Growth and venison production from red deer (*Cervus elaphus*) grazing red clover (*Trifolium pratense*) or perennial ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) pasture

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SUMMARY

A study of growth and venison production from weaner red deer grazing pure tetraploid red clover (RC) or conventional perennial ryegrass/white clover (PRG) pasture was conducted in 1990, with the objective of attaining a minimum slaughter liveweight of 92 kg (50 kg carcass) by 12 months of age in the stags. Ten weaner red deer stags and ten weaner red deer hinds were randomly selected and rotationally grazed on either RC or PRG forage. In autumn and spring, forage allowances were 7 kgDM/hd/day and 8 kgDM/hd/day respectively. In winter, the animals from both groups were grazed together on PRG pasture, at a residual dry matter (DM) of 1100 kgDM/ha. Total nitrogen (N) concentration was higher in RC on offer than in PRG on offer (autumn 3·4 *v.* 3·1 %DM; spring 3·8 *v.* 3·1 %DM), whilst organic matter digestibility (OMD; autumn 80·5 *v.* 76·5%; spring 82·1 *v.* 80·3%) was also higher for RC on offer. Diet selected showed similar differences in total N concentration, but there were negligible differences between forages in OMD.

Liveweight gains of RC and PRG stags were respectively 263 *v.* 192 g/day, 101 *v.* 106 g/day and 354 *v.* 341 g/day during autumn, winter and spring, with the corresponding values for hinds being 198 *v.* 173 g/day, 52 *v.* 53 g/day and 242 *v.* 218 g/day. At one year of age, stags grazing RC were 7 kg heavier and hinds 3 kg heavier than animals grazing PRG pasture. Animals grazing RC forage had higher voluntary feed intake (VFI) in both autumn ($P < 0·10$) and spring ($P < 0·001$), than animals grazing PRG pasture.

All stags grazing RC forage reached the minimum slaughter liveweight by one year of age, compared to 75% of those grazing PRG pasture. At slaughter, stags that had grazed RC produced heavier carcass weights (59·9 *v.* 54·5 kg, $P < 0·01$), had higher carcass dressing percentage (55·3 *v.* 53·2%; $P < 0·01$), and tended to have slightly greater carcass subcutaneous fat depth than stags grazing PRG pasture, but this effect disappeared when the data were corrected to equal carcass weight. All stags grazing RC produced velvet antler, relative to 75% of those grazing PRG; in stags producing harvestable velvet antler, there was no difference in antler weight between those grazing RC and PRG. It is concluded that RC offers potential as a special-purpose forage for the growth of weaner red deer.

INTRODUCTION

Young deer show seasonality in their growth and voluntary feed intake (VFI), with high values in spring and summer, and low values in winter (Barry *et al.* 1991). This acts as a constraint in the development of venison production systems to suit the requirements of overseas markets.

The New Zealand (NZ) venison price is normally highest between August and December (spring; Ataja *et al.* 1992) and pays the highest premium for carcasses weighing > 50 kg (92 kg liveweight), reflecting northern hemisphere consumer demand. For greatest profitability, these targets should be attained by one year of age. However, under current pasture management, young red deer stags usually reach this slaughter liveweight when 15 months old (Drew 1989), when venison schedule prices have declined. Attempts to attain a minimum slaughter liveweight of 92 kg in red deer stags by one year of age, grazing

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annual ryegrass pastures, have been conducted by Ataja *et al.* (1992), who showed that by giving high allowances (6·3 kgDM/hd/day) during both winter and spring, the target could be attained by 75% of weaner stags.

Tetraploid red clover (*Trifolium pratense*) is known as a summer crop, with a high nutritive value, and is strongly preferred by red deer (Hunt & Hay 1990). Red deer fawns, reared on hinds grazing pure red clover (RC) swards during lactation, had significantly higher growth rates and weaning weights compared with control animals grazing conventional perennial ryegrass/white clover (PRG) pasture (Niezen *et al.* 1993). The objectives of the present study were to determine the growth, VFI and venison production, by one year of age, of weaner red deer grazed on pure RC forage, relative to control animals grazed on conventional PRG pasture.

