat flours of varying starch amylose content were prepared by blending wheat flours of normal starch with 0 to 30% waxy wheat flour of 5.1% starch amylose content. Reduction of starch amylose content by the addition of waxy wheat flour generally increased the specific volume and crumb softness of steamed bread. Wheat flour of 22.4 to 24.7% starch amylose content produced steamed bread with superior crumb structure scores without negatively affecting other quality attributes. Wheat flours of less than 20.6% starch amylose content prepared by blending more than 25% waxy wheat flour resulted in a decreased stress relaxation score, crumb structure, surface smoothness and total score. SRW wheat flour blended with 15-20% waxy wheat flour to obtain a starch amylose content of 20.5-22.7% showed retarded staling of steamed bread with comparable quality to the steamed bread of control wheat flour.

3. **Effects of nitrogen fertilizer application rate on the milling and baking quality of soft red winter wheat**
   The proper rate of nitrogen fertilizer application is essential for the improvement of grain yield and protein content, and could affect the grain characteristics related to milling and baking quality. We tested soft red winter wheat grain grown with different nitrogen application rates (0 to 120 lb/acre) for grain characteristics, milling properties, flour composition, solvent retention capacity (SRC) and protein strength. Nitrogen application rate significantly influenced most of the wheat grain quality characteristics, with the exception of flour yield and sodium carbonate SRC. With an increased nitrogen application rate, test weight, grain protein content and kernel hardness increased; kernel diameter and kernel weight decreased; softness equivalence decreased; and flour yield showed little change. Flour protein content, lactic acid SRC and SDS sedimentation volume (measures of protein strength), significantly increased with an increased nitrogen application rate. With increased nitrogen application, water SRC significantly decreased, while little to no change in sodium carbonate SRC of flour was observed. Grain protein content, lactic acid SRC and SDS sedimentation volume of flour increased from 8.4 to 10.5%, from 97.8 to 113.2 % and from 13.2 to 23.3 mL, respectively, with the increase in nitrogen application rate from 0 to 120 lb/acre.

4. **Falling number and quality characteristics of wheat grain harvested at different developmental stages**
   We investigated the changes in falling number (FN) and the quality characteristics of wheat grain during the grain filling period to identify the earliest possible harvest time without deleterious effects on grain quality. One soft white and eight soft red winter wheat varieties

were grown in 2015 in Wooster, Ohio. Each variety was grown in two plots, which were divided into four subplots. Wheat grain was harvested from each subplot at 20, 25, 30 and 35 days post-anthesis (DPA). Kernel weight was maximum at around 30 DPA, and remained constant until 40 DPA. FN of grain was highest at maturity (around 30 DPA) and decreased rapidly after 35 DPA, probably due to rainfall and consequent pre-harvest sprouting. Alpha-amylase activity of grain followed the trend of FN during the grain filling period with a significant negative relationship. Protein content and weight of grain generally increased with maturity, but kernel hardness and ash content decreased. Increases in lactic acid SRC, sodium carbonate SRC, and SDS-sedimentation volume of wheat flour were also observed with the delayed harvest. Soft winter wheat could be harvested after 30 DPA without any significant loss in grain yield and quality, including low FN.

5. **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. Sequence variants in the unexpressed, control region of the gene could influence differential expression. Near-isogenic, homozygous lines (NILs) will be tested for *TaSus2-2B* expression in 2016, grown in the field for harvest and evaluated for milling quality in 2017. 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.

6. **Volatile organic compound profile of soft winter wheat grain**

   To determine the inherent volatile organic compound (VOC) composition of wheat grain, unaffected by extrinsic factors (including fungal infestation and weathering), we analyzed the VOCs of wheat grain harvested at 20, 25, 30, 35, and 40 days post-anthesis (DPA) using gas chromatography. We observed 57 VOCs of wheat grain at 20 DAP, a number that decreased with further maturation. The 57 VOCs included alcohols, aldehydes, ketones, alkanes, alkenes, furans, esters and carbon dioxide and 15 of these were identified. Based on concentration, 3-methyl-1-butanol, 2-methyl-1-butanol, 1-pentanol, hexanal and 1-hexanol were considered to be the prominent VOCs of wheat grain, and largely contribute to wheat grain volatile flavor. Wheat varieties exhibited variation in appearance of volatile compounds during grain developmental stages, but shared similar VOC profiles.

## END-USE QUALITY EVALUATION OF WHEAT BREEDING LINES AND VARIETIES

Sixteen cooperators, including public and private breeding programs of the eastern soft winter wheat and the state variety testing programs, have thus far submitted approximately 4,800 samples harvested in the 2015 crop year for end-use quality evaluation. Five breeding programs are still expected to submit their breeding lines for quality evaluation. Analyses for approximately 60% of the samples received were completed by the end of February, 2016. Milling and baking quality evaluation for the samples from three state variety performance test trials and eight uniform regional cooperative testing trials in the 2015 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, 2016.

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 the breeding stages and screening needs. 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 2008 and 2013. 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) and Overseas Varietal Analysis (OVA) projects in collaboration with the Wheat Quality Council and U.S. Wheat Associates. We obtained wheat grain, milled it and shipped the flour to cooperators in the domestic and overseas milling and baking industries for end-users' evaluations of flour quality and baking performance. In 2015, five entries for the SWQC and 10 entries for the OVA were processed and distributed to cooperators.

# VARIETY DESCRIPTIONS – NEW WHEAT CULTIVARS

The Soft Wheat Quality Laboratory solicits newly and soon to be released varieties for 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 2016. The SWQL thanks each of the cooperating breeders for their collaboration. Collaborating institutions and breeders are listed below followed by breeder's descriptions of their contributed cultivars. The full list of descriptions for cultivars grown at the SWQL is available on the SWQL website.

### Beck's Hybrids - Trek Murray

*Beck 114* *NEW 2016*

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 soil-borne 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.

This smooth headed variety expresses great standability and high test weight every year. Beck 114 has excellent versatility and a tremendous amount of utility for either grain or straw. Beck 114 will be a farmer favorite for high management practices. Beck 114 will be released in 2016 for fall planting.

*Beck 123* *NEW 2016*

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 soil-borne 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 114 will be released in 2016 for fall planting.

*Beck 128* *NEW 2016*

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 soil-borne 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 will be released in 2016 for fall planting.

*Beck 88*
Beck 88 is an awnless, medium height soft red winter wheat with excellent winter hardiness. Beck 88 is blue-green before maturity, extremely early maturing (3 days earlier than Clark) and recommended for double cropping. It has tremendous standability and excellent Scab tolerance. Beck 88 is best suited for growth in Missouri, Illinois, Indiana, Ohio and Kentucky and shows resistance to Septoria leaf blotch, tolerance to Septoria glume blotch, leaf rust, barley yellow dwarf virus and soil-borne wheat mosaic virus. Beck 88 was released in 2014.

Beck 88 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 scab tolerance. Beck 88 opens new opportunities for double crop in Beck's northern market area.

*Beck 125*
Beck 125 is an awned, medium tall soft red winter wheat with outstanding yield, test weight, winter hardiness and standability. 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 soil-borne wheat mosaic virus. Beck 125 is medium green before maturity. Beck 125 was released in 2014.

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. With a gorgeous look at harvest time, Beck 125 is a farmer favorite in a medium maturity. With higher rates of nitrogen. Beck 125 is a broadly adapted, medium early farmer favorite.

## KWS Cereals USA – Jana Murche

*KWS 019* *NEW 2016*
KWS 019 is a high yielding soft white winter wheat bred by KWS and is scheduled for release in 2017. KWS 019 is resistant to stripe rust, leaf rust, and wheat soil-borne mosaic virus and moderately resistant to powdery mildew. KWS 019 has very good standability and is similar in height to P25R47 and slightly shorter than Ambassador. KWS 019 is an apically awnletted, medium maturing, soft white wheat targeted for growing in Michigan and northwest Ohio.

*KWS 034* *NEW 2016*
KWS 034 is a high yielding soft white winter wheat bred by KWS and is scheduled for release in 2017. KWS 034 is resistant to stripe rust, leaf rust, stem rust, wheat soil-borne mosaic virus and powdery mildew. KWS 034 has very good standability and is similar in height to Ambassador. KWS 034 is an apically awnletted, late maturing, soft white wheat targeted for growing in Michigan and northwest Ohio.

*KWS 050* *NEW 2016*
KWS050 is an awnless soft red winter wheat bred by KWS especially for use in the extensive Great Lakes Region market. It is scheduled for release in 2017. KWS050 is very short with excellent straw stiffness to respond well to higher N-input. It is a medium late maturing line with good winter hardiness. KWS050 has very good resistance to powdery mildew, stripe rust and leaf rust, moderate resistance to Fusarium Head Blight and moderately susceptible to Septoria leaf blotch and soil-borne mosaic virus (SBMV). It also showed above average test weight results.

*KWS 052* *NEW 2016*
KWS052 is well rounded soft red winter wheat bred by KWS without major flaws. KWS052 is awned with medium height and medium-early maturity. It has good winter hardiness and good

standability. KWS052 has a good test weight and quality package. It has very good resistance to powdery mildew, stripe rust, leaf rust and SBMV, moderately good resistance to Septoria leaf blotch and scab.

*KWS 053* *NEW 2016*
KWS053 is a high yielding soft red winter wheat bred by KWS and tested well in the entire UMW and LMW SRW region. It is scheduled for release in 2016. KWS053 is an awnletted, average tall, early maturing line with good winter hardiness and good standability. KWS053 has excellent resistance to leaf rust, good resistance to stripe rust, Fusarium Head Blight and SBMV and moderate resistance to powdery mildew and Septoria leaf blotch. KWS053 has shown an excellent test weight.

*KWS023*
KWS023 is a high yielding soft red winter wheat bred by KWS and scheduled for release in 2016. KWS023 is an awnletted, moderately tall, medium maturing line with very strong winter hardiness and standability. KWS023 has very good resistance to leaf rust, good resistance to stem rust, powdery mildew and barley yellow dwarf virus and moderate resistance to stripe rust, Septoria leaf blotch and scab.

*KWS026*
KWS026 is a high yielding soft red winter wheat bred by KWS and scheduled for release in 2016. KWS026 is an awnletted, medium height, medium maturing line with very strong winter hardiness and good standability. KWS026 has a very good test weight and very good resistance to powdery mildew, good resistance to Septoria leaf blotch, scab and barley yellow dwarf virus and moderate resistance to leaf, stem and stripe rust as well as Septoria glume blotch.

*KWS028*
KWS028 is a high yielding soft red winter wheat bred by KWS and scheduled for release in 2016. KWS028 is an awnletted, taller, medium-late maturing line with excellent winter hardiness and good standability. KWS028 has excellent resistance to leaf rust and powdery mildew, good resistance to Septoria leaf blotch, medium-good resistance to scab and moderate resistance to stripe rust.

*KWS033*
KWS033 is a soft white winter wheat bred by KWS and is scheduled for release in 2016. KWS033 is resistant to leaf and stem rust, moderately resistant to powdery mildew and shows an intermediate reaction to stripe rust and wheat soil-borne mosaic virus. KWS 033 is medium height and comparable in height to P25R47. KWS033 is an awnless, medium late maturing, full season, soft white wheat targeted for growing in Michigan and northwest Ohio.

*KWS036*
KWS036 is a soft white winter wheat bred by KWS and is scheduled for release in 2016. KWS036 is resistant to stripe rust and wheat soil-borne mosaic virus and moderately resistant to powdery mildew and leaf rust. KWS036 is medium height and slightly shorter than P25R47. KWS036 is an apically awnletted, medium late maturing, full season, soft white wheat targeted for growing in Michigan and northwest Ohio.

## Michigan State University, Eric Olson

*E6012*
E6012 (Caledonia/P25W33) is a soft white winter wheat adapted to Michigan growing environments. E6012 is fully awned and short statured with white chaff. The early maturity of E6012 will enable growers to spread their maturities from early to late. Yield potential is stable and comparable to contemporary soft white winter wheat varieties grown in Michigan.

The most distinguishing trait E6012 carries is resistance to DON under heavy Fhb pressure. Across four years of evaluation in a misted-inoculated Fhb nursery, E6012 accumulates 6.5 ppm in contrast to DON levels of over 11 ppm in the widely planted varieties AC Mountain, Ambassador and Hopewell (LSD0.05 = 2.3 ppm). The resistance to DON in E6012 is likely conferred in part by a known Fhb resistance QTL carried on chromosome 5A. E6012 Fhb incidence and severity are similar to trial means.

E6012 demonstrated a four-year average yield of 84.8 bu/Ac which is not significantly different (LSD0.05 = 3.9 bu/Ac) from contemporary Michigan soft winter wheat varieties AC Mountain, Aubrey, Hopewell, Jupiter, Shirley and Red Ruby. Although yield potential is not the highest of all varieties tested, yields are not different from contemporary varieties. Yield stability of E6012is improved over varieties that perform well in Michigan but were not developed and selected as varieties in Michigan. An example of contrasting yield stability is the soft red winter wheat variety, Shirley, which has a four-year average of 87.1 bu/Ac and yielded 79.4 bu/Ac in 2014, a 7.7 bu/Ac difference. E6012 has consistently yielded between 84 and 86 bu/Ac each year of testing.

## Rupp Seed – John King

*RS910*
RS910 is an awned, soft red winter wheat with average head size and white chaff. RS910 is tolerant to Scab, Powdery Mildew and Glume Blotch. The variety has excellent test weight, very good winter hardiness, excellent straw strength for standability and produces medium sized seed. The plant is green at early stages, medium height with upright flag leaf and medium late maturity.

*RS9xp511*
RS9xp511 is an awnless, soft red winter wheat with average head size and white chaff. RS910 is resistant to Scab and tolerant to Powdery Mildew and Glume Blotch. The variety has excellent test weight, winter hardiness and straw strength for standability and produces medium sized seed. The plant is green at early stages, medium height with upright flag leaf and medium late maturity.

*RS907*
RS907 is an awned, hard red winter wheat with very good winter hardiness and excellent standability. RS907 is medium height with medium late maturity. It was developed from a unique genetic pool featuring high yields and strong agronomics. RS907 features outstanding test weight and standability. It is highly tolerant to head scab, tolerant to powdery mildew and Septoria glume blotch.

*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.

## Seed Consultants – Bill Mullen

*SC 13S26* *NEW 2016*
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* *NEW 2016*

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* *NEW 2016*
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.

*Evans* *NEW 2016*
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* *NEW 2016*

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.

*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.

*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 – Barton Fogleman**

*SY Viper*

SY Viper (B08-91993) is a medium to medium-tall height, semi-dwarf variety bred by Syngenta Seeds, Inc. It is medium to medium-early in maturity with white chaff and heading date almost three and one-half days earlier than "Oakes". SY Viper (B08-91993) has shown broad adaptation with very good yield performance and test weight across the major wheat growing areas of southeast Missouri, eastern Arkansas, western Tennessee and Kentucky, the 'Delta' region of Mississippi, northern Louisiana, eastern North Carolina, and northeastern South Carolina. It has shown moderate resistance to the current races of powdery mildew and moderate susceptibility to the current races of leaf rust in these areas. Milling and baking characteristics are equivalent to those of soft wheat variety, Jamestown, and SY Viper is intended for grain production.

Syngenta Seeds, Inc. has applied for PVP and AOSCA certification and maintains seed stock and certified classes of Foundation, Registered and Certified. Limited amounts of certified seed stocks of SY Viper will be available in the fall of 2015. Certified acreage is not to be published by AOSCA and certifying agencies. SY Viper may only be sold as a class of certified seed and all seed sales are royalty bearing.

SY Viper was evaluated for the 2015 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.

SY Cypress was evaluated for the 2015 Wheat Quality Council.

*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.

Coker 9553 was evaluated as a check for the 2015 Wheat Quality Council.

## Syngenta, NOAM Cereals - Jennifer Vonderwell

*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.

W1104 was evaluated for the 2015 Wheat Quality Council as a check variety.

*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.

*M11-2024#*

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, soil-borne virus, powdery mildew, leaf rust and stripe rust. It has shown very good milling with average cookie baking properties.

*SY 100 (formerly M10-1100#)*

SY 100 is a soft red winter wheat bred by Syngenta Seeds, Inc. for grain production. SY100 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 2015 Wheat Quality Council as M10-1100#.

*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.

SY 547 was evaluated for the 2015 Wheat Quality Council.

**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 1102 was evaluated for the 2015 Wheat Quality Council.

*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* *NEW 2016*
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 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. 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.

VA11W-279 has exhibited milling and baking qualities that are similar to those of 'Jamestown'. VA11W-279 is resistant Hessian fly biotypes B, C, D, O, and L and 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, bacterial leaf blight (*Xanthomonas campestris*), barley and cereal yellow dwarf viruses, and wheat soil-borne mosaic virus.

*VA11W-313* *NEW - 2016*

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.

*VA12W-72* *NEW - 2016*
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 is a high yielding, awned, moderately early heading, short height semi-dwarf (Rht2) wheat variety that is adapted to the southern and mid-Atlantic SRW wheat regions. VA12W-72 was evaluated at 16 locations in the 2015 USSRWWN, and ranked first among 30 entries for grain yield (78.5 Bu/ac). Average test weight of VA12W-72 (55.9 Lb/Bu) over 15 locations was most similar to that of AGS 2000 (55.5 Lb/Bu).

VA12W-72 has exhibited milling and baking qualities that are most similar to those of 'Jamestown'. VA12W-72 is resistant to Hessian fly biotypes B, C, D, O, and L, and 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, 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.

*'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 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.

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 over all 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).

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 powdery mildew, leaf rust, stripe rust, leaf and glume blotch, bacterial leaf

streak, soil-borne mosaic virus, barley and cereal yellow dwarf viruses, Fusarium head blight, and Hessian fly.

Hilliard 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.

VA 258 was evaluated for the 2016 Soft Wheat Quality Council as a check variety

*VA11W-106*

Soft red winter (SRW) wheat line VA11W-106 was derived from the cross Pioneer Brand '25R47' (PI 631473) / 'Jamestown' (PI 653731).

VA11W-106 is a broadly adapted, high yielding, full-season, medium height, semi-dwarf (gene Rht2) 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. 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 ($P < 0.05$) higher than that of 'USG 3555' (54.4 lb/bu).

VA11W-106 has exhibited milling and baking qualities that are most similar to those of Jamestown and better than those of 'Yorktown'. With the exception of stem rust and Hessian fly, VA11W-106 has expressed moderate to high levels of resistance to powdery mildew, leaf rust, stripe rust, leaf and glume blotch, bacterial leaf streak, barley and cereal yellow dwarf viruses, and Fusarium head blight.

*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-119*

VA10W-119 was derived from the cross KY97C-0540-04 / GA951079-2E31 (PI 644020). Parental line KY97C-0540-04 was derived from the cross 'Coker 9803' (PI 548845) / L910097 // Pioneer Brand '2552' (PI 566924). The parentage of GA951079-2E31 is GA881130 / 'GA-Gore' (PI 561842).

VA10W-119 is an early heading, medium height, semi-dwarf (Rht2) wheat that is broadly adapted, high yielding, and has gene H13 for resistance to Hessian fly. Plants of VA10W-119 are blue-green in color and its awned spikes are slightly tapering to strap in shape.

VA10W-119 was evaluated at 21 locations in the 2012 Uniform Southern SRW Wheat Nursery, and ranked second among 29 entries for grain yield (69.3 Bu/ac). In the 2013 Uniform Southern Nursery, VA10W-119 was evaluated at 18 locations and ranked third among 33 entries in grain yield (76.0 Bu/ac). Average test weight of VA10W-119 in the 2012 nursery (57.8 Lb/Bu) was most similar to AGS 2000 and in the 2013 nursery (57.1 Lb/Bu) was most similar to Pioneer Brand 26R61. Milling and baking quality of VA10W-119 in the 2012 and 2013 Uniform Southern Nurseries was intermediate between those of AGS 2000 and Pioneer Brand 26R61.

VA10W-119 expresses moderate to high levels of resistance to leaf rust and stripe rust, powdery mildew, Fusarium head blight, *Septoria tritici* leaf blotch, *Stagonospora nodorum* glume blotch, barley and cereal yellow dwarf viruses, wheat soil-borne mosaic virus, and most notably Hessian fly.

*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.

MCIA Venus was evaluated for the 2016 Soft Wheat Quality Council as a check variety.

# USDA-ARS 2015 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. The SWQL performs quality evaluations for three main collaborative projects: Soft Wheat Quality Council, Overseas Variety Analysis and Regional Cooperative Nurseries.

## 2015 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 2015 crop year, the eastern soft winter wheat growing region experienced widespread pre-harvest sprouting damage and was unable to procure enough wheat grain free of sprouting damage, limiting the number of entries available for the WQC project. A total of five entries, including two check varieties, were submitted for the WQC project from two wheat breeding programs. The SWQL milled the wheat grain of the submitted entries using a Miag Multomat mill and distributed them 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 March 1-2, 2016, in Cincinnati, OH.

### *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**

AgriMAXX 462
Hilliard
VA 258*

**Eric Olson, Michigan State University**

E 6012
MCIA Venus*

*Check varieties.

## *MILLING AND BAKING RESULTS OF 2015 CROP SWQC ENTRIES REPORTED BY COLLABORATORS AND THE SWQL*

Table 1. Miag Multomat Mill Stream Yields of the 2015 crop SWQC Entries by SWQL

| Mill Stream | AgriMAXX 462 | Hilliard | VA 258* | E 6012 | MCIA Venus* |
|---|---|---|---|---|---|
| 1st Break | 6.7 | 12.0 | 7.0 | 8.3 | 5.9 |
| 2nd Break | 6.9 | 13.3 | 8.5 | 9.0 | 4.1 |
| Grader | 3.0 | 4.8 | 4.8 | 3.8 | 2.4 |
| 3rd Break | 9.6 | 7.2 | 6.4 | 8.5 | 12.0 |
| Total Brk | 26.2 | 37.3 | 26.8 | 29.7 | 24.3 |
| | | | | | |
| 1st Middlings | 11.5 | 9.8 | 9.6 | 10.6 | 8.8 |
| 2nd Middlings | 16.0 | 10.3 | 14.7 | 14.5 | 15.6 |
| 3rd Middlings | 6.7 | 2.9 | 7.6 | 6.6 | 11.5 |
| Re-Dust | 7.5 | 5.7 | 7.3 | 6.5 | 5.9 |
| 4th Middlings | 2.9 | 1.8 | 4.4 | 3.6 | 6.9 |
| 5th Middlings | 1.1 | 1.0 | 1.8 | 1.4 | 1.6 |
| Total Middlings | 45.6 | 31.5 | 45.5 | 43.3 | 50.5 |
| | | | | | |
| Straight Grade | 71.8 | 68.8 | 72.2 | 73.0 | 74.8 |
| | | | | | |
| Break Shorts | 6.2 | 6.6 | 6.1 | 5.6 | 6.4 |
| Red Dog | 0.7 | 0.6 | 0.9 | 0.7 | 0.6 |
| Tail Shorts | 0.3 | 0.2 | 0.4 | 0.2 | 0.2 |
| Bran | 19.9 | 22.8 | 20.0 | 20.4 | 17.9 |
| Total Byproduct | 27.2 | 30.2 | 27.4 | 27.0 | 25.2 |

*Check varieties.

