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Performance of Hard Red Winter Wheat in Late-Planted Fallow

Field Research in the Low-Precipitation Zone

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Soft white winter wheat is grown almost exclusively throughout the Pacific Northwest, except in the low precipitation zone of north-central Oregon and south-central Washington (Figure 1). In this region, hard red winter wheat is an attractive option because it helps growers achieve minimum grain protein goals, which increases the wheat's market value, without applying cost-prohibitive quantities of nitrogen fertilizer. Nitrogen inputs are relatively low because the water stress that occurs during much of the growing season limits yield potential.

Maximum winter wheat grain yield is usually produced during years when early planting (late August to the second or third week of September) is possible. Late planting, normally conducted in mid- to late October, may reduce yield; in some years or locations, this reduction can be very significant, with losses of 5 to 15 bu/ac or more. Even so, growers sometimes find themselves in a situation where planting must be delayed.

Delayed planting is commonly used to minimize the risk associated with diseases such as dryland foot rot or insect-vectored viruses such as cereal yellow dwarf (CYD), barley yellow dwarf (BYD), and wheat streak mosaic (WSM). Some farmers wait for October rainfall, the subsequent growth of winter annual grasses, and the opportunity to spray them out before planting. Planting of no-till fallow is frequently delayed because seed-zone moisture is inadequate for germination and emergence of winter wheat during optimum (early) planting dates. The yield reduction associated with late planting can be offset, to some extent, by placing sufficient fertilizer below and beside the seed while planting and by selecting a well-adapted cultivar. This publication is a summary of field research designed to identify cultivars of hard red winter wheat that perform reasonably well when planted late in the fall.

Figure 1. Hard red winter wheat production in north-central Oregon and south-central Washington occurs on plateaus and uplands bisected by ravines, canyons, or drainages. Most soils are silt loams or very fine sandy loams formed in windblown loess and range in depth from moderately deep to deep. Precipitation is limited (7 to 10 inches annually); the frost-free period varies from 140 to 170 days; and summers are dry, hot, and windy.

Methods

Location of Research and Growing Conditions

Field research was conducted in Morrow County, Oregon during the 2012–2013, 2013–2014, and 2014–2015 crop years. In each year, there was one

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research site with 33 plots (11 cultivars replicated three times) in a randomized complete block design.

Research sites were 4 to 10 miles north-northeast of Lexington, Oregon, and 1,200 to 1,500 feet above sea level (Figure 2). Growing conditions are summarized in Table 1.

Cultivar Selection

Cultivars (table 2) from Colorado State University were selected because of their reported tolerance to drought. Cultivars from Montana State University were chosen because they have solid stems and are more tolerant of the wheat stem sawfly, which may be an emerging pest problem. Some cultivars were used because they are commonly grown in either north-central Oregon or south-central Washington and are the basis for comparison.

Others were included in this experiment because they performed well in previous variety testing programs conducted by Oregon State University and Washington State University.

Figure 2. Research sites were 4 to 10 miles north-northeast of Lexington, Oregon, and 1,200 to 1,500 feet above sea level. Growing conditions are summarized in Table 1.

Table 1. Soil characteristics, soil water content, and crop-year precipitation for 2012–2013, 2013–2014, and 2014–2015 field experiments

Crop year	Soil name[1]	Soil depth (ft)	AWHC[2] (in.)	pH[3]	Organic matter[3] (%)	Soil water content[4] (in.)	Crop-year precipitation (in.)
2012–2013	Mikkalo	4	9.6	7.8	1.3	2.5	8.5
2013–2014	Willis	4	9.1	7.4	1.1	2.0	7.9
2014–2015	Ritzville	6	12.5	7.6	1.0	2.0	6.2

[1] Mikkalo, Willis, and Ritzville silt loams are representative of soils found in north-central Oregon and south-central Washington.

[2] Available water-holding capacity (AWHC) of the soil profile.

