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Arable Extra

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Efficacy and crop safety of different herbicides against key grass weeds and arable crops

Background

New Zealand arable farms are experiencing an increase in instances of herbicide-resistant grass weeds, with growers in some regions struggling to control populations, particularly of ryegrass (*Lolium* spp.), that have become resistant to Group 2 Mode-of-Action (MoA). This group, which all inhibit the plant enzyme acetolactate synthase, include important grass-control herbicides such as iodosulfuron and mesosulfuron-methyl.

Increasing cases of herbicide resistance means annual screening of the efficacy of commercial and close-to-market grass weed herbicides belonging to a range of MoAs is more important than ever. This report describes 2022 data from FAR's ongoing herbicide screening trial at Chertsey, mid-Canterbury, where the efficacy and crop safety of a number of new and old herbicides were tested against several problematic weed species and in a number of common crops. This is the second consecutive year that FAR has run this trial, after taking a nine-year hiatus from this kind of work.

The trial works for un-replicated demonstration purposes only, but treatments can be compared across seasons to provide additional information on herbicide efficacy. Furthermore, the grass weeds were grown without crop competition and sown at a single depth. Thus, these data should be interpreted with such limitations in mind.

Key points

- The emergence of herbicide resistance means that testing the efficacy of commercial and close-to-market grass weed herbicides belonging to a range of MoAs is important.
- In 2022, a herbicide screening trial identified the relative efficacy of different herbicides, at different rates, on a range of grass and crop species, using a log sprayer.
- Several promising options for grass weed control were identified, including two new coded products for management of key grass weeds.
- Using the most effective herbicide rate possible within the crop grown reduces the risk of herbicide resistance emerging to an active ingredient.

2022 herbicide screening trial

The trial was established on 26 April, 2022 at the FAR Arable Site, Chertsey, Mid Canterbury. Twelve grass weed and crop species (Table 1) were sown in 18 m strips. A four-row hoe coulter cone seeder drill was used to establish the trial for seven species. Awned weed species were hand sown by spreading seed and hand-raking to incorporate below the soil surface.

Fourteen different herbicide treatments were applied (Table 2) across all species using a log sprayer which gave a concentration gradient down the length of the plots. Rates began at double the label rate and were diluted down the length of the plot to <10% of the label rate. Note that "label rate" was chosen as a typical grass weed application rate, as many products suggest a range. Application rates for products that did not list grass weeds on the label were chosen based on the rate for other weeds, or on advice from the manufacturer. All applications were made at a water rate of 250 L/ha with 4 x 110 02xr tee jet flat fan nozzles producing a very fine spray droplet.

The level of control was recorded by visual observation at double, one, half and quarter times the "label rate" as a score out of ten, with ten representing complete plant death and zero no control. Final weed control scores were taken approximately 70 days after the final herbicide treatment for the pre-drill and pre-emergence (1 August 2022) and post-emergence (16 September) treatments.

There were three herbicide timings (Table 2). Avadex® and Trifluralin (pre-drill) were incorporated into the soil with the drill at sowing on 26 April. Pre-emergence treatments were applied on 4 May, while post-emergence treatments were applied at growth stage (GS) 12-21 of the grass weeds on 5 July.

A random survey of South Canterbury arable farms found half of them had ryegrass populations with resistance to herbicides in MoA Group 1 (ACCase inhibitors) and/or Group 2 (ALS inhibitors). Similar resistant ryegrass populations have been found in other parts of New Zealand. Research in this area is ongoing, but it is clear that future management of ryegrass weeds will require the rotational use of herbicides from multiple MoA groups (Table 1), as well as non-chemical control methods. Non-chemical control methods would include a well-planned crop rotation, which might include the use of spring crops to disrupt weed life cycles.

Table 1. Grass weed and crop species sown in the herbicide screening trial at Chertsey in 2022. Species marked with a (*) were hand-sown, while all others were drilled.

