A DIVERSIFIED HIGH-RESIDUE NO-TILL CROPPING

SYSTEM FOR THE LOW-RAINFALL ZONE

By

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Abstract

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The low-rainfall wheat production zone of Eastern Washington is plagued by wind erosion due to its fine-textured soils, low soil organic matter content, and tillage-based summer fallow practices. Increasing residue cover of the soil surface has been shown to reduce wind speeds and reduce the risk of soil erosion. Annual spring cropping has been evaluated many times to replace the summer fallow period, without economic success due to non-competitive yields. We conducted a 4-year study at Ralston, WA to evaluate winter triticale biomass production, yield, and nutrient use efficiency, seed zone soil moisture during no-till fallow, and establishment of fall-seeded canola. Winter triticale produced more grain per pound of nitrogen fertilizer and per inch of soil water available than winter wheat, and overall yield was 30 to 80% greater than that of winter wheat. Full-height cereals produced 20 to 90% more biomass than their semi-dwarf counterparts. Stripper header triticale stubble maintained with no-till chemical fallow reduced average wind speed at the soil surface to less than one half of average wind speed recorded over reduced-tillage winter wheat fallow. Soil moisture in the 0 to 3-inch seed zone was greater and more uniform in stripper header no-till fallow than in reduced-tillage fallow. This maintenance of soil moisture was conducive to timely planting and establishment of fall-seeded canola, and led to greater crop establishment in no-till fallow.

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Introduction

The low-rainfall wheat production zone of Eastern Washington is characterized by average annual rainfall of less than 12 inches. A majority of the precipitation is received during the winter months and is stored in the soil profile during a fallow period to produce a crop the following year. Since 1880 the conventional farming practice in Eastern Washington's low-rainfall zone has been a winter wheat – summer fallow rotation (Schillinger and Papendick, 2008). Winter wheat – fallow production systems are used on nearly 4 million acres in low-rainfall areas of eastern Washington and north-central Oregon (Schillinger and Young, 2004). In this system a crop is only harvested once every two years: planted in August or September of the first year, harvested 9 to 10 months later, and then the land is left uncropped until the following fall when the next crop is planted. Because no crop is grown in the second summer in this system, it is often referred to as "summer fallow." In the traditional tillage fallow system, a rodweeder is used to set a soil moisture line, which breaks capillary flow of soil water to the surface where it would evaporate. Although the practice of winter wheat--fallow leads to crop yields that are profitable to the grower, regular tillage of the soil disrupts its structure and leaves it prone to wind erosion. Shifting from a traditional intensive-tillage fallow to reduced-tillage or no-till fallow would reduce the erosion potential in the low-rainfall zone (Thorne et al., 2003).

The Great Plains states of Kansas and Nebraska lead the United States in no-till and conservation tillage acres (NASS 2014). Throughout the Great Plains, adoption of no-till has flourished because it enabled farmers to intensify and diversify their cropping systems (Hansen et al., 2012). Proso millet (*Panicum miliaceum*), which is a more efficient user of soil moisture than winter wheat, is one crop that has enabled farmers of this region to reduce or eliminate fallow periods in rotation (Lyon et al., 2007). Compared to the traditional winter wheat-fallow system, fallow acreage is reduced by growing two crops every three years and annual grain yield and net return is increased in the intensified system (Peterson and Westfall, 2004; Hansen et al., 2012). Additionally, no-till increased the amount of

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available soil water and thus total water used by crops in the intensified rotations when compared to a traditional winter wheat-fallow system (Hansen et al., 2012; McGee et al., 1997).

Cropping system intensification with no-till was evaluated in Eastern Washington, without the same success as the Great Plains. This approach used spring-planted cereals in a no-till system for elimination of the summer fallow period and harvest of a crop each year (Thorne et al., 2003; Schillinger and Young, 2004; Juergens et al., 2004; Young et al., 2015). Though annual spring cropping reduced the susceptibility of soils to wind erosion (Thorne et al., 2003), a summer fallow system yielded 25% more grain over the course of six cropping seasons (Young et al., 2015). Reduced wind erosion benefits public safety, but yields of spring crops were lower, and therefore annual spring cropping was not as profitable as the winter wheat-summer fallow system. In the Horse Heaven Hills, one of Washington's driest rainfed wheat production areas, no-till annual cereals were not economically feasible compared to winter wheat–summer fallow, even in years with higher than average rainfall (Schillinger and Young, 2004). In other low-rainfall areas of Washington when rainfall was plentiful, no-till annual spring wheat was economically competitive with the traditional winter wheat-summer fallow, though riskier because of variations in annual rainfall (Juergens et al. 2004). Winter wheat--summer fallow reduced economic variability and increased average profitability compared to annual cropping in the low-rainfall zone (Schillinger et al., 2007; Young et al. 2015). Due to its economic benefits to growers, fallow remains a common practice in the low-rainfall zone.

A second option to reduce wind erosion in winter wheat-fallow systems may be for farmers to use chemical fallow/no-till practices during the fallow period. Wuest and Schillinger (2011) found that because tillage severed the capillary flow of water to the soil surface, no-till fallow had greater seed-zone drying than tilled fallow and therefore cumulative profile water loss in no-till fallow typically exceeded losses from tilled fallow (Wuest and Schillinger, 2011). Because of excessive seed-zone drying,

planting of cereal crops is generally delayed in no-till fallow until fall rains replenish seed zone moisture levels for germination. Delayed no-till planting causes winter wheat heading to occur later, resulting in crop yields 36% lower than a tilled fallow system with wheat planted at the optimal time (Higginbotham et al. 2011).

