ORCF-101
CLEARFIELD* Soft White Winter Wheat

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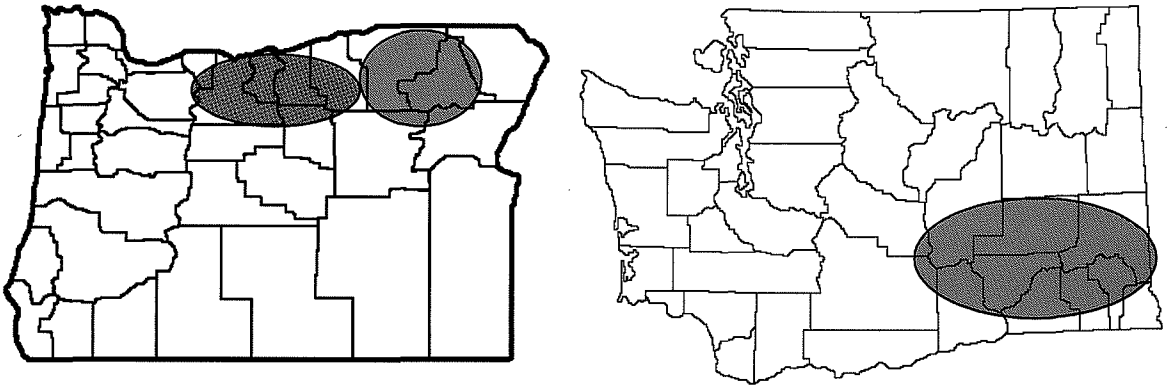
Variety Description:
'ORCF-101' is a common soft white winter wheat developed by Oregon State University and the BASF Corporation in cooperation with USDA-ARS. It is an awned, short-statured, semidwarf variety with midseason maturity and high yield potential. ORCF-101 is a non-GM wheat variety that carries a form of the acetolactate synthase (also known as acetohydroxyacid synthase) enzyme. The altered enzyme is not affected by imazamox, the active ingredient in Beyond™ herbicide and one of the active ingredients in Clearmax™ herbicide. When ORCF-101 is used in combination with Beyond™ or Clearmax™ at labeled rates, this CLEARFIELD* technology provides growers with an effective tool for control of several grassy weeds.

Area of Adaptation:



ORCF-101 is best adapted to the dryland wheat growing regions in Wasco, Sherman, Gilliam, and Morrow counties in Oregon (blue shaded regions). Secondary areas of adaptation (red shaded regions) for ORCF-101 are the general dryland wheat growing areas of eastern Oregon and southeastern Washington. In these secondary regions, performance of ORCF-101 is similar to other soft white winter wheat varieties. However, growers should consider a more disease resistant variety, such as ORCF-102, especially in high residue management situations. Moderate winterhardiness and susceptibility to snow mold restricts production of ORCF-101 in southeastern Washington to areas south of Highway 2.

Year Released:

ORCF-101 was released in 2003 and is protected under the Plant Variety Protection with the Title 5 option. ORCF-101 was released through Oregon State University's non-exclusive CLEARFIELD* variety licensing program. Foundation and Registered seed stocks may be sold only to those granted a license by OSU. Certified seed stocks may be used to plant a single commercial crop and may not be used to generate seed stocks for replanting. A signed BASF CLEARFIELD* wheat stewardship grower agreement is required prior to purchasing seed for planting.

Agronomic Characteristics:

Height and Lodging Resistance

In trials over 22 site-years in Oregon and 37 site-years in Washington, ORCF-101 has averaged 34.1 and 34.3 inches, respectively. This is similar to Madsen and approximately 2 inches shorter than Tubbs, Tubbs 06, and ORCF-102 (Tables 1 and 2). Straw strength of ORCF-101 is good and lodging has not been observed in any production environment.

Maturity

ORCF-101 is a mid-season maturing variety, similar to Tubbs, Tubbs 06, Madsen, and ORCF-102. It heads 2 days earlier than Madsen and approximately 1 to 2 days later than Stephens (Tables 1 and 2).

Vernalization and Cold Tolerance

ORCF-101 is a winter wheat that requires vernalization to initiate flowering. Results from crown freezing tests, a measure of cold tolerance, conducted by the USDA-ARS have shown that the cold tolerance of ORCF-101 is similar to Stephens. ORCF-101 is less cold tolerant than Tubbs, Tubbs 06, and slightly less than ORCF-102 (Table 3). However, under normal conditions growers in the Columbia Basin region of Oregon where ORCF-101 is best adapted are unlikely to observe winter injury during production of ORCF-101.

