Weed seed control at harvest: preliminary results

Judit Barroso[1]✉, Carolina San Martín[1], Jennifer A. Gourlie[1]
[1]Columbia Basin Agricultural Research Center – Oregon State University, 48037 Tubbs Ranch Road, 97810 Adams, OR,
✉ judit.barroso@oregonstate.edu

Summary: The continuing evolution of herbicide resistance in major crop weeds is a driving force to develop new weed control strategies. The use of chaff carts and direct bale systems are two sustainable practices that have not been adequately evaluated. The objectives of this study were: 1) Evaluation of seed retention of important weed species at harvest, 2) Evaluation of chaff collection and chaff plus straw collection at harvest to reduce weed infestations. Preliminary results show that the efficacy of control, among other factors, will depend on the species characteristics and harvest time. The average percentage of relative weed reduction (for only one year of study) was 15% for the chaff collection and 22% for the chaff plus straw collection compared to harvest with the combine alone.

Keywords: seed retention, chaff cart, direct bale system, HWSC.

1. INTRODUCTION

Conservation agriculture (no-till or minimum tillage systems) and the use of herbicide resistant crops are two agricultural practices that rely heavily on the use of herbicides for weed control. The wide adoption of both practices in the USA and worldwide has produced an exponential development of herbicide resistant weed populations that are threatening some cropping systems such as the wheat-based systems of the Pacific Northwest (PNW). In wheat production systems, crop productivity and herbicide efficacy go hand-in-hand, particularly in dryland production systems. The consequence of herbicide resistance is that some herbicides are no longer useful. It is critical that herbicide resources are supported and preserved through the use of integrated weed management and innovative weed control techniques such as the ones proposed in this study.

Harvest weed seed control practices (HWSC) have been identified in Australia as an opportunity to control weeds and enhance the efficacy of herbicide-based weed management programs (Walsh et al., 2013). The objective of these practices is to prevent weed seeds collected by the combine from becoming part of the weed seedbank. Producers in Australia, after having adopted HWSC practices for several years, are nearly eliminating infestations of weeds. With these very low weed densities, the amount and frequency of herbicide use can be significantly reduced.

Although there is little use of HWSC outside Australian wheat cropping systems, there is much interest in the global potential for these strategies (Walsh and Powles, 2014). The potential of HWSC practices is dependent on having a significant proportion of total weed seed retained at crop maturity. Seed retention is likely to be influenced by each weed species biology, climatic and agronomic variables, with the potential for significant variation across regions.

The objectives of this study were: 1) Evaluate seed production, height, and retention at harvest of important weed species in wheat-production systems of the PNW, and 2) Evaluate the use of chaff carts (chaff collection) and direct bale systems (chaff plus straw collection) pulled behind the combine at harvest to reduce weed infestations.

2. MATERIAL AND METHODS

2.1. Objective 1. Evaluation of seed production, height and retention of important weed species at wheat harvest. In surrounding areas of four experiments established for Objective 2 (see below), six weeks approximately before harvest, ten plants per weed species were collected. Each plant was bagged independently in a paper bag for later processing. At two sampling dates, the total plant and seed height per sample was also measured. At the laboratory, different protocols per weed species were followed to count or estimate the number of seeds per plant at each collection time.

The species that we were studying are: *Secale cereale*, *Bromus tectorum*, *Vulpia myuros*, *Sisymbrium altissimum*, *Choriospora tenella*, *Descurainia pinnata* and *Amsinckia intermedia*.

2.2. Objective 2. Evaluation of chaff collection and chaff plus straw collection practices at harvest to reduce weed species density and dispersion. Experiments were established on naturally occurring weed-infested areas at three farms of northeastern Oregon in spring 2016. The Coppock, Nelson, and Allen farms, which were located at Adams, Pendleton and Pilot Rock, receive a mean annual precipitation of 500, 360, and 350 mm, respectively. The experiments were randomized complete block designs with two treatments and three repetitions. Each plot was more than 60 m long and the width of the farmer's combine (commonly 12 m). The two treatments were harvesting with the combine alone (control treatment), and using a chaff cart pulled by the combine (chaff collection) at The Coppock and Allen farms, and harvesting with the combine alone and using a direct bale system (chaff plus straw collection) pulled by the combine at Nelson's farm. In addition to the on-farm experiments, we conducted a supplemental experiment at the Columbia Basin Agricultural Research Center (CBARC) (Adams, OR) that receive 425 mm of annual precipitation on average. At CBARC, we had both treatments/practices (i.e. chaff collection and chaff plus straw collection) in the same location with four replications each.

