EVALUATION OF CHEMICAL AND MECHANICAL METHODS FOR MAINTAINING STAND PRODUCTIVITY IN FINE FESCUE SEED CROP PRODUCTIONS SYSTEMS IN THE ABSENCE OF OPEN FIELD BURNING, 2011

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There are no effective non-thermal post-harvest residue management practices available that maintain an economic yield over the life of the stand (5 years +) in fine fescue seed production for Western Oregon. Seed yields typically decline following the first harvest in the absence of field burning. Yield declines of 10 to >50% were measured in research trials (Young et al., 1998; Zapiola et al., 2006) where non-thermal treatments such as baling and flail chopping the stubble were used. More aggressive stubble management improved yields over just baling, but it was still lower yielding and not an economic substitute for field burning given the added cost of baling and flail chopping.

The primary obstacle in fine fescues (and Kentucky bluegrass) is the need to expose the lower crown area at the soil surface (Meints et al., 2001; Chastain et al., 1997) and to minimize the amount of crop residue remaining. Research has been conducted on both fine fescues and Kentucky bluegrass in an effort to determine a way to substitute field burning with a non-thermal mechanical method. Vigorous fall tillers that are the major contributor to seed yield originate from the crowns of established plants (Canode and Law, 1979). In addition to the need for crown tillers to predominate, the creeping habit of red fescues also can cause excessive crowding in the stand and limit the size and capability of the new tillers. If stand conditions are too crowded in the fall, tillers will not respond to the vernalization process that occurs during the winter resulting in reduced seed production.

With these two factors in mind, residue management and stand crowding, this research will determine if there is a lower cost way of encouraging strong tiller development in the fall using two different strategies:

1) Use row spraying technology (Young et al., 1996) to reduce overcrowded stands and strengthen growth of rows.
2) Rather than flailing the whole stand to expose plant crowns for regrowth, no-till row cleaners will be used to expose row strips on regular intervals. Improved light penetration should increase growth in the exposed rows and shade all areas between the rows to act as a cover mulch.

Procedures and Results

Trials were established in cooperating grower fields. Table 1 lists the different fields and stand ages that were used in these trials. Treatments in fields varied depending on the primary residue removal that was used following harvest. Additional treatments in non-burned fields/field sections include rowspray treatments (using a 2% glyphosate solution) and/or mechanical row cleaner (thatching) treatments. All sites were either baled + flail chopped (BFC) or had the full straw load flail chopped back on the stand in unburned treatments. Rowspray (RS) and rowcleaner (RC) treatments were applied in the late fall or spring using equipment purchased with the grant for this project. A tractor from one of the farms was used to operate the equipment. Plots were large ~25-50 ft. wide and ~300 ft. long to facilitate grower harvest.

In addition to harvesting for seed yield, foot-row samples were taken at maturity to determine fertile tiller number, height, and specific dry weight (dry weight per tiller).

<u>Site 1</u>. This site is a long term trial that was started in fall 2008 following the first seed crop harvest. The 34 acre field was divided into four equal quarters (Figure 1) to examine different residue management practices over the life of the stand. Table 2 lists the sequence of post-harvest residue treatments imposed for the second through fourth seed crops. One quarter of the field (SE) was open burned (OB) every year as a reference treatment and one quarter of the field (NW) had a BFC residue treatment each year and was not open burned for the life of this study. The other two quarters alternated between BFC and OB on either odd or even crop years to determine if yields can be maintained with alternating annual open burns. The rowspray trial was imposed only within the continuous BFC section of the field. Rowspray treatments were applied in fall 2009, spring 2010 and spring 2011 to determine if the timing/stand age is important in maintaining or renovating stands. The rowspray trial is designed as a five treatment randomized complete block with three replications.

Table 1. Creeping red fescue fields with non-burn residue treatments, 2009-2011.

Site	Farm	Variety	Stand age (yrs)	2009	2010	2011
1	Doerfler Farms	Wendy Jean	2-4	X	X	X
2	Ioka Farms	Lustrous	3,4	X	X	
3	Ioka Farms	Lustrous	6,7		X	X
4	Victor Point Farms	Foxfire	5,6		X	X
5	Smith Farms	Garnet	3			X

Field Study

In the larger quartered field study, yields for 2009 (2nd crop) were about the same for either the BFC or the OB treatments (only two treatments for 2009). However, in 2010 (3rd crop), the two field sections that received the fall 2009 BFC treatment yielded about 300-400 pounds per acre less than the OB treatments. For field sections in 2009 or 2010, the effect on seed yield from treatment in 2008 or 2009, respectively, did not seem to carry into the second crop year. Both 2009 and 2010 open burned sections yielded similarly even though the previous year one of the quarters had the BFC treatment. In contrast, the two sections with the BFC treatment in 2009 had lower yields in 2010.

