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Effect of feeding level on the seasonal liveweight gain of young red deer *(Cervus elaphus)* and red/elk hybrid stags

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ABSTRACT

Elk (*Cervus elaphus ssp.*) are becoming increasingly popular as a terminal sire for crossing with New Zealand red deer (*Cervus elaphus*). Hybrid offspring are significantly heavier at weaning and have a faster post-weaning liveweight gain. However no formal comparisons of liveweight gain responses of red deer and hybrids to pasture allowance have been made. The aim of this work was to compare the growth rate of young red deer and red/elk hybrid stags over a range of nutritional levels during 3 seasons.

Single species groups (10-12) of red deer and hybrid weaner stags were offered one of four pasture allowances under rotational grazing for a period of 9 weeks in the winter (June-July), spring (October-December) and summer (February-March). Stags were weighed and given a new allocation of pasture weekly. Pasture allowance ranged from 0.08 to 0.51 kg DM/$W^{0.75}$ /day and pre-grazing pasture mass from 800 to 4500kg DM/ha.

Winter growth rate was low (35g-85g/d), was relatively unaffected by quantity of pasture offered and was similar for both genotypes. In spring however hybrids grew on average 73g/day (29%) more rapidly than red deer across all pasture allowances and 87g/d more at the highest allowance. The hybrid response to extra spring pasture allowance was large compared to reds (190g/day at 2kg DM/head/day to 300g/day at 9.5kg DM/head/day). Although summer liveweight gain was similar to spring when compared across genotype and allowance, the difference between genotypes was generally small except at the highest allowance where hybrids grew significantly faster than red deer. Highest liveweight gain per hectare was achieved by red deer during the spring offered 4kg DM/h/day of a 14cm high pasture.

Hybrid liveweight gain was only greater than red deer during spring and during summer when pasture availability was high. Genotype differences in the proportion of deer reaching 92kg liveweight in 12 months were sensitive to pre-winter liveweight.

Keywords: red deer; elk; hybrids; growth rate; pasture allowance; rotational grazing; pasture availability.

INTRODUCTION

Integrated livestock production systems often involve the use of terminal sires to produce animals specifically for slaughter. Elk (*Cervus elaphus* spp) are becoming more widely used as a terminal sire within the New Zealand deer industry. Elk/red crosses (hybrids) have a higher weaning weight and faster pre-and post-weaning growth rate compared to traditional red deer (Moore & Littlejohn, 1989). This advantage in growth enables producers to more easily attain target slaughter weights (92kg liveweight) within 12 months to produce slaughter animals at a time when northern hemisphere demand gives rise to a high price for venison.

However on farm evidence suggests the liveweight gain advantage of hybrids over red deer is reduced when feed supply is limited and/or in winter but there is confounding of season and feeding level effects in these data. Data exist to show responses of liveweight gain to pasture allowance for red deer on a variety of swards (chicory, perennial ryegrass, red clover and annual ryegrass) but there has been no systematic comparison of red deer and hybrids over a wide range of pasture allowances.

The aim of this study was to quantify any differences in the liveweight gain response to pasture feeding level which may occur between red deer and hybrids in the winter, spring and summer.

MATERIALS AND METHODS

Experimental Design

Single species groups of red deer and hybrid weaner stags were rotationally grazed on ryegrass (*Lolium perenne*)/ white clover (*Trifolium repens*) pastures during winter (21 June - 15 August), spring (12 October - 14 December) and summer (25 January - 28 March).There were 10 deer per group in the winter and summer and 12 per group during the spring. In each season, groups of red deer and hybrids were paired and offered separately one of four pasture allowances ranging from low to very high. Liveweight was measured weekly.