Without the ability to profitably grow crops annually, or to delay winter wheat planting with chemical/no-till fallow and achieve yields similar to traditional fallow, current fallow practices must be more sustainable by reducing soil loss to wind erosion and conserving seed-zone soil moisture. Young and Schillinger (2012) evaluated a delayed minimum tillage system that utilized a cultivator (undercutter) equipped with 32-inch sweep blades set ~5 inches deep as a primary tillage operation in the spring/fall. Secondary tillage operations included a harrow to reduce clod size and a reduced number of rodweedings to establish the moisture line. This system was as profitable as conventional tillage fallow and conserved 40 to 80% of surface residues (Schillinger, 2001). An alternative to this system would be one that conserves 100% of surface residue in a no-till chemical fallow system. By augmenting surface crop residues produced by soft white spring wheat to 4x and 7x in a 6-year study, Wuest and Schillinger (2011) demonstrated that increased residues could have an ameliorating effect on seed zone soil moisture. They measured soil moisture in 0.8 inch increments to 10 inches, as this is the seed zone typically used for deep-furrow planting of winter wheat in the low-rainfall zone. Seed-zone soil moisture was greater in no-till fallow of 1x, 4x and 7x residue until the 5.5-inch depth, at which point the tilled fallow showed greater seed zone water (Wuest and Schillinger, 2011). These are applicable results for deep-furrow planted winter wheat, which can emerge from planting depths of 6 inches and beyond, but winter canola, a crop expanding in acres in the low-rainfall zone, requires a much shallower seed placement due to its small seed size and epigeal emergence habit. Canola's shallow seeding depth, generally less than 3 inches from the soil surface, means that the maintenance of higher soil moisture

near the soil surface that has been seen in high-residue, no-till fallow, may be a benefit for establishing the canola crop.

Another fallow option not previously researched is to implement a diversified, high-residue, no-till system coupled with the use of a stripper header for grain harvest. In the hot, dry Mediterranean climate of Eastern Washington, there are few alternative crops to integrate with winter wheat to diversify the rain-fed crop rotations. Triticale (× *Triticosecale*), a manmade cross between rye (*Secale cereale*) and durum wheat (*Triticum turgidum* subsp. *durum*), harnesses the resilience and nutrient efficiencies of rye, while combining them with the yield and quality characteristics of wheat (Schlegel, 1996). Winter triticale is a viable crop for building residues in a no-till system in the low-rainfall zone because it has a greater yield efficiency and produces more biomass than winter wheat (Laroche and Gate, 1996; Shebeski, 1974).

Maintaining the residues by harvesting a tall crop with a combine header designed to leave intact standing stubble in the field by stripping just the kernels from the head may prove the key to a low-rainfall no-till fallow system that can compete with traditional summer fallow. Conventional cutter bar headers used for cereal harvest cut the stem of the crop above the soil surface and feed the head and stem material through the combine for threshing. In contrast, stripper headers are composed of a rotating drum mounted with rows of metal fingers. The rotation speed of the drum is varied depending on harvest conditions, and header height adjusted to just below the base of the heads. The drum spins opposite to the direction of travel and strips the grain kernels from the head. When adjusted properly, the entire plant (stem and rachis) remains standing. Following harvest with a stripper header, standing residues nearly the full height of the mature crop remain in the field. One make of stripper header widely in use today was developed at Silsole Research Institue, UK, and has been commercially produced by Shelbourne Reynolds Engineering, Ltd. since 1988 (Tado et al. 1998).

Use of the stripper header for winter wheat harvest in the Great Plains reduced both evaporation potential and erosive force at the soil surface due to a decrease in wind velocity (Baumhardt et al., 2002; McMaster et al., 2000). The effect of stubble height with cutter bar harvest of cereals has been evaluated in multiple cropping systems. Standing stubble has been recognized to have a buffering influence on minimum temperatures experienced at the growing point of wheat, which may result in reduced winter kill (Aase and Siddoway, 1980). Crops growing in tall standing stubble (12-18 inches) had greater yields and increased water use efficiencies than when grown in shorter stubble (Cutforth and McConkey, 1997; Cutforth et al. 2011). In the PNW, the only stripper header research that has been conducted focused on potential header yield loss and the feasibility of seeding into the tall crop residues (Wilkins et al., 1996). A stripper header-equipped combine traveling at 4.3 mi/hr had similar grain loss to a cutter-bar-equipped combine traveling at a rate of 0.8 to 2.7 mi/hr. In addition, grain loss decreased as combine speed increased from 0.8 to 6.1 mi/hr with a stripper header. These are important benefits, as increased harvest efficiency may be a key factor in a grower's decision to use a stripper header, with the positive effects of standing residues on soil loss by wind and water erosion, and soil temperature as secondary benefits.

The goal of the Ralston project is to develop a diversified no-till fallow system for the low-rainfall zone of Eastern Washington. Specific objectives include: 1) Compare winter triticale biomass production, water use efficiency, and nitrogen use efficiency to a standard height winter wheat; 2) Compare seed-zone and soil profile moisture in a reduced-tillage winter wheat fallow system and a stripper header no-till winter triticale system; 3) Compare harvest efficiency of a stripper header and conventional cutter bar header; and 4) Compare establishment of winter canola in four different crop x residue treatments. High-residue no-till is predicted to conserve seed-zone soil water better than reduced tillage fallow due to buffering of the microclimate at the soil surface. A greater seed-zone soil moisture is beneficial for establishing a winter canola crop in the harsh conditions of late summer.

Materials and Methods

The long-term research plots used in this study are located southwest of Ritzville, Washington (-46°54'48.3''N, 118°23'49.4''W) (Young et al., 2015). The site is flat, and soil is characterized as a Ritzville silt loam. Long-term annual precipitation for the study site is 10.5 inches; average annual rainfall during our 2011-2014 study period was 9.4 inches (Table 1). Information about previous crop rotations on the study plots can be found in Young et al., 2015.

