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The effect of weaning date, gastro-intestinal nematode challenge and nutrition on beef calf growth

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ABSTRACT

Two experiments were conducted to understand the interactions between calf weaning date, level of nutrition and parasite challenge. In the first experiment, spring-born calves were weaned at 6 or 9 months of age (early or late weaning) and subject to natural parasite challenge, or natural plus an additional dose of 7500 infective larvae/day. Late weaned calves (with cows) also had either high or low pasture allowance treatments imposed. When calves were 9 months of age, calf liveweights (kg) were 253, 302 and 277 (SED 3.9) for the early wean/high nutrition, late wean/high nutrition and late wean/low nutrition treatments respectively and high and low nutrition cow liveweights were 494 and 479 kg (SED 4.8) respectively. At 9 months of age, early weaned calves showed higher faecal egg counts ($P<0.05$). Dosing with additional parasitic larvae had no effect on early weaned calves, but lowered late weaned calf weights. In the second experiment, calves were weaned at 6 months of age or left un-weaned until the age of 9 months when all calves were slaughtered. Un-weaned calves showed lower gastro-intestinal worm counts than early weaned calves. In both experiments, late weaned calves showed substantial liveweight advantage and lower parasite burdens. Reducing the nutrition of late weaned calves and cows reduced the size of this liveweight benefit. Later weaning is a management option for farmers seeking to reduce reliance on anthelmintic drenches without the associated production loss.

Keywords: calf weaning date; beef cattle; nematodes; parasite management

INTRODUCTION

Spring born beef calves generally display few signs of internal parasites before weaning, but they appear to become vulnerable after weaning (Michel *et al*., 1972; Anderson, 1980). In New Zealand, weaning of spring born calves commonly occurs during autumn at around 6-7 months of age. At this time of the year pasture supply can be limited, pasture quality is often poor, fungal toxins can be prevalent, and parasite challenge is often high. Weaning at this time imposes physiological stress and may compromise calf nutrition at a time when animal health is challenged. This can result in poor calf performance during this season.

Beef producers who are seeking to minimise the use of synthetic chemicals rely largely on management strategies to overcome animal health constraints. Manipulation of weaning date is one of these strategies. Un-weaned calves can grow better than weaned calves, and this is often associated with reduced impact of animal health constraints (Smith *et al*., 1973; Pate *et al*., 1985; McCall & Scott, 1988; Boom *et al*., 2003). It has also been demonstrated that parasite burdens can be lower in calves and lambs that are receiving milk (Rohrbacher *et al*., 1958; Zeng *et al*., 2001).

Boom *et al*. (2003) recently tested the hypothesis that later weaning of spring-born calves would mitigate the effects of parasites. This study showed that milk intake by calves had substantial benefits in calf growth rate, but was not conclusive as to whether this response was due to lower parasite burdens. It also did not investigate the effects of un-weaned calves being subject to lower pasture levels than weaned calves. This paper reports on two experiments that sought to add to the previous study of Boom *et al*. (2003), by investigating the interaction of calf weaning date, parasite challenge and pre-weaning nutrition on calf growth rate and parasite burden.

MATERIALS AND METHODS

Experiment 1 - Treatments

The experiment commenced on 18 March 2002 at AgResearch Whatawhata, New Zealand, when 112 Hereford x Friesian calves and 64 Hereford x Friesian cows were allocated into 7 treatments. Calves were born between 25 August and 10 September 2001. Treatments were:

1. Weaned 18 March 2002 (early wean), high pasture grazing residual (high residual), natural parasite challenge (no dosing), no anthelmintic drench use (no drench) – **Early/High**
2. Early wean, high residual, natural parasite challenge plus dosing with 7500 infective larvae/day (L3 dosing), no drench – **Early/High/Dosed**
3. Early wean, high residual, no dosing, anthelmintic drench use – **Early/High/Drench**
4. Weaned on 9 July 2002 (late wean), high residual, no dosing, no drench – **Late/High**
5. Late wean, high residual, L3 dosing, no drench – **Late/High/Dosed**
6. Late wean, low pasture grazing residual (low residual), no dosing, no drench – **Late/Low**
7. Late wean, low residual, L3 dosing, no drench – **Late/Low/Dosed**

Treatments contained 16 calves (and 16 cows in the late wean treatments) within two replicates. Experimental treatments finished at late weaning (9 July) when the cows were removed. Calves were then randomly allocated into grazing groups within each replicate until

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21 January 2003 in order to assess any carry-over treatment effects.

