EVALUATION OF EXPERIMENTAL HERBICIDES IN SEEDLING RED AND WHITE CLOVER GROWN FOR SEED

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Introduction

Clover grown for seed is an important crop in Oregon's Willamette Valley. Oregon produces approximately 89% and 68% of the nation's red clover and white clover seed, respectively (USDA-NASS, 2020). Weed interference may reduce crop yield. Furthermore, for certified product, seed quality and purity dictate the marketability of the product, as stringent certification requirements must be met. In this context, weed control becomes crucial to prevent crop loss, weed seed contamination, and depreciation of the clover seed.

Weed control in clover seed crops is achieved with a combination of pre- and postemergence herbicide applications, with the former typically applied in late fall/early winter and the latter applied during winter dormancy. This approach allows the use of postemergence, burn-down herbicides, which can be very effective for control of most weed species. It also allows for the recovery of the clover plants, as herbicide translocation and crop damage are minimized due to reduced metabolism during dormancy. Postemergence herbicide applications, after clover crop growth resumes, may have additional weed-control benefits such as targeting summer annual species.

The dormant application is particularly attractive when winter annual weed species germinate November–February and have the potential to set seed during the summer if not controlled. It also is beneficial to choose a burn-down herbicide that could provide some residual activity for the remainder of the growing season, particularly for control of broadleaf weed species.

The objective of this study was to test potential postemergence burn-down herbicides in seedling clover seed crops in western Oregon. We also included a preemergence herbicide that has shown potential to control plantain species (*Plantago* spp.). We focused our efforts on comparing herbicide products that are currently registered for clover seed crops, but also identified new products to evaluate efficacy and possible candidacy for future registrations. Of the herbicides tested in this work, only flumioxazin and paraquat are currently registered for use in clover grown for seed, and the results from this research should not be used as recommendations for commercial use.

Materials and Methods

The field experiments were performed in the 2019–2020 season at the Oregon State University Schmidt Research Farm, near Corvallis, OR. New clover stands were planted on September 25, 2019 at a planting rate of 13.5 lb/acre on 7.5-inch row spacing. Plots were 8 feet x 35 feet. Study design was a randomized complete block with four replications.

Several herbicides were selected for these two studies |in seedling red clover (Table 1) and white clover (Table 2). An application timing factor (Tables 1 and 2) was also included in the treatments to quantify the response of clover. Herbicide treatments were applied with a customized bicycle sprayer equipped with air induction nozzle tips (AIXR 11003) calibrated to deliver 20 gal/acre. Application dates were November 19 (A), January 20 (B), March 19 (C), and May 11 for red clover and April 20 for white clover (D). In the red clover trial, the last application timing occurred immediately after chopping the red clover for forage.

Weed-control evaluations were performed in January and March for red clover and in May for white clover, using a 0–100% scale, where 0% represents absence of weed control and 100% represents complete control. Crop injury was also evaluated using the same scale. Red clover was harvested on August 19, and white clover was harvested on August 13, 2020 with a small-plot combine. Harvested seed was conditioned to determine clean seed yield.

Results and Discussion

<u>Seedling red clover</u>

Seedling red clover exhibited excellent crop tolerance to most of the herbicide treatments tested. We observed increased injury for the May application, when some of the treatments exhibited as high as 35% crop damage (Table 1).

We were not able to analyze the crop yield statistically even after data transformation, as data did not meet ANOVA assumptions; thus, data are provided as means without multiple comparisons. The crop yield data seem to reflect the injury observed on June 23, in that

Table 1. Weed control and crop safety of experimental herbicides applied between November 19, 2019 and May 11, 2020 in seedling red clover.[1]

				Control (Mar. 26, 2020)		Red clover	
Treatment	Rate	Unit	Date applied	Shepherd's purse	Desert rock purslane	Injury (Jun. 23)	Seed yield (Aug. 19)
				(%)	(%)	(%)	(lb/a)
Untreated	—	—	—	0 e	0 f	0 b	437
Norflurazon	0.49	lb ai/a	Nov. 19	28 d	18 ef	0 b	453
Norflurazon	1	lb ai/a	Nov. 19	63 bc	45 cde	0 b	426
Norflurazon	1	lb ai/a	Jan. 20	25 d	25 ef	0 b	443
Norflurazon	1.97	lb ai/a	Jan. 20	25 d	18 ef	0 b	463
Pyridate	0.94	lb ai/a	Jan. 20	20 d	25 ef	0 b	450
+ COC	1	% v/v					
Paraquat	0.5	lb ai/a	Jan. 20	58 bc	73 bc	0 b	434
+ NIS	0.25	% v/v					
Saflufenacil	0.0445	lb ai/a	Jan. 20	93 a	83 ab	10 b	325
+ MSO	1	% v/v					
+ AMS	1.67	lb ai/a					
Flumioxazin	0.128	lb ai/a	Jan. 20	100 a	100 a	0 b	424
+ MOS	0.25	% v/v					
Pyridate	0.94	lb ai/a	Mar. 19	0 e	0 f	5 b	471
+ COC	1	% v/v					
Paraquat	0.5	lb ai/a	Mar. 19	68 b	68 bcd	8 b	370
+ NIS	0.25	% v/v					
Saflufenacil	0.0445	lb ai/a	Mar. 19	63 bc	63 bcd	10 b	350
+ MSO	1	% v/v					
+ AMS	1.67	lb ai/a					
Flumioxazin	0.128	lb ai/a	Mar. 19	43 cd	43 de	3 b	423
+ NIS	0.25	% v/v					
Pyridate	0.94	lb ai/a	May 11	—	—	0 b	463
+ COC	1	% v/v					
Paraquat	0.5	lb ai/a	May 11	—	—	10 b	454
+ NIS	0.25	% v/v					
Saflufenacil	0.0445	lb ai/a	May 11	—	—	35 a	401
+ MSO	1	% v/v					
+ AMS	1.67	lb ai/a					
Flumioxazin	0.128	lb ai/a	May 11	—	—	5 b	377
+ NIS	0.25	% v/v					
LSD *P* = 0.05	—	—	—	16	21	6	—
CV	—	—	—	26	34	87	—