At CBARC, control and direct bale plots were harvested on July 14. Two of the chaff cart plots were harvested on July 15 and the other two on July 28. Plots at the Nelson, Coppock and Allen farms were harvested on July 26, August 5, and August 10, respectively.

In all experiments (commercial and research farms), weed infestations were evaluated before crop harvest and in the following spring. The evaluations were conducted with a discrete sampling using frames of 0.5 m x 0.5 m along two equidistant transects inside the plots, parallel to the long side of the plots. The frames were thrown every three meters along the transects. Weed cover and density per species were measured in each frame (approximately 40 frames per plot).

3. RESULTS AND DISCUSSION

3.1. Objective 1. *Bromus tectorum*, the most problematic weed species in small grain crops of the PNW, was collected at three farms. Preliminary results showed that the species did not shed the seed until mid-June. However, after that date, the species shed the seed very quickly. By early July, seed retention was less than 50% and by mid-July the species only retained 27% of the seed on average. Thereafter, the species did not shed much until early August, which was when the last two farms were harvested (Fig. 1a). In 2016, the average *B. tectorum* seed production was 450 seeds per plant.

Sisymbrium altissimum, one of the most common broadleaved weeds in the semi-arid region of the PNW, was collected at two farms. It did not get total seed maturity until the end of June. However, once total maturity was reached, the species started to shed seeds quickly. In ten days, the species shed 50% of its seed on average (Fig. 1b). In 2016, the average *S. altissimum* seed production was 53,600 seeds per plant.

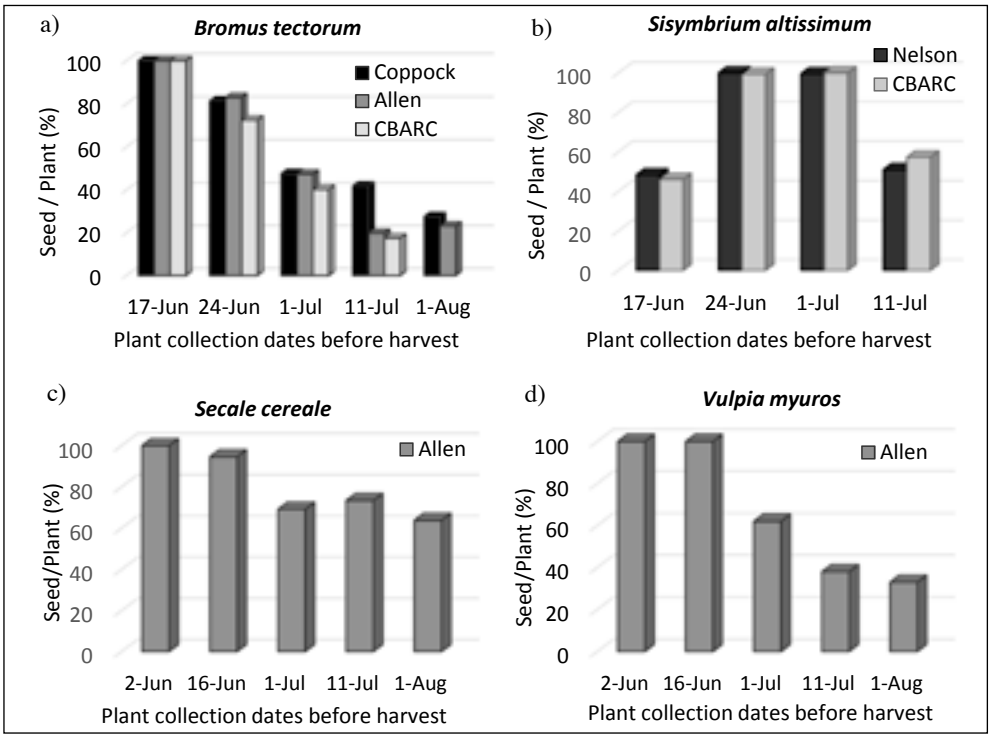

Figure 1. Percentage of seed retention per weed species at harvest: 1a) *Bromus tectorum*, 1b) *Sisymbrium altissimum*, 1c) *Secale cereale*, and 1d) *Vulpia myuros*.

