Proposal for Variety Release
OK93P656H3299-2C04

Hard Red Winter Wheat

…for Dual-purpose and Grain-only Production Systems

Submitted by OSU's
Wheat Improvement Team

OSU Division of AGRICULTURAL SCIENCES & NATURAL RESOURCES

Acknowledgments

The OSU Wheat Improvement Team gratefully acknowledges the generous and continual support of the

Oklahoma Agricultural Experiment Station
Oklahoma Wheat Commission
and the
Oklahoma Wheat Research Foundation.

The development and release of this cultivar embraces the mission of OSU's Division of Agricultural Sciences and Natural Resources to stimulate progress in Oklahoma's wheat industry.

The WIT also acknowledges the following individuals who supported the development and characterization of OK93P656H3299-2C04:

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Bobby Weidenmaier
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Richard Austin
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Vickie Brake
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Experimental Designation

OK93P656H3299-2C04, Hard Red Winter Wheat, *Triticum aestivum* L.(see Exhibit 1 for USDA-GIPSA classification)

Proposed Name

Duster, cleared for use by USDA, Marketing and Regulatory Programs, Seed Regulatory & Testing Branch on 8 May 2006 (Exhibit 2)

Origination and Breeding Procedure

OK93P656H3299-2C04 is the culmination of 19 years of selection and re-selection for first-rate adaptation in the Great Plains, foliar disease resistance, and phenotypic uniformity. It is a late-generation line (F_{18} in 2005-2006), and as the suffix in the experimental name indicates, a composite (C) of two (2) lines ($F_{13:16}$) selected in 2004 (04) from the experimental line, OK93P656RMH3299, that in turn was a reselection from OK93P656. OK93P656 was derived from a single $F_{2:3}$ head row among a population of 100 $F_{2:3}$ head rows named VBJ0503 that originated in the former hard red winter wheat breeding program of Pioneer Hi-Bred International, Inc. Approximately 30,000 head rows were donated by Pioneer and evaluated in the OSU breeding program by Dr. Ed Smith in 1991. The pedigree of VBJ0503 was identified by Pioneer (B. Laskar, 2006, personal communication) as W0405D/NE78488/ /W7469C/TX81V6187. None of these parents have a direct or obvious relationship with commercial cultivars either currently or recently in production. Their pedigrees were identified by Pioneer as follows:

W0405D W603/PL145//W6500
W603 = complex cross, involving prodominately SRW parents
PL145 (Newton sib) = Bluebird sib/Scout
W6500 (Newton sib) = Bluebird sib/Scout
NE78488 PI511676 = Warrior*5/Agent//Aurora/3/Centurk
W7469C Caprock/MoW7910//Scott City 3213
TX81V6187 unknown pedigree; 50% of Ogallala's parentage

Oklahoma State University received seed of VBJ0503 in 1990, which was planted for evaluation during the 1990-1991 crop season under OSU population number P114 (Exhibit 3). Two lines were selected from this head-row population for evaluation in the Wheat Observation I nursery in 1992 as $F_{2:4}$ lines. One was harvested (plot 1811) and advanced for testing in the 1993 Preliminary Yield Nursery 3.

In 1994, Dr. Ed Smith renamed VBJ0503, a Pioneer population designation, as OK93P656, an experimental line designation. Concomitant with the 1995 evaluation, Dr. Bob Hunger conducted a single-plant growout to identify plants of OK93P656 with leaf rust and wheat soilborne mosaic virus resistance. Five F_7 plants were harvested in 1995 and advanced for further observation as plant-rows in 1996, from which one $F_{7:8}$ line was identified with the desired level of wheat soilborne mosaic virus resistance. In 1997, Dr. Hunger evaluated this progeny line ($F_{7:9}$), and after observing consistent

resistance to soilborne mosaic virus and leaf rust, this line was transferred to Dr. Smith for another year of observation in a nursery identified in 1998 as "RMH SBMV Obsn".

Among other reselections with different pedigrees, this line was named OK93P656-RMH3299 and transferred to Dr. Carver, who tested it in a replicated yield trial at three locations in 1999. More extensive testing was conducted in the two following years, i.e., the 2000 OET1 and 2001 OET2. OK93P656-RMH3299 was also evaluated in the 2001 Regional Germplasm Observation Nursery (RGON) and the 2001 Southern Regional Performance Nursery (SRPN), where it ranked 32nd out of 45 entries across the Central Plains in grain yield. Reselection in 1996 should have been sufficient to generate the desired uniformity, but as OK93P656-RMH3299 was closely monitored in 2001, excessive segregation was noted for plant height. The decision was made in 2001 to try to purify this line for better uniformity of plant height and to identify selections with improved lodging resistance, yield performance, and kernel size. Its resistance to WSBMV and leaf rust, and tolerance to acid soils, were considered highly favorable attributes.

Random heads were sampled from a breeder-seed increase plot in 2001 to generate a series of 288 head rows in the $F_{13:14}$ generation in 2002. Twenty-six progeny were selected based on uniformity of height and larger kernel size and evaluated in an observation nursery at Stillwater and Lahoma, OK in 2003. Traits monitored in this nursery were plant height, heading date, lodging resistance, test weight, kernel size, and yield potential. Two lines (OK93P656H3299-84 and OK93P656H3299-99) were advanced to the OET2 nursery (Oklahoma Elite Trial) in 2004 and composited in equal proportions only for statewide field testing. This was repeated in 2005, except that each line was tested individually. The two lines were increased separately for a breeder-seed increase in both years. The trials in 2005 affirmed that OK93P656H3299-84 and OK93P656H3299-99 are indistinguishable on the basis of plant type, plant height, grain yield performance, and test weight; hence, testing in 2006 is currently based on the composite formed from equal proportions of seed by weight. Molecular marker data based on random SSR primers has since confirmed their genotypic similarity.

The results presented herein predominately derive from trials conducted on the most recent reselections during the period 2004 to 2006. Though the two reselections were tested separately in 2005, the data were reported herein as the mean across both lines. *For the purpose of this report, the composite line is identified as OK93P656H3299*, though Exhibit 3 shows the precise names used during testing. Exhibit 3 also indicates the appearance of OK93P656H3299 in the SRPN and the Oklahoma Wheat Variety Trials (WVT).

Breeder-seed multiplication occurred during the harvest years of 2004 and 2005 for each component line separately. No phenotypically distinguishable variants were observed in either line, and they were observed to be uniform and stable for two generations. The first increase in 2004 occurred in Stillwater, OK, whereas the second increase occurred at Goodwell, OK under irrigation. The 2005 increase produced approximately 12 bu breeder seed per component line, from which 10.9 bu of OK93P656H3299-84 and 9.7 bu of OK93P656H3299-99 were planted for foundation seed production during the 2005-2006 crop year. We propose that the variety be released to seed producers by harvesting OK93P656H3299-84 and OK93P656H3299-99 together.

Description and Performance

Three sources of data were used to assess agronomic and end-use quality performance in the main body of this proposal (excluding the exhibits). These included local breeder trials across Oklahoma, the Oklahoma Wheat Variety Trials (WVT), and regional performance nurseries conducted throughout the Great Plains. Cultivar comparisons were directed primarily at Ok101, Endurance, and Jagalene, but other comparisons included, as available, 2174 and cultivars currently in production. Though key differences exist, OK93P656H3299 most closely resembles Endurance in plant type, kernel characteristics, and performance trends. It is that comparison which should be used in establishing distinctness in the application for U.S. Plant Variety Protection. Jagalene has shown a four-year history of proven superior performance in the Oklahoma WVT and offers a legitimate basis for justifying cultivar release. The nursery mean reported in each table reflects the mean performance of all checks and breeder lines selected and advanced for further testing from a given nursery, and not only the entries listed in the table.

Grain yield performance

In statewide breeder trials that branched out into Colorado and Kansas in 2005,OK93P656H3299 averaged 52 bu/ac (Table 1), or 3 bu/ac better than Endurance or Jagalene or 6 bu/ac better than Ok101. It was the highest-yielding entry in many environments, particularly the southernmost locations of Altus and Ft. Cobb. Before the final reselections were made in 2002, the parent line did not exceed the check cultivar, 2174, particularly in northcentral OK; however, it fared much better in the panhandle and in southwest Oklahoma. The 4 bu/ac yield advantage of OK93P656H3299 over Jagalene in 2005 was accentuated by Jagalene's inferior leaf rust resistance but reduced by Jagalene's superior stripe rust resistance.