The study contained four cropping systems, each replicated four times in a randomized complete block experimental design. Treatments included: 1) standard height 'Farnum' winter wheat (WW) harvested with a cutter bar header (CB), and reduced tillage fallow (RTF); 2) WW, stripper header (SH), and chemical fallow (CF); 3) '099' winter triticale (WT), CB and CF, and 4) WT, SH, CF. There are two complete sets of plots, one on either side of a north-south roadway, with fallow on one side of the road alternating with crops on the other side within a given year (Table 2). This design allows data to be collected in-crop and in-fallow each year. Individual plots are 30 feet wide and 500 feet long. Winter cereals were planted the first two years of the study in 2011 and 2012, and winter canola in 2013 and 2014. In 2011, winter wheat was seeded with a cross-slot no-till drill (39 lbs/ac) into chemical fallow on September 15 and on September 27 with a John Deere HZ 616 deep furrow drill (40 lbs/ac) in reduced tillage fallow. Winter triticale was seeded with a John Deere 9400 hoe drill (47 lbs/ac) in chemical fallow on October 7 and 13. In 2012, winter triticale (45 lbs/ac) was seeded into chemical fallow and winter wheat (50 lbs/ac) was seeded into chemical fallow and reduced tillage fallow using a John Deere 9400 hoe drill (14 inch row spacing) on September 17 and 18. Each year, winter wheat and triticale were fertilized with nitrogen (ranging from 70 to 80 pounds per acre), phosphorous, and sulfur as needed according to soil tests.

	Year		
Month	2011-2012	2012-2013	2013-2014
	------------------ inches ------------------		
September	0.1	0.0	0.9
October	0.9	1.4	0.0
November	0.4	2.6	0.6
December	0.6	1.7	0.4
January	0.7	0.4	0.6
February	0.9	0.5	0.9
March	2.1	0.5	1.6
April	1.3	0.6	0.9
May	0.3	0.6	0.3
June	2.5	1.4	0.4
July	0.4	0.0	0.3
August	0.0	1.5	0.7
Total:	10.2	11.2	7.6

Table 1: Annual cropping-season rainfall received at Ralston, 2011-2014.

Crop Year	West Side Plots	East Side Plots
2011-2012	Fallow	'099' winter triticale and 'Farnum' winter wheat
2012-2013	'099' winter triticale and 'Farnum' winter wheat	Fallow – winter canola planted late July 2013
2013-2014	Fallow – Winter canola planted August 2014	'Champion' spring barley planted following freeze kill of winter canola.
2014-2015	Crop failure - no harvest	Fallow

Table 2: 2012-2015 crop-fallow rotation followed at the Ralston Project

In 2013, 'Sumner' winter canola was planted in reduced tillage fallow plots on July 25 at a rate of 3 pounds per acre with a John Deere HZ 714 drill. 'Sumner' was chosen because of its tolerance to residual sulfonylurea herbicides in the soil, which had been applied during a previous fallow period. Portions of these plots were re-seeded to fill-in areas of poor establishment on August 26, 2013. On July 26, 2013 'CP125', a glyphosate resistant variety of winter canola, was seeded at a rate of 3 to 5 pounds per acre in the no-till fallow plots.

In 2014, 'Claremore' winter canola was seeded at a rate of 4 pounds per acre using a no-till drill manufactured by AgPro in Lewiston, Idaho, into reduced tillage fallow on August 27 and into no-till fallow on August 28.

Two 10.75 ft^2 biomass samples of mature crop were collected per plot prior to harvest each year. Samples were threshed using a stationary thresher to determine the amount of stem and grain biomass and calculate a harvest index. Harvest index is defined as grain weight/(grain weight + stem weight).

All plots were harvested with a John Deere 7720 combine equipped with a 20-foot Shelbourne Reynolds stripper header or 16-foot cutter-bar header, as dictated by system. Chemical fallow was established following harvest with the stripper header in both winter wheat and winter triticale. Chemical fallow was also established after winter triticale was harvested with the cutter bar header. Glyphosate, and 2,4-D were applied as needed to control weeds in the chemical fallow period. Weeds were controlled in fallow after cutter bar harvest of winter wheat with a combination of tillage and herbicides (Table 3). In contrast to the conventional tillage practiced by most growers in the area, where primary tillage occurs in the fall, followed by cultivation plus fertilization in the spring and multiple rodweedings during the summer fallow period to control weeds and set and maintain a moisture line, our reduced-tillage fallow relied on herbicides to postpone the primary tillage operation until the spring, and used fewer rodweedings over the course of the summer season.

Treatment	Crop and Harvest Method	Fallow Treatment following crop harvest
1	Triticale – stripper header	Chemical fallow
2	Triticale – cutter bar header	Chemical fallow
3	Winter wheat – stripper header	Chemical fallow
4	Winter wheat – cutter bar header	Reduced tillage fallow

Table 3: Crop, harvest method, and fallow maintenance of treatments at the Ralston Project.

In 2013 and 2014 soil was sampled bi-weekly during the summer fallow period using an AMS slide hammer, with a sampling cup 1.25 inches in diameter, and plastic liners so that samples could be split

into 0-3, 3-6, and 6-12 inch depths and gravimetric water content determined. The shallow 0-3-inch depth was specifically chosen in order to track moisture in the seed zone. Three replicate samples were taken in each of the sixteen fallow plots on each sampling date.

In each year of the study, soil was sampled to a depth of 6 feet using a tractor-mounted hydraulic sampler (Giddings Machine Company, Inc.). These samples were taken in April to determine overwinter moisture recharge, and in September or October to determine soil nutrient status, crop water use, and crop nutrient use.

In the 2014 fallow period, DS-2 Sonic Anemometers were placed at heights of 6 and 20 inches above the soil surface in stripper header triticale stubble chemical fallow and cutter bar winter wheat reduced tillage fallow in three replicates of each treatment (Decagon Devices, Inc.). Data were recorded on an EM50 data logger on 2 minute intervals (Decagon Devices, Inc.).

Statistical analysis of agronomic and soil data was conducted using Minitab 17 (Minitab, Inc.) and Sigma Plot 12.3 (Systat Software, Inc.). Data was evaluated for variation across and within years. It was found that there was enough variation in the two crop years of the study to justify analyzing each year separately using Tukey pairwise comparisons, $\alpha = 0.05$.

