Grazing and chemical options to manage feathertop Rhodes grass in southern NSW

Hanwen Wu, Eric Koetz and Md Asaduzzaman
NSW Department of Primary Industries, Wagga Wagga Agricultural Institute

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Take home message

- Grazing Feathertop Rhodes grass with sheep at the vegetative stage may provide useful feed in certain situations and may have complementary weed control benefits. However, grazing mature plants should be avoided as it is unlikely to prevent seed set.
- Multiple bouts of heavy grazing can significantly reduce seed production of feathertop Rhodes grass, especially when grazed at the early vegetative stage.
- Graze/spray or spray/graze can effectively reduce the vegetative and reproductive features of feathertop Rhodes grass.
- In cropping paddocks, registered residual herbicides can provide long-term suppression of feathertop Rhodes grass. However, the plantback periods of these residuals should be taken into consideration when planning crop rotations.
- Post-emergent herbicides are only effective when applied to actively growing young plants.
- Alternative strategies such as integrating grazing and/or residual herbicides will be essential, to reduce the pressure on the few effective group A herbicides.

Introduction

In southern NSW, feathertop Rhodes grass (FTR) has historically occurred on bare ground including roadsides, fence lines and wasteland areas. However, it is emerging as an issue in cropping fields, particularly where minimum or zero tillage has been practiced. With minimal disturbance, the seed remains on the soil surface, which is ideal for the emergence and proliferation of this weed. It is a challenging weed to manage as it stresses easily and can set seed rapidly. It is also a prolific seed producer under ideal conditions.

Previous research and grower experience have demonstrated that no single weed management option will provide 100 per cent control of FTR. It is not overly susceptible to glyphosate, particularly after the early tillering stage (Werth *et al.* 2013; Widderick *et al.* 2014). Therefore, glyphosate alone is not effective, nor is it registered, to control this weed. Some Group A herbicides are registered but are typically restricted to one application each season and need to be double-knocked with paraquat (in fallow) to minimise the risks of developing herbicide resistance. Furthermore, the effectiveness and suitability of residual herbicides is dependent on regional soil and climatic conditions, the timeliness of rainfall post application and the crop rotation being employed.

Limitations of individual chemistries and the fact that FTR can demonstrate multiple emergence from early spring to early autumn suggests that an integrated approach is required to effectively manage this weed. In a fully cropped system, non-chemical options such as crop competition have

proven to be highly effective in suppressing weed growth and seed set. However, limited research has been conducted using non-chemical options in mixed farming systems, in particular, options for control during the pasture phase or the effectiveness of livestock as a management tool.

A research program has been initiated to formulate integrated control strategies for FTR in southern NSW farming systems. The aim of the following research was to evaluate the role of grazing on FTR and to identify effective residual and post emergent options to control this weed.

Sheep grazing

Pasture phases and livestock are a valuable part of the farming system in southern NSW and present opportunities for weed management that differ from continuous cropping systems. Given that much of the research on FTR has occurred in continuous cropping areas, there is a need to investigate the role of livestock in FTR spread or control.

The first phase of this grazing research was to establish two grazing field trials using sheep at Wagga Wagga Agricultural Institute (WWAI) in 2020, to investigate the impact of grazing timing and frequency on vegetative and reproductive traits of FTR.

A trial site was established in February 2020 and by the end of March, the average FTR population was 5 plants/m^2. Five grazing treatments were imposed: nil grazing, early grazing, mid grazing, late grazing and multiple grazing (Table 1). Two crossbred lambs (11 months old and 50 kg live weight) per plot (35 m^2) were allowed to graze for 1 hour, with 3 lambs per plot grazing the late grazing treatment. Plant growth and reproductive features were measured one month after the late grazing treatment to assess regrowth capability and seed production of FTR.