Secale cereale, a problematic weed species because of the absence of herbicide options to control it in traditional wheat varieties, was sampled at one farm. This species started to shed seed earlier than others, but slowly. On average, by mid-July, the species retained 71% and by beginning of August still maintained 64% of the seed (Fig. 1c). In 2016, the species had 175 seed per plant on average (35 seeds per spike and 5 spikes per plant).

Vulpia myuros, a weed that is increasing in the PNW due to the increasing adoption of no-till systems, was collected at one farm. Its seed shedding pattern was similar to *B. tectorum* (Fig. 1d). By early July, the percentage seed retention was about 60% and by late July about 30% on average. In 2016, the average *V. myuros* seed production was 335 seeds per plant.

The seeds of most of the species studied were above a regular cutting height of combines in the region (between 25 and 30 cm). *Vulpia myuros* and *Choriospora tenella* were the only two spe-

cies where an important proportion of seeds might develop or laid out below the cutting height. It reduces the potential control of these two species with HWSC practices.

The rate of seed shedding in most of the studied species in the PNW seems to be faster than the species studied in Australia by Walsh and Powles (2014). In Western Australia, those scientists found that brome species retained 50% of its seed 30 days past crop maturity. In our experiments, considering end of July as 30 days past crop maturity, preliminary results showed that the brome species most commonly found in the region (*B. tectorum*) retained only 25% of the seed by that time. The only weed species where harvest time did not seem to be as critical to improve potential control was *Secale cereale*.

Growers in this region say that harvest season starts after the 4th of July. However, the winter wheat crop can be matured by the end of June in the lower precipitation areas such as at two of the farms included in this study depending on the year conditions. According to preliminary

