A Pacific Northwest Extension Publication

Oregon State University • University of Idaho • Washington State University

PNW 635 • September 2012

Performance of Hard Red Winter Wheat in Late-Planted No-Till 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 (HRWW) is an attractive option because growers can usually achieve minimum grain protein goals, which increase 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.

The winter wheat–fallow rotation has been the dominant cropping system in low-precipitation areas of the Pacific Northwest since 1890. Tillage is conducted in spring of the fallow year to establish a low-bulk-density surface mulch that retains seed-zone moisture. Subsequent tillage operations maintain the mulch and control weeds. Tilled fallow is often necessary for early planting (late August to mid-September).

No-till fallow is an alternative, but growers' optimism about no-till fallow is tempered by concerns that late planting may reduce grain yields (figure 2). Late planting (October or after the onset of fall rains) is necessary in no-till fallow because seed-zone moisture during early planting dates is often inadequate for uniform germination and emergence.

Yield reductions can be offset, to some extent, by placing the required fertilizer below or below and beside the seed while planting. Cultivar selection may be equally important for minimizing the yield penalty associated with late planting, and identifying adapted cultivars may lead to increased use of no-till fallow.

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 moderately deep to deep silt loams or very fine sandy loams formed in windblown loess. Precipitation is limited (7 to 10 inches annually), the frost-free period ranges from 140 to 170 days, and summers are dry and hot.

Figure 2. Newly emerged wheat plants in a field planted in late October after 15 months of no-till fallow. This photo was taken on November 12, 2006. Plants reached the 3-leaf stage of growth before going dormant in December.

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Field Research and Growing Conditions

This field research was conducted in Morrow County, Oregon, during the 2006–2007, 2007–2008, and 2008–2009 crop years. In each year, there was one research site with 21 plots (seven cultivars replicated three times). The research sites were 4 to 10 miles north-northeast of Lexington, Oregon, and 1,200 to 1,700 feet above sea level. Tables 1 and 2 summarize the growing conditions, and table 3 describes the cultivars studied.

Seed coated with a broad-spectrum fungicide treatment was planted about ¾ inch deep in mid- to late October after 15 months of no-till fallow. Planting and fertilizing were accomplished with a customized plot drill designed to place fertilizer below and beside the seed (figure 3).

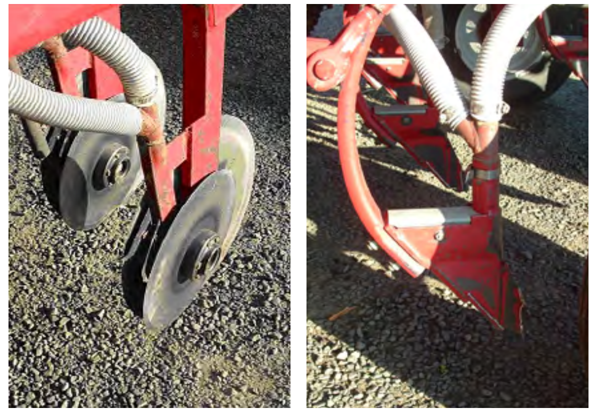

Figure 3. The customized plot drill had 13.5-inch-diameter, double-disc blades (left) mounted on a separate gang in front of narrow, hoe-type seed openers (right) on 12-inch row spacing.

Table 1. Soil characteristics for 2006–2007, 2007–2008, and 2008–2009 field experiments.

Crop year	Soil name[1]	Soil depth (ft)	AWHC[2] (in.)	pH	Organic matter (%)	Sand (%)	Silt (%)	Clay (%)
2006–2007	Willis	4	9.1	8.0	1.1	27.2	67.8	5.0
2007–2008	Mikkalo	4	9.6	7.4	1.3	17.3	74.2	8.5
2008–2009	Ritzville	6	12.5	7.6	0.9	33.4	60.5	6.1

Note. pH, organic matter, sand, silt, and clay values are from samples taken from the top 12 inches of soil.

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

[2] Available water holding capacity of the soil profile.

Table 2. Planting rate and growing conditions for 2006–2007, 2007–2008, and 2008–2009 field experiments.

