RESIDUE MANAGEMENT INFLUENCE ON DOWNY BROME CONTROL IN ESTABLISHED KENTUCKY BLUEGRASS GROWN FOR SEED

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Introduction

Timely and effective management of postharvest residue is key to preparing an established Kentucky bluegrass (KBG) stand to achieve optimal seed yield potential in the next crop. Previous research has demonstrated that residue management strategies can maintain seed yield and quality in the absence of open field burning. However, straw removal must be thorough, and stubble height must be reduced prior to crop regrowth in the fall (Chastain et al., 1997). Currently, the primary residue management method utilized by KBG seed growers in the Grande Ronde Valley (GRV) of Oregon involves removing the straw by raking/baling and then propane-flaming the field to reduce stubble height and open up the plant crown for tiller development.

The optimal window for managing postharvest residue with propane-flaming occurs soon after harvest (July–August), as KBG stand regrowth typically occurs by late August–September (Walenta et al., 2004). In some years, however, wildfire smoke intrusion into the GRV degrades air quality to a level that prohibits thermal (propane-flame and open field burn) residue management activities during the regulated field burn season (July 15–September 30). In this situation, mechanical removal (baling) is the only option, but a substantial amount of fine residue is left on the field surface.

Control of downy brome (*Bromus tectorum*) is difficult to achieve with preemergent (PRE) herbicides following postharvest residue management due to interception of applied herbicide by ash and/or unburnt residue on the field surface. To improve field surface conditions for PRE herbicide application, it is necessary to harrow and/or irrigate the field to disperse ash/unburnt residue. The effectiveness of these technique is variable and contributes to poor herbicide performance, especially when crop rows have closed in older KBG stands. Further research is warranted to investigate postharvest residue and irrigation water management strategies that can improve PRE herbicide control of winter annual grass weeds.

The objectives of this study were to:

- Compare downy brome control with sequential herbicide application following two post-harvest residue management techniques: bale only (nonthermal) and bale + propane-flame (thermal).
- Evaluate residual herbicide control of downy brome and crop safety in the subsequent winter wheat crop.

Note: The active ingredients indaziflam (Alion) and pyroxasulfone (Zidua) applied in this study are not registered for use in KBG seed crops in Oregon. Product evaluations are for experimental purposes only, not for commercial use.

Materials and Methods

Objective 1

The study was initiated in 2021 in a commercial seed production field of KBG cv. 'Full Moon' following the third seed harvest. Postharvest straw was raked and baled in late July. The entire field, including the study site, was irrigated with 0.5 inch irrigation water on August 12.

The study design was a randomized complete block in a split-block arrangement. Main blocks were bale + propane flame and bale-only residue management treatments. Propane-flamed blocks were flamed and harrowed with a pasture harrow on August 9. The bale-only block was not propane-flamed and was not harrowed. Subplots were herbicide treatments with four replications.

Environmental conditions at the time of herbicide application are summarized in Table 1. Herbicide treatment subplots were 8 feet x 25 feet. An 8-foot hand-held CO_2 sprayer calibrated to deliver 21 gpa at 36 psi was used to apply herbicides. Downy brome control and KBG crop injury evaluations were made on September 16, 2021 (34 days after PRE application) and May 3, 2022 (226 days after PRE application). KBG seed yield was not measured in this study.

Objective 2

After the fourth seed harvest in July 2022, the KBG stand was taken out of production. When KBG attained 3–6 inches regrowth, the stand was sprayed out with glyphosate, and the field was rototilled 2 weeks later. Winter wheat was conventionally seeded with a double disc drill on October 20, 2022. The study area was

Table 1. Crop/weed growth stage and weather conditions at time of herbicide application to Kentucky bluegrass (KBG).

Application timing	Aug. 13, 2021 Preemergence (PRE)	Aug. 31, 2021 Early postemergence (EPOST)
KBG growth stage	No regrowth	3–6 inches regrowth
Downy brome growth stage	Not yet emerged	1–3 leaf
Air temperature (°F)	56	60
Relative humidity (%)	69	45
Cloud cover (%)	None, heavy smoke haze	None, smoke haze
Wind velocity (mph)	0–2 from N	0–4 from N
Soil temp., surface (°F)	56	78
Soil temp., 1 inch (°F)	58	70
Soil temp., 2 inch (°F)	62	61
Soil temp., 4 inch (°F)	65	60
1st irrigation event after PRE application	1 inch applied Aug. 16 (3 days after application)	0.5 inch applied Aug. 31 (4 hours after application)

restaked and monitored for residual downy brome control and winter wheat crop injury from potential herbicide carryover. Winter wheat crop injury and *Bromus tectorum* density evaluations were made on May 4, 2023. Winter wheat grain yield was not measured in this study.

Analysis of variance was performed to test residue management and herbicide treatment effects and their interaction on crop injury and downy brome control. Herbicide treatment means were separated by Tukey's all-pairwise comparison method at 5% level of significance.