Species/cultivar	Scientific name	Sowing rate (kg/ha)
*Barley grass	*Hordeum murinum*	2.5
Canary grass	*Phalaris minor*	5
Annual ryegrass cv. Tama	*Lolium multiflorum*	30
Perennial ryegrass cv. Nui	*Lolium perenne*	20
*Hairgrass	*Vulpia bromoides/myuros*	10
*Prairie grass	*Bromus wildenowii*	5
*Soft brome	*Bromus hordeaceus*	5
*Ripgut brome	*Bromus diandrus*	5
Wheat cv. Firelight	*Triticum aestivum*	100
Barley cv. Planet	*Hordeum vulgare*	140
Oilseed rape	*Brassica napus*	0.5
Oats L5 Milling	*Avena sativa*	30

Table 2. Herbicides, rates and timings investigated in the herbicide screening trial sown at Chertsey in 2022.

Herbicide application timing			Starting rate[1] (double the label rate) (L/ha)[2]	Active ingredient(s)	Mode-of-Action Group(s)
Pre-plant incorporate	Pre-emergence	Post-emergence			
Avadex® + Triflur® 480			5.6 + 4	tri-allate trifluralin	15 3
	Terb 500®	Glean®	3 + 40 g/ha	terbuthylazine chlorsulfuron	5 2
	Firebird®		1	flufenacet diflufenican	15 12
	Firebird® + Terb 500®		1 + 3	flufenacet diflufenican terbuthylazine	15 12 5
	Sakura®		300 g/ha	pyroxasulfone	15
	Sakura® + Terb 500®		300 g/ha + 3	pyroxasulfone terbuthylazine	15 5
		Othello®	2	diflufenican mesosulfuron iodosulfuron	12 2 2
		Rexade™ GoDRI™	200 g/ha	halauxifen-methyl pyroxsulam	4 2
		Prominent®	4	prometryn	5
		Twister®	6	isoproturon	5
	H21/01		1.3		30
	AG590		5		3+5+12
	Nortron® + *Quantum®		8 + 0.1*	ethofumesate diflufenican	15 12
	Nortron® + Simatop™		8 + 1.5	ethofumesate simazine	15 5

*Quantum® was applied at a fixed rate, while Nortron® was applied using the log sprayer.
[1]Surfactants and additives added as required by product labels.
[2]Application rates are in L/ha unless otherwise stated.

Results

Many of the products investigated in the 2022 trial had been tested in previous years. Results in 2022 were mostly similar to those observed in the past. The exception was Twister® (MoA Group 5), which was overall less effective than in other trials. This could suggest an issue with the chemical or its application, as it was much more effective in the 2021 trial.

Note: *Results in the summary below refer to the label (1x) rates. Complete results are shown in Table 3 for your interpretation. f.b. = followed by, which denotes a sequence of products. Always consult your agronomist when making herbicide decisions.*

Barley grass

Barley grass was one of the more difficult grass weeds to control in this trial. Either terbuthylazine or ethofumesate was present in each of the most effective treatments. Note that barley grass is specifically mentioned on the label for products containing ethofumesate. Sakura® and the two experimental products provided some control. There were no effective post-emergent herbicides.

- Tolerant to: Terb 500® f.b. Glean®, Firebird®, Rexade™ GoDRI™, Prominent®, Twister®
- Mostly tolerant to: Avadex® + Triflur® 480
- Mostly susceptible to: Sakura®, H21/01, AG590
- Susceptible to: Firebird® + Terb 500®, Sakura® + Terb 500®, Nortron® + Quantum®, Nortron® + Simatop™

Canary grass

All pre-emergence treatments were effective at controlling *canary grass*, as well as some of the post-emerge herbicides.

