Release of 'UI Stone' Soft White Spring Wheat

J. Chen, J. Wheeler, J. Clayton, W. Zhao, K. O'Brien, C. Jackson, J. M. Marshall, B.D. Brown, K. Campbell, X.M. Chen, R. Zemetra, and E.J. Souza

J. Chen, J. Wheeler, J Clayton, W. Zhao, K. O'Brien, C. Jackson, and J.M. Marshall , Univ. of Idaho, Aberdeen Research and Extension Center, 1693 S 2700 S, Aberdeen, ID 83210. B.D. Brown, Univ. of Idaho, Parma Research and Extension Center, ID 29603, U of I Lane, Parma, ID 83660; K. Campbell and X.M. Chen, USDA-ARS, 361 Johnson Hall, Washington State Univ., Pullman, WA 99164. R. Zemetra, Depart. of Crop and Soil Science, 109 Crop Science Building, Oregon State University, Corvallis, OR 97331; E.J. Souza, Bayer Crop Science LP, 206 Biochemistry Hall, UNL East Campus, Lincoln, NE 68583. Research was supported by the Idaho Wheat Commission, the Idaho Agricultural Experiment Station Hatch Projects, and the USDA National Institute of Food and Agriculture Triticeae-CAP 2011-68002-30029.
* Corresponding Author (jchen@uidaho.edu)

ABSTRACT

Soft white spring wheat (*Triticum aestivum* L.) is an important wheat class for domestic and international markets that is widely grown in the U.S. Pacific Northwest (PNW). The objective of this study was to develop a soft white spring (SWS) wheat cultivar with high grain yield, desirable end-use quality, and resistance to *Fusarium* head blight [FHB; caused by *Fusarium graminearum* Schwabe; telomorph Gibberellazeae (Schwein.) Petch], an emerging disease for spring wheat in southern Idaho and some areas in the PNW. 'UI Stone' (Reg. No. CV------, PI660550) SWS wheat was developed by the Idaho Agricultural Experiment Station using a modified backcross breeding procedure. UI Stone was derived from a backcross 'Pomerelle' (PI 592983)*2/ 'Tui' (Unknown PI) made in 1994 in Aberdeen, ID and tested under experimental numbers A94368-B-7 and IDO599. UI Stone is being released due to its superior grain yield under non-irrigated and irrigated production conditions in southern Idaho and the PNW, its excellent end-use quality, and good resistance to FHB. UI Stone has better or equivalent flour

and break flour yield as well as cookie baking quality compared to widely grown cultivars 'Alturas' (PI 620631), 'Alpowa' (PI 566596), and 'UI Pettit' (PI 620631). Heading date of UI Stone is similar to the early maturity cultivar 'Nick' but is later than UI Pettit, and earlier than Alturas, 'Louise' (PI 634865), and Alpowa. FHB resistance of UI Stone was identified based on two field and three greenhouse experiments and two known molecular makers *UMN10* and *Xbarc117* associated with resistance gene *Fhb1* and a QTL on chromosome 5AS, respectively. UI Stone has moderate resistance to stripe rust and might require fungicide application when severe epidemics occur. UI Stone has potential to be released with Plant Variety Protection (PVP) and as a licensed cultivar. UI Stone is the first released cultivar with resistance to FHB in the PNW.

INTRODUCTION

Fusarium head blight [FHB; caused by *Fusarium graminearum* Schwabe; telomorph Gibberellazeae (Schwein.) Petch], also called scab, is one of the most destructive diseases of wheat causing significant reductions in grain yield and quality. The development of resistant cultivars is an effective means of reducing the impacts of FHB. FHB has not been a serious problem for small grain production in southeastern Idaho. However, FHB epidemics occurred in sprinkler-irrigated wheat and barley fields in south central and eastern Idaho in 1982 and 1984, resulting in estimated yield losses as high as 50% (Mihuta-Grimmet al., 1989). Scab infection was also observed in wheat fields in southern Idaho in 2008 to 2011. In 2010 and 2011, high DON was identified in grain samples from several grain elevators. This is an emerging threat to the Idaho wheat industries.

