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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

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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.

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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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# TABLE OF CONTENTS

DECLARATION ......................................................................................................................... Error! Bookmark not defined.
ABSTRACT ........................................................................................................................................ ii
ACKNOWLEDGEMENTS ........................................................................................................... v
TABLE OF CONTENTS ............................................................................................................... vii
LIST OF FIGURES .................................................................................................................. xi
LIST OF TABLES ..................................................................................................................... xii
LIST OF ABBREVIATIONS AND CODES ............................................................................... xiii
CHAPTER 1: ................................................................................................................................... 1
LITERATURE REVIEW ............................................................................................................. 1

1.1. Introduction ......................................................................................................................... 1

1.2. The history of the New Zealand farmed deer industry .......................................................... 1
1.2.1. Introduction of deer to New Zealand ............................................................................. 1
1.2.2. Venison production ....................................................................................................... 3
1.2.3. Annual farming calendar ............................................................................................... 5

1.3. Seasonality of temperate deer species ............................................................................. 6
1.3.1. Seasonality in reproduction and breeding ..................................................................... 6
1.3.2. Seasonality in voluntary feed intake ............................................................................ 7
1.3.3. Seasonality of digestion ............................................................................................... 8
1.3.4. Seasonality of growth ................................................................................................... 9

1.4. Feed requirements of temperate deer species and seasonal feed supply ....................... 12
1.4.1 Nutrition of temperate deer species ............................................................................. 12
1.4.2 Feed requirements of the temperate deer ..................................................................... 12
1.4.2.1 Metabolisable energy requirements for growth and maintenance ......................... 12
1.4.2.2 Metabolisable energy requirements for pregnancy and lactation ......................... 13
1.4.2.3 Metabolisable protein requirements ...................................................................... 13
1.4.3 The seasonality of pasture production in New Zealand ............................................... 13
1.4.3.1. Ryegrasses ............................................................................................................ 14
1.4.3.2. Alternative forages ............................................................................................... 14
1.4.3.3. Sward height and herbage allowance ................................................................... 15
1.4.4 Matching grazing deer feed requirements with feed supply in New Zealand ............ 16
1.4.5. Principles of forage feeding value .............................................................................. 17
1.4.5.1. The concept of feeding value and nutritive value ................................................. 17
1.4.5.2. Forage physical and chemical composition .......................................................... 18
1.4.5.3. Digestibility of the ingested feed ................................................................. 18
1.4.5.4. Site of digestion ......................................................................................... 19
1.4.5.5. Efficiency of utilisation of digested nutrients .......................................... 20
1.4.5.6. Differences between forages in feeding value .......................................... 20
1.4.5.7. Secondary compounds ............................................................................. 21
1.4.6. Forage intake by grazing animals ................................................................. 22
1.4.7. Methods of measuring feed intake on grazing animals .................................... 24
   1.4.7.1. Indirect animal-based techniques for estimating voluntary feed intake .... 24
   1.4.7.1.1. Estimating voluntary feed intake using faecal output ......................... 25
   1.4.7.1.2. Estimating voluntary feed intake using indigestible markers .......... 25
   1.4.7.1.3. Estimating voluntary feed intake using the double η-alkane technique 25
   1.4.7.2 Sward technique ..................................................................................... 27
1.5. Internal parasitism of temperate deer species .................................................... 28
   1.5.1. Lungworms (Dictyocaulus spp.) ............................................................... 28
   1.5.1.1. Epidemiology of lungworm infections ....................................................... 28
   1.5.1.2. Clinical signs and pathogenicity of lungworm infections ....................... 29
   1.5.1.3 Diagnosis of lungworm infections .............................................................. 29
   1.5.2. Gastrointestinal parasite infections .............................................................. 30
   1.5.2.1. Epidemiology of gastrointestinal nematode infections ......................... 30
   1.5.2.2. Clinical signs and pathogenicity of gastrointestinal nematode infections 31
   1.5.2.3. Diagnosis of gastrointestinal nematode infections ................................ 32
1.5.3. Impact of internal parasites on farmed deer .................................................... 33
   1.5.4. Control of internal parasites in farmed deer ............................................... 33
   1.5.4.1. Use of anthelmintics ................................................................................ 35
   1.5.4.2. Specialized forage crops and internal parasites ..................................... 38
1.6. Conclusion and requirements for further research on internal parasitism and specialist forages ............................................................... 40
CHAPTER 2: .............................................................................................................. 41
IMPACT OF PARASITISM AND WEANING DATE ON GROWTH OF DEER CALVES, AND BODY CONDITION AND REPRODUCTIVE PERFORMANCE OF HINDS ... 41
2.1. ABSTRACT ........................................................................................................... 41