- Tolerant to: Prominent®
- Mostly tolerant to: Twister®
- Mostly susceptible to: Othello®
- Susceptible to: Avadex® + Triflur® 480, Terb 500® f.b. Glean®, Firebird®, Firebird® + Terb 500®, Sakura®, Sakura® + Terb 500®, H21/01, AG590, Nortron® + Quantum®, Nortron® + Simatop™, Rexade™ GoDRI™

Annual ryegrass

When present as a weed, pre-emergence herbicides remain the most reliable method of control. Post-emergence herbicides, particularly Rexade™, are useful to control late flushes that may have been missed by the pre-emergence spray. The two Nortron® treatments show promise for controlling certain grass weeds (especially hairgrass) in annual ryegrass seed crops.

- Tolerant to: Nortron® + Quantum®, Nortron® + Simatop™, Prominent®, Twister®
- Mostly tolerant to: none of the treatments
- Mostly susceptible to: Avadex® + Triflur® 480, Terb 500® f.b. Glean®, AG590, Othello®
- Susceptible to: Firebird®, Firebird® + Terb 500®, Sakura®, Sakura® + Terb 500®, H21/01, Rexade™ GoDRI™

Perennial ryegrass

Perennial ryegrass showed slightly more sensitivity to Nortron®-containing treatments than annual ryegrass. These two treatments were included in the trial as they have been under investigation recently as hairgass control herbicides in ryegrass seed crops. Many of the pre-emergence herbicides that controlled annual ryegrass were also effective here.

- Tolerant to: Prominent®
- Mostly tolerant to: Nortron® + Quantum®, Nortron® + Simatop™, Twister®
- Mostly susceptible to: Avadex® + Triflur® 480, Terb 500® f.b. Glean®, H21/01, Othello®, Rexade™ GoDRI™
- Susceptible to: Firebird®, Firebird® + Terb 500®, Sakura®, Sakura® + Terb 500®, AG590, Othello®

Hairgrass

Pre-emergence herbicides were the best-performing treatments against hairgrass. The weed's susceptibility to Prominent® may suggest a role in ryegrass seed crops; this would require further investigation. Of interest is the result given by Terb 500® followed by Glean®. This combination has often been ineffective at controlling hairgrass in previous trials, although it had provided moderate control in the 2021 trial.

- Tolerant to: Avadex® + Triflur® 480, Rexade™ GoDRI™
- Mostly tolerant to: Twister®
- Mostly susceptible to: Othello®, Prominent®
- Susceptible to: Terb 500® f.b. Glean®, Firebird®, Firebird® + Terb 500®, Sakura®, Sakura® + Terb 500®, H21/01, AG590, Nortron® + Quantum®, Nortron® + Simatop™

Prairie grass

Many species of *Bromus* are difficult to manage – growers in Southland and elsewhere have communicated a desire to improve weed control of these species. The addition of terbuthylazine to Sakura® improved control in this trial. Rexade™ was the only effective post-emergence treatment. The effectiveness of the two treatments containing Nortron® is encouraging for control of bromes in ryegrass seed crops.

- Tolerant to: Avadex® + Triflur® 480, Terb 500® f.b. Glean®, Othello®, Prominent®, Twister®
- Mostly tolerant to: none of the treatments
- Mostly susceptible to: Firebird®, Firebird® + Terb 500®, Sakura®, H21/01, AG590
- Susceptible to: Sakura® + Terb 500®, Nortron® + Quantum®, Nortron® + Simatop™, Rexade™ GoDRI™

Soft brome

Soft brome was very similar in response to prairie grass. It was interesting to note that Firebird® was ineffective in this trial.

- Tolerant to: Avadex® + Triflur® 480, Terb 500® f.b. Glean®, Firebird®, H21/01, AG590, Prominent®, Twister®
- Mostly tolerant to: none of the treatments
- Mostly susceptible to: Firebird® + Terb 500®, Sakura®, Othello®
- Susceptible to: Sakura® + Terb 500®, Nortron® + Quantum®, Nortron® + Simatop™, Rexade™ GoDRI™

Ripgut brome

Ripgut brome is generally considered to be the most troublesome of the *Bromus weeds*. Treatments containing Nortron® were not as effective as against other *Bromus weeds*. The addition of terbuthylazine to Firebird® improved efficacy. Rexade™ remains an effective control option against ripgut brome, although it should be noted that in cropping situations a second application is often warranted for full control.