The grain yield superiority of OK93P656H3299 in a grain-only production system was most strongly evidenced by its top-ranking position in the 2005 SRPN (Table 2), where it averaged 61.0 bu/ac. With a twist of irony, its relative ranking was most impressive in Kansas, a region where historically Oklahoma materials have not prospered as much as in other regions. In the four Oklahoma locations, OK93P656H3299 and OK Bullet showed equivalent mean yields but widely different yields at specific sites. OK Bullet exceeded OK93P656H3299 by 14 bu/ac at Goodwell (perhaps indicative of the severe stripe rust infection at that site), whereas OK93P656H3299 exceeded OK Bullet by 12 bu/ac at Lahoma. The SRPN results, albeit a one-year test, place OK93P656H3299 in a highly competitive position for grain yield with future cultivars coming out of the Central Plains.

The 2005 Oklahoma WVT results reinforced that position in both dual-purpose (DP) and grain-only (GO) conditions (Table 3). The relatively poor performance of OK93P656H3299 in the GO trial at Marshall cannot be explained by the severe stripe rust infection at that site, because stripe rust was equally present in the dual-purpose trial where it was the highest-ranking entry. Resistance to Hessian fly likely played in its favor in the DP trial. A closer examination of DP vs. GO performance at Marshall shows that OK93P656H3299 had superior yield performance in the DP environment, and likewise, the reduction in grain yield between GO and DP systems was

proportionately low (Table 4). The data collected in 2005 should be interpreted with caution because the grain yield reduction in the DP system well exceeded the long-term mean of about 20%. OK93P656H3299 is exceedingly high-tillering, which may play to its advantage in recovery from grazing and sustaining its yield potential. Its potential ability to withstand intensive grazing or an above-average stocking rate warrants further study.

Test weight

Test weight of OK93P656H3299 is intermediate and equidistant to higher-test weight cultivars such as 2174 and Jagalene and lower-test weight cultivars such as Ok101 and Endurance. Across 24 site-years in 2004 and 2005, OK93P656H3299 averaged 58.5 lb/bu compared with 57.7 lb/bu for Endurance and 59.4 lb/bu for Jagalene (Table 5). OK93P656H3299 has shown good stability of test weight performance with little change in ranking across diverse environments. Overall, test weight performance for this candidate is best described as acceptable, but not exceptional. Relative to recent OSU releases, we would place it as follows: OK Guymon = Bullet > Deliver > OK93P656H3299 > Ok101=Endurance > Okfield.

Dual purpose profile

Primary selection targets which comprise the OSU *GRAZE*n*GRAIN* breeding system include the following:

Rapid germination and stand establishment
Rapid canopy closure
Continuous vegetative regeneration throughout grazing
Tiller survival and canopy regeneration following grazing
Calendar-appropriate first-hollow-stem (FHS) stage for extended grazing
Rapid stem elongation with timely heading to escape late-spring freezes
Minimal yield loss between grain-only and dual-purpose systems

From data collected at Stillwater and the Expanded Wheat Pasture Unit at Marshall in 2004 and 2005, OK93P656H3299 exhibits no high-temperature sensitivity, similar to OK Bullet and Jagger. Moreover, its emergence rate is considered exceptional and leads to a rapid stand establishment and canopy closure. Its high tillering capacity allows for good vegetative regeneration throughout grazing. OK93P656H3299 appears to have optimal wheat pasture attributes, but its actual forage accumulation prior to grazing has not been quantified. It maintains a consistent, semi-erect growth habit, with a rating of 2 on a 1 (erect)-to-4 (highly prostrate) scale. Cultivars with a similar growth habit are Jagalene, Deliver, Intrada, and Jagger. Cultivars which might show a more erect posture are OK Bullet, Cutter, and Overley. Endurance is one cultivar that is expected to grow more prostrate. Onset of FHS stage for OK93P656H3299 is intermediate. Based on data collected in 2005 and 2006, it is expected to reach FHS stage in north central Oklahoma approximately March 1 (Table 6), or about the same time as Jagalene. Jagger is about one week earlier, whereas Endurance is about one week later.

Other agronomic attributes

Coupled with an intermediate FHS date is an intermediate heading date (Table 7). Its mean heading date in northern Oklahoma is 27 April. Endurance is 0.4 days later, and Jagalene is 0.8 days earlier. OK93P656H3299 has shown above-average stay-green capacity, even during the severe stripe rust year of 2005 (Table 7). In 2004, its flag leaf presumbably succumbed to the pressure of drought stress, as it did in the spring of 2006.

OK93P656H3299 is a semidwarf wheat and postulated to contain the *Rht*1 gene (G. Bai, USDA-ARS, Manhattan, personal communication, 2006), which is common among contemporary HRW wheat cultivars. It does not contain either *Rht*2 or *Rht*8. Though measurements of coleoptile length are not available, field plantings and emergence ratings have indicated no potential concerns with poor coleoptile elongation. Adult-plant height is intermediate for the semidwarf class, averaging 82 cm in 2005 across Oklahoma (Table 8). It averaged 80 cm across the Central Plains in the 2005 SRPN (data not shown), which equaled the mean of the entire nursery, or 14 cm shorter than the non-semidwarf Scout 66 and 4 cm taller than TAM 107. Its mean height is similar to Endurance and Ok101, but those two cultivars will be shorter under infection by wheat soilborne mosaic and wheat spindle streak mosaic viruses (see Stillwater and Lahoma data in Table 8). The two component lines of OK93P656H3299 are indistinguishable for plant height (Table 8).

The greatest agronomic weakness of OK93P656H3299 is its intermediate tendency for lodging. On a scale of 1 (resistant) to 5 (highly susceptible), its mean rating in 2005 at sites where lodging occurred was 2.2 and was similar to lodging patterns of Ok101 and Jagalene (Table 9). Straw strength of OK93P656H3299 is not considered a critical weakness, but under conditions of rank vegetative growth (e.g., planted early and not grazed) and high grain yield, this weakness will likely be more exposed.

Reactions to aluminum (Al) toxicity under low-pH field conditions were collected during the last three crop seasons (2004-2006). OK93P656H3299 is tolerant to soil acidity, and exhibits a reaction similar to varieties in the most tolerant class such as Ok101 and Endurance. Its genotypic profile is inconclusive for the major gene region conferring aluminum tolerance on chromosome 4DL. OK93P656H3299 lacks the resistant allele at the ALMT1 (aluminum malate transferase locus) also found in resistant cultivars such as Endurance and Atlas 66, yet it contains the resistance allele for one of the two flanking SSR markers for the 4DL QTLs (G. Bai, 2006). Thus it may contain other resistance gene(s) not commonly associated with aluminum tolerance.

Disease and insect reactions

Disease	**Reaction in Oklahoma as of June 2006**
Leaf rust (adult-plant)	Resistant
Leaf rust (seedling)	Susceptible

Stripe rust (adult plant)	Intermediate to moderately susceptible
Stem rust	Intermediate
WSBMV/WSSMV complex	Resistant
Wheat streak mosaic virus	Moderately susceptible
Barley yellow dwarf virus	Intermediate
Septoria leaf blotch	Intermediate
Tan spot	Moderately susceptible
Powdery mildew (adult)	Resistant (field reaction)
Fusarium head blight (scab)	Unknown

Based on allelic composition at three flanking SSR marker loci, OK93P656H3299 appears not to carry the slow leaf rusting gene *Lr*34, though it often expresses leaf-tip necrosis in the field.

OK93P656H3299 is susceptible to prevalent biotypes of greenbug and Russian wheat aphid. The Hessian fly reaction of OK93P656H3299 is somewhat of an anomaly. Its source of resistance is unknown, as its specific biotype resistance. Rarely will a cultivar currently adapted to Oklahoma show any resistance (heterogeneous or homogeneous) in seedling assays using a composite biotype population. OK Bullet, Deliver, Endurance, Overley, Jagalene, and Jagger all show completely susceptible reactions (Ming Chen, USDA-ARS, Manhattan, personal communication, 2006). However, OK93P656H3299 showed an unusual homogeneous and resistant reaction in seedling assays in 2006. Based on molecular-marker assays, it may carry resistance to biotype H13. Resistance to other specific biotypes is yet to be tested either by phenotypic assays or by marker analysis.