[3] Organic matter and pH samples collected from the top 12 inches of soil.

[4] Plant-available water content of the soil profile was determined 2 weeks before planting.

Table 2. Description of cultivars used in 2012–2013, 2013–2014, and 2014–2015 field experiments

Cultivar	Class[1]	Release date	Originator
AgriPro Whetstone	HRWW	2008	AgriPro Syngenta
Bearpaw	HRWW	2011	Montana State University
Brawl CL Plus	HRWW	2011	Colorado State University
Byrd	HRWW	2011	Colorado State University
Farnum	HRWW	2008	Washington State University
Judee	HRWW	2011	Montana State University
LCS Azimut	HRWW	2011	LCS Limagrain
Norwest 553	HRWW	2007	Oregon State University
Sprinter[2]	HRWW	2014	Washington State University
WB-Arrowhead	HRWW	2011	WestBred
AgriPro Legion[3]	*SWWW*	*2008*	*AgriPro Syngenta*

[1] HRWW = hard red winter wheat.

[2] Sprinter can grade as a hard red spring wheat; classification is a function of environmental conditions.

[3] SWWW = soft white winter wheat; used as a local reference cultivar.

Planting, Fertilizing, and Pest Control

Fungicide-treated seed was planted (24 seeds/ft²) about 1 inch deep in late October or early November after 15 months of no-till fallow. Varieties were planted in plots that were 7 feet wide and 120 feet long. Planting and fertilizing were accomplished with a customized plot drill designed to place fertilizer below and beside the seed (Figure 3).

Urea fertilizer (46-0-0) was applied at rates that would bring the total nitrogen supply (fertilizer plus residual nitrogen in the soil) to 80 lb/ac (Table 3). Phosphorus and sulfur fertilizers were not applied because soil test results revealed non-yield-limiting levels of both nutrients. Extension publications from Oregon State University and Washington State University provide additional information about fertilizer recommendations for dryland winter wheat (see "For More Information," page 6). Cooperating farmers used labeled rates of approved herbicides (Beyond was not used in plots of Brawl CL Plus) to achieve optimum weed control, and plots showed no symptoms of insect or disease pressure.

Data Collection

Early season biomass and yield components were determined from samples collected along 3 feet of row in each plot. Samples for early season dry matter production were collected in mid- to late April. Samples for yield components were collected 2 to 4 days before harvest.

Wheat was harvested from each plot using a research combine (Figure 4). Grain yield was calculated from the weight of harvested grain. Test weight was determined with a 1-pint filling hopper, funnel, and handheld density tester. Grain yield and test weight were adjusted to 10 percent moisture. Grain protein content was estimated by using near-infrared spectroscopy. Data, presented as an average from all three years, was analyzed using the ANOVA option in the Statistix 8 program.

Results

Early Season Biomass

Brawl CL Plus, a two-gene Clearfield wheat from Colorado State University, matures rapidly. Early season biomass was about double the biomass produced by traditionally grown cultivars in north-central Oregon (Norwest 553) and south-central

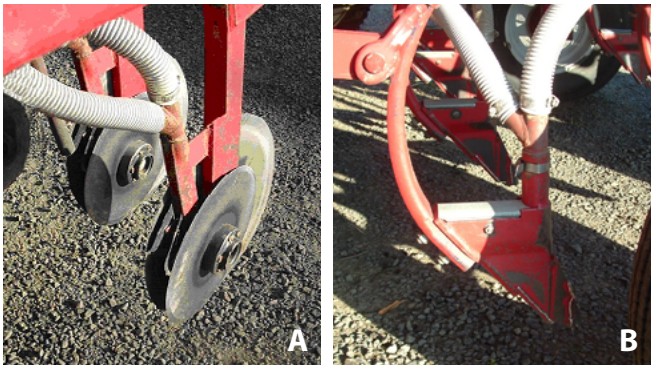

Figure 3. The customized Fabro drill places fertilizer below and beside the seed using double disc blades (A). Double disc blades are mounted on a separate gang in front of narrow, hoe-type (atom jet) seed openers (B) on 12-inch row spacing.