'UI Stone' (Reg. No. CV------, PI660550) SWS wheat was developed by the Idaho Agricultural Experiment Station using a modified backcross breeding procedure. UI Stone was derived from a backcross 'Pomerelle' (PI 592983)*2/ 'Tui' (Unknown PI) made in 1994 in Aberdeen, ID and tested under experimental numbers A94368-B-7 and IDO599. UI Stone is being released due to its superior grain yield under non-irrigated and irrigated production conditions in southern Idaho and the PNW, its excellent end-use quality, and good resistance to FHB. UI Stone has better or equivalent flour and break flour yield as well as cookie baking quality compared to widely grown cultivars 'Alturas' (PI 620631), 'Alpowa' (PI 566596), and 'UI Pettit' (PI 620631).

Heading date of UI Stone is similar to the early maturity cultivar 'Nick' but is later than UI Pettit, and earlier than Alturas, 'Louise' (PI 634865), and Alpowa. FHB resistance of UI Stone was identified based on two field and three greenhouse experiments and two known molecular makers *UMN10* and *Xbarc117* associated with resistance gene *Fhb1* and a QTL on chromosome 5AS, respectively. UI Stone has moderate resistance to stripe rust and might require fungicide application when severe epidemics occur. UI Stone has potential to be released with Plant Variety Protection (PVP) and as a licensed cultivar. UI Stone is the first released cultivar with resistance to FHB in the PNW.

METHODS

Pedigree and Breeding History

UI Stone was derived from a BC_1F_9 line of the backcross Pomerelle*2/Tui. Pomerelle (Souza et al., 1997) was released in 1996 by the Idaho, Washington, and Oregon Agricultural Experiment Stations and the USDA-ARS. Pomerelle was derived from the cross A771084-B/IDO246. The breeding line IDO246 is a sister selection to 'Treasure' (PI 468962, Sunderman and O'Connell, 1988). Pomerelle has adult-plant resistance to stripe rust, moderate susceptibility to leaf rust (*P.triticina*Erikss.) and resistance to stem rust (*P. graminis*Pers.:Pers. f. sp. *tritici*Erickss. & E.Henn.) (Souza et al., 1997). Tui is a short, high yielding wheat released by CYMMIT (reference is not available).

The initial cross of UI Stone was made between Pomerelle and Tui in a greenhouse in Aberdeen, ID in January1994. The F1 (A9442S) was planted in a field headrow in spring1994. One F_1 plant was backcrossed to Pomerelle in the field in summer 1994. The BC_1F_1 (A94368S) were planted in the greenhouse in fall 1994. The harvested BC_1F_1 plants were individually planted in 4.5 m^2 plots in a field nursery inoculated with stripe rust in 1995. One BC_1F_2 plot A94368S-B was selected with better resistance to stripe rust and harvested in summer 1995 and planted in 1996 in 4.5 m^2 F_3 plot in which fifty short heads were selected. In 1997, the 50 heads (F_4) were planted in 1.2-m headrows in Aberdeen, ID. Out of 50 headrows, seven (F_5) were selected based on uniformity and performance in the summer of 1997. The selected seven lines were planted in a non-replicated observation trial in Aberdeen in spring 1998. Four(F_6) of the seven lines

A94368S-B-4,7,30, and 38 were selected and advanced in a replicated preliminary yield trial in two locations Aberdeen and Tetonia in spring 1999. Two F_6 lines, A94368S-B-7 and A94368S-B-30 were selected and evaluated in the elite yield trials in four locations Aberdeen, Hazelton, Tetonia, and Moscow, ID in 2000 and 2001. A94368S-B-7 was designated IDO599 in 2002 and entered into the tri-state trials in 2002 and the Western Regional Soft Spring Wheat Nurseries (WRSSWN) in 2003 and 2004.

Line Selection and Evaluation

IDO599 (UI Stone) has been officially evaluated since 2008 due to personnel changes in the breeding program from 2005 to 2007. Grain yield and agronomic performance of UI Stone were evaluated in the University of Idaho Spring Wheat Elite Yield Trials (UISWEYTs) in one rain-fed location (Moscow), and two irrigated locations (Hazelton and Aberdeen) in southern Idaho from 2008 to 2011; in the University of Idaho's State Extension Variety Trials (IDEVTs) in four irrigated locations (Rupert, Idaho Falls, Ashton, and Aberdeen)in southern Idaho from 2009 to 2011. Alturas, Alpowa, and UI Pettit were used as checks in the UISWEYTs and IDEYTs. UI Stone was simultaneously evaluated in the WRSSWNs from 2008 to 2010 at 11 locations each year across the states of Idaho, Oregon, Montana, and Washington. The cultivars Alpowa, Louise, Nick, and Alturas were used as checks in the WRSSWN trials.