Milling quality

Kernel size was assessed by: i) determining large-kernel fraction as the weight of kernels retained on a No. 7 screen from a 200-g sample sifted with a RoTap machine for two minutes, and ii) kernel weight and kernel diameter measurements generated by the single-kernel characterization system (SKCS). In these comparisons, we included the additional check variety, Intrada, as a baseline standard for minimal kernel size and milling quality (Table 10). Ok101, Endurance, and Jagalene have moderately large kernel size among contemporary cultivars. Each cultivar exceeded OK93P656H3299 for all kernel size parameters, though Endurance and OK93P656H3299 were indistinguishable in kernel weight and diameter in 2005. Like most cultivars, the proportion of large kernels was negatively affected in OK93P656H3299 during the high stripe-rust year of 2005, though it performed well above average in grain yield comparisons that year. Interestingly, it maintained kernel weight and kernel diameter at 2004 levels.

Examination of the large-kernel fraction data at individual locations (not shown in Table 10) offers one plausible explanation for the small kernel size of OK93P656H3299. Rather than label OK93P656H3299 as a genetically small-kernel cultivar (a suitable label for Intrada), it would be more accurate to describe it as having

a high propensity for tillering. It produces more tillers, and consequently more kernels per plant, than it likely can fill to the same extent as lower-tillering varieties such as OK Bullet, Jagalene, and Overley. Post-flowering stress conditions which compromise kernel filling will likely penalize OK93P656H3299 more than most cultivars. Supportive evidence is lended by environments where diseases or drought were not as imposing on high-tillering types and produced acceptable large-kernel fractions exceeding 60%. These environments included Altus and Ft. Cobb in 2005 and all locations in 2004, except Marshall and Sweetwater. At Ft. Cobb in 2004, OK93P656H3299 had a large-kernel fraction of 87%, a level which would never be achieved by a low-kernel weight cultivar such as Intrada. Management practices which capitalize on, rather than promote, the high-tillering capacity of OK93P656H3299 will likely produce a more acceptable kernel size.

Comparisons of OK93P656H3299 versus the check cultivars for milling extraction or flour yield paralleled those for kernel size using small breeder samples (175 g) (Table 11). Although OK93P apparently lacked the milling extraction of Ok101, Endurance, or Jagalene on the Quadromat Senior experimental mill, it performed similar to other cultivars with desirable milling quality when milled at the Hard Winter Wheat Quality Laboratory (HWWQL, Manhattan, KS) and at ConAgra Foods, Inc. (Omaha, NE) (Exhibits 5 and 6, respectively). Kernel hardness based on the SKCS, another indicator of milling quality, was in the optimal range for OK93P656H3299 (Table 11), averaging 73 across 12 site-years versus 58 for Endurance.

Protein content

Wheat protein content of OK93P656H3299 averaged 12.0% across 19 site-years, placing it in an intermediate category (Table 12). Endurance, a moderately low-protein cultivar with good dough strength, averaged 11.6% across the same environments. Other cultivars which span the typical range of wheat protein are reported in Table 12 for comparison, in which 2137 and Ok101 represent the lower range and 2174 represents the upper range. Protein loss, or the difference between wheat and flour protein, was biased upward for each year comparisons are shown in Table 12, due to reduced milling extraction of our experimental mill. The Quadromat Senior mill has since been repaired to achieve a greater flour extraction rate and proportionately lower protein loss in the expected range of 1 to 2%. Using multi-location composite samples submitted to the HWWQL and ConAgra Foods, Inc., OK93P656H3299 is most similar to Deliver in wheat protein but about 1.5 percentage units lower than the high-protein cultivar, OK Bullet (Exhibits 5 and 6).

Baking quality

Flour quality and dough strength were judged from two years of mixograph and SDS-sedimentation analysis. Across 12 site-years, OK93P656H3299 averaged 5.5 min for corrected mixing time, 14.8 mm for mixogram curve width at 2 minutes past peak development, and 3.3 for stability index (Table 13). This mixograph signature represents moderately strong mixing tolerance, which is indeed reflected in the visual composite ratings of the class, whether on a 1-to-10 or 0-to-6 scale. We have migrated

to the latter scale to be consistent with the HWWQL rating system. A mean sedimentation volume of 6.6 mL, adjusted for flour protein concentration, indicates good loaf volume potential for OK93P656H3299. Relative to the check cultivars in Table 13, OK93P656H3299 has equivalent or superior mixing tolerance. Mixogram parameters for the less tolerant check, Endurance, averaged 4.7 min for corrected mixing time, 10.2 mm for mixogram curve width at 2 minutes past peak development, and 5.8 for stability index (Table 13).

The mixing performance summarized in Exhibits 5 and 6 provides comparisons to other cultivars with good end-use quality, such as OK Bullet and Deliver. According to the HWWQL (Exhibit 5), mixing tolerance of OK93P656H3299 was intermediate to OK Bullet and Deliver. A different assessment of dough strength was provided by the farinograph results in Exhibit 6, which place OK93P656H3299 in a similar performance class as OK Bullet except for the lower farinograph absorption of OK93P656H3299 (consistent with its lower protein content). The high-molecular-weight glutenin-subunit (HMW-GS) signature for OK93P656H3299 is 2*/7+9/5+10, which is identical to Endurance.

Actual baking performance was assessed in the OSU Wheat Quality Laboratory, relative to three cultivars with moderate (Ok101) to moderately good baking quality (Ok102 and Jagalene). The lower flour protein content of OK93P656H3299 was reflected in its lower loaf volume (Table 14). All other baking characteristics were similar between OK93P656H3299 and the checks. In a separate baking test, an adjustment for genetic differences in flour protein content, referred to as loaf volume regression, placed OK93P656H3299 in the same class as OK Bullet and Deliver (Exhibit 5). The baking assessment by ConAgra, Inc. positioned OK93P656H3299 in an acceptable category, though it received a total score (82) several points lower than Deliver (89), Endurance (88), and OK Bullet (87) (Exhibit 6). Nearly all of this differential was attributed to a lower dough-handling score. OK93P656H3299 presents no serious flaws in baking quality, yet it does not appear to offer any exceptional features in that area either.

In summary, the following quality profile of OK93P656H3299 may be extracted from currently available data: intermediate test weight, intermediate kernel size that can be highly sensitive to environmental conditions during grain-filling, good straight-grade flour yield with moderately low or desirable ash content, intermediate protein levels with good tolerance to over-mixing but moderately long mixing time, intermediate bake water absorption, loaf volume that is commensurate with its protein content, good crumb grain, and acceptable crumb color. Its genotype for high-molecular-weight glutenin subunit composition does not contain alleles at any of the three loci which have been negatively associated with baking quality. Two independent tests showed OK93P656H3299 to be a non-carrier of any wheat-1RS rye translocation.

Summary Justification

Having earned the highest rank position in the 2005 SRPN for grain yield, OK93P656H3299 certainly has the yield potential to perform well in grain-only management systems, with an extremely wide adaptation range to boot. It showed a 3 bu/ac increase in region-wide grain yield over OK Bullet (the fifth highest entry), which

appeared to possess stronger resistance to stripe rust, the primary disease across the Great Plains in 2005. What makes OK93P656H3299 even more attractive is its dual-purpose capability, though this feature was suppressed during the severe drought of 2005-2006. From the perspective of forage production, it shows exceptional emergence and take-off that was easily noticed in the dry fall of 2005. Combined with exceptional tillering capacity, OK93P656H3299 is expected to appeal to producers for its stand establishment and canopy closure. If that is not enough, its "rebound" from grazing is propelled by high tiller survival and spike formation.

Early planting in north central Oklahoma has been plagued in recent years by spring and fall infestation of Hessian fly. The associated damage, in the form of straw breakage, has been observed on breeding nurseries at the Expanded Wheat Pasture Center and at Enid, where conventional tillage practices still remain in effect. OK93P656H3299 shows good resistance to the current biotypes of Hessian fly collected in Kansas and Oklahoma, based on seedling assays that often divulge susceptibility of cultivars that may appear resistant in field reactions. Specific biotype reactions have not yet been ascertained, but this level of resistance is extremely unique, especially at this level of yield performance.