Table 3. Early season biomass of hard red winter wheat cultivars

Cultivar	Early season biomass (lb/ac)
AgriPro Whetstone	2,469
Bearpaw	2,397
Brawl CL Plus	**4,860**
Byrd	3,714
Farnum	2,507
Judee	2,972
LCS Azimut	2,349
Norwest 553	2,264
Sprinter	2,928
WB-Arrowhead	2,850
AgriPro Legion[1]	2,744
Site average	*2,914*
$LSD_{(0.01)}$[2]	*512*
CV (%)[3]	*31.0*

[1] AgriPro Legion is a soft white winter wheat reference cultivar.

[2] Least significant difference ($P \leq 0.01$). Highlighted number(s) within a column are maximum and statistically similar values. Values are a 3-year average.

[3] Coefficient of variation.

Figure 4. Wheat was harvested from the center of each plot with a research combine equipped with a 5-foot cutting platform. Plots were 7 feet wide and 120 feet long.

Washington (Farnum). It was also 1,946 lb/ac greater than the overall site average. Norwest 553 produced the least amount of biomass. Reduced biomass of Norwest 553 is an outcome of winterkill resulting from near-zero temperatures without snow cover in December 2013.

» **Norwest 553 in not a cold-tolerant cultivar. Without snow cover, fields of Norwest 553 will be susceptible to winterkill.**

Yield Components and Grain Yield

Farnum had more heads than any of the other cultivars (Table 4). The number of kernels per head ranged from 27 for Farnum to 40 for Norwest 553 and LCS Azimut. The number of kernels per head for AgriPro Whetstone, Brawl CL Plus, and WB-Arrowhead was statistically similar ($P \leq 0.01$) to that measured in plots of LCS Azimut and Norwest 553. Brawl CL Plus, Sprinter, and WB-Arrowhead had the greatest kernel weight. Lower values were obtained from samples of AgriPro Whetstone, Bearpaw, Byrd, Farnum, Judee, LCS Azimut, and Norwest 553.

» **Millers are usually interested in kernel weight because it positively correlates to the quantity of flour extracted from grain.**

Reduced kernel weight is common in cultivars that produce a large number of kernels per head. This was not true for Brawl CL Plus and WB-Arrowhead, which had greater-than-average values for both traits.

The average grain yield of all HRWW cultivars was 24.9 bu/ac (Table 4). Norwest 553 yielded 24.0 bu/ac. Lower yields were produced by Farnum and the two solid-stem cultivars (Bearpaw and Judee) that are popular in Montana. Brawl CL Plus and Byrd produced the highest yield, approximately 3 to 4 bu/ac more than AgriPro Whetstone and WB-Arrowhead.

Test Weight and Protein Content of Harvested Grain

Grain test weight ranged from 57.3 lb/bu for LCS Azimut to 62.9 lb/bu for Brawl CL Plus (Table 3, page 3). The test weight of LCS Azimut, like Farnum, was less than the preferred benchmark value of 60 lb/bu.

Table 4. Yield components, grain yield, test weight, and grain protein content of hard red winter wheat cultivars.[1]

Cultivar	Number of heads[2]	Kernels per head	Kernel weight[3] (grams)	Grain yield (bu/ac)	Test weight (lb/bu)	Protein content (%)
AgriPro Whetstone	88	**36**	29.4	25.4	61.8	12.5
Bearpaw	83	34	30.1	22.2	61.6	**13.2**
Brawl CL Plus	85	**38**	**35.0**	**29.5**	**62.9**	12.0
Byrd	95	35	30.2	**28.2**	61.3	11.0
Farnum	**111**	27	28.1	22.6	58.7	13.0
Judee	89	29	31.2	22.7	61.7	**13.5**
LCS Azimut	95	**40**	24.6	24.6	57.3	12.4
Norwest 553	77	**40**	29.4	24.0	60.7	**13.1**
Sprinter	91	31	**32.2**	24.1	60.4	12.9
WB-Arrowhead	84	**36**	**32.5**	25.2	62.0	12.6
AgriPro Legion	82	34	**33.4**	25.0	58.1	**13.3**
Site average	*89.1*	*34.5*	*30.6*	*24.9*	*60.6*	*12.7*
$LSD_{(0.01)}$[4]	*7.3*	*4.4*	*3.7*	*2.5*	*0.9*	*0.5*
CV(%)[5]	*20.4*	*18.4*	*15.8*	*15.1*	*3.9*	*8.8*