Specifics of plot sizes, testing locations, evaluation methods and results for the WRSSWNs and the IDEVTs are documented at their web siteshttp://www.ars.usda.gov/Services/docs.htm?docid=3712and (http://www.extension.uidaho.edu/cereals/), respectively.

The UISWEYTs consisted of three replicated plots planted in a randomized complete block design. Plots in the UISWEYTs were comprised of seven 3-m rows with 22 cm between rows with harvest areas of 66 m^2.Plots were harvested using a Wintersteiger Classic small plot combine (1998 Wintersteiger Elite, Wintersteiger Seedmech, Salt Lake City, UT) equipped with a Harvest Master weighsystem (HM-400, Juniper Systems, Logan, UT). Grain yield, grain volume weight (GVW), days to heading (DTH) (50% of heads in the plot completely visible from Jan. 1 or from the date of planting), and plant height (PH, distance from ground to top of

spike excluding awns) were measured in most locations, while lodging (0–9; 0 = no lodging; 9 = 100% plants lodged) was recorded only when significant lodging was present in the field.

Evaluation of End-use Quality

Milling and baking quality were assessed by Idaho Wheat Quality Lab at Aberdeen, IDusing approved methods of the American Association of Cereal Chemistry (AACC, 2000). Composite grain samplesof 500 g of each genotype from each location were milled using modifications to AACC method 26-50 as described by Finney and Andrews (1986). Near-infrared analysis was performed with a Perten 8611 (Perten Instruments, Springfield, IL) according to the American Association of Cereal Chemists method 39-10 (AACC, 2000) to determine flour protein concentration with values calibrated by combustion analysis of total nitrogen content with a LECO Model FP-428 (LECO Corp., St. Joseph, MO)and corrected to 120 g kg^{-1}. Baking quality of the flour samples was measured using the micro sugar-snap cookie method (AACC, 2000, approved method 10-52).Solvent retention capacity of flour was measured using four water-based solvents according to the AACC method 56-11 (Gaines, 2000) with minor modifications as described previously (Guttieri et al., 2001a). Noodle quality was measured from a composite grain sample harvested in Aberdeen and Hazelton, ID using an Asian-style alkaline noodle. Alkaline noodles were prepared as described in Guttieri et al. (2001b).

Evaluation of FHB Resistance

Wheat materials from the PNW have not been previously evaluated for FHB resistance. The University of Idaho Wheat Breeding and Genetics Program initiated a project in 2008 to evaluate and characterize FHB resistance in spring wheat. UI Stone and 46 other PNW spring wheat lines and two known spring resistance sources ‘Sumai3’(PI 481542) and ‘CJW14’ (W14, PI 641164) (Ward et al., 2006) were evaluated in two field and three greenhouse experiments. One field experiment was conducted by Charla Hollingsworth in a nursery at the Northwest Research & Outreach Center, Crookston, Minnesota in spring 2008 and another by William Grey at Montana State University in Bozeman, Montana in 2009. A conidial suspension (5 x 10^4 spores/ml) of *F. graminearum* was sprayed on heads in the field experiments. The field experiments were conducted using randomized complete block designs with two replications in 1.5-m-long single-

row plots. Ten spikes of each line were evaluated and the percentage of infected spikelets (disease severity) was calculated21 days after inoculation. Deoxynivalenol (DON, ppm) content was tested on grain harvested from the 2008 field experiment. The three greenhouse (GH) experiments were conducted in Aberdeen, Idaho in 2010 and 2011. Three pots of each plant, two to three heads per plant were inoculated with *F. culmorum* (8×10^4 spores/ml) with the floret injection method (Chen et al., 2006). Disease severity for each line was calculated based on a grand mean of 3 to 10 infected spikes per line.

The 50 lines included in this GH evaluation was tested at the Western Regional Genotyping Lab at Pullman, WA with DNA markers diagnostic for the presence of *Fhb1* based on marker *UMN10* (Liu et al., 2008) and the quantitative trait locus (QTL) on chromosome 5AS based on markers *Xbarc117* (Chen et al., 2006).