Disease Resistance

ORCF-101 is moderately susceptible to stripe and leaf rust, Septoria leaf blotch, and *Fusarium* crown rot (dryland foot rot). ORCF-101 is susceptible to *Cephalosporium* stripe, Strawbreaker (eyespot) footrot, and snow mold. A seed treatment is recommended to control bunt and other seedling diseases (Table 3).

Yield

ORCF-101 has been shown to have good yield potential across a range of environments in Oregon and Washington. Across 34 site-years of OSU variety testing, ORCF-101 averaged 85.8 bushels per acre as compared to 90.4, 87.6, 90.7, 86.0, and 92.1 bushels per acre for Tubbs, Stephens, ORCF-102, Madsen, and Westbred 528, respectively (Table 1). Similarly, in 55 site-years of WSU variety testing ORCF-101 averaged 101.3 bushels per acre as compared to 110.4, 101.1, 108.4, 102.1, and 104.5 bushels per acre

for Tubbs, Stephens, ORCF-102, Madsen, and Masami, respectively (Table 2). In its primary adaptation region of Wasco, Sherman, Gilliam, and Morrow counties, ORCF-101 averaged 69.6 bushels per acre, similar to ORCF-102 and 3 bushels per acre higher than Tubbs (Table 1). In the low to intermediate rainfall environments south of highway 2 in Washington, ORCF-101 averaged 71.3 bushels per acre, similar to Eltan and Madsen but 6 to 8 bushels lower than ORCF-102, Tubbs, and Masami (Table 2).

Test Weight and Quality

Test weight of ORCF-101 averaged 59.2 pounds per bushel across 24 site-years in Oregon and 59.1 pounds per bushel across 37 site-years in Washington. These test weights are similar to Stephens and Madsen. Test weight of ORCF-101 was approximately 0.5 pounds per bushel more than Tubbs or Tubbs 06 and 1 pound per bushel less than ORCF-102 (Tables 1 and 2). Grain protein of ORCF-101 averaged 10.1% in Oregon and 11.7% in Washington, similar to Stephens and Madsen.

Milling and baking evaluations from the Western Wheat Quality Laboratory and the Wheat Quality Council suggest that ORCF-101 is similar to Tubbs and acceptable for a soft white winter wheat. Grain hardness values for ORCF-101 averaged 6 points higher than Stephens and 3 points less than Tubbs when measured with the Pertin Single Kernel Characterization System (SCKS). Average break flour yields were similar to Stephens and Tubbs. Cookie baking performance is similar to Stephens and average 0.16 centimeters wider cookie spread than Tubbs. Flour swelling volume tests suggest ORCF-101 has normal starch properties (Table 4).

Development

ORCF-101 was derived from the three way cross 'CV-9804'/'Malcom'//'OR939481' made in 1996 and 1997 at the OSU Hyslop Field Research Farm. CV-9804, also known as 'FS-4', is the donor of the Clearfield trait developed through mutagenesis of the cultivar 'Fidel'. 'OR939481' is a selection from the cross 'Stephens'/'Madsen'. ORCF-101 is an F_2 derived line, identified as a single plant in 1999 when it was selected from a bulk plot at the Columbia Basin Agricultural Research Center. The selection was evaluated under the experimental number OR2010051.

Breeder and Foundation seed will be maintained by Washington State Crop Improvement Association (WSCIA). ORCF-101 is protected under U.S. Plant Variety Protection with the Title 5 option (PVP 200300286). Certification classes recognized for ORCF-101 include Foundation, Registered and Certified. Certified seed will be produced and sold only under non-exclusive license with Oregon State University. Commercial growers may not retain seed for purposes of planting or replanting. Seed stocks that fail to meet certification standards can not be sold as seed, nor used as seed. Seed of ORCF-101 has been deposited in the USDA National Small Grains Collection, Aberdeen, Idaho. It is requested that the source of this material be acknowledged in future use by wheat breeding and genetics programs.

Acknowledgements

Appreciation is extended to the Oregon Wheat Commission and BASF for financial support in the development of ORCF-101.

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Management Guidelines:

Planting Date

ORCF-101 has shown its highest yield potential in its primary adaptation zones with "on-time" plantings (Tables 1, 2, 5). Plantings in early to mid-October are considered "on-time" for much of Oregon.

