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Rearing conditions for lambs may increase tansy ragwort grazing

ROBERT D. SUTHERLAND, KEITH BETTERIDGE, ROBIN A. FORDHAM, KEVIN J. STAFFORD, AND DES A. COSTALL

Authors are postgraduate, Ecology Group, Institute of Natural Resources, Massey University, Palmerston North, New Zealand; scientist, AgResearch Grasslands, Private Bag 11008, Palmerston North; associate professor, Ecology Group, Institute of Natural Resources, Massey University; associate professor, Institute of Veterinary, Animal, and Biomedical Sciences, Massey University; and senior technician, AgResearch Grasslands.

Abstract

Grazing by sheep is an accepted method of controlling tansy ragwort (*Senecio jacobaea* L.), but some flock members seldom eat it. Our objectives were to determine if pre-weaning exposure to tansy ragwort increases later consumption of the plant by lambs, and if confinement with ragwort-eating ewes after weaning facilitates ragwort eating. The sampling periods were Weeks 1, 3, and 12 following weaning. During each period grazing behavior was observed for 1-hour each day and the 24-hour reduction in ragwort volume measured on each of 4 or 5 consecutive days. Lambs exposed to ragwort before weaning removed more ragwort than ragwort-naïve lambs during the first 2 sampling periods ($P < 0.05$). Lambs that grazed with ewes for 11 weeks following weaning ate ragwort more frequently during direct observation, than lambs without ewes during Weeks 3 and 12 ($P < 0.05$). The ragwort-eating of all lamb groups increased markedly between Weeks 1 and 12 ($P < 0.05$). This may indicate an increased ability of lambs to consume ragwort with increasing age or an acclimation period during which most lambs come to accept ragwort. Behavioral interventions aimed at increasing the consumption of weeds by lambs may need to take into account age-related differences in toxin tolerances. Exposing lambs to ragwort before weaning and grazing newly-weaned lambs with older ragwort-eating sheep after weaning may increase later ragwort-eating by lambs.

Resumen

El apacentamiento con ovinos es un método aceptado para controlar el "Tansy ragwort" (*Senecio jacobea* L.), sin embargo, algunos miembros del rebaño raramente lo consumen. Nuestros objetivos fueron determinar si el exponer los corderos en la etapa de pre-destete al "Tansy ragwort" incrementa el consumo posterior de esta planta por parte de los corderos, y determinar si el confinamiento de los corderos con borregas que comen "Tansy ragwort" facilita el consumo de "Tansy ragwort" por los corderos. Los periodos de muestreo fueron 1, 3, y 12 semanas después del destete. En cada periodo de muestro se observo durante 1 hora el comportamiento de apacentamiento y cada 24 horas durante 4 o 5 días se midió la reducción de volumen del "Tansy ragwort". En los primeros dos periodos de muestreo, los corderos expuestos al "Tansy ragwort" antes del destete consumieron mas "Tansy ragwort" que los corderos no expuestos ($P < 0.05$). En el tiempo de observación directa de los periodos de muestreo de 1 y 12 semanas, los corderos que apacentaron con borregas durante 11 semanas después del destete comieron 'Tansy ragwort" mas frecuentemente que los corderos sin borregas. ($P < 0.05$). El consumo de "Tansy ragwort" de todos los grupos de corderos se incremento marcadamente durante las semanas 3 y 12 ($P < 0.05$). Esto puede indicar un aumento en la capacidad de los corderos para consumir "Tansy ragwort" al aumentar la edad o un periodo de aclimatación durante el cual la mayoría de los corderos vienen a aceptar el "Tansy ragwort". Las modificaciones de comportamiento encaminadas a incrementar el consumo de malezas por corderos puede necesitar tomar en cuenta las diferencias en tolerancia a las toxinas relacionadas con la edad del animal. El exponer los corderos al "Tansy ragwort" antes del destete y el que los corderos recién destetados apacienten con ovinos más viejos que consumen "Tansy ragwort" puede incrementar el consumo posterior de "Tansy ragwort" por los corderos.

Key Words: ***Senecio jacobaea*, training, social facilitation**

Tansy ragwort (*Senecio jacobaea* L.) is a biennial, broadleaf weed of cattle pastures found in Europe, North Western areas of the United States, New Zealand, and elsewhere (Wardle 1987). Cattle and horses tend to avoid grazing ragwort which contains pyrrolizidine alkaloids that are highly toxic to them (Cheeke 1994). Despite this natural avoidance, accidental or forced ingestion can occur, and stock losses often result (Sharrow and Mosher 1982).

