Control options for annual grass weeds in New Zealand high country pastures

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Summary Ripgut brome, barley grass, downy brome and vulpia hair grass are winter-active annual grasses prevalent in hill and high country in the South Island of New Zealand. Their seeds contaminate the hides, fleeces and carcasses of grazing livestock. A microsward study was established at Lincoln University to determine the relative grazing defoliation of these four grasses when grazed by Merino cross-bred ewes in late spring. Pre- and post-grazing tiller height, percentage area of the microsward defoliated and nutritive quality assessments were undertaken. At the first grazing seed heads were present only in the ripgut brome microswards. During the second grazing seed heads were present in all microswards and nutritive value of all species had declined. Vulpia hair grass was consistently grazed lower and more of its foliage was removed than for the other three grasses. Additionally, a greater proportion of the vulpia hair grass microsward surface area was grazed on both occasions, possibly due to its greater palatability and its smaller seed heads than the other species. Results suggest a greater potential for controlling the ingress of vulpia hair grass than the brome and barley grasses by strategic grazing management in dryland pastures. A second study compared the spread of downy brome in ryegrass and cocksfoot pastures to determine if pasture type had an influence on annual grass weed ingress. Over two summers, downy brome spread over a greater area in ryegrass than cocksfoot pastures, suggesting that cocksfoot may be a better alternative than ryegrass to suppress annual grass weed spread in summer-dry environments.

Keywords Ripgut brome (*Bromus diandrus*), barley grass (*Hordeum leporinum*), downy brome (*Bromus tectorum*), vulpia hair grass (*Vulpia* spp.), grazing management.

INTRODUCTION

In many hill and high country properties in the South Island of New Zealand, annual grasses such as ripgut brome (*Bromus diandrus*), downy brome (*Bromus tectorum*), barley grass (*Critesion murinum* subsp. *leporinum*) and vulpia hair grass (*Vulpia* spp.) are prevalent. They often dominate sheep camps, ridges or north facing slopes where other species are unable to grow (e.g. ripgut brome, Tozer *et al.* 2007). Although they contribute reasonable quality feed during autumn and winter, during spring and summer their seeds can penetrate and damage hides, carcasses and fleeces, contributing significantly to the cost of processing meat, pelts and wool (Dowling and Kemp 1997). Ripgut brome and barley grass in particular have been the focus of considerable research due to their ability to cause significant damage (Hancock and Schuster 2004). While a range of options are available for weed control (e.g. herbicides, cultivation and manual removal), these are often not feasible on hill and high country properties where paddocks are large, the terrain is rugged and steep, labour is constrained and costly control options are uneconomic.

One option available to hill and high country farmers is to graze paddocks during early seed head emergence of key annual grass weeds to limit their seed production (Dowling and Kemp 1997). The effectiveness of this targeted grazing strategy will depend on the extent to which the livestock will graze these weeds, especially once seed heads emerge. Another strategy is to suppress them through the introduction of competitive and drought tolerant perennial pasture species which can persist in hill and high country environments. In this paper we report on two separate studies: 1) a study to assess the extent to which sheep defoliated microswards of ripgut brome, downy brome, barley grass and vulpia hair grass with and without seed heads; and 2) a comparison of perennial ryegrass (*Lolium perenne*) and cocksfoot (*Dactylis glomerata*) based pastures for their ability to limit the spread of downy brome.

MATERIALS AND METHODS

Grazing study The study was undertaken between October and November 2007 at Lincoln University in the South Island of New Zealand in a perennial ryegrass and white clover (*Trifolium repens*) based 1.6 ha pasture. The soil was a Wakanui silt loam (pH 6.2, Olsen P 45 mg/L, potassium 2.0 me/100 g, calcium 8.6 me/100 g, magnesium 1.9 me/100 g, sodium 0.14 me/100 g and sulfate-S 3 mg/kg).

Monoculture turves (40 × 25 cm × 5 cm deep) of the four annual grass weeds were sourced from paddocks in the Canterbury and Otago regions and transplanted into the 1.6 ha experimental paddock in October 2007. Nitrogen fertiliser (30 kg N ha^{-1}) was then applied to the experimental area which was irrigated as necessary to ensure that plants survived the transplanting. The microswards were first grazed by Merino crossbred ewes for 24 h at a rate of 3.7 stock units/ha on 1 November and subsequently on 23 November. For the first grazing there were 2290 and 1380 kg DM ha^{-1} and for the second grazing 2560 and 1140 kg DM ha^{-1}, pre- and post-grazing respectively (averaged across the experimental paddock).

Standing tiller height of 15 randomly selected annual grass tillers was measured before and after each grazing for each microsward. The percentage of the microsward area which had been defoliated was also visually assessed after each grazing. For an assessment of nutritive quality, 10 tillers were cut to ground level within each microsward prior to grazing, bulked according to annual grass species, oven dried at 60°C for 48 hours and sent to a commercial laboratory for near infra-red spectroscopy (NIRS) analyses.

