# 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 overlooked and producers oftentimes settle on a common seeding rate that is used in a given wheat production region. Seeding rates in Tulelake are generally higher than in other production regions in the Intermountain area and recent research by OSU in Klamath Falls has suggested that even higher seeding rates could be beneficial. A research project was initiated to evaluate the impact of planting date (April or May), cultivar (four common spring wheats representing different classes) and seeding rate (5 rates ranging from approximately 80 to 200 lbs. per acre) on wheat yield and bushel weight. Across all varieties, seeding rate had a profound effect on plant density, a lesser effect on tiller density and no effect on the density of reproductive tillers. For this reason, it appears that yield was relatively similar across a broad range of seeding rates. Very High seeding rates over approximately 140 pounds per acre were not justified for any of the varieties or planting dates evaluated. However, the effect of seeding rate varied depending on the planting date and cultivar. This initial year of data suggests that for this high-yield potential site, growers could further maximize profitability by fine tuning the seeding rate according to the variety and planting date.

**Introduction and Objectives**
Many wheat growers in the intermountain area feel that they have reached a yield plateau and growers seek new ways to maximize yield potential. Spring wheat in the intermountain area is generally seeded in April to early May. Unlike wheat plantings in fall/winter where there is a prolonged time period with cool temperatures after seeding, temperatures often rise considerably soon after a spring wheat planting. Warm temperatures may limit the degree of tillering in spring wheat. Therefore, a logical approach may be to increase the seeding rate to increase the number of productive tillers per unit area. Seeding rates are oftentimes based on past practice and a "standard" seeding rate is often settled upon for a given production area. Most seeding rate studies have focused on a relatively narrow range of rates, but recent research conducted by Richard Roseburg at the OSU Klamath Experiment Station in the OR side of the Klamath Basin evaluated a broad range of seeding. 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.

These results from the Klamath study demonstrated the need for additional research on seeding rate. Planting date can also have a significant impact on the number of tillers produced per plant with early plantings producing more tillers. Hence, the optimum seeding rate may vary depending on seeding rate. Therefore, the effect of seeding rate should be evaluated under different planting dates.

**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 productive tiller production, kernel number, bushel weight and yield
3. Quantify the interaction between seeding rate and planting date.

**Materials and Methods**

The trial is 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 9, 2013 and the later planting date was May 2, 2013. 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** |
|---|---|---|---|---|
| **(x 1,000,000)** | ----------Lbs./Acre---------- | | | |
| 0.8 | 90 | 80 | 77 | 84 |
| 1.1 | 124 | 110 | 106 | 116 |
| 1.4 | 158 | 139 | 135 | 147 |
| 1.7 | 192 | 169 | 164 | 179 |
| 2.0 | 226 | 199 | 193 | 211 |

The density of wheat seedlings was determined when the plants had approximately 1.5 leaves for both planting dates. Tillers were counted a little over 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). Yield and bushel weight were also determined for all planting date, cultivar and seeding rate combinations.

**Budget**

The funds were spent on the IREC recharge rate for hourly labor ($12.64 per hour). This includes labor used for field preparation, irrigation, harvest and general plot maintenance as well as data collection. Funds were also spent for two Student Assistants who helped with field labor. This project was 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. We are still in the process of determining the spikelet counts and the number of kernels per head on samples collected prior to harvest. A more detailed accounting of how funds were spent can be prepared if desired.

**Results**

Planting date was found to have a highly significant effect on yield. Averaged over all varieties and seeding rates the April planting date yielded 3.77 tons per acre while the May planting yielded 3.62 tons per acre. 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 3.22, 3.68, 4.12 and 3.77 tons per acre, respectively. This ranking is consistent with grower experience in the area. There was also a highly significant interaction between planting date and variety (Table 2). This means that not all varieties responded the same to the two planting dates. Fuzion and Alpowa yielded higher at the early planting date for all five seeding densities. However, the exact opposite was the case for Yecoro rojo which actually tended to yield higher at the later seeding date for each of the five seeding rates evaluated. The same trend was also indicated for the variety Nick at most seeding rates.

It is interesting to note that seeding rate did not have a significant effect on yield (Table 2). However, there was a significant interaction between variety and seeding rate. What this means is that the effect of seeding rate changed depending on the varieties evaluated (Table 8). There was no clear trend for Yecoro rojo. For the variety Fuzion the yield increased when seeding rate was increased from 80 to 110 pounds per acre but there was no increase in yield at rates above that. For the soft white varieties Alpowa and Nick, yield actually decreased with increasing seeding rate at the early planting date but not for the late planting date.