Grazing by sheep is an effective ragwort-control method (Poole and Cairns 1940, Sharrow and Mosher 1982, Amor et al. 1983, Betteridge et al. 1994). Unlike cattle, sheep can tolerate, and often readily include, large amounts (up to 50%) of ragwort in their diet (Cheeke 1994).

In New Zealand, a trend towards all-cattle farming has seen the subsequent removal of sheep from previously integrated sheep and cattle systems. This has resulted in dense stands of ragwort in areas where previously it was not a problem. Re-introducing a minimum number of sheep to control ragwort infestations could be a suitable compromise. However, quantifying the minimum number of sheep relies on all individuals having similar ragwort-

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eating behavior. In practice this appears not to be the case and a small percentage of sheep may avoid eating ragwort altogether (Betteridge et al. 1994).

The grazing experiences of lambs during weaning influence their food preferences as adult sheep (Ramos and Tennessen 1992). Grazing with mothers (Nolte et al. 1990), older sheep (Chapple and Lynch 1986), or conspecifics (Scott et al. 1996), can also modify food preferences of lambs. The objectives of the present study were to examine the effect of pre-weaning ragwort exposure on the subsequent grazing of ragwort by lambs; to see if the presence of older, ragwort-eating ewes would enhance acceptance of ragwort by weaned lambs; and to assess the usefulness of any induced behavioral differences in improving ragwort biological control by sheep.

Materials and Methods

Study Area

The experiment lasted 3 months on hill country farmland at the AgResearch *Ballantrae* Research Station (36°S) near Palmerston North, New Zealand. Pastures, on slopes ranging between 20% and 60%, comprised of *Agrostis capillaris* L., *Holcus lanatus* L., *Lolium perenne* L. and *Anthoxanthum odoratum* L. as the major grasses and *Trifolium repens* L. as the dominant legume. Tansy ragwort, *Cirsium vulgare* (Savi) Tenore and C. *arvense* (L.) Scop.were common weeds. The Aquic Eutrocepts soils were of sedimentary origin and had a low phosphorus status. Stocking rate at this fertility level is typically 10 adult sheep stock units/ha/year. Annual rainfall is 1,200 mm yr^{-1}.

Formation of treatment groups

Sixty pregnant Romney ewes with a history of grazing on ragwort infested pastures were obtained from *Ballantrae*. Thirty ewes were randomly selected and transported to Flock House, a ragwort-free farm, in mid-August (early spring) 1995. The remaining 30 ewes continued to graze on ragwort-present pasture at *Ballantrae*. Lambing began in early September and lambs were reared with their mothers on their respective background pasture types.

On 14 November 1995 the ewes and lambs on ragwort-free pasture were returned to *Ballantrae* and retained on pasture cleared of ragwort. After 24-hours the lambs from both background pasture types were weaned. Each group of lambs was split into 2 groups using a weight-restricted randomization. Experimental groups comprised only the 15 heaviest lambs from each of the 4 randomized groups. During the experiment, 1 group of lambs from each of the 2 pasture backgrounds was confined with 6 ewes from the opposite pasture background. Thus, 15 lambs from ragwort-present pasture were confined with ewes that had not grazed ragwort-present pasture from lambing, and 15 lambs from ragwort-free pasture were confined with ewes that had recently grazed ragwort infested pasture. The ewes in both lamb + ewe groups were selected because they each displayed a similarly high propensity for eating ragwort when cut plants were offered to each ewe flock in sheep-yards. The 2 remaining lamb groups grazed without ewes.

All lambs were individually identified with numbered ear-tags, color-coded for each of the 4 groups. In addition to ear-tags, all lambs were spray-painted with a number (1–15) on each shoulder, side, and rump, with a group-specific color-code. The 12 ewes were similarly marked.

The weaned lambs born on ragwort-free pasture were retained on ragwort-free pasture at *Ballantrae* for 2 weeks before post-weaning observations on ragwort-present pasture began on 27 November 1995.

