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## OKLAHOMA

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### *Wheat extension and wheat management research.*

Jeff T. Edwards.

The 2007–08 wheat production year was outstanding for most Oklahoma wheat producers. Average yield was 2,486 kg/ha on 1.82 x $10^6$ total harvested hectares, resulting in total crop value of $1.082 billion. In most of the state, wheat yields were 50 to 75% higher than historical averages. Many producers reported dryland wheat yields in excess of 5,000 kg/ha, and several variety-trial test plots exceeded 6,000 kg/ha. These record yields were present despite a lackluster environment for wheat emergence and growth during autumn 2007. In fact, many fields did not emerge until late winter. Timely spring rainfalls, adequate soil nitrogen mineralization, and moderate temperatures throughout late spring and early summer, however, allowed wheat plants to tiller and recover from a late start.

One interesting phenomenon that emerged in 2008 was a yield increase associated with grazing in some of our experiments. Winter wheat in the southern Great Plains is commonly grazed by cattle from late autumn through late winter, but a yield penalty, not increase, is generally associated with this practice. In 2008, grazed treatments yielded as much as 600 kg/ha more than nongrazed treatments when both were sown in mid-September. Nongrazed treatments, however, yielded approximately 500 kg/ha more than grazed treatments when nongrazed plots were sown at an optimal mid-October date. These data reinforce a hypothesis shared among many dual-purpose wheat researchers that the earlier-than-optimal sowing date in dual-purpose wheat production system probably has equivalent or greater impact on grain yield than grazing by cattle.

### *Cultivar development and breeding research.*

Brett F. Carver.

Proposals submitted by the Oklahoma Wheat Improvement Team have been accepted by the Oklahoma Agricultural Experiment Station for the release of **OK Rising** hard white wheat in early 2008 and **Billings** and **Pete** hard red winter wheat in early 2009.

OK Rising was tested as experimental line OK02522W in the Southern Regional Performance Nursery (SRPN) in harvest years 2006 and 2007. The naming of this cultivar was intended to coincide with the 100th anniversary of Oklahoma's statehood (1907–2007); the cultivar's namesake is a contemporary musical piece composed specifically for the centennial by Oklahomans Jimmy Webb and Vince Gill, entitled 'Oklahoma Rising'. The name OK Rising also was intended to show linkage with its closely related HRWW counterpart and sister line, OK Bullet. Both OK Bullet and OK Rising came from the cross 'Jagger/KS96WGRC39'.

Substantial genetic improvement has been realized in the US HWWW class in the past decade, such that HWWW wheat lacks nothing for yield and quality compared with its sister class HRWW. What the HWWW class does lack is genetic depth, or to the wheat producer, varietal choice. With a restricted genetic base often comes a restricted adaptation range. The current state of HWWW is that superior cultivars are available to producers, but primarily in the High Plains area of the U.S. Great Plains region. The primary driver for release of OK Rising was its greater adaptation range, extending from the High Plains to lower-elevation and higher-rainfall regions of Oklahoma and the southern and central Plains, where previous releases such as Intrada and Guymon were not adapted. Its capability is derived from a yield-performance history and disease resistance package comparable, if not identical, to OK Bullet, substantially improved straw strength and standability, and improved tolerance to pre-harvest sprouting over Intrada and Guymon.

Preharvest-sprouting tolerance has been observed by germination tests of seed harvested from field plots at physiological maturity or falling number determination from grain samples collected after harvest maturity. OK Rising has demonstrated the ability to maintain falling number values in excess of 350 to 400 sec when harvested two to three weeks after harvest maturity in extreme high-rainfall environments (years 2007 and 2008). OK Rising also shows heat-sensitive germination much like the cultivars 2174 and Cimarron. This type of seed dormancy pattern causes delayed germination in hot soils when planting early for the purpose of forage production in grazed or dual-purpose systems. OK Rising produces the same band pattern as 2174 at the SSR marker locus, *Xbarc310*, which is tightly linked to a QTL for heat-sensitive germination, *QGhs.osu-3A* (Liuling Yan and Shuwen Wang, personal communication).