Seed yields from the third year treatments (2011 crop) depended on the three year sequence of treatments. The continuous BFC treatments yielded 350-450 pounds per acre less in 2011 than treatments that had at least one OB year. The other three treatments were within 100 pounds per acre yield with the continuous OB yielding the highest, the BFC/OB/BFC intermediate and the OB/BFC/OB a little less. Averaging the seed yield over the three crop years, the BFC/OB/BFC sequence produced yield that was similar to the continuous OB sequence. The OB/BFC/OB sequence and the continuous BFC treatment averaged about 150 and 300 pounds per acre, respectively, less than the continuous OB sequence. At $0.70/lb for seed, this equates to about $210 per acre reduced revenue and $630 per acre reduction over the three years with the FBC management. In this field, the even year rotation (one OB in the third crop year) yield was similar to the continuous three year OB sequence.

Rowspray trial

Yield data from the replicated trial within the continuous BFC section are also reported in Table 2. Seed yields in 2010 for the fall 2009 RS and the untreated BFC were very similar and very close to the field yields that were measured for the NW quarter of the field. Even though at least 50% of the stand was sprayed out, the plants were able to compensate and yield a little higher than the untreated BFC treatments. Seed yields in the second year following the rowspraying were significantly increased over the untreated BFC plots in both the fall and spring RS treatments. Row cleaner treatments were not very effective and the main impact on yield and growth was a result of the RS treatments; also, difficulties in plot harvesting prevented measuring data from RC treatments. The spring RS was very effective at stand thinning and removed over 75% of the stand resulting in a reduction of fertile tillers at harvest the first year of treatment. The spring RS plots in both years (2010, 11) were unable to compensate for this initial loss of fertile tillers causing seed yield to drop dramatically to about half of the other treatments. However, in the subsequent year, spring RS resulted in the highest overall yield. Biomass and fertile tiller densities parallel seed yield impact for both years (Tables 3 and 4), and the measured improvement in seed yield in the second crop year following the spring RS as shown with the spring RS 2010 data in Table 4. Overall, the fall 2009 rowspray gave the highest average seed yield and was intermediate between treatments that had any type of OB treatment and the continuous BFC. This treatment averaged about 100 pounds per acre more than BFC, so was effective in increasing yield but not as effective as OB treatments.