Evaluation of Resistance to Stripe Rust and Stem Rust

UI Stone was evaluated by X.M. Chen as single row plot (1.0 m long) for resistance to stripe rust under natural infections in both Pullman and Mt.Vernon, WA in 2003, 2004, 2008, 2009, and 2010 in either or both of two nurseries: the Southern Idaho Wheat Breeding Nursery and the Western Uniform Regional Nursery (WURN). Stripe rust races prevalent at these locations during those years in the Pacific Northwest included PST-114, PST-116, PST-127, and PST-139 (Chen et al. 1995; Chen et al. 2010, A. Wan and X.M. Chen, unpublished data). Stripe rust resistance was evaluated twice at Feekes growth stages 5-6 and 10.1-10.5 in Mt. Vernon and once at stage 10.1-10.5 in Pullman, WA when the susceptible check 'Lemhi' had about 30% severity at the early stage and greater than 80% severity at both locations at the late growth stage. Infection type (IT) was recorded based on the 0-9 scale as described by Line and Qayoum (1992), and severity (SEV) was recorded as percentage of foliage infected. In addition, UI Stone was evaluated in the greenhouse together with the other entries in the 2010 WURN at two temperatures profiles: the low temperature profile (diurnal temperature cycle gradually changing from 4^oC at 2:00 am to 20^oC at 2:00 pm) with 16 h light long day time with selected races PST-37, PST-45, PST-100, PST-116, and PST-127 in the seedling stage at and at the high temperature profile (diurnal temperature cycle gradually changing from 10^oC at 2:00 am to 30^oC at 2:00 pm)

with races PST-100, PST-116, and PST-127 in adult-plant stages (boot to flowering stage) (Chen and Line 1995).

In 2009, UI Stone was evaluated in a controlled greenhouse conditions by X.M. Chen for resistance to stem rust using a bulked isolate of stem rust collected from the Palouse region.

Statistical Analysis

Data from the UISWEYTs, WRSSWNs, IDEVTs, and the DSNs were analyzed separately using SAS v. 9.2 (SAS institute, Cary, NC) corresponding to the field design. Grain yield and other agronomic data such as height and test weight were subjected to analysis of variance across locations within years and a combined analysis for common entries across location-years. Least significant difference lines function (α= 0.05) were used to compare the least squares means for the genotype effects.

Seed Purification and Increase

Seed-increase plots were planted each year from 2008- 2011 in parallel with yield trials. In spring 2008, 400 heads were selected from a seed-increase plot. These were threshed individually and planted in headrows in spring 2009. Uniform headrows were selected and harvested individually and composited to form the breeder seeds in summer 2009. Ten kg of breeder seed was planted in Tetonia in spring 2010 for pre-foundation seed and in spring 2011 for a large amount of foundation seed. Further seed increases and requests will be handled by the University of Idaho, Foundation Seed Program, at Kimberly Research and Extension Center, Kimberly, ID.

CHARACTERISTICS

General Description

UI Stone's juvenile plant growth is erect. At boot stage, UI Stone's plants are blue-green and have recurved flag leaves. Light pubescence is present on the stem and glumes. Coleoptiles are

white and the anthers are yellow. Stem internodes are hollow, and peduncles are erect. UI Stone has awned, white chaffed, mid-dense, and tapering heads. UI Stone's kernels are white, soft, and ovate, with rounded cheeks, a shallow crease, and the brush length is midsized and short similar to the recurrent parent Pomerelle. On the basis of four years data (2008-2011), UI Stone has an average kernel weight of 34.8 mg, similar to Alturas (34.0 mg) and slightly higher than Treasure (33.5 mg).

Grain Yield and Agronomic Performance

In the WRHWWN trials (Table 1), UI Stone ranked among the top five cultivars for grain yield, with a 3-yr average (2008, 2009, 2010) of 62.4 bu/A in rain-fed and 119.7 bu/A in irrigated tests, respectively. On the basis of the mean data over all locations of the three years, grain yield of UI Stone was similar to that of Alturas, but significantly higher than Alpowa, Louise, and Nick; grain volume weight (GVW) of UI Stone (58.6 Lb/Bu) was not significantly different from the other three check cultivars; days to heading (DTH, Julian) of UI Stone was similar to Louise but three to four days earlier than that of Alturas, Alpowa and Nick; and plant height (PH) of UI Stone was not significantly different from Alturas, Alpowa, and Nick, but 1.9 inches shorter than that of Louise.

In the UISWEYTs (Table 2), yield of UI Stone was not significantly different from Alturas, Alpowa, and UI Pettit. GVW of UI Stone was significantly higher than that of UI Pettit. UI Stone was two days later heading than UI Pettit but 2 and 3 d earlier than Alturas and Alpowa, respectively. UI Stone was six and one inch taller than UI Pettit and Alpowa, respectively; but similar in height to Alturas.

