Northwest Columbia Plateau PM_{10} Project

Objective #5: ***Wind Erosion and PM_{10} Emission Control Methods***

Title: ***Agronomic Comparison of Pacific Northwest Winter Wheat Varieties and Advanced Breeding Lines in Early Planted Tilled Fallow versus Late-Planted Chemical Fallow***

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Abstract of Research Findings
Sixty percent of Washington's winter wheat production area receives only 150 to 300 mm annual precipitation (Hasslen and McCall, 1995). In this 3.7 million acre dryland area, stand establishment is the most important single factor affecting grain yield (Bolton, 1983). Through the practice of summer fallow, growers can generally achieve adequate stands of winter wheat (*Triticum aestivum* L.) by sowing in late August or early September into soil moisture accumulated from the previous winter. However, this practice leads to significant wind erosion. The alternative is to chemical fallow, but this production system leaves little moisture in the ground, requiring the producer to delay planting until significant moisture is accumulated through rainfall, usually mid to late October. The objective of this study is to determine which wheat cultivars are best suited for late planting into chemical fallow conditions compared to the conventional tilled fallow systems. When comparisons are made between market classes, the soft white and club classes are the most productive. Many cultivars show cross-over interactions between systems and years, usually indicative of emergence problems. Lines which can't emerge under the tilled system can emerge under the chemical fallow system. The tilled fallow system consistently has higher grain yield than the chemical fallow system. This is due to the delay in plant growth and heading (16 days later) of tested cultivars under the late planted conditions. This primarily results from testing cultivars not specifically selected for late-planting conditions. As growers make the decision to adopt chemical fallow conditions to reduce wind erosion, profitability becomes an issue. Although some cultivars perform well in both systems, grain yields are significantly reduced under late planting. It is hypothesized that to maximize production and grain yield in a late planted chemical fallow system, direct selection of breeding lines will be required.

Project Objective

The objective of this study is to evaluate the performance of current winter wheat cultivars direct seeded late (after mid-October rain) into chemical fallow as compared to the standard practice of early deep-furrow seeding (end of August) into conventional summer fallow.

Methods and Materials

Two research sites, Kahlotus, WA and Lind, WA, were established in the spring of 2009 with four replications of tilled fallow and chemical fallow strips randomly assigned. Fertility, tillage and weed control was managed by the cooperators with nitrogen and sulfur rates held constant for both fallow systems. A four-row deep furrow drill with split packers and 16" row spacing was used to plant the tilled fallow plots in August of 2009 and a no-till cross-slot drill with 10" row spacing was used to plant and fertilize in one pass the chemical fallow plots in October of 2009. Table 1 shows the agronomic data for each location. Data was collected on heading date, plant height, test weight, grain protein content, grain hardness, and grain yield. Planted were 12 soft white, 4 club, 10 hard red, and 4 hard white winter cultivars and breeding lines (Table 2).

Table 1. 2009-2010 data for the tilled fallow and chemical fallow plots at Lind, WA and Kahlotus WA.

Location	**Kahlotus, WA**		**Lind, WA**	
Treatment	Tilled fallow	Chem fallow	Tilled fallow	Chem fallow
Date of seeding	Aug. 18, 2009	Oct. 19, 2009	Aug. 25, 2009	Oct. 19, 2009
Rate of seeding	40 lbs/ac	60 lbs/ac	40 lbs/ac	60 lbs/ac
Fertility	50N-10S	50N-30P-10S	50N-10S	50N-30P-10S
Precipitation	9.71"		9.61"	
Planting depth	6.0"	• 1"	6.5"	• 1"
Harvest date	July 26, 2010	July 26, 2010	July 28, 2010	July 28, 2010

Table 2. Wheat cultivars/breeding lines and market class

Variety	**Market class**	**Variety**	**Market class**	**Variety**	**Market class**	**Variety**	**Market class**
Madsen	SWW	WA8065	SWW	Finley	HRW	Buchanan	HRW
Eltan	SWW	WA8064	SWW	Bauermeister	HRW	Hatton	HRW
Finch	SWW	WA8066	SWW	Eddy	HRW	MDM	HWW
Tubbs06	SWW	WA8094	SWW	Paladin	HRW	Palomino	HWW
Masami	SWW	Bruehl	Club	Farnum	HRW	WA8096	HWW
Xerpha	SWW	Chukar	Club	WA8068	HRW	WA8097	HWW
Stephens	SWW	Edwin	Club	WA8095	HRW		
Lewjain	SWW	Moro	Club	WA8022	HRW		

Results and Discussion

The early seeded wheat emerged well at both the Kahlotus and Lind research sites. Seed zone moisture was adequate, and planting depth was between 6 to 7 inches. The late planting on the chemical fallow ground also had good moisture for planting. There was no snow cover over most of the winter months and emergence was good under both the early and late seeded conditions. Early spring rains provided adequate moisture for early growth in both the conventional and chemical fallow systems. Extensive weed pressure was observed in all plots at both locations (primarily downy brome) which were poorly controlled with herbicides (due to the cool wet spring) and secondarily controlled through cultivation and hand-weeding. The Kahlotus location also had a high incidence of stripe rust. This manifested in resistant lines (primarily the club wheats) having higher grain yield than the other market classes.