Animals

Forty eight red weaner stags of initial liveweight 57.4 ± 2.0kg (mean ± SD) and forty eight hybrid weaner stags of initial liveweight 68.0 ± 2.2kg (mean ± SD) at approximately 7 months old were used in the experiment. Blood typing (gel electrophoresis) confirmed parentage of red deer and revealed hybrids contained on average 35% elk genes. Deer were sourced in equal sized groups from 8 commercial properties in the Canterbury region, brought to the Lincoln University Deer Research Unit and exposed to temporary electric fencing and yarding facilities to accustom them to experimental routines. Deer were kept as a single mob during this period and between experimental periods. Deer received a moxidectin anthelmintic (Vetdectin; Cyanamid; New Zealand Ltd) prior to the start of the experiment and were re-drenched if faecal egg count rose above 500 eggs/gram. Deer also received a yersiniosis vaccine (Yersiniavax, Agvax Developments Ltd) with a booster 6 weeks latter and a 5g copper bolus (Copacaps, Rhone Merieux).

Prior to the start of the winter experimental period deer of each genotype were divided into 4 groups of 10 animals. Within genotype, each group contained a similar number of deer from each source and was similar in mean liveweight and within group variation in liveweight. Those animals not required during the winter period were run together with commercial animals of the same age under conventional management. Allocation of deer to groups for spring and summer experimental periods was also balanced for previous nutritional treatment.

During each season, paired groups (one of each genotype) grazed in adjacent sections of similar pasture. Pasture was allocated to groups on a mean metabolic liveweight basis at four allowances (Table 1).

Pasture

Groups of stags were rotationally grazed on perennial ryegrass/white clover swards with a fresh area provided weekly. Increases in level of feeding were achieved by increasing both pre-grazing pasture mass/height and allowance. For each pasture allowance treatment a target pre-grazing pasture mass or height was set for each seasonal period. Pre-grazing pasture mass was estimated from mean sward height and weekly treatment-specific calibration. For calibration, a total of 3 quadrats ($0.2m^2$) representing low, average and high pasture mass in each area were selected, average height calculated (20 measurements) for each quadrat and herbage cut to ground level. Pasture was washed and dried at 70°C for 48 hrs before weighing. Post-grazing pasture mass was determined in a similar fashion.

TABLE 1: Pasture allowance treatments (per metabolic liveweight (kg DM/$W^{0.75}$/d) and per head (kg DM/h/d)) for red deer and hybrid stags during winter, spring and summer experimental periods.

Pasture treatment		1	2	3	4	5
				Winter		
Allowance (kg DM/$W^{0.75}$/d)		0.10	0.13	0.19	0.25	
Allowance	Red	2.0	2.7	3.8	5.1	
(kg DM/h/d)	Hyb	2.3	3.0	4.3	6.0	
				Spring		
Allowance (kg DM/$W^{0.75}$/d)		0.08		0.16	0.25	0.40
Allowance	Red	1.8		3.7	5.7	9.1
(kg DM/h/d)	Hyb	2.1		4.1	6.4	10.3
				Summer		
Allowance (kg DM/$W^{0.75}$/d)		0.14		0.20	0.33	0.51
Allowance	Red	3.7		5.7	9.3	14.4
(kg DM/h/d)	Hyb	4.3		6.3	10.5	16.5

Post-grazed summer pasture was mechanically topped to remove any seed head to maintain pasture quality. During the summer period all pastures were irrigated with 75mm of water after topping.

Statistical Analysis

Genotype, source and season plus previous and current nutritional level were used as fixed effects in a generalised linear model. Least squared means were used to test for differences between treatments.

RESULTS

Mean pre- and post-grazing sward surface height for the four pasture allowance treatments in each of the three experimental periods are given in Table 2. Pre-grazing sward surface height was similar within allowance for each of the three seasons. Post-grazing sward surface height for spring and summer was similar within each allowance for spring and summer but significantly lower for winter. There was no effect of genotype on either pre- or post-grazing sward surface height.

Season and deer genotype had a significant effect on liveweight gain ($P<0.01$). During the winter mean liveweight gain was low and not significantly different between genotypes ($P> 0.05$) (Table 3.). Liveweight gain in spring was on average about four times that achieved in the winter and hybrids gained on average 73g/day (29%) more during the spring than red deer. Summer liveweight gain across genotype was lower than in the spring (219g/day vs197g/day for spring and summer respectively). Red deer and hybrids had similar liveweight gain during summer.