Early planting of ORCF-101, prior to October 1 for most areas, is not recommended. Studies have documented the yields of ORCF-101 in early plantings are similar to varieties such as Tubbs and Stephens (Table 5). However early seeding increases the incidence of diseases such as *Fusarium* crown rot, strawbreaker (eyespot) foot rot, and *Cephalosporium* stripe as well as insect vectored diseases such as Barley Yellow Dwarf Virus. The relative susceptibility of ORCF-101 to these diseases increases the risks of significant yield reductions due in plantings prior to October 1.

In late plantings, yields of all varieties will be reduced compared to "on-time" plantings. ORCF-101 is a relatively poor choice for late plantings. Studies have shown that yields of ORCF-101 will be significantly reduced by 6 to 13 bushels per acre compared to ORCF-102, and Tubbs 06 (Table 5).

Seeding Rate

The recommended seeding rate for soft white winter wheat in Oregon is 22 seeds per square foot. For late planted wheat it is recommended that the seeding rate be increased to 33 seeds per square foot. Seeding rate trials have confirmed that these general recommendations are valid for ORCF-101 (Table 6).

Seeding rates for most equipment are adjusted in pounds per acre. To avoid heavy or light plantings, it is important to determine the proper seeding rate using the number of seeds per pound. Conversions for a range of seeds per pound are found in Table 7.

The number of seeds per pound depends on seed size and varies based on variety, production environment, and year. Research has shown the ORCF-101 will have a

higher number of seeds per pound compared to Stephens and Tubbs due to its lower kernel weight. The seeds per pound may be obtained from your seed dealer or determined by weighing a 50-seed sample and using Table 7.

Fertility

ORCF-101 has been grown across a wide range of environments and no special fertility requirements have been observed. Therefore, it is recommended that growers follow the recommended fertility guidelines for soft white winter wheat in their area.

Herbicide Applications

Postemergence applications of Beyond™ or Clearmax™ may be made in the fall/winter or spring to ORCF-101 after tiller initiation but before jointing. Apply Beyond™ (imazamox) at a rate of 4-6 oz/acre of product (0.031 to 0.047 lb ai/acre) or Clearmax™ (imazamox + MCPA ester co-pack) at a rate of 4-6 oz/acre Beyond™ + 8-12 oz/a (0.23 to 0.35 lb ae/a) MCPA ester. Beyond™ and Clearmax™ applications require the addition of a nonionic surfactant (0.25 % vol/vol) and a liquid nitrogen fertilizer (2.5 gallons/100 gallons of spray solution) or ammonium sulfate solution (12-15 lbs/100 gallons of spray solution) to the spray mixture. Do not use crop oil concentrate or methylated seed oil surfactants when making Beyond™ applications to ORCF-101 or injury will result. Beyond™ may be applied in a liquid fertilizer carrier as long as the liquid fertilizer/water solution is at least 50 % water. Do not tank mix Beyond™ and Clearmax™ with Group 2 sulfonylurea herbicides or unacceptable wheat injury may result. Review current Beyond™ and Clearmax™ labels for recommended tank mixture partners and mixing instructions.

Beyond™ and Clearmax™ will control or suppress many problem grass weed species in wheat production cropping systems including jointed goatgrass, downy brome, feral rye as well as many broadleaf weeds. Beyond™ or Clearmax™ should be applied to actively growing grass weeds in the 4-5 leaf stage and broadleaf weeds that are less than 3 inches tall. Refer to the weed control tables in the Beyond™ and Clearmax™ labels for more specific information on application timings, including fall timings, and recommended tank mixtures for specific problem weeds including feral rye, Italian ryegrass, wild oat and kochia. Further information on optimizing weed control utilizing CLEARFIELD technology may be found in:

> PNW Weed Management Handbook.
> Weed Management in Clearfield Wheat with Imazamox. EM 8833.
> Available online at:http://extension.oregonstate.edu.

Table 9 lists the plant back restrictions for some common rotation crops that could follow ORCF-101 wheat in OR. Review the Beyond™ or Clearmax™ labels for the full list of crop rotational intervals before electing to plant and making applications of Beyond™ or Clearmax™ to ORCF-101 to insure that future crop rotation goals can be achieved. For some oilseed crops newer to the region , such as safflower or camelina, not currently listed on the labels and for which the plant back intervals have yet to be determined the plant back interval is likely greater than 18 months and may be a long as 26 months.