## *WHEAT GRAIN AND FLOUR CHARACTERISTICS OF 2015 CROP SWQC ENTRIES*

Table 2. Grain characteristics, SKCS test parameters 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 | AgriMAXX 462 | 57.9 | 9.9 | 366 | 54.3 | 30.7 | 2.7 |
| 1 | Hilliard | 58.5 | 11.0 | 398 | 13.4 | 26.5 | 2.6 |
| 1 | VA 258* | 60.0 | 9.4 | 369 | 29.4 | 32.4 | 2.6 |
| 2 | E 6012 | 59.8 | 11.0 | 355 | 24.0 | 31.8 | 2.6 |
| 2 | MCIA Venus* | 60.8 | 9.0 | 384 | 39.9 | 39.3 | 2.8 |

*Check varieties.

Table 3. Milling quality parameters of the entries by USDA-ARS Soft Wheat Quality Laboratory

| Group | Entry | Miag Milling Quality | | Qudrumat Milling Quality | |
|---|---|---|---|---|---|
| | | Break Flour Yield (%) | Straight Grade Flour Yield (%) | Flour Yield (%) | Softness Equivalence (%) |
| 1 | AgriMAXX 462 | 26.2 | 71.8 | 68.5 | 51.5 |
| 1 | Hilliard | 37.3 | 68.8 | 68.5 | 64.8 |
| 1 | VA 258* | 26.8 | 72.2 | 67.3 | 54.5 |
| 2 | E 6012 | 29.7 | 73.0 | 68.6 | 57.0 |
| 2 | MCIA Venus* | 24.3 | 74.8 | 69.4 | 43.9 |

*Check varieties.

Table 4. Flour quality test parameters by USDA-ARS Soft Wheat Quality Laboratory, 2015 crop SWQC

| Group | Entry | Moisture (%) | Protein (%, 14% mb) | pH | α-amylase Activity | Starch Damage (%) | Flour Ash (%, 14% mb) |
|---|---|---|---|---|---|---|---|
| 1 | AgriMAXX 462 | 12.5 | 8.3 | 6.0 | 0.09 | 5.8 | 0.38 |
| 1 | Hilliard | 12.5 | 9.0 | 6.1 | 0.04 | 2.2 | 0.41 |
| 1 | VA 258* | 12.3 | 8.1 | 6.0 | 0.04 | 3.4 | 0.43 |
| 2 | E 6012 | 12.2 | 9.7 | 6.0 | 0.05 | 2.8 | 0.47 |
| 2 | MCIA Venus* | 12.2 | 7.4 | 6.1 | 0.02 | 6.8 | 0.41 |

*Check varieties.

## *SUMMARIES AND STATISTICS OF COMBINED COOPERATOR TEST PARAMETERS OF 2015 CROP SWQC ENTRIES*

Table 5. Mean SRC test parameters and overall flour quality scores by ten cooperators (n=10), 2015 crop SWQC[a]

| Group | Entry | Solvent Retention Capacity (%)* | | | | Flour Quality Score* |
|---|---|---|---|---|---|---|
| | | Water | Sodium Carbonate | Sucrose | Lactic Acid | |
| 1 | AgriMAXX 462 | 61.7 a | 80.0 a | 106.2 a | 129.4 a | 4.5 b |
| 1 | Hilliard | 55.4 b | 78.0 a | 107.5 a | 123.4 a | 6.0 a |
| 1 | VA 258* | 57.8 b | 80.6 a | 112.8 a | 115.9 a | 5.8 ab |
| 2 | E 6012 | 53.0 b | 72.3 a | 97.3 a | 102.1 a | 6.0 a |
| 2 | MCIA Venus* | 58.7 a | 75.3 a | 95.0 a | 77.3 b | 5.3 a |

*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 two collaborators (n=1) 2015 crop SWQC

| Group | Entry | Alveograph | | | |
|---|---|---|---|---|---|
| | | P | L | P/L Ratio | W |
| 1 | AgriMAXX 462 | 73.9 | 48.8 | 1.5 | 159.6 |
| 1 | Hilliard | 43.8 | 95.6 | 0.5 | 123.9 |
| 1 | VA 258* | 51.3 | 101.0 | 0.5 | 128.2 |
| 2 | E 6012 | 35.1 | 162.6 | 0.2 | 137.6 |
| 2 | MCIA Venus* | 58.9 | 37.0 | 1.6 | 86.7 |

*Check varieties.

Table 7. Mean Farinograph test parameters by two collaborators (n=2) 2015 crop SWQC

| Group | Entry | Farinograph (n=2)* | | | |
|---|---|---|---|---|---|
| | | Water Absorption (%) | Development Time (min) | Stability (min) | Mixing Tolerance Index (BU) |
| 1 | AgriMAXX 462 | 57.2 a | 1.3 a | 2.0 b | 97.0 |
| 1 | Hilliard | 54.0 a | 1.5 a | 4.7 a | 68.0 |
| 1 | VA 258* | 54.8 a | 1.7 a | 4.5 a | 82.0 |
| 2 | E 6012 | 52.7 a | 2.1 a | 8.2 a | 49.0 |
| 2 | MCIA Venus* | 57.7 a | 1.1 a | 2.4 b | 122.0 |

*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 2015 crop SWQC

| 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 | AgriMAXX 462 | 5.6 a | 1851 c | 898 c | 952 a | 887 a | 1998 c | 67 a | 0.93 a |
| 1 | Hilliard | 6.0 a | 3385 a | 2059 a | 1326 a | 1365 a | 3699 a | 71 a | 0.92 a |
| 1 | VA 258* | 6.0 a | 2551 b | 1477 b | 1074 a | 1113 a | 2841 b | 68 a | 0.90 a |
| 2 | E 6012 | 6.1 a | 2746 a | 1496 a | 1250 a | 1072 a | 2868 a | 77 a | 0.96 a |
| 2 | MCIA Venus* | 6.0 a | 1774 b | 1340 a | 434 b | 1238 a | 2683 a | 60 a | 0.66 b |

*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=4) & 10-52 (n=4)) parameters, 2015 crop SWQC

| | | Sugar-Snap Cookie (10-50D) | | | | Sugar-Snap Cookie (10-52) | Overall Product Quality Score |
|---|---|---|---|---|---|---|---|
| | | Width (mm) | Thickness (mm) | W/T Ratio (mm) | Spread Factor | Width (cm) | |
| 1 | AgriMAXX 462 | 449 c | 69 a | 6.5 c | 64 b | 16.0 b | 3.0 b |
| 1 | Hilliard | 490 a | 60 b | 8.1 a | 80 a | 17.4 a | 5.9 a |
| 1 | VA 258* | 474 b | 62 b | 7.6 b | 75 a | 17.0 a | 4.6 a |
| 2 | E 6012 | 491 a | 62 b | 7.9 a | 78 a | 17.7 a | 5.9 a |
| 2 | MCIA Venus* | 456 b | 70 a | 6.5 b | 63 b | 16.9 b | 4.1 b |

*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 2015 crop SWQC

| Group | Entry | Sponge Cake | |
|---|---|---|---|
| | | Volume (mL) | Texture Score |
| 1 | AgriMAXX 462 | 1032 a | 26 a |
| 1 | Hilliard | 1175 a | 30 a |
| 1 | VA 258* | 1170 a | 27 a |
| 2 | E 6012 | 1116 a | 32 a |
| 2 | MCIA Venus* | 1125 a | 33 a |

*Check varieties.

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

## *GENOTYPING FOR QUALITY TRAITS: 2015 SOFT WHEAT QUALITY COUNCIL*

Anne Sturbaum, January, 2016

Genotyping for traits associated with quality, physiology and disease resistance was done at the Regional Small Grains Genotyping Laboratory (RSGGL) in Raleigh, N.C. for the three WQC entries, AgriMAXX 462, Hilliard and E6012 with check varieties VA 258 and Venus.

**Quality**

High molecular weight glutenins, especially the alleles for Dx5 ("5+10") at *Glu-D1*, the over expressed Bx7 subunit at *Glu-B1* and Ax2* at the *Glu-A1* 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 *Glu-A1, Glu-B1* and *Glu-D1* loci involved in selecting for varieties with specific dough quality.

Amplification for high molecular weight glutenins at the *Glu-A1* locus, adapted from the marker umn19 (Liu et al., 2008a) identified the Ax2* genotype in the WQC entries Hilliard, VA 258 and Venus. AgriMAXX 462 and E6012 have the Ax1 or null alleles at the *GluA1* locus.

None of the cultivars have the overexpressing the *Glu-B1* 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 *Glu-D1* alleles Dx5 and Dx2 generated a PCR product corresponding to the "5+10" strong gluten allele for AgriMAXX 462 and "2+12" for Hilliard, E6012 and Venus. VA 258 was heterozygous at the *Glu-D1* 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). None of the five cultivars tested have the 1RS/1BR translocation.

All cultivars in this set produced the anticipated banding patterns for normal amylose genotypes (non-waxy) at the A, B and D, Granule Bound Starch Synthase (GBSS) loci (Nakamura et al., 2002).

**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 five WQC varieties lack photoperiod sensitivity through one or more of the mutant photoperiod alleles described above. All WQC varieties are homozygous for the mutant form of the *Ppd-D1* gene (*Ppd-D1a*). In addition, Hilliard is heterozygous at the *Ppd-A1* locus.

Dwarfing genes were tested using markers specific for reduced height genes *Rht-B1* and *Rht-D1* (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). All five WQC varieties were homozygous for the single dwarfing allele, *Rht-D1b*.

**Disease Resistance**

Markers identifying resistance genes to stem (Sr), leaf (Lr) and stripe (Yr) rusts, fusarium head blight (FHB) and tan spot (Tsn1) were assayed at the RSGGL for WQC varieties. Resistance to fusarium head blight was evaluated using markers associated with QTL on chromosomes 3BS (*Fhb-1*) (Liu et al., 2008b), 2DL (*Fhb-2DL*) (Somers et al., 2003), and 5A (*Fhb-5A* Ernie and *Fhb-5A* Ning) (McCartney et al., 2007). Varieties were evaluated for the rust resistance genes (Sr2, Sr36, Sr38, L9) and multiple stem, leaf and stripe rust resistance loci (Sr24/Lr24, Lr34/Yr18 and Yr17/Lr37/Sr38). Markers, protocols and references for the disease resistance loci can be found on the MASWheat website: http://maswheat.ucdavis.edu/protocols/index.htm.

The only resistance gene detected in the set was the fusarium head blight resistance gene, Fhb5A-Ernie, present in E6012.

The preferred haplotype for sucrose synthase 2B (HapH for high grain weight) was absent in all cultivars of this WQC set.

Table 11. Genotypes 2015 WQC cultivars[a]

| Cultivar | Dwarfing | Photoperiod Insensitivity | High Molecular Weight Glutenins* | | | 1RS RyeTL | Sucrose Synthase HapH | Disease Resistance |
|---|---|---|---|---|---|---|---|---|
| | | | *GluA1 Ax2** | *GluB1 Bx7OE* | *GluD1 Dx5+10* | | | |
| **AgriMAXX 462** | ***Rht-D1b*** | ***D1a*** | Ax1 or null | no | **5+10** | no | no | none detected |
| **Hilliard** | ***Rht-D1b*** | ***D1a, A1a Het*** | **Ax2*** | no | 2+12 | no | no | none detected |
| **VA 258** | ***Rht-D1b*** | ***D1a*** | **Ax2*** | no | Het | no | no | none detected |
| **E6012** | ***Rht-D1b*** | ***D1a*** | Ax1 or null | no | 2+12 | no | no | **Fhb 5A Ernie** |
| **MCIA Venus** | ***Rht-D1b*** | ***D1a*** | **Ax2*** | no | 2+12 | no | no | none detected |

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

[a]A preferred allele is presented in bold type.

**Genotyping References**


Beales, J., Turner, A., Griffiths, S., Snape, J.W., and Laurie, D.A. (2007). A pseudo-response regulator is misexpressed in the photoperiod insensitive Ppd-D1a mutant of wheat (*Triticum aestivum L.*). TAG Theor. Appl. Genet. Theor. Angew. Genet. 115, 721–733.

Díaz, A., Zikhali, M., Turner, A.S., Isaac, P., and Laurie, D.A. (2012). Copy Number Variation Affecting the Photoperiod-B1 and Vernalization-A1 Genes Is Associated with Altered Flowering Time in Wheat (*Triticum aestivum*). PLoS ONE 7, e33234.

Guttieri, M., A. Sturbaum, Smith, N., and Sneller, C. (2008). Optimized PCR Primer Set for Determining Gluten Strength Quality in soft wheat germplasm (Plant and Animal Genome 2008).

Liu, S., Chao, S., and Anderson, J.A. (2008a). New DNA markers for high molecular weight glutenin subunits in wheat. Theor. Appl. Genet. 118, 177–183.

Liu, S., Pumphrey, M.O., Gill, B.S., Trick, H.N., Zhang, J.X., Dolezel, J., Chalhoub, B., and Anderson, J.A. (2008b). Toward positional cloning of *Fhb1* , a major QTL for Fusarium head blight resistance in wheat. Cereal Res. Commun. 36, 195–201.

Ma, W., Zhang, W., and Gale, K.R. (2003). Multiplex-PCR typing of high molecular weight glutenin alleles in wheat. Euphytica 134, 51–60.

McCartney, C.A., Somers, D.J., Fedak, G., DePauw, R.M., Thomas, J., Fox, S.L., Humphreys, D.G., Lukow, O., Savard, M.E., McCallum, B.D., et al. (2007). The evaluation of FHB resistance QTLs introgressed into elite Canadian spring wheat germplasm. Mol. Breed. 20, 209–221.

Nakamura, T., Vrinten, P., Saito, M., and Konda, M. (2002). Rapid classification of partial waxy wheats using PCR-based markers. Genome Natl. Res. Counc. Can. Génome Cons. Natl. Rech. Can. 45, 1150–1156.

Nishida, H., Yoshida, T., Kawakami, K., Fujita, M., Long, B., Akashi, Y., Laurie, D.A., and Kato, K. (2013). Structural variation in the 5′ upstream region of photoperiod-insensitive alleles *Ppd-A1a* and *Ppd-B1a* identified in hexaploid wheat (*Triticum aestivum L.*), and their effect on heading time. Mol. Breed. 31, 27–37.

Saal, B., and Wricke, G. (1999). Development of simple sequence repeat markers in rye (*Secale cereale L.*). Genome 42, 964–972.

Somers, D.J., Fedak, G., and Savard, M. (2003). Molecular mapping of novel genes controlling Fusarium head blight resistance and deoxynivalenol accumulation in spring wheat. Genome Natl. Res. Counc. Can. Génome Cons. Natl. Rech. Can. 46, 555–564.

Wan, Y., Yan, Z., Liu, K., Zheng, Y., D'Ovidio, R., Shewry, P.R., Halford, N.G., and Wang, D. (2005). Comparative analysis of the D genome-encoded high-molecular weight subunits of glutenin. Theor. Appl. Genet. 111, 1183–1190.

Zhang, X., Yang, S., Zhou, Y., He, Z., and Xia, X. (2006). Distribution of the *Rht-B1b, Rht-D1b* and *Rht8* reduced height genes in autumn-sown Chinese wheats detected by molecular markers. Euphytica 152, 109–116.

## OVERSEAS VARIETAL ANALYSIS OF 2014 CROP ENTRIES

### *EXECUTIVE SUMMARY OF INTERNATIONAL COOPERATORS' RESULTS*

### Wheat Sources and Characteristics

The 2014 U.S. Wheat Associates Overseas Varietal Analysis project evaluated ten soft red winter wheat (SRW) varieties: LCS News and WB-196 from Ohio; Yorktown and Jamestown from Virginia; TV 8525 and TV 8535 from Louisiana; and USG 3612, USG 3120, SY Harrison and Oakes from North Carolina. The grain samples of WB-196, Yorktown, Jamestown, USG 3120 and Oakes were graded U.S. #1. LCS News, TV 8525, TV 8535, USG 3612 and SY Harrison were graded U.S. #2 due to low test weight. TV 8525 contained 3.3% damaged kernels, which also would have graded it #2. Wheat grain samples were evaluated for grain characteristics, milled using a Miag Multomat pilot mill, and assessed for flour composition, solvent absorption characteristics 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, OR. Flour samples were further tested by nine overseas cooperators from the Dominican Republic, Indonesia, Malaysia, Mexico, the Philippines and Thailand for making cookies, sponge cakes, and chiffon cakes.

The ten OVA varieties ranged from 58.0 to 63.7 lb/bu in test weight, 29.8 to 38.0 g in 1000 kernel weight, 7.5 to 9.6% in grain protein content (12% moisture basis) and 7.4 to 24.0 in single kernel characterization system (SKCS) kernel hardness. Falling number of grain ranged from 292 sec in TV 8525 to 356 sec in USG 3120. Flour yield of the ten entries ranged from 70.4 to 73.8%, with a flour ash content (14% moisture basis) of 0.31 to 0.42%. Flour protein content (14% moisture basis) was lowest in WB-196 (5.9%) and highest in USG 3120 (8.0%). Flours exhibited water and sodium carbonate Solvent Retention Capacities (SRCs) of 53.3 to 61.3% and 67.7 to 83.5%, respectively. The ten varieties showed relatively small differences in sucrose and lactic acid SRC values, which ranged from 90.6 to 108.1% and 80.4 to 107.0%, respectively. Jamestown had the longest farinograph peak time of 1.7 min, followed by Yorktown and TV 8535. USG 3120, which was highest in flour protein content, showed a much higher dough stability of 4.4 min than other varieties which had dough stabilities lower than 1.7 min. Jamestown and USG 3120 exhibited alveograph W values of over 122 x $10^{-4}$ joules, whereas the W values of other varieties were lower than 96 x $10^{-4}$ joules, producing relatively strong and stable dough. USG 3612, SY Harrison, TV 8535 and WB-196 produced sugar-snap cookies with a diameter greater than 18.0 cm, while cookie diameters of Yorktown and Jamestown were lower than 16.9 cm.

The summary that follows is primarily based on the rankings in Table 21. The relative ranks of SRW varieties for baking cookies, sponge cakes and chiffon cakes varied widely among cooperators, possibly due to differences in formulas, baking procedures and preferences.

**Product Preferences**

1) Among all cooperators that evaluated the entries for baking cookies, WB-196 was ranked highest with an average ranking of 3.5, followed by LCS News, Jamestown, Oakes, Yorktown and TV 8535, all of which were rated higher than the average ranking of the cooperator standard flours (controls). USG 3612 showed the lowest average ranking of 7.8 for baking cookies.
2) For baking sponge cakes, the cooperator standard flours exhibited a higher average ranking of 3.4 than the OVA varieties. Among the OVA varieties, SY Harrison exhibited the highest ranking (3.6), followed by TV 8535 (4.6) and USG 3120 (4.8).
3) USG 3120 performed best for baking chiffon cakes among the ten varieties with an average ranking of 2.7, followed by USG 3612 (3.0), Jamestown (4.0) and Oakes (5.0). LCS News and TV 8525 exhibited the lowest average rankings of 10. The cooperator standard flours had a higher average ranking of 2.3 than any of the ten SRW wheat varieties.
4) The rankings of SRW wheat flours for baking cookies showed negative relationships with those for making sponge cakes ($r = -0.4$, $P < 0.1$) and chiffon cakes ($r = -0.5$, $P < 0.1$). The rankings for baking sponge cakes are correlated with those for baking chiffon cakes ($r = 0.50$, $P < 0.1$).

Jamestown exhibited the highest overall average ranking (4.9) for preparation of cookies, sponge cakes and chiffon cakes, followed by Oakes (5.4), SY Harrison (5.6) and USG 3120 (5.7). TV 8525 ranked last in the overall average ranking, due to its ranking lowest for baking chiffon cakes and its relatively low rankings for making cookies and sponge 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 test performed by the SWQL (Table 12, Table 13, Table 14), and the rankings and desirability scores for making cookies, sponge cakes, chiffon cakes and steam buns (Table 16, Table 17, Table 18Table 19,Table 21 and Table 21).

**LCS News** exhibited grain characteristics, flour yield and flour composition values close to the average of the ten OVA varieties tested. LCS News had relatively higher water, sodium carbonate, sucrose and lactic acid SRC values than the averages of the ten entries. Despite its soft kernel texture, low protein content, low starch damage and weak protein, LCS News produced cookies of average diameter, probably due to the relatively high SRC scores.

LCS News was rated high for making cookies, but low for making sponge cakes and chiffon cakes. It received above average desirability scores for flour characteristics, cookie dough properties and cookie baking quality, but received poor desirability scores for cake batter properties, and sponge cake and chiffon cake quality.

**WB-196** had the lowest grain and flour protein content, kernel hardness, and SDS sedimentation volume. The water, sodium carbonate and sucrose SRC values of WB-196 were close to the average of the ten entries, but the lactic acid SRC of WB-196 was second lowest among the entries. WB-196 produced sugar-snap cookies of average diameter.

WB-196 was rated best for making cookies by the cooperators, but low for making sponge and chiffon cakes. It had the lowest desirability scores of flour for making cookies and sponge cakes, and ranked slightly above the average of the entries for making chiffon cakes. Desirability scores of WB-196 were intermediate for cookie dough and cake batter properties, high for cookie quality, and low for sponge and chiffon cake quality.

**Yorktown** exhibited the highest kernel hardness, intermediate protein content and strength, low flour yield, and the lowest values for all four SRC tests, producing sugar-snap cookies of the smallest diameter.

