FINAL REPORT

Seeding Rate and Planting Date Effects on Spring Wheat Yield in the Intermountain Region

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Abstract/Summary of Results and Conclusions
Seeding rate is a production decision that is sometimes passed over and producers oftentimes settle on a common seeding rate that is used in a given wheat production region. Seeding rates commonly used in Tulelake are 125 for soft white spring wheat and 145 pounds per acre for hard red spring wheat. A research project was conducted from 2013-2015 to evaluate the impact of planting date (April or May), cultivar (four common spring wheats representing soft white and hard red classes) and seeding rate (5 rates ranging from approximately 80 to 200 lbs. per acre) on wheat yield and bushel weight and the different growth parameters that contribute to yield. Across all varieties, seeding rate affected plant density with plant density increasing with each incremental increase in seeding rate. Tiller density was much less affected by seeding rate than initial stand and there was no effect of seeding rate on the number of reproductive tillers. For this reason, yield was similar across a broad range of seeding rates for all varieties each of the 3 years studied. Therefore, high seeding rates do not appear justified.

Introduction and Objectives
Unlike the rest of California, spring wheat in the Intermountain Region is not seeded until April to early May rather than over the winter months. Temperatures often rise considerably soon after planting, potentially limiting the amount of tillering that occurs compared with areas with prolonged cool temperatures after seeding. A logical approach to compensate for reduced tillering potential may be to increase the seeding rate.

Seeding rates are often arrived at based on tradition for a given production area rather than grounded in research results. Common seeding rates currently used in the Klamath Basin are 125 and 140 pounds per acre for soft white wheat and hard red spring wheat, respectively. A research study conducted in 2012 by Richard Roseburg at the OSU Klamath Experiment Station on the Oregon side of the Klamath Basin evaluated a broad range of seeding rates. Doubling the seeding rate from approximately 100 to 200 lbs. per acre resulted in a yield increase of 28% for Alpowa, 26% for Bullseye, 18% for Yecora Rojo and 18% for Twin. More moderate yield increases occurred when seeding rate was only increased 25% to 125 pounds per acre. Planting date can also have a significant impact on the number of tillers produced per plant, with early plantings typically producing more tillers. Hence, the optimum seeding rate may vary depending on seeding date. Therefore, the effect of seeding rate should be evaluated under different planting dates and conducted in different years to determine the influence weather conditions in a specific year may have on seeding rate effects. These conflicting results demonstrated the need for an additional year of seeding rate research under different weather conditions.

Our results to date (as well as a subsequent OSU study in 2013) have disagreed with the initial OSU results. We have not found a positive correlation between seeding rate and yield. In fact, some varieties have had higher yield at lower seeding rate.

The objectives of this research were to:

1. Determine the effect of seeding rate on the yield of four commonly grown hard red and soft white spring wheats.
2. Assess the impact of planting date on stand, tiller number, productive tiller production, bushel weight and yield.
3. Quantify the interaction between seeding rate and planting date for different wheat cultivars.

Materials and Methods

This was the final year of the seeding rate research trial at IREC and was a duplication of the research conducted in 2013 and 2014. The trial was a three-way factorial with a split plot restriction for the main plot. The main plot factor is the planting date with two planting dates: the earlier planting date was April 11, 2015 and the later planting date was May 20, 2015. Four common spring wheat cultivars were planted representing popular soft white and hard red classes. The hard red spring varieties were the standard Yecoro Rojo and a newer variety Fuzion. The soft white wheat varieties were Alpowa and Nick. Five seeding rates were evaluated based on an actual seed population density rather than number of pounds per acre. Therefore, the number of pounds per acre varied somewhat depending on the cultivar and seed size. The seeding rates are presented in Table 1 below.

Table 1. Relationship between seed density per acre and pounds per acre for the seeding rate treatments selected.

Seeding rate Seeds/acre	**Yecoro Rojo**	**Fuzion**	**Alpowa**	**Nick**	**Average**
(x 1,000,000)	----------lbs./Acre----------				
0.8	77	85	77	87	82
1.1	105	117	106	120	112
1.4	134	149	135	152	143
1.7	163	181	164	185	173
2.0	191	213	193	218	204

Stand density was determined when wheat seedlings had approximately 1.5 leaves for both planting dates. Tillers were counted approximately a month later at around the jointing stage and again after heading to determine the density of productive tillers. Thirty seedheads were collected per plot to determine head size (number of spikelets per head, number of kernels per head and average kernel weight). Those numbers are still being determined and are not available at this time. Yield and bushel weight were also determined for all planting date, cultivar and seeding rate combinations.