- Tolerant to: Terb 500® f.b. Glean®, H21/01, AG590, Prominent®, Twister®
- Mostly tolerant to: Othello®
- Mostly susceptible to: Firebird®, Sakura® + Terb 500®, Nortron® + Quantum®, Nortron® + Simatop™
- Susceptible to: Avadex® + Triflur® 480, Firebird® + Terb 500®, Sakura®, Rexade™ GoDRI™

Wheat

Wheat is a target crop for many of the herbicides used in this trial, so it was no surprise to see that it was tolerant to almost all of the treatments. The Nortron® mixes were the exception and may provide useful control of wheat in ryegrass seed crops. The two experimental products showed good crop safety in wheat, which followed the same result from the 2021 trial.

- Tolerant to: Avadex® + Trifluralin, Firebird®, Firebird® + Terb 500®, Sakura®, Sakura® + Terb 500®, H21/01, AG590, Othello®, Rexade™ GoDRI™, Prominent®, Twister®
- Mostly tolerant to: Nortron® + Simatop™
- Mostly susceptible to: Nortron® + Quantum®
- Susceptible to: none of the treatments

Barley

Barley, similar to wheat, showed good crop safety with almost all of the products tested. In the 2021 trial, barley showed susceptibility to H21/01, which was not repeated in the 2022 trial. Barley is not an on-label crop for many of these products, so always check the label before applying herbicides.

- Tolerant to: Avadex® + Triflur® 480, Terb 500® f.b. Glean®, Firebird®, Firebird® + Terb 500®, Sakura®, Sakura® + Terb 500®, H21/01, AG590, Nortron® + Simatop™, Othello®, Prominent®, Twister®
- Mostly tolerant to: Nortron® + Quantum®, Rexade™ GoDRI™
- Mostly susceptible to: none of the treatments
- Susceptible to: none of the treatments

Oilseed rape

Oilseed rape was included as a reference brassica crop in this year's trial while control of Oilseed rape can be an issue in areas where the crop is grown. As expected, it proved susceptible to many herbicides that target broadleaf weeds. The lack of efficacy of Twister®, which targets broadleaf weeds, was surprising. Tolerant to: Avadex® + Triflur® 480, Nortron® + simazine, Prominent®, Twister®

- Tolerant to: Avadex® + Triflur® 480, Nortron® + Simatop™, Prominent®, Twister®
- Mostly tolerant to: H21/01, Sakura®

- Mostly susceptible to: none of the treatments.
- Susceptible to: Terb 500® f.b. Glean®, Firebird®, Firebird® + Terb 500®, Sakura® + Terb 500®, AG590, Nortron® + Quantum®, Othello®, Rexade™ GoDRI™

Oats

This trial used tame oats as a proxy for wild oats. Wild oats are more difficult to control due to variable germination and emergence dates. There were a number of moderately effective treatments in this trial, but only two were highly effective. Wild oats are on the label as being controlled by Rexade™ GoDRI™.

- Tolerant to: Terb 500® f.b. Glean®, H21/01, Prominent®, Twister®
- Mostly tolerant to: Firebird®
- Mostly susceptible to: Avadex® + Triflur® 480, Firebird® + Terb 500®, Sakura®, Sakura® + Terb 500®, AG590, Nortron® + Quantum®, Othello®
- Susceptible to: Nortron® + Simatop™, Rexade™ GoDRI™