Table 1. Schedule and effects of grazing treatments on the growth and reproductive features of feathertop Rhodes grass measured in March and April 2020

Treatment	Weed growth stage	Sheep number	Grazing duration	No of tillers /plant	No of seed heads/plant	Plant mass (g/plant)	Seeds /plant
No-grazing	-	-	-	59	51	16.5	9510
Early grazing	Before seed head formation (26 March)	2	1 hour	59	48	14.8	5375
Mid grazing	At anthesis (9 April)	2	1 hour	61	59	15.45	7000
Late grazing	At mature seed formation (23 April)	3	1 hour	60	51	15.9	4937
Multiple grazing	(1) Before seed head formation, (2) at anthesis and (3) at mature seed formation	2, 2, 3	1 hour	47	42	8.9	2570
$LSD_{0.05}$	-	-	-	*32*	*30*	*9*	*1870*

Table 1 shows that when tillers and seed production were assessed one month after the last grazing, there were no significant ($p > 0.05$) differences among the grazing treatments for the number of tillers/plant and number of seed heads/plant, indicating that FTR can recover quickly after grazing.

However, the grazing treatments did have a significant ($p < 0.001$) impact on the reproductive parts of the plant, with the multiple grazing treatment having the shortest seed head (Figure 1), and the lowest number of seeds/plant (Table 1). There was no significant difference among early, mid and late grazing for seed head size, indicating that grazing frequency may have more impact than time of grazing for this measurement.

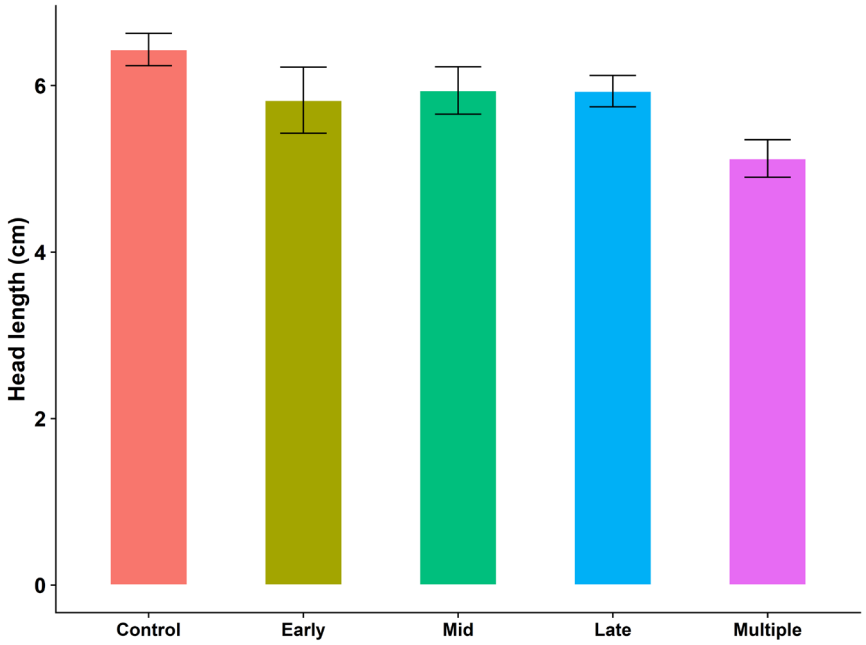

Figure 1. The effect of grazing treatments on seed head length (cm) of feathertop Rhodes grass (March and April 2020)

The seed production/plant in the no-grazing treatment was almost 4 times of that in the multiple grazing treatment, which is due to the former producing more spikelets/seed head.

It was observed that sheep preferred to graze young FTR plants rather than the mature plants with seed heads. This observation is supported by the feed value of FTR (Table 2). The feed value test indicates that FTR plants could be a valuable feed source to sheep, capable of supporting potential growth rates in excess of 150 g/day in weaners. Metabolisable energy and crude protein content of FTR plants declined steadily from the tillering stage to maturity. Feed values exceeded maintenance requirements at both the tillering and heading stage, but not at the maturity stage.