Herbicide resistance management is a key consideration when utilizing CLEARFIELD* technology. Maintaining the utility of ALS-inhibiting Group 2 herbicides in wheat production cropping systems is crucial for increasing the longevity of this production technology. Thus, Oregon State University strongly advocates that growers follow the BASF stewardship recommendations outlined in the CLEARFIELD* Wheat Stewardship Guide. These recommendations include:

1) Do not plant ORCF-101 or any other CLEARFIELD* wheat variety continually and apply Beyond™ or Clearmax™ more than 2 out of every 4 years.
2) Limit the reliance on ALS-inhibiting herbicides and when applicable use herbicides with different modes-of-action.
3) Properly manage weeds in wheat-fallow-wheat rotations.
4) Treat the entire field with a labeled rate of Beyond™ or Clearmax™ for jointed goatgrass control.
5) Control jointed goatgrass in fencerows, road ditches, and pastures around CLEARFIELD* wheat fields.

In addition, the following two publications outline some strategies for slowing or preventing the development of herbicide resistant weed populations:

Management Strategies for Preventing Herbicide-Resistant Grass Weeds in Clearfield Wheat Systems. PNW 572.
Available at: http://info.ag.uidaho.edu/pdf/PNW/PNW0572.pdf.

Herbicide-Resistant Weeds and Their Management. PNW 437.
Available at: http://info.ag.uidaho.edu/pdf/PNW/PNW0437.pdf.

There are no grazing or feeding restrictions of wheat forage following applications of Beyond™. Do not graze or feed wheat forage to meat or dairy animals for 7 days following applications of Clearmax™.

Fungicide Applications

A fungicide application is unlikely to be necessary when growing ORCF-101. ORCF-101 is moderately susceptible to current races of stripe rust which provides adequate protection in the field under normal conditions. However, no sensitivity to current fungicides are known. When applying fungicides, follow label directions and all applicable state and federal regulations.

Yield Components:

Wheat yield can be broken down into three components; head number, kernels per head, and kernel weight. Both head number and kernels per head are determined early in wheat development, Feekes 2 – 5. Kernel weight is determined later in the growing season, Feekes 10.1 – 10.5. While environment plays an important role in yield determination, genetic factors heavily influence the way in which the three components combine to determine final wheat yield. In as such, total grain yield of ORCF-101 will be determined more by early factors influencing head size and head fertility than kernel

weight and head number. ORCF-101, as compared with widely grown varieties such as Tubbs and Stephens can be characterized by low to average head numbers, a large head size, high head fertility, and lower average kernel weights (Table 8).

Table 1. Grain yield and agronomic data for 11 soft white winter wheat varieties grown across a range of environments in Oregon.

Variety	Grain Yield				Agronomic Data			
	Sherman, Gilliam, and Morrow Counties		OWEYT		Test Weight	Grain Protein	Plant Height	Heading Date
	2-Year Mean	3-Year Mean	2-Year Mean	3-Year Mean	2-Year Mean	2-Year Mean	2-Year Mean	2-Year Mean
	8-Site Years	13-Site Years	24-Site Years	34-Site Years	24-Site Years	22-Site Years	22-Site Years	8-Site Years
	bu/ac	bu/ac	bu/ac	bu/ac	lbs/bu	%	in	DOY
ORCF-101	62.5	69.6	84.0	85.8	59.2	10.1	34.1	145.5
Brundage 96	64.8	68.4	88.8	89.0	59.1	9.5	33.2	145.4
Gene	57.5	67.5	78.0	83.3	57.9	10.5	30.4	141.6
Goetze	64.6	69.5	87.7	91.4	58.9	9.7	31.8	141.9
Madsen	61.6	65.9	84.9	86.0	59.2	10.3	34.1	147.5
Masami	69.6	70.4	89.6	88.9	58.7	9.4	35.8	148.7
ORCF-102	66.9	69.6	92.0	90.7	60.2	9.8	36.3	145.7
Stephens	62.1	67.9	86.6	87.6	59.0	10.1	33.7	144.3
Tubbs	62.6	66.6	89.8	90.4	58.7	9.6	36.7	146.1
Tubbs-06	64.9		91.8		58.8	9.6	37.0	145.7
Westbred 528	65.8	69.8	90.7	92.1	60.8	9.9	33.9	142.9
Mean	63.9	68.5	87.6	88.5	59.1	9.9	34.3	145.0
LSD (0.05)	3.3	2.9	3.2	2.6	0.4	0.3	0.6	0.7
CV (%)	8.7	9.3	11.2	10.8	2.1	7.0	4.9	0.9

Table 2. Grain yield and agronomic data for 10 soft white winter wheat varieties grown across a range of environments in Washington.