A note on other weeds

While not specifically sown, a number of other weeds were observed in the trial area. This included Field pansy, Speedwell, Fumitory, Shepherd's purse and *Poa annua*. These weeds were scored so that data could be collected about the efficacy of each herbicide (Table 4). Most of the pre-emergence herbicide treatments showed a high level of control for all species observed in the trial area (Table 4). The main exception was the Avadex® + Trifluralin treatment, which only showed moderate activity against shepherd's purse. H21/01 was ineffective against fumitory, while Nortron® + simazine was ineffective against field pansy. Firebird had some activity against fumitory in this trial. Of the post-emergence treatments, Othello® and Rexade™ GoDRI™ were particularly effective against many weeds, but the latter was ineffective against *Poa annua*. Prominent® had excellent activity against fumitory, while the results for Twister® were as ineffective as they had been in the main trial. Isoproturon is labelled to control shepherd's purse and *Poa annua*, suggesting that there may have been an issue with the application in this trial. In previous years' trials, isoproturon was more effective at controlling some of the weeds included in this trial.

Table 3. The results of screening of 14 herbicide treatments at four different application rates across 12 grass and crop species in a un-replicated demonstration trial at Chertsey in 2022. Scores were taken on 1 August (pre-emerge) and 9 September (post-emerge). 0 = herbicide ineffective, 10 = weed completely controlled.

Species	Rate	Pre-emergence treatments 1 Aug										Post-emergence 16 Sep			
		Avadex® + Triflur® 480	Terb 500® f.b. *Glean®	Firebird®	Firebird® f.b. Terb 500®	Sakura®	Sakura® f.b. Terb 500®	H21/01	AG590	Nortron® + Quantum®	Nortron® + Simatop™	Othello®	Rexade™ GoDRI™	Prominent®	Twister®
Barley grass	2x	6	3	0	10	8	10	6	9	10	10	4	5	4	3
	1x	5	1	0	10	6	9	6	8	10	10	3	2	0	1
	0.5x	6	0	0	6	8	6	6	7	10	10	1	0	0	2
	0.25x	0	0	0	6	9	3	3	5	8	9	0	0	0	0
Canary grass	2x	10	10	10	10	10	10	10	10	10	10	10	9	4	10
	1x	10	9	10	10	10	10	9	10	9	10	8	10	2	5
	0.5x	7	10	10	9	10	10	10	9	9	10	3	7	0	4
	0.25x	0	6	10	10	10	9	6	7	8	10	0	4	0	2
Annual ryegrass	2x	10	3	9	10	9	10	9	8	0	3	10	9	2	2
	1x	6	6	9	10	9	10	9	8	0	2	10	9	1	3
	0.5x	3	5	5	8	7	8	9	7	0	1	7	9	0	3
	0.25x	0	4	4	7	7	5	8	2	0	0	3	3	0	2
Perennial ryegrass	2x	10	5	10	10	9	10	9	9	6	7	9	8	4	4
	1x	7	7	9	10	9	10	8	9	5	4	7	8	3	4
	0.5x	9	4	7	8	8	9	9	7	3	3	5	6	0	3
	0.25x	0	2	4	9	6	5	7	2	0	1	1	2	0	2
Hairgrass	2x	2	9	10	10	10	10	10	10	10	10	7	3	10	9
	1x	1	9	10	10	10	10	10	10	9	10	6	2	8	4
	0.5x	0	7	9	10	10	10	10	8	9	7	3	1	1	3
	0.25x	0	7	9	9	10	10	9	6	7	7	1	0	0	2
Prairie grass	2x	2	0	7	9	9	10	7	7	10	10	4	10	2	2
	1x	1	0	7	7	10	9	8	8	10	10	2	10	1	2
	0.5x	0	0	7	7	9	8	9	3	10	10	0	6	0	0
	0.25x	0	0	4	7	8	6	5	2	7	10	0	4	0	0
Soft brome	2x	3	0	3	9	9	10	4	4	9	10	8	9	3	0
	1x	6	0	2	7	7	10	3	3	9	9	6	9	2	0
	0.5x	2	0	0	5	5	7	5	3	8	8	4	8	2	0
	0.25x	1	0	0	5	3	4	2	0	2	5	1	7	1	0
Ripgut brome	2x	8	0	6	10	10	10	4	0	10	9	8	8	2	0
	1x	9	0	7	9	9	8	3	0	8	8	5	10	1	0
	0.5x	8	0	5	6	7	8	6	0	8	7	1	5	0	0
	0.25x	3	0	2	6	7	5	2	0	3	7	0	4	0	0
Wheat	2x	0	0	0	0	4	4	0	0	7	7	4	2	0	1
	1x	0	0	0	0	0	0	0	0	8	3	0	2	0	1
	0.5x	0	0	0	0	0	0	0	0	6	2	0	0	0	0
	0.25x	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Barley	2x	0	0	0	0	3	3	2	0	4	3	4	2	0	3
	1x	0	0	0	0	0	0	0	0	3	0	0	4	0	1
	0.5x	0	0	0	0	0	0	0	0	2	0	0	0	0	0
	0.25x	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Oilseed rape	2x	0	10	10	10	8	10	3	10	9	0	10	10	3	0
	1x	0	10	10	10	5	10	4	10	10	0	10	10	3	0
	0.5x	0	10	8	10	2	9	4	10	10	0	10	10	1	1
	0.25x	0	8	7	10	0	2	2	8	9	0	10	10	1	1
Oats	2x	8	3	6	7	7	8	3	6	9	9	10	9	2	3
	1x	6	1	4	7	6	8	1	6	8	9	7	9	1	2
	0.5x	1	0	2	5	2	5	3	4	5	7	6	7	0	1
	0.25x	1	0	3	4	0	3	2	2	4	4	2	4	0	1