Experiment Design

Four, 10-m wide pasture lanes were created with electric sheep netting in a paddock infested with ragwort. Care was taken to ensure that ragwort content and plant size distribution, both between and within lanes, was similar. Each of the 4 sheep groups were randomly assigned a fresh lane of pasture during each observation week. The lanes used during Weeks 3 and 12 were set up in a separate area of the farm to that used in Week 1 to ensure fresh ragwort was available on each observation day. Each lane was divided into daily grazing areas sufficient for 24-hour feeding to provide moderate animal growth, but less than *ad libitum* feeding. Lambs with ewes present were given larger areas (~130-m^2 day^{-1}) than lambs grazed alone (~100-m^2 day^{-1}). Sheep were introduced into a new pasture area immediately prior to observational recording each day. Lamb weaning weight was 20-kg and this increased to 29.7-kg at the conclusion of Week 12.

Plant measurements and animal observations were made during 3 separate observation periods; Week 1 (first exposure of ragwort-naïve lambs to ragwort), Week 3, and Week 12. Five consecutive days of observation were made during Week 1, and 4 consecutive days during Weeks 3 and 12.

The ewes grazed with their respective treatment groups for 11 weeks but were removed from their respective lamb groups immediately prior to the first observation day of Week 12. All 4 groups were grazed separately from Week 1 through Week 12, both during and between observation periods on pastures containing ragwort.

Animal Measurements

Each of the 4 groups was observed for 1-hour on each observation day. Because of a limited number of observers (n = 5), only 2 groups could be observed at the same time. For each observation day the order for observing the groups was randomized to allow for possible time-of-day effects.

At 0900 hours (or 1030) 2 observers collectively scan-sampled (Altmann 1974) 1 group of lambs at 2-min intervals. One observer made the observations while the other recorded them. This provided 30 scan-samples of the group for each observation day. During a scan each lamb was categorized as (1) eating ragwort, (2) eating a plant other than ragwort, or (3) not eating. A third observer recorded the same activities for the ewes (if present).

The percentage of total grazing scans in which ragwort was consumed was used as the dependent variable for analysis. As there was no significant day-within-week effect, the percentages of total grazing scans on ragwort were averaged over the 4 or 5 days to create the Week factor for each animal. The main effects of sampling period (Week), presence of a ewe, and background pasture type were assessed using the GLM procedures of SAS (SAS Institute 1990) in a split plot design using individual lambs within each group as the error term. Any interactions between the independent variables were also examined.

For the ewes, the mean percentage of total feeding scans in which ragwort was consumed was determined for each of the 2 groups for each day and again averaged over the week. Sampling period (Week) and background pasture type were the independent variables. Where necessary, lamb scan data were square root transformed and ewe data arcsine transformed to stabilise variances before analysis with the GLM procedures of SAS (SAS Institute 1990).

Plant Measurements

Within each daily grazing area, 20 ragwort plants were identified with a numbered peg, and the height and 2 width dimensions at ground level (taken at right-angles to each other) were recorded. The growth stage of each plant was also noted and categorised as either rosette or elongated. These initial plant measurements were completed before the sheep were allowed into the grazing area for 24-hours. Plant volumes were estimated on the assumption that plants were cylindrical in shape and that reduction in volume equated to ragwort consumption. These measurements were repeated once animals were removed from the plot after a 24-hour confinement. The mean volume of ragwort material removed per day by each ewe-absent group during Weeks 1 and 3 and all 4 lamb-only groups in Week 12 was analysed using the GLM procedures of SAS (SAS Institute 1990). As there were no days-within-week effects, ragwort volume removed per day was averaged for each week. Sampling period (Week), grazing with ewes, and background pasture type were the independent variables.

Mean pasture height was determined from 50 ‘first hit on green plant tissue’ sward stick (Barthram 1986) measurements made daily in each lane. Pasture mass was estimated from *Ballantrae* calibrations of height against pasture dry matter (DM) following the method used by Webby and Pengelly (1986).

Results

Pasture Measurements

Mean (SD) ragwort plant heights measured during Weeks 1, 3, and 12, were 25 (±13), 29 (±13), and 48 (±23) cm respectively; and mean volumes were 0.28 (±0.40), 0.22 (± 0.26), and 0.39 (± 0.46) m^3. Ragwort heights and volumes were similar between lanes within each week (week x group interaction; P = 0.35). Mean grass height before grazing was 16 (±6), 13 (±7), and 11 (±5) cm (estimated mass was 3,100, 2,500 and 2,100 kg DM ha^{-1}) in Weeks 1, 3 and 12 respectively. This decline represented usual seasonal growth patterns during spring and mid summer. Post-24-hour grazing height reduction was always between 46 and 48%. Each lane contained an average of 6 mature ragwort plants m^{-2}.