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

**Jamestown** had the highest grain protein content and SDS sedimentation volume, relatively high kernel hardness, high in all four SRC test values, and produced the second smallest sugar-snap cookies.

Jamestown ranked higher than the median of the entries for making cookies, sponge cakes and chiffon cakes. The desirability scores of flour characteristics were highest for making cookies and sponge cakes, and second highest for making chiffon cakes. It had the best cookie dough property scores, average cake batter property scores, near average scores for cookie and sponge cake quality, and the second highest score for chiffon cake quality.

**TV 8525** exhibited low kernel hardness, and was intermediate in grain protein content, protein strength, all four SRC values and cookie diameter. The quality ranking was relatively low for making cookies, intermediate for sponge cakes and lowest for chiffon cakes. Flour desirability scores for making cookies and cakes were either lowest or close to the lowest. Desirability scores for cookie dough and cake batter properties were intermediate or higher. TV 8525 produced intermediate quality cookies and sponge cakes, and the lowest quality chiffon cakes.

**TV 8535** had above average grain protein content, below average kernel hardness, excellent flour milling yield, above average protein strength, the lowest water SRC value, low sodium carbonate and sucrose SRC values, the second highest lactic acid SRC value, and produced sugar-snap cookies of large diameter. It ranked intermediate for making cookies, high for sponge cakes and low for chiffon cakes. The desirability scores of flour characteristics were intermediate for making cookies and sponge cakes, but low for chiffon cakes. It was rated as intermediately desirable in cookie dough and cake batter properties, and intermediate for cookie and sponge cake quality, but poor for chiffon cake quality.

**USG 3612** had low protein content, a low kernel hardness score, weak protein, and intermediate to low water, sodium carbonate and sucrose SRC values. With the lowest lactic acid SRC value, it produced the largest sugar-snap cookies. With low desirability scores for flour characteristics, and

intermediate to low desirability scores for cookie dough and cake batter properties, it received low to medium desirability scores for cookie, sponge cake and chiffon cake quality.

**USG 3120** had the highest grain protein content, intermediate kernel hardness, and near average protein strength and four SRC values, and produced small cookies. It ranked low for making cookies, but near the top for sponge cakes and chiffon cakes. Flour characteristics were rated as mediocre for making cookies and sponge cakes, but poor for chiffon cakes. Cookie dough and cake batter properties were mediocre or less. Its desirability scores were lower than average for cookie quality, but highest for sponge cake quality and high for chiffon cake quality.

**SY Harrison** was high in grain protein content, low in kernel hardness, intermediate in protein strength and relatively low in all four SRC values, and produced sugar-snap cookies of the second largest diameter. It ranked lower than the median for making cookies, highest among the entries for sponge cakes, and average for chiffon cakes. The desirability scores of flour characteristics were intermediate for making cookies and sponge cakes, but low for chiffon cakes. SY Harrison exhibited intermediate desirability scores for cookie dough and cake batter properties, low scores for cookie quality, but above average scores for sponge cake and chiffon cake quality.

**Oakes** had intermediate grain protein content, relatively high kernel hardness, below average flour yield, above average protein strength, and low water, sodium carbonate and sucrose SRC values, but a high lactic acid SRC value. It produced cookies of intermediate diameter. Oakes was ranked better than the average for making cookies and chiffon cakes, and intermediate for sponge cakes. Flour characteristics received intermediate desirability scores for making cookies and sponge cakes, but the highest score for chiffon cakes. The desirability scores for cookie dough and cake batter properties ranged from the lowest to intermediate. Oakes received near intermediate desirability scores for cookie, sponge cake and chiffon cake quality.

**Recommendations for Class**

This year's OVA entries exhibited the typical grain and flour quality characteristics of SRW wheat, with flour yield ranging from 70.4 to 73.8%, grain protein content from 7.5 to 9.6% and kernel hardness from 7.4 to 24.0 (Table 13 andTable 14). With water SRCs less than 6.13%, sodium carbonate SRCs less than 83.5%, and sucrose SRCs less than 108%, all the entries appear to be suitable for making baked soft wheat products with low moisture content such as cookies. With lactic acid SRCs less than 107% (indicative of relatively weak protein), they would not be suitable for producing soft wheat products requiring gluten development and intermediate protein strength such as crackers. Varietal differences were evident in grain and flour characteristics, especially for kernel hardness, SDS sedimentation volume and lactic acid SRC. SKCS kernel hardness was less than 9.9 in WB-196, TV 8525, USG 3612 and SY Harrison, while it was greater than 22.7 in Yorktown, Jamestown and Oakes. The lowest SDS sedimentation volume of 12 was observed in WB-196 and the highest volume of 25 in Jamestown. USG 3612 produced sugar-snap cookies of the largest diameter and Yorktown the smallest.

As observed in the previous year's study, the cooperators' preference rankings of the ten varieties for making cookies, sponge cakes and chiffon cakes are quite different, exhibiting relatively large variation among the cooperators in the assigned ranking of each entry for baking each product

(Table 21). The large differences in cooperators' preferences of the ten varieties for baking each product proved challenging in the selection of universally satisfactory varieties. WB-196 received the highest average ranking for baking cookies, and USG 3612 the lowest. WB-196 had the lowest SKCS kernel hardness, suggesting the importance of kernel hardness for baking cookies. USG 3612 produced sugar-snap cookies of the largest diameter in the SWQL test; however, this result disagrees with the cooperators' ranking, thus illustrating the challenge associated with the reliable evaluation of baking quality using the sugar-snap cookie baking test for overseas markets. WB-196 was, however, the lowest ranked variety for baking sponge cakes. SY Harrison received the highest ranking for baking sponge cakes. USG 3120 was ranked highest for baking chiffon cakes, while LCS News and TV 8525 were ranked lowest.

Compared to the cooperator standard flours (controls), six SRW wheat varieties received higher rankings for baking cookies. While none showed better rankings for baking sponge cakes and chiffon cakes than the control flours, SY Harrison and USG 3120 had rankings comparable to the control flour for baking sponge cakes and chiffon cakes, respectively.

Table 12. Yield of flour mill streams of ten 2014 OVA soft red winter wheat varieties

| Flour Stream | LCS News | WB-196 | Yorktown | Jamestown | TV 8525 | TV 8535 | USG 3612 | USG 3120 | SY Harrison | Oakes | Mean | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st Bk | 10.0 | 10.0 | 10.1 | 8.4 | 10.1 | 8.9 | 10.6 | 9.0 | 10.3 | 8.8 | 9.6 | 8.4 | 10.6 |
| 2nd Bk | 10.5 | 9.6 | 9.2 | 8.0 | 13.1 | 9.0 | 11.5 | 9.2 | 11.4 | 9.6 | 10.1 | 8.0 | 13.1 |
| Grader | 4.6 | 4.1 | 4.1 | 3.8 | 5.7 | 4.4 | 4.2 | 4.3 | 5.1 | 4.4 | 4.5 | 3.8 | 5.7 |
| 3rd Bk | 8.5 | 9.3 | 10.4 | 8.6 | 8.0 | 7.9 | 7.3 | 8.3 | 7.8 | 6.8 | 8.3 | 6.8 | 10.4 |
| **Total Break** | **33.6** | **33.0** | **33.8** | **28.7** | **36.8** | **30.2** | **33.5** | **30.8** | **34.6** | **29.7** | **32.5** | **28.7** | **36.8** |
| 1st Mids | 9.0 | 10.2 | 8.1 | 9.6 | 8.9 | 12.3 | 10.2 | 11.0 | 10.6 | 11.2 | 10.1 | 8.1 | 12.3 |
| 2nd Mids | 13.7 | 13.6 | 12.4 | 14.2 | 12.7 | 14.5 | 12.4 | 13.6 | 12.4 | 13.6 | 13.3 | 12.4 | 14.5 |
| 3rd Mids | 5.5 | 6.3 | 6.4 | 7.5 | 4.7 | 7.6 | 4.8 | 6.3 | 4.9 | 5.4 | 6.0 | 4.7 | 7.6 |
| Redust | 5.1 | 5.3 | 4.1 | 5.8 | 5.2 | 4.9 | 5.2 | 6.6 | 6.0 | 6.7 | 5.5 | 4.1 | 6.7 |
| 4th Mids | 3.5 | 3.6 | 4.0 | 4.5 | 2.5 | 2.5 | 2.8 | 3.2 | 2.7 | 3.2 | 3.3 | 2.5 | 4.5 |
| 5th Mids | 1.8 | 1.7 | 2.3 | 1.8 | 1.2 | 1.0 | 1.4 | 1.3 | 1.3 | 1.4 | 1.5 | 1.0 | 2.3 |
| **Total Mids** | **38.6** | **40.7** | **37.3** | **43.6** | **35.2** | **42.9** | **36.9** | **42.1** | **38.0** | **41.5** | **39.7** | **35.2** | **43.6** |
| **Total Flour** | **72.3** | **73.8** | **71.0** | **72.3** | **72.0** | **73.2** | **70.4** | **72.9** | **72.5** | **71.1** | **72.1** | **70.4** | **73.8** |
| Bk Shorts | 9.1 | 7.5 | 8.8 | 7.9 | 7.4 | 6.3 | 7.6 | 6.3 | 6.3 | 6.4 | 7.4 | 6.3 | 9.1 |
| Red Dog | 1.3 | 1.1 | 1.7 | 1.2 | 0.9 | 0.7 | 1.0 | 0.9 | 0.8 | 0.8 | 1.0 | 0.7 | 1.7 |
| Tail Shorts | 0.7 | 0.6 | 0.7 | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 | 0.4 | 0.7 |
| Bran | 16.6 | 17.0 | 17.6 | 17.8 | 18.9 | 18.8 | 20.0 | 19.2 | 19.7 | 20.9 | 18.7 | 16.6 | 20.9 |
| **Total Byproduct** | **27.7** | **26.1** | **28.7** | **27.4** | **27.7** | **26.3** | **29.2** | **26.9** | **27.2** | **28.6** | **27.6** | **26.1** | **29.2** |

Table 13. Grain Characteristics of 2014 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) |
|---|---|---|---|---|---|---|
| LCS News | 59.8 | 8.7 | 11.2 | 36.6 | 2.5 | 301 |
| WB-196 | 60.0 | 7.5 | 7.4 | 34.0 | 2.3 | 315 |
| Yorktown | 61.2 | 8.5 | 24.0 | 38.0 | 2.4 | 341 |
| Jamestown | 63.7 | 9.6 | 22.7 | 33.5 | 2.6 | 319 |
| TV 8525 | 59.3 | 8.6 | 8.8 | 36.8 | 2.4 | 292 |
| TV 8535 | 58.0 | 9.2 | 13.6 | 29.8 | 2.2 | 305 |
| USG 3612 | 58.8 | 8.1 | 9.9 | 37.4 | 2.4 | 355 |
| USG 3120 | 60.6 | 9.6 | 15.7 | 37.1 | 2.5 | 356 |
| SY Harrison | 59.4 | 9.0 | 7.5 | 36.0 | 2.8 | 334 |
| Oakes | 61.5 | 8.9 | 22.9 | 32.7 | 2.7 | 352 |

Table 14. Milling Yield, Composition, Falling Number and Solvent Retention Capacities of 2014 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 (%) |
| LCS News | 33.6 | 72.3 | 6.4 | 0.36 | 16 | 92.8 | 0.018 | 2.40 | 61.0 | 78.7 | 102.2 | 99.9 |
| WB-196 | 33.0 | 73.8 | 5.9 | 0.36 | 12 | 93.4 | 0.031 | 2.56 | 56.9 | 74.5 | 97.4 | 86.9 |
| Yorktown | 33.8 | 71.0 | 6.8 | 0.42 | 19 | 93.0 | 0.014 | 3.62 | 61.3 | 83.5 | 108.1 | 107.0 |
| Jamestown | 28.7 | 72.3 | 7.7 | 0.40 | 25 | 92.9 | 0.037 | 4.00 | 59.0 | 78.2 | 100.3 | 99.9 |
| TV 8525 | 36.8 | 72.0 | 6.6 | 0.35 | 16 | 93.0 | 0.014 | 2.54 | 56.1 | 79.5 | 99.1 | 97.4 |
| TV 8535 | 30.2 | 73.2 | 7.5 | 0.31 | 20 | 92.6 | 0.038 | 2.81 | 53.3 | 71.7 | 90.9 | 101.9 |
| USG 3612 | 33.5 | 70.4 | 6.3 | 0.35 | 13 | 93.0 | 0.049 | 2.03 | 57.3 | 69.1 | 92.3 | 80.4 |
| USG 3120 | 30.8 | 72.9 | 8.0 | 0.37 | 19 | 92.4 | 0.043 | 3.09 | 57.0 | 74.9 | 99.3 | 99.1 |
| SY Harrison | 34.6 | 72.5 | 6.9 | 0.33 | 18 | 93.1 | 0.011 | 0.87 | 56.1 | 67.7 | 90.6 | 94.4 |
| Oakes | 29.7 | 71.1 | 7.1 | 0.35 | 21 | 93.3 | 0.031 | 2.79 | 56.0 | 72.6 | 94.6 | 100.2 |

Table 15. Dough Rheological Characteristics and Sugar Snap cookie Diameter of 2014 crop OVA SRW Wheat Flours

| Variety | Mixograph | | Farinograph: | | | | Alveograph: | | | | Sugar Snap Cookie Diameter (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Abs. (%) | Peak Time (min) | Abs. (%) | Dev. Time (min) | Stability (min) | MTI (FU) | P (mm) | L (mm) | P/L | W ($10^{-4}$ joules) | |
| LCS News | 55.5 | 1.0 | 53.4 | 1.0 | 0.7 | 117 | 59 | 39 | 1.51 | 93 | 17.6 |
| WB-196 | 52.0 | 0.7 | 50.4 | 1.0 | 0.6 | 119 | 34 | 66 | 0.52 | 67 | 18.0 |
| Yorktown | 56.0 | 0.7 | 54.3 | 1.4 | 1.2 | 79 | 60 | 35 | 1.71 | 82 | 16.8 |
| Jamestown | 54.5 | 0.7 | 53.2 | 1.7 | 1.7 | 90 | 55 | 80 | 0.69 | 135 | 16.9 |
| TV 8525 | 53.0 | 0.8 | 51.7 | 1.0 | 1.1 | 110 | 38 | 66 | 0.58 | 86 | 17.9 |
| TV 8535 | 53.0 | 0.7 | 49.8 | 1.3 | 1.7 | 83 | 29 | 70 | 0.41 | 73 | 18.3 |
| USG 3612 | 53.0 | 0.8 | 51.0 | 1.0 | 0.6 | 119 | 35 | 47 | 0.74 | 62 | 18.8 |
| USG 3120 | 55.0 | 0.8 | 51.1 | 1.2 | 4.4 | 37 | 47 | 76 | 0.62 | 122 | 17.3 |
| SY Harrison | 53.0 | 0.8 | 49.1 | 1.0 | 1.0 | 97 | 29 | 69 | 0.42 | 70 | 18.6 |
| Oakes | 53.0 | 0.8 | 52.3 | 1.2 | 1.6 | 90 | 38 | 72 | 0.53 | 96 | 17.8 |

## *COOPERATORS' RANKINGS AND SCORES BY PRODUCT 2014 CROP OVA*

**Introduction**

The cooperators compared flours of the ten SRW wheat varieties to their own standard flours for suitability in making cookies, sponge cakes, chiffon cakes and steam buns. 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 16, 17, 18, 20 and 21)**

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. WB-196 was the most preferred variety for baking cookies with a ranking of 3.5, followed by LCS News, Jamestown and Oakes with rankings of 4.5, 5.3 and 5.3, respectively. USG 3612, USG 3120, TV 8525 and SY Harrison received lower average rankings compared to that of the cooperator standard flours (controls).

The desirability scores for flour and dough characteristics showed small variations among the varieties. Despite achieving the highest ranking for baking cookies, WB-196 received the lowest desirability scores for flour quality, indicating the discrepancies between desirability scores for flour and dough characteristics, and the preference ranking for baking cookies. Desirability scores for cookie quality and overall desirability scores, on the other hand, were in agreement with the preference rankings.

The average rankings of the OVA varieties failed to show any relationships with flour composition, SRC test values, dough rheological properties or sugar-snap cookie diameter. On the other hand, the average desirability scores for flour quality exhibited positive correlations with test weight, grain and flour protein content, kernel hardness, SDS sedimentation volume, farinograph development time and stability, and alveograph W value, but showed a negative correlation with break flour yield, indicating the overseas cooperators' preferences for the flours with relatively high protein content and strong protein.

**Sponge Cakes (Tables 16, 17, 19, 20 and 21)**

The quality ranking and desirability scores of the OVA varieties for baking sponge cakes were evaluated by five cooperators. For baking sponge cakes, the cooperator standard flours received the highest average ranking of 3.4, followed closely by SY Harrison with an average ranking of 3.6. WB-196, which was ranked first for making cookies, was ranked last with an average ranking of 8.8, due to its lower desirability scores for flour quality and low overall desirability scores for making sponge cakes. The large contrast in the preference rankings of WB-196 for making cookies and sponge cakes again indicates the differences in desired flour characteristics for making cookies and cakes by the overseas SRW wheat users.

No correlation was observed between the average rankings for making cookies and those for making sponge cakes. The average preference ranking of the varieties for baking sponge cakes showed significant relationships with the desirability scores for flour characteristics and sponge cake quality, and the overall desirability score, but not with the desirability score for batter properties for baking sponge cakes. The average ranking of the OVA varieties for baking sponge cakes showed significant correlations with flour protein content and alveograph L value.

**Chiffon cakes (Tables 16, 17, 19, 20 and 21)**

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 2.3 for making chiffon cakes, followed closely by USG 3120 and USG 3612 with average rankings of 2.7 and 3.0, respectively. LCS News and TV 8525 received average rankings of 10. 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 significant correlations with the desirability score for chiffon cake quality and the overall desirability score. The average ranking of the OVA varieties for baking chiffon cakes showed no relationships with grain and flour characteristics and SRC test values, making it difficult to predict the chiffon cake making potential of wheat varieties from grain and flour characteristics.

**Summary**

Six out of ten OVA SRW wheat varieties received higher ratings than the cooperator standard flours for making cookies. The highest ranked variety, WB-196, had the lowest kernel hardness and flour protein content, and low to average protein strength and solvent retention capacity values. 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 no significant relationships with flour characteristics.

For baking sponge cakes and chiffon cakes, the OVA varieties were all ranked lower than the respective cooperator standard flours. SY Harrison (for sponge cakes) and USG 3120 (for chiffon cakes) were ranked closest to the cooperator standard flours. SY Harrison had relatively low kernel hardness, protein content, and water, sodium carbonate and sucrose SRC values, and produced weak dough with a short development time, low stability and a low alveograph W value. On the other hand, USG 3120 was highest in flour protein content, high in damaged starch content, and had close to average values in all four SRC tests. As observed with the preference ranking for cookies, most of the grain and flour characteristics, with the exception of protein content and the alveograph L value, failed to show significant and meaningful relationships with the preference rankings of the varieties for baking sponge cakes and chiffon cakes. The positive correlation between the variety average rankings for baking sponge cakes and protein content supports the idea that protein characteristics heavily influenced the cooperators' preferences for making sponge cakes. The diversity of SRW wheat produced in the eastern United States was again observed in grain hardness, absorption capacity, protein strength and rheological properties.