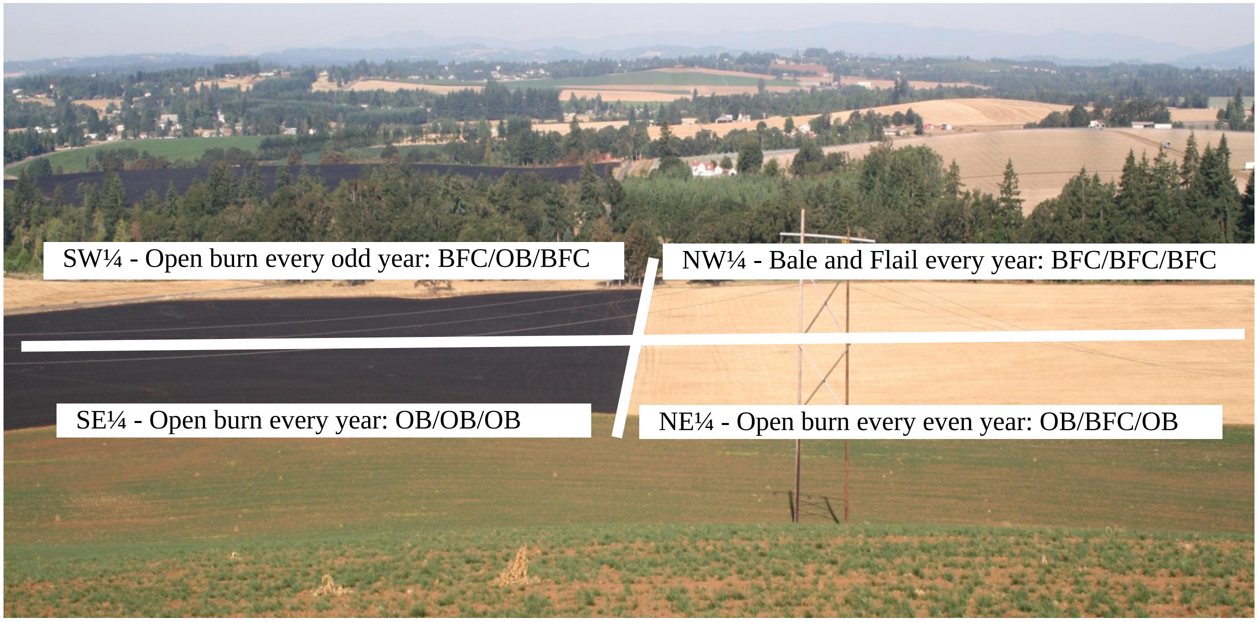

Figure 1. Doerfler field following OB on second sequence year, fall 2009.

Table 2. Site 1 - Doerfler Farms yield summary 2009-2011, Wendy Jean creeping red fescue.

	Post harvest residue treatments	- - - - - - - - - - seed yield (lb/a)[1] - - - - - - - - - -			
Field quarter	Fall 2008/2009/2010	2009	2010	2011	3 yr avg.
NW	BFC / BFC / BFC[2]	1710	1822	1346	1626
SW	BFC / OB / BFC		2254	1746	1903
NE	OB / BFC / OB	1690	1909	1708	1769
SE	OB / OB / OB		2275	1803	1923

[1] Numbers followed by the same letter are not significantly different by Fishers protected LSD 0.05 (0.10)
[2] BFC = Bale + Flail, OB = Full straw open field burn

Replicated Trial within BFC only section	2010		2011		3 yr avg.[3]
Untreated	1884	a	1314	b	1636
Fall RS 2009	1940	a	1529	a	1726
Fall RS + RC 2009			1572	a	
Spring RS 2010	740	b	1648	a	1366
Spring RS 2011			892	c	1495

[3] 3 yr average uses untreated yield for years without treatments (1710 lb/a for 2009, 1884 lb/a for 2010)

Table 3. Tiller data, 2010

Farm	Treatment	Total dry wt	Fertile tillers	Dry wt	Plant height
		per ft-row 10" spacing			
		(g)	(no.)	(mg/tiller)	(cm)
Site 1 - Doerfler Farms (bale+flail)					
	Untreated check	75.8	246	248	74.6
	Fall 2009 RS	73.8	257	228	76.6
	Fall 2009 row cleaner + RS	74.1	266	297	77.8
	Spring RS 2010	56.0	129	257	74.3
	Untreated check	90.3	347	211	77.6
Site 3 - Ioka Farms Strips (full straw load flailed)					
	Disk/regrow	50.8	173	261	64.9
	Untreated	87.8	326	235	74.3
	Thatch	76.6	315	231	71.6
	Fall RS	75.0	280	229	74.7
	Spring RS	41.8	133	253	61.3
Site 4 - Victor Point Farms					
	Residue main factor				
	Full straw load flail chop 1X	53.8	184	220	70.1
	Bale + Flail chop 1X	60.1	233	210	69.9
	Rowspray main factor				
	Untreated	58.1	237 a	194	70.2
	Fall row cleaner + RS	46.6	150 b	236	68.2
	Fall RS	66.2	238 a	215	71.6

[1] Numbers followed by the same letter are not significantly different by Fishers protected LSD 0.05 (0.10)

