FINAL REPORT

Planting Date and Cultivar Effects on Winter Wheat Yield

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Abstract/Summary of Results and Conclusions
There has been an increase in winter wheat plantings in recent years because the yield is typically consistently higher than that achieved with spring wheat. This has been a practice that was discouraged in the past due to concerns over winter kill or frost injury. There is a broad range of planting dates for winter wheat in the Klamath Basin from October to February, and research was needed to determine the most advantageous planting window. The trial conducted in 2014 was duplicated in 2015. Eight high yielding winter wheat varieties (5 soft white winter and 3 hard red winter varieties) were seeded at the Intermountain Research and Extension Center (IREC) in Tulelake at four planting dates (September 26, October 14, November 10 and February 20). This year the February planting date was the lowest yielding, followed by the earliest planting date (September). February planting is considered risky and should be avoided, while the September planting is too early and should similarly be avoided. The October planting date was the overall highest yielding for all eight varieties and significantly better than November. The results over the last two years suggest that October planting is the preferred timing for planting winter wheat in the Klamath Basin.

Introduction and Objectives
Despite the recent downturn in wheat prices, wheat remains an important crop in the Klamath Basin and will remain so in the future. Unlike other wheat production areas in California, where spring wheat cultivars are actually grown over the winter, spring wheat in the intermountain area is sown in spring and grown over the summer. True winter wheat cultivars are required for planting in the fall in order to survive the harsh winter temperatures. Spring wheat is more common, but winter wheat production is gaining in popularity because in many or most years it is higher yielding. Spring wheat is typically seeded in April and warm/hot temperatures often follow within a couple of months after seeding, limiting the potential yield. Because of the climatic conditions in the Klamath Basin, the actual timing of winter wheat plantings occur over a long time period. Planting dates for winter wheat typically range from October through November, then cease in mid-winter due to the severe cold, and some plantings may occur in late-winter (February). In the past, winter wheat production in the Klamath Basin was typically discouraged because of the possibility of winter kill or floret sterility caused by untimely spring frosts. To overcome this risk, winter wheat is sometimes planted in February, but with this timing yield potential may be reduced because there is less time for tillering, and growers run the risk of there not being sufficient chill hours to satisfy the vernalization requirement of winter wheat.

Research conducted in 2014 showed that the earliest planting date (September) was the lowest yielding. The November planting date did not perform as well either for some cultivars due to the lack of sufficient rainfall after seeding. October and February planting dates were the overall highest yielding. These results are very interesting and were not predicted. Therefore, was imperative to duplicate this study for another year due to year-to-year variability in weather conditions to determine if these were consistent and can be used to guide planting date decisions.

The objectives of this research are to:

1. Compare the yield potential of several leading cultivars of soft white winter wheat and hard red winter wheat across a range of planting dates

2. Determine the effect of four different planting dates (September, October, November, and February) on the yield of eight different winter wheat cultivars

Materials and Methods

Eight winter wheat varieties were seeded at 120 pounds per acre using a cone seeder at four different planting dates at the Intermountain Research and Extension Center (IREC) in Tulelake, CA. Because soft white winter wheat has been more popular than hard red varieties, we selected 5 soft white varieties and three hard red varieties (Soft white varieties: Bruneau, Mary, Tubbs, Bobtail and SY Ovation. Hard red varieties: Norwest 553, Azimut and Keldin). The planting dates we evaluated were September 26, October 14, November 10 and February 20. Sprinkler irrigation occurred after planting for the September and October planting dates. November and February planting dates were not irrigated after planting and relied on rainfall and soil moisture for germination.

A split-plot experimental design was used with planting date as the main plot and winter wheat cultivar as the sub plot. The planting date main plots were separated from each other so that the September and October planting date plots could be irrigated independently in the fall. All plots were uniformly irrigated during the spring and summer. Heading date was determined for all plots. Plant height was measured before harvest. All plots were harvested for yield with a small plot combine and bushel weight determined.

Budget

The total amount of funding for this project was $5600.0 Of that total, $1347.56 were spent for the IREC recharge rate for hourly labor ($13.75 per hour). This includes labor used for field preparation, irrigation, harvest and general plot maintenance as well as data collection. Funds were also used for my Field Assistant who helped conduct the trial. Total labor charges were $3186.84 for salary and $1065.60 for benefits.