All calves received vaccination for clostridial diseases, vitamin B12, a copper oxide capsule, and ectoparasiticide (lice control) treatment. No anthelmintic treatment was given to the calves prior to the commencement of the experiment. All calves within the **Early/High/Drench** treatment were treated with both endectocide and levamisole anthelmintics on 18 March, 28 May and 30 July, and with levamisole on 23 April, 25 June and 10 September 2002. Calves within the other treatments (non-drench) received anthelmintic treatment for ethical reasons if they showed significant weight loss, faecal egg count (FEC) >600 epg or serum pepsinogen level (pepsinogen) >3.2 mU/l. These treated calves and their data remained within the treatment group.

The calves within treatments 2, 5 and 7 were dosed twice weekly with approximately 26,250 infective larvae (L3) from 18 March until 18 June, totalling approximately 700,000 L3/dosed calf. L3 were generated by collection and incubation of faecal material from infected calves. L3 were extracted from the faeces and rinsed using a Baermann tray and a 20 micron sieve.

Management and measurement

During the treatment period, treatments 1, 2 & 3 were grazed together as one mob within each replicate, as were treatments 4 & 5 and treatments 6 & 7. All treatments received similar pre-graze herbage mass, quality, natural L3 contamination level and paddock grazing durations. High and low pasture grazing residual treatments were applied by adjusting the size of the paddock. Pre- and post-grazing herbage mass was assessed on alternate weeks. Herbage samples were collected to determine metabolisable energy (ME) concentration and for L3 enumeration and identification.
All calves were faecal and blood sampled on 6 March, 14 May, 8 July and 3 September and analysed for FEC and serum pepsinogen levels respectively. Milk composition and calf milk intake was assessed over a 24 hour period on 24 April, 25 May and 5 July. Calf herbage intakes were measured on 8 calves within the 'no dose' treatments during April and June through the use of n-alkane methodology (Dove and Mayes, 1991). The assessment methods of milk and herbage intake were similar to those described by Boom *et al.* (2003).

Experiment 2

To examine the effects of weaning date on gastro-intestinal parasite burdens, 10 heifer calves were weaned on 18 March 2003 while another 10 remained un-weaned. The weaned calves were grazed separately for 10 days post-weaning and then joined with the un-weaned calves and cows. The weaned calves were observed to ensure no suckling from the un-weaned cows occurred. Grazing management and data collection techniques were similar to Experiment 1.
All calves were slaughtered on 24 June when the abomasum and the first 10 metres of the small intestine were sealed and collected. Nematodes within these organs were extracted and counted using similar techniques as described by MAFF (1977).

Analyses

Statistical analysis was undertaken using analysis of variance (GenStat 6.1). Liveweights were adjusted using start liveweight as a covariate. Faecal egg and total nematode counts were log transformed prior to analysis.
Farm systems analysis was undertaken to assess the efficiency of the early and late weaning treatments, using the computer programme 'Stockpol' (Marshall *et al.*, 1991). This analysis was based on a North Island hill country farm with a 50:50 breeding ewe:breeding cow policy, calving in early September with all cattle progeny sold for slaughter at 17 months of age. Cow liveweight differences at the time of late weaning were equalised by calving time. Liveweights and weaning dates were based on those in **Early/High** and **Late/High** treatments of Experiment 1.

RESULTS

Experiment 1

Pre-graze herbage mass (Table 1) was similar for all treatments during the treatment period (18 March – 8 July). Herbage ME and green leaf content averaged 9.3 and 80% respectively. Low nutrition treatments received approximately 60% the pasture area of the high residual treatments, resulting in almost 600 kg DM/ha difference in post-grazing herbage mass. Over this period, L3 concentration on pasture averaged 345 larvae/kg moist herbage, peaking at 1293 larvae/kg in early June. During the carry-over period the average L3 concentration was 65/kg. L3 extracted from pasture were 45% *Cooperia* spp., 27% *Ostertagia ostertagi*, 15% *Trichostrongylus* and 13% other species. The dosed L3 comprised 91% *Cooperia* spp., 4% *Ostertagia ostertagi*, 3% *Trichostrongylus* and 2% others.

TABLE 1: Pre- and post-graze herbage mass (kg DM/ha) during the treatment period.

	Pre-graze	Post-graze
Early/High	3248	2294
Late/High	3181	2264
Late/Low	3161	1700
SED	160	126

During the treatment period, the **Late/High** calves grew faster (P<0.001) and the **Early/High** un-drenched calves grew slower (P<0.001) than other treatments (Table 2).

This was somewhat reversed during the carry-over period, where the **Late/High** calves grew slower (P<0.05) and the **Early/High/Drench** grew faster (P<0.05) than other treatments. At the end of the study, the **Late/High** calves remained the heaviest (P<0.01) and **Early/High** calves the lightest (P<0.001). Cow weight loss was greater (P<0.001) in the **Late/Low** treatments compared with the **Late/High** treatments.

