**Progress Report SW16-010**

**Impacts of chaff collection or chaff plus straw collection at harvest to improve weed control**

**Summary**

The beginning of the project has been pretty successful. All the experiments have been established except one with a direct bale system in Washington. The initial infestation in the experiments established last spring (four sites in total) were evaluated through two different methodologies, as was proposed. Plant height and the height at the beginning of the inflorescence per weed species present in the experiment areas have been evaluated. However, seed production and seed retention at harvest are still in process for most of the species except for downy brome. Soil samples to analyze the impact of the chaff collection and chaff plus straw collection on soil health (organic matter and moisture content) have been taken periodically at CBARC and have started to be taken more recently at Hyslop.

**Objectives**

1. *Evaluation of chaff collection and chaff plus straw collection practices at harvest to reduce weed species density and dispersion*

We established the experiment at CBARC (one of the experimental farms) and in three of our participating farms in Oregon (Appendix 1). In Washington, we scouted fields of our participating growers, but we could not find enough weed infestation to put the experiment. The idea was not to interfere with farmer practices, but we may need to interfere to have some weedy areas to establish the experiment this year in Washington. The other experimental farm, Hyslop, has established the experiment this fall.

In each location, we sampled the weed infestation per plot before harvest following two different methodologies:

A.- A continuous method - where the evaluator walked the plots in parallel transects to the longest plot direction (simulating a posterior pass of the combine) carrying a handheld computer with built-in GPS receiver (Yuma2® Rugged Tablet Computer, Trimble, Sunnyvale, CA, USA) that was used to partition the plot into numerous cells (6 × 3 m (20 ft x 10 ft)). In each cell, percentage of weed cover per species was evaluated (Figure 1). The weed maps from this method are shown in Appendix 2.

B.- A discrete method – in the same evaluation units (cells - defined by the previous methodology) for the experiment at CBARC and once per two evaluation units in the participating farms, the evaluator threw a sampling frame (0.5 m x 0.5 m) randomly where he/she counted the number of plants per weed species (Figure 2). The weed maps of the experiment at CBARC from this method are shown in Appendix 2.

The initial weed infestation mapped during this first year of the project will allow us to evaluate the efficacy of weed reduction through harvesting with a chaff cart or with a direct bale system versus harvesting with the combine alone.

Total 40 cells

12 m = 40 ft

20 ft

70m = 200ft

Plot

b)

70m = 200ft

6 m = 20 ft

10 ft

Total 20 cells

Plot

a)

**Figure 1.** Description of evaluation units (cells) for method A.; a) in the experiment at CBARC, and b) in the experiment at participating farms.

b)

a)

20 frames of 0.5 m x 0.5 m

12 m = 40 ft

20 ft

70m = 200ft

Plot

70m = 200ft

6 m = 20 ft

10 ft

20 frames of 0.5m x 0.5m

Plot

**Figure 2.** Description of frame location for method B.; a) in the experiment at CBARC, and b) in the experiment at the participating farms.

1. *Evaluation of seed production, seed height, and seed retention of important weed species at harvest*

We started to collect ten plants per species approximately once per week starting the end of May 2016. We collected three different species in Sterling Allen’s farm (feral rye (*Secale cereal*), downy brome (*Bromus tectorum*) and rattail fescue (*Vulpia myuros*)), four species in Eric Nelson’s farm (tumble mustard (*Sisymbrium altissimum*), purple mustard (*Choriospora tenella*), tansy mustard (*Descurainia pinnata*) and Fiddle neck (Amsinckia intermedia)), three species at CBARC (downy brome (*Bromus tectorum*), tumble mustard (*Sisymbrium altissimum*) and fiddle neck (*Amsinckia intermedia*)) and one weed species in Larry Coppock’ s farm (downy brome (*Bromus tectorum*)).

However, due to the enormous volume of samples we are still processing them. The only species that we have finished processing is downy brome.

Downy brome was collected at three farms. Results showed that its seed reached maximum maturity by mid-June with an average of 400 seeds per plant (Figure 3). Averaging the data from the three locations, we found that in the last two weeks of June this species shed 50% of its seed (Figure 4). During the first 10 days of July, the species keep shedding seeds quickly. The percentage of seeds left on the plant by July 11 was about 24%. Thereafter, the species did not shed much until the crop (winter wheat) was harvested. Harvest was conducted in July 14 at CBARC and the first week of August in the participating farms.

**Figure 3.** Downy brome seed retention in three of the farms where we collected this species during summer of 2016.

**Figure 4**. Average of downy brome seed retention per plant from maximum seed production in mid-June.

Purple mustard, feral rye, and rattail fescue have not been processed yet, and tumble mustard and fiddle neck have only been processed at one location.