Results

Winter wheat yields in the Klamath Basin were much lower than normal this year—both in this trial and in commercial fields. In fact, average yield across all treatments and planting dates was over a ton per acre lower in 2015 than 2014. The reason for such low yields this year are not fully understood, but is likely due to a combination of low rainfall over the winter and early spring resulting in a lack of deep soil moisture, hot temperatures in early spring/summer impacting grain fill, and the occurrence of a bacterial leaf disease. Also, the February planting this year performed particularly poorly (discussed in detail later), lowering overall yields. It is

interesting to note that the heading date for the first three planting dates was often as much as 10 days earlier in 2015 than 2014, except for the February planting date which actually had a heading date 2-4 days later than in 2014 for most varieties (Table 1). This early maturity due to hot spring/early summer temperatures may in part explain the low yields in 2015.

Table 1. The effect of planting date and cultivar on the heading date of winter wheat in the Klamath Basin. IREC 2014.

	Heading Date 2015			
	Planting Date			
	Sept 26	**Oct 14**	**Nov 10**	**Feb 20**
Bruneau	10-Jul	16-Jul	18-Jul	1-Aug
Mary	10-Jul	10-Jul	15-Jul	28-Jul
Tubbs	12-Jul	13-Jul	17-Jul	31-Jul
Bobtail	9-Jul	12-Jul	17-Jul	1-Aug
SY Ovation	10-Jul	10-Jul	15-Jul	28-Jul
Norwest 553	11-Jul	12-Jul	15-Jul	3-Aug
Azimut	10-Jul	10-Jul	13-Jul	25-Jul
Keldin	8-Jul	10-Jul	14-Jul	25-Jul
	Heading Date 2014			
	Planting Date			
	Sept 25	**Oct 15**	**Nov 10**	**Feb 4**
Bruneau	21-Jul	27-Jul	4-Aug	31-Jul
Mary	19-Jul	21-Jul	30-Jul	26-Jul
Tubbs	20-Jul	27-Jul	2-Aug	1-Aug
Bobtail	19-Jul	19-Jul	30-Jul	3-Aug
SY Ovation	19-Jul	24-Jul	8-Aug	27-Jul
Norwest 553	21-Jul	27-Jul	3-Aug	28-Jul
Azimut	19-Jul	22-Jul	1-Aug	27-Jul
Keldin	19-Jul	19-Jul	24-Jul	21-Jul

There was a highly significant difference in yield between cultivars (Table 2). In 2014, the soft white winter wheats tended to yield higher than the hard red varieties. However, this year the hard red variety Keldin actually yielded higher (Table 3) than the soft white varieties (it was the highest yielding hard red variety last year but not the highest yielding variety overall). In 2014 Tubbs was the highest yielding soft white variety but this year SY Ovation was higher yielding averaged across all four planting dates but Tubbs was higher at the first two planting dates.

Table 2. Analysis of variance evaluating the effect of planting date, variety, and the interaction of planting date and variety on plant height, yield, and bushel weight.

	Height	**% Cover**	**Yield**	**Bushel Weight**
Planting Date	0.0006	0.0017	0.0037	0.037
Variety	<.0001	0.0006	<.0001	<.0001

Planting Date x Variety	<.0001	<.0001	<.0001	0.0001

Planting date was found to have a highly significant effect on yield but the results were somewhat different from the previous year. In 2014, the February planting date generally performed as well as the earlier planting dates. However, this year the February planting date had by far the lowest yield (in many cases less than half the yield of other planting dates). This was true for all eight varieties except for Azimut, where the September planting date was numerically lower (Table 3 and Figure 1). This year the February planting date was seeded little later due to weather (February 20 versus February 4th in 2014) and temperatures after planting were warmer than average. It appeared at first that the plants may not have enough chill hours to satisfy their vernalization requirement, but eventually the plants did produce a seed head. The September planting date was lower yielding than the October or November planting dates, in agreement with last year's results. The October planting was numerically higher than any of the other three planting dates for all 8 varieties. The difference was especially dramatic for some varieties. For example, the variety Keldin yielded 3.46 tons/A when planted in October (a yield comparable to the yield levels seen last year), but had less than half the yield (1.54 tons/A) when planted in February. The October planting date was also far superior to the September planting, especially for some varieties. For example, Azimut yield was 2.20 tons/A with an October planting but had just over half the yield when planted in September (1.13 tons/A).

Table 3. The effect of planting date and cultivar on the yield of winter wheat in the Klamath Basin. IREC 2015. (95% confidence intervals between: planting date means: 0.46, variety means: 0.26, planting date and variety means 0.51).