The logical question is why was there not a consistent increase in yield with increasing seeding rate across all varieties. Perhaps this can be explained by studying the other grain growth parameters evaluated. As shown in Table 2, variety, seeding rate and seeding date x seeding rate all had a significant effect on wheat stand. There was a steady increase in plant population with every increase in seeding rate for all four varieties. Plant population was highly correlated with seeding rate with over twice as many plants for the highest seeding rate compared with the lowest (Table 3). While seeding rate also had a strong effect on the number of tillers per unit area (Table 4), the increase in tillers was not nearly as great as the increase in plant population with increasing seeding rate. What this means is that the number of tillers per plant decreased as seeding rate increased. This was especially true when one considers the number of productive tillers. Post-heading counts indicated there was no difference in reproductive tillers associated with the different seeding rates (Table 5). Apparently higher seeding rates increased the number or plants but had less of an effect on the number of tillers per unit area and no significant 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 (when averaged across all four varieties). However, 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. It will be completed at another date.

There were significant differences in bushel weight between varieties. However, seeding rate had no effect on bushel weight. There was a significant difference in lodging between varieties. While not statistically significant, there was a trend for increased lodging at higher seeding rates.

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

| | Stand | Tiller Counts | Spike Counts | Height | Lodging | Yield | Bushel Weight |
|---|---|---|---|---|---|---|---|
| **Planting Date** | 0.6145 | 0.0002 | 0.4362 | 0.0006 | 0.0813 | 0.039 | 0.3762 |
| **Variety** | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 |
| **Seeding rate** | <.0001 | <.0001 | 0.2580 | 0.2475 | 0.0656 | 0.315 | 0.2425 |
| **Date x Variety** | 0.4118 | <.0001 | 0.8596 | 0.0486 | 0.4577 | 0.0004 | 0.0028 |
| **Variety x Rate** | 0.0143 | 0.2869 | 0.1647 | 0.8616 | 0.4649 | 0.0088 | 0.1177 |
| **Date x Rate** | <.0001 | 0.0132 | 0.0883 | 0.1460 | 0.5737 | 0.1159 | 0.0707 |
| **Date x Variety X Rate** | 0.5617 | 0.3258 | 0.8335 | 0.5652 | 0.6657 | 0.8757 | 0.1138 |

**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; however, the effect differed between varieties. Fuzion and Alpowa performed significantly better at the early planting date; whereas, the opposite was the case for Yecoro rojo and Nick. This demonstrates the importance of planting date when evaluating the performance of different wheat cultivars. In contrast to the results from the previous study conducted at the OSU Klamath Experiment Station, we did not find an increase in yield with increasing seeding rate. This may be due to the higher yield potential at the Tulelake site. It appears that at a high yielding site plants seeded at a lower density were able to compensate. Increasing seeding rate resulted in higher plant density and a slightly higher tiller density. However, when it came to reproductive tiller density there was no difference in tiller number across seeding rates. This suggests that with a high seeding rate more of the tillers fail to produce heads. Overall, real high seeding rates were not justified for any variety or planting date. In general, yield did not increase for any variety when seeding rate increased above 1,400,000 seeds per acre (approximately 140 lbs. per acre). It is important to note that varieties responded somewhat differently to seeding rate and at the early planting date, the soft white varieties Alpowa and Nick actually tended to yield higher at a low seeding rate compared with a higher seeding rate. However, at the later planting date this did not appear to be the case.

These results just represent one year of data and this research should be repeated to have more confidence in the findings. However, they suggest that very high seeding rates are not needed for any of the varieties tested and yield is relatively similar across quite a wide range of seeding rates. This finding can save growers money in seed costs. However, this does not mean that seeding rates cannot be fine-tuned to greater maximize profitability. It appears that both variety and seeding date should be considered when selecting a seeding rate to settle on the most appropriate seeding rate for the conditions. However, another year of research is important to confirm these trends.

**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 date | 0.8 | 1.1 | 1.4 | 1.7 | 2 |
| **Yecoro Rojo** | **----------Number of plants/linear foot of row----------** | | | | |
| Early | 29.5 | 41.3 | 54.0 | 56.8 | 71.7 |
| Late | 33.7 | 41.5 | 51.7 | 61.2 | 62.8 |
| **Fuzion** | | | | | |
| Early | 28.6 | 41.7 | 48.3 | 55.4 | 76.7 |
| Late | 33.1 | 43.9 | 49.2 | 57.4 | 64.8 |
| **Alpowa** | | | | | |
| Early | 29.7 | 38.4 | 48.3 | 64.0 | 66.5 |
| Late | 31.25 | 38.85 | 49.93 | 56.65 | 51.18 |
| **Nick** | | | | | |
| Early | 27.0 | 35.6 | 47.4 | 57.4 | 63.4 |
| Late | 30.9 | 38.7 | 47.7 | 49.6 | 55.9 |

**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 row----------** | | | | |
| Early | 48.6 | 49.6 | 45.8 | 59.1 | 49.9 |
| Late | 42.3 | 52.0 | 51.0 | 58.8 | 58.5 |
| **Fuzion** | | | | | |
| Early | 36.9 | 41.0 | 49.6 | 47.6 | 46.5 |
| Late | 35.3 | 44.1 | 47.9 | 54.0 | 52.5 |
| **Alpowa** | | | | | |
| Early | 46.25 | 54.0 | 60.3 | 59.5 | 52.75 |
| Late | 69.1 | 77.1 | 71.5 | 76.3 | 82.5 |
| **Nick** | | | | | |
| Early | 49.6 | 50.1 | 55.3 | 49.8 | 53.4 |
| Late | 38.0 | 39.5 | 45.9 | 50.4 | 51.6 |