Tumble mustard seems to reach maximum seed maturity from the end of June to the beginning of July with a maximum of 80,000 seeds per plant (Figure 5a). It seems that once it reaches maturity, it sheds seeds very fast. During the first 10 days of July, the plants from Eric Nelson’s farm lost 50% of their seeds. However, data from CBARC, where we are studying this weed as well, are needed to confirm these preliminary results due to the high variance in the data.

b)

a)

**Figure 5**. Mean of seeds per plant in different sampling dates of: a) tumble mustard collected at Eric Nelson‘s farm and, b) fiddle neck collected at CBARC.

Fiddle neck reached a maximum of seed maturity by mid-June with an average of 1,750 seeds per plant (Figure 5b). In two weeks, it shed an average of 75% of the seeds. Data from the other location where we are studying this species will confirm these preliminary results.

Plant and seed height were measured in two of the sampling dates (June 24 and July 1) from ten plants selected randomly each time. Average of plant and seed height (beginning of the inflorescence) are given in Table 1. Last column of Table 1 indicates the potential percentage of seeds that would be gathered by the combine if the species did not shed seeds before harvest. Considering 30 cm (12 in) as a regular cutting height for the region, rattail fescue could not be controlled by these practices. At Allen’s farm, where the experiment area was infested with rattail fescue, we tried to cut the crop as short as possible to get some control of this species. We had the idea of trying two different cutting heights in that experiment but the crop was so short that we couldn’t.

Table 1. Average of plant height and seed height\*1 of the weed species that we are studying.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | Location | Plant height (cm) | Seed height (cm) | Seed above cutting height\*2 (%) |
| *Downy brome* | Allen | 42.5 | 34.3 | 100 |
|  | Coppock | 92.5 | 83.7 | 100 |
|  | CBARC | 105.4 | 93.4 | 100 |
| *Cereal rye* | Allen | 75.3 | 69.2 | 100 |
|  | CBARC | 148.3 | 140.5 | 100 |
| *Rattail fescue* | Allen | 27.1 | 20.7 | 0 |
| *Tumble mustard* | Nelson | 106.6 | 75.6 | 100 |
|  | CBARC | 129.9 | 79.2 | 100 |
| *Purple mustard* | Nelson | 65.0 | 24.6 | 82.8 |
| *Fiddle neck* | Nelson | 76.7 | 32.8 | 100 |
|  | CBARC | 105.1 | 50.6 | 100 |

 \*1 The height of the beginning of the inflorescence.

 \*2 30cm was considered as the regular cutting height.

1. *Effects of chaff or chaff and straw removal on soil organic matter and moisture content*

Seven monthly soil samples have been collected from the chaff removal experiment on the Pendleton research farm (CBARC). The samples have been weighed and dried to determine moisture content, and are waiting for lab analysis. The December sampling was skipped due to snow and freezing weather. In Corvallis, at Hyslop farm, the tools and methods were delivered and discussed with Drs. Carol Mallory-Smith and Andy Hulting on October 28, and they took the first soil sample in the plots on January 3, 2017.

1. *Conduct extension activities oriented to farmers, ag-professionals, students and stakeholders*

Some of the extension activities that the PI and Co-PIs have conducted in relation to the project are described below:

April 6 – CBARC seminar series, Pendleton, OR. Judit Barroso gave a seminar titled ‘Impacts of chaff collection or chaff plus straw collection at harvest to improve weed control’ to talk about the project with growers in the region. 29 people in attendance.

June 27-29. Brand experiment station directors’ summer meeting, CBARC, OR. Judit Barroso introduced the project to several OSU directors of experiment stations, one university dean and, several summer students. 15 people in attendance.

September 7-8. PNW Weed Workers Gathering. Corvallis, OR. Judit Barroso presented the project to other weed scientists not directly involved and to several graduate students. 36 people in attendance.

October 11. Invited Lecture in AGRI299 course: “Weed Science Program at CBARC”, La Grande, OR (EOU & OSU). Judit Barroso discussed the project with the students of the AGRI299 course. 28 people in attendance.

Drew Lyon included discussion of Harvest Weed Seed Control in several extension presentations on herbicide resistance and Integrated Weed Management:

November 1 – Walla Walla County Wheat Growers Association Annual Meeting in Walla Walla, WA; 21 people in attendance.

November 22 – Spokane County Crop Improvement Association Annual Meeting in Spokane, WA; 52 people in attendance.