In 2010, the conventional system provided the best agronomic performance when averaged over all entries (Table 3). This is similar to the 2009 data except that this year the protein content of lines in the conventional system was significantly higher. The main factor leading to the better performance of the conventional system is the difference in heading date. The conventional system headed 16 days earlier than the chemical fallow system. This meant that more heads were able to fill, and fill longer than the chemical fallow system. This was evident in both the decline in grain yield as well as test weight (Table 3). When comparing market class difference, the club and soft white lines significantly ($p<0.001$) yielded more than the hard red and white lines (Table 3). The hard red lines had significantly ($p<0.001$) higher test weight than other market classes (Table 3). The hard red and white market classes has significantly ($p<0.001$) higher protein content than the soft white and club wheat market classes (Table 3). The hard red and club market classes also had significantly ($p<0.05$) higher plant heights, which is primarily due to the fact that there are both standard height and semi-dwarf lines in these two market classes, which increases the mean value (Table 3).

Table 3. Differences between the conventional and chemical fallow systems as well as differing wheat market classes for five agronomic traits collected in 2010 and averaged over both the Kahlotus and Lind, WA locations.

Treatment	Heading Date	Plant Height	Grain Yield	Test Weight	Grain Protein
Conventional	142	32	47.7	61.6	11.3
Chemical	158	30	35.3	59.9	11.3
Difference	16 days***	2 inches*	12.4 bu/a***	1.7 lb/bu***	---
SWW	150	30	43.0***	60.3	10.8
Club	150	32*	46.3***	60.3	10.8
HRW	149	33*	38.8	61.6***	11.8***
HWW	150	30	38.7	60.4	11.7***

*P<0.05; **P<0.01; ***P<0.001

Tables 4, 5, and 6 include the data from individual market classes. Line performances are evaluated against those within their market class. Highlighted values are those which are significantly higher based on LSD values at $p=0.05$. Of most importance are grain yield values, and protein values in the hard market class, as these are the criteria for profit margins. Of particular interest are those lines which perform well under both the conventional and chemical fallow system. Conversely, lines which perform well under the chemical fallow system but not the conventional system may also be of interest. This data will help growers using the chemical fallow system to select lines which would have the greatest potential to be high yielding under their respective system. For example, the hard red breeding line WA8068 and cultivar Farnum were the highest yielding in both systems. The cultivar Paladin performed very poorly under the conventional system due to its poor emergence capability, but performed well under the chemical fallow system where emergence was not as great of an issue. Similar trends are seen with the club cultivar Chukar and the soft white cultivars Finch, Lewjain, and Masami. In 2009, many cross-over interactions were seen with the data. Tables 7 and 8 represent the top yielding cultivars for each year. Due to the differences in climatic conditions, there are not many consistencies across years. Hopefully the third year of data will further aid in determining which cultivars would perform best under each production system.

Based on the observations made in 2010, cultivars which have been breed and selected for conventional systems are not well suited for late planting conditions. This is primarily due to the slow growth of the plants in the springtime. Under conventional systems, winter wheat plants have accumulated significant growth before going dormant for the winter months. Conversely, the late planted crop has little time to grow before dormancy is initiated. Thus, a different mechanism is needed for late planted cultivars in order for them to be fully productive in this cropping system. For example, photoperiod insensitive lines may have a quicker growth pattern in the spring which would allow them to 'catch up' with the conventionally planted cultivars. Although this is only a hypothesis, it is estimated that to reach full grain yield potential under late planted chemical fallow systems, direct breeding efforts and selection in this system will be needed to maximize potential. This maximization is needed to aid wheat producers to switch from conventional systems to chemical fallow systems in order to mitigate wind erosion.

Table 4. Agronomic differences between genotypes in the soft white wheat market class under both conventional tilled fallow and chemical fallow cropping systems.

Location	**Combined**							
Treatment	Tillled fallow				Chem fallow			
Variety	**Rank**	**Yield**	**Twt**	**Prot.**	**Rank**	**Yield**	**Twt**	**Prot.**
Eltan	7	51.9	60.8	10.2	5	37.9	58.8	10.8
Finch	3	60.5	61.8	10.6	2	40.1	58.4	10.7
Lewjain	2	60.8	60.6	10.8	1	40.5	58.4	10.3
Madsen	12	35.1	61.1	11.8	9	32.7	59.3	11.6
Masami	1	62.3	61.6	10.0	3	39.9	58.5	10.4
Stephens	10	43.5	62.3	12.4	6	36.9	61.5	11.6
Tubbs06	9	48.7	60.1	10.5	4	38.8	58.0	10.8
WA008064	11	36.1	61.9	11.3	12	23.9	60.6	11.5
WA008065	8	50.9	62.2	10.5	8	34.7	60.6	11.5
WA008066	4	58.5	62.2	10.2	10	30.4	58.6	11.2
WA008094	5	53.8	61.8	10.7	7	35.9	59.8	10.5
Xerpha	6	52.5	60.5	10.2	11	26.1	57.1	10.5
Soft White		51.2	61.4	10.8		34.8	59.1	10.9
Overall		47.7	61.6	11.3		35.3	59.9	11.3
CV		18.4	1.48	9.92		20.3	1.44	5.50
LSD@.05		8.6	0.9	1.1		7.1	0.8	0.6

Table 5. Agronomic differences between genotypes in the club wheat market class under both conventional tilled fallow and chemical fallow cropping systems.