Variety	Grain Yield				Agronomic Data			
	Low to Intermediate Rainfall Zone South of Highway 2		WSU Variety Trials		Test Weight	Grain Protein	Plant Height	Heading Date
	2-Year Mean	3-Year Mean	2-Year Mean	3-Year Mean	2-Year Mean	2-Year Mean	2-Year Mean	2-Year Mean
	12-Site Years	17-Site Years	37-Site Years	55-Site Years	37-Site Years	37-Site Years	37-Site Years	37-Site Years
	bu/ac	bu/ac	bu/ac	bu/ac	lbs/bu	%	in	DOY
ORCF-101	67.3	71.3	96.2	101.3	59.1	11.7	34.3	152.1
Brundage 96	70.7	74.4	101.7	103.8	58.5	11.1	33.3	152.5
Eltan	72.3	71.1	99.3	97.7	59.3	11.2	36.2	157.0
Madsen	70.0	72.8	98.4	102.1	59.1	11.6	34.6	154.9
Masami	76.3	79.5	102.0	104.5	58.1	10.9	35.3	156.4
ORCF-102	75.9	77.5	105.3	108.4	59.9	11.3	36.2	152.6
Stephens	66.5	69.0	97.7	101.1	58.9	11.4	32.8	150.6
Tubbs	74.4	78.6	107.5	110.4	58.5	10.8	36.1	152.5
Tubbs-06	71.0		103.7		58.3	11.1	36.4	153.1
Westbred 528	66.7	67.5	101.1	102.4	60.8	11.3	33.5	149.4
Mean	71.1	73.5	101.3	103.5	59.0	11.2	34.9	153.1
LSD (0.05)	3.4	3.0	2.4	2.1	0.2	0.2	0.4	0.3
CV (%)	12.0	12.0	10.5	10.9	1.7	6.8	4.7	0.8

Table 3. Agronomic and disease ratings for 12 soft white winter wheat varieties grown in Oregon and Washington.

Variety	Maturity	Winter Hardiness*	Rust†		Septoria†	Crown Rot†	Cephalosporium Stripe†	Strawbreaker Foot-Rot† *Pseudocercosporella*
			Stripe	Leaf				
ORCF-101	Mid-Season	3	MS	MS	MS	MS/MR	S	S
Brundage 96	Mid-Season	5	MR	MS	S	MR	MR/MS	S
Eltan	Mid-Late	10						
Gene	Early	2	MR/MS	S	S	MR	MS	MS/MR
Goetze	Early-Mid	2	R	MR	MR	MR/MS	MS	MR
Madsen	Mid-Season	5	R	MR	MS	MR/MS	MR	R
Masami	Mid-Season	5	MS		S	MR	MR/MS	
ORCF-102	Mid-Season	4	R/MR	MR	MS	MR/MS	MR/MS	R
Stephens	Early-Mid	3	R	S	S	S	S	S
Tubbs	Mid-Season	5	MS	MS	MS	S	S	R
Tubbs-06	Mid-Season	5	MR/MS	MS	MS	S	S	R
Westbred 528	Early-Mid	4	MS	MS	S	MR	S	S

* Scale: 1 to 10, with 10 being excellent and 1 being poor.

† Scale: R = Resistant; MR = Moderately Resistant; MS = Moderately Susceptible; S = Susceptible

Data is complied from the following sources: Winter Grain Varieties for 2003, Special report 775, Oregon State University Extension Service; 2004 through 2007 Oregon Winter Elite Yield Trial Disease Ratings; and variety Characteristics, Washington State Crop Improvement Association.

Table 4. End-use quality analyses of ORCF-101 soft white winter wheat in paired comparisons with Stephens and Tubbs. Data provided by USDA-ARS Western Wheat Quality Lab.

Variety	Kernel Hardness	Break Flour Yield	Flour Yield	Flour Ash	Milling Score	Flour Protein	Mix Absorption	Cookie Diameter
	SKCS	%	%	%		%	%	mm
ORCF-101	42.1*	47.4	68.5	0.43*	81.1	9.0	56.0	9.34
Stephens	36.0	47.8	69.1*	0.41	83.1*	9.3	56.0	9.32
ORCF-101	43.3	47.7	69.0	0.43	81.5	8.9	55.9	9.34*
Tubbs	46.5*	48.4	68.9	0.45	80.6	8.6	55.7	9.18

* indicates a statistically significant increase ($p < 0.05$) based on a paired t-test.