Results and Discussion

There were no significant interactions between residue management technique and herbicide treatment effects on KBG/winter wheat crop injury or downy brome control within either crop. Herbicide treatment differences were observed in KBG (fall 2021) for downy brome control; treatments that provided acceptable control included Alion applied at the PRE application date at either 2 or 3 fl oz/acre (Table 2). By spring 2022, the downy brome infestation had increased to severe levels, and there were no differences among herbicide treatments. However, KBG injury observed the previous fall was not detectable the following spring (data not shown).

There was no crop injury in recrop winter wheat (spring 2023) from any herbicide treatments applied during the last cycle of KBG seed production (Table 3). The herbicide treatments were applied 13–14 months prior to planting the winter wheat. Crop injury potential may have been minimized by tillage utilized to prepare the field for planting winter wheat, which may have diluted the herbicide within the soil disturbance zone. The downy brome infestation in the winter wheat crop was light and variable, so plant density was determined for each plot (200 ft^2). Differences in plant density were detected, but it was not possible to attribute those differences to herbicide treatments applied previously to KBG.

Conclusions

Postemergent (POST) herbicide options are extremely limited for control of winter annual grass weed species in KBG seed crops. Therefore, it is critical to maximize efficacy potential of PRE herbicides for these weed species.

The results of this study suggest that further investigation is needed to explore harrowing techniques and irrigation management strategies that might more effectively disperse ash/fine residue and allow applied herbicide to reach the soil surface in an established KBG stand. For example, indaziflam requires 48 hours of binding time on dry soil to prevent movement into the crop root zone (Bayer Crop Science). Recent research has also demonstrated that certain soil-active herbicides can be desorbed from winter annual grass litter with simulated rainfall (Clark et al., 2019). If sufficient irrigation water could be delivered soon after herbicide application, it might be possible to move indaziflam or other soil-active herbicides to the soil surface in KBG seed production fields that received either thermal or nonthermal postharvest residue management. If such strategies can be developed, it might also be possible to extend the window for downy brome control in the fall by applying two different PRE herbicides in sequence (Table 2).

Table 2. Crop injury and downy brome control in established Kentucky bluegrass (KBG) grown for seed with sequential herbicide applications under thermal and nonthermal postharvest residue management techniques.

				Sep. 16, 2021[1]			
Tmt	Herbicide treatment	Product rate/a	Timing	KBG crop injury		Downy brome control	
				Bale only	Bale + propane	Bale only	Bale + propane
				(%)		(%)	
1	Check	Untreated		0 b	1	0 b	0 d
2	Prowl H2O // Beacon	5 pt 0.76 oz	PRE EPOST	2 ab	1	42 ab	46 c
3	Zidua WG // Outrider	1.85 oz 0.76 oz	PRE EPOST	9 a	5	50 ab	37 c
4	Prowl H2O // Outrider	5 pt 0.76 oz	PRE EPOST	2 ab	2	31 ab	34 c
5	Alion	1 fl oz	PRE	0 b	0	35 ab	49 bc
6	Alion	2 fl oz	PRE	0 b	0	44 ab	71 ab
7	Alion	3 fl oz	PRE	0 b	0	72 a	75 a
8	Prowl H2O // Alion	5 pt 1 fl oz	PRE EPOST	0 b	0	0 b	0 d
9	Prowl H2O // Alion	5 pt 2 fl oz	PRE EPOST	0 b	0	22 ab	7 d
10	Prowl H2O // Alion	5 pt 3 fl oz	PRE EPOST	0 b	0	18 ab	0 d
	LSD (0.05)	—	—	6	ns	65	23

[1]Numbers followed by the same letter are not significantly different at LSD ($P = 0.05$).

References

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Table 3. Crop injury and downy brome density in recrop winter wheat following sequential herbicide application in established Kentucky bluegrass under thermal and nonthermal postharvest residue management techniques.

				May 4, 2023			
Tmt	Herbicide treatment	Product rate/a	Timing	Winter wheat crop injury		Downy brome density[1, 2]	
				Bale only	Bale + propane	Bale only	Bale + propane
				(%)		(%)	
1	Check	Untreated		0	0	3	2 b
2	Prowl H2O // Beacon	5 pt 0.76 oz	PRE EPOST	0	0	18	6 ab
3	Zidua WG // Outrider	1.85 oz 0.76 oz	PRE EPOST	0	0	10	19 a
4	Prowl H2O // Outrider	5 pt 0.76 oz	PRE EPOST	0	0	6	3 b
5	Alion	1 fl oz	PRE	0	0	17	4 ab
6	Alion	2 fl oz	PRE	0	0	7	2 b
7	Alion	3 fl oz	PRE	0	0	4	5 ab
8	Prowl H2O // Alion	5 pt 1 fl oz	PRE EPOST	0	0	2	8 ab
9	Prowl H2O // Alion	5 pt 2 fl oz	PRE EPOST	0	0	1	2 b
10	Prowl H2O // Alion	5 pt 3 fl oz	PRE EPOST	0	0	2	1 b
	LSD (0.05)	—	—	ns	ns	ns	15

[1]Mean of four replications.
[2]Numbers followed by the same letter are not significantly different at LSD (*P* = 0.05).