Scan-sampling of Lambs

For all lamb groups, the mean percentage of ragwort-feeding-scans increased from 0.5 to 1.2% from Week 1 to 3 and then to 6.5% for Week 12 (P < 0.05). In Week 1, all 4 lamb groups grazed ragwort with a similar frequency. However, in Weeks 3 and 12 both lamb groups with ewes grazed ragwort more frequently (1.89 and 7.7 for Weeks 3 and 12 respectively; P < 0.05) than those without ewes (.84 and 6.5 for Week 3 and 12 respectively) (Table 1). There was no main effect (P = 0.22) of background pasture type on subsequent ragwort grazing by lambs (Table 1). There was also no interaction between background pasture type and ewe presence (P = 0.89).

Table 1. Mean percentage (±SE) of feeding scans spent eating ragwort by lambs from ragwort-free (naïve) or ragwort-present (ragwort-exposed) pasture backgrounds pre-weaning, grazing with or without ewes during Weeks 1, 3, and 12 from first introduction of naïve lambs to ragwort.

	Ragwort-exposed		Naïve	
Week	Ewes present	Ewes absent	Ewes Present	Ewes absent
	(%)			
1	0.8 ± 0.4 a*	0.8 ± 0.2 a	0.5 ± 0.2 a	0.1 ± 0.1 a
3	2.5 ± 0.5 a	0.5 ± 0.3 b	1.3 ± 0.3 a	0.3 ± 0.2 b
12	7.1 ± 0.9 a	6.2 ± 1.2 b	8.3 ± 1.3 a	6.8 ± 1.2 b

*Means within rows with similar letters are not significantly different (P < 0.05)

Plant Volume Reduction

The mean percentage of ragwort removed from the plots after 24-hours by the 2 lamb groups without ewes increased from Week 1 to 3, from 16 to 30%, and then to 60% during Week 12 (P < 0.05). Table 2 shows that during Weeks 1 and 3 the lambs reared on ragwort-present pasture removed more ragwort on a daily basis (33% of original volume), than the lambs reared on ragwort-absent pasture (13%), averaged over both weeks (P < 0.05). A comparison of daily ragwort consumption by the lambs that grazed with ewes during Weeks 1 and 3 was not possible because of the inseparable contributions of ewes and lambs to the reduction of ragwort volume.

When all 4 lamb groups grazed alone during Week 12 there was no effect of either background pasture type (P = 0.16) or ewe presence (P = 0.59) on 24-hour ragwort volume reduction (Table 2). There was also no interaction between background pasture type and ewe presence (P = 0.12).

Ewe Behavior

The scan-sampling data shows that the ewes deprived of access to ragwort during lactation spent more time eating ragwort than those ewes which were exposed to ragwort continuously (P < 0.05), during Weeks 1 and 3 (Table 3). There was also an interaction between week and ewe group (P < 0.01), with the non-exposed ewes spending more time grazing ragwort during Week 1 than Week 3, compared with no difference between Week 1 and Week 3 for the other ewe group.

Discussion

Ragwort Exposure

The animal measurements did not detect the increase in ragwort grazing from Weeks 1 to 3 shown by the plant volume reduction data for both groups of lambs that grazed alone. This suggests that the 1-hour animal grazing observations and the 24-hour plant volume reduction measurements were not equivalent measures of ragwort grazing by the lambs. Either lamb group rarely grazed ragwort plants during each 1-hour period during Weeks 1 and 3. Instead, as soon as the lambs were released onto a new grazing area they immediately began to graze other pasture

Table 2. Mean percentage (±SE) of ragwort volume reduced after 24-hour grazing periods by lambs from ragwort-free (naïve) or ragwort-present (ragwort-exposed) pasture, grazing with or without ewes during Weeks 1, 3, and 12 from first introduction of naïve lambs to ragwort.

	Ragwort-exposed		Naïve	
Week	Ewes present	Ewes absent	Ewes Present	Ewes absent
	(%)			
1	—	27.1 ± 6.4 a*	—	4.4 ± 1.5 b
3	—	38.7 ± 9.2 a	—	21.0 ± 3.5 b
12	50.8 ± 9.5 a	60.6 ± 10.2 a	64.7 ± 6.3 a	59.7 ± 5.3 a

*Means within rows with similar letters are not significantly different (P < 0.05)

Table 3. Mean percentage (±SE) of feeding scans spent eating ragwort by ewes that grazed with lambs from ragwort-free (naïve) or ragwort-present (ragwort-exposed) pasture background during Weeks 1 and 3 from first introduction of naïve lambs to ragwort.