[1]Means followed by the same letter are not different at LSD (*P* = 0.05, Student-Newman-Keuls). Multiple comparison analysis was not performed for crop yield. Weeds were not evaluated for treatments 14–17, as the crop canopy closed and weeds were suppressed.

treatments unaffected by the herbicide applications yielded approximately 450 lb/acre (Table 1).

The predominant weed species in the red clover site were Shepherd's purse and desert rock purslane. Norflurazon (Solicam), which is a preemergence herbicide, exhibited poor control of both weed species. Treatments containing saflufenacil (Sharpen) and flumioxazin (Chateau) were superior for Shepherd's purse and desert rock purslane control.

Seedling white clover

More variation in crop response was observed in the seedling white clover trial (Table 2). For this

Table 2. Weed control and crop safety of experimental herbicides applied between November 19, 2019 and April 20, 2020 in seedling white clover.[1]

Treatment	Rate	Unit	Date applied	Prickly lettuce control (May 20, 2020)	White clover: Injury (Jun. 23)	White clover: Seed yield (Aug. 13)
				(%)	(%)	(lb/a)
Untreated	—	—	—	0 d	0 c	392 ab
Norflurazon	0.49	lb ai/a	Nov. 19	0 d	0 c	397 ab
Norflurazon	1	lb ai/a	Nov. 19	0 d	0 c	416 ab
Norflurazon	1	lb ai/a	Jan. 20	25 cd	0 c	505 a
Norflurazon	1.97	lb ai/a	Jan. 20	0 d	0 c	394 ab
Pyridate	0.94	lb ai/a	Jan. 20	23 cd	0 c	422 ab
+ COC	1	% v/v				
Paraquat	0.5	lb ai/a	Jan. 20	95 a	0 c	367 b
+ NIS	0.25	% v/v				
Saflufenacil	0.0445	lb ai/a	Jan. 20	100 a	38 a	307 bc
+ MSO	1	% v/v				
+ AMS	1.67	lb ai/a				
Flumioxazin	0.128	lb ai/a	Jan. 20	95 a	0 c	386 ab
+ MOS	0.25	% v/v				
Pyridate	0.94	lb ai/a	Mar. 19	65 ab	0 c	427 ab
+ COC	1	% v/v				
Paraquat	0.5	lb ai/a	Mar. 19	100 a	3 c	367 b
+ NIS	0.25	% v/v				
Saflufenacil	0.0445	lb ai/a	Mar. 19	100 a	25 b	245 c
+ MSO	1	% v/v				
+ AMS	1.67	lb ai/a				
Flumioxazin	0.128	lb ai/a	Mar. 19	88 a	0 c	397 ab
+ NIS	0.25	% v/v				
Pyridate	0.94	lb ai/a	Apr. 20	45 bc	0 c	415 ab
+ COC	1	% v/v				
Paraquat	0.5	lb ai/a	Apr. 20	96 a	0 c	375 b
+ NIS	0.25	% v/v				
Saflufenacil	0.0445	lb ai/a	Apr. 20	98 a	23 b	296 bc
+ MSO	1	% v/v				
+ AMS	1.67	lb ai/a				
Flumioxazin	0.128	lb ai/a	Apr. 20	90 a	3 c	362 b
+ NIS	0.25	% v/v				
LSD $P = 0.05$	—	—	—	27	9	76
CV	—	—	—	31	114	14

[1]Means followed by the same letter are not different at LSD ($P = 0.05$, Student-Newman-Keuls).

crop, high injury levels were observed in the March evaluation (data not shown). However, plants recovered for the most part before the June visual assessment. Interestingly, visual crop injury did not reflect the differences observed in seed yield. Treatments with saflufenacil reduced crop yield.

Most of the treatments controlled wild carrot, except those containing norflurazon (data not shown). In addition, reduced wild carrot control was observed for pyridate (Tough) regardless of application timing.

Conclusion

This study highlights the potential of new herbicide chemistries to be assimilated into clover seed production systems in western Oregon. For example, flumioxazin is currently registered only for established red and white clover. However, our results suggest flumioxazin should be considered for registration for dormant applications to seedling red and white clover. Similarly, we observed that saflufenacil has excellent crop safety when used as a postemergence burn-down herbicide in dormant seedling red clover. The OSU Weeds program is currently repeating these experiments, and additional data will help support future herbicide registration efforts in Oregon clover grown for seed.

References

[USDA-NASS] U.S. Department of Agriculture National Agricultural Statistics Service. 2020. Oregon Agricultural Statistics. https://www.oregon.gov/oda/shared/Documents/Publications/Administration/ORAgFactsFigures.pdf.

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