Table 2. Feed values of feathertop Rhodes grass at different plant growth stage

Plant growth stage	Neutral detergent fibre (%)	Acid detergent fibre (%)	Crude protein (%)	Metabolisable energy (MJ/Kg DM)	Water soluble carbohydrate (%)
Tillering stage	59.0	33.0	17.0	10.7	7.8
Heading stage	65.0	36.0	12.7	10.1	10.3
Maturity stage	74.0	42.0	6.4	7.9	4.1

Notes: All feed values were detected more than LOR = Limit of Reporting, the minimum quantity that can be reported with confidence.

Based on results from the first grazing trial, the ineffective late grazing treatment was removed from the second trial in December 2020. Two additional treatments were included to investigate the combined effect of herbicide and grazing. These were spray followed by grazing (spray/graze) and

grazing followed by spraying (graze/spray). The spray/graze technique is a recognised commercial practice for weed control in pastures but its effectiveness in controlling FTR has not been investigated. For the spray/graze treatment, glyphosate (570 g ai/L glyphosate) at 500 mL/ha was applied on 10 December 2020 and followed by grazing six days later. For the graze/spray treatment, grazing on 16 December 2020 was followed by an application of haloxyfop 900 at 90 mL/ha on 23 December 2020, followed by paraquat 250 at 2.4 L/ha on 1 January 2021.

The site had an average plant population of 50 plants/m^2 prior to grazing. 3 lambs were used to graze for 1.5 hours per treatment. This grazing pressure reduced FTR plants almost to ground level. Plant growth and reproductive features were measured to assess regrowth capability and seed production one month after each grazing treatment.

The second grazing trial also showed that feathertop Rhodes grass regrew quickly after grazing. The highest number of tillers were recorded in the no-grazing treatment at 25 tillers/plant, followed by the mid and early grazing treatments (Table 3). Multiple grazing (early grazing followed by mid grazing) significantly ($p < 0.005$) reduced the tiller numbers by 50% as compared to either early grazing or mid grazing alone.

Table 3. Schedule and effects of grazing treatments on growth and seed production of feathertop Rhodes grass measured in December 2020 and early January 2021

Grazing treatment	Weed growth stage	Sheep number	Grazing duration	No of tillers/plant	No of seed head/plant	No of seeds/plant
No-grazing	-	-	-	25	16	1160
Early grazing	Before seed head formation (3 December)	3	1.5 hours	21	11	745
Mid grazing	At anthesis (17 December)	3	1.5 hours	22	9	621
Multiple grazing (2 times)	(1) Before seed head formation, and (2) at anthesis	3 (each grazing)	1.5 hours	11	6	449
Spray/graze[a]	At anthesis (16 December)	3	1.5 hours	6	1	142
Graze/spray[a]	At anthesis (16 December)	3	1.5 hours	7	1	155
$LSD_{0.05}$	-	-	-	4	5	120

Notes: [a]For spray/graze treatment, glyphosate (570 g ae/L glyphosate) at 500mL/ha was applied on 10 December 2020. For the grazing + spray treatment, haloxyfop 900 at 90mL/ha was applied on 23 December 2020, followed by paraquat 250 at 2.4L/ha on 1 January 2021.

The combination of herbicide application and grazing further suppressed the formation of new tillers, with the spray/graze and graze/spray treatments resulting in the lowest number of tillers (6-7 tillers/plant) at the time of measurement, reducing the tiller numbers by 74% compared with the no-grazing control.

The grazing treatments also had significant ($p < 0.001$) effects on the seedset, as a consequence of both low number of tillers and seed heads. The spray/graze and graze/spray treatments were the most effective, reducing seed production by 87-88% compared with the no-grazing control. The multiple grazing treatment reduced seed production by 61%, while the early and mid-grazing treatments reduced seed production by 36-46%.