The OSU wheat-improvement program continues to emphasize dual development of HWWW and HRWW cultivars. Currently, we allocate 80% of our resources in the latter stages of selection to HRWW inbred line development. In the past three crossing cycles, 49% (2007), 37% (2008), and 26% (2009) of the crosses made each year involved HWWW parentage to varying degrees, and our program tends to produce about 900 hybrid combinations per year. In those same years, the percentage of crosses involving strictly HW parentage decreased from 19% in 2007 to 15% in 2008 to 12% in 2009. These declining numbers do not indicate a declining interest in HW cultivar development but instead a more concerted focus on parentage with suitable agronomic and sprout-tolerant patterns.

Two new HRWW cultivars will be introduced to certified seed producers during fall 2009. Having appeared in the SRPN in harvest years 2007 and 2008, **Billings** was tested as OK03522, and **Pete** was tested as OK03305. Billings is a $F_{4:5}$ line from the cross 'N566/OK94P597', which N566 is 'Eritrospermum 2755-91'/'Odisseya' and OK94P597 is 'HBY359A/Fundulea 133//TAM 200'. Pete also is a $F_{4:5}$ line from the cross 'N40/OK94P455'; N40 was derived from 'Lutestens 11291 Vumpel/Istok' and OK94P455 was derived from a double-cross of Pioneer and Kansas State University experimental lines (W0405D/KS831957//W3416/KS831957). Both N40 and N566 were germ plasm lines graciously provided by the Institute of Plant Breeding, Odessa, Ukraine, made possible through a germ plasm exchange program in the early 1990s between the Institute and USDA–ARS (ARS oversight provided by Jim Peterson).

Both cultivars were produced through our ***GRAZE*n*GRAIN*** breeding system, though Pete is better adapted to dual-purpose management systems. Pete is awnless but has produced excellent test weight patterns, with acceptable milling and break baking quality. The cultivar is projected to replace some of the acreage currently occupied by Deliver, an awnless HRWW cultivar released by OSU in 2004, because Pete offers improved yield potential throughout the state, has slightly improved aluminum tolerance in acidic soils, and shows much improved straw strength. Pete is resistant to *wheat soilborne mosaic virus* and *wheat spindle streak mosaic virus*, and it has shown effective adult-plant resistance to leaf rust and powdery mildew. Pete's resistance to stripe rust is classified as intermediate and similar to that of Endurance.

Billings will be positioned for the northern half Oklahoma, including irrigated production in the Oklahoma panhandle (High Plains areas), and its range of adaptation extends into southern Kansas. The foliar disease package is similar to Pete, except that Billings provides excellent adult-plant resistance to stripe rust. Billings also is more tolerant of low pH conditions. Milling quality is outstanding, as kernel size typically exceeds 32 g in 1,000-kernel weight and 2.40 mm in kernel diameter based on the single-kernel characterization system. Mixing tolerance is above average for the HRWW class, with reasonably a good combination of dough strength and extensibility, at an intermediate level of wheat protein (12.0–13.0% on a 12% moisture basis). Billings is considered a suitable replacement for HRWW cultivars Endurance, OK Bullet, or Overley, all of which occupy significant acreage in Oklahoma in 2009.

Marker-assisted selection is playing an increasing role in our wheat improvement program, primarily for the purpose of gene enrichment in early segregating generations. This activity is tied directly to participation in the multi-institutional CAP project funded by USDA–CSREES (award no. 2006-55606-16629), in conjunction with the Hard Winter Wheat Genotyping Laboratory (USDA–ARS, Manhattan, KS) supervised by Dr. Guihua Bai and in cooperation with Dr.

Liuling Yan (Oklahoma State University molecular geneticist). Target traits currently under watch are Hessian fly resistance, acid-soil tolerance, and resistance to leaf rust, *wheat streak mosaic virus*, and *barley yellow dwarf virus*.

### *Wheat genomic research: genetic regulation of reproductive development in winter wheat.*

Liuling Yan.

Central to the research mission of the OSU Wheat Improvement Team is to use molecular tools to regulate the reproductive development process in winter wheat to maximize adaptation to specific management systems, with an emphasis on dual-purpose production systems in the southern Great Plains.