2.2. INTRODUCTION ............................................................................................... 43
2.2.1. Parasitism .................................................................................................................... 43
2.2.2. Reproduction and weaning date .................................................................................. 44
2.3. MATERIALS AND METHODS ....................................................................................... 46
  2.3.1. Experimental design .................................................................................................... 46
  2.3.2. Animals ........................................................................................................................ 46
  2.3.3. Faecal sampling and Laboratory analysis .................................................................... 47
  2.3.4. Blood sampling, serum biochemistry and haematology ........................................... 47
  2.3.5. Pasture and grazing measurements ........................................................................... 48
  2.3.5 Statistical Methods ..................................................................................................... 48
2.4. RESULTS ........................................................................................................................... 49
  2.4.1. Calf weight .................................................................................................................. 49
  2.4.2. Calf Parasitology ......................................................................................................... 51
    2.4.2.1 Faecal larval count ................................................................................................. 51
    2.4.2.2. Faecal egg count ................................................................................................... 53
  2.4.3. Hind parasitology ........................................................................................................ 56
  2.4.4. Hind reproduction ....................................................................................................... 57
  2.4.5. Body condition score ................................................................................................. 59
  2.4.5. Serum biochemistry and haematology ...................................................................... 59
    2.4.5.1. Calf serum protein concentrations ........................................................................ 59
    2.4.5.2. Adult hind serum protein concentrations ............................................................. 63
  2.4.6. Haematology ................................................................................................................ 65
    2.4.6.1. Calf haematology .................................................................................................. 65
    2.4.6.2. Adult hind haematology ....................................................................................... 66
2.5. DISCUSSION ..................................................................................................................... 67
2.9 APPENDIX ......................................................................................................................... 72
CHAPTER 3: ............................................................................................................................ 77
PRELIMINARY COMPARATIVE EVALUATION OF FORAGE SPECIES AND
COMBINATIONS ON AUTUMN GROWTH AND PARASITISM OF YOUNG FARMINDED
RED DEER ............................................................................................................................ 77
  3.1. ABSTRACT ....................................................................................................................... 77
  3.2. INTRODUCTION ............................................................................................................... 79
  3.3. MATERIALS AND METHODS ....................................................................................... 81
    3.3.1. Experimental design and animals ............................................................................ 81
3.3.2. Forages and grazing management ................................................................. 82
3.3.3. Forage sampling and measurements ............................................................. 82
3.3.4. Parasitology ................................................................................................. 83
3.3.5. Blood sampling, serum biochemistry and haematology ............................... 84
3.3.6. Forage chemical analysis .............................................................................. 84
3.3.7. Data calculation and statistical analysis ....................................................... 85
3.4. RESULTS ........................................................................................................... 86
3.4.1. Forage botanical composition and herbage mass ........................................ 86
3.4.2. Forage chemical composition ...................................................................... 88
3.4.3. Voluntary feed intake and faecal output ....................................................... 90
3.4.4. Trigger treatment with anthelmintic ............................................................. 91
3.4.5. Deer liveweight gain .................................................................................... 93
3.4.6. Faecal egg and larval counts ....................................................................... 95
3.4.7. Serum biochemistry and haematology ......................................................... 97
  3.4.7.1. Serum biochemistry ................................................................................. 97
  3.4.7.2. Haematology parameters of the stags ....................................................... 102
3.5. DISCUSSION .................................................................................................... 108
3.6. APPENDICES .................................................................................................. 114
CHAPTER 4: .............................................................................................................. 120
GENERAL DISCUSSION .......................................................................................... 120
  4.1. Introduction .................................................................................................... 120
  4.2. Indicators of internal parasitism ................................................................. 121
    4.2.1. Diagnostic markers .................................................................................. 121
    4.2.2. Effects of internal parasitism on deer growth and reproduction .......... 123
  4.3. Impact of weaning date on deer growth and reproduction .......................... 124
    4.3.1. Growth of deer calves ........................................................................... 124
    4.3.2. Hind reproduction .................................................................................. 125
  4.4. Forages for deer production ........................................................................ 126
  4.5. Conclusion .................................................................................................... 127
  4.6. Recommendations for future research ....................................................... 128
5.0: LIST OF REFERENCES .................................................................................. 130
LIST OF FIGURES