Probable Area of Adaptation and Limitations

OK93P656H3299 has no apparent geographic limitations throughout Oklahoma, and it apparently extends well north and south of Oklahoma. With strong resistance to the two prevalent viral diseases in north central Oklahoma, wheat soilborne mosaic and wheat spindle streak mosaic viruses, it should be positioned in that area with preference over Endurance, and possibly OK Bullet. Its resistance to leaf rust remains undefeated as of May 2006, both in Oklahoma and in Texas. With added tolerance to low-pH soils, OK93P656H3299 it pulls together into one variety the strengths of Endurance and OK Bullet. It remains uncertain as of the 2006 wheat harvest how OK93P656H3299 will respond to extreme stripe rust pressure previously observed in 2005. Though it cannot be branded with a "resistant" reaction type, OK93P656H3299 certainly showed resilience in grain yielding ability under those conditions in 2005. Based on preliminary yield results from 2006, OK93P656H3299 lost some of its competitiveness under the extreme drought conditions of 2005-2006, producing many more fertile tillers than the remnant moisture supply during the grain-filling period could support. However, it still managed to take top-yielding positions in elite breeding nurseries conducted at Altus and Ft. Cobb, OK.

OK93P656H3299 does not show any serious blemish for milling and baking quality, though OK Bullet should maintain its top ranking in this area. A tendency toward smaller kernel size is its primary weakness. Other relatively minor limitations include susceptibility to all biotypes of greenbug and Russian wheat aphid, and moderate susceptibility to lodging that becomes most apparent under conditions of rank vegetative growth.

Varietal Replacement

Cultivar	Superior attribute of OK93P656H3299 justifying replacement
Jagger	Greater yield potential (7 bu/ac differential in 2005; limited data) Leaf rust resistance Hessian fly resistance Better visual estimate of forage production (quantitative data unavailable) Later onset of first-hollow-stem stage
2174	Greater yield potential (8 bu/ac differential in 2005; limited data) Insensitivity to temperature during germination Rapid stand establishment Leaf rust resistance Greater acid-soil tolerance Preferred HMW-GS at the *Glu-B1* locus
Jagalene	Improved grain yield, except under extreme spring drought stress Insensitivity to temperature during germination Rapid stand establishment and improved recovery from grazing Leaf rust resistance Hessian fly resistance Shatter resistance

In regard to varietal complementation, producers who prefer to produce two or more varieties might consider OK93P656H3299 as the first cultivar to plant, since its stand establishment is excellent. In situations of splitting acreage for dual-purpose and grain-only management, it would appear at this time to be a better fit for dual-purpose use. It will also allow producers to dilute any sensitivity to a late winter freeze by reaching the FHS stage at a later time than earlier cultivars such as OK Bullet, Overley, and Jagger. OK93P656H3299 will also reach harvest-maturity slightly later than Overley or Jagger, and with minimal risk of shattering.

Seed Increase Status

OK93P656H3299 was placed under foundation seed production by OKFSS Inc. near Kildaire, OK in the fall of 2005. Breeder seed was provided of each component line in the amounts of 10.9 bu for OK93P656H3299-84, and 9.7 bu for OK93P656H3299-99. Each line was compared for alleles at 200 random SSR marker loci, and no polymorphisms were detected. Hence these sister lines may be considered genetically identical. Their phenotypic similarity in plant height, plant type, chaff color, juvenile growth habit, and other traits further supports combining seed from both lines to create the cultivar for seed distribution.

Pedigree Classes

Recommended classes of seed production are Breeder, Foundation, Registered, and Certified.

Proposed Method of Release

A non-public release under licensing agreement with Oklahoma Genetics, Inc. is recommended. Application for plant variety protection (Title V) will be filed in 2006-2007. Joint release with USDA-ARS is anticipated.

Cooperating Scientists

Identification of OK93P656H3299 as a candidate cultivar was accomplished through OSU's Wheat Improvement Team, which includes Brett Carver (lead scientist), Bob Hunger, Jeff Edwards, Art Klatt, Dave Porter, Patricia Rayas-Duarte, Bjorn Martin, Kris Giles, and Tom Royer. Also cooperating in the testing of OK93P656H329 were breeders throughout the Great Plains associated with the Hard Winter Wheat Performance Nursery Program. They represent state Agricultural Experiment Stations, the USDA-ARS, and private companies.

The persistence and diligence of Dr. Ed Smith, retired OSU wheat breeder and original occupant of the Wheat Genetics Chair in Agriculture, were central to the development of the original lines, OK93P656 and OK93P656-RMH3299. The hard winter wheat breeding team at Pioneer Hi-Bred International, Inc. is also recognized for their development of VBJ0503, from which OK93P656 was selected as a selfed progeny. Special assistance was provided by Brad Seabourn with USDA-ARS-GMPRC-HWWQL at Manhattan, KS and Mary Sorenson with ConAgra Foods, Inc. at Omaha,NE. Others cooperating in the release of OK93P656H3299 were credited at the beginning of this report.

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Table 1. Per-annum **grain yield** means recorded in as many as 32 breeder trials over a 5-yr span since 1999 (*n* sites per year).

Entry	1999 RYT2 (*3*)	2000 OET1 (*4*)	2001 OET2 (*8*)	2004 OET2 (*6*)	2005 OET2 (*11*)	Weighted yield superiority of OK93P656H3299[1]
				bu/ac		
OK93P656H3299	**39**	**55**	**55**	**58**	**49**	
2174	38	46	55			2.6
Ok101			54	52	39	6.2
Endurance		48	56	54	44	3.4
Jagalene				56	45	3.3
Nursery mean	36	46	54	52	42	5.2
LSD (0.05)	7	6	4	6	4	

[1] Weighting is by number of sites per year.
Calculation determined only in years where the comparison check appears with OK93P656H3299.
Positive differential indicates OK93P656H3299 had higher yield by the amount indicated.

Table 2. **Grain yield** comparisons of OK93P656H3299 with the newest HRW and HW releases, and the long-term check TAM 107, tested side-by-side in the 2005 SRPN.

	Oklahoma		Kansas		Nebraska		Texas		South Dakota		Colorado		New Mexico		**Region**	
Entry	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank
								kg/ha								
OK93P656H3299	**3782**	***5***	**4300**	***1***	**4840**	***3***	**3775**	***11***	**2906**	***38***	**2744**	***6***	**5472**	***8***	**4102**	***1***
OK Bullet	3812	*2*	4112	*4*	4374	*13*	3758	*12*	3524	*9*	2648	*8*	5484	*6*	3911	*5*
AgriPro Fannin	3700	*7*	3909	*14*	4286	*19*	3599	*18*	2870	*40*	1964	*43*	5458	*10*	3759	*13*
West Bred Keota	3136	*28*	3539	*30*	3728	*39*	2756	*43*	3387	*14*	1840	*46*	4536	*44*	3290	*42*
Guymon	2882	*39*	3525	*31*	4304	*17*	3169	*29*	3123	*25*	2438	*20*	4970	*29*	3544	*28*
Danby	3102	*30*	3395	*37*	4482	*10*	3534	*22*	3072	*27*	2459	*19*	4833	*33*	3565	*25*
AgriPro NuDakota	3408	*15*	4300	*2*	4842	*2*	3778	*10*	3008	*34*	2596	*11*	6112	*1*	4073	*2*
TAM 107	2608	*42*	2768	*47*	3128	*46*	2488	*45*	2897	*39*	2246	*31*	5092	*24*	3045	*46*
Nursery mean	3181		3628		4073		3329		3168		2345		5029		3559	
LSD (0.05)	627		560		778		760		574		612		1067		273	

Table 3. **Grain yields** from four Oklahoma sites in the 2005 Wheat Variety Trials.

Entry	El Reno dual-purpose	Marshall dual-purpose	Alva	Marshall	Variety mean
			bu/ac		
OK93P656H3299	**53**	**22**	**57**	**32**	**41**
Jagger	45	12	48	31	34
2174	43	14	42	31	33
Endurance	53	13	53	30	37
Deliver	50	17	42	40	37
Jagalene	43	18	44	27	33
Fannin	42	11	54	32	35
Overley	48	16	60	45	42
OK Bullet	54	17	42	38	38
Trial mean	46	16	46	30	35
LSD (0.05)	7	6	7	6	

[1] Top LSD (0.05) group of varieties for a given site appear in red.

Table 4. **Grain yields** in dual-purpose (DP) vs. grain-only (GO) management systems at the Wheat Pasture Center near Marshall, OK during 2004 and 2005.

