RESISTANCE TO ACCASE INHIBITORS IN DOWNY BROME POPULATIONS FROM FINE FESCUE SEED FIELDS

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Introduction

In the United States, Oregon is the largest fine fescue (*Festuca* L. spp.) seed-producing state. Species produced include Chewings fescue (*F. rubra* L. ssp. *commutata* Gaudin), creeping red fescue (*F. rubra* L. ssp. *rubra* Gaudin), and hard fescue (*F. brevipila* Tracey), with an estimated 26,800 harvested acres in 2021 (Oregon State University, 2021b). About 60% of fine fescue seed production in Oregon occurs in the foothills of the Cascade Mountain Range in the Willamette Valley, and an additional 40% of seed production is in the Grande Ronde Valley and the Columbia Basin in the northeastern part of the state (Oregon State University, 2021a).

Weed management, particularly of grass weeds, represents one of the biggest challenges fine fescue growers face in Oregon. Among the several weed species that can negatively impact fine fescue grown for seed, downy brome (*Bromus tectorum* L.) is one of the most difficult species to control in the northeastern region. Preemergence herbicide options are limited and often do not provide effective downy brome control in the fall because of a lack of sufficient rainfall or irrigation to activate them; therefore, additional herbicide applications are required to reduce downy brome infestation levels after emergence. There are only two postemergence (POST) grass herbicides (fluazifop and sethoxydim) registered for use in fine fescue seed production in Oregon, and both herbicides are acetyl-coenzyme A carboxylase (ACCase) inhibitors (Group 1). Previously, one ACCase-resistant downy brome population was confirmed in fine fescue seed production systems in northeastern Oregon (Ball et al., 2007).

Since 2007, fine fescue seed growers in northeastern Oregon have reported diminished downy brome control with ACCase inhibitor herbicides. These reports raised concerns that multiple downy brome populations have evolved resistance to this group of herbicides. Therefore, the objective of this study was to evaluate downy brome populations for resistance to the ACCase inhibitors sethoxydim, clethodim, fluazifop-P-butyl, and quizalofop-P-ethyl, and the acetolactate synthase (ALS) inhibitor sulfosulfuron.

Materials and Methods

Ten downy brome plants were collected at physiological maturity from nine commercial fine fescue seed production fields in the Grande Ronde Valley, Union County, OR, in 2020. Fields were selected based on grower observations of poor control of downy brome populations with ACCase inhibitor herbicides. Panicles were hand threshed for seed collection, and seeds were stored in envelopes at room temperature until the screenings were initiated.

The experiment was conducted at Oregon State University greenhouses, Corvallis, OR (44.56°N, 123.28°W) using a randomized complete block design with six replications. The experiment was repeated. Plants were grown at 75°F (day) and 59°F (night), and artificial lighting was provided using 400-watt high-pressure sodium light bulbs to ensure a 12-hour photoperiod.

Herbicide rates of 0, 1, and 2 times the recommended labeled rate were tested (Table 1). Application rates

Table 1. Herbicides, trade names, and rates used in the study.

Herbicide	Trade name	Rate[1]	
		----- (oz a^{-1}) -----	
		1X	2X
Clethodim[2]	Select MAX	16	32
Sethoxydim[2]	Poast	40	80
Fluazifop-P-butyl[2]	Fusilade DX	8	16
Quizalofop-P-ethyl[2]	Assure II	12	24
Sulfosulfuron[3]	Outrider	0.66	1.32

[1]Rate based on label recommendation, where 1X = labeled rate. Clethodim and quizalofop-P-ethyl label rates were based on the recommendation for alfalfa. Sulfosulfuron label rate was based on the recommendation for winter wheat.
[2]COC (crop oil concentrate [1% v/v]) was added to the spray solution.
[3]NIS (nonionic surfactant [0.25% v/v]) was added to the spray solution.

for herbicides (clethodim, quizalofop-P-ethyl, and sulfosulfuron) not registered for use in fine fescue seed production were determined by the recommended rate for representative rotational crops grown in the Grande Ronde Valley. Herbicides were applied with appropriate adjuvants using a research cabinet sprayer delivering 15 gpa spray volume through a single 8002E nozzle at 40 psi to individual downy brome plants at the two- to three-leaf stage.

Downy brome plants were visually assessed as dead or alive 21 days after treatment. Plants were considered alive if green tissue was observed in growing plants, whereas completely necrotic plants were considered dead. Survival was expressed as the proportion of surviving individuals compared to the total number of treated seedlings.

Results and Discussion

Results confirmed that most downy brome populations tested were resistant to the ACCase inhibitors sethoxydim, clethodim, fluazifop-P-butyl, and quizalofop-P-ethyl (Figure 1). Survival levels varied among the populations for each herbicide tested. The populations were cross-resistant to the ACCase-inhibitors clethodim and quizalofop-P-ethyl in fine fescue. Although these herbicides are not labeled for use in fine fescue, they may be used in many other crops grown in the area, such as canola, peas, mint, alfalfa, and sunflower.

Clethodim

Downy brome survival ranged from 9 to 58% when treated with the labeled rate of clethodim (16 fl oz a^{-1}) (Figure 1). Populations UDB-1, UDB-2, UDB-3, and UDB-4 had greater than 50% survival. Populations UDB-6, UDB-7, UDB-8, UDB-9, and UDB-10 had less than 45% survival. All populations were sensitive to two times the labeled rate of clethodim (32 fl oz a^{-1}).