Note: 2x = double the label rate, label rate, 0.5x = half the label rate, 0.25x = quarter label rate). 0 = no effect, 10 = full control (all plants killed). Note that "label rate" here was chosen to be a typical grassweed application rate, as many product labels suggest a range. Starting rates given in Table 2 are the 2x rates. Scores are those from 70 days after application. Avadex® was incorporated at drilling. f.b. = followed by. *Glean applied at post-emergence timing.

Table 4. Efficacy of 14 herbicide treatments against five weed species present in a herbicide screening trial located at Chertsey, 2022. Scores taken on 16 August 2022. 0 = herbicide ineffective, 10 = weed completely controlled.

Species	Rate	Pre-emergence treatments 1 Aug										Post-emergence 16 Sep			
		Avadex® + Triflur® 480	Terb 500® f.b. *Glean®	Firebird®	Firebird® f.b. Terb 500®	Sakura®	Sakura® f.b. Terb 500®	H21/01	AG590	Nortron® + Quantum®	Nortron® + Simatop™	Othello®	Rexade™ GoDRI™	Prominent®	Twister®
Field pansy *Viola arvensis*	2x	5	10	10	10	10	10	10	10	10	4	9	9	2	5
	1x	0	10	10	10	5	10	9	10	10	3	7	9	0	4
	0.5x	0	8	10	10	5	9	8	10	10	2	5	4	0	0
Speedwell *Veronica persica*	2x	3	10	10	10	10	10	10	10	10	10	9	10	2	1
	1x	0	10	10	10	8	10	9	10	10	10	7	10	0	0
	0.5x	0	10	10	10	6	10	9	10	10	10	5	10	0	0
Fumitory *Fumaria muralis*	2x	0	10	10	10	10	10	0	9	10	10	9	10	10	1
	1x	0	10	9	10	10	10	0	10	10	10	7	10	10	0
	0.5x	0	10	2	10	7	10	0	9	9	10	4	10	10	0
Shepherd's purse *Capsella bursa-pastoris*	2x	4	10	10	10	10	10	10	10	10	8	10	10	2	2
	1x	5	10	10	10	10	10	10	10	10	7	10	7	2	0
	0.5x	0	10	10	10	8	10	10	10	10	5	10	9	0	0
Poa annua	2x	6	10	10	10	10	10	10	10	10	10	10	3	8	8
	1x	1	10	10	10	10	10	10	10	10	10	9	0	4	9
	0.5x	0	7	10	10	10	10	10	10	10	10	7	0	0	3

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