	2004 OET2			2005 OET2			2005 WVT			Across nurseries		
Entry	DP	GO	% reduction[1]	DP	GO	% reduction[2]	DP	GO	% reduction[2]	DP	GO	% reduction[2]
							bu/ac					
OK93P656H3299	60	50	na	27	39	31	22	32	31	36	40	10
Ok101	53	39	na	18	34	47	13	26	50	28	33	15
Endurance	59	50	na	22	33	33	13	30	57	31	38	17
Jagalene	57	52	na	17	29	41	18	27	33	31	36	15
Nursery mean	53	40	na	19	32	41	16	30	47	29	34	14
LSD (0.05)	5	9		5	5		6	6				

[1] Indicates the yield loss in a DP system relative to the GO system; no reduction was computed in 2004, because DP yield exceeded GO yield

[2] % reduction shown may differ from calculations based on table values due to rounding differences

Table 4
Grain yield -- DP vs. GO

Table 5. Per-annum **test weight** means recorded in breeder trials from 1999 to 2005, the 2005 OWVT, and the 2005 SRPN, with (*n*) Oklahoma sites per year.

Entry	1999 RHT2 (*3*)	2000 OET1 (*3*)	2001 OET2 (*7*)	2004 OET2 (*5*)	2005 OET2 (*11*)	2005 WVT (*4*)	2005 SRPN (*4*)	Weighted differential of OK93P656H3299[1]
					lb/bu			
OK93P656H3299	**58.3**	**56.7**	**58.8**	**58.7**	**58.9**	**58.3**	**57.3**	
2174	59.4	56.1	59.7			58.3		-0.5
Ok101			57.9	58.6	58.5	57.5		0.5
Endurance		55.8	58.2	58.5	57.8	58.0	56.2	0.7
Jagalene				60.7	59.6	58.5	58.3	-0.9
Nursery mean	58.0	55.8	58.9	59.7	58.2	57.8	56.6	0.3
LSD (0.05)	1.5	1.1	0.7	0.9	0.8	1.0	1.5	

[1] Weighting is by number of sites per year.
Calculation determined only in years where the comparison check appears with OK93P656H3299.
Positive differential indicates OK93P656H3299 had higher test weight by the amount indicated.

Table 6. Date of **first-hollow-stem** development at Stillwater, OK of early-planted, non-clipped varieties selected from the Oklahoma Wheat Variety Trials, 2005 and 2006 (data provided by J. Edwards).

Entry	2005	2006	Across years
		d after Jan. 31	
OK93P656H3299	**22**	**35**	28.5
Fannin	14	29	21.5
Jagger	15	29	22.0
Jagalene	21	35	28.0
Overley	10	35	22.5
OK Bullet	15	35	25.0
2174	35	38	36.5
Ok101	22	35	28.5
Endurance	33	38	35.5
Deliver	20	38	29.0
Trial mean	22	33	27.5

Table 7. Deviation from the nursery mean for **heading date** (*n* sites per year), estimated heading date, and stay-green ratings from breeder trials in 2004 and 2005.

	Heading date			Green-leaf retention score[2]					
Entry	2004 OET2 (*3*)	2005 OET2 (*4*)	Estimated heading date[1]	05AL	05FC	05ER	05LA	04FC	04LA
	d		d after Mar 31	3-9					
OK93P656H3299	**+0.7**	**+0.9**	**27.2**	**5.5**	**4.0**	**4.8**	**4.8**	**6.5**	**8.0**
Ok101	-1.3	-1.1	25.2	5.0	6.0	7.0	7.0	6.5	7.0
Endurance	+0.7	+1.6	27.6	4.5	5.5	7.0	8.0	5.5	6.5
Jagalene	-0.3	+0.1	26.4	6.5	4.5	5.5	6.0	6.0	5.5
Nursery mean	26.3	26.4	26.4	5.4	5.5	5.7	6.2	6.2	7.1

[1] Estimated as the weighted mean deviation from the overall nursery mean of 26 days after March 31; readings taken from Stillwater, Lahoma, and Goodwell.

[2] Potential scale of 1 to 9, but actual scale of 3 to 9, where lower values indicate better green-leaf retention or stay-green. Environments arranged left to right for decreasing overall stay-green, and abbreviated as Altus (AL), Ft. Cobb (FC), El Reno (ER), Lahoma (LA) for years 2004 (04) and 2005 (05).

Table 8. Plant **height** across Oklahoma in 2005 from breeder trials and the Oklahoma Wheat Variety Trials (OWVT).

Entry	Marshall GO[1]	Stillwater	Altus	Alva (OWVT) [2]	Lahoma	Goodwell irrigated	Mean
				cm			
OK93P656H3299-84	**68**	**80**	**76**	**81**	**91**	**94**	**82**
OK93P656H3299-99	**67**	**81**	**77**	**81**	**91**	**94**	**82**
Ok101	74	66	81	84	80	100	**81**
Endurance	67	65	77	86	85	101	**80**
Jagalene	71	72	83	86	96	101	**85**
Nursery mean	69	73	80	85	87	99	**82**
LSD (0.05)	6		5		7	7	

[1] 2 reps per location, except for Stillwater (1 rep) and Alva (1 rep)

[2] The two component lines of OK93P656H3299 were measured as a composite line at Alva.

Table 8
Plant height

Table 9. Plant **lodging** across Oklahoma in 2005 from three breeder trials[1].

Entry	Altus	Lahoma	Goodwell irrigated	Mean
		1-5		
OK93P656H3299-84	**2.0**	**1.5**	**3.0**	**2.2**
OK93P656H3299-99	**2.0**	**1.5**	**2.5**	**2.0**
Ok101	2.0	2.0	2.0	**2.0**
Endurance	1.5	2.0	1.5	**1.7**
Jagalene	3.0	1.0	3.5	**2.5**
Chisholm	2.5	4.0	4.0	**3.5**
Nursery mean	1.8	1.7	1.7	1.7
LSD (0.05)	1.0	0.7	0.9	

[1] 2 reps per location

Table 9
Lodging resistance

Table 10. **Kernel size** attributes based on Ro-tap separation and the single-kernel characterization system (SKCS), reported annually across *n* environments from breeder trials, 2004 and 2005. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

	Large-kernel fraction		Kernel wt. (SKCS)		Kernel diam (SKCS)	
	2004[1]	2005	2004	2005	2004	2005
Entry	(*5*)	(*6*)	(*6*)	(*6*)	(*6*)	(*6*)
	%		mg		mm	
OK93P656H3299	**53.5**	**44.8**	**25.9**	**27.2**	**2.12**	**2.21**
Ok101	73.4	60.4	30.3	30.4	2.34	2.35
Endurance	68.1	57.8	30.2	27.9	2.22	2.14
Jagalene	77.0	55.3	30.7	29.5	2.39	2.34
Intrada	51.4		27.0		2.19	
Nursery mean	66.4	60.6	28.7	29.4	2.24	2.29
LSD (0.05)	6.5	7.4	1.4	1.7	0.06	0.08
Target value	**>60.0**		**>29.0**		**>2.20**	

[1] Large-kernel fraction for Endurance and Jagalene in 2004 taken from adjacent nursery

Cultivars shaded in blue had significantly higher values than OK93P656H3299; those in red had significantly lower values (no occurrences)

Table 11. Two-year summary (2004-2005) of **hardness index**, measured by the single-kernel characterization system (SKCS) and by near-infrared reflectance (NIR), and straight-grade **flour yield** determined with a Quadrumat Senior mill, reported annually across *n* environments from breeder trials. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

	Flour yield		Hardness index (SKCS)		Hardness index (NIR)	
	2004[1]	2005	2004	2005	2004	2005
Entry	(*6*)	(*6*)	(*6*)	(*6*)	(*6*)	(*6*)
	%					
OK93P656H3299	**57.7**	**62.6**	**72**	**73**	**69**	**82**
Ok101	60.4	65.1	53	57	67	80
Endurance	59.6	62.7	56	59	61	70
Jagalene	60.5	64.4	66	67	70	82
Nursery mean	58.5	62.1	62	65	63	76
LSD (0.05)	1.6	1.5	4	4	5	3

Cultivars shaded in blue had significantly higher values than OK93P656H3299; those in red had significantly lower values

Table 12. Three-year summary of **wheat and flour protein** reported annually across *n* environments from breeder trials. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

	Wheat protein (12% mb)			Flour protein (14% mb)		
Entry	2001 (*7*)	2004 (*6*)	2005 (*6*)	2001 ()	2004 (*6*)	2005 (*6*)
		%			%	
OK93P656H3299	**11.3**	**12.6**	**12.1**	**na**	**10.0**	**9.3**
Ok101	10.6	12.0	12.4		9.7	10.2
Endurance	11.1	11.8	11.9		9.2	9.6
Jagalene		13.0	12.6		10.6	10.3
2137	11.2					
Deliver	11.5		12.7			10.6
Ok102	11.9	13.1			11.1	
2174	12.6					
Nursery mean	11.3	12.6	12.4		10.3	10.1
LSD (0.05)	0.5	0.6	0.5		0.6	0.6

Cultivars shaded in blue had significantly higher values than OK93P656H3299; those in red had significantly lower values.