The design was a randomised complete block with two sample microswards of each of the four grass treatments in each of the five replicate blocks. All analyses were performed in a two-way ANOVA using GenStat 13. A repeated-measures ANOVA demonstrated that there were significant interactions between grazing date and species; therefore the two dates were analysed and reported separately.

Downy brome spread The study was established in existing four year old perennial ryegrass (cv. Aries AR1)–white clover (cv. Demand) or cocksfoot (cv. Vision)–white clover swards in March 2006 which were part of another long-term experiment (Mills *et al*. 2008). Within each plot, the centre of an approximately circular patch of downy brome was randomly selected, a small peg inserted into the ground at the patch centre and the distance to the outer edges of the patch from the central peg recorded. Only one patch of downy brome was marked in each pasture sward plot. A patch was chosen such that it was at least 50 cm away from other downy brome patches present in the pasture. The pastures were rotationally grazed throughout the year – by Coopworth hoggets in early spring and weaned Coopworth lambs from late spring onwards. Pastures were usually grazed by ewes in autumn to remove excessive pasture drymatter.

Assessments of the area occupied by the patch were made on 7 March 2006 and 12 months later on 20 March 2007. The area occupied by the patch was assumed to be circular.

The design was a randomised complete block with one downy brome patch in each of 4 replicate swards for each of the ryegrass and cocksfoot treatments. Initial analysis demonstrated that replicate effects were negligible so these were ignored in the analysis to increase the power. All analyses were performed in a one-way ANOVA using GenStat 13. The patch data was square-root transformed to better meet the normality assumptions of the analysis. Untransformed means are presented along with significance from the transformed analysis.

RESULTS

Grazing study Prior to the first grazing, ripgut brome was taller than vulpia hair grass, with barley grass and downy brome intermediate (Figure 1, $P < 0.001$). Post-grazing residual was also highest for ripgut brome, lowest for vulpia hair grass and intermediate for the other two grasses. Prior to the second grazing, both ripgut and downy brome were taller than vulpia hair grass with barley grass intermediate. Post-grazing residual was similarly highest for ripgut and downy brome and lowest for vulpia hair grass (all $P < 0.001$).

During the first grazing, the proportion of plant material removed was greatest for vulpia hair grass: 40% of vulpia hair grass was removed in comparison to 19–29% for the other three grasses, ((pre-grazing height – post-grazing height)/pre-grazing height, $P = 0.002$). During the second grazing an even greater proportion of vulpia hair grass was removed (63% for vulpia hair grass vs. 12 – 26% for the other three grasses, $P < 0.001$).

As seed heads were produced, nutritive quality of the grasses declined (Table 1) and there was a trend

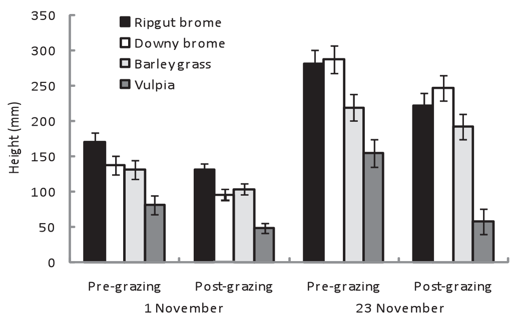

Figure 1. Pre-grazing and post-grazing height of ripgut brome, downy brome, barley grass and vulpia hair grass when grazed by Merino crossbred ewes on 1 and 23 November, 2007. Bars are standard errors of the mean and are for comparisons on either 1 or 23 November for pre- or post-grazing.

towards higher post-grazing residuals. At the time of the first grazing, ripgut brome had seed heads, its metabolisable energy (ME) was under 11 MJ ME/kg DM and less than 25% of the microsward area showed visual signs of defoliation. In contrast, there were no seed heads present for the other three grass species and their ME values were all over 11 MJ ME/kg DM. Additionally, 50–75% of downy brome and barley grass and 75–100% of vulpia hair grass microsward surface areas were defoliated.

At the time of the second grazing, all species had seed heads showing. Metabolisable energy values for all species ranged from 10.0 to 11.1 MJ kg DM ha^{-1}. Only 0–25% of the microsward area was defoliated for ripgut brome, downy brome and barley grass while 75–100% of vulpia hair grass microsward area was grazed (Table 1).

Downy brome spread Patch area was similar in ryegrass and cocksfoot swards in 2006 (Table 2). The area occupied by the patches had doubled in size by the following year in both ryegrass and cocksfoot based pastures. The percentage increase in the radius of the downy brome patch between years was greater for ryegrass (82%) than for cocksfoot (37%) (Table 2, P = 0.054).

DISCUSSION

There is greater potential for limiting the ingress of vulpia hair grass than brome and barley grasses by targeted grazing in dryland pastures. This is demonstrated by vulpia hair grass being consistently grazed lower and more vulpia hair grass being removed, especially when compared to the brome grasses. Additionally, a greater proportion of the vulpia hair grass microsward area was grazed on both occasions — regardless of seed head presence.