Call to action

This small plot research has shown that grazing by sheep can reduce the growth and seed production of FTR, especially when plants are at the vegetative growth stage and prior to seed head emergence. However, the grazed plants can re-grow quickly and produce enough seed heads to replenish the seedbank, if follow up treatments are not applied.

The results suggest that multiple heavy grazing with sheep (or multiple slashing operations) will be necessary to continually reduce vegetative growth and prevent seed production. As FTR is a very prolific seed producer, allowing just a few plants to set seed over summer will result in seedbanks increasing in the soil.

Utilising the spray/graze and graze/spray techniques may assist in limiting FTR seed production. Further field experiments are evaluating effective herbicidal options to control the fresh regrowth of FTR after grazing.

In southern NSW, we have observed that winter frost appears to kill mature FTR. There may be an opportunity that this unique frost condition in southern NSW could be used to manage this weed. For example, FTR can be continuously grazed (or slashed) before seed head emergence from summer to early winter, with the re-growth killed by the frost during the winter period. Experiments are underway to determine if the frost also kills the root system over winter in southern NSW.

Post-emergent herbicide trials

Post-emergent herbicides have been the 'go-to' option for weed management for many years due to their convenience and cost effectiveness. However, their application in managing FTR is limited due to the inherent tolerance to glyphosate and the restrictions to the number of Group A applications that can be applied each year (for resistance management purposes).

Two experiments were established at Goolgowi and Barellan in summer 2020/21 comparing Group A herbicides applied alone or with paraquat as the double-knock partner. FTR was sprayed at the early tillering stage (2-3 tillers). The Goolgowi site had a good soil moisture at time of herbicide application, while the weeds were severely moisture-stressed at Barellan site.

