ENDOPHYTIC PERENNIAL RYEGRASS AND REPRODUCTIVE PERFORMANCE OF THE EWE

A thesis presented in partial fulfilment
of the requirements for the degree of
Doctor of Philosophy
in Animal Science
at Massey University

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2000

ABSTRACT

Watson, R.H. 2000. *Endophytic perennial ryegrass and reproductive performance of the ewe.* PhD thesis, Massey University, Palmerston North, New Zealand, 224pp.

A series of grazing and indoor trials were conducted to investigate the effects of perennial ryegrass infected with *Neotyphodium lolii* and its toxins on the reproductive performance of the ewe. Comparisons made were in ovulation rate, conception rate, lambs carried at scanning and lambs born per ewe, milk production and lamb growth rate between groups of ewes grazing either endophyte-infected (E+) or endophyte-free (E-) perennial ryegrass. Differences in ewe liveweight and its relationship with feed intake were also determined. More intensive trials were conducted to examine the effects of endophyte toxins on the endocrine systems that regulate the oestrous cycle and lactation.

In a 4-year grazing trial in the Manawatu there were no significant differences in ovulation rate, conception rate, scanning % or lambing % between the E+ and E- groups in any year of the trial. Mean mating date was 1.8 days later ($P<0.05$) in the E+ group than in the E- group. There was a greater ($P<0.05$) proportion of non-pregnant (dry) ewes in the E+ group compared with the E- group (14% vs 6% respectively) over the entire trial period (1996-1999), but no significant difference in any of the other parameters.

Ewes in the E+ group had lower liveweights ($P<0.001$) than ewes in the E- group throughout the duration of the trial. Ewe liveweight was a significant ($P<0.05$) source of variation in ovulation rate in the E+ group in 1998. The growth rate of single and twin lambs between birth and nine weeks of age was lower ($P<0.01$) in the E+ group than the E- group in 1998 only.

Cumulative milksolid yields were lower ($P<0.05$) in the E+ single- and twin-rearing ewes compared to the E- single and twin-rearing ewes in 1997.

E+ ewes had more faecal soiling (dags) ($P<0.05$), lower serum prolactin at mating ($P<0.05$), had higher rectal temperatures during summer ($P<0.05$) than E- ewes, and left greater postgrazing dry matter residues in autumn ($P<0.05$).

In two grazing trials in Northland (1998 and 1999), there were no significant differences in ovulation rate, conception rate or the number of lambs carried per ewe at scanning between ewes grazing E+ ryegrass and ewes grazing E- ryegrass. Serum prolactin was significantly ($P<0.05$) lower in E+ ewes than in E- ewes in 1999 but was not different between the two groups in 1998.

E+ ewes lost significantly ($P<0.05$) less weight than the E- ewes prior to mating in the1998 trial, which was due to the poor establishment of the new E- pasture and hence low dry matter production. However, E+ ewes lost significantly ($P<0.05$) more weight than E- ewes prior to, and during mating, in the 1999 trial.
Reproductive results obtained in these trials were confounded by inadequate control over experimental conditions.

In a further trial in Northland, twin-bearing/rearing ewes grazing E+ ryegrass pasture were lighter than E- ewes prior to, and during lactation. Lambs reared by the E+ ewes had ($P<0.05$) lower liveweight gains between docking and weaning, and lower weaning weights than lambs reared by the E- ewes.

A trial was conducted where daily blood samples were collected for approximately one oestrous cycle (21 days) from synchronised ewes (n=20) grazing either E+ or E- ryegrass to measure levels of serum prolactin (PRL), luteinizing hormone (LH) and progesterone.
Serum PRL levels were ($P<0.01$) lower in the E+ ewes than in the E- ewes during the oestrous cycle, and the pre-ovulatory PRL surge was completely abolished in the E+ ewes. Serum LH levels were not different between the E+ and E- ewes, however, this may have been due to the sampling regime not being able to eliminate the effects of diurnal variation in LH secretion. The profile of serum progesterone secretion was significantly ($P<0.05$) different between the E+ and E- ewes.