[1] Flour protein not measured in 2004 for OK93P656H3299

Table 13. Two-year summary (2004, 2005) of **mixograph** characteristics and sedimentation volume, reported annually across 6 environments from breeder trials. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

	Mixing time[2]		Mixing tolerance rating		Mixogram curve width[2]		Mixogram stability		Adjusted SDS-sedimentation[2]	
Entry[1]	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
	min		1-10	0-6	mm				mL	
OK93P656H3299	6.2	4.7	6.5	3.7	14.0	15.5	3.9	2.6	6.2	7.0
Ok101	6.0	5.8	5.3	2.0	8.3	12.3	7.5	6.7	6.7	6.9
Endurance	5.1	4.3	5.8	2.1	8.9	11.4	5.0	6.6	6.6	6.7
Jagalene	6.3	5.7	5.6	3.0	12.4	15.3	6.1	5.2	6.7	7.1
Ok102	6.3		5.6		13.5		7.3		6.9	
Overley		7.5		3.0		14.6		7.0		7.0
Nursery mean	6.2	5.3	6.0	2.7	12.3	14.3	5.4	5.7	7.0	7.0
LSD (0.05)	1.2	1.0	0.7	0.7	1.8	2.3	2.3	2.5	0.6	0.5
Target value	**3.0-8.0**		**>4.0**	**>2.5**	**>10.0**		**<10.0**		**<7.0**	

With exception of mixing time (no highlighting), cultivars shaded in red had significantly less desirable values than OK93P656H3299; those shaded in blue had significantly more desirable values.

[1] Ok102 and Overley added for more comparisons to checks with strong dough strength.

[2] Mixing time and SDS-sedimentation adjusted for flour protein, and mixogram curve width was measured at 2 min past peak development.

Table 14. Two-year summary (2004, 2005) of **baking** characteristics for composite grain samples produced statewide in the Oklahoma Elite Nursery. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

	Bake absorption		Loaf volume		Visual rating External		Visual rating Internal		Visual rating Total	
Entry	2004 [1]	2005 [2]	2004	2005	2004	2005	2004	2005	2004	2005
	%		cc		1-35		1-30		1-65	
OK93P656H3299	**63.0**	**65.0**	**730**	**743**	**29.5**	**29.5**	**27.0**	**24.3**	**56.5**	**53.8**
Ok101	63.0	63.0	705	810	31.0	30.0	27.5	26.5	58.5	56.5
Ok102	65.0		763		29.0		27.0		56.0	
Jagalene		63.0		808		30.0		24.5		54.5
Sample mean	63.7	64.2	764	791	30.9	30.0	26.9	24.3	57.8	54.0

[1] 11 samples composited from grain produced at Marshall (grazed and grain-only), Lahoma, Ft. Cobb, Sweetwater (grazed), and Goodwell (irrig.)

[2] 18 samples composited from grain produced at Stillwater, Marshall (grazed and grain-only), Ft. Cobb, Sweetwater (grazed), and Goodwell (irrig. and dryland)

Exhibit 1
USDA-GIPSA-FGIS Grain Classification
Stillwater, OK
2004-2005 crop year
1 page

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK93P656H3299

USDA
United States Department of Agriculture
Grain Inspection Packers and Stockyards Administration
Technical Services Division
Board of Appeals and Review
10383 N. Ambassador Drive
Kansas City, MO 64153
(816) 891-0457

January 23, 2006

Brett F. Carver - Wheat Breeder
Oklahoma State University
368 Agricultural Hall
Stillwater, OK 74078-6028

Re: OK93P656H3299-2C04

Thank you for submitting a type sample of OK93P656H3299-2C04 which is intended to be released as Hard Red Winter Wheat . We evaluated the variety using the criteria listed below to determine how well suited it is for the current visual wheat classification system. Based on this review, we would classify the subject variety Hard Red Winter Wheat .1

Weight of sample submitted 500 grams . To ensure this variety is properly classed throughout the national inspection system, please submit a minimum of 4000 grams so we can distribute type samples to the various inspection laboratories.

EVALUATION CRITERIA (based on intended class):

	ACCEPTABLE	UNACCEPTABLE
Kernel Morphology	✓	
Hardness Index	✓	

COMMENTS:

Hardness Score 90.
Good HRW. (Sturdy type)
Pedgree: Pioneer experimentals.

Sincerely,

Michael Eustrom, Chief
Board of Appeals and Review

cc: MASB

1 The above decision applies to the quantity of wheat submitted for our review and does not apply to any other identified lots. The effect of environment on morphological characteristics may be significant and necessitate reevaluation.

Exhibit 2
Variety Name Clearance
USDA, Seed Regulatory and Testing Branch
1 page

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK93P656H3299

United States Department of Agriculture

Marketing and Regulatory Programs

Agricultural Marketing Service

Livestock and Seed Program

Seed Regulatory & Testing Branch
801 Summit Crossing Place
Gastonia,
North Carolina
28054-2193

Phone:
704-810-8871

FAX:
704-852-4109

E-mail:
Kevin.Robinson2@usda.gov

Web Site:
www.ams.usda.gov/lsg/seed.htm

June 27, 2006

Mr. Brett F. Carver
Regents Professor and Wheat Breeder
Oklahoma State University
368 AG Hall
Oklahoma State University
Stillwater, Oklahoma 74078

Dear Mr. Carver:

In response to your inquiry concerning variety names, we have checked our variety name database and found the following:

Name Cleared: 'Duster' for wheat has been cleared.

We are no longer doing Trademark searches on proposed variety names. The Trademark database can be accessed via the Internet at the following web site: "tess2.uspto.gov". Because there is no variety registration system, we cannot assure you that these names are free of conflicts. Moreover, our clearance confers no legal precedence.

We are happy to help you in this matter. **Please inform us about your new variety releases, including the kind, release date, and experimental designation(s) of the new varieties. Also, please indicate which names you decline to use so that they may be returned to the pool of available names.**

Thank you.

Sincerely,

Kevin Robinson
Seed Marketing Specialist

Exhibit 3
Breeding History Chart
1 page

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK93P656H3299

	Performance-Tested					Observation or Increase			Regional Test		
Year	NID	Nursery	Entry no.	Selection number		Nursery	Entry no.	Selection number	Nursery	Entry no.	Comments
2006	92	OET2	8	OK93P656H3299-2C04	*F13:18*	92N	8	OK93P656H3299-2C04	SRPN	7	released to OFSS as 2 lines; WVT's - 21 sites
2005	92	OET2	1	OK93P656H3299-84	*F13:17*	92N	1	OK93P656H3299-84	SRPN	12	
			2	OK92P656H3299-99			2	OK92P656H3299-99	SRPN	12	
2004	93	OET2	22	OK93P656H3299-2C03	*F13:16*	94N	16	OK93P656-396N84			
							17	OK93P656-396N99			
2003					*F13:15*	96N	84	OK93P656-RMH3299			Variety purification
							99	OK93P656-RMH3299			
2002					*F13:14*	60	6	OK93P656-RMH3299			Head rows
2001	92	OET2	19	OK93P656-RMH3299	*F7:13*	92N	19	OK93P656-RMH3299	SRPN	20	WVT's - 9 sites
									RGON	170	
2000	90	OET1	9	OK93P656-RMH3299	*F7:12*	92N	9	OK93P656-RMH3299			
1999	68	RMH Reseln	5	OK93P656-RMH3299	*F7:11*	68	5	OK93P656-RMH3299			
1998					*F7:10*	RMH SBMV Obsn (Smith)	716	OK93P656H			Identified in Smith's book as RMH45/98
1997					*F7:9*	*Hunger SBMV Observation Nursery*					Selected for uniformity of SB/Lr resistance by Hunger
1996					*F7:8*	*Hunger SBMV Observation Nursery*					Plant-row progeny evaluated by Hunger for SBMV
1995	61	AWPN	14	OK93P656	*F2:7*	*Not harvested from AWPN increase*					Evaluated F_7 single plants by Hunger for SBMV
1994	51	IWPN	14	OK93P656	*F2:6*	IWPN	94LA61	OK93P656			200 heads, 40 lb seed harvested
1993	23	PYN3	8	VBJ0503	*F2:5*	PYN	93-1123008	VBJ0503			
1992					*F2:4*	Wht. Obsn. I	1811	VBJ0503			2 lines evaluated, one harvested
1991					*F2:3*	F3 Head rows	P114	VBJ0503			100 head rows, tray 2105
1990	*Pioneer owned and operated*										Pioneer owned and operated
1989					*F2*	F2	617 16				Source label for F3 head rows reads 89VN F2 617 16