TABLE 2: Average calf liveweight (LW, kg), calf and cow liveweight gain (LWG, kg/day), and calf herbage intake (kg DM/head/day). Significant main effect differences and the level of significance are displayed based on analysis of selected treatments; 'weaning date' includes treatments 1, 2, 4 and 5 only, 'parasite dosing' and 'grazing residual' includes treatments 4 to 7 only; 'anthelmintic drench' includes treatments 1 and 3 only.

Treatment	**Calf LW 8/7/02**	**Calf LW 3/9/02**	**Calf LW 21/1/03**	**Calf LWG 18/3-8/7**	**Calf LWG 8/7-21/1**	**Cow LW 8/7/02**	**Cow LWG 18/3-8/7**	**Calf Intake April**	**Calf Intake June**
1. Early/High	253	288	409	0.10	0.79			4.2	4.5
2. Early/High/Dosed	254	294	417	0.10	0.82				
3. Early/High/Drench	268	321	442	0.23	0.88				4.8
4. Late/High	305	340	455	0.56	0.75	498	-0.06	3.8	4.1
5. Late/High/Dosed	298	329	438	0.50	0.71	490	-0.12		
6. Late/Low	280	319	437	0.33	0.80	481	-0.21	3.2	3.5
7. Late/Low/Dosed	273	317	434	0.28	0.81	476	-0.26		
SED	3.9	5.6	4.1	0.018	0.021	6.8	0.062	0.35	0.27
Weaning date	48 ***	44 ***	34 ***	0.43 ***	0.18 *			NS	NS
Parasite dosing	7 *	NS	10 *	0.06 *	NS	NS	NS		
Grazing residual	25 ***	17 ***	11 *	0.23 ***	0.08 **	16 ***	0.15 ***	NS	0.6 *
Anthelmintic drench	15 ***	33 ***	33 ***	0.13 ***	0.09 *				NS

TABLE 3: Mean calf faecal nematode eggs (FEC, Eggs/g) and calf serum pepsinogen levels (Pep, mU/l). FEC were back-transformed from log means. Significant main effect differences analysed as in Table 2.

Treatment	**FEC 14/5/02**	**FEC 8/7/02**	**FEC 3/9/02**	**Pep 14/5/02**	**Pep 8/7/02**	**Pep 3/9/02**
1. Early/High	141	97	34	1.58	1.84	2.08
2. Early/High/Dosed	125	123	13	1.57	1.87	2.20
3. Early/High/Drench	0	13	0	1.40	1.58	1.38
4. Late/High	113	60	18	1.39	1.72	1.92
5. Late/High/Dosed	54	14	21	1.58	1.65	1.98
6. Late/Low	49	34	17	1.45	1.76	1.87
7. Late/Low/Dosed	71	39	0	1.30	1.79	1.84
SED	35.6	25.4	11.2	0.16	0.18	0.26
Weaning date	NS	21 **	NS	NS	NS	NS
Parasite dosing	NS	NS	NS	NS	NS	NS
Grazing residual	NS	NS	NS	NS	NS	NS
Anthelmintic drench	NS	NS	34 **	NS	NS	0.7 *

Dosing with additional L3, reduced calf growth rates within the late weaned treatments ($P<0.05$), but not within the early weaned treatments (Table 2). Dosing with L3 did not affect calf FEC or pepsinogen levels (Table 3). Early weaned/un-drenched calves had higher FEC than the late weaned calves ($P<0.01$) at the time of late weaning (Table 3). The proportion of calves requiring anthelmintic drenching for ethical reasons were 25% and 7% for the early wean un-drenched and late weaned treatments respectively.

Calf herbage intakes tended to be highest in the **Early/High** treatment and lowest in the **Late/Low** calves, but these differences were not statistically significant. Calf milk intake averaged 3.7 kg/head/day, although calves in the low grazing residual treatments tended to show lower milk intakes during the latter part of the treatment period. **Late/Low** cows had higher ($P<0.05$) milk fat and total milk solid concentrations (4.4% and 13.9%) than the **Late/High** cows (5.3% and 14.6%).

Experiment 2

Un-weaned calves grew faster ($P<0.001$) than early weaned calves, resulting in a 32 kg liveweight and 21 kg carcass weight difference at the end of the study (Table 4). Early weaned calves had higher parasite burdens for all 3 parasite species, though these differences were only significant for *Cooperia oncophora*.