Crop year	Planting rate[1] (seeds/ft²)	Crop-year precipitation (in.)	Soil water content[2] (in.)	Soil nitrogen[3] (lb/a)	Applied nitrogen[4] (lb/a)
2006–2007	26	9.4	4.1	50	40
2007–2008	24	9.2	3.0	35	55
2008–2009	24	7.2	4.2	48	42

[1] Planting rate (lb/a) was based on the number of seeds per pound.

[2] Plant-available water content of the soil profile; see table 1 for soil profile depths.

[3] Soil nitrogen was sampled 1 month before planting.

[4] Application rate is ±5 lb nitrogen/a.

Table 3. Description of cultivars used in 2006–2007, 2007–2008, and 2008–2009 field experiments.

Cultivar	Class[1]	Release date	Originator
AgriPro Paladin	HRWW	2005	AgriPro
Boundary	HRWW	1997	University of Idaho
Declo	HRWW	1999	Sunderman Breeding
Eddy	HRWW	2005	WestBred
Finley	HRWW	2000	Washington State University
Norwest 553	HRWW	2007	Oregon State University
Tubbs 06[2]	SWWW	2006	Oregon State University

[1] HRWW = hard red winter wheat; SWWW = soft white winter wheat.

[2] Tubbs 06 was used as a reference cultivar. It is a high-yielding SWWW cultivar most growers are familiar with.

Urea fertilizer (46-0-0) was applied at rates that would bring the total nitrogen supply (fertilizer plus residual nitrogen in the soil) to 90 lb/a (table 2). 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" on p. 5).

Cooperating farmers used labeled herbicides to achieve optimum weed control, and plots showed no symptoms of insect damage. There was a low-level (non-yield-limiting) stripe rust infection at the 2006–2007 site.

Early season dry-matter production 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 at Feekes Growth Stage 6 (jointing) in mid- to late April. Samples for yield components were collected 2 to 4 days before harvest.

Wheat was harvested from the center of each plot with 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% moisture. Grain protein content was estimated by using near-infrared spectroscopy.

Figure 4. Wheat was harvested from the center of each plot with a research combine equipped with a 5-foot cutting platform. Plots were 8 feet wide and 120 feet long.

Results

Early Season Dry-Matter Production and Yield Components

AgriPro Paladin had the most early season dry-matter production (table 4), but values for Eddy, Norwest 553, and Tubbs 06 were similar. Finley had slightly less than average early season dry-matter production, and Boundary and Declo had the least.

Eddy, Declo, Norwest 553, and Tubbs 06 had fewer heads than other cultivars. But for Norwest 553 and Tubbs 06, the high number of kernels per head seemed to offset reduced head production. Values for 1,000-kernel weight, which can significantly affect flour yield, were similar among cultivars.

Table 4. Early season dry-matter production and yield components.

Cultivar	Early season dry matter (lb/a)	Heads per square yard	Kernels per head	1,000-kernel weight (grams)
AgriPro Paladin	3,381 a	297 a	25.7 bc	30.7 a
Boundary	2,049 c	283 abc	23.5 cd	31.4 a
Declo	2,357 c	266 cde	25.6 bc	29.8 a
Eddy	3,168 ab	275 bcd	26.6 b	30.5 a
Finley	2,834 b	290 ab	22.3 d	32.8 a
Norwest 553	3,211 a	257 de	31.2 a	30.8 a
Tubbs 06	3,292 a	252 e	30.9 a	29.6 a
Average	**2,899**	**274**	**26.5**	**30.8**

Note. Data are averages from all three sites. Within columns, values followed by a different letter are significantly different at $p \leq 0.05$.

Test Weight, Yield, and Protein Content of Harvested Grain

Grain test weight ranged from 59.2 lb/bu for Tubbs 06 to 62.0 lb/bu for AgriPro Paladin (table 5). Boundary also had a test weight less than 60 lb/bu. Test weights of Eddy and Norwest 553 were similar to that of AgriPro Paladin.