Week	Ewes - non-exposed for 3 months during lactation (Lambs - ragwort-exposed)	Ewes - ragwort-exposed continuously (Lambs - naïve)
	(%)	
1	20.4 ± 2.0 a	3.5 ± 0.7 b
3	11.8 ± 2.2 a	6.2 ± 1.1 b

*Means within rows with similar letters are not significantly different (P < 0.05)

species. During Weeks 1 and 3 the lambs from the ragwort-present pasture usually grazed ragwort in quantity sometime after the observation period had finished, as did the lambs from ragwort-free pasture during Week 3. Lambs from ragwort-free pasture grazed very little ragwort at any time during Week 1. This finding, that short-term observations of grazing behavior, made at a single time of day, may not represent longer-term grazing patterns, has been found by Parsons et al. (1994) with Scottish halfbred ewes that exhibited changing preferences for clover and ryegrass.

There are at least 2 alternative explanations for the apparent increase in ragwort eating by the ragwort-exposed lambs during the remaining 23-hours after introduction to new pasture. The first is that ragwort may not have been a preferred food for the lambs and therefore remained relatively untouched until more preferred species were depleted, and/or rendered inedible through trampling. Walker et al. (1992) found that lambs avoided grazing leafy spurge when other pasture species were readily accessible, but switched to grazing leafy spurge when its biomass was high relative to other pasture species. A second possibility is that ragwort was not preferred by ragwort-exposed lambs in the morning, but was taken at some time later in the day. This type of regular diurnal preference pattern, for reasons other than the depletion of a previously preferred species, could indicate a determined strategy of ingestion (Sibley 1981). Both possibilities are equally likely, and distinguishing between them would involve observing lambs grazing on large areas of pasture, to ensure the maintenance of free-choice grazing throughout each 24-hour period of confinement (Parsons et al. 1994). Further, both possibilities require the ragwort-exposed lambs to have sampled ragwort before weaning, and to have developed a learned response that persisted after weaning in a familiar grazing environment (Scott et al. 1996). In contrast, lambs reared on ragwort-free pasture probably grazed only familiar species when first exposed to ragwort (a novel plant) in an environment that was initially unfamiliar to them (Scott et al. 1996); and ragwort remained relatively untouched as a consequence.

Social Facilitation

Social facilitation occurs when a learned behavior is performed at a greater rate when animals co-act with other individuals, than when the behavior is emitted in the absence of others (Thorhallsdottir et al. 1990). During Week 3, the presence of ewes facilitated the sampling of ragwort by lambs from both grazing backgrounds. It is unclear whether this resulted from social facilitation (physical presence of ewes eating ragwort) or changes in ragwort preferences learned by the lambs between Weeks 1 and 3 because the relative contributions of the 2 factors were inseparable. However, the effect persisted into Week 12 when the ewes were removed, suggesting that previous grazing with ewes had changed the ragwort preferences of the lambs. There was no difference in the Week 12 percentage of ragwort volume removed over 24-hours by any of the groups. This suggests that the ewes may have facilitated a change in the pattern of ragwort ingestion without increasing its percentage in the diet. However, the size of the pastures may have placed limits on the amount of ragwort available or acceptable for grazing. The greater incidence of ragwort sampling in Week 3 by the lambs reared on ragwort-free pasture and confined with ewes, compared with lambs without ewes, suggests that the ewes may have facilitated the lambs' initial consumption of ragwort. The small number of observed grazings must, however, limit the confidence of this finding.

Ewe Behavior

The ewes that had returned from a ragwort-free environment, where they were grazed from lambing until weaning, were observed eating ragwort 4 times as often as their counterparts from the ragwort-present background during Weeks 1 and 3. Sheep often prefer pasture species different to those grazed most recently (Newman et al. 1992), although this preference disappears over time (Parsons et al. 1994). In the case of the ewes deprived of ragwort from lambing until weaning, increased ragwort-eating following reintroduction to ragwort-dense pasture may indicate a short-lived preference for a familiar food type that had not been recently encountered. The reduction of time spent eating ragwort from Week 1 through Week 3 by ewes deprived of ragwort from lambing to weaning suggests learning from negative post-ingestive consequences (Provenza 1995). It is not known what effect this differential ragwort eating by the 2 ewe groups may have had on the lambs that they grazed with. One possibility is that the ewe group that grazed ragwort more frequently provided the lambs that grazed with them increased opportunities to co-act in ragwort grazing. However, the possible effect of differential social facilitation may not be directly proportional to the ragwort-grazing of the ewes.