MATERIALS AND METHODS

Experimental design

Forty weaner red deer, comprising equal numbers of males and females were rotationally grazed on either pure red clover (*Trifolium pratense*, cv. Pawera) or perennial ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) pasture. The trial was conducted from 19 March 1990 to 29 November 1990, at Massey University deer research unit, New Zealand. Body weight gain was monitored regularly, and VFI measured using chromium slow release capsules in autumn and spring, with slaughter measurements made at the end of the experiment (i.e. at one year of age).

Animals

Twenty male and 20 female weaner red deer, aged *c.* 3·5 months (mean calving date 24 November 1989), were randomly allocated into one of two pastures; pure RC or PRG pasture. During the study, two stags from the PRG group died, and one stag from the RC group showed a very low performance, and data from these were excluded from the analysis. At the end of the trial, all stags attaining a minimum slaughter liveweight of 92 kg (50 kg carcass weight) were sent for slaughter at the Deer Slaughter Premises (DSP) in Feilding. The hinds were retained for breeding purposes.

At four and half months old, all animals were vaccinated against clostridial infections (Coopers Animal Health Ltd, NZ). Ivermectin (IVOMEC; Merck, Sharpe & Dohm Ltd, NZ), to protect from internal parasites and lungworm, was given orally every 3 weeks, when the animals were also weighed.

Velvet antler was removed when this attained a minimum length of 20 cm. The animals were sedated using 10% xylazine (Rompun; Bayer Ltd, NZ) at a dosage rate of 0·5 mg/kg body weight, intramuscularly. When the animals were mildly sedated, local anaesthetic was then given by administering 15 ml lignocaine hydrochloride (Xylotox; A. H. Robins Co Ltd, England) per antler, in a ring block. A tourniquet was applied in the coronet area 4 min later, and the velvet was cut. As the blood clotted, the tourniquet was released and xylazine reversed with 1·5–2·0 ml yohimbine hydrochloride (Recervyl; Aspiring Veterinary Services, NZ) to counteract the xylazine effect.

Pastures

In autumn and spring, the allocated animals were rotationally grazed on either RC (2·4 ha; 8 paddocks) or PRG (2·0 ha; 4 paddocks) pasture. Animals were offered a forage allowance of 7 kgDM/hd/day in autumn, and 8 kgDM/hd/day in spring. As red clover is dormant over winter, all animals were grazed together on PRG pasture (4 ha; 8 paddocks) during this time, with the pasture being maintained at a residual dry matter of 1100 kgDM/ha; 0·5 kgDM/hd/day of meadow hay was also provided over winter. Rotation length was generally 28–42 days, with the lower values in spring. The RC was in its first year with PRG being several years old.

Prior to the animals being introduced into each paddock, pre-grazing forage samples were cut to soil level (8 quadrats each of 0·08 m²), to measure the available herbage dry matter mass (kgDM/ha). The length of time for the animals grazing in the allocated paddock was then calculated as:

$$\text{Total days} = \frac{\text{herbage mass(kgDM/ha)} \times \text{paddock area}}{\text{(animals/group)} \times \text{pasture allowance/hd/day}} \quad (1)$$

Subsamples of fresh herbage on offer were also taken to soil level and divided into two parts, to determine their nutritive value and botanical composition. Diet selection was carried out by hand-plucking plants in the areas that were being grazed by the animals. The samples were collected daily, pooled for each paddock, and then divided into two parts; one for nutritive value and one for botanical composition.