Exhibit 4
Disease reaction summary
Compiled by Dr. Bob Hunger and Dr. Jeanmarie Verchot
5 pages

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK93P656H3299

20 June 2006

Dr. Brett Carver
Department of Plant & Soil Sciences
Oklahoma State University
Stillwater, OK 74078

Dear Dr. Carver:

Below is a summary describing the reactions of **OK93P656H3299-2C04** to various wheat diseases, including wheat soilborne mosaic virus (WSBMV)/wheat spindle streak mosaic virus (WSSMV), leaf rust (*Puccinia triticina*), stripe rust (*P. striiformis*), stem rust (*P. graminis* f. sp. *tritici*), powdery mildew (*Blumeria graminis* f. sp. *tritici*), septoria leaf blotch (*Septoria tritici*), and tan spot (*Pyrenophora tritici-repentis*). I also included data I found on the reaction of this candidate cultivar to Hessian fly (*Mayetiola destructor*). A summary of the observations used to determine these reactions are presented on the page attached to this letter. Reactions to WSBMV, leaf rust, and stripe rust are based on multiple ratings over several years. Reactions to the other diseases may be based on more limited observations, which for some of the diseases are exclusively greenhouse trials.

OK93P656H3299-2C04 is **resistant to both WSBMV / WSSMV** as indicated by testing at multiple locations over multiple years.

Various greenhouse tests have indicated primarily susceptibility to leaf rust in the seedling stage, although some tests have indicated moderate resistance. However, OK93P656H3299-2C04 expresses a **resistant field reaction to wheat leaf rust** in Oklahoma and Texas during the three growing seasons from 2004-2006.

OK93P656H3299-2C04 has expressed a **reaction to stripe rust** that has ranged from **intermediate to moderately susceptible** in the Plains states. Thus, reaction to stripe rust may be highly dependent on environment

and/or races of the pathogen present, and may vary significantly from year to year.

Results from other testing indicate that OK93P656H3299-2C04 shows a **moderately susceptible reaction to tan spot** (greenhouse and field tests), **an intermediate reaction to septoria leaf blotch** (greenhouse and field tests)**, and a reaction to powdery mildew that varies from intermediate to moderately resistant** (greenhouse and field tests). The variability in the reaction to powdery mildew in the greenhouse testing may have resulted from the use of different races of *B. graminis* f. sp. *tritici* being used in different years. Further, OK93P656H3299-2C04 demonstrated an **intermediate reaction to wheat stem rust** (greenhouse and field) and a **resistant reaction to Hessian fly** (greenhouse).

Please contact me if clarification or additional information is needed.

Sincerely,

Robert M. Hunger
Professor

Jeanmarie Verchot
Associate Professor

DISEASE REACTIONS OF OK93P656H3299

Wheat Soilborne Mosaic Virus / Wheat Spindle Streak Mosaic Virus

Year/location	Symptoms (1-4)	ELISA WSBMV	ELISA WSSMV
2006/Stw (PLP; BFC NID92 #08)	1 1 1	0.229 0.233 0.148	0.223 0.226 0.192
2006/Stw (PLP; SRPN #07)	1 1 1	0.163 0.190 0.140	0.166 0.231 0.195
2005/Stw (PLP; BFC NID92 #01)	2 1		
2005/Stw (PLP; BFC NID92 #02)	1 1		
2005/Lah (SRPN #12)	1 (1-4)		
2005/IL (SRPN #12)	1 (1-9)		
2005/Wichita, KS (SRPN #12)	1 (1-9)		
2005/Winfield, KS (SRPN #12)	1 (1-5)		
2004/Stw (PLP; BFC NID93 #22)	2		
2001/Stw (PLP; BFC NID92 #19)	2		
2001/Stw (PLP; SRPN #20)	1.7 (avg. of three reps)		
2001/Lah (SRPN #20)	2		
2001/Wichita (SRPN #20)	1 (0-9)		
2001/Winfield (SRPN #20)	2 (0-9)		
2001/Stw (PLP;RGON #170)	1		

DISEASE REACTIONS OF OK93P656H3299

Rusts (Stem rust listed in last section)

Year/location	Leaf rust Sdlng	Leaf rust Field	Stripe rust
2006/Stw (Grnhse; BFC NID92 #08)	3- 3- 3-	2 LD 2	
2006/Stw (Grnhse; SRPN #07)	X;3= X;3- X;3=	LD 2 2	
2006/College Station (11-Apr; R. Harrington)		0 (0-100S)	
2005/Stw (Grnhse; BFC NID92 #01)	3 3 3		
2005/Stw (Grnhse; BFC NID92 #02)	3 3 3		
2005/Lah (27-Apr; BFC NID92 #01)			R (R to S)
2005/Lah (27-Apr; BFC NID92 #02)			R (R to S)
2005/Mar (27-Apr; BFC NID92 #01)		25R (65S highest rating)	MR/MS (R to S)
2005/Mar (27-Apr; BFC NID92 #02)		50R (65S highest rating)	MR/MS (R to S)
2005/Alt (7-Apr; BFC NID92 #01)			0 (0 to ++)
2005/Alt (7-Apr; BFC NID92 #02)			0 (0 to ++)
2005/Ftc (7-Apr; BFC NID92 #01)	0 0 0		0 (0 to +++)
2005/Ftc (7-Apr; BFC NID92 #02)	0 + 0		0 (0 to +++)

2005/Stripe rust at:	BTX-I	BTX-D	Ft.CC	WinKS	BrSD	CCNE	PuWA	MtV WA
	80S	80S	8 (1-9)	3 (0-5)	15MS (0R-20S)	3 (0-10)	8 100	8 100

2005/St. Paul, MN (SRPN #12) TR (TR – 70)

2005/St. Paul, MN (SRPN #12) ; ;1c ; 0; ; 0; ;2c-3 ;1c* - postulated gene = Lr41

*this reaction (;1c) is to the bulk of races

2005/Brookings, SD (SRPN #12) - IT 0R (0R – 75S)

2005/Brookings, SD (SRPN #12) – Severity 1 (1-7)

2005/So TX (AK?) 30RMR (Tr – 100S)

2004/Stw (Grnhse; BFC NID93 #22) ; ; ;

2001/Stw (PLP; BFC NID92 #19) 3 X;3 3

2001/Stw (PLP; SRPN #20) S

2001/Stw (PLP;RGON #170) 3+

2001/MN (grnhse; SRPN #20) – LEAF RUST: ; ; S ; ; ;1-c (to six leaf rust isolates)

2001/MN (SRPN #20)		20MS-S (TR-40S)	
2001/IN (SRPN #20)		1 (1-9)	
2001/Beeville, TX (SRPN #20)			3 (0-5)
2001/Bushland, TX (SRPN #20)			8 (0-9) 65% (0-88%)
2001/Wichita, KS (SRPN #20)			3 (0-9)
2001/Salina, KS (SRPN #20)			4 (1-9)

DISEASE REACTIONS OF OK93P656H3299

Other Diseases

Powdery mildew:

	Grnhouse
2006/Stw (BFC NID92 #08):	3+ 3+ 3+
2005/Stw (BFC NID92 #01):	; ; 3=
2005/Stw (BFC NID92 #02):	; ; ;
2004/Stw (BFC NID93 #22):	3
2005/El Reno (BFC reading):	0 (on a scale of 0-3 with highs of '2's)
2004/Stw (BFC reading @ PLP farm):	2 (on a scale of 1-4 with many '4's)