**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 row--------** | | | | |
| Early | 40.2 | 42.8 | 41.7 | 48.4 | 43.4 |
| Late | 43.1 | 41.9 | 40.4 | 42.5 | 40.1 |
| **Fuzion** | | | | | |
| Early | 32.5 | 36.6 | 42.2 | 37.7 | 36.2 |
| Late | 35.0 | 37.4 | 37.3 | 37.0 | 37.3 |
| **Alpowa** | | | | | |
| Early | 44.6 | 44.0 | 45.3 | 52.0 | 46.8 |
| Late | 47.8 | 42.4 | 45.8 | 45.8 | 42.4 |
| **Nick** | | | | | |
| Early | 40.2 | 42.3 | 43.3 | 39.1 | 39.4 |
| Late | 41.2 | 37.9 | 39.9 | 37.4 | 39.3 |

**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 date | 0.8 | 1.1 | 1.4 | 1.7 | 2 |
| **Yecoro Rojo** | **----------Plant Height (cm)----------** | | | | |
| Early | 64.0 | 64.3 | 63.8 | 66.8 | 64.3 |
| Late | 61.8 | 65.8 | 62.3 | 62.5 | 62.8 |
| **Fuzion** | | | | | |
| Early | 98.5 | 97.5 | 100.0 | 98.8 | 96.3 |
| Late | 91.8 | 96.0 | 92.0 | 93.0 | 95.0 |
| **Alpowa** | | | | | |
| Early | 90.3 | 88.5 | 90.3 | 95.0 | 87.8 |
| Late | 90.5 | 90.8 | 89.8 | 89.3 | 88.8 |
| **Nick** | | | | | |
| Early | 89.0 | 92.5 | 88.5 | 88.0 | 86.5 |
| Late | 88.3 | 88.3 | 87.3 | 87.5 | 87.8 |

**Table 7.** The effect of seeding date and rate on the lodging 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** | ---------- Lodging (%)---------- | | | | |
| Early | 18.8 | 36.3 | 38.8 | 21.3 | 11.3 |
| Late | 0 | 0 | 0 | 0 | 21.3 |
| **Fuzion** | | | | | |
| Early | 1.3 | 5.0 | 25.0 | 51.3 | 22.5 |
| Late | 1.3 | 21.3 | 7.5 | 42.5 | 16.3 |
| **Alpowa** | | | | | |
| Early | 50.0 | 65.0 | 38.8 | 81.3 | 82.5 |
| Late | 63.8 | 46.3 | 32.5 | 73.8 | 57.5 |
| **Nick** | | | | | |
| Early | 66.3 | 60.0 | 80.0 | 65.0 | 53.8 |
| Late | 20.0 | 36.3 | 30.0 | 62.5 | 58.8 |

**Table 8.** 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 | 3.13 | 3.06 | 3.22 | 3.06 | 3.14 |
| Late | 3.29 | 3.29 | 3.35 | 3.31 | 3.38 |
| **Fuzion** | | | | | |
| Early | 3.71 | 3.95 | 3.87 | 3.85 | 3.82 |
| Late | 3.24 | 3.62 | 3.42 | 3.71 | 3.59 |
| **Alpowa** | | | | | |
| Early | 4.87 | 4.51 | 4.37 | 4.12 | 4.32 |
| Late | 3.88 | 3.66 | 4.00 | 3.56 | 3.95 |
| **Nick** | | | | | |
| Early | 4.00 | 3.76 | 3.70 | 3.57 | 3.43 |
| Late | 3.94 | 3.98 | 3.78 | 3.81 | 3.78 |

**Table 9.** 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 date | 0.8 | 1.1 | 1.4 | 1.7 | 2 |
| **Yecoro Rojo** | ----------**Bushel Wt (lbs.)**---------- | | | | |
| Early | 62.0 | 61.6 | 61.5 | 61.7 | 62.1 |
| Late | 61.6 | 61.7 | 62.0 | 61.3 | 61.6 |
| **Fuzion** | | | | | |
| Early | 62.2 | 62.0 | 61.6 | 62.6 | 61.6 |
| Late | 60.5 | 61.8 | 60.3 | 61.4 | 61.4 |
| **Alpowa** | | | | | |
| Early | 61.4 | 62.3 | 62.4 | 62.3 | 61.6 |
| Late | 62.4 | 62.1 | 61.5 | 61.6 | 62.0 |
| **Nick** | | | | | |
| Early | 61.5 | 60.1 | 60.5 | 60.9 | 59.5 |
| Late | 61.0 | 61.5 | 60.6 | 60.6 | 60.6 |