New Wheat Varieties

ORCF-101

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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 (genetically modified) wheat variety that carries an altered 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 dryland wheat-growing regions in Wasco, Sherman, Gilliam, and Morrow counties in Oregon (Figure 1a, blue-shaded regions). Secondary areas of adaptation (red-shaded regions) are the general dryland wheat-growing areas of eastern Oregon and southeastern Washington (Figure 1a and 1b).

In secondary adaptation regions, performance of ORCF-101 is similar to that of other soft white winter wheat varieties.

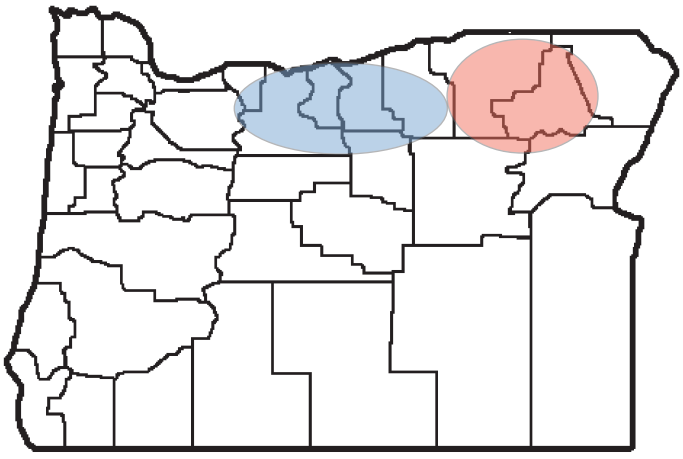

Figure 1a. Region of Oregon where ORCF-101 wheat can be grown (red) and region where ORCF-101 is best adapted (blue).

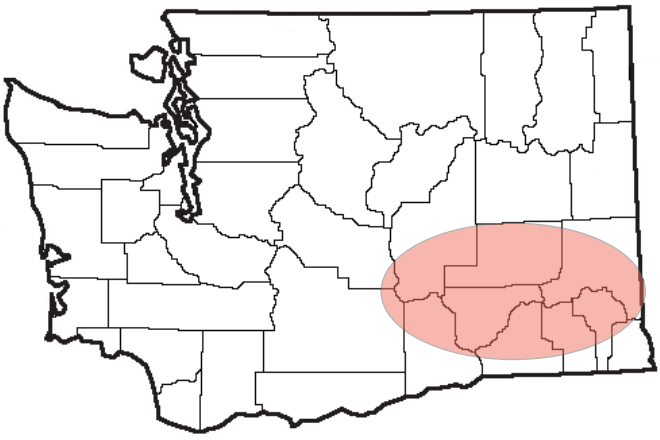

Figure 1b. Region of Washington where ORCF-101 wheat can be grown (red).

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However, growers should consider a more disease-resistant variety, such as ORCF-102, especially in high-residue-management situations. ORCF-101's moderate winter hardiness and susceptibility to snow mold restrict its production in southeastern Washington to areas south of Highway 2.

Figure 2. Greg Vollmer in an ORCF-101 wheat field.

Year released

ORCF-101 was released in 2003 and is protected under the Plant Variety Protection Act with the Title 5 option. ORCF-101 was released through Oregon State University's nonexclusive CLEARFIELD variety licensing program.

Table 1. Grain yield and agronomic data for 11 soft white winter wheat varieties grown across a range of environments in Oregon, 2005–2007.

	Grain yield				Agronomic data			
	Sherman, Gilliam, and Morrow counties		OWEYT*		Test weight	Grain protein	Plant height	Heading date
Variety	2-year mean 8 site-years (bu/ac)	3-year mean 13 site-years (bu/ac)	2-year mean 24 site-years (bu/ac)	3-year mean 34 site-years (bu/ac)	2-year mean 24 site-years (lb/bu)	2-year mean 22 site-years (%)	2-year mean 22 site-years (in)	2-year mean 8 site-years (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
	8.7	9.3	11.2	10.8	2.1	7.0	4.9	0.9

*Oregon Winter Elite Yield Trial

**Day of year

***Least significant difference

Agronomic characteristics

Height and lodging resistance

In trials over 22 site-years in Oregon and 37 site-years in Washington, plant height of ORCF-101 has averaged 34.1 and 34.3 inches, respectively. Height is similar to that of 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 midseason-maturing variety, similar to Tubbs, Tubbs-06, Madsen, and ORCF-102. It heads 2 days earlier than Madsen and approximately 1 or 2 days later than Stephens (Tables 1 and 2).

Table 2. Grain yield and agronomic data for 10 soft white winter wheat varieties grown across a range of environments in Washington, 2005–2007.