December 16 – Integrated Pest Management Update, Clarkston, WA; 42 people in attendance.

Comment: As an adjunct to the Western SARE project, Drs. Wuest and Barroso collected transects of wheat plants from fields where winter wheat was re-cropped after wheat. This is a situation where chaff rows show up both in weed numbers and, perhaps more significantly, in volunteer wheat. We are measuring the effect of volunteer wheat on the productivity of the planted wheat. Chaff collection methods should help reduce problems with volunteer wheat, and may help make annual winter wheat a more viable option. (Despite the bad reputation that continuous cropping has, annual winter wheat has proven very good at increasing soil organic matter, reducing soil erosion, and might be considered “peri-perennial”, the closest thing to a perennial grain that we currently have).

**Accomplishments/Milestones**

With a very tight budget we created a prototype of a chaff cart that allowed us to harvest the plots with this treatment or practice.

We also accomplished the establishment of most of the experiments proposed. We were unable to find an area in a field of one of the participating growers from WA that had not been already harvested with a direct bale system in previous years and had enough infestation to evaluate the practice.

We have mapped exhaustively the weed infestation per species in all sites where the experiment has been established. It will allow us to evaluate the effectiveness on weed reduction of chaff collection and chaff plus straw collection at harvest in subsequent years.

We have started to gain knowledge on the percentage of seed retention at harvest of very important weed species that infest wheat fields in our region (downy brome, feral rye, rattail fescue, tumble mustard, purple mustard, and fiddle neck). This information will be used to estimate practices efficacy as well.

We have started to talk about the project and its objectives among multiple audiences to get feedback and also to spread the idea of this innovative way to control weed seed at harvest among the grower community.

**Impacts and Contributions/Outcomes**

It is a little bit soon to evaluate impacts after only nine months of project.

However, during 2017, we will increase our extension activities to reach more growers interested in this new approach to control weeds.

During this second year, we also plan to write a scientific and an extension publication about seed production, seed height, and seed shed of the weed species studied. The article/s will include potential values of practice efficacy.

We will also create some videos harvesting wheat with a chaff cart pulled by the combine that we will upload online in our university websites (Oregon State University and Washington State University).

**Appendix 1 – Experimental design of the established experiments**

1. In the participating farms

Farm 1: Eric Nelson



Plot 6

Plot 5

Plot 4

Plot 3

Plot 2

Plot 1

Farm2: Larry Coppock

 

Plot 2

Plot 3

Plot 4

Plot 5

Plot 6

Plot 1

Farm 3: Sterling Allen

  

1. At CBARC experimental farm



Harvest direction

**Appendix 2 – Weed maps of the initial infestation evaluated through two different methods**

1. At CBARC research farm.
	1. Percentage of weed cover per species in the 12 plots (3 treatments x 4 repetitions) following the continuous sampling methodology described in point A.
	2. Weed plants per square meter and species in the 12 plots following the discrete sampling methodology described in point B.

Tumble mustard (*Sisymbrium altissimum*) cover (%)

Cereal rye (*Secale cereale*) cover (%)

a.

** **

Fiddle neck (*Amsinckia intermedia*) cover (%)

Downy brome (*Bromus tectorum*) cover (%)

****

Note: The X and Y axis indicate distances in meters

Tumble mustard (*Sisymbrium altissimum*) density (m2)

b.

** **

Cereal rye (*Secale cereale*) density (m2)

Fiddle neck (*Amsinckia intermedia*) density (m2)

Downy brome (*Bromus tectorum*) density (m2)

**  **

Note: The X and Y axis indicate distances in meters

1. At participating farms:
	1. Percentage of weed cover per species in 6 plots (2 treatments x 3 repetitions) at Eric Nelson’s farm following the continuous sampling methodology.
	2. Percentage of weed cover per species in 9 plots (3 treatments x 3 repetitions) at Sterling Allen’s farm following the continuous sampling methodology.
	3. Percentage of weed cover per weed species in 6 plots (2 treatments x 3 repetitions) at Larry Coppock’ s farm following the continuous sampling methodology.

a.

Tumble mustard (*Sisymbrium altissimum*) cover (%)

**  **

Tansy mustard (*Descurainia pinnata*) cover (%)

Fiddle neck (*Amsinckia intermedia*) cover (%)

Purple mustard (*Chorispora tenella*) cover (%)

** **

Note: The X and Y axis indicate distances in meters

Rattail fescue cover (%)

Downy brome cover (%)

Cereal rye cover (%)

b.

 **   ** 

40ft = 12m

200ft = 70m

Downy brome cover (%)

c..

 

Note: The X and Y axis indicate distances in meters