Table 16. Rankings of ten 2014 crop OVA soft red winter wheat varieties for making cookies, sponge cakes, and chiffon cakes*

| Product | Cooperator | Control** | LCS News | WB-196 | Yorktown | Jamestown | TV 8525 | TV 8535 | USG 3612 | USG 3120 | SY Harrison | Oakes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cookie | Indonesia-1 | 5 | 6 | 2 | 4 | 1 | 7 | 3 | 11 | 8 | 10 | 9 |
| Cookie | Indonesia-2 | 6 | 8 | 7 | 4 | 3 | 9 | 10 | 11 | 2 | 1 | 5 |
| Cookie | Malaysia | 8 | 7 | 5 | 4 | 1 | 11 | 3 | 9 | 6 | 10 | 2 |
| Cookie | Mexico | . | 5 | 10 | 3 | 4 | 9 | 6 | 8 | 7 | 1 | 2 |
| Cookie | Philippines-1 | 6 | 4 | 1 | 10 | 7 | 5 | . | 2 | 8 | 9 | 3 |
| Cookie | Philippines-2 | 5 | 2 | 1 | 6 | 11 | 8 | 9 | 7 | 10 | 3 | 4 |
| Cookie | Philippines-3 | 4 | 2 | 1 | 6 | 9 | 5 | 3 | 11 | 7 | 10 | 8 |
| Cookie | Thailand | 8 | 2 | 1 | 7 | 6 | 4 | 5 | 3 | 11 | 10 | 9 |
| | **Average** | **6.0** | **4.5** | **3.5** | **5.5** | **5.3** | **7.3** | **5.6** | **7.8** | **7.4** | **6.8** | **5.3** |
| Sponge Cake | Dominican Rep. | 1 | 11 | 9 | 10 | 4 | 8 | 6 | 5 | 2 | 3 | 7 |
| Sponge Cake | Indonesia-1 | 6 | 7 | 4 | 11 | 8 | 2 | 1 | 10 | 3 | 9 | 5 |
| Sponge Cake | Indonesia-2 | 1 | 5 | 10 | 9 | 8 | 4 | 7 | 6 | 3 | 2 | 11 |
| Sponge Cake | Malaysia | 7 | 8 | 10 | 5 | 2 | 11 | 4 | 9 | 6 | 3 | 1 |
| Sponge Cake | Thailand | 2 | 8 | 11 | 7 | 3 | 9 | 5 | 4 | 10 | 1 | 6 |
| | **Average** | **3.4** | **7.8** | **8.8** | **8.4** | **5.0** | **6.8** | **4.6** | **6.8** | **4.8** | **3.6** | **6.0** |
| Chiffon Cake | Philippines-1 | 1 | 9 | 10 | 5 | 2 | 11 | 8 | 6 | 3 | 7 | 4 |
| Chiffon Cake | Philippines-2 | 4 | 10 | 9 | 6 | 7 | 11 | 8 | 2 | 1 | 3 | 5 |
| Chiffon Cake | Philippines-3 | 2 | 11 | 10 | 5 | 3 | 8 | 9 | 1 | 4 | 7 | 6 |
| | **Average** | **2.3** | **10.0** | **9.7** | **5.3** | **4.0** | **10.0** | **8.3** | **3.0** | **2.7** | **5.7** | **5.0** |
| | **Overall Average** | **4.5** | **6.6** | **6.3** | **6.4** | **4.9** | **7.6** | **5.8** | **6.6** | **5.7** | **5.6** | **5.4** |

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

Table 17. Desirability scores of ten soft red winter wheat FLOURS for making cookies, sponge cakes, and chiffon cakes*

| Product | Cooperator | Control ** | LCS News | WB-196 | Yorktown | Jamestown | TV 8525 | TV 8535 | USG 3612 | USG 3120 | SY Harrison | Oakes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cookies | Indonesia-1 | 7.0 | 6.0 | 7.0 | 6.5 | 7.0 | 6.5 | 7.0 | 6.0 | 6.5 | 6.0 | 6.5 |
| Cookies | Indonesia-2 | 7.0 | 5.0 | 4.8 | 6.0 | 7.0 | 6.0 | 5.8 | 6.0 | 6.0 | 6.0 | 6.0 |
| Cookies | Malaysia | 7.0 | 6.0 | 6.0 | 7.0 | 8.0 | 6.0 | 7.0 | 6.5 | 7.0 | 7.0 | 7.0 |
| Cookies | Mexico | . | 7.8 | 6.5 | 7.8 | 7.8 | 6.5 | 7.8 | 7.8 | 6.5 | 8.4 | 7.8 |
| Cookies | Philippines-1 | 7.0 | 6.0 | 6.0 | 5.0 | 7.0 | 4.0 | 5.0 | 5.0 | 7.0 | 5.0 | 7.0 |
| Cookies | Philippines-2 | 7.0 | 6.0 | 6.0 | 6.5 | 6.0 | 6.5 | 6.0 | 5.5 | 6.5 | 5.5 | 5.5 |
| Cookies | Philippines-3 | 7.0 | 5.5 | 5.6 | 5.7 | 6.2 | 5.7 | 5.9 | 5.4 | 6.9 | 5.7 | 6.1 |
| Cookies | Thailand | 7.0 | 5.5 | 4.5 | 5.5 | 6.5 | 5.5 | 6.0 | 5.0 | 6.5 | 6.0 | 6.0 |
| | **Average** | **7.0** | **6.0** | **5.8** | **6.3** | **6.9** | **5.8** | **6.3** | **5.9** | **6.6** | **6.2** | **6.5** |
| Sponge Cake | Dominican Rep. | . | 6.0 | 5.0 | 5.0 | 8.0 | 6.0 | 6.5 | 5.5 | 7.5 | 5.5 | 5.5 |
| Sponge Cake | Indonesia-1 | 7.0 | 7.5 | 8.0 | 7.5 | 8.0 | 7.5 | 8.0 | 7.0 | 7.5 | 7.0 | 7.5 |
| Sponge Cake | Indonesia-2 | 7.0 | 6.0 | 6.0 | 6.3 | 6.7 | 5.0 | 5.4 | 5.4 | 6.0 | 6.4 | 6.4 |
| Sponge Cake | Malaysia | 7.0 | 6.0 | 6.0 | 7.0 | 8.0 | 6.0 | 7.0 | 6.5 | 7.0 | 7.0 | 7.0 |
| Sponge Cake | Thailand | 7.0 | 5.5 | 4.5 | 5.5 | 6.5 | 5.5 | 6.0 | 5.0 | 6.5 | 6.0 | 6.0 |
| | **Average** | **7.0** | **6.2** | **5.9** | **6.3** | **7.4** | **6.0** | **6.6** | **5.9** | **6.9** | **6.4** | **6.5** |
| Chiffon Cake | Philippines-1 | 7.0 | 6.0 | 6.0 | 5.0 | 7.0 | 4.0 | 5.0 | 5.0 | 7.0 | 5.0 | 7.0 |
| Chiffon Cake | Philippines-2 | 7.0 | 5.5 | 5.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.0 | 6.0 | 5.5 | 6.5 |
| Chiffon Cake | Philippines-3 | 7.0 | 5.7 | 3.0 | 4.0 | 6.0 | 3.0 | 1.0 | 3.0 | 1.0 | 1.0 | 8.0 |
| | **Average** | **7.0** | **5.7** | **4.8** | **5.2** | **6.5** | **4.5** | **4.2** | **4.7** | **4.7** | **3.8** | **7.2** |
| | **Overall Average** | **7.0** | **6.0** | **5.7** | **6.1** | **7.0** | **5.6** | **6.0** | **5.7** | **6.3** | **5.8** | **6.6** |

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

Table 18. Desirability scores of DOUGH of ten 2014 crop OVA soft red winter wheat flours for making cookies*

| Product | Cooperator | Control** | LCS News | WB-196 | Yorktown | Jamestown | TV 8525 | TV 8535 | USG 3612 | USG 3120 | SY Harrison | Oakes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cookies | Indonesia-1 | 7.0 | 7.0 | 7.0 | 7.0 | 8.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 6.5 |
| Cookies | Indonesia-2 | 7.0 | 5.0 | 7.0 | 4.0 | 9.0 | 7.0 | 7.0 | 5.0 | 5.0 | 7.0 | 4.0 |
| Cookies | Malaysia | 7.0 | 8.0 | 8.0 | 7.5 | 7.0 | 7.0 | 8.0 | 6.5 | 8.5 | 6.5 | 8.5 |
| Cookies | Mexico | . | 7.5 | 6.0 | 8.5 | 7.5 | 6.3 | 6.8 | 6.5 | 6.8 | 8.5 | 8.5 |
| Cookies | Philippines-1 | 5.0 | 6.0 | 5.0 | 6.0 | 8.0 | 7.0 | 7.0 | 6.0 | 6.0 | 5.0 | 6.0 |
| Cookies | Philippines-2 | 6.0 | 6.5 | 6.0 | 6.5 | 7.0 | 6.5 | 6.5 | 6.5 | 6.5 | 6.0 | 6.0 |
| Cookies | Philippines-3 | 7.0 | 8.0 | 7.0 | 5.0 | 9.0 | 7.0 | 7.0 | 6.0 | 8.0 | 7.0 | 5.0 |
| Cookies | Thailand | 7.0 | 6.5 | 6.0 | 5.5 | 7.0 | 6.0 | 6.0 | 6.5 | 6.5 | 5.5 | 5.0 |
| | **Average** | **6.6** | **6.8** | **6.5** | **6.3** | **7.8** | **6.7** | **6.9** | **6.3** | **6.8** | **6.6** | **6.2** |

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

Table 19. Desirability scores of batter of ten 2014 crop OVA soft red winter wheat flours for making sponge cake and Chiffon cake*

| Product | Cooperators | Control** | LCS News | WB-196 | Yorktown | Jamestown | TV 8525 | TV 8535 | USG 3612 | USG 3120 | SY Harrison | Oakes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sponge Cake | Dominican Rep. | 8.0 | 6.5 | 6.5 | 5.0 | 8.0 | 8.0 | 6.0 | 6.0 | 6.0 | 6.0 | 7.0 |
| Sponge Cake | Indonesia-1 | 7.0 | 8.0 | 8.0 | 7.5 | 7.5 | 8.0 | 7.5 | 8.0 | 8.0 | 7.5 | 7.0 |
| Sponge Cake | Indonesia-2 | 7.0 | 9.0 | 8.0 | 9.0 | 8.0 | 8.0 | 9.0 | 9.0 | 8.0 | 9.0 | 8.0 |
| Sponge Cake | Malaysia | 7.0 | 8.0 | 8.0 | 7.5 | 7.0 | 7.5 | 8.0 | 8.0 | 7.5 | 8.0 | 7.5 |
| Sponge Cake | Thailand | 7.0 | 6.5 | 6.5 | 6.8 | 7.0 | 6.5 | 6.8 | 6.5 | 6.5 | 6.8 | 7.0 |
| | **Average** | **7.2** | **7.6** | **7.4** | **7.2** | **7.5** | **7.6** | **7.5** | **7.5** | **7.2** | **7.5** | **7.3** |
| Chiffon Cake | Philippines-1 | 7.0 | 7.0 | 6.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Chiffon Cake | Philippines-2 | 7.0 | 7.0 | 7.0 | 7.0 | 6.0 | 7.0 | 7.0 | 7.0 | 7.0 | 6.0 | 7.0 |
| Chiffon Cake | Philippines-3 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| | **Average** | **7.0** | **7.0** | **6.7** | **7.0** | **6.7** | **7.0** | **7.0** | **7.0** | **7.0** | **6.7** | **7.0** |
| | **Overall Average** | **7.1** | **7.4** | **7.1** | **7.1** | **7.2** | **7.4** | **7.3** | **7.3** | **7.1** | **7.2** | **7.2** |

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

Table 20. Desirability scores for quality of cookies, sponge cakes and chiffon cakes of ten soft red winter wheat flours*

| Product | Cooperators | Control** | LCS News | WB-196 | Yorktown | Jamestown | TV 8525 | TV 8535 | USG 3612 | USG 3120 | SY Harrison | Oakes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cookies | Indonesia-1 | 7.0 | 9.0 | 9.0 | 8.5 | 8.5 | 8.0 | 8.5 | 7.0 | 8.0 | 8.0 | 8.0 |
| Cookies | Indonesia-2 | 7.0 | 9.0 | 9.0 | 6.0 | 7.0 | 6.0 | 6.0 | 5.0 | 9.0 | 4.0 | 4.0 |
| Cookies | Malaysia | 7.0 | 7.8 | 8.0 | 7.8 | 8.0 | 7.0 | 7.5 | 7.3 | 6.8 | 6.8 | 7.5 |
| Cookies | Mexico | . | 7.2 | 6.3 | 7.2 | 8.8 | 7.2 | 8.0 | 6.3 | 7.8 | 8.2 | 8.5 |
| Cookies | Philippines-1 | 6.0 | 6.0 | 8.5 | 5.0 | 5.0 | 6.0 | 6.5 | 8.0 | 5.0 | 6.0 | 6.0 |
| Cookies | Philippines-2 | 6.0 | 7.0 | 7.5 | 6.0 | 5.0 | 6.0 | 6.0 | 6.0 | 5.0 | 7.0 | 6.5 |
| Cookies | Philippines-3 | 7.0 | 8.0 | 3.0 | 7.0 | 3.0 | 7.0 | 8.0 | 2.0 | 5.0 | 4.0 | 5.0 |
| Cookies | Thailand | 7.0 | 9.0 | 8.5 | 7.5 | 7.8 | 8.0 | 8.0 | 8.3 | 6.2 | 6.5 | 7.0 |
| | **Average** | **6.7** | **7.9** | **7.5** | **6.9** | **6.6** | **6.9** | **7.3** | **6.2** | **6.6** | **6.3** | **6.6** |
| Sponge Cake | Dominican Rep. | 7.5 | 6.0 | 8.0 | 6.5 | 7.5 | 6.5 | 7.0 | 9.0 | 8.0 | 9.0 | 8.0 |
| Sponge Cake | Indonesia-1 | 7.0 | 6.0 | 5.5 | 5.0 | 5.0 | 7.0 | 6.5 | 5.0 | 7.0 | 6.0 | 6.0 |
| Sponge Cake | Indonesia-2 | 7.0 | 6.0 | 4.0 | 3.0 | 6.0 | 6.0 | 5.5 | 5.7 | 8.0 | 6.0 | 4.6 |
| Sponge Cake | Malaysia | 7.0 | 7.6 | 7.0 | 7.2 | 7.0 | 7.5 | 7.2 | 7.0 | 7.1 | 7.3 | 8.0 |
| Sponge Cake | Thailand | 7.0 | 6.0 | 5.8 | 6.5 | 7.0 | 6.0 | 7.0 | 7.0 | 6.0 | 7.5 | 6.5 |
| | **Average** | **7.1** | **6.3** | **6.1** | **5.6** | **6.5** | **6.6** | **6.6** | **6.7** | **7.2** | **7.2** | **6.6** |
| Chiffon Cake | Philippines-1 | 9.0 | 4.0 | 4.0 | 7.5 | 9.0 | 4.0 | 6.0 | 7.0 | 7.5 | 6.0 | 7.0 |
| Chiffon Cake | Philippines-2 | 7.0 | 6.0 | 7.0 | 7.5 | | 5.0 | 4.0 | 6.5 | 7.5 | 7.5 | 7.0 |
| Chiffon Cake | Philippines-3 | 7.0 | 4.0 | 5.0 | 6.0 | 6.0 | 5.0 | 5.0 | 8.0 | 6.0 | 6.0 | 6.0 |
| | **Average** | **7.7** | **4.7** | **5.3** | **7.0** | **7.5** | **4.7** | **5.0** | **7.2** | **7.0** | **6.5** | **6.7** |
| | **Overall Average** | **7.0** | **6.8** | **6.6** | **6.5** | **6.8** | **6.4** | **6.7** | **6.6** | **6.9** | **6.6** | **6.6** |

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

Table 21. Overall desirability scores of ten soft red winter wheat flours for making cookie, sponge cakes and chiffon cakes*

| Product | Cooperators | Control** | LCS News | WB-196 | Yorktown | Jamestown | TV 8525 | TV 8535 | USG 3612 | USG 3120 | SY Harrison | Oakes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cookies | Indonesia-1 | 7.0 | 6.0 | 7.0 | 6.5 | 7.0 | 6.5 | 7.0 | 6.0 | 6.5 | 6.0 | 6.5 |
| Cookies | Indonesia-2 | 7.0 | 6.3 | 6.9 | 7.6 | 7.7 | 6.3 | 6.3 | 5.3 | 8.4 | 8.5 | 7.5 |
| Cookies | Malaysia | 7.0 | 7.5 | 7.5 | 7.5 | 8.0 | 6.5 | 7.5 | 6.5 | 7.5 | 6.5 | 8.0 |
| Cookies | Mexico | . | 7.5 | 6.0 | 8.5 | 7.5 | 6.3 | 6.8 | 6.5 | 6.8 | 8.5 | 8.5 |
| Cookies | Philippines-1 | 6.0 | 7.0 | 8.0 | 6.0 | 6.0 | 7.5 | 6.0 | 6.5 | 5.0 | 5.0 | 7.0 |
| Cookies | Philippines-2 | 7.0 | 7.5 | 8.0 | 6.0 | 6.0 | 6.5 | 6.5 | 6.5 | 5.5 | 7.5 | 7.0 |
| Cookies | Philippines-3 | 7.0 | 7.3 | 7.6 | 6.4 | 5.2 | 6.6 | 7.2 | 4.2 | 6.2 | 5.1 | 5.3 |
| Cookies | Thailand | 7.0 | 9.0 | 8.5 | 7.5 | 7.8 | 8.0 | 8.0 | 8.3 | 6.2 | 6.5 | 7.0 |
| | **Average** | **6.9** | **7.3** | **7.4** | **7.0** | **6.9** | **6.8** | **6.9** | **6.2** | **6.5** | **6.7** | **7.1** |
| Sponge Cake | Dominican Rep. | 8.0 | 6.0 | 5.0 | 6.0 | 8.0 | 6.0 | 7.5 | 8.0 | 8.5 | 8.5 | 7.5 |
| Sponge Cake | Indonesia-1 | 7.0 | 7.0 | 7.5 | 7.0 | 7.5 | 7.0 | 7.5 | 7.0 | 7.0 | 6.5 | 7.0 |
| Sponge Cake | Indonesia-2 | 7.0 | 4.3 | 4.2 | 4.3 | 5.2 | 4.3 | 5.0 | 5.0 | 5.2 | 5.0 | 4.8 |
| Sponge Cake | Malaysia | 7.0 | 7.0 | 6.5 | 7.3 | 7.5 | 7.0 | 7.5 | 7.0 | 7.3 | 7.5 | 7.8 |
| Sponge Cake | Thailand | 7.0 | 6.0 | 5.8 | 6.5 | 7.0 | 6.0 | 7.0 | 7.0 | 6.0 | 7.5 | 6.5 |
| | **Average** | **7.2** | **6.1** | **5.8** | **6.2** | **7.0** | **6.1** | **6.9** | **6.8** | **6.8** | **7.0** | **6.7** |
| Chiffon Cake | Philippines-1 | 8.0 | 6.0 | 6.0 | 7.0 | 8.0 | 5.5 | 6.5 | 7.0 | 7.0 | 7.5 | 7.0 |
| Chiffon Cake | Philippines-2 | 7.5 | 6.0 | 6.5 | 7.0 | 6.0 | 4.0 | 6.0 | 7.5 | 7.5 | 7.5 | 7.0 |
| Chiffon Cake | Philippines-3 | 7.0 | 5.1 | 5.6 | 6.2 | 6.4 | 5.7 | 5.6 | 7.1 | 6.3 | 6.1 | 6.2 |
| | **Average** | **7.5** | **5.7** | **6.0** | **6.7** | **6.8** | **5.1** | **6.0** | **7.2** | **6.9** | **7.0** | **6.7** |
| | **Overall Average** | **7.1** | **6.6** | **6.7** | **6.7** | **6.9** | **6.2** | **6.7** | **6.6** | **6.7** | **6.9** | **6.9** |

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

## REGIONAL AND STATE PERFORMANCE NURSERIES – 2015 CROP

### *QUALITY CHARACTERISTICS OF REGIONAL NURSERY ENTRIES*

### 2015 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*

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

## *NORTHERN UNIFORM WINTER WHEAT SCAB NURSERY*

*Carl Griffey, Virginia Polytechnic Institute and State University*

A total of 64 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. In addition to the test data, a t-score (which is the number of standard deviations away from the check variety for each quality parameter) was generated to show how different the entry's quality trait is from that of the check variety, Truman. Total t-score was also calculated by summing (0.15 x test weight), (-0.10 x kernel hardness), (0.4 x flour yield), (0.15 x softness equivalence) and (-0.2 x sodium carbonate SRC) to show the difference in overall quality potential between each entry and the check variety, and used to generate the overall end-use quality rankings of varieties and breeding lines. 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 2008-2014. Those entries that fell in the flour yield range of the top 15% of lines and varieties 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 relatively lower test weights, higher grain and flour protein contents, and lower flour yields than typical soft red winter wheat, possibly due to the unfavorable climatic conditions during the grain-filling period. The average test weight, grain protein content and flour yield of the entries were 57.9 lb/bu, 10.9% and 67.9%, respectively. Four entries (NE05548, NE10589, NW13455 and NE13511) showed unusually high kernel hardness (>44.2), resulting in low SE (<49.7%) and high sodium carbonate SRC (>74.2%). A large number of entries exhibited high lactic SRC values, indicating the presence of relatively strong gluten protein. MO130203 exhibited a flour yield of 71.0%, sodium carbonate SRC of 64.9%, and lactic acid SRC of 141.5%, and ranked first in total t-score among 64 entries.

Table 22. Northern Uniform Winter Wheat Scab Nursery wheat variety trial 2015 crop quality data