Winter Cereal Biomass

Winter triticale biomass was similar to or greater than winter wheat biomass each year of the study. When compared to Lewjain and Rely, semi-dwarf soft white winter wheat varieties grown in the first phase of research at the Ralston Project (Young et al., 2015), the cereals used in the current rotation usually produced greater amounts of biomass (Figure 1). The harvest index of triticale was significantly greater than winter wheat in 2012, indicating that it produced proportionally more grain per total biomass than winter wheat produced (Table 4). In 2013, harvest index was similar among treatments, possibly because of the yield variability.
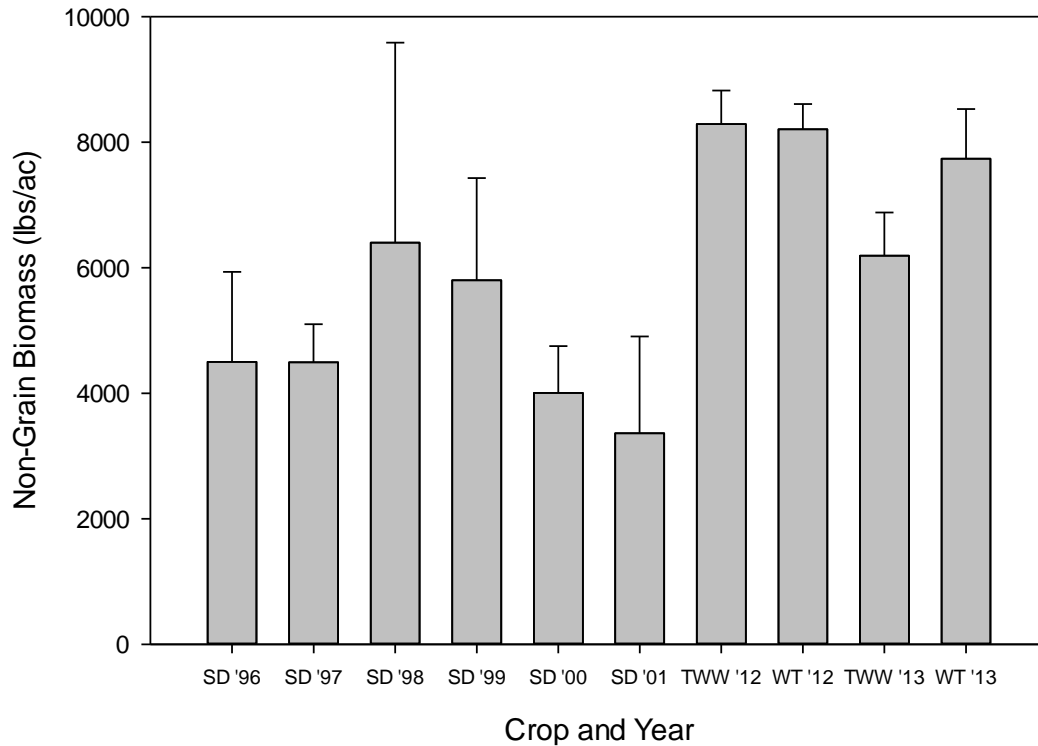
Figure 1: Non-grain biomass produced by semi-dwarf 'Lewjain' and/or 'Rely' winter wheat from 1996-2001 (SD '96-SD'01), and biomass produced by 'Farnum' winter wheat (TWW '12 and TWW '13) and '099' winter triticale (WT '12 and WT '13). There was no significant difference between harvest methods, so crop values for each crop each year are presented as averages. The whiskers indicate maximum values within a 95% confidence interval.

Crop Yield and Header Loss

Excess grain loss when using a stripper header is of concern to growers because of its design differences from a conventional cutter bar header. In our study, winter triticale yield was similar regardless of combine header used and was significantly greater than yield of winter wheat in both years of the study (Table 4). The higher triticale yield is advantageous to growers, because triticale typically trades at a lower price than wheat and in order to get the same gross return per acre, triticale must yield higher than wheat. For example, the price of soft white wheat was $4.36/bu ($0.0727/lb), and triticale was $135/ton ($0.0675/lb) (January 20, 2016 prices at Central Washington Grain Growers). At these prices,

triticale would have to yield 108% of wheat in order to provide the same gross return. In this study,

triticale yielded 126 to 180% of wheat yield each year (Table 4).

Crop Yield and Other Factors for Winter Triticale and Winter Wheat in 2012 and 2013 at Ralston, WA					
Crop•Harvest Method	Grain Yield lbs/ac	Biomass lbs/ac	Harvest Index	PFP (lbs/lb N)	Grain WUE (lbs/in)
2012 CROP YEAR DATA					
WT•CB	4800a	7100a	0.40a	68.7a	616a
WT•SH	4650a	7147a	0.39a	66.5a	627a
WW•CB	3300c	5730b	0.37b	47.2b	412b
WW•SH	3550b	6710a	0.35c	44.4b	400b
2013 CROP YEAR DATA					
WT•CB	4220a	5190ab	0.45a	60.3a	592a
WT•SH	4340a	5660a	0.43a	62.0a	611a
WW•CB	3350b	4870ab	0.41a	47.8b	473b
WW•SH	2410c	3650b	0.40a	34.5c	339c

Table 4: Yield of winter triticale (WT) and winter wheat (WW) at Ralston in 2012 and 2013. Cutter bar (CB) or stripper header (SH) harvest method is also indicated. PFP = partial factor productivity; WUE = water use efficiency. Within-column values for each crop year followed by the same letter are not significantly different in a Tukey pairwise comparison.

Triticale used nitrogen fertilizer and soil water more efficiently than winter wheat. In both 2012 and

2013 the partial factor productivity (PFP) for triticale, calculated as the pounds of grain produced per

pound of nitrogen fertilizer added, was greater than the PFP of winter wheat (Table 4). Triticale

produced 12 to 28 pounds of grain more per pound of nitrogen fertilizer added than winter wheat.

Triticale's water use efficiency (pounds of grain produced/acre per inch of water used) was also greater

than wheat from 119 to 272 pounds per inch of water (Table 4). Its more-efficient use of nitrogen and

water resources would suggest that triticale is a valuable rotational crop when these resources are

limited (Dhindsa and Singh, 1996).

