INVESTIGATING SUMMER AND AUTUMN ENDOPARASITISM IN FARMED RED DEER, EFFECTS OF WEANING DATE, ANTHELMINTIC TREATMENT AND FORAGE SPECIES

A thesis in partial fulfilment of the requirements for the degree of Masters of Science in Animal Science at Massey University, Palmerston North. New Zealand

JAMES MUSYIMI MWENDWA

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DECLARATION

The studies presented in this thesis were completed by the author while a post-graduate student in the Institute of Veterinary, Animal and Biomedical Sciences, College of Sciences, Massey University, Palmerston North, New Zealand. This is all my own work and the views presented are mine alone. Any assistance received is acknowledged in the thesis.

I officially state that the contents of the thesis have not been submitted for any other degree and are not currently being submitted for any other degree. I certify that to the best of my knowledge, any help received in preparing this thesis, and all sources used, have been acknowledged in the thesis.

James M. Mwendwa

MSc Candidate ....Date 08/08/08..................

Dr. S. O. Hoskin

Chief Supervisor ....Date 8/8/08...................

Professor P. R. Wilson

Co-Supervisor P.R. Wilson ....Date 12/8/08...................

Associate Professor W. E. Pomroy

Co-Supervisor ....Date 13/8/08...................

ABSTRACT

Previous research has shown that even small numbers of lung and gastro-intestinal (GI) nematodes cause sub-clinical infections during autumn and can reduce voluntary feed intake (VFI) and liveweight gain (LWG) post-weaning in farmed deer. However, little is known about the effect of parasitism on growth of young farmed deer prior to weaning (summer and early autumn). At present, the control of deer parasites is largely by anthelmintic treatment. Alternatively, chicory sown as a pure sward has been shown to reduce parasitism and increase post-weaning growth of deer compared with perennial ryegrass-based pasture, although, neither forage plantain nor the inclusion of chicory in a pasture mix have yet been evaluated in this context. In addition, it has been suggested that to achieve a high pregnancy rate early in the mating season, deer calves should be weaned prior to mating to optimise nutrition and body condition of the hinds. At present there is no adequate evidence in the published literature to justify this.

Two experiments were conducted in 2005 and 2006 respectively. The first experiment investigated the impact of early or late pre-rut weaning, with and without anthelmintic treatment, on parasitism and growth (LWG g/day) of deer calves during summer and early autumn. Weaning date effects on hind reproductive parameters were also investigated. The second experiment was a preliminary investigation to compare the effect of grazing permanent perennial ryegrass pasture (*Lolium perenne*) with chicory (*Cichorium intybus*) narrow-leaved plantain (*Plantago lanceolata*) and pasture mixes based on short-rotation tetraploid ryegrass (TSR-mix; nil endophyte) or long-rotation tetraploid ryegrass (TLR-mix; low endophyte), with both mixes sown with the same clover (white and red) and chicory, on post-weaning growth and endoparasitism of weaned farmed red deer calves in autumn.

In 2005, seventy-six deer calves were randomly allocated in a 2x2 factorial design, involving sex, genotype, weaning date (February 17 or March 17), treatment with either topical moxidectin (0.5mg/kg) on January 14 and February 25 or no anthelmintic treatment. Liveweight gain, faecal gastrointestinal egg counts (FEC) and lungworm larval counts (FLC), haematological parameters and serum proteins concentrations (i.e., total protein, albumin and globulin) of calves were measured. Mixed-age adult hinds (64) were used to investigate the effect of weaning date on internal parasitism, conception date and pregnancy rate determined by ultrasound scanning. These hinds were not given anthelmintic treatment, but FLC and FEC were determined on

January 12, February 17, March 17, March 31 and May 4. All deer rotationally grazed permanent perennial ryegrass-based pasture (*Lolium perenne*) together until weaning at which point calves were removed to separate but similar pasture.

Calves weaned in March had a higher LWG to March 31 than those weaned in February ($P<0.0001$). Faecal larval count in treated calves was zero, but FEC remained similar to the untreated control calves, regardless of when they had been treated (average 136 epg, range 0-600 epg in mid February and average 92, range 0-350 epg at the end of March). Treated calves had higher serum albumin, and lower serum globulin concentrations than the untreated control group (albumin, 36.2 ± 0.3 vs 35.2 ± 0.3g/L; $P<0.001$; globulin, 23.9 ± 0.4 vs 25.5 ± 0.4g/L; $P<0.005$). In hinds, FLC averaged 5 lpg (range 0 – 122) and FEC averaged 26 (range 0- 200) with no significant relationship between weaning date and either FLC or FEC. No effect of weaning date on conception rate or date was observed.

This study showed that pre-rut weaning date, (although confounded by weaning process management) and sub-clinical parasitism during summer and early autumn may influence LWG in young farmed deer. The failure of moxidectin to reduce FEC to zero raises the question of the efficacy of this macrocyclic lactone anthelmintic against GI nematodes in farmed deer and/or emergence of farmed deer GI nematode resistance. Potential diagnostic parameters such as serum albumin concentration, which was reduced in untreated control deer, warrant further investigation for clinical diagnostic use in farmed deer. The study also highlighted the need for further research to demonstrate the advantages or disadvantages of pre-rut weaning on growth of deer calves and hind reproduction.