In the IDSWEVTs (Table 3), yield of UI Stone (118.1 bu/A) was not significantly different from Alturas (115.7 bu/A) but significantly higher than Alpowa (113.0 bu/A) and UI Pettit (111.9 bu/A). GVW of UI Stone was not significantly different from the other three check cultivars. UI Stone was two days later heading than UI Pettit but two and four days earlier than Alturas and Alpowa, respectively. UI Stone was four inches taller than UI Pettit, two inches shorter than Alpowa but similar in height to Alturas.

End-Use Quality

Based on the baking data of five year-location environments in Hazelton and Aberdeen under irrigation in 2008-2010 (Table 4), UI Stone has good end-use quality for a soft white spring wheat. Flour protein of UI Stone (8.9%) was significantly higher than that of UI Pettit (8.5%), but not different from Alpowa (8.9%) and Alturas (8.8%). Flour yield (67%) and cookie diameter (8.7 cm) of UI Stone were similar to Alturas (66% and 8.6 cm) and UI Pettit (67% and 8.8 cm), but significantly higher than that of Alpowa (63% and 8.5 cm). Flour ash of UI Stone was significantly lower, while the break flour yield was not significantly different from that of the three check cultivars. UI Stone had good noodle quality, similar to Alturas and UI Pettit, and better noodle quality (Chinese raw noodle) than Alpowa based on noodle color change between 0 and 24 h (*L** differential value) (Table 4). Lactic acid solvent retention capacity of UI Stone was greater than UI Pettit but less than Alturas and Alpowa.

Resistance to FHB

Table 5 summarizes the overall performance of fifty lines evaluated over two field and three greenhouse experiments. FHB resistance was characterized based on the mean data of each line. DON content smaller than 2 ppm with disease severities less than 25% in the field and greenhouse were used to delineate resistant reactions. Out of 50 lines evaluated, the nine PNW lines 'Whitebird' (PI 592982, Souza et al., 1997), IDO629, 'Otis' (PI 634866, Kidwell et al., 2006), 'Lolo' (PI 614840, Souza et al., 2003), UI Stone, IDO686, IDO668, IDO671, and 'Lassik' (PI 653535) and two resistance checks Sumai 3 and CJW14 showed good resistance in greenhouse and field inoculation experiments and lower DON accumulation in the field inoculation experiment in MN in 2008. Based on the analysis of two molecular markers *Xumn10* and *Xbarc117*, UI Stone has same resistance alleles of the two known resistant sources Sumai 3 and W14. This supports the phenotypic performance of this line in response to FHB inoculation. However, UI Stone and the other eight resistant lines have no known resistance sources in the pedigree. They all have two common parents Norin 10 and Breva, a cross made in 1950s for the introduction of *RhtB1* and *RhtD1* dwarfing gene. Norin10 has the resistant allele of *Fhb1* same as

Sumai 3 (James Anderson, University of Minnesota, Personal communication). Furthermore, six of the nine resistant lines didn't have the resistant allele of *Xumn10*, suggesting additional or different genes controlling the FHB resistance caused by *F. culmorum*. Results obtained from this screening suggested that the nine resistant lines can be used as adapted resistance sources for the improvement of FHB resistance in spring wheat and mapping of resistance genes in these sources are needed.

Resistance to Stripe Rust and Stem Rust

UI Stone showed good resistance to stripe rust in the flowering stage at the Mt. Vernon, WA location from 2008 to 2011 (Table 6). However, it showed a variable reaction (resistant to susceptible) at the Pullman, WA location over the four years it was tested. Resistance of UI Stone was similar to Alpowa and Treasure but not as good as Alturas and Louise. UI Stone was moderately resistant to stripe rust in four of the six locations in WRUNs in 2008 and 2010 (data not presented). In greenhouse evaluations (data not presented), adult plants of UI Stone were resistant to race PST-127 (infection type 1 or 2), but moderately susceptible to PST-100 (infection type 6) and PST-114 (infection type 4 or 5); seedlings of UI Stone were also resistant to races PST-45 and PST-127. Based on both greenhouse and field assessments, UI Stone has a moderate level of resistance to stripe rust in most of environments.

UI Stone showed a resistant reaction to the bulked races of stem rust collected from the Palouse region, compared to Alpowa which showed a susceptible reaction (Chen, personal communication).

Other Observed Characteristics

UI Stone was evaluated in eastern Colorado where there was high pressure populations of cereal cyst nematodes (CCN). UI Stone performed well in these environments, indicating that this cultivar may have resistance or tolerance to CCN (Dillon, personnel communications).