Persistence of Training

Ragwort-eating, in comparison to other feeding, increased substantially between Weeks 3 and 12 for all 4 lamb groups. This pattern of initial low intake of a food type by lambs, followed increasing consumption as the feed becomes familiar is a regularly reported finding; eg Chapple and Lynch (1986) with wheat; and Ralphs et al. (1990) and Pfister and Price (1996) with locoweed, a plant which, like ragwort, also contains toxic alkaloids. The gradual process of habituation to a novel food is one possible interpretation of the increase in consumption over time (Ralphs et al. 1990). This, however, fails to explain why lambs exposed to ragwort from birth underwent an increase similar in magnitude to the lambs that remained ragwort-naïve until after weaning. Because of the data gap between weeks 3 and 12 we do not know: when the marked increase in ragwort-eating during this period occurred; whether the transition was sudden or gradual; and whether the pattern was the same for each group.

Thus it is unclear if the lambs in all 4 groups independently reached an experience threshold after which ragwort grazing increased markedly. For example, once sheep eat more than 10-grams of wheat during daily, 15-min feeding sessions, wheat-eating increases very rapidly

(Chapple and Lynch 1986). The difference in volume of ragwort removed (consumed) between the lambs from ragwort-free and ragwort-present backgrounds that grazed without ewes did not persist into Week 12. This suggests that 12 weeks of exposure to ragwort may have allowed the lambs from the ragwort-free background to develop similar ragwort grazing skills to those reared with their mothers on ragwort-present pastures. However, a second variable that may determine the amount of ragwort included in the diet of lambs is age. Unfortunately, age is confounded with experience so the relative effects of the 2 variables can only be speculated.

Young calves are generally more susceptible to ragwort pyrrolizidine alkaloid (PA) toxicosis than older cows, because of increased cellular activity and higher levels of PA bioactivating enzymes in the liver (Johnson et al. 1985). Lambs also are more susceptible than older sheep to the toxic effects of excess ragwort ingestion (Cameron 1935, Olson and Lacey 1994). Possibly the lambs used in the present study developed an increased tolerance for the alkaloids that came with age, between Weeks 3 and 12, that enabled them to eat more ragwort. This could have occurred through a combination of factors, including a decline in PA bioactivating enzymes, an increase in PA detoxifying enzymes in the liver (Cheeke 1994) and/or development of de-toxifying rumen microflora (Wachenheim et al. 1992).

Physiological changes that allow the ingestion of toxic foods may not only occur as a result of developmental processes; but may also occur as an adaptive response to a major change in forage type (Olson and Lacey 1994). Such adaptations could also involve changes in rumen microflora and/or the relative concentrations of enzymes in the liver (Olson and Lacey 1994). This may help to explain the observation by Poole and Cairns (1940) that adult sheep with no ragwort experience tend to eat very little of the plant initially, but after continued sampling, a taste for the plant rapidly develops; and it eventually becomes a large component of the diet.

Clearly, further research should aim to separate the relative effects of age, physiology, and learning, on the level of ragwort-eating by sheep. This could involve identifying the sheep in different aged flocks that may lack the physiological plasticity to consume ragwort. The greater toxicity of ragwort to lambs compared with ewes suggests that sheep may not develop a stable pattern of ragwort ingestion until they can eat it ‘safely’. Perhaps a greater preference for ragwort could be induced if lambs were denied access to the plant until they were old enough to detoxify the alkaloids effectively. Poole and Cairns (1940) reported that sheep from “non-ragwort country” developed a clear “preference” for the plant “once they had acquired a taste for it”. A comparison between adult ewes that have never experienced ragwort, with a group retained on ragwort-present pasture since birth, could be used to investigate this possibility.

Conclusions

Lambs may graze very little ragwort immediately following weaning, regardless of background pasture type. From a practical perspective, freshly weaned lambs may not provide immediate ragwort control, although their ragwort-grazing will probably increase within 14 weeks (viz. Week 12). Also, farmers may not need to ensure that lambs destined for ragwort-control experience ragwort-present pastures before weaning, because simply confining lambs to such pastures immediately after weaning may have a similar effect on subsequent ragwort grazing. Further, allowing lambs to graze with ragwort-eating ewes after weaning may increase subsequent ragwort grazing by lambs.

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