Standing Stubble and No-Till Fallow

The increased biomass production from winter triticale and tall winter wheat, coupled with stripper header harvest that leaves the tall residues standing in the field can influence the microclimate at the soil surface to protect soil particles from wind erosion and soil moisture from evaporation (McMaster et al., 2000). Humid air removed by wind from the soil surface creates a gradient from the vapor-saturated soil pore space to the unsaturated air above the soil surface, leading to increased evaporation of soil water. During a 9-day period in 2014, wind speeds measured 6 inches above the soil surface in 36-inch-tall stripper header triticale stubble (3 replications per treatment) were lower than wind speeds measured at the same height over reduced tillage fallow of winter wheat cutter bar stubble (Figure 2). Average wind speed in reduced tillage fallow was consistently three times greater than the average wind speed in stripper header stubble (Figure 3). Maximum wind speed was reduced by standing stubble to one half to one third of what was recorded in reduced tillage fallow.
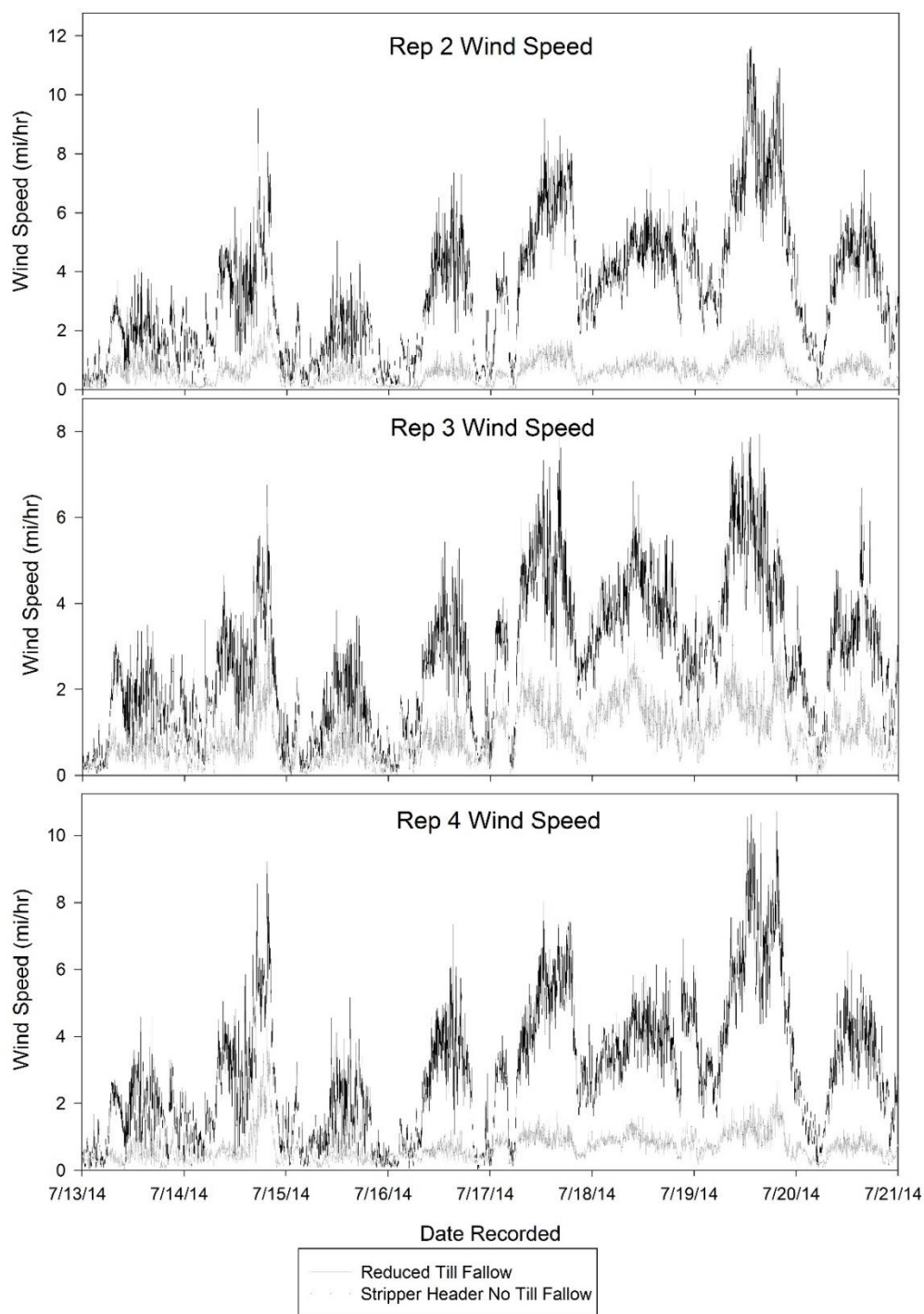
Figure 2: Wind speeds in reduced tillage winter wheat fallow, and no-till winter triticale stripper header stubble. Black line is wind speeds measured over reduced till fallow, and grey line is wind speeds measured in stripper header no till fallow
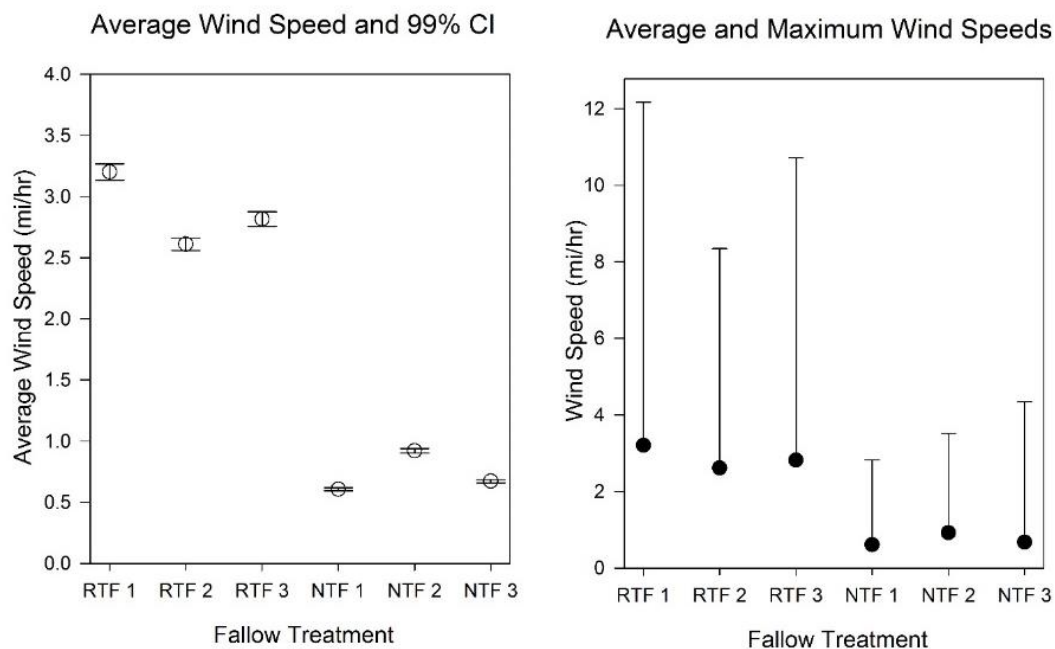
Figure 3: Average and maximum wind speeds record during fallow period.
Left panel: average wind speeds recorded in three replicates of reduced tillage fallow (RTF1-3), and no-till stubble (NTF 1-3), with 99% confidence interval. Right panel: Average and maximum wind speeds recorded in three replicates of reduced tillage fallow (RTF1-3), and no-till stubble (NTF 1-3). Filled circle is the average value, and bar represents the maximum recorded wind speed
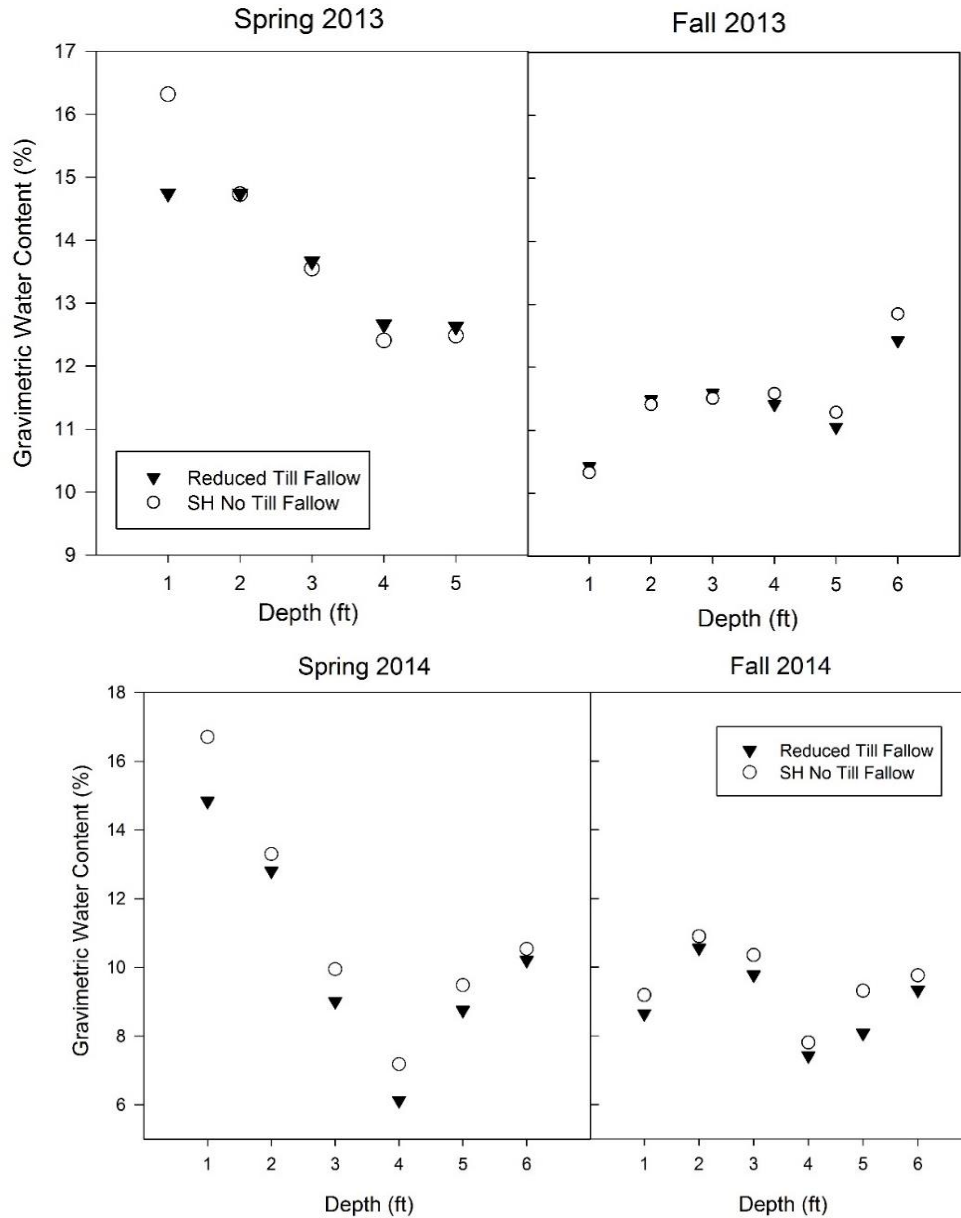
Figure 4: Full-profile soil gravimetric water content for 2013 and 2014 fallow periods. No significant difference in soil moisture between fallow treatments was found at any depth, though water content was generally observed to be greater in stripper header fallow at all depths both in spring and fall.