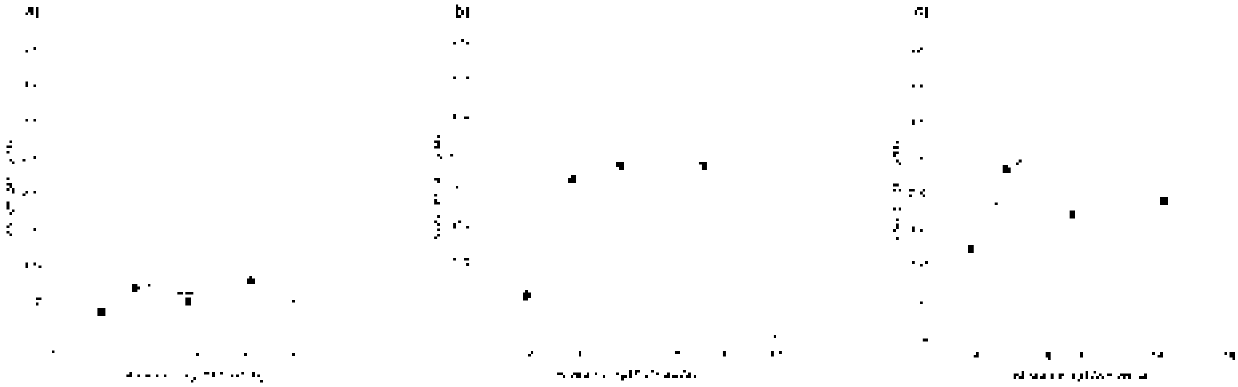
TABLE 2: Pre- and post-grazing mean sward surface height (cm) and standard error of the mean (SEM) for pasture allowance treatments in each of the experimental periods.

Nutritional treatment	1	2	3	4	5	SEM
			Winter			
Pre	4.5	10.0	13.0	17.0		0.43
Post	1.8	3.0	4.0	8.0		0.33
			Spring			
Pre	5.2		13.0	19.0	22.0	0.45
Post	2.7		8.0	14.0	18.0	0.24
			Summer			
Pre	4.8		14.0	19.0	22.0	0.40
Post	2.7		7.0	12.0	16.0	0.24

TABLE 3: Mean growth rate (g/day) of red and hybrid weaner stags and the difference between genotypes(averaged across allowance) during winter, spring and summer.

	Winter	Spring	Summer	SEM
Reds	58	182	189	19
Hybrids	61	255	205	
Difference (g/d)	3	73	16	

FIGURE 1: Liveweight gain of red deer(■) and hybrids (◯) over a range of pasture availabilities during a)winter b)spring and c)summer



Winter liveweight gain of both genotypes was relatively unaffected by pasture allowance. (P>0.05) (Fig 1a). During the spring, both genotypes responded to increases in pasture allowance. The interaction between feeding level and species was significant during the spring (P< 0.01) indicating a greater response in hybrid liveweight gain to the highest feeding level compared to reds. The interaction was not significant during other seasons.

The large difference in liveweight gain between genotypes at the lowest pasture allowance in spring was associated with a lower post-grazing pasture mass or height for hybrids (2.2 vs 3.7cm) (P< 0.01) in this treatment but such differences were not picked up in other treatments probably because the methods of sward height measurement employed were not sensitive enough to pick up differences in post-grazing height which were less than 2-3cm.

Summer liveweight gain was lower at each pasture allowance than that observed in spring and the mean difference between genotypes was generally small (16g/d) except at the highest availability where hybrids exhibited a significantly greater liveweight gain than red deer.

Actual liveweight gain data for winter and spring were used to simulate liveweight at 12 months of age for both genotypes at all pasture availabilities, assuming animals had remained on the same treatments for both winter and spring (Table 4).

The simulated mean final weight and the measured SD of liveweight in treatment groups was used to estimate the percentage of animals in each group which would have attained 92kg liveweight by December 15.