AVAILABILITY

Seed Source, Status and Availability: 400 heads were selected from a purificationplot grown at Aberdeen in 2009. Out of 400 headrows planted in Aberdeen in 2010, uniform headrows were harvested and bulked and used as breeder seeds. Ten pounds of the breeder seeds were planted in Tetonia, ID and Foundation seed was harvested in 2011. The Foundation, Registered, and Certified seed will be maintained and produced and distributed by the UI Foundation Seeds Program at Kimberly, ID. Small amounts (5g) of seed are available from the corresponding author for research purposes.

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Table 1. Grain yield, volume weight, days to heading, and plant height of UI Stone (IDO599) soft white spring wheat compared with check cultivars evaluated under rainfed and irrigated conditions in the Western Regional Soft Spring Wheat Nurseries in 2008, 2009, and 2010.†

Cultivar	All Grain yield	All Rank*	Rain-fed Grain yield	Rain-fed Rank	Irrigated Grain yield	Irrigated Rank	All Volume weight	All Days to heading	All Plant height
	Bu/A		Bu/A		Bu/A		Lb/Bu	d	In.
					2008				
IDO599	79.0	A	60.8	A	133.4	A	58.7	179.5	29.6
Alturas	73.3	AB	53.9	AB	131.5	A	58.4	182.9	28.6
Alpowa	69.1	AB	55.0	AB	111.6	A	59.4	183.3	30.6
Louise	62.9	B	50.3	B	100.5	A	58.3	183.0	31.3
Nick	74.4	A	55.4	AB	131.1	A	58.6	180.6	29.1
Mean of 9 entries	70.8		55.1		117.7		59.1	181.7	30.5
LSD (0.05)	10.8		8.1		42.8		1.4	2.1	1.7
No. of sites	8		6		2		5	4	6
					2009				
IDO599	76.5	A	60.2	A	109.1	A	61.0	173.4	29.7
Alturas	74.5	A	58.6	A	106.4	A	60.4	177.1	30.2
Alpowa	69.4	B	57.7	A	92.9	B	61.7	178.7	31.1
Louise	71.9	A	62.3	A	91.2	B	61.1	175.8	32.1
Nick	66.5	B	51.2	B	97.1	AB	61.2	174.9	28.4
Mean of 15 entries	72.4		58.1		101.2		61.1	176.3	31.2
LSD (0.05)	6.7		6.0		14.8		0.9	1.9	1.3
No. of sites	9		6		3		7	5	7
					2010				
IDO599	74.6	A	66.4	A	123.7	A	56.2	180.3	33.1
Alturas	69.3	AB	62.6	AB	109.6	A	57.5	183.3	32.0
Alpowa	64.5	AB	53.0	B	118.7	A	54.9	182.2	34.5
Louise	62.4	B	56.1	AB	115.1	A	56.6	186.1	33.8
Nick	51.1	C	39.6	C	120.4	A	54.9	180.6	31.8
Mean of 21 entries	68.9		60.3		115.9		57.2	183.8	33.5
LSD (0.05)	10.4		11.1		31.8		2.3	1.5	2.2
No. of sites	7		6		1		7	3	5
					All years				
IDO599	76.7	A	62.4	A	119.7	A	58.6	177	30.6
Alturas	72.6	AB	58.3	AB	115.3	AB	58.8	181	30.2
Alpowa	67.3	B	55.2	A	103.4	BC	59.2	182	31.7
Louise	66.7	B	56.2	AB	98.2	C	58.1	180	32.5
Nick	64.6	B	48.7	B	112.3	ABC	58.2	178	29.6
Mean of 5 entries	69.6		54.6		107.3		58.6	180	30.9
LSD (0.05)	8.6		10.2		14.8		1.6	2	1.4
No. of sites	24		18		6		19	13	18

†Complete data summaries can be found at http://www.ars.usda.gov/Services/docs.htm?docid=3712 (verified 15 Mar. 2012).

*Different letters indicate significant differences among the five cultivars based on the LSD values.

Table 2. Grain yield, volume weight, days to heading, and plant height of UI Stone soft white spring wheat compared with check cultivars evaluated under irrigated conditions in the UISWEYTs in 2008, 2009, and 2010.