Table 4. Average calf liveweight (LW, kg), liveweight gains (LWG, kg/day), calf faecal nematode eggs (FEC, eggs/g), pepsinogen (Pep, mU/l), carcass weight (CW, kg) and gastro-intestinal nematode counts for abomasums (Abo) and small intestine (SI). Nematode species: *Ostertagia ostertagi* (Ost), *Trichostrongylus* (Trich) and *Cooperia oncophora* (Coop). FEC and nematode counts were back-transformed from log means.

	LW 19/6/03	**LWG 18/3-19/6**	**FEC 19/6/03**	**Pep 19/6/03**	**CW 24/6/03**	**Abo Ost**	**Abo Trich**	**SI Coop**
Weaned	248	0.13	52	2.44	127	3030	1010	1880
Un-weaned	280	0.47	30	2.26	148	1370	510	240
SED	5.7	0.05	23	0.327	4.4	825	395	411
Significance	***	***	NS	NS	***	NS	NS	**

DISCUSSION

Late weaning resulted in a 48 kg liveweight advantage in calf liveweight over early weaning at the time of late weaning. This gain is similar to the finding of Boom *et al*. (2003) who identified that this response was mainly due to the increased energy intake of the calf through milk ingestion. Some of this liveweight advantage was lost during the subsequent 6 month carry-over period. Where cows and calves grazed to lower residuals, the calf liveweight advantage to late weaning was reduced to 23 kg. The data suggest that these calves had lower milk and herbage intakes than the **Late/High** calves. The grazing residuals of these **Late/Low** treatments (1700 kg DM/ha) would not be considered low in conventional beef cow-calf systems. However, the pasture had a thick herbage base so that much of this quantity was unavailable to cattle.

Larval-dosed calves had approximately twice the L3 intake of the un-dosed calves during the dosing period, being approximately 14400 and 6900 L3/day respectively. Larval dosing compromised calf growth rates within the late weaned treatments, but not within the early wean treatments. This would suggest that the calf liveweight advantage to late weaning was subject to parasite challenge. The relatively small effect of dosing on treatments may be due to the majority of L3 being *Cooperia* spp., which are usually considered less pathogenic than *Ostertagia ostertagi*.

Faecal egg, pepsinogen levels and worm burdens recorded in this study were low compared with other those reported by Bisset and Marshall (1987). However, the anthelmintic treatment of early weaned calves resulted in a 33 kg liveweight advantage at the end of the study, showing that parasites were a significant constraint to liveweight gain. In experiment 1, later-weaned calves showed significantly lower FEC in July and fewer calves required treatment for clinical parasitism. Experiment 2 showed that later weaning reduced numbers of Cooperia *spp*., which concurs with the findings of Rohrbacher et al. (1958). Overall, the post-mortem worm counts from experiment 2 were low compared to the clinical infection levels recorded by Bisset and Marshall (1987), and McKenna (1997). Considering the likely L3 ingestion rates of the calves at around 7000 L3/day, it can be considered that calf immunity levels must have been well developed to maintain such low worm burdens.

Application

These studies and others (McCall and Scott, 1988; Boom et al., 2003) show that delaying calf weaning is a useful strategy for those wishing to reduce dependency on anthelmintics. Most farm managers who seek to use cows for clean-up of poor quality pasture would provide better pasture conditions to weaned calves than to un-weaned calves and cows. In Experiment 1, un-weaned calves still grew better than weaned calves when they were grazed to significantly lower pasture residuals. One cost of later weaning is expressed in cow liveweight, especially when un-weaned calves and cows are grazed to low residuals. If cows are approaching liveweights where conception is affected, this liveweight would need to be reinstated, resulting in higher feed demands during winter and early spring.

Based on the farm system context used within the Stockpol analyses, a farm changing from weaning spring-born calves in March to weaning in early July would need to reduce overall stocking rate by 2%, due to increased calf weight and the need for post-weaning cow weight gain on the late weaned system. With this reduced stocking rate the late weaned system still produced 13 kg more beef liveweight per hectare than the early weaned system. The calculated gross margins were $833/ha and $881/ha for early and late weaning respectively. This benefit to late weaning was mainly due to the higher returns per kg of carcass from heavier cattle rather than a production increase and may not be realised if stock were sold store.

On sheep and beef farm systems, the beef cow has a dual purpose. Firstly, to rear a high value calf, and secondly, to be a lower priority stock class which can be used to maintain pasture quality. This research has clearly shown that within a reduced chemical use context, later weaning has the potential to improve the value of the calf, even where cows with calves at foot are used for a certain amount of pasture control. Whether these benefits overcome the loss in management flexibility, cow liveweight or pasture quality control will depend on the individual farm system.

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