| Entry | Test Weight (LB/BU) | NIR Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Total T-Score Rank | Flour Yield % Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TRUMAN*** | **56.0** | **10.7** | **-1.6** | **2.4** | **30.3** | **67.6** | **65.3** | **8.6** | **121.9** | **70.1** | **35** | **D** |
| ERNIE | 57.8 | 11.8 | 0.5 | 2.8 | 36.5 | 67.8 | 57.8 | 9.4 | 132.2 | 67.4 | 30 | D |
| FREEDOM | 58.0 | 12.0 | 0.6 | 2.8 | 35.8 | 67.2 | 57.1 | 9.6 | 134.9 | 67.2 | 36 | D |
| PIONEER2545 | 55.6 | 11.0 | 15.8 | 2.6 | 31.7 | 65.3 | 59.7 | 9.5 | 121.3 | 70.6 | 60 | F |
| NY99056-161 | 55.8 | 10.9 | 15.3 | 2.6 | 31.2 | 67.3 | 60.9 | 9.2 | 134.3 | 69.6 | 49 | D |
| NY09067-2-69-1097 | 57.0 | 10.9 | 9.5 | 2.7 | 34.1 | 68.9 | 62.0 | 9.2 | 109.9 | 67.5 | 15 | C |
| NY05152-818 | 55.6 | 11.2 | 4.4 | 2.5 | 31.8 | 64.1 | 64.6 | 9.2 | 109.0 | 78.3 | 63 | F |
| NY05152-825 | 57.5 | 11.6 | 4.1 | 2.5 | 30.4 | 66.1 | 63.4 | 9.4 | 100.8 | 71.8 | 51 | F |
| NY05152-821 | 55.8 | 12.1 | 11.1 | 2.6 | 30.5 | 63.2 | 64.1 | 10.0 | 110.9 | 80.0 | 64 | F |
| KWS050 | 59.0 | 10.3 | 26.8 | 2.6 | 31.9 | 66.8 | 57.1 | 9.0 | 121.8 | 73.3 | 53 | F |
| KWS051 | 57.3 | 10.9 | 18.3 | 2.7 | 35.5 | 67.8 | 56.2 | 9.1 | 132.5 | 69.4 | 44 | D |
| KWS052 | 57.7 | 10.8 | 9.6 | 2.6 | 31.9 | 68.8 | 58.7 | 9.0 | 115.0 | 67.8 | 21 | C |
| KWS036 | 57.2 | 11.0 | 4.6 | 2.7 | 37.9 | 70.0 | 60.8 | 9.0 | 98.1 | 64.8 | 6 | B |
| ES12-3030 | 59.7 | 11.4 | 16.0 | 2.7 | 34.0 | 66.3 | 53.4 | 9.7 | 137.4 | 66.7 | 46 | F |
| ES12-1358 | 61.2 | 11.4 | 8.8 | 2.7 | 37.8 | 67.5 | 61.9 | 9.6 | 150.1 | 71.0 | 25 | D |
| ES12-1275 | 59.2 | 12.0 | 13.3 | 2.8 | 34.7 | 66.7 | 54.0 | 10.2 | 151.4 | 66.4 | 41 | F |
| F1014 | 55.3 | 10.8 | 16.6 | 2.6 | 30.1 | 67.1 | 59.2 | 8.8 | 90.3 | 68.3 | 52 | D |
| E6012 | 56.0 | 10.6 | 2.0 | 2.7 | 33.3 | 69.1 | 64.2 | 8.7 | 134.2 | 69.0 | 16 | C |
| OH09-207-24 | 57.8 | 10.9 | 8.1 | 2.7 | 34.0 | 68.8 | 59.2 | 8.9 | 124.3 | 67.2 | 17 | C |
| OH09-281-10 | 58.7 | 10.6 | 20.9 | 2.8 | 33.8 | 69.9 | 54.8 | 8.7 | 119.8 | 65.3 | 12 | B |
| OH10-200-49 | 56.0 | 10.4 | -0.3 | 2.5 | 28.7 | 67.2 | 68.6 | 10.0 | 130.6 | 71.9 | 40 | D |
| Jamestown | 60.2 | 11.9 | 11.4 | 2.8 | 32.5 | 67.4 | 57.5 | 9.5 | 133.3 | 70.4 | 33 | D |
| Shirley | 55.9 | 10.3 | -2.4 | 2.6 | 34.7 | 69.3 | 60.5 | 8.2 | 104.8 | 67.5 | 14 | C |
| 10641B1-9-11-7 | 59.4 | 12.7 | 34.6 | 2.9 | 35.5 | 67.7 | 44.6 | 10.8 | 134.7 | 75.7 | 58 | D |
| 0762A1-2-8 | 56.4 | 10.4 | 9.3 | 2.8 | 35.4 | 67.0 | 58.1 | 9.0 | 126.7 | 65.7 | 42 | D |
| 08334A1-31 | 57.0 | 10.4 | 3.4 | 2.8 | 38.9 | 68.7 | 64.4 | 8.4 | 126.6 | 66.6 | 13 | C |
| 0566A1-3-1-6 | 58.0 | 11.3 | 12.2 | 2.8 | 35.7 | 66.7 | 57.6 | 9.1 | 126.8 | 66.4 | 43 | F |
| 10512RA1-8 | 56.7 | 11.2 | 9.5 | 2.8 | 35.3 | 66.6 | 58.1 | 9.3 | 122.0 | 72.2 | 54 | F |
| M11-2024# | 60.0 | 11.7 | 17.3 | 2.8 | 36.0 | 68.1 | 50.4 | 10.3 | 88.6 | 66.1 | 29 | D |
| M12-3312CW | 58.5 | 11.1 | 26.9 | 2.7 | 31.6 | 66.5 | 53.2 | 9.3 | 111.6 | 65.2 | 50 | F |
| M12-3301 | 57.0 | 9.3 | 4.4 | 2.5 | 31.7 | 70.0 | 65.2 | 7.8 | 110.8 | 63.7 | 3 | B |
| M12-2036# | 56.8 | 9.8 | 6.0 | 2.6 | 32.2 | 70.5 | 64.4 | 8.0 | 140.6 | 65.2 | 2 | B |
| M12-2031# | 57.3 | 10.3 | 19.6 | 2.7 | 32.5 | 66.3 | 56.4 | 8.6 | 94.9 | 63.9 | 48 | F |
| CA9-72 | 57.7 | 10.1 | 15.4 | 2.8 | 35.0 | 66.6 | 58.0 | 8.3 | 106.6 | 67.5 | 47 | F |
| CA9-76 | 57.6 | 10.7 | 7.1 | 2.8 | 33.4 | 68.1 | 60.8 | 8.7 | 117.7 | 65.9 | 23 | D |
| DH5-15 | 60.1 | 11.1 | 14.1 | 2.7 | 34.1 | 67.2 | 57.4 | 9.2 | 109.4 | 63.0 | 24 | D |
| CA13-53 | 53.9 | 10.8 | 10.6 | 2.7 | 35.6 | 65.7 | 61.8 | 9.3 | 102.3 | 72.1 | 61 | F |
| CA13-63 | 56.9 | 10.1 | 11.6 | 2.7 | 38.1 | 65.6 | 58.9 | 8.6 | 109.2 | 69.6 | 56 | F |
| IL10-19464 | 60.3 | 11.0 | 3.6 | 2.8 | 37.7 | 69.6 | 56.1 | 9.3 | 130.5 | 64.1 | 4 | C |
| IL10-21934 | 60.2 | 10.6 | 10.0 | 2.7 | 33.7 | 67.1 | 54.8 | 9.2 | 132.6 | 63.6 | 27 | D |
| IL10-21937 | 60.0 | 11.1 | 8.9 | 2.8 | 34.7 | 65.9 | 52.1 | 9.3 | 131.2 | 64.1 | 45 | F |
| IL11-36131 | 59.9 | 11.6 | 4.2 | 2.7 | 36.2 | 68.5 | 59.2 | 9.7 | 150.6 | 65.0 | 11 | C |
| IL11-27667 | 59.2 | 10.4 | 7.3 | 2.6 | 30.9 | 69.3 | 60.1 | 8.6 | 130.7 | 66.3 | 9 | C |

| Entry | Test Weight (LB/BU) | NIR Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Total T-Score Rank | Flour Yield % Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| USG 3120 | 60.5 | 10.9 | 4.0 | 2.8 | 40.2 | 70.0 | 58.1 | 9.0 | 117.6 | 67.6 | 5 | B |
| Branson | 57.3 | 10.8 | 0.3 | 2.6 | 33.5 | 69.5 | 63.7 | 8.7 | 135.7 | 66.0 | 7 | C |
| KY06C-1195-37-2-5 | 59.0 | 10.4 | 6.4 | 2.8 | 35.8 | 67.9 | 58.5 | 8.7 | 123.6 | 67.5 | 26 | D |
| KY06C-1201-18-6-3 | 59.3 | 10.6 | 14.1 | 2.6 | 32.0 | 68.7 | 57.9 | 8.7 | 138.7 | 69.3 | 20 | C |
| KY06C-1107-7-2-5 | 58.8 | 11.0 | 17.0 | 2.7 | 35.5 | 66.1 | 55.1 | 9.1 | 111.3 | 73.1 | 57 | F |
| KY06C-2020-10-5-3 | 57.8 | 10.6 | -3.4 | 2.6 | 32.4 | 69.1 | 62.3 | 8.7 | 148.1 | 64.8 | 8 | C |
| KY06C-2020-11-12-1 | 58.6 | 10.9 | 0.8 | 2.6 | 30.3 | 68.9 | 62.3 | 9.0 | 143.2 | 65.5 | 10 | C |
| MO122246 | 60.9 | 11.2 | 20.3 | 2.8 | 33.3 | 66.6 | 56.9 | 9.3 | 139.3 | 67.6 | 39 | F |
| MO130203 | 59.2 | 11.4 | 1.5 | 2.7 | 30.6 | 71.0 | 61.9 | 9.4 | 141.5 | 64.9 | 1 | A |
| MO130765 | 58.3 | 10.5 | 7.0 | 2.5 | 31.0 | 67.2 | 62.1 | 8.7 | 127.0 | 66.9 | 31 | D |
| MO131838 | 58.2 | 10.2 | 6.6 | 2.5 | 29.4 | 67.5 | 63.1 | 8.4 | 117.7 | 67.2 | 28 | D |
| NE05548 | 57.3 | 11.6 | 47.9 | 2.7 | 32.4 | 71.4 | 47.9 | 10.5 | 147.3 | 74.2 | 34 | A |
| NE10589 | 56.9 | 10.9 | 58.7 | 2.7 | 30.1 | 69.3 | 43.4 | 9.6 | 138.7 | 77.1 | 59 | C |
| NW13455 | 58.0 | 10.2 | 44.2 | 2.9 | 35.3 | 68.6 | 49.7 | 8.7 | 137.1 | 75.4 | 55 | C |
| NE13511 | 58.1 | 10.6 | 58.3 | 2.6 | 28.9 | 67.9 | 45.2 | 9.0 | 146.8 | 80.3 | 62 | D |
| NE06545 | 56.7 | 10.2 | 33.1 | 2.8 | 33.3 | 70.1 | 61.2 | 8.2 | 147.7 | 77.7 | 38 | B |
| VA11W-108 | 58.5 | 10.4 | 8.1 | 2.7 | 33.7 | 67.6 | 63.5 | 8.5 | 133.8 | 71.4 | 32 | D |
| VA11W-182 | 55.4 | 10.4 | -1.4 | 2.5 | 30.1 | 68.9 | 65.5 | 8.2 | 114.8 | 69.2 | 19 | C |
| VA12W-150 | 58.7 | 10.5 | 10.1 | 2.6 | 29.1 | 68.7 | 59.6 | 8.4 | 127.8 | 68.7 | 18 | C |
| VA12FHB-4 | 57.5 | 10.9 | 2.3 | 2.7 | 34.5 | 67.2 | 59.4 | 9.1 | 104.6 | 67.7 | 37 | D |
| VA12FHB-55 | 56.8 | 10.2 | 8.6 | 2.6 | 34.5 | 69.1 | 60.2 | 8.3 | 110.2 | 68.8 | 22 | C |
| | | | | | | | | | | | | |
| Mean | 57.9 | 10.9 | 12.4 | 2.7 | 33.5 | 67.9 | 58.6 | 9.1 | 124.6 | 68.8 | | |
| Std Dev | 1.6 | 0.6 | 13.2 | 0.1 | 2.6 | 1.6 | 5.1 | 0.6 | 15.7 | 4.1 | | |

*Check variety.

## *SOUTHERN UNIFORM WINTER WHEAT SCAB NURSERY*

*Carl Griffey, Virginia Polytechnic Institute and State University*

Fifty-three 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. In addition to the test data, a t-score (which is the number of standard deviations away from the check variety for each quality parameter) was generated to show how different the entry's quality trait is from that of the check variety, Ernie. Total t-score was also calculated by summing up (0.15 x test weight), (-0.10 x kernel hardness), (0.4 x flour yield), (0.15 x softness equivalence) and (-0.2 x sodium carbonate SRC) to show the difference in overall quality potential between each entry and the check variety, and used to generate the overall end-use quality rankings of varieties and breeding lines. 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 2008-2014. Those entries that fell in the flour yield range of the top 15% of lines and varieties 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, higher protein contents and higher lactic acid SRCs than the SWQL SRW wheat averages. The majority of breeding lines exhibited higher test weights, lower grain protein contents, higher flour yields and lower sodium carbonate SRC values than the check variety, Ernie, indicating better milling and baking quality. Twenty-six out of 53 entries exhibited lactic acid SRC values ranging from 130 to 161%, indicating their strong gluten protein.

Table 23. Southern Uniform Winter Wheat Scab Nursery wheat variety trial 2015 crop quality data

| Entry | Test Weight (LB/BU) | NIR Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Total T-Score Rank | Flour Yield % Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ERNIE*** | **58.3** | **11.6** | **0.4** | **2.9** | **38.2** | **66.6** | **55.3** | **9.2** | **129.5** | **66.8** | **36** | **F** |
| COKER9835 | 57.4 | 10.4 | 1.2 | 2.6 | 33.5 | 68.1 | 65.5 | 8.3 | 113.0 | 72.4 | 31 | D |
| BESS | 58.5 | 10.4 | 5.8 | 2.5 | 31.9 | 67.2 | 61.4 | 8.5 | 119.9 | 69.1 | 33 | D |
| JAMESTOWN | 60.2 | 11.6 | 10.8 | 2.8 | 31.1 | 67.5 | 58.6 | 9.5 | 133.8 | 70.1 | 32 | D |
| LA07085CW-P4 | 59.1 | 10.5 | 3.0 | 2.8 | 37.9 | 68.5 | 62.7 | 8.4 | 117.7 | 71.7 | 26 | C |
| LANC8170-41-2 | 59.6 | 11.0 | 21.4 | 2.8 | 34.4 | 66.5 | 49.8 | 9.7 | 128.1 | 63.5 | 43 | F |
| NC11-22289 | 59.7 | 12.1 | 13.0 | 2.9 | 36.1 | 66.1 | 52.1 | 9.8 | 137.2 | 64.0 | 40 | F |
| AR06024-7-2 | 61.9 | 11.3 | 13.9 | 2.8 | 31.4 | 66.0 | 56.2 | 9.1 | 114.0 | 65.4 | 34 | F |
| AR06037-17-2 | 57.0 | 10.0 | 9.5 | 2.4 | 28.7 | 68.0 | 58.9 | 8.4 | 130.1 | 70.5 | 38 | D |
| AR06045-2-4 | 58.7 | 10.4 | 1.8 | 2.6 | 32.2 | 67.8 | 62.0 | 8.5 | 134.4 | 70.0 | 27 | D |
| AR06045-16-4 | 58.8 | 10.6 | 1.4 | 2.6 | 32.5 | 67.9 | 61.8 | 8.6 | 136.0 | 69.1 | 25 | D |
| AR06046-10-3 | 57.6 | 11.3 | 3.2 | 2.6 | 34.9 | 67.9 | 58.3 | 9.0 | 115.0 | 68.0 | 30 | D |
| AR06061-11-1 | 58.3 | 10.1 | 3.1 | 2.5 | 30.8 | 67.4 | 63.0 | 8.3 | 121.5 | 69.1 | 29 | D |
| LW08190C-57-3 | 57.8 | 10.9 | 19.9 | 2.6 | 33.6 | 67.3 | 58.0 | 9.1 | 104.9 | 70.8 | 50 | D |
| ARGE08-1398 | 57.2 | 10.9 | 19.9 | 2.6 | 33.4 | 67.3 | 58.3 | 8.8 | 105.6 | 70.6 | 51 | D |
| B12*1792 | 58.9 | 10.3 | 9.8 | 2.8 | 37.2 | 68.2 | 59.1 | 8.7 | 135.3 | 64.7 | 20 | D |
| B12-2180NC# | 57.1 | 10.7 | 17.1 | 2.4 | 28.0 | 67.5 | 60.1 | 8.8 | 126.5 | 68.4 | 41 | D |
| GA 071171-14ES8 | 62.1 | 10.4 | 2.5 | 2.9 | 37.2 | 70.2 | 57.5 | 8.7 | 139.0 | 64.9 | 1 | B |
| GA 071092-14ES11 | 59.2 | 9.6 | 5.8 | 2.8 | 37.6 | 70.9 | 61.3 | 8.1 | 130.6 | 65.3 | 2 | A |
| GA071092-14ES13 | 59.0 | 9.4 | 0.5 | 2.8 | 37.7 | 70.6 | 64.2 | 8.0 | 130.5 | 66.5 | 3 | B |
| GA 081129-14ES16 | 61.2 | 11.2 | 13.4 | 3.0 | 40.7 | 69.6 | 52.6 | 9.5 | 141.4 | 65.0 | 12 | C |
| GA 08250-14ES7 | 59.0 | 10.8 | -2.1 | 2.8 | 36.1 | 69.7 | 63.0 | 8.9 | 132.4 | 68.5 | 10 | C |
| GA 08250-14ES5 | 60.6 | 10.2 | -3.8 | 2.8 | 33.7 | 68.8 | 61.1 | 8.7 | 152.2 | 67.5 | 11 | C |
| GA 071171-14ES19 | 62.1 | 10.8 | 9.3 | 2.9 | 37.9 | 69.8 | 56.0 | 9.1 | 135.3 | 65.6 | 6 | B |
| GA 081562-14ES14 | 59.4 | 10.5 | 6.3 | 2.7 | 33.3 | 70.9 | 55.7 | 9.0 | 127.3 | 63.9 | 4 | A |
| Jamestown | 60.5 | 11.3 | 9.2 | 2.8 | 32.4 | 67.1 | 58.4 | 8.9 | 138.3 | 70.8 | 35 | D |
| Shirley | 56.0 | 10.0 | -2.9 | 2.7 | 35.7 | 68.7 | 60.5 | 8.0 | 102.2 | 68.1 | 24 | C |
| KWS 054 | 58.9 | 10.0 | -4.7 | 2.7 | 33.7 | 69.2 | 64.1 | 8.4 | 128.7 | 67.4 | 9 | C |
| LA06146E-P4 | 60.6 | 11.3 | 24.8 | 3.0 | 38.9 | 68.0 | 50.4 | 9.1 | 138.9 | 68.7 | 39 | D |
| LA08265C-50 | 60.8 | 10.0 | 11.3 | 2.8 | 35.6 | 67.7 | 57.9 | 8.4 | 143.6 | 63.7 | 19 | D |
| LA09144C-6 | 60.2 | 11.2 | -2.1 | 2.7 | 34.9 | 69.6 | 56.6 | 9.2 | 138.2 | 66.1 | 8 | C |
| LANC8248-1 | 58.8 | 11.1 | 21.2 | 2.6 | 31.8 | 70.5 | 51.9 | 9.3 | 130.1 | 65.3 | 16 | B |
| ES13-1591 | 58.1 | 11.6 | 1.0 | 2.8 | 38.4 | 68.8 | 61.4 | 9.5 | 101.6 | 69.3 | 21 | C |
| ES13-3423 | 58.6 | 11.5 | 7.0 | 2.6 | 33.8 | 65.1 | 57.9 | 9.3 | 125.9 | 72.6 | 53 | F |
| ES12-3030 | 59.8 | 11.2 | 15.8 | 2.7 | 35.2 | 66.2 | 52.6 | 9.4 | 139.6 | 66.1 | 45 | F |
| M11-2024# | 60.1 | 12.1 | 11.8 | 2.8 | 36.5 | 68.3 | 51.8 | 10.0 | 91.0 | 65.2 | 23 | D |
| M12-3301 | 57.2 | 10.6 | 2.5 | 2.5 | 30.1 | 68.8 | 64.2 | 8.8 | 114.7 | 65.1 | 14 | C |
| M12-2036# | 56.9 | 10.4 | 1.3 | 2.6 | 32.0 | 70.0 | 64.1 | 8.5 | 151.9 | 65.2 | 7 | B |
| NC11-23084 | 60.5 | 11.6 | 11.8 | 2.9 | 38.1 | 70.2 | 54.9 | 9.7 | 120.7 | 62.8 | 5 | B |
| NC12-23576 | 58.5 | 11.6 | 16.0 | 2.6 | 32.9 | 66.6 | 52.6 | 9.8 | 150.2 | 67.2 | 48 | F |
| NC12-23219 | 60.6 | 12.0 | 12.9 | 2.7 | 31.9 | 65.3 | 55.4 | 10.0 | 148.1 | 69.0 | 52 | F |
| NC12-20662 | 61.1 | 11.8 | 1.2 | 2.9 | 41.4 | 66.1 | 52.7 | 9.6 | 161.2 | 70.0 | 44 | F |
| NC9305-7 | 59.1 | 11.4 | 4.5 | 2.6 | 32.7 | 66.8 | 57.9 | 9.2 | 124.7 | 70.2 | 42 | F |

| Entry | Test Weight (LB/BU) | NIR Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Total T-Score Rank | Flour Yield % Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VA11W-106 | 57.9 | 10.5 | 2.1 | 2.6 | 31.9 | 66.7 | 63.9 | 8.7 | 127.7 | 74.0 | 46 | F |
| VA11W-313 | 56.9 | 11.4 | 18.1 | 2.9 | 39.2 | 67.1 | 54.2 | 9.8 | 138.1 | 67.0 | 49 | D |
| VA12W-72 | 57.5 | 12.3 | 3.7 | 2.9 | 43.6 | 65.3 | 57.1 | 10.3 | 123.5 | 65.7 | 47 | F |
| VA12W-54 | 59.5 | 10.9 | 6.9 | 2.7 | 33.4 | 68.2 | 58.3 | 9.0 | 137.2 | 67.9 | 22 | D |
| VA12FHB-53 | 58.8 | 11.9 | 10.3 | 2.7 | 33.2 | 66.5 | 59.4 | 9.5 | 120.4 | 67.3 | 37 | F |
| VA12FHB-4 | 58.0 | 12.2 | -1.1 | 2.7 | 34.8 | 67.4 | 59.1 | 9.7 | 108.3 | 67.3 | 28 | D |
| VA13W-177 | 60.9 | 12.1 | 12.1 | 2.7 | 32.5 | 68.5 | 53.7 | 9.8 | 124.6 | 64.0 | 18 | C |
| VA08MAS5-39-6-4 | 59.2 | 11.3 | 2.6 | 2.6 | 36.0 | 69.5 | 59.1 | 9.1 | 120.1 | 69.1 | 15 | C |
| USG 3120 | 60.2 | 10.7 | 3.9 | 2.8 | 40.8 | 69.7 | 58.2 | 8.9 | 117.6 | 68.5 | 13 | C |
| Branson | 56.8 | 11.1 | 1.6 | 2.6 | 33.3 | 69.0 | 64.7 | 9.0 | 137.3 | 67.1 | 17 | C |
| | | | | | | | | | | | | |
| Mean | 59.1 | 11.0 | 7.4 | 2.7 | 34.8 | 68.1 | 58.2 | 9.0 | 128.2 | 67.6 | | |
| Std Dev | 1.5 | 0.7 | 7.3 | 0.1 | 3.3 | 1.5 | 4.1 | 0.6 | 14.1 | 2.6 | | |

*Check variety.

## *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. In addition to the test data, a t-score (which is the number of standard deviations away from the check variety for each quality parameter) was generated to show how different the entry's quality trait is from that of the check variety, Truman. Total t-score was also calculated by summing up (0.15 x test weight), (-0.10 x kernel hardness), (0.4 x flour yield), (0.15 x softness equivalence) and (-0.2 x sodium carbonate SRC) to show the difference in overall quality potential between each entry and the check variety, and used to generate the overall end-use quality rankings of varieties and breeding lines. 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 2008-2014. Those entries that fell in the flour yield range of the top 15% of lines and varieties 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 majority of breeding lines exhibited lower test weights, higher grain protein contents and lower flour yields compared to typical SRW wheat. The average test weight, grain protein content and flour yield of 45 entries were 58.6 lb/bu, 11.0% and 67.9%, respectively. MO 130660 exhibited an unusually high SKCS kernel hardness value of 48.4, and consequently the lowest SE and highest sodium carbonate SRC among 45 entries. Compared to the check variety, about a half of the entries in the nursery showed better test weights, flour yields, lower sodium carbonate SRC values, and higher total t-score rankings. The average lactic acid SRC value of 45 entries was 127%, and 20 entries exhibited lactic acid SRC values ranging from 130.9 to 151.6%, indicating the possession of strong gluten protein by the entries.