A reduction of wind speed at the soil surface may reduce evaporation of water from the soil surface

(Aase and Siddoway, 1980). Evaluation of the whole-profile soil moisture for both fallow years show no

significant difference in gravimetric water content between reduced till and stripper header no-till

fallow (Figure 4). The significant difference in gravimetric water content was apparent in a more detailed

analysis of the soil profile—focusing just on the seeding depth of 0-3 inches. Throughout the 2013 and

2014 fallow periods, seed zone water content increased and declined as the soil was subjected to

rainfall and drying patterns. More importantly, seed zone water content was significantly greater in

stripper header winter triticale no-till fallow than in winter wheat reduced tillage fallow at time of

planting in 2013 and 2014 (Figure 5). This is similar to the results of Wuest and Schillinger (2011) where

no-till residue was augmented in the field, and demonstrated that by producing a high-biomass crop,

and maintaining that biomass through chemical fallow, it is possible to maintain seed-zone soil moisture

in no-till fallow. Though the full-profile water contents are not significantly different under the two

fallow management strategies (Figure 4), the difference in seed-zone soil moisture may influence the
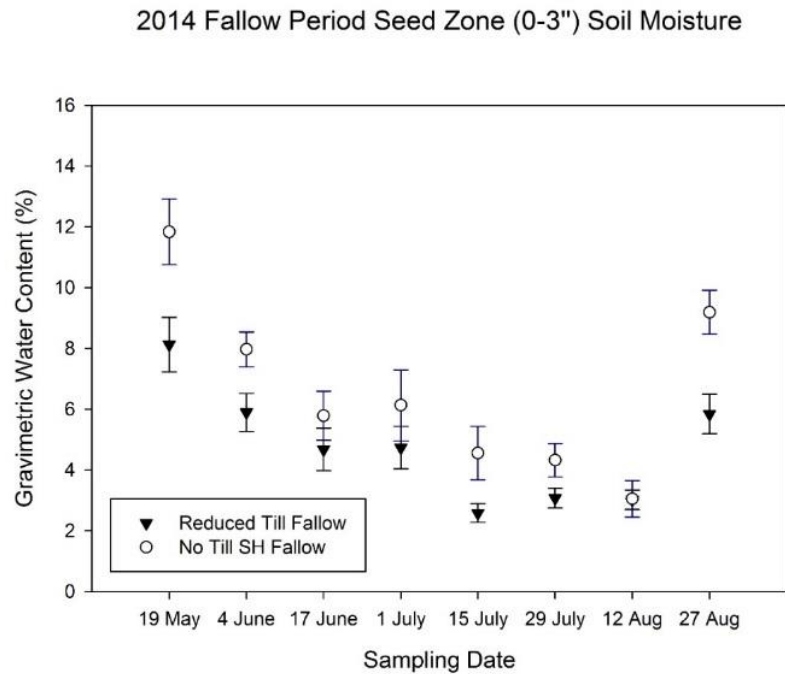
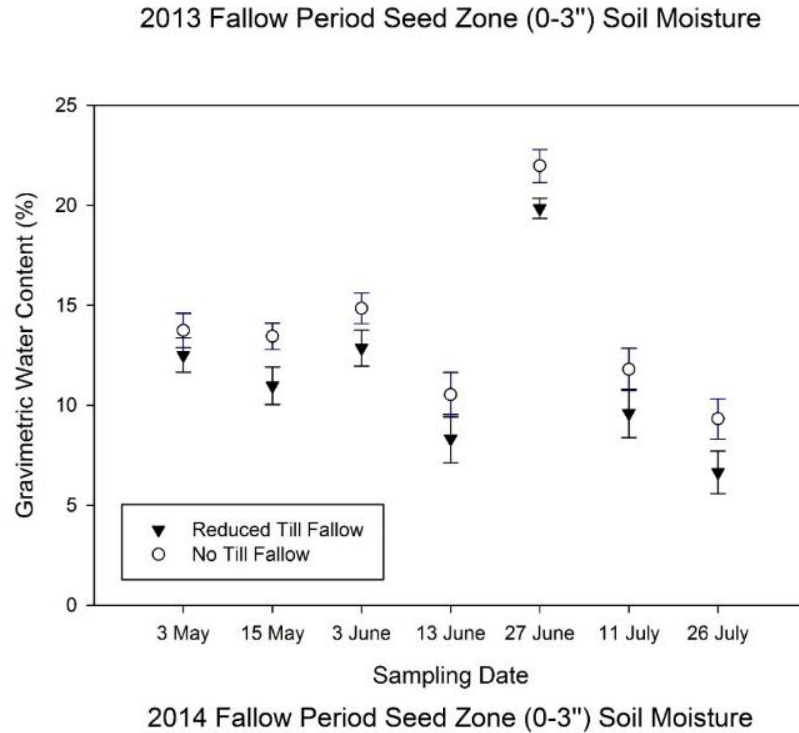establishment of the crop, and therefore yield.

2013 Fallow Period Seed Zone (0-3") Soil Moisture

2014 Fallow Period Seed Zone (0-3") Soil Moisture

Figure 5: Fallow period seed zone soil moisture, 2013 and 2014.

Winter Canola Establishment

In 2013 and 2014, winter canola was seeded into all fallow plots. The seed-zone soil moisture

differences between cereal crop and fallow treatments led to differences in canola establishment. In no-

till fallow, where seed-zone soil moisture was greater and more uniform than in reduced tillage fallow,

canola stand establishment was 80 to 95% in 2013. Establishment in the reduced tillage fallow was 50 to