TABLE 4: Winter liveweight (measured), 12 month liveweight (simulated) and the percentage of animals attaining 92kg liveweight for red deer (R) and hybrids (H) over a range of pasture allowances . The percentage of the difference (% lwt difference) in 12 month weight between the genotypes attributed to winter weight is also given.

Genotype	R	H	R	H	R	H	R	H
Allowance (kg DM/h/d)	1.8	2.1	3.7	4.1	5.7	6.4	9.1	10.3
Winter wt (kg)	57.7	68.5	57.5	68.0	57.4	67.6	57.0	67.8
12 month wt (kg)	82.3	94.8	83.3	96.4	85.0	99.5	87.2	104.8
% >92kg	0	68	1	77	3	90	10	99
% lwt difference	87		80		70		61	

While less than 10% of red deer reached target liveweight at even the highest allowance, 68-99% of hybrids would have reached target slaughter by December depending on allowance offered.

Carrying capacity (deer/ha) and liveweight gain per hectare for spring and summer experimental periods for each pasture allowance are given in Table 5. Liveweight gain per hectare was greater in spring compared with summer (23.8kg/ha/week vs 15.8 kg/ha/week for spring and summer respectively). During spring, hybrid per hectare liveweight gain (26.8kg/ha/week) was greater than

TABLE 5: Per hectare performance and carrying capacity of red deer(R) and hybrid (H) weaner stags.

Genotype	R	H	R	H	R	H	R	H
Spring								
Allowance (kg DM/h/d)	1.8	2.1	3.7	4.1	5.7	6.4	9.1	10.3
Liveweight gain (g/d)	53	187	211	207	231	305	232	319
Deer/ha	26.8	22.9	23.7	21.6	15.3	14	7.8	7.1
Production (kg/ha/week)	10	30	35	31	25	30	13	16
Summer								
Allowance(kg DM/h/d)	3.7	4.3	5.7	6.3	9.3	10.5	14.4	16.5
Liveweight gain (g/d)	122	93	233	245	170	184	230	297
Deer/ha	18.2	16.1	15.8	14.9	11.5	10.4	6	5.2
Production (kg/ha/week)	16	10	26	26	14	13	10	11

red deer (20.8kg/ha/week). However during summer, the mean production per hectare was similar (15.0 and 16.5kg/ha/week for hybrid and red deer respectively)

Maximum weekly per hectare liveweight gain for both genotypes occurred at an allowance of approximately 4 kg DM/head/day during the spring and 6kg DM/head/day during the summer. During the spring a penalty in per hectare production of offering high pasture allowances only occurred at the highest pasture allowance (10.3kg DM/h/d) with hybrids whereas red deer per hectare production declined when offered allowances at > 5.7kg DM/h/d.

DISCUSSION

Weaner stags in this study followed a similar seasonal pattern of liveweight gain to those in previous work (Kay, 1985; Semiadi, *et al.*, 1992; Ataja *et al.*, 1992; Kusmartono, *et al.*, 1995) with low winter and high spring liveweight gain. The winter liveweight gain reported here (35-85 g/d) was lower than that reported previously (140 - 165 g/d, Ataja, *et al.*, 1992; 171g/d, Kusmartono, *et al.*, 1995) but similar to those reported by Semiadi, *et al.*, 1992 (106g/d) and Soetrisno *et al.*, 1994 (94g/d) when compared at similar pasture allowances. Discrepancies in winter liveweight gain between this and other studies may originate from the inclusion of August and September data in some "winter" measurements.

Differences between genotypes in mean winter liveweight gain were small and non-significant. During winter the liveweight gain response to extra pasture was also low suggesting that in our environment there was little benefit in offering deer large quantities of pasture during this period. Deer grazed to a lower post-grazing pasture height at similar allowances during winter compared with spring and summer (Table 2). However it is questionable, considering the small response to increasing pasture allowance, whether grazing to a post-grazing pasture mass equivalent to spring/summer values would have increased winter growth rate significantly.