	Grain yield				Agronomic data			
	Low to intermediate rainfall zone south of Highway 2		WSU variety trials		Test weight	Grain protein	Plant height	Heading date
Variety	2-year mean 12 site-years (bu/ac)	3-year mean 17 site-years (bu/ac)	2-year mean 37 site-years (bu/ac)	3-year mean 34 site-years (bu/ac)	2-year mean 24 site-years (lb/bu)	2-year mean 22 site-years (%)	2-year mean 22 site-years (in)	2-year mean 8 site-years (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

*Day of year

**Least significant difference

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 that of Stephens. ORCF-101 is less cold tolerant than Tubbs and Tubbs-06, and slightly less cold tolerant 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.

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) foot rot, and snow mold (Table 3). A fungicide seed treatment is recommended to control common bunt and other seed-borne diseases.

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, 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,

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	*Midseason*	*3*	*MS*	*MS*	*MS*	*MS/MR*	*S*	*S*
Brundage 96	Midseason	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	Midseason	5	R	MR	MS	MR/MS	MR	R
Masami	Midseason	5	MS	—	S	MR	MR/MS	—
ORCF-102	Midseason	4	R/MR	MR	MS	MR/MS	MR/MS	R
Stephens	Early–mid	3	R	S	S	S	S	S
Tubbs	Midseason	5	MS	MS	MS	S	S	R
Tubbs-06	Midseason	5	MR/MS	MS	MS	S	S	R
Westbred 528	Early–mid	4	MS	MS	S	MR	S	S

*Scale: 1–10 (10 = excellent; 1 = poor)

**R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible

Data were compiled 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.

in 55 site-years of WSU variety testing, ORCF-101 averaged 101.3 bushels per acre, 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 (Oregon), 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 those for Stephens and Madsen. Test weight of ORCF-101 was approximately 0.5 pound 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 percent in Oregon and 11.7 percent in Washington, similar to Stephens and Madsen.

Milling and baking evaluations from the USDA-ARS Western Wheat Quality Laboratory and the PNW 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 (SKCS). Average break flour yields were similar to those for Stephens and Tubbs. Cookie baking performance was similar to Stephens, with an average cookie spread 0.16 millimeter wider than Tubbs (Table 4). Flour swelling volume tests suggest ORCF-101 has normal starch properties.

Table 4. End-use quality analyses of ORCF-101 soft white winter wheat in paired comparisons with Stephens and Tubbs.

Variety	Kernel hardness (SKCS)*	Break flour yield (%)	Flour yield (%)	Flour ash (%)	Milling score	Flour protein (%)	Mix absorption (%)	Cookie diameter (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

*Single Kernel Characterization System

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

Data provided by USDA-ARS Western Wheat Quality Laboratory, Pullman, Washington.

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, Pendleton, Oregon. The selection was evaluated under the experimental number OR2010051.

Seed availability

Breeder and Foundation seed will be maintained by the 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. Seed stocks that fail to meet certification standards cannot be sold as seed, nor used as seed.

Foundation and Registered seed stocks may be sold only to those granted a license by OSU. Certified seed will be produced and sold only under nonexclusive license with Oregon State University. 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.

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 use by wheat breeding and genetics programs.

Acknowledgments

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Variety development team

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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 in most areas, is not recommended. Studies have documented yields of ORCF-101 in early plantings that are similar to yields of 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 risk of significant yield reductions in plantings made before October 1.

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

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

Planting date	Stephens (bu/ac)	Madsen (bu/ac)	Tubbs (bu/ac)	Tubbs-06 (bu/ac)	ORCF-101 (bu/ac)	ORCF-102 (bu/ac)	Goetze (bu/ac)	Skiles (bu/ac)	$LSD_{(0.05)}$* (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

*Least significant difference

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, which varies depending on variety, production environment, and year. Research has shown that ORCF-101 has more seeds per pound than Stephens and Tubbs due to its lower kernel weight. Seeds per pound may be obtained from your seed dealer or can be determined by weighing a 50-seed sample and using Table 7.

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

	Seeding rate (seeds/ft²)			
Planting date	11 (bu/ac)	22 (bu/ac)	33 (bu/ac)	$LSD_{(0.10)}$* (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

*Least significant difference

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

		Seeding rate	
Seeds per pound	Weight of 50-seed sample (g)	Pounds per acre needed for 22 seeds/ft²	Pounds per acre needed for 33 seeds/ft²
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

Fertilization

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 in spring after tiller initiation but before jointing. Rates are as follows:

- Beyond (imazamox): 4–6 oz/acre of product (0.031–0.047 lb ai/acre)
- Clearmax (imazamox + MCPA ester co-pack): 4–6 oz/acre Beyond + 8–12 oz/acre (0.23–0.35 lb ae/acre) MCPA ester

Observe the following precautions regarding tank mixing:

- Beyond and Clearmax applications require the addition of a nonionic surfactant (0.25% vol/vol) and a liquid nitrogen fertilizer (2.5 gal/100 gal of spray solution) or ammonium sulfate solution (12–15 lb/100 gal 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, as these mixtures will injure wheat plants.
- Beyond may be applied in a liquid fertilizer carrier as long as the liquid fertilizer/water solution is at least 50 percent water.
- Do not tank mix Beyond and Clearmax with Group 2 sulfonylurea herbicides, as 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, and feral rye, as well as many broadleaf weeds. Apply Beyond or Clearmax to actively growing grass weeds in the 4–5 leaf stage and to broadleaf weeds that are less than 3 inches tall. Refer to the weed control tables on 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.