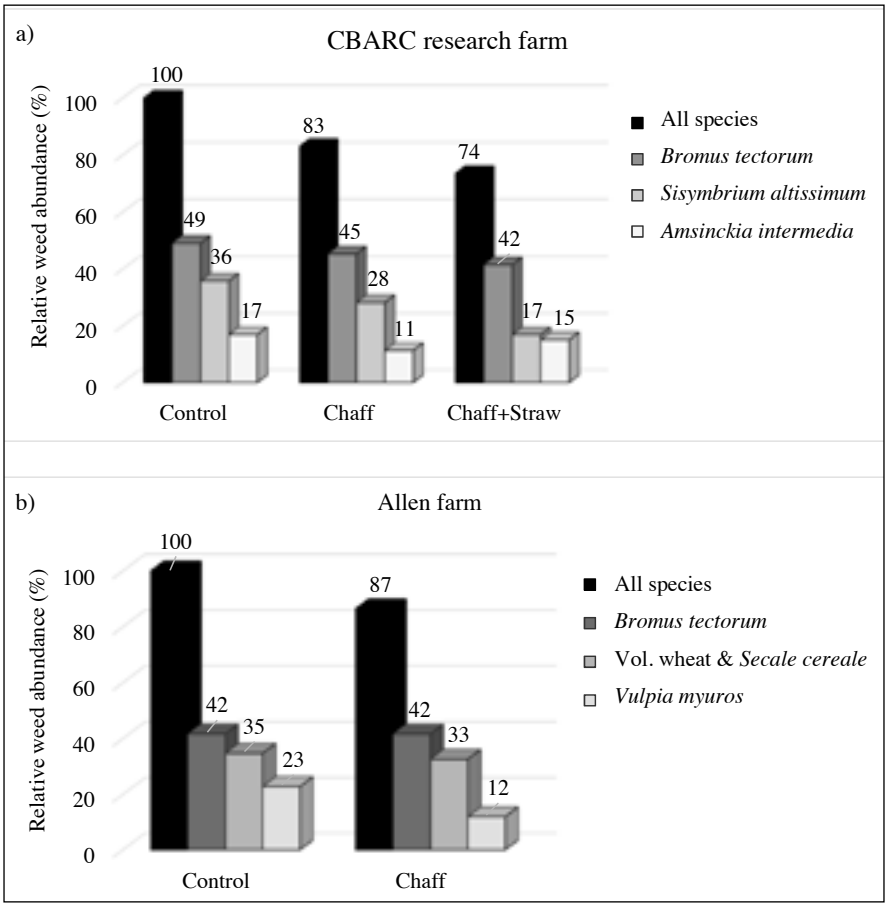

Figure 2. Relative percentage of weed abundance in plots harvested pulling a chaff cart (chaff collection) or a direct bale system (chaff plus straw collection) behind the combine compared with plots harvested with the combine alone (control) in spring 2017, 2a) at CBARC research farm, and 2b) at the Allen farm.

results, the potential HWSC will dependent on harvest time, seed shedding pattern of the weed species, cutting height of the crop, and height of the seeds in the weed species.

3.2. Objective 2. Weed infestation reduction was obtained with the collection of chaff or chaff plus straw at harvest. At CBARC, for all the species present at harvest, an averaged reduction of 17% for the chaff collection and 26% for the direct bale system was found compared with the control (Fig. 2a). *S. altissimum* was the species that showed the highest percentage of control with HWSC practices (37% on average). At the Nelson farm, the same species harvested 12 days later showed an averaged reduction of 22% with the direct bale systems (data are not shown).

At the Allen farm, the average weed reduction (volunteer wheat was included as a weed in the spring evaluation) with the chaff cart for all the species present at harvest was 13% (Fig. 2b). The lower percentage of reduction found in this farm compared to CBARC research farm could be due to it being harvested one month later. At CBARC, the average reduction of *B. tectorum* with the chaff collection was 7%, however, at the Allen and Coppock farms, we did not observe any reduction of this species (results are not shown for the Coppock farm).

Preliminary results showed that collection of chaff and/or collection of chaff plus straw could be useful to reduce weed pressure in integrated weed control plans and help extend the life of herbicides. However, more years of study are necessary to have more conclusive results and evaluate how the year effect could impact the percentage of seed retention and the efficacy of these practices.

4. ACKNOWLEGEMENTS

This research was possible thanks to the funds of a WesternSARE project and to the collaboration of the growers Larry Coppock, Sterling Allen, and Eric Nelson. In addition, we want to thank the summer students Austin Weinke and Mikayla Kelly for helping us with the sample processing.

5. REFERENCES

Walsh M, Newman P and Powles S (2013). Targeting weed seeds in-crop: a new weed control paradigm for global agriculture. *Weed Technology*, 27, 431-436.

Walsh M & Powles S (2014). High seed retention at maturity of annual weeds infesting crop fields highlights the potential for harvest weed seed control. *Weed Technology*, 28, 486-493.

Eco-innovación en malherbología y su transferencia

Resumen: La evolución continua de la resistencia a herbicidas en las principales malas hierbas es una fuerza impulsora para desarrollar nuevas estrategias de control. La recogida del tamo y la recogida del tamo más la paja directamente en la cosecha son dos prácticas sostenibles que no han sido evaluadas adecuadamente. Los objetivos de este estudio fueron: 1) Evaluación de la retención de semillas de malas hierbas de trigo a la cosecha; 2) Evaluación de la eficacia de las practicas mencionadas. Resultados preliminares muestran que la eficacia de control está determinada, entre otros factores, por el momento de la cosecha y por las características de las especies a controlar. Los porcentajes medios de reducción relativa de malas hierbas (obtenidos de un solo año de estudio) fueron de 15% cuando se recolectó el tamo y de 22% cuando se recolectó el tamo y la paja.

Palabras clave: retención de semillas, recolección del tamo, empacado directo de la paja, control de semillas de malas hierbas en la cosecha.