	Combined							
Treatment	**Tillled fallow**				**Chem fallow**			
Variety	**Rank**	**Yield**	**Twt**	**Prot.**	**Rank**	**Yield**	**Twt**	**Prot.**
Bruehl	2	57.2	60.7	11.1	4	32.3	57.8	11.3
Chukar	1	65.6	61.1	10.4	1	44.4	58.2	10.4
Edwin	3	54.6	63.1	10.7	3	37.1	61.1	10.6
Moro	4	41.9	60.6	11.2	2	37.4	59.9	11.0
Club		54.8	61.4	10.9		37.8	59.2	10.8
Overall		47.7	61.6	11.3		35.3	59.9	11.3
CV		18.4	1.48	9.92		20.3	1.44	5.50
LSD@.05		8.6	0.9	1.1		7.1	0.8	0.6

Table 6. Agronomic differences between genotypes in the hard (both red and white) wheat market class under both conventional tilled fallow and chemical fallow cropping systems.

Location	**Combined**							
Treatment	**Tillled fallow**				**Chem fallow**			
Variety	**Rank**	**Yield**	**T wt**	**Prot.**	**Rank**	**Yield**	**T wt**	**Prot.**
Bauermeister	6	43.1	61.2	10.5	8	32.0	59.1	11.1
Buchanan	4	50.0	62.3	10.7	4	37.4	60.4	10.7
Eddy	9	35.1	62.9	13.6	10	25.7	62.8	12.7
Farnum	2	50.8	60.4	11.5	2	38.7	58.1	11.5
Finley	7	41.4	63.0	12.2	7	34.1	62.3	12.1
Hatton	5	45.2	63.5	10.8	9	30.3	62.4	11.1
Paladin	10	23.7	62.0	12.9	5	35.5	62.8	12.5
WA008022	8	38.3	61.6	11.9	6	34.2	59.7	11.6
WA008068	1	52.0	62.7	13.0	1	40.4	61.8	11.9
WA008095	3	50.2	61.7	11.6	3	38.1	60.9	11.7
MDM	3	43.8	61.0	10.7	4	33.4	59.4	11.3
Palomino	4	32.1	61.3	14.3	1	38.5	61.9	13.2
WA008096	1	46.3	60.7	10.6	2	36.0	59.0	11.6
WA008097	2	44.9	60.8	10.9	3	34.9	59.0	11.2
Hard Winter		42.6	61.8	11.8		34.9	60.7	11.7
Overall Mean		47.7	61.6	11.3		35.3	59.9	11.3
CV		18.4	1.48	9.92		20.3	1.44	5.50
LSD@.05		8.6	0.9	1.1		7.1	0.8	0.6

Table 7. Tilled summer fallow, early seeding: top five yielding cultivars for 2009 and 2010.

2009						2010					
Variety	Market class	Rank	Yield	Twt	Prot.	Variety	Market class	Rank	Yield	Twt	Prot.
Madsen	SWW	1	61.4	60.6	8.9	Chukar	Club	1	65.6	61.1	10.4
MDM	HWW	2	60.2	60.6	7.4	Masami	SWW	2	62.3	61.6	10
WA8094	SWW	3	56.7	61.6	8.1	Lewjain	SWW	3	60.8	60.6	10.8
Finch	SWW	4	56.5	60.5	9.4	Finch	SWW	4	60.5	61.8	10.6
Xerpha	SWW	5	55.7	60.1	7.7	WA008066	SWW	5	58.5	62.2	10.2

Table 8. Chemical fallow, late seeding: top five yielding cultivars for 2009 and 2010.

2009						2010					
Variety	Market class	Rank	Yield	T wt	Prot.	Variety	Market class	Rank	Yield	Twt	Prot.
WA8065	SWW	1	30.1	60.0	11.4	Chukar	Club	1	44.4	58.2	10.4
WA8095	HRW	2	28.2	60.0	11.2	Lewjain	SWW	2	40.5	58.4	10.3
Xerpha	SWW	3	27.8	58.5	11.9	WA008068	HRW	3	40.4	61.8	11.9
Finley	HRW	4	27.5	60.9	11.3	Finch	SWW	4	40.1	58.4	10.7
Stephens	SWW	5	27.0	57.6	11.9	Masami	SWW	5	39.9	58.5	10.4

References

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