Two trials were conducted to examine the effects of the endophyte toxin, ergovaline, and ambient temperature on the major hormones regulating parturition and mammogenesis in pregnant ewes. Serum PRL levels were ($P<0.0001$) lower in ewes fed diets containing ergovaline (Ev+) than in ewes fed ergovaline-free (Ev-) diets at high (30°C) ambient temperature. Serum progesterone levels were ($P<0.001$) lower in Ev+ than in Ev- ewes at both high and low (18°C) ambient temperature. There were no differences in serum cortisol levels between any group of ewes. Serum insulin levels were ($P<0.01$) lower in the Ev+ ewes than in the Ev- ewes in the low ambient temperature treatment but were not different between the groups of ewes at high ambient temperature. High ambient temperature ($P<0.1$) reduced serum insulin levels in the Ev- group.

High ambient temperature significantly ($P<0.001$) increased PRL and depressed progesterone levels in both Ev+ and Ev- ewes, and significantly ($P<0.1$) depressed insulin in the Ev- group only. There was a significant ($P<0.001$) Ev X temperature interaction for PRL and progesterone.

Mammogenesis and lactogenesis were completely abolished in the Ev+ ewes at high ambient temperature but there appeared to be no difference between the Ev+ or Ev- ewes at low ambient temperature. Ev+ ewes at both high and low ambient temperature exhibited abnormally hostile behaviour towards their offspring that was not observed in the Ev- groups.

Rectal temperatures were higher (significant, $P<0.001$) in the Ev+ ewes than in the Ev- ewes in Trial 1and in the high temperature treatment in Trial 2.

A grazing trial in which slow release chromium oxide tracer was administered to ewes and lambs grazing either E+ or E- ryegrass pasture showed that feed intakes were significantly lower in the ewes and lambs grazing E+ ryegrass compared with ewes and lambs grazing E- ryegrass. Differences in feed intake between the E+ and E- groups were related to liveweight and liveweight change.

There were also differences in grazing behaviour between the E+ and E- groups. Ryegrass components of the pasture, and especially the leaf-sheath, were less acceptable to ewes and lambs grazing E+ than E- pastures.

It is concluded that the toxins produced by the endophyte, *N. lolii*, commonly found in perennial ryegrass, have the potential to reduce fertility, milk production, lamb growth rate and the liveweight of ewes. The range of toxin levels normally associated with E+ ryegrass pastures appears to be too low to cause large negative effects on reproductive performance. However, some small effects were observed such as a delay in mating, a reduction in milk production, and a higher incidence of dry ewes in ewes grazing E+ ryegrass pasture.

Ewes and lambs grazing E+ ryegrass pasture have lower liveweight gains, which is associated with lower voluntary feed intakes. Chronically lower liveweight in ewes associated with grazing E+ ryegrass is likely to reduce life-time performance of the ewes.

ACKNOWLEDGMENTS

First and foremost I would like to thank my supervisors, Associate Professor Maurice McDonald (Massey University) and Mr Reg Keogh (AgResearch Grasslands) who have shown immeasurable patience and guidance during the last six years. I believe that I will be a better scientist for having been associated with you both.

I would also like to thank Professor Hugh Blair (Massey University) for agreeing to step-in as my chief supervisor with the retirement of Maurie. I am grateful for all your efforts.

A huge thanks must go to Syd Easton (AgResearch Grasslands) for his supervision and guidance, and to all the members of the endophyte programme at AgResearch who have enriched my learning experience immensely.

I am extremely grateful to Michelle Kirk, Margaret Mason, and Paul and Cheryl Doyle, who have, without complaint, provided technical assistance with all the experimental trials, and shown patience beyond the call of duty with tempestuous sheep and demanding PhD students.

Thanks go to Derek Sagar and Angus Petersen (AgResearch Aorangi) for accommodating the trials at Aorangi and some of the associated impracticalities of conducting research on a farm.