[1] AgriPro Legion is a soft white winter wheat reference cultivar. Highlighted number(s) within a column are maximum and statistically similar values. Values are a 3-year average.

[2] Number of heads in 3 ft of row.

[3] Weight of 1000 kernels.

[4] Least significant difference ($P \leq 0.01$).

[5] Coefficient of variation.

Average grain protein content of HRWW cultivars was 12.6 percent. Lower-yielding Bearpaw, Judee, and Norwest 553 had the highest grain protein values. Less-than-average grain protein values were measured in samples from plots of the two higher yielding cultivars from Colorado (Brawl CL Plus and Byrd).

Summary and Recommendations

There were no significant interactions between year and cultivar, indicating that overall trends for yield, test weight, and grain protein content stayed consistent during each year of this 3-year field experiment. Brawl CL Plus and Byrd were the highest yielding cultivars in these trials, with Brawl CL Plus having the greatest number of kernels per head. Grain of Brawl CL Plus had a high kernel and test weight and an acceptable protein content. Grain of Byrd had near-average kernel weight and met standard test weight values (greater than 60 lb/bu), but the grain protein content of Byrd was less than the required minimum (11.5 percent) for making protein.

Brawl CL Plus and Byrd matured rapidly in the spring, and they were ready to be harvested 2 to 3 weeks before any other cultivar. Rapid maturity is a desirable trait in water-stressed environments because it often allows wheat to produce grain before the onset of a late-season water shortage. The major risk associated with Brawl CL Plus and other rapidly maturing cultivars is that they are much more susceptible to damage from a late-spring frost, which did not occur during this research trial. Farmers who are interested in growing Brawl CL Plus are advised to do so only on a limited number of acres, until more is known about its response to below-freezing temperatures in April or May.

» **Brawl CL Plus and Byrd grow quickly in the spring. They transition from vegetative to reproductive growth well before other traditionally grown cultivars. Rapid, early season growth of these cultivars could make them more susceptible to damage from a late-spring frost.**

AgriPro Whetstone and WB-Arrowhead were solid performers in each and every year of this experiment—years when stripe rust was not a problem. AgriPro Whetstone (and Bearpaw, Brawl CL Plus, and Byrd) are all very susceptible to stripe rust (Table 5). **Results from this research are not applicable to early planting situations.**

Table 5. Ratings of cold tolerance and resistance to disease[1]

Cultivar	Cold tolerance	Resistance to:		
		Soil-borne wheat mosaic virus	Stripe rust	Fusarium crown rot
AgriPro Whetstone	Good	Good	Poor	Fair
Bearpaw	Good	*	Poor	*
Brawl CL Plus	Good	Good	Poor	*
Byrd	Good	Fair/Poor	Poor	*
Farnum	Good	*	Good	*
Judee	Good	*	Good	*
LCS Azimut	Fair/Good	Poor	Good	Fair/Good
Norwest 553	Poor	Poor	Good	Fair
Sprinter	Fair	*	Good	*
WB-Arrowhead	Good	Fair	Good	Fair
AgriPro Legion	Good	Poor	Good	Fair/Good

[1] Ratings are from Oregon State University and/or the seed developer and are believed to be accurate as of the time of publishing.

* Insufficient data

For More Information

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