Besides the regular hand-plucking procedure for diet selection, two oesophageal fistulated (OF) stags (4 years of age, castrated) were also used in the spring. The OF animals were introduced one day prior to the introduction of the main groups into the allocated paddock, and reintroduced one day before the main animals were due to leave the paddock. Sampling took place during the morning, by allowing the OF animals to graze alone for a maximum of one hour, without having access to drinking water. Extrusa samples were collected from the collection bag of the OF animals, and placed in an airtight plastic bag. All

Table 1. *Pre- and post-grazing herbage mass (kgDM/ha ± S.E.) of red clover (RC) and perennial ryegrass/white clover (PRG) forages grazed by red deer* (Cervus elaphus) *at Massey University, New Zealand, during the autumn, winter and spring of 1990*

	PRG (kgDM/ha)			RC (kgDM/ha)		
	N*	Pre-grazing	Post-grazing	N	Pre-grazing	Post-grazing
Autumn	6	2780 ± 147·8	2177 ± 122·5	9	3320 ± 137·7	2901 ± 122·9
Winter†	23	1539 ± 66·8	1128 ± 59·0			
Spring	10	2360 ± 171·1	1848 ± 116·9	12	3542 ± 197·3	2779 ± 141·6

* Number of samples taken per season.
† Both PRG and RC animals were grazed together on PRG pasture during the winter.

samples were kept separate between the animals and paddocks.

Voluntary feed intake

During autumn and spring, nine males and nine females in both groups were administered with sheep size chromium slow releasing capsules (CRD; Cr_2O_3 matrix, Captec Ltd, Auckland, NZ), to estimate faecal organic matter output. Rectal faecal samples (ten pellets) from individual animals were collected from days 8 to 20 after the CRD was administered, on six occasions at 2-day intervals. The faecal samples were stored in plastic bottles until the analysis was done.

Carcass

Hot carcass weight and soft tissue depth over the second to last rib, an index of subcutaneous fat depth (GR; Kirton *et al.* 1989), were recorded at slaughter. Carcass dressing percentage (CDP) was then calculated as hot carcass weight/liveweight.

Laboratory analysis

All samples were stored at −20 °C until required for analysis. Samples for nutritive value analysis were freeze-dried and ground to pass a 1 mm diameter sieve (Wiley Mill, USA). Dry matter (DM) was determined by heating at 110 °C for 16 h. Total nitrogen (N) was determined by the Kjeldahl procedure, whilst *in-vitro* digestibility followed the method described by Roughan & Holland (1977). Chromium analysis was done as reported by Parker *et al.* (1989). A 0·5 g ground sample was taken from individual daily faecal samples and pooled per animal. Samples were oven dried for 17 h at 100°, reweighed after being cooled, and then ashed for 17 h. Faecal output (FO) was calculated as:

$$\text{FO (gOM/day)} = \frac{\text{Chromium release rate (121 mg/day)}}{\text{Faecal chromium concentration (mg/g OM)}} \quad (2)$$

The chromium release rate was assumed to be 121 mg/day, based on the release rate obtained in rumen fistulated red deer (A. M. Ataja, personal communication). VFI was then calculated from the formula:

$$\text{VFI (gOM/day)} = \frac{\text{Faecal output (gOM/day)}}{1-\text{Digestibility}} \quad (3)$$

where the organic digestibility (OMD) value was taken from the hand-plucked sampling value.

Botanical composition of the feed on offer and of hand-plucked samples was determined by sorting the plants into grasses, red clover, white clover, dead matter and weeds. The components were oven dried at 90 °C for 17 h and weighed. Data were expressed as percentage of DM.

Statistical analysis

Liveweight changes, growth rate, carcass weight, GR measurements, velvet antler weights and VFI were analysed using Generalized Linear Models (GLM; SAS 1987), as a 2 × 2 factorial design, with two levels of sex and two pasture types, per season. Except for VFI and velvet antler values, initial body weight was fitted as a covariate. Least square means (L.S.M.) were used to test the differences between treatments.