Figure 1.1: New Zealand venison export by market (Anon., 2007) ........................................3
Figure 1.2: Seasonal fluctuations in venison weekly average schedule prices .........................4
Figure 1.3: A generalised annual disease prevention, monitoring and management plan ....... 5
Figure 1.4: Mean monthly dry matter intake (DMI) of stags and hinds fed to appetite ....... 7
Figure 1.5: Mean seasonal growth rates of young red deer from birth to slaughter ........ 10
Figure 1.6: Mean monthly live weight (kg) of hinds and stags fed indoors for one year .... 11
Figure 1.7: Growth responses of weaner red deer stags to changes in pasture ............... 16
Figure 1.8: The feed demand (kg DM/day) of breeding hinds (5.5/ha) ......................... 17
Figure 1.9: Digestibility and intake of herbage organic matter, ...................................... 23
Figure 2.1: Mean (± SEM) body live weight (LW; kg) of calves weaned ...................... 49
Figure 2.2: Mean (±SEM) faecal larval count (FLC; lpg) of deer calves .................... 53
Figure 2.3: The daily cumulative conception rate (%) of hinds weaned in February ...... 57
Figure 2.4: Box plot representation of conception date of February and March-hinds ... 58
Figure 2.5: Mean (±SEM) serum total protein (g/l) of young deer calves ................. 60
Figure 2.6: Mean (±SEM) serum albumin concentrations (g/l) of young deer calves .... 61
Figure 2.7: Mean (±SEM) serum globulin concentrations (g/l) of young deer calves .... 62
Figure 3.1: The accumulative percentage at each sampling date of young deer ........... 92
Figure 3.2: Mean (±SEM) liveweight (kg) of young deer trigger treated ................... 94
Figure 3.3: Mean (g/l±SEM) serum total protein concentration by sampling dates ...... 98
Figure 3.4: Mean (g/l±SEM) serum albumin (alb) and globulin (glo) concentrations ... 100
Figure 3.5: Mean (g/l±SEM) serum albumin to globulin ratio (AGR) ...................... 101
Figure 3.6: Mean (cells/L±SEM) red blood cell (RBC) counts of stags ..................... 103
Figure 3.7: Mean (cells/L±SEM) white blood cell (WBC) counts of stags ................. 104
Figure 3.8: Mean (% cells/l±SEM) neutrophils stags grazing .................................. 106
Figure 3.9: Mean (% cells/L±SEM) eosinophils of stags grazing ............................. 107
LIST OF TABLES