Table 24. Preliminary Northern Uniform Winter Wheat Nursery wheat variety trial 2015 crop quality data

| Entry | Test Weight (LB/BU) | NIR Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Total T-Score Rank | Flour Yield % Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TRUMAN** | **56.2** | **9.8** | **1.0** | **2.4** | **30.7** | **67.8** | **65.7** | **7.9** | **116.5** | **69.4** | **25** | **D** |
| ERNIE | 57.9 | 11.0 | 0.7 | 2.9 | 36.7 | 67.6 | 58.3 | 8.8 | 128.3 | 66.8 | 22 | D |
| FREEDOM | 56.9 | 10.3 | 7.5 | 2.6 | 32.6 | 67.7 | 59.3 | 8.4 | 113.0 | 66.4 | 24 | D |
| PIONEER2545 | 56.2 | 10.6 | 15.1 | 2.6 | 32.4 | 65.8 | 60.4 | 9.0 | 117.9 | 70.2 | 43 | F |
| KWS055 | 55.2 | 10.2 | 2.4 | 2.6 | 31.9 | 68.7 | 66.9 | 8.4 | 128.3 | 67.2 | 14 | C |
| KWS053 | 60.4 | 11.3 | 11.0 | 2.8 | 38.9 | 67.5 | 53.4 | 9.4 | 141.4 | 65.4 | 19 | D |
| KWS054 | 58.9 | 10.7 | -2.5 | 2.7 | 33.1 | 69.0 | 62.7 | 8.9 | 138.4 | 67.2 | 7 | C |
| KWS037 | 55.8 | 10.6 | 4.9 | 2.6 | 30.7 | 68.7 | 65.1 | 8.6 | 135.0 | 67.1 | 15 | C |
| KWS041 | 59.5 | 11.3 | 17.9 | 2.7 | 34.2 | 66.6 | 55.5 | 9.1 | 148.8 | 69.2 | 42 | F |
| OH10-304-71 | 58.9 | 11.0 | 13.5 | 2.8 | 34.1 | 69.6 | 56.3 | 9.2 | 133.9 | 64.6 | 6 | C |
| OH10-316-20 | 59.3 | 10.7 | 14.9 | 2.7 | 33.3 | 69.6 | 56.1 | 9.1 | 132.0 | 65.6 | 8 | C |
| 1042A1-1-2 | 56.3 | 11.0 | 6.3 | 2.7 | 31.3 | 67.3 | 63.6 | 8.8 | 125.5 | 72.6 | 41 | D |
| 053A1-2-5-3-5-3 | 57.2 | 12.1 | 8.1 | 2.7 | 33.8 | 68.3 | 59.2 | 9.6 | 97.7 | 67.9 | 20 | D |
| 10565C1-1 | 58.2 | 11.1 | 9.2 | 2.7 | 34.2 | 67.6 | 60.3 | 9.1 | 121.1 | 67.9 | 26 | D |
| 082A1-3-1 | 57.8 | 10.7 | 5.7 | 2.7 | 33.5 | 67.6 | 61.3 | 8.7 | 132.1 | 70.3 | 34 | D |
| 11405A1-4 | 58.0 | 11.4 | 14.8 | 2.9 | 34.8 | 67.8 | 52.8 | 9.1 | 93.7 | 65.5 | 28 | D |
| B12*1792 | 59.3 | 10.9 | 12.0 | 2.7 | 35.6 | 68.0 | 56.9 | 9.2 | 142.8 | 65.4 | 16 | D |
| B12-2180NC# | 58.0 | 11.4 | 21.1 | 2.5 | 28.0 | 67.4 | 58.2 | 9.3 | 134.7 | 69.3 | 38 | D |
| B12-2125FHB | 60.3 | 10.5 | 19.4 | 2.7 | 32.7 | 69.0 | 56.2 | 8.4 | 113.5 | 65.7 | 11 | C |
| M12-3189 | 59.3 | 11.3 | 8.7 | 2.6 | 30.1 | 69.8 | 57.3 | 9.3 | 126.4 | 63.2 | 2 | C |
| Jamestown | 60.5 | 11.7 | 11.2 | 2.8 | 31.8 | 67.1 | 57.5 | 9.4 | 135.8 | 70.6 | 35 | D |
| Shirley | 56.6 | 10.4 | -0.1 | 2.6 | 35.3 | 69.1 | 59.3 | 8.2 | 101.9 | 66.9 | 13 | C |
| IL10-12009 | 58.3 | 11.0 | 14.3 | 2.7 | 31.6 | 66.4 | 54.4 | 9.1 | 127.2 | 65.8 | 40 | F |
| IL10-23236 | 59.2 | 10.5 | 11.8 | 2.6 | 31.7 | 65.9 | 59.3 | 8.8 | 132.4 | 65.6 | 37 | F |
| IL11-6543 | 61.2 | 10.8 | 0.7 | 2.7 | 33.1 | 67.9 | 59.4 | 9.3 | 136.0 | 65.6 | 10 | D |
| IL11-6626 | 60.4 | 11.7 | 17.3 | 2.8 | 33.8 | 67.1 | 53.9 | 9.6 | 130.9 | 64.1 | 21 | D |
| IL11-8141 | 59.0 | 10.5 | 4.9 | 2.6 | 31.4 | 71.2 | 57.9 | 8.7 | 134.7 | 62.9 | 1 | A |
| KY06C-1178-16-10-3 | 58.5 | 10.6 | -0.1 | 2.7 | 38.2 | 68.9 | 60.1 | 8.5 | 136.5 | 66.3 | 9 | C |
| KY06C-3058-53-3-3 | 59.5 | 10.9 | 16.8 | 2.7 | 33.2 | 67.3 | 58.2 | 8.9 | 151.6 | 67.8 | 32 | D |
| KY06C-2020-10-18-3 | 58.6 | 10.9 | 5.0 | 2.7 | 31.2 | 67.5 | 61.4 | 8.7 | 138.0 | 65.4 | 17 | D |
| KY05C-1369-14-6-3 | 61.2 | 12.5 | 14.3 | 2.8 | 35.0 | 67.3 | 53.2 | 10.5 | 145.7 | 67.0 | 23 | D |
| KY05C-1017-30-6-3 | 60.0 | 11.2 | 21.5 | 2.6 | 32.3 | 68.7 | 55.7 | 9.4 | 123.2 | 64.7 | 12 | C |
| MO 130651 | 59.4 | 9.9 | -5.0 | 2.6 | 33.4 | 69.1 | 63.8 | 8.0 | 113.9 | 66.6 | 3 | C |
| MO 130660 | 58.8 | 11.4 | 48.4 | 2.6 | 30.3 | 66.6 | 39.7 | 10.1 | 110.4 | 75.7 | 45 | F |
| MO 130669 | 57.0 | 10.0 | 0.9 | 2.5 | 31.0 | 68.3 | 65.1 | 8.1 | 119.4 | 69.1 | 18 | D |
| MO 130435 | 58.9 | 11.7 | 3.4 | 2.5 | 31.7 | 66.9 | 59.3 | 9.5 | 125.0 | 67.2 | 30 | F |
| MO 130906 | 58.9 | 11.7 | 19.3 | 2.6 | 32.0 | 64.8 | 58.1 | 9.6 | 129.0 | 73.0 | 44 | F |
| MO 131378 | 57.9 | 11.2 | 2.3 | 2.5 | 30.2 | 67.5 | 61.6 | 9.4 | 139.4 | 70.0 | 33 | D |
| VA13W-56 | 60.8 | 12.0 | 14.1 | 2.9 | 34.1 | 67.0 | 52.2 | 9.9 | 127.1 | 65.0 | 27 | F |
| VA13W-124 | 58.1 | 10.1 | 19.1 | 2.8 | 36.5 | 68.2 | 55.3 | 8.8 | 127.1 | 67.7 | 29 | D |
| VA07MAS4-7417-1-3-3 | 58.2 | 11.5 | 6.7 | 2.8 | 37.5 | 67.4 | 54.8 | 9.2 | 122.3 | 68.6 | 36 | D |
| VA08MAS1-188-6-4 | 58.5 | 11.9 | -0.2 | 2.7 | 35.2 | 67.2 | 55.8 | 9.3 | 123.4 | 71.3 | 39 | D |
| VA13FHB-5 | 59.9 | 12.3 | 16.2 | 2.9 | 37.7 | 67.5 | 51.8 | 9.9 | 112.1 | 66.1 | 31 | D |

| Entry | Test Weight (LB/BU) | NIR Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Total T-Score Rank | Flour Yield % Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| USG 3120 | 60.2 | 10.8 | 5.7 | 2.8 | 40.5 | 69.5 | 57.6 | 9.1 | 116.8 | 67.5 | 5 | C |
| Branson | 57.4 | 10.5 | 0.4 | 2.6 | 32.8 | 69.3 | 65.0 | 8.7 | 135.5 | 66.1 | 4 | C |
| | | | | | | | | | | | | |
| Mean | 58.6 | 11.0 | 9.8 | 2.7 | 33.4 | 67.9 | 58.1 | 9.0 | 127.0 | 67.4 | | |
| Std Dev | 1.5 | 0.6 | 9.2 | 0.1 | 2.6 | 1.2 | 4.7 | 0.5 | 12.6 | 2.6 | | |

*Check variety.

## *GULF ATLANTIC WHEAT NURSERY*

*Stephen Harrison, Louisiana State University*

Forty-four 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 and lactic acid SRC. In addition to the test data, a t-score (which is the number of standard deviations away from the check variety for each quality parameter) was generated to show how different the entry's quality trait is from that of the check variety, USG3120. Total t-score was also calculated by summing up (0.15 x test weight), (-0.10 x kernel hardness), (0.4 x flour yield), (0.15 x softness equivalence) and (-0.2 x sodium carbonate SRC) to show the difference in overall quality potential between each entry and the check variety, and used to generate the overall end-use quality rankings of varieties and breeding lines. 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 2008-2014. Those entries that fell in the flour yield range of the top 15% of lines and varieties 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 test weights, kernel hardness values and grain protein contents, but lower flour yields and SE values compared to typical SRW wheat with an average test weight, kernel hardness, grain protein content, flour yield and SE of 61.2 lb/bu, 36, 11.8%, 66.5% and 46.3%, respectively. Thirty-three out of 44 entries exhibited kernel hardness values greater than 30. Three entries, including AR05079-2-2, AR05079-2-1, AR05055-1-1, showed kernel hardness scores of typical hard wheat, ranging from 65.8 to 72.6. Unusually high kernel hardness was probably responsible for the relatively low flour yields and SE values of the entries. The entries were mostly comparable to the check varieties in grain and flour characteristics, except flour yield. Forty out of 44 entries exhibited lower flour yields than the check variety.

Table 25. Gulf Atlantic Wheat Nursery wheat variety trial 2015 crop quality data

| Entry | Test Weight (LB/BU) | Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Total T-Score Rank | Flour Yield % Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| USG3555 | 59.7 | 11.2 | 25.7 | 2.9 | 38.6 | 65.5 | 48.8 | 9.4 | 112.8 | 69.2 | 34 | F |
| TX12D4625 | 62.5 | 11.5 | 35.0 | 3.0 | 38.1 | 65.2 | 50.4 | 9.6 | 127.9 | 70.1 | 26 | F |
| TX12D4768 | 63.4 | 12.7 | 32.1 | 3.0 | 40.3 | 66.1 | 42.9 | 10.8 | 116.2 | 65.2 | 19 | F |
| TX12D4791 | 62.2 | 13.0 | 34.1 | 2.8 | 34.4 | 65.5 | 46.4 | 10.9 | 142.1 | 63.5 | 22 | F |
| TX12D4898 | 62.4 | 12.4 | 27.5 | 2.8 | 38.2 | 64.3 | 50.8 | 10.3 | 142.0 | 68.9 | 29 | F |
| TXGA06343-17-3-5-EL2 | 60.6 | 11.2 | 30.1 | 2.8 | 35.0 | 70.3 | 49.1 | 9.6 | 110.6 | 65.6 | 1 | B |
| TXGA051407-2-15-6-EL61 | 61.6 | 12.0 | 32.8 | 3.1 | 43.0 | 64.3 | 47.3 | 10.1 | 133.1 | 67.8 | 38 | F |
| SHIRLEY | 58.5 | 11.7 | 27.7 | 2.7 | 32.4 | 66.4 | 48.8 | 9.3 | 83.7 | 67.9 | 31 | F |
| LA06146E-P4 | 61.9 | 10.9 | 24.5 | 3.0 | 38.4 | 67.5 | 48.6 | 8.9 | 118.8 | 67.8 | 6 | D |
| LA08115C-30 | 61.9 | 11.5 | 22.2 | 2.8 | 36.7 | 66.4 | 51.9 | 9.5 | 140.5 | 70.0 | 15 | F |
| LA09011UB-2 | 62.5 | 11.1 | 35.0 | 2.9 | 34.3 | 67.7 | 47.7 | 9.3 | 114.3 | 69.6 | 8 | D |
| LA09264C-P2 | 59.4 | 11.0 | 18.5 | 2.8 | 39.0 | 68.1 | 51.3 | 9.4 | 117.5 | 67.9 | 7 | D |
| LA09264C-P5 | 62.7 | 12.6 | 35.7 | 2.7 | 33.9 | 66.2 | 44.1 | 10.1 | 104.5 | 67.2 | 21 | F |
| LANC8170-41-2 | 61.1 | 12.4 | 31.3 | 2.8 | 33.6 | 65.3 | 44.7 | 10.0 | 115.9 | 63.9 | 28 | F |
| GA04434-13E52 | 61.7 | 10.5 | 37.9 | 2.7 | 31.7 | 66.9 | 49.8 | 8.9 | 97.3 | 66.5 | 13 | F |
| GA061349-13LE31 | 62.7 | 11.5 | 30.4 | 2.9 | 39.4 | 66.3 | 48.2 | 9.0 | 123.0 | 69.1 | 18 | F |
| GA06493-13LE6 | 59.1 | 12.4 | 30.0 | 2.8 | 34.6 | 65.5 | 48.5 | 9.8 | 114.3 | 69.7 | 40 | F |
| GA 051102-13LE43 | 61.4 | 11.6 | 39.4 | 2.7 | 31.1 | 65.3 | 45.7 | 9.8 | 115.2 | 66.6 | 33 | F |
| GA061349-13LE29 | 61.5 | 11.6 | 37.1 | 2.8 | 32.9 | 65.5 | 45.9 | 9.6 | 112.0 | 66.5 | 30 | F |
| GA061349-13E5 | 62.3 | 12.3 | 32.9 | 3.0 | 40.5 | 65.5 | 45.5 | 10.0 | 126.2 | 66.4 | 24 | F |
| **USG3120*** | **61.4** | **11.4** | **28.7** | **2.8** | **37.9** | **68.9** | **48.1** | **9.6** | **96.5** | **69.4** | **3** | C |
| AR05055-1-1 | 61.5 | 11.9 | 72.6 | 2.9 | 32.8 | 65.2 | 31.4 | 10.0 | 89.6 | 92.9 | 44 | F |
| AR05074-12-1 | 60.4 | 10.4 | 29.5 | 2.6 | 31.4 | 66.7 | 46.9 | 8.7 | 85.7 | 67.9 | 23 | F |
| AR05079-2-1 | 61.7 | 10.3 | 68.2 | 3.1 | 40.2 | 67.3 | 35.6 | 8.6 | 83.6 | 84.8 | 41 | D |
| AR05079-2-2 | 59.1 | 10.4 | 65.8 | 3.1 | 40.9 | 67.5 | 36.9 | 9.0 | 83.2 | 83.4 | 42 | D |
| AR05094-4-1 | 60.1 | 11.2 | 30.1 | 2.7 | 30.1 | 69.3 | 55.1 | 9.3 | 103.1 | 68.6 | 2 | C |
| ARGA04494-11E49 | 61.6 | 11.5 | 47.1 | 2.8 | 35.5 | 67.0 | 42.2 | 10.1 | 104.6 | 69.1 | 27 | D |
| NC11-21982 | 61.0 | 12.7 | 43.2 | 2.8 | 30.2 | 67.5 | 44.2 | 10.5 | 103.6 | 67.7 | 20 | D |
| NC11-23084 | 61.0 | 13.6 | 40.0 | 2.9 | 33.6 | 69.0 | 44.8 | 11.4 | 91.3 | 64.3 | 4 | C |
| NC11-20553 | 61.6 | 11.8 | 43.4 | 2.7 | 29.8 | 67.8 | 47.7 | 9.8 | 122.8 | 67.4 | 12 | D |
| NC11-22289 | 61.4 | 13.6 | 36.4 | 2.9 | 32.2 | 65.8 | 43.8 | 11.4 | 125.9 | 67.7 | 32 | F |
| NC11-21899 | 61.6 | 13.2 | 42.4 | 2.8 | 32.4 | 64.5 | 44.8 | 10.7 | 119.5 | 64.6 | 39 | F |
| NC9305-7 | 59.9 | 14.1 | 48.2 | 2.6 | 26.5 | 61.9 | 41.9 | 11.5 | 106.1 | 69.0 | 43 | F |
| SS8641 | 61.2 | 12.6 | 40.6 | 2.7 | 31.4 | 64.7 | 45.9 | 10.2 | 122.2 | 65.6 | 36 | F |
| VA12W-22 | 61.4 | 11.7 | 39.5 | 2.7 | 29.3 | 68.2 | 47.7 | 9.6 | 101.2 | 63.9 | 5 | D |
| VA12W-31 | 61.2 | 10.1 | 40.5 | 2.7 | 28.4 | 65.9 | 49.4 | 8.3 | 106.9 | 67.5 | 25 | F |
| VA12W-97 | 61.5 | 10.6 | 33.4 | 2.6 | 32.4 | 67.7 | 47.6 | 9.0 | 101.8 | 70.4 | 14 | D |
| VA13W-38 | 60.6 | 13.0 | 25.3 | 2.6 | 28.8 | 67.0 | 45.4 | 11.0 | 121.1 | 63.4 | 16 | F |
| VA13W-56 | 62.4 | 12.3 | 29.9 | 2.8 | 30.2 | 66.7 | 47.7 | 10.1 | 110.4 | 65.7 | 11 | F |

| Entry | Test Weight (LB/BU) | Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Total T-Score Rank | Flour Yield % Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VA13W-124 | 59.6 | 9.9 | 32.8 | 2.8 | 34.8 | 67.9 | 49.6 | 8.3 | 99.0 | 68.7 | 17 | D |
| VA13W-177 | 61.8 | 13.3 | 34.5 | 2.6 | 28.9 | 67.7 | 44.2 | 10.8 | 111.9 | 65.1 | 10 | D |
| VA07MAS4-7417-1-3-3 | 60.4 | 11.9 | 32.6 | 2.7 | 30.0 | 65.5 | 46.9 | 9.8 | 103.8 | 69.4 | 35 | F |
| VA07MAS14-9260-8-2-2 | 61.9 | 11.0 | 37.0 | 2.7 | 30.8 | 68.1 | 46.3 | 9.3 | 106.9 | 68.4 | 9 | D |
| VA08MAS1-188-6-4 | 60.0 | 12.0 | 22.4 | 2.7 | 32.3 | 65.1 | 46.9 | 9.6 | 96.2 | 69.4 | 37 | F |
| | | | | | | | | | | | | |
| Mean | 61.2 | 11.8 | 36.0 | 2.8 | 34.0 | 66.5 | 46.3 | 9.8 | 110.6 | 68.7 | | |
| Std Dev | 1.1 | 1.0 | 11.1 | 0.1 | 4.0 | 1.6 | 4.2 | 0.8 | 15.1 | 5.5 | | |

*Check variety.

## *MASON-DIXON REGIONAL NURSERY*

*Carl Griffey, Virginia Polytechnic Institute and State University*

Seventy nine 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, SE, flour protein content, sodium carbonate SRC, lactic acid SRC and sugar-snap cookie baking quality. In addition to the test data, a t-score (which is the number of standard deviations away from the check variety for each quality parameter) was generated to show how different the entry's quality trait is from that of the check variety, Shirley. Total t-score was also calculated by summing up (0.15 x test weight), (-0.10 x kernel hardness), (0.4 x flour yield), (0.15 x softness equivalence) and (-0.2 x sodium carbonate SRC) to show the difference in overall quality potential between each entry and the check variety, and used to generate the overall end-use quality rankings of varieties and breeding lines. 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 2008-2014. Those entries that fell in the flour yield range of the top 15% of lines and varieties 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 majority of entries exhibited similar test weights, higher grain protein contents, lower flour yields, lower SE values, slightly higher sodium carbonate SRCs, and similar sugar-snap cookie diameters compared to typical SRW wheat. Five entries produced cookies with diameters greater than 19.0 cm. Only three entries exhibited higher flour yields than the check variety, Shirley. All the entries exhibited higher lactic acid SRC values than the check, indicating their stronger gluten protein. Forty-two entries produced sugar-snap cookies of greater diameter than that of the check variety.