RESULTS

Means of pre- and post-grazing herbage masses for the RC and PRG forages in each season are shown in Table 1. Pasture on offer (Table 2) contained predominantly perennial ryegrass, with 7–13% of white clover. The red clover forage contained predominantly red clover during autumn, but white clover increased in spring to attain 35% of sward DM. Both the PRG and RC forages contained *c.* 20% of dead matter during autumn, following a dry summer. Under the very high forage allowances used, the dead matter content of estimated diet selected was negligible for RC and very low for PRG, and the consumption of grasses and legumes reflected their proportions in the forage on offer.

Table 2. *Botanical composition (%DM ± S.E.) of red clover (RC) and perennial ryegrass/white clover (PRG) forages on offer to growing red deer at Massey University, New Zealand during 1990*

	PRG					RC					
	Perennial ryegrass	White clover	Weed	Dead matter	*n**	Grass	Red clover	White clover	Weed	Dead matter	*n**
					On offer						
Autumn	66·1	12·5	0·8	20·6	6	2·7	78·0	0	1·4	17·9	9
S.E.	4·7	2·8	0·4	2·5		1·3	3·5	—	1·2	2·8	
Winter	79·7	7·2	4·9	8·2	21						
S.E.	1·8	0·9	1·5	1·6							
Spring	78·7	13·4	0·4	7·6	10	6·2	46·6	35·9	1·6	9·7	12
S.E.	2·0	1·8	0·2	1·5		2·9	5·6	4·8	0·6	1·3	
					Diet selected (hand-plucked)						
Autumn	84·3	13·6	0	2·1	10	7·7	92·3	0	0	0	9
S.E.	2·1	1·9	—	1·4		3·9	3·9	—	—	—	
Winter	85·5	8·0	0·7	5·8	21						
S.E.	1·9	1·7	0·4	1·1							
Spring	89·9	7·8	0·1	2·3	10	3·8	40·1	56·1	0	0	12
S.E.	1·3	1·4	0·07	0·8		2·6	7·5	7·0	—	—	

* Number of samples taken per season.

Table 3. *Nutritive value (%DM ± S.E.) of herbage on offer and diet selected for growing red deer* (Cervus elaphus) *grazing red clover (RC) and perennial ryegrass/white clover (PRG) forages at Massey University, New Zealand during 1990*

	Total N (%DM)				OMD (%DM)	
	PRG	*n**	RC	*n**	PRG	RC
			On offer			
Autumn (S.E.)	3·1 (0·14)	7	3·4 (0·13)	8	76·5 (0·77)	80·5 (0·72)
Winter (S.E.)	3·7 (0·14)	12			82·7 (1·18)	
Spring (S.E.)	3·1 (0·13)	8	3·8 (0·11)	11	80·3 (0·58)	82·1 (0·49)
			Diet selected (hand-plucked)			
Autumn (S.E.)	4·4 (0·13)	7	4·9 (0·11)	9	82·6 (0·61)	84·6 (0·54)
Winter (S.E.)	4·4 (0·14)	12			86·3 (1·18)	
Spring (S.E.)	3·6 (0·13)	10	5·1 (0·12)	11	84·2 (0·30)	84·2 (0·28)
			Diet selected (oesophageal fistulae)			
Spring (S.E.)	3·2 (0·19)	7	3·9 (0·12)	8	85·3 (0·37)	85·2 (0·30)

* Number of samples taken per season. The same samples were used for total N and OMD determinations.

The RC forage on offer was generally of higher OMD and total N content than the PRG forage (Table 3), with the differences attaining significance for OMD in autumn ($P < 0·01$) and spring ($P < 0·05$) and for total N in spring ($P < 0·01$). Diet selected followed the same trend for total N, with the values being slightly higher than for herbage on offer. OMD of diet selected was substantially higher than for feed on offer and was similar for animals grazing PRG and RC during spring, but was slightly higher for animals grazing RC than PRG during autumn. During spring, OF extrusa and hand-plucked samples gave almost identical results for OMD; although hand-plucked samples contained greater concentrations of total N than OF samples, the relative differences between RC and PRG were similar for the two sampling techniques.