Table 1.1: Volume of the deer industry exports for the last five years ........................................2
Table 1.2: Value (NZ$) of the deer industry exports for the last five years .................................2
Table 1.3: Concentration of secondary compounds in temperate forage species .........................22
Table 1.4: Anthelmintic formulations with a label claim for use against nematode ..................35
Table 1.5: Summary data from Massey University trials with weaner deer ..........................39
Table 2.1: Mean (±SEM) liveweight gain (LWG; g/day) of male and female calves .................50
Table 2.2: Mean (±SEM) liveweight gain (LWG; g/day) of male and female calves ............51
Table 2.3: Mean (±SEM) faecal larval count (FLC; lpg) of deer calves ..............................52
Table 2.4: Mean, range and proportion positive (%+ve) of faecal lungworm larval ..........54
Table 2.5: Mean, range and proportion positive (%+ve) of faecal egg counts .....................55
Table 2.6: The mean, range and proportion positive for faecal larval count .................56
Table 2.7: The five-number summary of conception dates for hinds weaned ......................58
Table 2.8: Pregnancy and non-pregnancy rate of mixed-age deer hinds .........................59
Table 2.9: The mean (±SEM) and range of the serum total protein, albumin, globulin ...64
Table 2.10: The mean (g/litre) of serum total protein, albumin, globulin ......................72
Table 2.11: The mean (range) (g/litre) of serum total protein, albumin, globulin ..........73
Table 2.12: The mean and range of blood haematology concentration .........................74
Table 2.13: The mean and range of blood haematology concentration .........................75
Table 2.14: The mean and range of blood haematology concentrations of the red ........76
Table 3.1: Pre- and post-grazing mean herbage mass (kgDM/ha ± SEM) .........................87
Table 3.2: Mean chemical composition (feed on offer; g/kg DM±SEM) .........................89
Table 3.3: Mean in-vitro organic matter digestibility (OMD,%DM±SEM) .....................90
Table 3.4: Mean (±SEM) and range of faecal larval counts (FLC, epg) .........................96
Table 3.5: Mean (±SEM) and range of faecal larval counts (FLCDM, lpg) ...............96
Table 3.6: Pre-grazing mean herbage mass (kg DM/ha±SEM) .....................114
Table 3.7: Post-grazing mean herbage mass (kg DM/ha±SEM) ..........................115
Table 3.8: Mean chemical composition (g/kgDM) of ........................................116
Table 3.9: Mean and range (g/l) of serum total protein, albumin, globulin ..............118
Table 3.10: Mean of hematological parameters of the male deer grazing ..............119
LIST OF ABBREVIATIONS AND CODES

$/kg dollar per kilogram
%
< greater than
>
≤ less than or than
≥ greater than or equal to
μg microgram
°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
lpq larvae per gram
Ltd limited
LWG liveweight gain
LW liveweight
MCHC mean corpuscular haemoglobin count
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>RBC</td>
<td>red blood cell count</td>
</tr>
<tr>
<td>RFC:SC</td>
<td>ratio of readily fermentable to structural carbohydrates</td>
</tr>
<tr>
<td>SAS</td>
<td>statistical analysis system</td>
</tr>
<tr>
<td>SD</td>
<td>standard deviation</td>
</tr>
<tr>
<td>SEM</td>
<td>standard error mean</td>
</tr>
<tr>
<td>SL</td>
<td>sesquiterpene lactones</td>
</tr>
<tr>
<td>spp.</td>
<td>species</td>
</tr>
<tr>
<td>Sq metre</td>
<td>square metre</td>
</tr>
<tr>
<td>TLR</td>
<td>long-rotation tetraploid ryegrass</td>
</tr>
<tr>
<td>TSR</td>
<td>short-rotation tetraploid ryegrass</td>
</tr>
<tr>
<td>VFA</td>
<td>volatile fatty acids</td>
</tr>
<tr>
<td>VFI</td>
<td>voluntary feed intake</td>
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<tr>
<td>WBC</td>
<td>white blood cell count</td>
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<tr>
<td>WC</td>
<td>white clover</td>
</tr>
<tr>
<td>WM</td>
<td>wet matter</td>
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