Factors such as the abundance of the annual grass weed to be targeted, other species present, pasture height prior to grazing, pasture quality and presence of seed heads will influence the extent to which a target weed species is grazed. For example, taller plants may be grazed more readily (Cosgrove and Edwards 2007). However, the greater percentage removal of vulpia hair grass, which was shorter in stature than ripgut brome, demonstrates that other factors were contributing to the grazing of these species.

Another key factor of grazing defoliation is nutritive quality (Rutter 2006). For example, Ciavarella *et al.* (2000) showed that Merino wethers select for forage containing higher water soluble carbohydrate levels. In this case higher nutritive values were not associated with greater plant removal or a lower post-grazing residual when comparing species. Metabolisable energy, organic matter digestibility and water soluble carbohydrate levels were highest and fibre levels lowest for barley grass at the time of both grazings, yet barley grass post-grazing height was intermediate to the brome species and vulpia hair grass, and percentage removal was also greater for vulpia hair grass than barley grass.

Of the four species, vulpia hair grass has the smallest seed (Edgar and Connor 2000). Downy brome and

Table 2. Area occupied by a patch of downy brome (cm^2) in two year old cocksfoot and ryegrass pastures.

Parameter	Cocksfoot	Ryegrass	P value
Patch area March 2006 (cm^2)	20.7	36.2	0.391
Patch area March 2007 (cm^2)	42.0	84.0	0.095
Increase in patch radius 2006 to 2007 (%)	37	82	0.054

Table 1. Seed head presence, percentage of the sward area grazed and nutritional quality of four annual grasses prior to grazing on 1 and 23 November.

Date	Species	Seed head presence	Percentage sward area grazed	ME*	CP	OMD	CHO	ADF	NDF
1 Nov	Ripgut brome	Yes	0–25	10.8	15.7	77.8	17.5	25.9	50.3
	Downy brome	No	50–75	11.5	16.9	84.7	18.6	22.8	43.3
	Barley Grass	No	50–75	12.1	16.2	87.5	22.0	22.1	40.5
	Vulpia hair grass	No	75–100	11.2	16.2	81.1	18.2	23.4	45.1
23 Nov	Ripgut brome	Yes	0–25	10.3	12.2	71.6	17.9	29.0	54.7
	Downy brome	Yes	0–25	10.0	10.6	68.8	20.3	30.7	57.1
	Barley Grass	Yes	0–25	11.1	12.4	77.6	23.9	25.7	49.2
	Vulpia hair grass	Yes	75–100	10.4	12.2	72.5	18.3	28.1	52.7

*ME: metabolisable energy, MJ ME/kg DM; CP: crude protein, %; OMD: organic matter digestibility, %; CHO: water–soluble carbohydrate, %: ADF: acid detergent fibre, % and NDF: neutral detergent fibre, NDF, %.

barley grass seeds are intermediate in size and seeds of ripgut brome are larger and harder, with a long awn. The physical characteristics of these plants (and especially ripgut brome) may be a key determinant of their palatability and lack of defoliation by grazing livestock.

Hartley *et al*. (1977) demonstrated how intensive grazing of barley grass in spring can prevent it from flowering and producing seed heads. However, this strategy is dependent on maintaining uniform and sufficiently high stocking rates to ensure grazing of the barley grass. This is difficult to achieve on extensive properties which often have large paddock sizes and low stocking rates — there is greater opportunity for selective grazing and avoidance of unpalatable species. In these situations, there may be greater potential to control vulpia hair grass than barley and brome grasses by targeted grazing.

When annual grass weeds are difficult to control by grazing alone, other strategies should be considered. One is to use salt as a grazing attractant to increase the grazing of unpalatable species as has been demonstrated successfully for ripgut brome in New Zealand high country (Gillespie *et al.* 2006).

Choice of pasture species is important; some pastures may be better than others at preventing establishment and spread of annual grass weeds. For example, cocksfoot is more drought tolerant than perennial ryegrass (Garwood and Sinclair 1979) and would presumably provide a better alternative to ryegrass in limiting the ingress of annual grass weeds in summer-dry pastures. This is supported by the greater increase in downy brome patch size in perennial ryegrass than cocksfoot swards at the Lincoln field site. Popay *et al.* (1981) also found that cocksfoot (cv. Vision) was effective in resisting barley grass invasion and that some cultivars of ryegrass resisted barley grass invasion better than others. Other factors, such as the rainfall, soil fertility and grazing management would also influence the extent to which different pasture species could resist the spread of these weeds.

In conclusion, of the four species considered, vulpia hair grass shows the greatest promise for control through targeted grazing as plants with as well as without seed heads were readily grazed by Merino ewes. Sowing competitive pasture species such as cocksfoot in summer dry environments may also reduce annual grass weed ingress in dryland pastures.

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