Voluntary feed intake (VFI) of animals grazing RC forage showed consistently higher values during both autumn ($P < 0·10$) and spring ($P < 0·001$) than for animals grazing PRG forage. The interaction between group and sex was significant in spring ($P < 0·05$; Table 4), but not in autumn.

During autumn, liveweight gain was significantly higher in the RC group than the PRG group ($P < 0·05$; Table 5). In winter, the liveweight gains of

Table 4. *Organic matter intake ($gOM/kgW^{0.75}/day$) of weaner red deer* (Cervus elaphus) *grazing either red clover (RC) or perennial ryegrass/white clover (PRG) forages, during autumn and spring 1990, at Massey University, New Zealand*

	Stags		Hinds		
	PRG ($n = 8$)	RC ($n = 9$)	PRG ($n = 9$)	RC ($n = 9$)	S.E.
Autumn	80	82	78	90	4·1
Spring	65	99	70	82	3·9

both RC and PRG groups averaged 77 *v.* 80 g/day, and during spring averaged 298 *v.* 279 g/day, respectively. The small differences during winter and spring did not attain significance. The interaction between group and sex was significant in autumn ($P < 0.05$), indicating a greater response to RC in stags than hinds; the interaction was not significant in the other seasons.

Animals grazing RC forage consistently had higher liveweights than those grazing PRG forage (end autumn, $P < 0.001$; end winter $P < 0.01$ and end spring $P < 0.01$). The interaction between group and sex was significant at the end of autumn ($P < 0.05$), but not in the other seasons. At one year of age, stags grazing RC were 7 kg heavier and hinds were 3 kg heavier than animals grazing PRG.

All stags that had been grazing RC pasture for two seasons (autumn and spring), attained their minimum slaughter liveweight (92 kg) at one year of age, compared to 75% of those grazing PRG pasture. RC stags that went to slaughter, had significantly higher carcass weight ($P < 0.01$) and dressing percentage ($P < 0.01$) than PRG stags (Table 6). After being adjusted to equal carcass weight, there was no difference in carcass subcutaneous fat depth (GR; $P > 0.05$).

Velvet antler weight was rather variable (Table 6), with there being no differences between stags grazing RC or PRG that produced velvet by one year of age.

Table 6. *Carcass and velvet antler production from red deer (*Cervus elaphus*) stags grazing either red clover (RC) or perennial ryegrass/white clover (PRG) forages and attaining slaughter liveweight (92 kg) by one year of age, at Massey University, New Zealand during 1990. Mean values were adjusted to equal initial liveweight for carcass data*

	PRG	RC	S.E.
	Carcass		
Stags attaining target slaughter liveweight (%)	75 (6)*	100 (9)*	
Liveweight (kg)	102·5	108·3	2·45
Carcass weight (kg)	54·5	59·9	1·29
Dressing percentage (%)	53·2	55·3	0·45
GR (mm)	6·3	9·4	1·33
GR (mm)†	7·7	8·6	1·14
	Velvet antler		
Stags producing velvet (%)	75	100	
First cut (g)	250 (6)	260 (9)	51·8
Regrowth (g)	448 (2)	365 (4)	89·8
First cut and regrowth (g)	400 (6)	422 (9)	111·9

* Number of stags per group.
† Adjusted to equal carcass weight.

Table 5. *Mean liveweight gain (g/day) and body weights (kg) of weaner red deer* (Cervus elaphus) *grazing either red clover (RC) or perennial ryegrass/white clover (PRG) forages, during autumn, winter and spring 1990, at Massey University, New Zealand. Mean values were adjusted to equal initial liveweight*

	Stags		Hinds		
	PRG ($n = 8$)	RC ($n = 9$)	PRG ($n = 10$)	RC ($n = 10$)	S.E.
Liveweight gain (g/day)					
Autumn	192	263	173	193	11·8
Winter	106	101	53	52	6·7
Spring	341	354	218	242	16·8
Body weight (kg)					
Initial (7.3.90)	48	47	48	50	2·3
End autumn (19.5.90)*	62	67	61	62	0·9
End winter (11.8.90)*	74	79	67	68	1·3
End spring (29.11.90)*	101	108	84	87	1·9

* Adjusted to equal initial liveweight.