Table 5. Grain yield of seven soft white winter wheat varieties in a planting date study at Moro Oregon in 2006 and 2007.

Planting Date	Variety								
	Stephens	Madsen	Tubbs	Tubbs-06	ORCF-101	ORCF-102	Goetze	Skiles	LSD $_{(0.05)}$
	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac
	2006								
September 12	72.2	59.2	70.3		67.0	71.6	75.3		8.4
October 3	74.8	69.7	74.7		76.0	73.7	80.1		3.3
November 20	45.8	43.5	50.5		48.7	55.2	42.8		4.5
	2007								
September 12	84.6			90.4	87.8	88.3	85.8	89.3	7.9
October 3	90.3			92.3	91.6	90.1	94.8	88.9	9.5
October 27	66.3			71.3	70.8	70.9	67.0	63.3	5.4
November 20	53.5			66.4	52.6	63.9	64.2	67.9	7.0

Table 6. Grain yield of ORCF-101 across three seeding rates at Moro and Pendleton Oregon in 2007.

Planting Date	Seeding Rate (seeds/ft^2)			
	11	22	33	LSD $_{(0.10)}$
	bu/ac	bu/ac	bu/ac	bu/ac
	Moro			
October 3	93.3	87.7	93.8	26.1
October 27	61.6	74.8	76.1	6.8
November 20	43.7	55.8	58.5	8.5
	Pendleton			
October 3	74.3	81.3	84.1	21.1
October 27	59.9	67.1	73.7	16.9
November 20	44.4	49.2	53.4	12.7

Table 7. Seeding rate conversion from seeds per square foot to pounds per acre.

Seeds per Pound	Weight of 50 Seed Sample (g)	Seeding Rate (pounds/ac)	
		22 seeds/ft^2	33 seeds/ft^2
8,000	2.84	120	180
9,000	2.52	106	160
10,000	2.27	96	144
11,000	2.06	87	131
12,000	1.89	80	120
13,000	1.75	74	110
14,000	1.62	68	103
15,000	1.51	64	96

Table 8. Yield component comparison of ORCF-101, Stephens and Tubbs/Tubbs-06.

Yield Component	Variety Comparison
Head Number	ORCF-101 < Tubbs/Tubbs-06 < Stephens
Head Size	Stephens < Tubbs/Tubbs-06 < ORCF-101
Head Fertlity	Tubbs/Tubbs-06 < Stephens ≤ ORCF-101
Kernel Weight	ORCF-101 ≤ Tubbs/Tubbs-06 < Stephens

Table 9. Partial Listing of Rotational Crop Plant Back Intervals Following Beyond™ and Clearmax™ Applications

Plant Back Interval (Months)	Crop(s)
0	CLEARFIELD* Wheat, CLEARFIELD* Sunflower, CLEARFIELD* Canola, Dry Beans, Dry Peas
3	Alfalfa, Wheat (non- CLEARFIELD*)
4	Cereal Rye
8.5	Corn (CLEARFIELD* and non- CLEARFIELD* pop, sweet, field, and seed)
9	Barley[1], Oat, Onion, Sunflowers, Peanut, Watermelon
18	Barley[1], Carrot, Potato
26	Canola, Condiment Mustards, Sugar Beet, Table Beet

[1] See Beyond™ or Clearmax™ labels for soil pH, tillage system and cumulative rainfall and/or irrigation requirements that most closely approximate your production system to determine the appropriate barley plant back interval.

Figure 1. Picture of ORCF-101 wheat.

Evidence of Uniformity and stability

ORCF-101 has been observed to be uniform and stable. In 2001 and 2002, uniformity and stability were evaluated in 15 replicated yield trials throughout Oregon and Idaho.

ORCF-101 may contain up to 5 red kernels per pound in Breeders, Foundation, Registered, or Certified classes of seed multiplication. ORCF-101 also may contain up to a total of 1 in 10,000 combined of the naturally occurring variants: plants that are 8 to 15 cm taller or plants with bronze (red or tan) chaff spikes. These variants described are distinct within the variety and are stable and predictable with a degree of reliability comparable to other varieties of the same kind, and within recognized tolerances, when the variety is reproduced or reconstructed, and was originally part of the variety when released.

To further determine variants in kernel color, a phenol staining reaction was determined. It was observed that 38% of the kernels stained are ivory, 7% are fawn, and 55% are light brown. No brown or brown-black staining kernels were observed.