Table 4. Tiller data, 2011

Farm	Treatment	Total dry wt		Fertile tillers		Dry wt	Plant height	
		per ft-row 10" spacing						
		(g)		(no.)		(mg/tiller)	(cm)	
Site 1 - Doerfler Farms (bale+flail)								
	Untreated check	74.1	c[1]	174	b	202	69.2	a
	Fall 2009 RS	85.6	b	257	a	229	67.1	a
	Fall 2009 row cleaner + RS	89.1	b	250	a	225	69.5	a
	Spring RS 2010	103.7	a	292	a	251	69.2	a
	Spring RS 2011	52.4	d	116	c	216	59.6	b
Site 3 - Ioka Farms Strips (full straw load flailed)								
	Disk/regrow	73.4		194		266	63.4	
	Untreated	67.6		191		230	66.3	
	Thatch	53.1		157		216	62.9	
	Fall RS	67.1		189		238	69.9	
	Spring RS	145.9		188		243	68.1	
Site 4 - Victor Point Farms								
	<u>Residue main factor</u>							
	Full straw load flail chop 1X	44.5	(b)	210		175	58.8	(b)
	Bale + Flail chop 1X	54.0	(a)	228		197	61.0	(a)
	<u>Rowspray main factor</u>							
	Untreated	45.7		213		175	59.1	
	Fall row cleaner + RS	50.9		214		198	61.7	
	Fall RS	51.1		229		185	58.9	
Site 5 - Smith Farms (bale+flail)								
	Untreated check	67.2		160		196	64.6	
	Spring RS 2011	30.5		40		177	46.3	
	Fall RS 2011	73.3		141		227	62.5	

[1] Numbers followed by the same letter are not significantly different by Fishers protected LSD 0.05 (0.10)

Figure 2. Untreated plot at Doerfler site, Fall, 2010.

Figure 3. Fall 2009 RS plot at Doerfler site, Fall, 2010.

Figure 4. Spring 2010 RS plot at Doerfler Site, Fall, 2010.

Site 2 – This site is a stand of creeping red fescue in its fourth crop harvest. The area for the row-spray treatments was baled and flail chopped. The design of this site was a randomized complete block with treated (row-sprayed) and untreated plots. Treatments were applied as in the previous trial. Row-spray treatments were not very effective in taking out much of the stand and thus, there was very little difference in the seed yields between row-spray treatment and untreated plots (Table 5). Seed yield from open burned areas adjacent to the non-burned area was about 250 pounds per acre greater. The previous year (2009), an area with a BFC treatment was compared to the open burn in the rest of the field. One year without burning decreased seed yield from 1537 lb/a to 1008 lb/a, a 1/3 drop in yield.

Site 3 – This site is an older stand (6th and 7th crop) of creeping red fescue that was declining in yield. The treated areas all had a full straw load flail chopped and left in the field. Treatments were applied in single strips approximately 50 ft. wide and 350 ft. long. The disk/re-grow treatment was done by the grower to renovate the stand. This strip was disked after harvest several times and left to re-grow. The untreated portion had the full straw load left on the field. The thatch treatment was applied by going over the area 4-5 times with the row cleaner in an attempt to cut out portions of the stand. The fall row spray was applied in November with nozzles set to spray a band width of about 6 inches spaced on 12 inch centers in an attempt to take out about 1/2 - 2/3 of the stand. The spring row spray was applied in mid March at the onset of rapid regrowth.

Seed yields were dramatically lower in the spring row-spray in 2010 (Table 5). There were also a lot fewer and shorter fertile tillers in this treatment (Table 3), which may have caused the lower yields. The spray out removed about 75% of the stand and it was unable to recover. All other treatments were comparable in yield. Regrowth on the spring row-spray was very good after harvest and the stand looked healthy with strong rows formed. For the 2011 harvest, the spring 2010 RS yielded the highest, at 937 lb/a compared to the untreated plots at 725 lb/a. The grower treatment of disking was the second highest treatment yield. From this data, any of the treatments improved yield in the second year of production following the treatments.

Site 4 – This site is an older stand (5th and 6th crop) of creeping red fescue that was declining in yield. A three acre section of the field was cordoned off to apply treatments. One-half of the area had the full straw load flail chopped in place and the other half was baled before flail chopping. The rest of the field was open burned. Row-spray (RS) treatments were applied across both residue regimes in November, 2009. Plots were 25 ft. x ~300 ft. and the trial was arranged in a split-block design with main treatments as either full straw load or baled + flail, and subplot treatments using row-spray (RS) /row-cleaner (RC) treatments replicated three times. Treat-ment combinations are listed in Table 6. The fall row-spray was applied in November 2010 with nozzles set to spay a band width of about 6 inches on 12 inch centers in an attempt to take out about 1/2 - 2/3 of the stand. The row-cleaner was operated in unison with the row-sprayer to thatch the strips between the nozzles that were not receiving the row-spray.

Table 5. Seed yield responses to row spraying and residue management in additional trial fields, 2009-2011.