However, more stags grazing RC produced velvet of harvestable length under these conditions than stags grazing PRG.

DISCUSSION

Table 5 showed seasonal liveweight gain patterns of the weaner red deer, which were intermediate in autumn, slow in winter and high in spring, as reported elsewhere (Kay 1985). Slow liveweight gain during winter is typical for red deer, because of seasonal loss of appetite (Kay 1985; Barry *et al.* 1991) and acts as a constraint to venison production.

The present study showed that with a high feed allowance during autumn, winter and spring, 75% of weaner red deer stags grazing PRG pasture can attain the target slaughter criteria (> 50 kg carcass, 92 kg liveweight) within one year of age. A similar result was achieved by Ataja *et al.* (1992) with red deer stags grazing annual ryegrass during winter and spring. The advantages of RC over PRG pasture as a feed for weaner red deer during autumn and spring include a higher nitrogen content and OMD in the feed on offer. Animals grazing RC pasture also showed higher VFI than those grazing PRG pasture. A high nutritive value of RC during summer was also reported by Niezen *et al.* (1993).

The direct response of those advantages from RC forage was higher liveweight being achieved at the end of each season, relative to deer grazing PRG pasture. As there were negligible differences in OMD of the diet selected between the two forages, it seems that a major reason for higher growth on RC was its higher VFI. Stags grazing RC forage over two seasons (autumn and spring), attained minimum slaughter liveweight within one year of age, in a higher proportion (100%) than those grazing PRG pasture (75%). Niezen *et al.* (1993) also reported that lactating red deer hinds grazing RC during summer were gaining weight, compared with those grazing PRG pasture, which were losing weight.

The greatest difference in liveweight gain between the RC and PRG groups occurred in autumn (+70 g/day in stags, +25 g/day in hinds), followed by spring (+13 g/day in stags, +24 g/day in hinds). Niezen *et al.* (1993) showed that red deer fawns reared on hinds grazing RC forage during summer had liveweight gains 100 g/day greater than red deer fawns reared on hinds grazing PRG pasture, under similar forage allowances. This suggests that areas of RC could best be used for the nutrition of lactating hinds and their fawns over summer, and could then be used for the growth of the weaner stags during autumn.

There was a problem in estimating VFI with red deer using the present CRD technique in that responses to RC in terms of VFI did not always match responses in liveweight gain. This might be due to general variability in chromium release and in sampling technique. Niezen *et al.* (1993) encountered this problem with lactating hinds, and Ataja *et al.* (1992) showed a lower value of stags' VFI compared to published data, using the same CRD technique. Further study is needed to validate the CRD technique in red deer.

The final liveweights of both RC and PRG stags were 16 and 9 kg higher than the minimum slaughter liveweight requirement (92 kg). Overall, stags grazing RC forage produced 5 kg heavier carcass yield and 2% higher dressing percentage, with no additional fat deposition (when corrected for carcass weight). Thus, with their accelerated growth, earlier slaughter (October) could be considered with stags grazing RC.

With high allowances during autumn, winter and spring, it is concluded that 75% of weaner red deer stags grazing PRG can attain the target slaughter criteria (> 50 kg carcass, 92 kg liveweight) by one year of age. With weaner red deer stags grazing RC forage over autumn and spring, this can be increased to 100% within one year of age. In order to achieve this target, summer (Niezen *et al.* 1993) and autumn (present study) grazing are the most important times, being the times when animals grazing RC forage attained the largest difference in liveweight gain relative to deer grazing PRG pasture.

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