ID	Grain yield	Volume weight	Days to heading	Plant height
	Bu/A	Lb/Bu	d	In
IDO599	123.2	60.7	177.5	37.6
Alturas	124.9	60.5	178.6	37.1
Alpowa	115.7	61.0	179.1	38.7
UI Pettit	112.1	59.1	175.3	31.5
No. of sites	7	7	7	7
LSD (0.05)	13.7	1.5	1.0	1.1
Mean of 11 entries	119.0	60.4	178.3	37.3

Table 3. Grain yield, volume weight, days to heading, and plant height of UI Stone (IDO599) soft white spring wheat compared with check cultivars evaluated under irrigated conditions in the IDSWEVTs in 2009, 2010, and 2011.†

ID	Grain yield	Volume weight	Days to heading	Plant height
	Bu/A	Lb/Bu	d	In
IDO599	118.1	60.2	186	36
Alturas	115.7	60.2	188	36
Alpowa	113.0	60.1	189	38
UI Pettit	111.9	60.2	184	32
Mean of 13 entries	113.3	60.4	187	36
LSD (0.05)	3.7	0.3	0.3	0.7

†Complete data summaries can be found at http://www.extension.uidaho.edu/cereals/(verified 15 Mar. 2012).

Table 4. Quality characteristics of wheat cultivar UI Stone (IDO599) compared to three check cultivars from the 2008 to 2010 UISWEYTS.

Cultivar	IDO599	Alturas	Alpowa	UI Pettit	Mean of 19 entries	LSD (0.05)	No. of sites
			Milling and baking quality				
Flour protein (%)	8.9	8.8	8.9	8.5	9.0	0.1	5
Flour yield (%)	67.0	66.2	63.1	67.4	66.4	1.4	5
Break flour yield (%)	42.3	40.1	41.3	40.8	40.3	2.4	5
Flour ash (%)	0.35	0.36	0.36	0.36	0.40	0.01	5
Cookie diam. (cm)	8.7	8.6	8.5	8.8	8.6	0.2	5
			Alkaline noodle dough initial color L0, color in 24 hours L24, and color change L*				
L0	90.8	90.6	90.9	89.7	90.5	1.4	3
L24	83.1	83.0	80.1	81.6	82.8	2.5	3
*ΔL**	-7.7	-7.6	-10.8	-8.1	-7.7	2.2	3
			Flour solvent retention capacity				
Water	45.0	44.0	46.8	43.0	44.8		1
Sodium carbonate	55.4	59.2	63.0	56.4	58.2		1
Lactic acid	97.3	104.0	103.8	77.8	101.0		1
Sucrose	85.1	91.8	93.2	85.4	88.6		1

Table 5. DON content, disease severity, and marker genotypes of 49 spring wheat lines evaluated in diverse environments over three years

ID	Genotype	Class	DON (ppm)	Severity (%)	Severity (%)	*Fhb1*	*Fhb 5AS*
			Field*	Field**	Greenhouse***	*XUMN10*	*Xbarc117*
1	Sumai3	SRW	**0.2**	**3.3**	**14.7**	+	+
2	W14	SRW	**0.2**	**4.0**	**6.9**	+	+
3	Whitebird	SWS	**0.4**	**8.8**	**23.0**	+	-
4	IDO629	SWS	**1.5**	**12.0**	**24.7**	-	-
5	Otis	HWS	**0.4**	**13.3**	**17.0**	-	-
6	Lolo	HWS	**1.1**	**15.5**	**23.7**	-	+
7	IDO599	SWS	**0.8**	**16.8**	**16.1**	+	+
8	IDO686	SWS	**0.7**	**17.8**	**13.1**	-	-
9	IDO668	SWS	**0.4**	**19.5**	**25.5**	-	-
10	IDO671	SWS	**0.6**	**23.8**	**17.5**	-	-
11	Lassik	HRS	**2.0**	**24.4**	**20.0**	+	-
12	Challis	SWS	**0.2**	**13.6**	32.4	+	-
13	Jubilee	SWS	**0.6**	**12.0**	36.8	-	-
14	Nick	SWS	**0.8**	**12.5**	45.8	-	-
15	Alturas	SWS	**0.8**	**14.5**	38.0	-	-
16	Pristine	HWS	**1.8**	**15.5**	42.6	-	-
17	Cataldo	SWS	**0.7**	**17.0**	31.5	-	-
18	Penawawa	SWS	**1.6**	**24.0**	31.0	-	-
19	Scarlet	HRS	**1.6**	**23.8**	32.6	-	-
20	Treasure	SWS	2.3	**10.8**	**22.1**	-	-
21	Idaho 377s	HWS	2.5	**15.0**	**9.1**	-	-
22	Blanca Grande	HWS	2.1	**18.5**	**16.7**	-	-
23	Patwin	HWS	3.7	**19.8**	**13.9**	-	-
24	UI Alta Blanca	HWS	**1.6**	30.0	**17.5**	-	-
25	IDO563	SWS	**0.6**	31.8	**20.7**	-	-
26	Alpowa	SWS	**0.7**	33.7	**17.5**	-	+
27	Hollis	HRS	**1.6**	37.4	30.9	-	-
28	Macon	HWS	**1.7**	25.5	33.0	-	-
29	UI Lochsa	HWS	**1.4**	26.8	42.9	-	-
30	Saxon	HRS	**1.1**	34.1	48.0	-	-
31	UI Pettit	SWS	**1.1**	28.5	38.5	+	-
32	Winsome	HWS	**2.0**	43.0	56.3	-	-
33	IDO687	SWS	2.7	33.0	**12.4**	-	-