Location	Seed yield (lb/a)	
Site 2. Ioka Farms, Lustrous creeping red fescue.		
	2009	2010
Open burn (field tmt)	1537	1481
Bale + FC (untreated)	1008	1255
Fall 2009 RS		1183
Site 3. Ioka Farms, Lustrous creeping red fescue.		
	2010	2011
Disk 2009/regrow	1018	875
Untreated	1047	725
Thatch fall 2009	1017	807
Fall 2009 RS	931	836
Spring 2010 RS	529	937
Site 5. Smith farms- Garnet creeping red fescue.		
		2011
RS spring 2011		322
Untreated		616
Untreated		670

The full straw main plot treatment reduced seed yields compared to the BFC treatments by about 200 pound per acre. There was also higher cleanout with the full straw load residue treatment as well as fewer fertile tillers (Table 3). Yields were somewhat lower in the RS+RC treatment. The two RS treatments were applied on sequential days and the effect of the row-spraying was much greater in the second day due to better spray conditions when the RS+RC treatments were applied. This may explain some of the differences in yield. Enough of the stand was taken out that the remaining stand was unable to compensate for the difference. Fertile tiller counts were significantly lower in the RS+RC treatment (Table 3) and were probably the main cause for differences in yield. Seed yields for the rest of the field were measured from windrows combined in the adjacent open burn area to assess a reference open burn field yield. The open burn strips were ~300 pounds per acre greater than the non-burn residue regime. The plot areas were open burned along with the rest of the field in 2011. Seed yields measured in 2011 were not affected by any of the treatments, nor by the residue main factor the previous year. There were some minor differences in dry matter production in the plots (Table 4) but none affecting yield.

Site 5 – This site was established in the winter of 2010-11 to test spring RS and fall RS the following year. The first set of treatments were sprayed in the spring 2010. The effect of this spring RS was similar to the other spring RS treatments at sites 1 and 3. Total dry weight and fertile tiller densities were impacted by the spring RS (Table 4), and seed yield (Table 5) was reduced by about half from 670 pounds per acre to 322 pounds per acre.

Benefits and Impacts

These trials were established to determine what would be the best, low cost post-harvest management method in the absence of burning, so open-burn treatments were not incorporated into the primary treatment areas. Row-spraying is effective at reducing the stand and taking out excessive growth. The thatch treatments that were applied did not do much to the stand and essentially any effect disappeared by mid-winter. This type of treatment needs to be much more aggressive and must remove a larger portion of the stand than was observed in this trial. A major finding in these trials was that in most cases, spraying out at least half of the stand in the fall did not reduce yields the year of treatment (except the RS+RC treatment at site 2). The plants were able to compensate for this loss in stand at harvest. Spring rowspraying generally had a negative effect on the current year crop, but the same

Table 6. Victor Point Farms (Site 4) seed yield summary 2010-2011. Foxfire creeping red fescue.

	Seed Yield (lb/a)		
Field strips	**2010**		**2011**
(open burn):	1499		863
Main factor comparisons			
Residue main factor			
Full straw flail 1X	1043	b[1]	843
Bale + Flail 1X	1258	a	825
Rowspray main factor			
Untreated	1181	(ab)	800
RS+RC	1012	(b)	874
RS only	1259	(a)	828
Two way table: sub-factor comparisons			
Full straw load Flail chop 1X 2009 only - open burn fall 2010			
Untreated	1102		790
RS+RC	910		920
RS only	1119		818
Bale + Flail chop 1X 2009 only - open burned fall 2010			
Untreated	1260		811
RS+RC	1115		827
RS only	1399		838

[1] Numbers followed by the same letter are not significantly different by Fishers protected LSD 0.05 (0.10)

treatments also had vigorous growth in the subsequent fall and demonstrated increased yields in the second year compared to the other rowspray treatments. Additionally, at all sites where the crop was followed for a second year after the rowspray treatments, all of the treatments improved yields over the untreated standard (bale + flail) treatment. This response seems to be intermediate to a full open field burn but can be an effective tool in extending the productivity under non-burn management.

This suggests that if a grower would want to reduce the number of fields that will be open burned, it may be best to allocate the open burns to older stands and/or try alternative treatments in the second or third year to keep the stand productive. This will permit the grower some flexibility in managing fields earlier in the season when burning is limited. The effect on long-term results of alternative residue management such as Site 1 will need to be tested on other varieties and locations to determine if this is a viable option.

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