The 2006 grazing experiment investigated the effect of pasture species grazed on post-weaning growth and endoparasitism of farmed red deer from 3- 6 months of age. Ninety-five red deer calves were randomly allocated to five groups based on sex, LW, FEC and FLC. These calves rotationally grazed either a permanent pasture based on perennial ryegrass, chicory, narrow-leaved plantain, or one of two pasture mixes based on either a short-rotation tetraploid ryegrass (TSR-mix) or long-rotation tetraploid ryegrass (TLR-mix). Both mixes included the same white clover, red clover and chicory. All deer were initially treated with an anthelmintic (albendazole), with subsequent trigger treatment withheld until weight loss or clinical parasitism was observed. Anthelmintic trigger treatment (albendazole) was given on an individual animal basis.

The anthelmintic trigger treatment and LWG data in this study suggest that plantain, TLR- and TSR-mixes and chicory may all have a role in aiding control of endoparasitism in young growing deer in autumn in deer production systems based on permanent perennial ryegrass-based pasture with low anthelmintic input. However, any potential effects of forage feeding value and anti-parasitic plant compounds of chicory, plantain and pasture-forage mixes on parasitism and growth could not be separated in this study. It is therefore acknowledged that these observations are preliminary and based on a design intended only to establish whether further replicated studies are warranted, particularly with plantain and pasture mixes. However, the study has shown that pasture species, either sown as a pure crop or in a pasture mix can influence LWG, resilience to internal parasitism and requirement for anthelmintic use in young farmed deer.

Data from the first experiment (2005) has shown that pre-rut weaning date and sub-clinical parasitism during summer and early autumn can influence LWG in young farmed deer while the trigger treatment and LWG data from the second experiment (2006), suggest that plantain, TLR- and TSR-mixes and chicory may have a role in aiding control of internal parasitism in young deer in autumn. The outcome of the second experiment has application to deer production systems with low anthelmintic input. Serum protein and haematological parameters investigated in both studies demonstrated the need for further research to establish diagnostic markers for both sub-clinical and clinical internal parasitism in farmed young deer.

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LIST OF ABBREVIATIONS AND CODES

$/kg	dollar per kilogram
%	percentage
<	greater than
>	less than
≤	less than or than
≥	greater than or equal to
µg	microgram
^{0}C	degrees Celsius
AGR	albumin to globulin ratio
AA	amino acids
ATP	adenosine tri- phosphate
BCS	body condition score
BZ	benzimidazoles
cm	centimetre
CO2	carbon dioxide
CP	crude protein
Cr2O3	chromium sesquioxide
CT	condensed tannins
cv.	cultivar
D	digestibility
d	day
DM	dry matter
DMI	dry matter intake
DOMD	digestible organic matter as a % of the dry matter
EAA	essential amino acids
EDTA	ethylenediamine tetraacetic acid (chelating agent)
epg	eggs per gram
et al.	and others
FEC	faecal egg count per gram of fresh faeces
FECDM	faecal egg count per gram of dry matter
Fig.	figure
FLC	faecal larval counts per gram of fresh faeces

FLCDM	faecal larval counts per gram of dry matter
FO	faecal output
FOR	fractional outflow rate
FV	feeding value
g	gram
g/d	grams/day
g/l	gram/litre
GE	gross energy
GENMOD	general mode
GI	gastro-intestinal
GLM	general linear mode
ha	hectare
HB	haemoglobin
HCT	haematocrit
hd	head (animal)
HGB	haemoglobin count
hr (s)	hour (s)
HT	hydrolysable tannins
HWSC	hot water-soluble carbohydrates
IGF-1	insulin-like growth factor-1
IVM	injectable ivermectin
Kg	kilogram
kg0.75	metabolic weight
L	litre
L1	first stage larvae
L2	second stage larvae
L3	third stage larvae (infective stage)
LOG	logarithm
lpg	larvae per gram
Ltd	limited
LWG	liveweight gain
LW	liveweight
MCHC	mean corpuscular haemoglobin count

MCV	mean corpuscular volume
ME	metabolisable energy
MEg	metabolisable energy for growth
MEI	metabolisable energy intake
MEm	metabolisable energy for maintenance
mg	milligram
Mg	milligram
Min	minute
MJ	mega joule
ML	macrocyclic lactones
MP	metabolisable protein
MPV	mean platelet volume
MRT	mean rumen retention time
n	numbers
N	nitrogen
N %	percentage of neutrophils
NAN	non-ammonia nitrogen
NDF	neutral detergent fibre
NH3	ammonia
NS	not statistically significant at $P<0.05$
NSC	non-structural carbohydrates
NUM	numbers
NV	nutritive value
NZ	New Zealand
NZ$	New Zealand dollar
OM	organic matter
OMD	organic matter digestibility
P	probability statistic
PCV	packed cell volume
Pers.comm.	personal communication
pH	measure of the acidity or alkalinity of a solution
PLT	platelet cell count
PRG	perennial ryegrass

RBC	red blood cell count
RFC:SC	ratio of readily fermentable to structural carbohydrates
SAS	statistical analysis system
SD	standard deviation
SEM	standard error mean
SL	sesquiterpene lactones
spp.	species
Sq metre	square metre
TLR	long-rotation tetraploid ryegrass
TSR	short-rotation tetraploid ryegrass
VFA	volatile fatty acids
VFI	voluntary feed intake
WBC	white blood cell count
WC	white clover
WM	wet matter