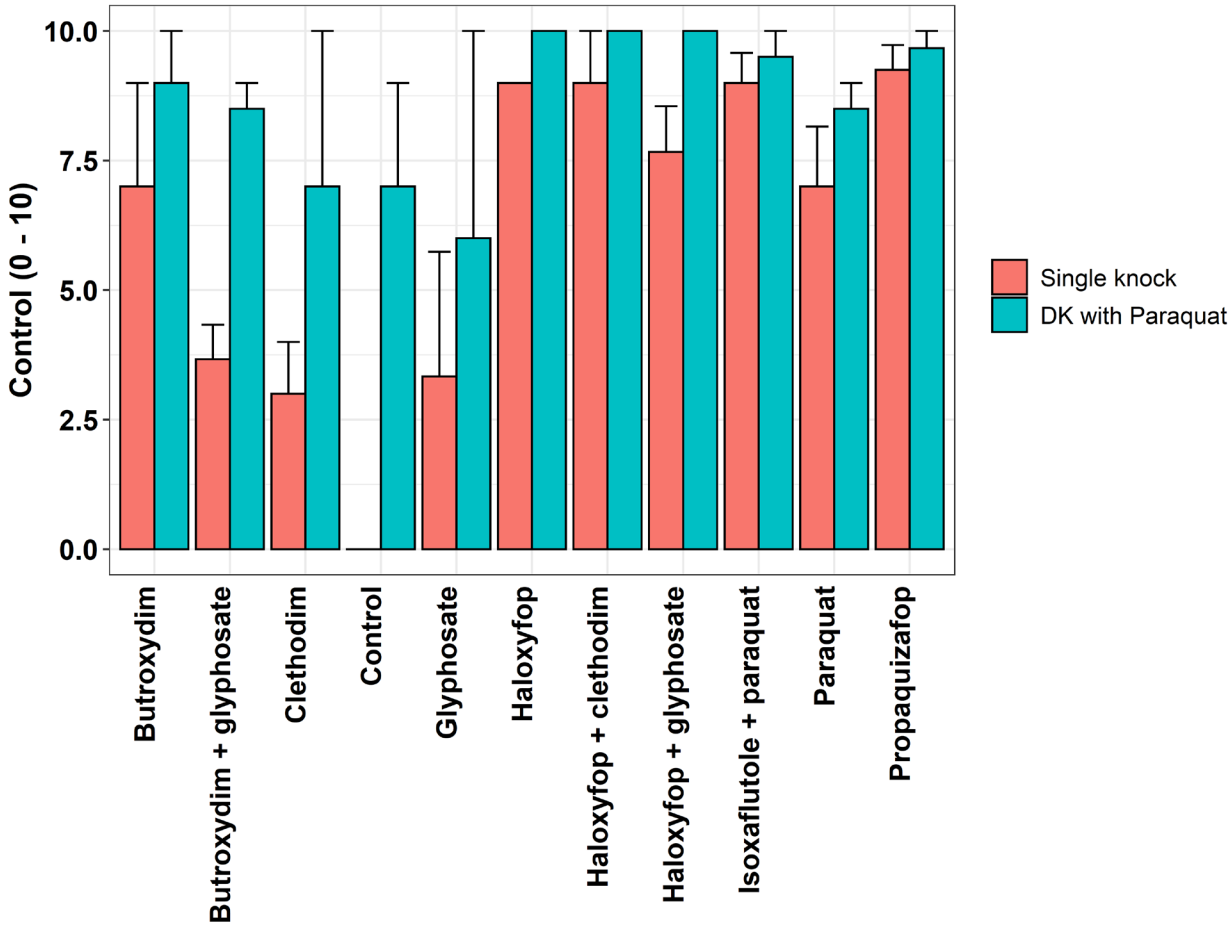

Figure 2. Feathertop Rhodes grass control with post-emergent herbicides and double knock partners, Goolgowi 2021. (1st knock applied on 18 January 2021, followed by the double-knock of paraquat on 27 January 2021). Label rates were used for all herbicide treatments.

The Group A herbicides included in Figure 2 have registrations or permits for feathertop Rhodes grass control in either summer crops or fallow, depending upon the various product (see product labels for specific use situations).

Glyphosate does not have any registrations for FTR control however was included in this trial to show that performance is often poor, even as a double knock with paraquat.

Amongst the Group A herbicides tested, the 'fops' (propaquizafop, haloxyfop) performed better than the 'dims' (butroxydim, clethodim) when used as stand-alone applications (Figure 2). Control was improved with the addition of a paraquat double-knock for all of the Group A herbicides. In addition to improving control, a double-knock should always be applied following a Group A application in fallow to reduce selection for resistance.

Where glyphosate was mixed with butroxydim or haloxyfop, control of the single pass was significantly reduced, evidence that to get the best performance from Group A and glyphosate they should be applied as separate applications.

Balance® (isoxaflutole) + paraquat is a treatment being evaluated as a tank mix option for either the first or second pass of a double knock program and is typically performing well.

As a rule of thumb, these results suggest that the initial (1st) herbicide application would have to achieve a control efficacy of more than 75% in order to reach a final high level of control close to 100% after the double-knock application.

At the Barellan site, which was much drier than Goolgowi, all herbicide treatments failed to achieve satisfactory control of FTR even with the double-knock of paraquat, with only 0-55% control achieved depending on the treatments (data not presented). The results strongly suggest that it is not possible to achieve a high level of control of FTR when weeds are under moisture stress, even though the herbicides were applied to weeds at early tillering stage.

Call to action

Whilst single applications of some Group A herbicides may achieve acceptable control under certain conditions, the addition of a double-knock provides more robust control (Number 2 on the WeedSmart BIG 6). Growers are urged to use a double-knock strategy following Group A application to prevent seed set and minimise the selection pressure on resistant individuals. To consistently achieve good results, mixing glyphosate and Group A herbicides should be avoided. Avoid applying herbicides to moisture stressed weeds, even when they are at the ideal early growth stage.