Tan spot:

2006/Stw (BFC NID92 #08):	S S S
2005/Stw (BFC NID92 #01):	MS MS MS
2005/Stw (BFC NID92 #02):	MS MS MS
2004/Stw (BFC NID93 #22)	MS
2001/Salina, KS (SRPN #20)	6 (1-9 with values from 3-8)

Septoria:

2006/Stw (BFC NIS 92 #08)	average rating of 6.3 on a scale of 1-9 (12 plants)
2005/Stw (BFC NID92 #01)	MR MR MR MR MR MR MR MR MR
2005/Stw (BFC NID92 #02)	MR MR MR MR MR MR MS MS MS
2001/Columbia, MO (SRPN #20)	35% (8-69%)
2001/Lafayette, IN (SRPN #20)	6 (1-9 with values from 3.5-7)

BYDV:

2005 SRPN #12/IL (fall inoc w/ PAV-IL): 24% dwarfing (range of 7-36%)

Stem rust:

	Seedling (5 races)	Field
2005/St. Paul, MN (SRPN #12)	3-? 2- S S S	30 S (0-70 R-S)
2001/MN (grnhse; SRPN #20)	0; 2 S 2 2- postulated; genes 17, 24)	20MS-S (0-40S)

Fusarium head blight:

@ Brookings, SD: Inc=100 (all entries 100); Sev=58.2 (24.8-81.5)

Hessian fly:

2001/Manhattan, KS (grnhse; SRPN #20): 16-R 0-S 15-R 3-S
2001/Prosper, TX (field; SRPN #20): 1.3 (range of 0.3-4.7)

Exhibit 5
USDA-ARS-HWWQL Quality Report
2004-2005 crop year
Grain composite from 9 Oklahoma environments
Compiled by Dr. Brad Seabourn, Manhattan, KS
1 page

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK93P656H3299

Trait	Unit	OK93P656H3299-84	OK93P656H3299-99	OK Bullet	Deliver	Endurance	Sample mean (*n*=16)
Test wt.	**lb/bu**	59.7	59.7	60.8	60.1	59.0	60.0
SKCS-TKW	**g**	26.4	25.1	28.2	28.4	27.7	28.1
SKCS-TKW SD	**g**	7.3	6.6	8.5	7.6	7.9	8.0
SKCS-Diam	**mm**	2.13	2.08	2.29	2.16	2.12	2.19
SKCS-Diam SD	**mm**	0.40	0.39	0.60	0.43	0.48	0.50
SKCS-Hardness		76	77	75	60	59	65
SKCS-Hardness SD		17.8	17.5	17.2	18.4	17.8	17.8
SKCS-Classification		HARD	HARD	HARD	HARD	HARD	
Flour yield	**%**	65.6	64.3	65.7	66.6	64.6	65.6
Flour ash (14% mb)	**%**	0.39	0.33	0.32	0.33	0.31	0.32
Wheat protein (14% mb)	**%**	12.6	12.6	14.0	12.9	11.5	12.8
Flour protein (14% mb)	**%**	10.7	10.6	12.5	11.6	10.2	11.4
Mixograph mix time	**min**	3.46	3.63	4.38	4.74	3.30	3.87
Mixograph mixing tolerance	**0-6**	4	4	3	5	2	3.3
Mixograph absorption	**%**	62.7	62.6	65.7	64.2	61.9	63.9
Farinograph absorption	**%**						
Farinograph time	**min**						
Farinograph stability	**min**						
Bake mix time	**min**	5.45	4.98	5.63	6.70	3.98	4.90
Bake absorption	**%**	63.0	63.0	64.0	62.8	60.9	62.6
Loaf volume	**cc**	790	810	903	860	810	858
Specific loaf volume	**cc/g**	5.4	5.6	6.1	5.9	5.6	5.9
Loaf volume regression		63.4	66.5	63.9	65.3	70.2	67.0
Crumb grain	**0-6**	3.4	3.0	3.5	4.3	3.5	3.8
Crumb color		dull	dull	creamy	creamy	creamy	

Exhibit 6
ConAgra Foods, Inc. (Enterprise Services) Quality Report
2004-2005 crop year
Grain composite from 9 Oklahoma environments
Compiled by Mary Sorensen, Omaha, NE
1 page

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK93P656H3299

Quality Trait	03974-2006-00842 HRW **OK93P656H3299-84**	03974-2006-00843 HRW **OK93P656H3299-99**	03974-2006-00841 HRW **OK01307**	03974-2006-00849 HRW **ENDURANCE**	03974-2006-00850 HRW **OK BULLET**	03974-2006-00852 HRW **DELIVER**
WHEAT ASH 12%	1.43	1.441	1.46	1.439	1.444	1.421
WHEAT PRO 12%	13.24	12.98	13.15	12.27	14.4	13.38
WHEAT FN 12%	230	311	444	351	416	429
WHEAT PPO	1005	1083	1213	792	740.1	977.5
WHEAT TW (lb / bu)	59.5	59.6	59	59.1	60.8	60
SKCS HARD	75	73	69	63	74	62
SKCS TKW (g)	26.5	26.7	27.4	28	30.9	30
SKCS DIAMETER (mm)	2.18	2.2	2.14	2.19	2.37	2.26
SKCS +7W (%)	26.7	26.7	24.7	33.3	47.7	36
SKCS +9W (%)	71.6	71.3	71.6	62.4	50	63
SKCS PAN (%)	1.7	2	3.7	4.3	2.3	1
MILLING EXTRACTION (%)	73.5	72.4	73.4	73.5	74.7	74.1
FLOUR ASH 14%	0.429	0.439	0.465	0.472	0.502	0.437
FLOUR PROTEIN 14%	11.41	11.94	11.73	10.48	12.99	12.09
FARINOGRAPH ABS 14%	58.4	58.3	58.4	57	61.1	58
FARINOGRAPH MTI	35	40	30	60	30	45
FARINOGRAPH PEAK (min)	5	5	5	5	5	7
FARINOGRAPH STABILITY (min)	10	9	10.5	8.5	10.5	12
BAKE RESULTS						
ABSORPTION (%)	60.0	59.0	59.5	59.5	61.0	59.0
MIX TIME (min)	30	22	19	8	18	30
VOLUME (cc's)	2625	2600	2650	2650	2650	2800
VOLUME COMMENTS	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	EXCESS
DOUGH HANDLING						
SPONGE - POINTS	4	4	4	4	4	4
SPONGE - COMMENTS	BOLD	BOLD	SL WET/BOLD	BOLD	BOLD	BOLD
AT MIX - POINTS	13	16	18	17	18	17
AT MIX - COMMENTS	SL DRY/SL STRONG	SL DRY/SL DEAD	GOOD	SL STICKY	GOOD	SL DRY
AT CUT - POINTS	16	14	18	18	18	17
AT CUT - COMMENTS	SL DRY/SL DEAD	SL DRY/SL DEAD/GOOD-	GOOD	GOOD	GOOD	SL DRY
DOUGH HANDLING TOTAL SCORE (45 pts)	33	34	40	39	40	38
INTERNALS						
COLOR - POINTS	10	9	10	10	9	10
COLOR - COMMENTS	BRIGHT	GOOD	BRIGHT	BRIGHT	BRIGHT BUT SL CREAMY	BRIGHT
BODY - POINTS	10	10	10	9	9	9
BODY - COMMENTS	VERY GOOD	VERY GOOD	VERY GOOD	GOOD	GOOD	GOOD
GRAIN - POINTS	13	12	11	12	12	13
GRAIN - COMMENTS	GOOD	SL IRREGULAR	SL ROUND, SL IRREGULAR	SL IRREGULAR	SL IRREGLUAR	GOOD
TEXTURE - POINTS	8	8	9	9	9	9
TEXTURE - COMMENTS	SL DRY	SL HARSH	GOOD	GOOD	GOOD	GOOD
INTERNAL TOTAL SCORE (45 pts)	41	39	40	40	39	41
EXTERNALS						
EXTERNAL TOTAL (10 pts)	8	8	10	9	8	10
EXTERNAL COMMENTS	SL CAPPING, SL UNEVEN	SL INSUFFICIENT, SL CAPPING	GOOD	SL RAGGED	RAGGED	GOOD
TOTAL SCORE (100 pts)	82	81	90	88	87	89
ADDITIONAL COMMENTS				SL LOW MIX REQUIREMENT		