34	Summit	SWS	2.2	38.5	**20.0**	-	-
35	Blanca Royale	HWS	5.7	41.9	**23.4**	-	+
36	SnowCrest	HRS	3.8	54.5	**14.7**	-	+
37	Pomerelle	SWS	4.3	**20.5**	28.4	+	-
38	Centennial	SWS	2.3	**22.3**	31.8	-	-
39	Choteau	HRS	2.8	26.0	77.0	-	-
40	Jefferson	HRS	3.0	26.3	56.2	-	-
41	Eden	SWS	2.2	28.0	32.5	-	-
42	Jerome	HRS	2.6	34.8	67.2	-	-
43	Iona	HRS	2.1	37.8	30.0	-	-
44	UI Winchester	HRS	2.7	38.5	25.7	-	-
45	Louise	SWS	3.5	36.0	71.5	-	-
46	WestBred 936	HRS	3.6	40.4	40.8	-	-
47	WestBred926	HRS	4.0	36.5	62.3	-	-
48	Hank	HRS	5.2	43.8	50.8	-	-
49	Klasic	HWS	9.2	55.9	36.9	-	-
Mean			3.0	35.2	39.5		

* DON content was tested using the grain harvested from MSU field nursery in 2009. Valuesof 2.0 and under were bolded

** Mean disease severity of MT (2009) and MN (2008) field nurseries. Values of 25% and less were bolded.

*** Mean disease severity of three GH experiments in 2010 in Aberdeen, ID. Values of 25% and less were bolded.

Table 6. Infection type (IT) and severity (%) of UI Stone (IDO599) compared to the check cultivars in responses to stripe rust infection in different growth stages planted in Pullman and Mt.Vernon, WA from 2008 to 2011.

	Pullman, flowering		Mt. Vernon, Boot stage		Mt. Vernon, flowering	
Cultivar	IT	%	IT	%	IT	%
	0-9[†]	%	0-9	%	0-9	%
			2008			
Lemhi	8	100	8	50	8	100
UI Pettit	8	20	8	10	8	90
Treasure	8	5	8	40	2	20
Alpowa	3	20	8	30	2	10
IDO599	7	10	8	20	2	30
Alturas	1	5	8	30	2	1
			2009			
Lemhi	8	70	8	80	8	100
UI Pettit	8	20	8	15	8	80
Treasure	2	1	8	10	2	10
Alpowa	2	10	7	30	2	20
IDO599	2	1	7	30	3	30
Alturas	2	1	8	20	2	10
			2010			
Lemhi	8	100	8	60	8	100
UI Pettit	8	70	2	10	5	40
Treasure	3	30	2	20	3	5
Alpowa	8	90	8	50	2	10
IDO599	8	40	8	40	3	5
Alturas	3	10	8	10	5	20
			2011			
Lemhi	8	90	8	80	8	80
UI Pettit	5	60	6	70	3	30
Treasure	3	30	5	60	2	30
Alpowa	5	30	7	70	3	40
IDO599	5	40	6	70	3	50
Alturas	2	40	3	50	2	10
			All years			
Lemhi	8	90	8	68	8	95
UI Pettit	7	43	6	26	6	60
Treasure	4	17	6	33	2	16
Alpowa	5	38	8	45	2	20
IDO599	6	23	7	40	3	29

Alturas	2	14	7	28	3	10
Mean	5	37	7	40	4	38
LSD (0.05)	3	23	3	19	2	26

†Infection type described by Line and Qayoum (1992).