Residual herbicide trials

Given the ineffectiveness of glyphosate and limit of one Group A application per year, it is impossible to control multiple flushes of FTR with post-emergent herbicides alone. Therefore, herbicides with residual activity are an important tool to incorporate into an integrated approach for controlling FTR in cropping situations.

Field trials were established at Lake Cargelligo (Monia Gap) with single pre-emergent herbicides (Table 4) and in mixtures (Table 5). Treatments were applied to fallow on 8 September 2020 and the establishment and survival of FTR was measured at 20, 40, 80, 135 and 165 days after application.

Very good control out to 165 days after application was achieved from each of the three herbicides currently registered for residual control of FTR, so the choice of residual herbicide is likely to be made with regard to rotation crop constraints, rather than any significant differences in efficacy.

Table 4. Cumulative emergence (plants/m^2) of feathertop Rhodes grass assessed 20 to 165 days after the application of singular residual herbicides on 8 September 2020.

Treatment	Rate/ha	Density (plants/m^2)				
		20 DAT	40 DAT	80 DAT	135 DAT	165 DAT
Valor® 500WG (500g/kg flumioxazin)	280 g	0.3	1.0	0.8	0.0	0.0
Balance® (750 g/kg isoxaflutole)	100 g	0.8	0.0	0.0	0.3	4.0
Dual® Gold (960 g/L s-metolachlor)	2 L	1.5	0.3	0.8	1.1	3.3
Untreated control	-	240.0	291.0	200.0	12.3	18.0
$LSD_{0.05}$	-	15.0	12.0	13.0	5.0	1.7

In a separate trial, mixtures of Valor® + Balance® or Valor® + Dual® Gold both provided 100% control out to 165 days after application.

Table 5. Cumulative emergence (plants/m^2) of feathertop Rhodes grass assessed 20 to 165 days after application of different residual herbicide mixtures on 8 September 2020

Treatments	Rate/ha	Density (plants/m^2)				
		20 DAT	40 DAT	80 DAT	135 DAT	165 DAT
Valor + Balance	280 g + 100 g	0.0	0.0	0.0	0.0	0.0
Dual Gold + Valor	2L + 280 g	0.0	0.0	0.0	0.0	0.0
Untreated control		136.0	76.7	74.0	9.3	15.0
$LSD_{0.05}$	--	5.0	4.0	5.0	3.0	1.3

Call to action

Under favourable conditions FTR can emerge from late August or early September in southern NSW. This is perhaps a chink in the armour of FTR by allowing residual herbicides to be applied in the winter fallow and potentially reducing the requirement for summer fallow post-emergent control. Crop rotations and plant back periods need to be considered in any residual program, with weather conditions playing a role in the rate of breakdown of herbicides in the soil.

Conclusion

Feathertop Rhodes grass will germinate from late August in southern NSW and may be followed by multiple germinations over spring and summer coinciding with any significant rainfall events. The growing period of feathertop Rhodes grass is about 9 months from September to June, thereby requiring multiple control actions. It is not recommended to apply more than one Group A herbicide application per summer due to the concerns of herbicide resistance evolution. Therefore, growers have one effective double knock application of a Group A herbicide followed by paraquat at their disposal each summer fallow, which should be targeted to control the first flush.

This places a high requirement on the need for residual herbicides to manage FTR over summer, either applied before the first flush, or in the second pass of a double-knock program.

Feathertop Rhodes grass grows and develops quickly in summer. The optimum spraying window at the early tillering stage (2-3 tillers) can be easily missed, especially if plants are placed under moisture stress. Advanced plants or stressed plants will easily survive herbicide applications. Under these scenarios, incorporating grazing or slashing with herbicides may improve control. The combination of chemical and non-chemical options will also slow the onset of herbicide resistance evolution.

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Contact

Hanwen Wu
NSW DPI
Wagga Wagga Agricultural Institute
Pine Gully Road

Wagga Wagga NSW 2650
Mb: 0401 686 218
Email: hanwen.wu@dpi.nsw.gov.au