Do not apply Beyond or Clearmax when cold, wet weather is expected within 1 week following application. Reduced weed control efficacy and crop injury may occur when maximum daytime temperatures are less than 40°F after application.

Further information on optimizing weed control utilizing CLEARFIELD technology may be found in the following:

- *PNW Weed Management Handbook*
- *Weed Management in Clearfield Wheat with Imazamox,* EM 8833

Both publications are available online at *http://extension.oregonstate.edu/catalog/*

Table 8 lists the plant-back restrictions for some common rotation crops that could follow ORCF-101 wheat in Oregon. Before planting ORCF-101

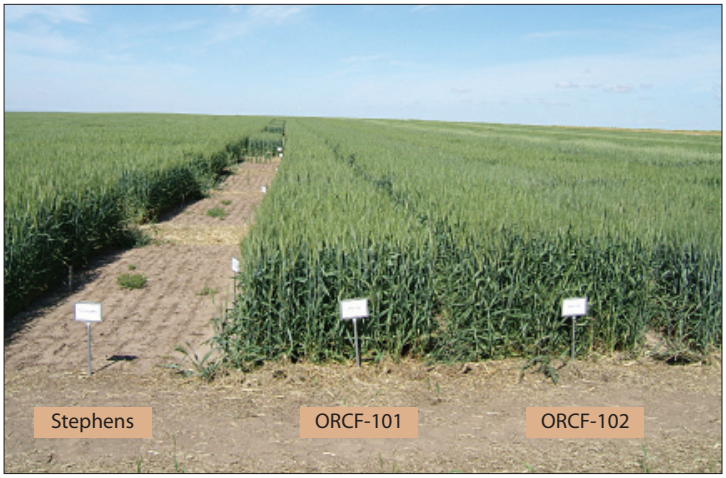

Figure 3. Stephens, ORCF-101, and ORCF-102 after application of Beyond herbicide.

and making applications of Beyond or Clearmax, review the most current labels for the full list of crop rotational intervals to ensure that future crop rotation goals can be achieved. Herbicide label changes are common, and plant-back restrictions are adjusted frequently to reflect the effects of cropping system management (e.g., tillage and irrigation practices) on the potential for herbicide carryover in specific regions.

Table 8. 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, sunflower, 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.

Some oilseed crops newer to the region, such as safflower or camelina, are not currently listed on the labels. Plant-back intervals for these crops have yet to be determined, but are likely to be greater than 18 months and perhaps as 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 the following:

- 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.
- Limit the reliance on ALS-inhibiting herbicides. When applicable, use herbicides with different modes of action.
- Properly manage weeds in wheat–fallow–wheat rotations.
- Treat the entire field with a labeled rate of Beyond or Clearmax for jointed goatgrass control.
- Control jointed goatgrass in fence rows, road ditches, and pastures around CLEARFIELD wheat fields.

In addition, the following publications outline 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. http://info.ag.uidaho.edu/pdf/PNW/PNW0572.pdf
- *Herbicide-Resistant Weeds and Their Management*, PNW 437. http://info.ag.uidaho.edu/pdf/PNW/PNW0437.pdf

There are no restrictions on grazing or feeding 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 foliar fungicide application is unlikely to be necessary when growing ORCF-101. ORCF-101 is only moderately susceptible to current races of stripe rust, which provides adequate protection under normal conditions. However, no sensitivity to current fungicides is known. When applying fungicides, follow label directions and all applicable state and federal regulations.

Yield components

Wheat yield consists of three components: head number, kernels per head, and kernel weight. Both head number and kernels per head are determined early in wheat development, at Feekes 2–5. Kernel weight is determined later in the growing season, at Feekes 10.1–10.5.

Although environment plays an important role in yield, genetic factors heavily influence the ways in which the three components combine to determine yield. Total grain yield of ORCF-101 is determined more by early factors influencing head size and head fertility than by kernel weight and head number. Compared to widely grown varieties such as Tubbs and Stephens, ORCF-101 is characterized by low to average head numbers, large head size, high head fertility, and low to average kernel weights (Table 9).

Table 9. 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 fertility	Tubbs/Tubbs-06 < Stephens ≤ ORCF-101
Kernel weight	ORCF-101 ≤ Tubbs/Tubbs-06 < Stephens

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