Budget

The total budget for this project in 2015 was $6700. A total of $1347.56 were spent on the IREC recharge rate for labor ($13.75 per hour) used for field preparation, irrigation, harvest, general plot maintenance, and data collection. Funds were also spent for a Field Assistant housed at my office in Yreka who helped with field labor, processing of the seed heads and protein analysis. This project is particularly labor intensive due to the nature of some of the data collected including stand counts, tiller counts, seed head counts, spikelet counts, and determination of the number of kernels per head. A total of $3186.84 for wages plus $1065.60 for benefits were used to support my Field Assistant's work on this project.

Results

As in previous years, planting date had a significant effect on yield. Averaged over all varieties and seeding rates, the April planting date yielded 2.60 tons per acre while the May planting yielded 2.92 tons per acre. These yield levels were comparable to 2014 yields, but lower than 2013. This was true for commercial fields in the Klamath Basin as well. This was likely due to the drought and abnormally high spring temperatures. Wheat variety had a highly significant effect on yield. Averaged over planting dates and seeding rates, the yield for Yecoro Rojo, Fuzion, Alpowa and Nick was 2.50, 2.88, 2.57 and 2.81 tons per acre, respectively. As in previous years, there was a highly significant interaction between planting date and variety (Table 2) with respect to yield. This means that not all varieties responded the same to the two planting dates. It is interesting to note that unlike the other varieties, the variety Yecoro rojo, yielded higher at the later seeding date, which is consistent with the previous year's research.

Averaged over varieties and planting dates, seeding rate did not have a significant effect on yield (Table 2). In addition, there were no significant interactions between seeding rate and any of the other factors (i.e., seeding rate x variety, seeding rate x date, or seeding rate x data x variety).

Why yield did not increase with increasing seeding rate may be explained by evaluating the growth parameters that contribute to yield. As shown in Table 2, planting date and seeding rate both had a significant effect on wheat stand. There was a steady increase in plant population with every incremental increase in seeding rate for all four varieties. Plant population was highly correlated with seeding rate with nearly twice as many plants per linear foot for the highest seeding rate compared with the lowest (Table 3). Similar to the results in 2013, seeding rate also affected the number of tillers (Table 4). However, the effect was significantly reduced compared with the effect on stand, and while statistically significant, the effect was somewhat variable. Similar to both previous years, post-heading spike counts indicated there was no difference in reproductive tillers associated with the different seeding rates (Table 5). Apparently, higher seeding rates had an effect on the initial number of plants but over time the plants are able to compensate for a lower density and the there is less effect on the number of tillers per unit area and no effect on the density of reproductive tillers. Data collected on the number of spikelets per head and the number of kernels per head should further explain why there was no effect of seeding rate on yield. Due to the late harvest of grain in the Intermountain area, there has not been time to finish collecting those data from stored seed heads, which are still being counted. It will be completed at a later date.

There were significant differences in bushel weight due to planting date and variety as well as a highly significant interaction between seeding date and rate. This is consistent with the results from previous years.

Table 2. Analysis of variance evaluating the effect of planting date, variety, seeding rate and their interaction on wheat growth and yield parameters.

	Stand	Tiller Counts	Spike Counts	Height	Yield	Bushel Weight
Planting Date	0.0057	0.0117	0.2077	0.1623	0.0419	0.0019
Variety	0.5003	<.0001	<0.0001	<.0001	<.0001	<.0008
Seeding rate	<.0001	0.0074	0.2578	0.3776	0.1445	0.0417
Date x Variety	0.8801	0.2475	0.0028	0.0143	<.0001	<.0001
Variety x Rate	0.8760	0.8247	0.7834	0.0995	0.2080	0.5100
Date x Rate	0.5841	0.3989	0.5151	0.7123	0.4636	0.0817
Date x Variety X Rate	0.8832	0.3448	0.2664	0.7649	0.6662	0.7342

Discussion, Conclusions and Recommendations (Discuss the implications of the results of the research on project objectives. What conclusions can be made based on current findings and what future research is needed?)

Planting date had a significant effect on yield with the earlier planting date being better for all the varieties at nearly all seeding rates, except for the variety Yecoro Rojo, which actually performed better at the later seeding date. This behavior for Yecoro Rojo was consistent with previous years where the late planting performed better. Increasing seeding rate did not improve yield. This was true each year of the study, even though yield potential was relatively low in 2014 and 2015 compared with 2013. These results are in contrast with the results of the earlier study at the OSU Klamath Experiment Station referred to in the introduction. High seeding rates were not justified for any variety or planting date. There was a slight trend for an increase in yield as seeding rate increased from 0.8 to 1.1 million seeds per acre for some varieties in 2015, but the trend was not statistically significant and did not occur in other years. There was no justification for any of the higher seeding rates used in this study. As mentioned in the introduction, common seeding rates currently used in the Klamath Basin are 125 lbs./A for soft white wheat and 140 lbs./A for hard red spring wheat. This finding demonstrates that these seeding rates are not justified, even in fairly low yield potential years, and growers can potentially save money in seeding costs.