Sethoxydim

All populations had greater than 80% survival when treated with the labeled rate of sethoxydim (40 fl oz a^{-1}), except population UDB-9 (Figure 1). Downy brome plant survival was slightly reduced when treated with two times the labeled rate of sethoxydim (80 fl oz a^{-1}), but still was greater than 50%.

Fluazifop-P-butyl

All downy brome populations were resistant to fluazifop-P-butyl (Figure 1). Downy brome plant survival was greater than 90% when treated with either the labeled rate (8 fl oz a^{-1}) or two times the labeled rate (16 fl oz a^{-1}).

Quizalofop-P-ethyl

All downy brome populations were resistant (100% survival) to the labeled rate of quizalofop-P-ethyl (12 fl oz a^{-1}) (Figure 1). All downy brome populations except UDB-9 had greater than 75% survival when

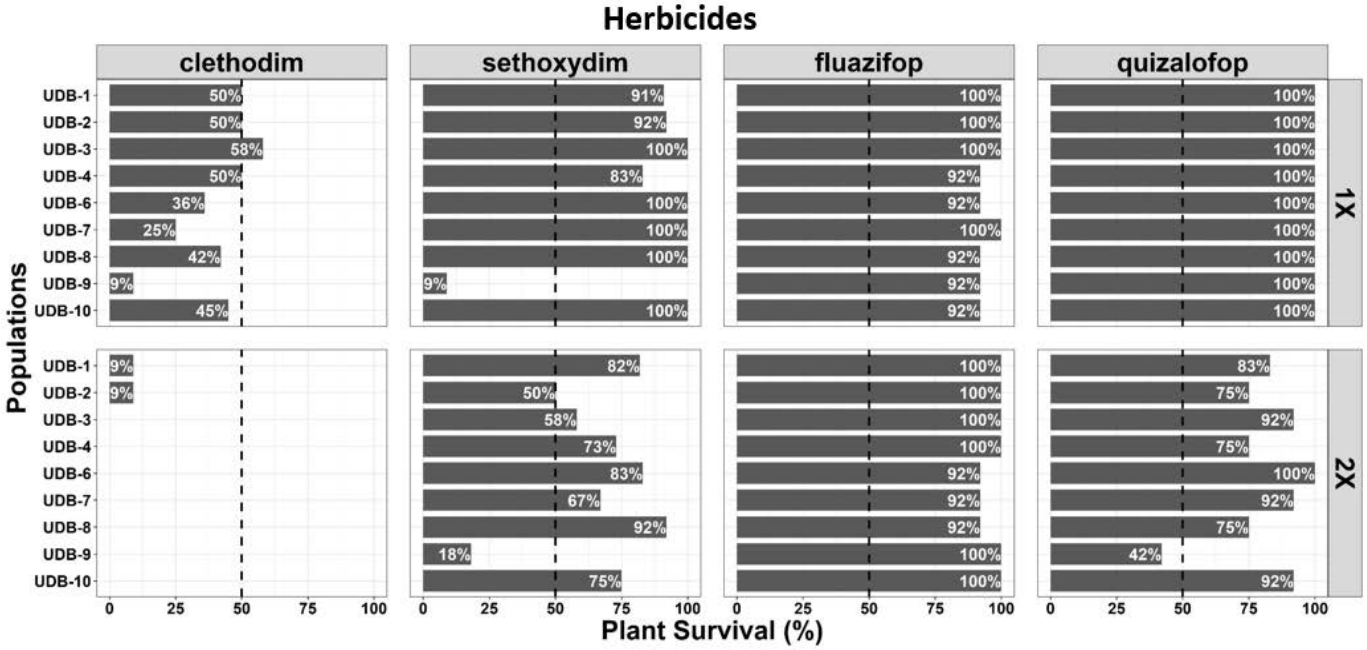

Figure 1. Downy brome survival to clethodim, sethoxydim, fluazifop-P-butyl, and quizalofop-P-ethyl at the labeled rate (1X) and two times the labeled rate (2X) of each herbicide.

treated with two times the labeled rate (24 fl oz a^{-1}). Population UDB-9 was controlled (42% survival) with two times the labeled rate, indicating different levels of resistance.

Sulfosulfuron

All downy brome populations tested in this study were susceptible to sulfosulfuron (data not shown). Sulfosulfuron is labeled for downy brome control in wheat and other crops, but it is not registered for use in fine fescue grown for seed.

Conclusion

The results of this study confirmed a high percentage of ACCase-resistant downy brome populations collected from multiple fine fescue seed production fields in northeastern Oregon. The ALS inhibitor sulfosulfuron effectively controlled these ACCase-resistant populations, but it is not labeled for use in fine fescue. Therefore, herbicides with different sites of action, including ALS inhibitors, are needed to control downy brome in fine fescue fields and rotational crops and to reduce the selection pressure of ACCase inhibitors in this system. Further study is needed to determine the extent and prevalence of ACCase-resistant downy brome in the region and to investigate integrated downy brome management strategies in local fine fescue seed cropping systems.

References

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