Table 26. Mason-Dixon Regional Nursery wheat variety trial 2015 crop quality data

| Entry | Test Weight (LB/BU) | Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Cookie Diameter (cm) | Top Grade (0-9) | Total T-Score Rank | Flour Yield Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MD08W48-14-1 | 60.6 | 10.5 | 18.8 | 2.6 | 28.0 | 68.0 | 60.6 | 8.9 | 124.2 | 72.5 | 18.2 | 2 | 9 | D |
| MD272-6-14-2 | 63.3 | 11.7 | 24.4 | 2.7 | 33.8 | 66.7 | 53.8 | 9.8 | 109.6 | 68.9 | 18.4 | 2 | 19 | F |
| MD07W494-14-1 | 60.5 | 11.3 | 32.1 | 2.7 | 33.8 | 65.6 | 56.2 | 9.6 | 131.0 | 73.0 | 17.8 | 2 | 64 | F |
| MD07W481-14-1 | 62.8 | 11.2 | 25.2 | 2.7 | 34.8 | 65.8 | 56.1 | 9.4 | 120.6 | 75.2 | 18.0 | 2 | 47 | F |
| MD07W481-14-2 | 61.6 | 10.7 | 27.2 | 2.6 | 32.5 | 64.4 | 56.0 | 9.0 | 127.4 | 80.2 | 16.9 | 2 | 75 | F |
| MD07W478-14-1 | 61.3 | 11.0 | 24.5 | 2.8 | 32.9 | 67.0 | 54.3 | 9.3 | 112.3 | 73.3 | 18.3 | 2 | 37 | D |
| MD07W478-14-2 | 61.8 | 11.3 | 24.1 | 2.7 | 31.3 | 68.4 | 54.4 | 9.3 | 113.1 | 72.7 | 18.5 | 3 | 13 | C |
| MD07W478-14-3 | 61.7 | 10.7 | 30.3 | 2.7 | 31.6 | 66.2 | 54.8 | 9.2 | 111.5 | 74.4 | 18.0 | 3 | 52 | F |
| MD07W478-14-4 | 61.3 | 11.4 | 29.1 | 2.7 | 32.1 | 66.1 | 55.5 | 9.5 | 110.8 | 74.8 | 18.2 | 2 | 53 | F |
| MD07W478-14-5 | 60.6 | 10.9 | 29.8 | 2.7 | 31.1 | 67.9 | 55.5 | 8.7 | 117.5 | 73.8 | 17.6 | 3 | 29 | D |
| MD07W478-14-6 | 61.4 | 11.3 | 27.1 | 2.8 | 33.3 | 67.9 | 52.6 | 8.9 | 116.3 | 70.3 | 17.4 | 3 | 21 | D |
| MD07W478-14-7 | 60.9 | 11.0 | 22.2 | 2.7 | 31.1 | 68.1 | 54.7 | 9.1 | 110.8 | 71.9 | 18.4 | 2 | 16 | D |
| MD83-3-1-14-1 | 58.9 | 11.3 | 9.8 | 2.6 | 33.0 | 66.9 | 58.9 | 9.1 | 137.9 | 75.9 | 18.9 | 2 | 40 | F |
| MD83-18-2-14-1 | 59.7 | 11.0 | 11.9 | 2.5 | 28.8 | 65.3 | 59.9 | 9.1 | 140.3 | 83.5 | 18.2 | 2 | 68 | F |
| MD83-18-2-14-5 | 61.3 | 11.1 | 11.8 | 2.6 | 30.6 | 66.9 | 59.6 | 9.1 | 141.8 | 85.3 | 17.9 | 2 | 45 | F |
| MD83-18-2-14-6 | 60.5 | 10.8 | 14.5 | 2.6 | 31.1 | 64.8 | 60.5 | 9.2 | 141.3 | 87.7 | 18.1 | 3 | 74 | F |
| MD272-8-4-14-2 | 60.7 | 11.8 | 21.0 | 2.6 | 32.6 | 65.9 | 59.3 | 10.2 | 123.2 | 80.4 | 17.8 | 2 | 61 | F |
| MD272-8-4-14-4 | 60.9 | 12.0 | 33.5 | 2.5 | 28.8 | 64.9 | 54.9 | 10.1 | 101.1 | 73.0 | 17.6 | 2 | 70 | F |
| MD272-8-4-14-6 | 61.0 | 11.8 | 23.4 | 2.6 | 32.5 | 65.7 | 60.3 | 9.8 | 117.3 | 75.8 | 17.8 | 2 | 51 | F |
| MD272-8-4-14-8 | 60.6 | 11.8 | 24.9 | 2.6 | 32.5 | 65.2 | 60.3 | 9.4 | 112.3 | 78.9 | 18.5 | 2 | 67 | F |
| KY06C-1029-2-11-3 | 59.8 | 11.0 | 34.8 | 2.7 | 31.4 | 66.6 | 52.2 | 9.6 | 119.6 | 69.5 | 18.3 | 3 | 55 | F |
| KY06C-1201-18-6-3 | 59.2 | 12.3 | 27.0 | 2.5 | 30.4 | 66.9 | 54.3 | 10.1 | 130.2 | 71.7 | 17.8 | 0 | 50 | F |
| KY06C-2067-15-1-1 | 59.2 | 10.5 | 24.0 | 2.7 | 32.0 | 68.1 | 56.6 | 8.9 | 104.1 | 70.9 | 17.6 | 3 | 20 | D |
| KY06C-2020-10-5-3 | 59.6 | 10.8 | 12.2 | 2.6 | 31.9 | 68.4 | 58.1 | 8.9 | 133.1 | 69.4 | 18.7 | 3 | 6 | C |
| KY06C-2067-16-7-1 | 58.1 | 11.8 | 21.9 | 2.6 | 31.5 | 67.9 | 54.8 | 10.0 | 104.7 | 70.1 | 17.5 | 2 | 31 | D |
| 718602 | 61.2 | 11.0 | 35.3 | 2.7 | 31.5 | 65.3 | 55.2 | 9.0 | 119.9 | 68.4 | 18.0 | 2 | 58 | F |
| KY0901008-2-17-5 | 61.2 | 12.8 | 26.2 | 2.7 | 29.2 | 64.6 | 54.8 | 10.2 | 117.6 | 73.8 | 17.4 | 1 | 69 | F |
| KY05C-1105-43-6-1 | 59.5 | 11.2 | 25.4 | 2.6 | 29.3 | 66.8 | 61.6 | 8.8 | 134.3 | 70.1 | 18.4 | 2 | 24 | F |
| KY05C-1204-72-13-3 | 60.8 | 11.3 | 28.9 | 2.6 | 28.1 | 64.9 | 52.3 | 9.4 | 122.9 | 67.9 | 18.2 | 3 | 66 | F |
| KY05C-1126-50-12-1 | 57.8 | 11.3 | 26.2 | 2.7 | 32.6 | 67.7 | 57.2 | 9.7 | 104.5 | 66.3 | 18.7 | 3 | 22 | D |
| KY05C-1105-42-20-1 | 59.4 | 11.3 | 21.8 | 2.6 | 29.0 | 66.8 | 61.8 | 9.4 | 138.1 | 71.7 | 17.6 | 2 | 27 | F |
| X08C-1502-25-5-1 | 60.8 | 11.8 | 50.3 | 2.7 | 33.9 | 67.2 | 42.6 | 10.3 | 102.6 | 77.5 | 17.4 | 2 | 77 | D |
| X08C-1502-28-11-3 | 60.7 | 12.0 | 29.2 | 2.5 | 29.5 | 65.6 | 57.1 | 9.9 | 113.3 | 74.6 | 17.9 | 2 | 63 | F |
| X08C-1299-42-18-3 | 59.0 | 10.2 | 17.5 | 2.8 | 38.1 | 67.1 | 58.8 | 8.5 | 111.9 | 71.5 | 18.4 | 3 | 28 | D |
| X08C-1299-44-4-5 | 60.6 | 11.5 | 23.5 | 2.7 | 32.5 | 67.2 | 54.8 | 9.5 | 98.8 | 73.1 | 19.0 | 3 | 35 | D |
| KY09C-2027-56-20-5 | 59.9 | 11.4 | 20.1 | 2.7 | 31.1 | 67.9 | 55.7 | 9.4 | 122.5 | 66.6 | 18.7 | 2 | 10 | D |
| KY09C-2027-57-2-5 | 60.6 | 12.2 | 26.0 | 2.8 | 32.5 | 66.9 | 50.6 | 9.9 | 116.7 | 69.2 | 17.7 | 3 | 41 | F |
| KY09C-1024-96-1-3 | 59.8 | 11.3 | 32.6 | 2.8 | 34.0 | 67.0 | 53.0 | 9.7 | 103.6 | 70.1 | 18.6 | 3 | 48 | D |
| KY09C-1245-99-1-5 | 61.3 | 12.1 | 30.2 | 2.6 | 30.2 | 64.6 | 53.8 | 9.6 | 121.2 | 75.5 | 17.3 | 2 | 73 | F |
| KY09C-1245-99-15-1 | 61.8 | 10.3 | 22.7 | 2.7 | 32.5 | 66.0 | 55.3 | 8.6 | 116.6 | 72.7 | 19.1 | 3 | 43 | F |
| ARS11-0064 | 59.1 | 10.8 | 26.6 | 2.7 | 30.3 | 66.8 | 60.2 | 8.9 | 119.7 | 73.8 | 18.2 | 2 | 42 | F |
| ARS11-0065 | 59.8 | 10.7 | 27.6 | 2.7 | 30.1 | 66.8 | 59.3 | 8.8 | 113.1 | 72.0 | 18.3 | 2 | 36 | F |
| ARS11-0229 | 60.8 | 10.5 | 16.9 | 2.9 | 38.0 | 66.8 | 60.3 | 8.7 | 105.5 | 75.5 | 17.6 | 3 | 26 | F |

| Entry | Test Weight (LB/BU) | Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Cookie Diameter (cm) | Top Grade (0-9) | Total T-Score Rank | Flour Yield Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARS11-0327 | 59.3 | 11.6 | 27.8 | 2.7 | 32.6 | 67.7 | 52.8 | 9.3 | 120.6 | 66.3 | 18.6 | 3 | 23 | D |
| ARS11-0423 | 58.3 | 11.8 | 27.4 | 2.8 | 34.7 | 63.4 | 57.1 | 9.7 | 147.2 | 86.8 | 17.4 | 1 | 79 | F |
| ARS12-024 | 58.3 | 11.8 | 29.7 | 2.6 | 27.9 | 64.7 | 58.6 | 9.4 | 123.9 | 76.1 | 17.9 | 2 | 78 | F |
| ARS12-025 | 60.0 | 11.1 | 30.0 | 2.6 | 28.2 | 64.8 | 58.1 | 9.2 | 119.5 | 75.8 | 18.0 | 2 | 71 | F |
| ARS12-026 | 59.5 | 10.6 | 29.2 | 2.6 | 28.1 | 65.2 | 59.5 | 8.8 | 121.4 | 73.2 | 18.8 | 2 | 65 | F |
| ARS12-093 | 60.4 | 11.5 | 16.0 | 2.8 | 36.9 | 66.0 | 60.3 | 9.4 | 106.3 | 80.4 | 17.9 | 2 | 54 | F |
| ARS12-102 | 58.6 | 11.6 | 21.9 | 2.8 | 34.1 | 68.9 | 53.8 | 9.6 | 124.0 | 69.1 | 18.5 | 4 | 14 | C |
| ARS12-105 | 59.0 | 12.4 | 10.6 | 2.6 | 27.2 | 66.7 | 58.6 | 10.3 | 154.3 | 73.2 | 18.4 | 2 | 34 | F |
| ARS12-201 | 61.2 | 11.6 | 23.3 | 2.8 | 37.2 | 70.7 | 54.0 | 9.4 | 108.7 | 66.4 | 18.6 | 5 | 1 | B |
| ARS12-301 | 62.1 | 11.2 | 28.3 | 2.8 | 33.9 | 68.2 | 51.5 | 9.7 | 98.4 | 69.9 | 17.9 | 2 | 15 | D |
| ARS12-576 | 61.7 | 11.7 | 31.1 | 3.1 | 40.7 | 67.1 | 47.7 | 9.5 | 141.7 | 75.5 | 17.6 | 3 | 57 | D |
| ARS12-780 | 60.1 | 11.4 | 20.4 | 2.7 | 34.4 | 69.4 | 55.6 | 9.3 | 116.5 | 68.5 | 18.7 | 3 | 2 | C |
| VA12W-22 | 59.6 | 11.1 | 14.7 | 2.7 | 33.7 | 68.6 | 56.7 | 8.6 | 106.6 | 66.6 | 18.9 | 6 | 3 | C |
| VA12W-31 | 60.7 | 11.0 | 30.5 | 2.7 | 30.9 | 65.8 | 52.1 | 8.8 | 129.2 | 69.4 | 18.5 | 3 | 59 | F |
| VA12W-68 | 59.9 | 12.0 | 14.3 | 3.0 | 43.4 | 65.4 | 53.1 | 10.0 | 103.9 | 70.1 | 18.7 | 3 | 60 | F |
| VA12W-97 | 60.6 | 13.0 | 29.7 | 2.6 | 32.7 | 66.3 | 53.0 | 11.0 | 112.1 | 75.1 | 17.0 | 2 | 62 | F |
| VA13W-38 | 60.5 | 11.0 | 8.5 | 2.8 | 33.8 | 68.1 | 54.3 | 9.0 | 119.6 | 66.7 | 18.9 | 6 | 5 | D |
| VA13W-56 | 63.1 | 11.5 | 22.8 | 2.8 | 33.3 | 66.7 | 50.7 | 9.5 | 114.5 | 69.7 | 18.8 | 4 | 25 | F |
| VA13W-124 | 58.8 | 11.0 | 31.6 | 2.7 | 34.2 | 66.0 | 51.3 | 9.0 | 109.3 | 73.6 | 17.7 | 3 | 72 | F |
| VA13W-177 | 62.3 | 11.8 | 23.9 | 2.7 | 33.8 | 67.7 | 50.7 | 9.3 | 116.5 | 69.0 | 18.7 | 5 | 17 | D |
| VA07MAS4-7417-1-3-3 | 60.5 | 11.7 | 17.7 | 2.7 | 34.6 | 66.1 | 53.0 | 9.3 | 115.6 | 71.0 | 18.8 | 3 | 49 | F |
| VA07MAS14-9260-8-2-2 | 62.1 | 11.8 | 23.1 | 2.7 | 33.1 | 67.8 | 54.2 | 9.8 | 146.3 | 69.3 | 17.9 | 3 | 12 | D |
| VA08MAS1-188-6-4 | 59.6 | 11.6 | 9.5 | 2.7 | 36.9 | 66.8 | 53.8 | 9.3 | 116.9 | 75.2 | 18.3 | 2 | 46 | F |
| VA08MAS1-190-4-1 | 59.5 | 11.5 | 14.1 | 2.7 | 34.8 | 67.4 | 51.1 | 9.3 | 110.6 | 70.0 | 19.1 | 2 | 32 | D |
| VA08MAS5-39-6-4 | 58.9 | 13.2 | 13.5 | 2.6 | 33.1 | 67.3 | 59.2 | 10.6 | 135.0 | 77.5 | 17.9 | 0 | 39 | D |
| VA12FHB-53 | 59.3 | 12.2 | 23.1 | 2.6 | 29.7 | 64.4 | 56.4 | 9.7 | 109.0 | 75.5 | 18.0 | 3 | 76 | F |
| VA12FHB-55 | 58.7 | 11.3 | 16.2 | 2.7 | 34.2 | 67.4 | 57.4 | 9.0 | 112.5 | 78.0 | 18.6 | 3 | 44 | D |
| VA12FHB-8 | 60.5 | 10.6 | 20.7 | 2.7 | 32.6 | 67.1 | 56.8 | 8.5 | 101.9 | 74.4 | 19.1 | 5 | 33 | D |
| VA12FHB-4 | 58.3 | 13.4 | 11.4 | 2.7 | 34.3 | 65.7 | 56.5 | 10.7 | 99.2 | 71.2 | 17.9 | 1 | 56 | F |
| VA13FHB-5† | 61.5 | 11.6 | 21.0 | 2.8 | 35.7 | 66.8 | 52.6 | 9.4 | 106.1 | 72.5 | 17.8 | 3 | 38 | F |
| VA13FHB-11† | 60.5 | 11.1 | 17.8 | 2.9 | 38.3 | 67.4 | 55.4 | 9.2 | 111.5 | 69.6 | 19.0 | 4 | 18 | D |
| VA13FHB-13† | 62.3 | 12.4 | 22.0 | 2.8 | 37.9 | 68.3 | 52.5 | 10.3 | 118.8 | 69.0 | 18.1 | 2 | 8 | D |
| **Shirley*** | **58.8** | **11.2** | **12.1** | **2.7** | **35.2** | **68.8** | **56.5** | **8.6** | **96.0** | **70.0** | **18.1** | **3** | **7** | **C** |
| Jamestown | 62.6 | 12.2 | 25.5 | 2.7 | 32.0 | 66.8 | 54.0 | 9.4 | 124.8 | 72.5 | 17.7 | 2 | 30 | F |
| Bess | 57.4 | 11.8 | 9.4 | 2.5 | 30.4 | 68.3 | 62.0 | 9.2 | 120.3 | 71.4 | 18.3 | 4 | 11 | D |
| Pioneer 26R10 | 60.0 | 10.6 | 19.1 | 2.7 | 36.8 | 68.5 | 63.7 | 8.4 | 109.4 | 72.3 | 17.6 | 3 | 4 | C |
| | | | | | | | | | | | | | | |
| Mean | 60.3 | 11.4 | 23.0 | 2.7 | 32.7 | 66.8 | 55.7 | 9.4 | 118.0 | 73.0 | 18.2 | 2.6 | | |
| Std Dev | 1.3 | 0.6 | 7.5 | 0.1 | 3.0 | 1.3 | 3.6 | 0.5 | 12.6 | 4.5 | 0.5 | 1.1 | | |

*Check variety.

## *UNIFORM SOUTHERN SOFT RED WINTER WHEAT NURSERY*

*Esten Mason, University of Arkansas*

Thirty 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. In addition to the test data, a t-score (which is the number of standard deviations away from the check variety for each quality parameter) was generated to show how different the entry's quality trait is from that of the check variety, AGS 2000. Total t-score was also calculated by summing up (0.15 x test weight), (-0.10 x kernel hardness), (0.4 x flour yield), (0.15 x softness equivalence) and (-0.2 x sodium carbonate SRC) to show the difference in overall quality potential between each entry and the check variety, and used to generate the overall end-use quality rankings of varieties and breeding lines. 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 2008-2014. Those entries that fell in the flour yield range of the top 15% of lines and varieties 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 quite comparable wheat grain and flour characteristics, including test weights, grain protein contents, kernel hardness values, sodium carbonate SRCs and sugar-snap cookie diameters, to typical SRW wheat. The average flour yield of the entries was lower by 1.1% than the SWQL average for SRW wheat. Compared to the check variety, AGS 200, most of the entries exhibited similar test weights, grain and flour protein contents, sodium carbonate SRCs and sugar-snap cookie diameters, but lower flour yields and SE values. ES12-2619 ranked first in total t-score with a flour yield of 70.7% and cookie diameter of 18.4 cm, followed by LA03224E-39 and AR11LE24 with flour yields and cookie diameters of 70.5 and 71.3%, and 18.2 and 19.2 cm, respectively.

Table 27. Uniform Southern Soft Red Winter Wheat Nursery wheat variety trial 2015 crop quality data

| Entry | Test Weight (LB/BU) | Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Cookie Diameter (cm) | Top Grade (0-9) | Total T-Score Rank | Flour Yield % Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AGS 2000*** | **60.0** | **10.9** | **7.9** | **2.8** | **37.9** | **70.7** | **59.6** | **8.9** | **108.5** | **69.5** | **18.9** | **4** | **4** | **B** |
| USG 3555 | 60.1 | 10.7 | 14.0 | 2.8 | 37.0 | 67.5 | 54.8 | 8.7 | 112.0 | 73.0 | 17.7 | 2 | 28 | D |
| Jamestown | 61.4 | 10.8 | 14.1 | 2.8 | 32.4 | 67.4 | 57.5 | 8.8 | 114.9 | 71.9 | 18.4 | 4 | 21 | D |
| USG 3120 | 60.5 | 10.2 | 12.7 | 2.8 | 39.4 | 70.1 | 58.1 | 8.4 | 103.8 | 70.1 | 18.5 | 4 | 7 | B |
| NC09-20986 | 61.4 | 10.8 | 19.8 | 2.8 | 32.2 | 67.1 | 58.8 | 9.0 | 133.2 | 69.0 | 18.5 | 3 | 17 | D |
| TXE21 | 59.7 | 11.2 | 19.8 | 2.8 | 33.8 | 68.5 | 55.0 | 9.1 | 107.6 | 66.7 | 18.4 | 3 | 13 | C |
| NC10-23720 | 60.4 | 10.6 | 18.2 | 2.6 | 34.1 | 64.5 | 53.5 | 8.9 | 106.9 | 77.4 | 18.1 | 2 | 30 | F |
| NC11-23321 | 59.9 | 10.4 | 20.0 | 2.6 | 31.9 | 68.3 | 57.8 | 8.5 | 116.6 | 68.8 | 17.9 | 3 | 14 | D |
| NC11-21899 | 60.3 | 10.8 | 24.7 | 2.7 | 32.2 | 67.9 | 55.1 | 8.8 | 112.9 | 65.2 | 19.0 | 2 | 15 | D |
| TN1501 | 57.8 | 9.7 | 14.2 | 2.8 | 34.8 | 68.3 | 61.5 | 8.0 | 118.8 | 68.9 | 18.7 | 5 | 18 | D |
| TN1503 | 58.3 | 9.5 | 11.5 | 2.7 | 32.8 | 69.6 | 61.7 | 7.9 | 89.7 | 69.2 | 18.1 | 2 | 10 | C |
| TN1504 | 59.7 | 10.6 | 18.5 | 2.7 | 33.3 | 68.5 | 58.5 | 8.5 | 128.0 | 74.4 | 18.4 | 4 | 24 | C |
| VA12W-72 | 59.2 | 10.8 | 12.4 | 2.9 | 38.5 | 67.1 | 58.5 | 8.7 | 101.7 | 66.7 | 19.5 | 3 | 20 | D |
| VA12W-54 | 59.4 | 10.2 | 15.9 | 2.6 | 30.4 | 67.9 | 56.9 | 8.7 | 126.1 | 67.9 | 18.6 | 4 | 19 | D |
| VA11W-313 | 58.6 | 10.0 | 17.8 | 2.9 | 37.0 | 67.9 | 56.1 | 8.6 | 113.9 | 68.1 | 19.2 | 5 | 23 | D |
| VA11W-279 | 59.7 | 10.4 | 25.1 | 2.7 | 32.8 | 66.7 | 54.0 | 8.8 | 116.9 | 69.9 | 18.8 | 6 | 29 | F |
| GA061082-13E24 | 59.9 | 10.8 | 14.2 | 2.8 | 33.7 | 70.3 | 56.9 | 9.0 | 126.9 | 69.0 | 18.7 | 3 | 8 | B |
| GA0051033-13LE14 | 60.8 | 10.7 | 20.3 | 2.6 | 31.1 | 66.9 | 56.9 | 8.6 | 120.8 | 69.8 | 18.6 | 4 | 26 | F |
| GA051335-13LE19 | 60.3 | 10.5 | 18.9 | 2.6 | 31.3 | 68.4 | 54.3 | 8.8 | 121.3 | 67.8 | 18.4 | 6 | 16 | C |
| LA03224E-39 | 61.4 | 11.2 | 13.0 | 2.8 | 37.6 | 70.5 | 54.7 | 9.3 | 129.2 | 65.5 | 18.2 | 5 | 2 | B |
| LANC8248-1 | 59.5 | 10.4 | 23.5 | 2.6 | 31.0 | 70.1 | 52.5 | 8.7 | 110.4 | 65.5 | 18.7 | 4 | 12 | B |
| LA06146E-P7 | 60.4 | 10.0 | 14.8 | 2.8 | 35.2 | 67.4 | 56.4 | 8.2 | 126.3 | 71.6 | 17.7 | 2 | 25 | D |
| MD07W64-13-4 | 60.7 | 10.2 | 6.5 | 2.7 | 32.5 | 69.5 | 64.9 | 8.3 | 118.3 | 72.6 | 19.3 | 4 | 5 | C |
| MD09W272-8-4-13-3 | 61.1 | 10.8 | 28.7 | 2.6 | 29.2 | 67.9 | 55.4 | 8.7 | 108.7 | 68.5 | 18.5 | 4 | 22 | D |
| MDC07026-F2-19-13-3 | 59.7 | 9.6 | 23.6 | 2.6 | 29.0 | 70.0 | 58.9 | 7.8 | 108.5 | 67.8 | 18.8 | 5 | 9 | B |
| MDC07026-F2-19-13-4 | 59.6 | 9.8 | 26.2 | 2.6 | 28.2 | 70.0 | 58.6 | 7.8 | 109.9 | 68.0 | 17.8 | 4 | 11 | B |
| ES12-0168 | 62.4 | 10.2 | 31.1 | 2.5 | 29.2 | 66.8 | 56.9 | 8.4 | 96.2 | 71.3 | 18.2 | 6 | 27 | F |
| ES12-2619 | 59.9 | 9.5 | 8.6 | 2.7 | 32.9 | 70.7 | 63.6 | 7.9 | 100.7 | 68.3 | 18.4 | 5 | 1 | B |
| AR11LE24 | 58.8 | 10.2 | 13.1 | 2.7 | 32.8 | 71.3 | 60.0 | 7.9 | 104.1 | 67.7 | 19.2 | 4 | 3 | A |
| AR01044-1-1 | 60.0 | 10.4 | 20.0 | 2.8 | 30.7 | 69.3 | 58.4 | 8.4 | 82.8 | 63.2 | 19.1 | 5 | 6 | C |
| | | | | | | | | | | | | | | |
| Mean | 60.0 | 10.4 | 17.6 | 2.7 | 33.2 | 68.6 | 57.5 | 8.5 | 112.5 | 69.1 | 18.5 | 3.9 | | |
| Std Dev | 1.0 | 0.5 | 6.1 | 0.1 | 3.0 | 1.6 | 2.9 | 0.4 | 11.7 | 2.9 | 0.5 | 1.2 | | |

*Check variety.