Table 3. The effect of seeding date and rate on **stand density** of four spring wheat cultivars in Tulelake, CA.

Variety	Seeding rate Seeds/acre (x 1,000,000)				
Planting	0.8	1.1	1.4	1.7	2
Yecoro Rojo	**----------Number of plants/linear foot of**				
Early	10.9	13.1	14.1	18.2	20.3
Late	9.2	11.4	13.0	15.7	18.8
Fuzion					
Early	10.7	12.6	14.4	16.4	17.3
Late	9.9	10.9	11.9	16.4	18.5
Alpowa					
Early	10.6	12.6	14.4	16.2	17.6
Late	9.5	10.6	11.9	15.8	16.3
Nick					
Early	11.4	12.4	14.3	17.3	18.1
Late	10.0	11.0	13.6	14.5	18.3

Table 4. The effect of seeding date and rate on the **tiller count** of four spring wheat cultivars in Tulelake, CA.

Variety	Seeding rate Seeds/acre (x 1,000,000)				
Planting	0.8	1.1	1.4	1.7	2
Yecoro Rojo	**--------Number of tillers per linear foot of**				
Early	39.7	43.6	43.4	45.1	43.1
Late	47.4	42.4	48.0	47.3	57.7
Fuzion					
Early	40.6	39.1	39.3	38.4	39.7
Late	45.1	41.7	47.3	50.3	46.3
Alpowa					
Early	48.2	49.1	56	54.1	50.8
Late	57.9	62.4	62.8	63.8	65.1
Nick					
Early	39.5	38.8	36.9	41.4	41.4
Late	45.3	45.9	51.3	53.9	49.1

Table 5. The effect of seeding date and rate on the **spike counts** of four spring wheat cultivars in Tulelake, CA.

Variety	Seeding rate Seeds/acre (x 1,000,000)				
Planting date	0.8	1.1	1.4	1.7	2
Yecoro Rojo	----------Number of spikes per linear foot of				
Early	36.5	33.5	34.4	34.6	36.2
Late	36.1	40.6	39.5	39.7	39.4
Fuzion					
Early	30.7	32.3	34.4	32.9	31.0
Late	34.5	33.1	33.9	36.3	34.5
Alpowa					
Early	38.8	40.1	41.2	40.2	38.9
Late	34.7	33.9	38.7	40.8	40.3
Nick					
Early	33.0	35.4	31.1	34.5	32.8
Late	38.5	37.6	39.0	38.7	37.1

Table 6. The effect of seeding date and rate on the **height** of four spring wheat cultivars in Tulelake, CA.

Variety	Seeding rate Seeds/acre (x 1,000,000)				
Planting	0.8	1.1	1.4	1.7	2
Yecoro Rojo	----------Plant Height				
Early	62.3	67.5	68.3	69.5	73.3
Late	69.0	72.0	71.8	70.5	72.5
Fuzion					
Early	99.5	104.0	105.8	100.8	105.0
Late	101.3	100.3	101.5	101.8	103.3
Alpowa					
Early	101.8	102.3	102.3	100.0	97.8
Late	98.8	100.5	100.0	96.8	94.5
Nick					
Early	96.8	99.5	96.3	101.0	95.0
Late	95.0	92.8	96.0	95.0	95.0

Table 7. The effect of seeding date and rate on the **yield** of four spring wheat cultivars in Tulelake, CA.

Variety	Seeding rate Seeds/acre (x 1,000,000)				
Planting date	0.8	1.1	1.4	1.7	2
Yecoro Rojo	----------tons/A----------				
Early	2.36	2.55	2.33	2.38	2.50
Late	2.61	2.59	2.57	2.57	2.52
Fuzion					
Early	2.84	3.09	3.14	3.00	3.08
Late	2.63	2.75	2.99	2.53	2.72
Alpowa					
Early	2.83	2.97	2.70	2.80	2.65
Late	2.24	2.39	2.43	2.46	2.29
Nick					
Early	2.75	3.07	2.78	2.87	2.86
Late	3.02	2.92	2.55	2.61	2.70

Table 8. The effect of seeding date and rate on the **bushel weight** of four spring wheat cultivars in Tulelake, CA.

Variety	Seeding rate Seeds/acre (x 1,000,000)				
Planting	0.8	1.1	1.4	1.7	2
Yecoro Rojo	----------Bushel Wt				
Early	57.8	58.2	56.9	57.4	58.2
Late	61.1	60.9	61.1	61.0	61.4
Fuzion					
Early	58.9	59.7	59.5	59.0	59.0
Late	60.8	60.3	60.8	60.3	60.7
Alpowa					
Early	60.0	60.2	59.4	59.0	59.3
Late	58.3	58.2	57.8	58.2	58.4
Nick					
Early	58.6	59.3	57.7	57.8	58.6
Late	59.8	59.8	58.7	60.1	59.1