When sown in the autumn, winter wheat cultivars show variation in developmental processes, including the initiation of stem elongation, heading, and physiological maturity. Phenotypic variation in the timing of a specific developmental stage can be subtle, spanning only a few days due to adaptive responses and synchronization with changes in photoperiod and low temperature in seasonal climates; however, this minor variation is important to final productivity. Delayed reproductive development may be optimized to generate more biomass for cattle grazing in dual-purpose production systems. Additionally, a relatively later stem-elongation time is desired to avoid frost damage frequently occurring during early spring, whereas a relatively early maturity time is desired to avoid the hot and dry summer season, or as global climate shifts toward warmer temperature.

In recent studies, we generated two populations of RILs that were used to map genetic loci controlling developmental processes in winter wheat. One was generated from a cross between two winter wheat cultivars, Jagger (early stem elongation) and 2174 (late stem elongation), and the other was generated from a cross between Intrada (undergoing stem elongation earlier but reaches heading later) and Cimarron (undergoing stem elongation later but reaches heading earlier). We mapped SSR markers and known genes related to vernalization and photoperiod responses in these two populations. We concluded that segregation in arrival time of stem elongation is mainly controlled by a major QTL on chromosome 5A associated with the vernalization gene *VRN-A1* (=*AP1*). When *VRN-A1* was fixed for the same allele, segregation in heading date and maturity time was controlled by QTL associated with the photoperiod gene *PPD-D1* and the vernalization gene *VRN-D3* (=*FT*). Several other genomic regions were associated with variation in these developmental traits. In addition to direct application of these molecular tools to winter wheat breeding populations, we are further pursuing the molecular mechanism of the developmental adaptation of winter wheat.

### *Personnel.*

The Wheat Improvement Team at OSU currently has nine members Brett Carver (team leader, wheat breeder), Liuling Yan (molecular genetics), Bob Hunger (disease resistance), Tom Royer and Kris Giles (Hessian fly resistance), Art Klatt (prebreeding and germ plasm development), Jeff Edwards (extension, management), Patricia Rayas-Duarte (cereal chemistry), and Bjorn Martin (stress physiology). The team services of David Porter, formerly USDA–ARS (aphid resistance), were lost in 2007 to his assuming the position of Department Head, Department of Plant and Soil Sciences, OSU.

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Bob Hunger.

### *Wheat diseases in Oklahoma in 2008.*

Until the month of May, 2008 was a fairly quiet year for diseases in Oklahoma. Prior to May, powdery mildew, leaf rust, stripe rust, septoria, tan spot, wheat streak mosaic, high plains, and barley yellow dwarf were all confirmed in the state. However, at the end of the first week of May, leaf rust exploded across central and north-central Oklahoma, and hot spots of stripe rust were observed. As May progressed, other diseases observed included dryland root rot, stem rust, and Fusarium head blight. Leaf rust did not hit the southern, northwestern, or panhandle regions of Oklahoma because of drought; however, in the central and north-central regions of Oklahoma, fungicide use was much greater than normal due to severe leaf rust.

### *Breeding for wheat disease resistance.*

Regional nurseries, including the Southern Regional Performance Nursery, the Northern Regional Performance Nursery, and the Regional Germplasm Observation Nursery, were tested for reaction to wheat soilborne mosaic/wheat spindle streak mosaic in the field, and to leaf rust in the greenhouse (seedling) and field. Results from these and other trials conducted on winter wheat are summarized at http://www.ars.usda.gov/Research/docs.htm?docid=11932.

### *Tan spot research.*

Three isolates of *P. tritici-repentis* were compared for hyphal growth, sporulation, reproduction, and virulence on wheat. These isolates, OKD-1, RBB6 and OK06-1, were collected in Oklahoma in 1983, 1996, and 2006, respectively. Greatest radial growth was observed for OK06-1, which also produced significantly ($P<0.05$) more conidia. Isolates were similar in number of pseudothecia formed; OK06-1 produced the highest percent of mature pseudothecia (22.0%), followed by OKD-1 and RBB6. RBB6 produced significantly less conidia than OKD-1 but was more virulent in the field. Maximum disease severity was recorded for OK06-1 in both greenhouse and field studies. In the field, OK06-1 reduced yield by 20.7% compared to the control, whereas RBB6 and OKD-1 reduced yield by 13.8 and 4.9%, respectively. Similar testing with additional isolates currently is ongoing.