Spring daily liveweight gain of both genotypes was similar to that reported previously (Semiadi, *et al.*, 1992; Ataja, *et al.*, 1990; Kusmartono, *et al.*, 1995) when compared at similar post grazing pasture mass or pasture allowance. There was a large increase in liveweight gain in response to increasing allowance but the increase above 3.7kg DM/h/d for red deer was low (20g/day> between allowance 3.7 and 9.1kg DM/h/d) suggesting red deer were nearing their maximum intake at this allowance. This is consistent with the observation of Hamilton *et al.*, (1995) that increasing sward height between 4 and 10cm on a set stocked pasture had no effect on liveweight gain of yearling red deer stags during the spring. In contrast hybrids continued to show a response to extra pasture allowance during spring even when availability was high (Fig 1b) implying maximum intake had not yet been achieved. Others have reported genotype x nutrition interactions (for example deer; Kusmartono *et al.*, (1995), beef cattle, Frisch & Vercoe (1977,1984).

Mean summer daily liveweight gain was similar for both genotypes, due mainly to a reduction in liveweight gain of hybrids compared with spring, rather than any increase in red deer growth rate from spring to summer. Previous studies of this kind have slaughtered stags at or before December and therefore comparable literature for summer is scarce. The liveweight gain response to changing allowance was similar for both genotypes and allowances above 6kg DM/h/d produced little extra liveweight gain.

In summary, hybrids showed a greater seasonal amplitude in liveweight gain compared with red deer and required a higher pasture allowance to express their greater spring liveweight gain.

The higher 12 month liveweight of hybrids is a combination of their more rapid liveweight gain in spring (9-10 months old) and greater pre-weaning (autumn) liveweight. In this study, spring liveweight gain only accounted for, on average, 26% of the difference in 12 month liveweight with the majority (74%) existing at the beginning of winter (Table 4). This illustrates the importance of pre-winter liveweight (a function of weaning weight and autumn growth rate) to yearling liveweight.

In previous studies investigating venison production in New Zealand the proportion of deer attaining 92kg by 12 months has been used as a measure of the success of nutrition, management and genotype treatments. Our pasture system at the highest allowances was only able to achieve a 92kg liveweight target in 10% of red deer which is similar to farm survey data (Wilson *et al.*, 1996) which indicates an industry average of about 10-15% of red deer reach 92kg within 12 months. These proportions are low compared with 75% reported by Semiadi et. al., (1993), 90% by Soetrisno *et al.*, (1994) and 100% by Kusmartono *et al.*,(1995) who all offered allowances less than our highest allowance. The difference is more due to greater initial liveweight than faster growth rate. If the pre-winter liveweight of 62kg reported by Semiadi *et al.*, (1993) is used in our simulation (instead of 58kg), 56% of our red deer reach 92kg by December which is more comparable with previous authors. The proportion of hybrids reaching 92kg from our highest pasture availability (99%) was similar to that reported by Kusmartono *et al.*, (1995) who fed at a similar level and had a similar pre-winter liveweight to this study. Increasing hybrid pre-winter liveweight by 4kg would have enabled all hybrids to reach 92kg in 12 months on a lower (6 vs 10 kg DM/h/day) pasture allowance.

Venison production should be assessed as liveweight gain per hectare as well as liveweight gain per animal. At all allowances during the spring (with the exception of 3.7kg DM/h/d), hybrids produced more liveweight gain per hectare compared with reds because their higher growth rate more than compensated for the lower carrying capacity. The exception was at an allowance of 3.7kg DM/h/d where red deer produced 4kg liveweight gain/ha/week more liveweight than hybrids fed similar amounts on a metabolic liveweight basis.

Summer liveweight gain per hectare was similar for both genotypes as the lower liveweight gain of reds was compensated for by their higher carrying capacity and vice versa for hybrids.

The liveweight gain of hybrids show a greater response to increasing pasture allowance compared to reds during spring, but differences during winter and summer were small. Hybrids showed a greater seasonal change in liveweight gain at all pasture allowances compared with red deer. The implication of this work to venison finishing systems is to highlight the importance of pasture supply in early spring compared to winter feeding and the need to offer hybrids greater pasture allowances than red deer for them to reach their potential in spring.

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