Average grain yield of all HRWW cultivars was 31.9 bu/a. Finley, a popular cultivar in the region, yielded 30.6 bu/a. Yields of Boundary and Declo were relatively low, and Norwest 553 had the maximum yield (35.4 bu/a). Yield of Norwest 553 was similar to that of Tubbs 06, overall and in each of the three experiments.

Average grain protein content of HRWW cultivars was 11.6%. AgriPro Paladin and Norwest 553 had the highest grain protein values. A genetic predisposition for lower protein was clearly evident in Tubbs 06, the soft white winter wheat reference cultivar.

Table 5. Test weight, yield, and protein content of harvested grain.

Cultivar	Test weight (lb/bu)	Yield (bu/a)	Protein content (%)
AgriPro Paladin	62.0 a	33.6 b	12.0 a
Boundary	59.6 d	31.0 c	11.2 d
Declo	60.8 c	29.5 d	11.7 b
Eddy	61.9 a	31.6 c	11.4 c
Finley	61.2 bc	30.6 cd	11.2 d
Norwest 553	61.4 ab	35.4 a	11.9 ab
Tubbs 06	59.2 d	34.4 ab	10.4 e
Average	**60.9**	**32.3**	**11.4**

Note. Data are averages from all three sites. Within columns, values followed by a different letter are significantly different at $p \leq 0.05$.

Summary and Recommendations

AgriPro Paladin and Norwest 553 performed well in a late-planted no-till fallow system during years when annual precipitation ranged from 7.2 to 9.4 inches.

» **Norwest 553 exhibited the best combination of traits—good test weight, maximum yield, and greater-than-average grain protein content.**

Early season dry-matter production of Norwest 553 was similar to that of AgriPro Paladin and Eddy and higher than that of Declo, Boundary, and Finley. It is possible that selection for rapid early season growth could produce cultivars that yield reasonably well in late-planting situations.

It is interesting that rapid early season growth for Norwest 553 did not coincide with increased head production. Instead, this cultivar's enhanced yield seemed to be due to the number of kernels per head. This is unusual and contrary to results from most research, which show a strong correlation between grain yield and number of heads per unit area. This trait may be advantageous in drier areas, where excessive dry-matter production ("haying-off") is a wasteful, inefficient use of water.

Of the HRWW cultivars studied, only Norwest 553 is resistant to current races of stripe rust. It is tolerant of Fusarium crown rot (dryland foot rot), moderately resistant to Cephalosporium stripe, and susceptible to strawbreaker (eyespot) foot rot and soilborne mosaic virus. It is also short statured and less cold tolerant than other HRWW cultivars.

» **For these reasons, Norwest 553 is not recommended for deep planting in August or September.**

Learn more about Norwest 553 in Oregon State University Extension Publication EM 8967 (see "For More Information" on p. 5).

This research began before the release of several new HRWW cultivars such as Farnum, WB-Arrowhead, Altigo, Azimut, and Whetstone. These cultivars have not yet been tested extensively, but several have performed well in the low-precipitation zone. Farnum, from Washington State University, was developed as a replacement for Finley and appears to be a good fit for early and deep-seeded planting. WB-Arrowhead and Azimut, from WestBred and Limagrain, respectively, are short-statured cultivars with good yield potential and grain protein content. Additional research is required to evaluate the performance of these cultivars in late-planting situations.

For More Information

Lutcher, L.K., D.A. Horneck, D.J. Wysocki, J.M. Hart, S.E. Petrie, and N.W. Christensen. 2006. *Winter Wheat in Summer-Fallow Systems (Low Precipitation Zone)*. FG 80. Corvallis, OR: Oregon State University Extension Service.

Flowers, M., C.J. Peterson, J. Burns, and J. Kuehner. 2008. *Norwest 553 Hard Red Winter Wheat*. EM 8967. Corvallis, OR: Oregon State University Extension Service.

Koenig, R.T. 2008. *Dryland Winter Wheat: Eastern Washington Nutrient Management Guide*. EB 1987. Pullman, WA: Washington State University Extension.

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- Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

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Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by the Oregon State University Extension Service, Washington State University Extension, University of Idaho Extension, and the U.S. Department of Agriculture cooperating.

Published September 2012.