60%. The 2014 fallow period was drier than the previous year, and all treatments were lacking in

moisture when canola was seeded in late August. Though soil moisture was generally low, the difference

between reduced and no-tillage again led to appreciable differences in establishment. In no-till plots,

canola stand establishment was 30 to 50%, while in reduced tillage fallow establishment was 0%. Soil

temperatures in the seed row recorded after planting were lower in no-till plots (Figure 6). The lower

soil temperature led to reduced stress on germinating and emerging seedlings, likely enabling the

observed differences in establishment. The buffering effect of tall standing stubble on soil temperatures

has also been noted to reduce winter stress on wheat growing in cold climates (Aase and Siddoway,
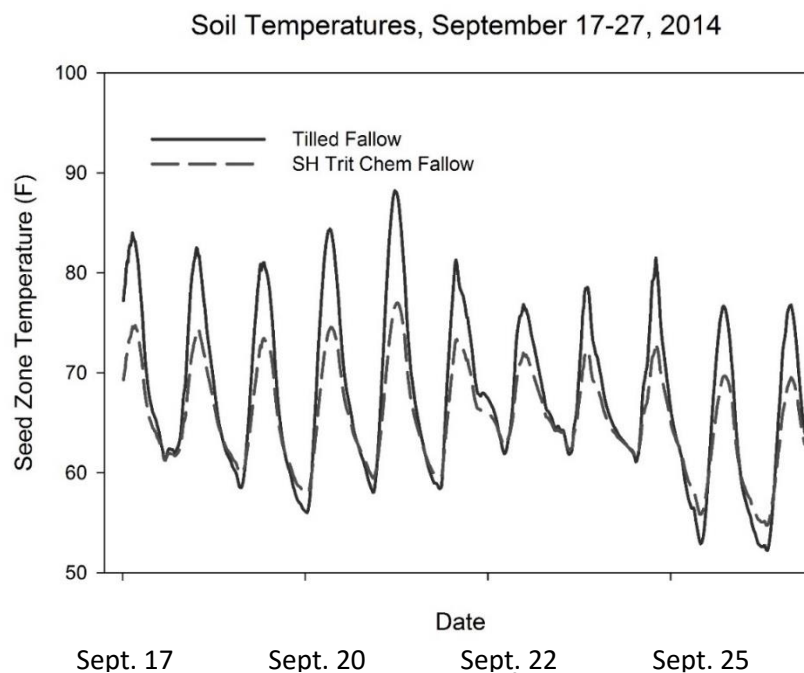
1980).

Figure 6: Seed zone soil temperatures recorded after planting of winter canola, 2014.

Neither the 2013 or 2014 fall plantings of winter canola survived to spring. In 2013, plants were killed by

extremely low temperatures in December 2013 and February 2014 (Figure 7), and the plots were

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replanted with spring barley. The canola plants that established in 2014 also did not survive the winter.

All plots were re-seeded in March 2015 with spring canola, but due to dry conditions the seed did not
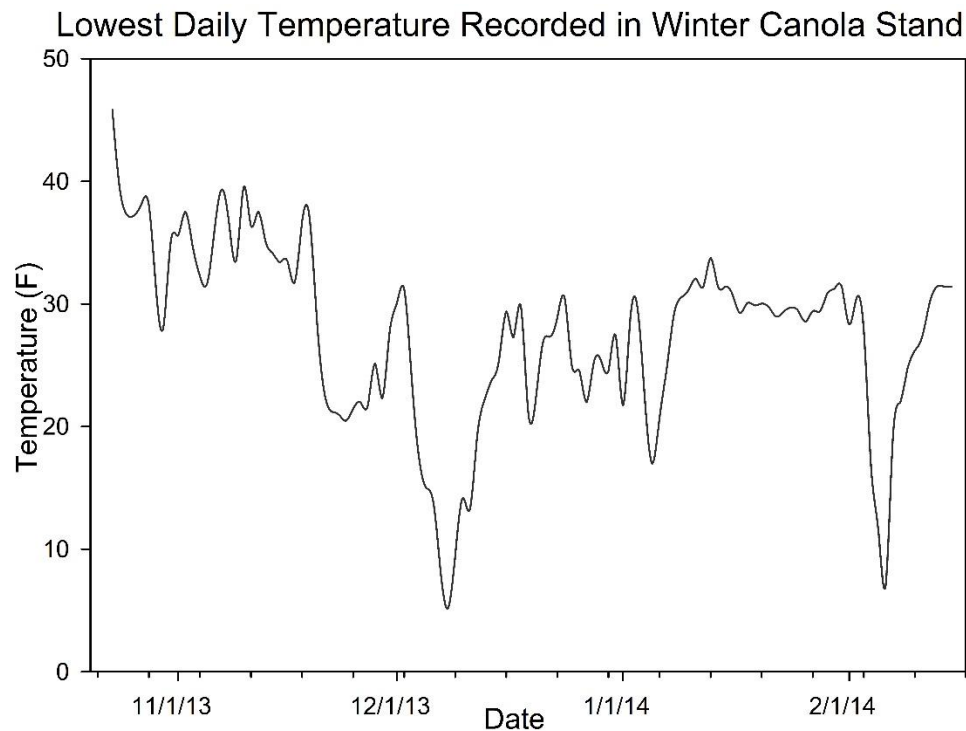
germinate and no crop was harvested in 2015.

Lowest Daily Temperature Recorded in Winter Canola Stand

*Figure 7: Minimum recorded temperatures in winter canola at Ralston site,
November 2013-February 2014.*

Conclusion

When compared to their semi-dwarf counterparts, tall cereals provide biomass in a high-residue no-till

system that is conducive to maintaining seed-zone soil moisture during summer fallow. Although winter

canola planted at the Ralston project was killed by abnormally dry and cold winters that prevented

harvest of the crop in 2014 and 2015, data indicate that tall stripper header stubble provides

microclimate-ameliorating effects that improve crop establishment, reduce the risk of wind erosion, and

do not rely on cool post-plant temperatures (Young et al. 2014). Tall no-till triticale stubble reduced

wind speeds at the soil surface when compared to reduced tillage fallow, which contributed to

conservation of seed-zone soil moisture. While a minor crop in Eastern Washington, winter triticale's

demonstrated fertilizer use efficiency and water use efficiency, and economic returns equal to or

greater than winter wheat may encourage growers to add this crop to their rotations.

Stripper header use in the low rainfall wheat-production areas of Eastern Washington has increased

since the start of the current phase of research at the Ralston Project (Personal communication, Dan

Harwood). We hope to see adoption continue as growers observe the benefits of tall residues in a no-till

system.

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