	Yield (tons/acre)				
	Sept 26	**Oct 14**	**Nov 10**	**Feb 20**	**Mean**
Bruneau	1.49	2.43	2.24	1.05	1.80
Mary	1.36	2.58	2.24	1.31	1.87
Tubbs	2.16	3.02	2.11	1.07	2.09
Bobtail	2.18	2.84	1.64	0.89	1.89
SY Ovation	1.76	2.81	2.44	1.55	2.14
Norwest 553	1.51	2.12	1.47	1.21	1.58
Azimut	1.13	2.20	1.64	1.26	1.56
Keldin	2.71	3.46	2.70	1.54	2.60
Mean	1.79	2.68	2.06	1.39	

In addition to yield, bushel weights were also significantly lower in 2015 compared with 2014. The variety Azimut had the lowest bushel weight (Table 4), in agreement with the results from last year. Bushel weight was significantly lower for the September planting date compared with other planting dates. There was also a significant planting date x variety interaction effect on bushel weight.

Table 4. The effect of planting date and cultivar on the bushel weight of winter wheat in the Klamath Basin. IREC 2015. (95% confidence intervals between: planting date means: 1.6, variety means: 1.4, planting date x variety means 2.0).

	Bushel Weight (lbs)				
	Sept 26	**Oct 14**	**Nov 10**	**Feb 20**	**Mean**
Bruneau	50.4	51.9	52.2	53.6	52.0
Mary	49.1	51.4	51.0	51.5	50.8
Tubbs	49.8	52.7	49.1	51.4	50.7
Bobtail	44.7	49.4	44.5	47.5	46.5
SY Ovation	51.1	52.5	52.8	54.3	52.7
Norwest 553	50.9	52.5	51.7	55.9	52.7
Azimut	42.6	47.7	44.3	45.1	44.9
Keldin	56.2	57.6	55.7	56.5	56.5
Mean	49.3	52.0	50.2	52.0	

Discussion, Conclusions and Recommendations

These results, together with the results from last year, provide significant insight into the optimum planting date for the Intermountain area. While a February planting performed very well the first year, it was the lowest yielding planting date the second year. Poor yields when planting in February this year were likely the result of warm weather after planting. The plants were the shortest of all the plantings and had the lowest percent cover at harvest (Tables 5 and 6). As it is not feasible to predict the weather after planting, there is significant risk inherent with a February planting. It may be successful some years, but a disaster in other years (like 2015). For this reason, February planting should be considered very risky and be avoided if possible.

Initially, before conducting this research many believed a September planting might be advantageous. While this planting time might be inconvenient for growers (due to harvest schedules for the preceding crop, and this planting time would likely require an irrigation for germination), it might yield significantly higher, as early fall-seeded wheat typically appears much larger and vigorous going into the winter. However, to our surprise, September was one of the worst planting dates (the worst in 2014 and second worst in 2015). It is believed that the September planting is low yielding because the plants grow more over the fall and enter the winter in a growth stage that is more susceptible to cold injury. It is interesting to note that the September planting date also resulted in the shortest plants in 2014 and second shortest in 2015 (see Table 5). Based on this results, a September planting is not recommended because it was low yielding and would be difficult for producers to accomplish.

Based on these 2 years of research, it appears that mid-October is the optimum planting date. It was the highest yielding planting date for all varieties this year and tended to be in 2014 as well. It appears that this planting date allows the plants to become well established before the onset for cold winter temperatures, yet they do not reach a growth stage that is particularly sensitive to

cold such as the September-planted wheat. This planting date has required an irrigation both study years, and the advantage may be lost or lessened if timely rainfall or an irrigation does not occur soon after planting.

Table 5. The effect of planting date and cultivar on the height of winter wheat in the Klamath Basin. IREC 2015. (95% confidence intervals between: planting date means: 7.2, variety means: 5.8, planting date x variety means 8.1).

	Plant Height (cm)				
	Sept 26	**Oct 14**	**Nov 10**	**Feb 20**	**Mean**
Bruneau	81	97	95	74	87
Mary	77	90	94	62	81
Tubbs	92	106	99	64	90
Bobtail	85	94	87	67	83
SY Ovation	83	98	94	71	87
Norwest 553	76	85	77	60	74
Azimut	71	78	75	59	71
Keldin	89	102	98	71	90
Mean	82	94	90	66	

Table 6. The effect of planting date and cultivar on percent cover of winter wheat in the Klamath Basin. IREC 2015. (95% confidence intervals between: planting date means: 6.7, variety means: 4.2, planting date x variety means 8.3).

	% Cover				
	Sept 26	**Oct 14**	**Nov 10**	**Feb 20**	**Mean**
Bruneau	80	88	90	65	81
Mary	81	90	89	70	83
Tubbs	91	93	89	73	87
Bobtail	88	88	84	57	79
SY Ovation	89	81	91	80	86
Norwest 553	91	94	81	66	83
Azimut	79	91	86	65	80
Keldin	93	90	89	75	87
Mean	86	89	87	69	83

Figure 1. The effect of planting date and cultivar on the yield of winter wheat in the Klamath Basin. IREC 2015.