## *UNIFORM EASTERN SOFT RED WINTER WHEAT NURSERY*

*Clay Sneller, The Ohio State University*

Thirty-one 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. In addition to the test data, a t-score (which is the number of standard deviations away from the check variety for each quality parameter) was generated to show how different the entry's quality trait is from that of the check variety, Branson. Total t-score was also calculated by summing up (0.15 x test weight), (-0.10 x kernel hardness), (0.4 x flour yield), (0.15 x softness equivalence) and (-0.2 x sodium carbonate SRC) to show the difference in overall quality potential between each entry and the check variety, and used to generate the overall end-use quality rankings of varieties and breeding lines. 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 2008-2014. Those entries that fell in the flour yield range of the top 15% of lines and varieties 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 quite comparable grain and flour quality characteristics to typical SRW wheat. The entry averages were similar to the SWQL SRW wheat averages for all the quality characteristics except test weight. The entries exhibited a higher average test weight by 1.4 lb/bu than the SWQL SRW wheat average. Compared to the check variety, Branson, 20 entries were higher in test weight, 22 in protein content, four in flour yield, and 22 in sugar-snap cookie diameter. AR05094-4-1, OH07-263-3 and IL10-19464 were ranked first, second and third in total t-score with flour yields of 72.1, 72.1 and 71.3%, respectively. AR05094-4-1 also exhibited a SE value of 70.1%, about 12% higher that the SWQL SRW wheat average.

Table 28. Uniform Eastern Soft Red Winter Wheat Nursery wheat variety trial 2015 crop quality data

| Entry | Test Weight (LB/BU) | Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Cookie Diameter (cm) | Top Grade (0-9) | Total T-Score Rank | Flour Yield Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Branson*** | **58.5** | **10.6** | **-2.0** | **2.6** | **34.9** | **71.4** | **67.1** | **8.8** | **135.1** | **68.1** | **18.1** | **3** | **5** | **A** |
| Bess | 58.7 | 10.8 | 1.9 | 2.5 | 32.4 | 69.6 | 61.8 | 9.1 | 124.4 | 67.8 | 18.3 | 3 | 18 | C |
| Shirley | 57.6 | 10.7 | -1.5 | 2.7 | 35.5 | 70.8 | 60.6 | 9.0 | 100.3 | 67.3 | 19.2 | 3 | 12 | B |
| MO080104 | 60.6 | 10.9 | 16.3 | 2.7 | 32.4 | 68.6 | 60.9 | 8.5 | 134.3 | 70.0 | 17.8 | 2 | 28 | C |
| 0762A1-2-8 | 56.9 | 10.6 | 6.2 | 2.9 | 35.7 | 68.8 | 60.2 | 9.1 | 122.3 | 66.4 | 18.8 | 3 | 27 | C |
| NC10-23663 | 59.9 | 10.8 | 1.3 | 2.6 | 31.0 | 68.5 | 62.1 | 8.9 | 127.2 | 72.7 | 19.0 | 3 | 29 | C |
| OH07-263-3 | 59.0 | 10.4 | -1.5 | 2.7 | 34.5 | 72.1 | 62.5 | 8.9 | 109.4 | 64.7 | 17.9 | 4 | 2 | A |
| TN1505 | 58.9 | 11.6 | 14.8 | 2.8 | 34.6 | 70.0 | 58.0 | 9.9 | 143.5 | 71.7 | 17.8 | 2 | 25 | B |
| VA11W-106 | 59.0 | 10.8 | 5.7 | 2.6 | 31.6 | 69.1 | 65.7 | 9.0 | 130.5 | 72.2 | 18.8 | 3 | 21 | C |
| VA11W-182 | 55.9 | 10.7 | -3.5 | 2.5 | 30.4 | 70.4 | 68.0 | 8.9 | 118.8 | 69.4 | 18.7 | 3 | 16 | B |
| VA12W-248 | 59.8 | 10.7 | 8.9 | 2.8 | 36.6 | 70.7 | 61.3 | 9.0 | 122.1 | 68.5 | 18.9 | 2 | 10 | B |
| OH07-206-69 | 56.2 | 10.7 | -1.7 | 2.8 | 37.4 | 71.1 | 66.4 | 9.0 | 116.5 | 68.1 | 18.9 | 3 | 8 | A |
| OH08-180-48 | 56.9 | 10.9 | 8.3 | 2.7 | 31.4 | 70.7 | 63.0 | 9.4 | 129.4 | 63.8 | 18.2 | 4 | 9 | B |
| 053A1-2-5-3-5-3 | 57.6 | 12.3 | 8.6 | 2.8 | 33.8 | 69.5 | 59.9 | 10.1 | 95.2 | 66.6 | 18.0 | 4 | 19 | C |
| 11405A1-4 | 57.5 | 10.3 | 3.7 | 2.7 | 33.4 | 69.7 | 64.4 | 8.8 | 126.2 | 70.9 | 18.5 | 3 | 20 | C |
| MD09W272-8-4-13-3 | 60.1 | 12.8 | 29.4 | 2.6 | 29.5 | 67.2 | 54.3 | 10.9 | 121.5 | 70.3 | 18.1 | 3 | 31 | D |
| MDC07026-F2-19-13-1 | 60.0 | 10.4 | 14.6 | 2.6 | 30.0 | 71.2 | 61.6 | 8.7 | 124.5 | 66.8 | 18.9 | 4 | 6 | A |
| MDC07026-F2-19-13-4 | 59.4 | 10.2 | 14.7 | 2.6 | 30.2 | 70.9 | 62.6 | 8.4 | 122.3 | 66.1 | 19.0 | 5 | 7 | B |
| F2024R | 59.0 | 10.8 | 9.3 | 2.6 | 34.2 | 67.8 | 67.1 | 9.1 | 118.4 | 79.0 | 17.3 | 2 | 30 | D |
| F2029R | 57.6 | 11.7 | 9.0 | 2.7 | 34.4 | 69.4 | 62.2 | 9.6 | 120.5 | 69.9 | 18.4 | 3 | 23 | C |
| MO 110201 | 59.3 | 10.2 | 3.9 | 2.6 | 30.8 | 70.0 | 64.5 | 8.7 | 109.8 | 67.2 | 19.3 | 3 | 11 | B |
| MO 121058 | 57.7 | 11.1 | -1.7 | 2.7 | 35.5 | 72.3 | 62.6 | 9.2 | 117.8 | 67.7 | 18.5 | 3 | 4 | A |
| ES12-1049 | 60.5 | 11.6 | 16.9 | 2.7 | 33.3 | 68.6 | 55.2 | 9.8 | 137.8 | 65.9 | 18.1 | 3 | 26 | C |
| ES12-1307 | 60.6 | 11.2 | 15.3 | 2.8 | 35.1 | 69.7 | 55.8 | 9.4 | 129.7 | 65.7 | 17.7 | 3 | 17 | C |
| AR05094-4-1 | 58.1 | 10.4 | -4.4 | 2.6 | 30.6 | 72.1 | 70.1 | 8.8 | 139.0 | 68.1 | 18.6 | 4 | 1 | A |
| AR05079-2-1 | 59.4 | 10.5 | 38.2 | 2.9 | 37.5 | 71.8 | 48.9 | 8.7 | 86.1 | 72.2 | 18.1 | 4 | 22 | A |
| KY05C-1369-14-6-3 | 61.8 | 12.0 | 16.7 | 2.8 | 34.1 | 70.2 | 56.0 | 10.9 | 141.0 | 68.0 | 17.8 | 3 | 15 | B |
| KY05C-1051-37-18-5 | 60.8 | 11.1 | 13.4 | 2.6 | 30.2 | 69.1 | 64.1 | 9.7 | 134.9 | 73.8 | 17.7 | 2 | 24 | C |
| IL02-19463-7 | 59.1 | 11.9 | -6.0 | 2.7 | 30.7 | 69.4 | 64.8 | 9.7 | 134.6 | 67.5 | 18.4 | 3 | 13 | C |
| IL10-19464 | 61.1 | 10.9 | 2.7 | 2.8 | 37.5 | 71.3 | 58.0 | 9.6 | 126.8 | 63.9 | 19.2 | 4 | 3 | A |
| IL10-21934 | 60.8 | 10.7 | 6.3 | 2.7 | 34.1 | 69.4 | 57.3 | 9.0 | 127.5 | 64.2 | 18.1 | 4 | 14 | C |
| | | | | | | | | | | | | | | |
| Mean | 59.0 | 11.0 | 7.9 | 2.7 | 33.3 | 70.0 | 61.5 | 9.2 | 123.5 | 68.5 | 18.4 | 3.2 | | |
| Std Dev | 1.5 | 0.6 | 9.9 | 0.1 | 2.4 | 1.3 | 4.6 | 0.6 | 13.0 | 3.3 | 0.5 | 0.7 | | |

*Check variety.

## *UNIFORM EASTERN SOFT WHITE WINTER WHEAT NURSERY*

Mark Sorrells, Cornell University

Seventeen eastern soft white winter wheat breeding lines and varieties will be 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. In addition to the test data, a t-score (which is the number of standard deviations away from the check variety for each quality parameter) was generated to show how different the entry's quality trait is from that of the check variety, Caledonia. Total t-score was also calculated by summing up (0.15 x test weight), (-0.10 x kernel hardness), (0.4 x flour yield), (0.15 x softness equivalence) and (-0.2 x sodium carbonate SRC) to show the difference in overall quality potential between each entry and the check variety, and used to generate the overall end-use quality rankings of varieties and breeding lines. 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 2008-2014. Those entries that fell in the flour yield range of the top 15% of lines and varieties 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 narrow ranges of wheat grain and flour characteristics, of which the averages were comparable to the SWQL soft wheat averages. The average kernel hardness of the entries was, however, lower by 8.5 than the SWQL soft wheat average. Compared to the check variety, Caledonia, 12 entries were higher in test weight, 11 in grain protein content, four in flour yield, and seven in sugar-snap cookie diameter. NY99069-326 was ranked first in total t-score with a flour yield of 72.6%, followed by NY01016-AN and KWS 036 with flour yields of 71.8 and 70.6%, respectively.

Table 29. Uniform Eastern Soft White Winter Wheat Nursery wheat variety trial 2015 crop quality data

| Entry | Test Weight (LB/BU) | Kernel Protein (at 12%) | SKCS Kernel Hardness | Kernel Diameter (mm) | Kernel Weight (mg) | Flour Yield (%) | Softness Equivalence (%) | Flour Protein (at 14%) | Lactic Acid SRC (%) | Sodium Carbonate SRC (%) | Cookie Diameter (cm) | Top Grade (0-9) | Total T-Score Rank | Flour Yield Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KWS 033 | 58.5 | 9.7 | 12.7 | 2.9 | 39.4 | 69.0 | 55.7 | 8.3 | 99.1 | 69.9 | 19.3 | 5 | 15 | C |
| F1014 | 58.1 | 8.7 | 23.4 | 2.8 | 34.2 | 69.2 | 57.1 | 7.1 | 70.2 | 71.6 | 19.0 | 5 | 16 | C |
| MCIA Venus | 58.7 | 9.8 | 19.6 | 2.8 | 36.6 | 71.5 | 55.8 | 8.3 | 96.4 | 72.1 | 18.4 | 4 | 10 | A |
| KWS 041 | 60.0 | 10.2 | 18.1 | 2.7 | 34.7 | 67.3 | 52.9 | 8.5 | 125.9 | 74.0 | 17.6 | 4 | 17 | D |
| **Caledonia*** | **58.0** | **9.2** | **6.1** | **2.9** | **37.0** | **71.2** | **60.9** | **7.7** | **100.3** | **68.8** | **19.1** | **5** | **5** | **A** |
| Cayuga | 60.1 | 9.7 | 10.7 | 2.8 | 36.2 | 68.4 | 61.0 | 8.3 | 109.2 | 73.7 | 17.8 | 3 | 12 | C |
| F2019 | 56.5 | 9.8 | 6.0 | 2.9 | 39.4 | 71.7 | 59.6 | 7.7 | 96.5 | 69.0 | 19.7 | 5 | 6 | A |
| KWS 037 | 59.8 | 8.9 | 10.4 | 2.9 | 38.5 | 70.8 | 60.1 | 7.4 | 108.0 | 68.9 | 18.9 | 5 | 4 | B |
| F2038 | 58.5 | 9.8 | 6.1 | 2.7 | 33.7 | 68.8 | 62.0 | 7.9 | 92.6 | 68.1 | 19.7 | 5 | 7 | C |
| F1027 | 59.5 | 9.6 | 3.9 | 2.8 | 35.9 | 68.4 | 61.0 | 7.8 | 101.8 | 76.0 | 18.8 | 4 | 14 | C |
| NY99069-326 | 58.7 | 8.8 | 9.8 | 2.8 | 36.9 | 72.6 | 61.8 | 7.5 | 118.2 | 67.5 | 18.9 | 5 | 1 | A |
| F2016 | 57.8 | 8.8 | 7.6 | 2.7 | 35.8 | 70.9 | 60.2 | 7.5 | 117.1 | 72.0 | 18.2 | 4 | 8 | A |
| NY01016-AN | 58.8 | 9.7 | 7.2 | 2.9 | 39.7 | 71.8 | 59.9 | 7.9 | 125.6 | 69.7 | 19.2 | 4 | 2 | A |
| KWS 036 | 58.8 | 9.9 | 5.0 | 2.8 | 38.7 | 70.6 | 60.2 | 7.7 | 81.8 | 67.5 | 19.4 | 6 | 3 | B |
| NY99069-352 | 57.8 | 9.0 | 11.0 | 2.7 | 32.9 | 69.6 | 58.5 | 7.3 | 91.0 | 66.7 | 19.1 | 5 | 9 | C |
| NY94025-136 | 58.1 | 9.7 | 6.0 | 2.7 | 33.7 | 68.4 | 62.3 | 8.3 | 106.5 | 71.3 | 18.9 | 4 | 11 | C |
| NY94052-207 | 57.6 | 9.7 | 3.8 | 3.0 | 43.1 | 68.3 | 59.3 | 7.7 | 86.1 | 69.1 | 19.8 | 5 | 13 | D |
| | | | | | | | | | | | | | | |
| Mean | 58.6 | 9.5 | 9.8 | 2.8 | 36.8 | 69.9 | 59.3 | 7.8 | 101.5 | 70.4 | 18.9 | 4.6 | | |
| Std Dev | 0.9 | 0.5 | 5.7 | 0.1 | 2.7 | 1.6 | 2.6 | 0.4 | 15.2 | 2.6 | 0.6 | 0.7 | | |

*Check variety.

# MATERIALS AND METHODS 2015

## 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.<br>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 (excluding bran) passing through 94-mesh* screen |
| Percent<br>Bran, Mids, Break Flour | % | Expressed as percent of grain weight<br>(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<br>Sodium Carbonate<br>Sucrose<br>Water | LA<br>SC<br>SU<br>WA | ((residue wt/ flour wt)-1) x (86/(100 - %FMOIST)) x 100<br>flour wt = weight of dry flour<br>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.

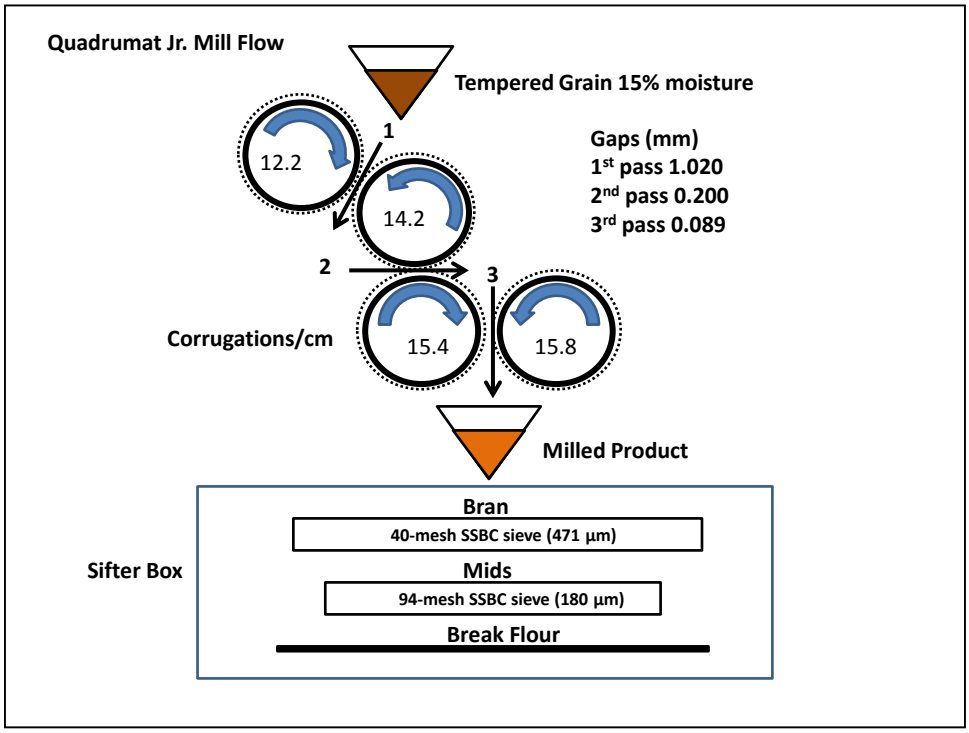
For the ***preliminary*** group samples, *tempered grain* is fed into the Quadrumat break roll unit and passed through three sets of milling rolls, each with increasing corrugations per centimeter and decreasing gaps to decrease particle size sequentially from grain to flour.

*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 | AACC Method 56-81.03 Perten Falling Number Tester | 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 | Content of Pentosans (Arabinoxylans) | |
| | Water | Overall water affinity | |
| Sugar-snap Cookie Diameter | AACC Method 10-52 Baking Quality of Cookie Flour, Intermediate Method | 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.

## Flour Yield

Flour yield is calculated as the percent total flour weight (break flour + mids) of the sample grain weight from a single pass through the Quadrumat break roll unit. For calculation of flour yield, the difference between the grain weight and the bran weight (over 40) is used.

**FY = ((GW-Bran)/GW) x 100**

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

## Softness Equivalence

Softness Equivalence (SE) is the percentage break flour (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.

**SE = (GW - Bran - Mids)/(GW - Bran) x 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 and color, from worst to best on a scale of 1 to 10.

## Falling Number

The falling number test (AACC Method 56-81B) measures the travel time of the plunger in seconds (falling number) from the top to the bottom position in a glass tube filled with a suspension of whole grain meal or milled flour, immediately after being cooked in a boiling water jacket to produce gelatinized starch. 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 viscosity of gelatinized starch, resulting in a decreased travel time of the plunger (falling number). The test is performed using the Perten Falling Number Instrument. 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.

Gaines, C. F. (2000). Developing agreement Between Very Short Flow and Longer Flow Test Wheat Mills. *Cereal Chemistry* , 187-192.

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.

Souza, E., Kweon, M., & Sturbaum, A. (2011). *Research Review.* USDA-ARS Soft Wheat Quality Laboratory.

## 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 2014 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: 2015 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$^{o}$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 | higher grain weight (Sus2-SNP-185/592H2) |
| Sus2-SNP-185 | TAAGCGATGAATTATGGC |
| Sus2-SNP-589H2 | GGTGTCCTTGAGCTTCTgG |
| Hap L | associated with low grain weight |
| Sus2-SNP-227 | ctataGTATGAGCTGGATCAATGGC |
| Sus2-SNP-589L2 | GGTGTCCTTGAGCTTCTgA |

Amplifies each of the primer pairs independently at 52$^{o}$C to produce a 423 or 381 bp fragment, haplotypes indicative of high or low grain weight, respectively. (Jiang et al., 2011)

*Pre-harvest sprouting*

| | |
|---|---|
| Vp1BF | TGCTCCTTTCCCAATTGG |
| Vp1BR | ACCCTCCTGCAGCTCATTG |

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