My sincere gratitude to Kevin and Gill Adshead for allowing trials to be conducted on their property and for showing me very generous hospitality. I would also like to thank Stephen Dill for his enthusiasm and help in animal handling, and David Baigent (Wellsford Vet Club) for performing laparoscopic examination of the Northland ewes.

My thanks to Phil Pearce (Massey University) and Jane Candy (Massey University) for their expertise in the many hormone assays performed. I would also like to thank Barry Parlane (APU, Massey University) for setting up the indoor trials.

Special thanks to Brian Tapper, Geoff Lane and Liz Davies (all AgResearch Grasslands) for alkaloid analyses of the herbage samples, and Willhelmina Martin for chromium analysis of faeces.

Finally, and most importantly, I would like to give my eternal gratitude to my mother, Lorna, my father, Brian, the rest of my family, my partner Belinda, and all my friends for all the loyal support and advice, without which I would have surely failed. This work is dedicated to you all.

TABLE OF CONTENTS

LIST OF TABLES

TABLE **PAGE**

TABLE **PAGE**

LIST OF FIGURES

FIGURE **PAGE**

LIST OF PLATES

LIST OF ABBREVIATIONS AND DEFINITIONS

$\alpha_{(1.2)}$	adrenoreceptor
ADF	acid detergent fibre
ADG	average daily gain
ANOVA	analysis of variance
AOR	Aorangi lowland research station
BSA	bovine serum albumin
CB154	2-Br-α-ergocriptine (bromocriptine)
CHO	soluble carbohydrate
CIDR	controlled internal drug release (device)
CNS	central nervous system
CV	co-efficient of variation
cv	cultivar
^{o}C	degrees Celsius
$D_{(1,2)}$	dopamine receptor
d	day(s)
DAR	donkey anti-rabbit antibody
DASP	double antibody/solid phase
DM	dry matter
2-4,5D	2,4-trichlorophenoxyacetic acid (herbicide)
E+	endophyte-infected
E-	endophyte-free
EA	ergopeptine alkaloids
Ev	ergovaline
g	grams; force due to gravity
GABA	gamma amino butyric acid
GGT	gamma glutamyl transpeptidase
GI	gastrointestinal
GLM	generalised linear model
GnRH	gonadotropin releasing hormone
h	head (1 animal)
ha	hectare
HPLC	high performance liquid chromatography
5-HT	5-hydroxytryptophan (serotonin)
iu	international units
K	potassium
kg	kilograms
l	litre(s)
LAA	lysergic acid amide
LH	luteinizing hormone
LOL	lolitrems
LSD	lysergic acid diethylamide
LW	liveweight
LWΔ	liveweight change
M	molar
m	metre(s)
MCPA	4-chloro-2-methylphenoxy acetic acid (herbicide)
MCPB	4-(4-chloro-2-methylphenoxy)butanoic acid) (herbicide)
ME	metabolisable energy

mg	milligram(s)
μg	microgram(s)
min	minute(s)
MJ	megajoule(s)
ml	millilitre(s)
μl	microlitre(s)
mM	millimole(s)
mm	millimetre(s)
μm	micrometre(s)
N	nitrogen
n	number
NDF	neutral detergent fibre
NIADKK	National Institute of Diabetes and Digestive and Kidney Diseases
nm	nanometre(s)
NRS	normal rabbit serum
NSB	non-specific binding
oLH	ovine luteinizing hormone
OMD	organic matter digestibility
oPRL	ovine prolactin
P	phosphorus
P(<)	probability
pg	picograms
PMSG	pregnant mare serum gonadotropin
ppb	parts per billion
ppm	parts per million
RGLB	ryegrass leaf blade
RGLS	ryegrass leaf sheath
RGS	ryegrass staggers
RIA	radio-immunoassay
rpm	revolutions per minute
SEM	standard error of the mean
v/v	volume per volume
WT	weight
↑	increase
↓	decrease

'wild-type'	naturally occurring endophyte in perennial ryegrass.
Fertility	used to collectively describe ovulation rate, conception rate, spermatogenesis in the ram, and mating behaviour.
Reproductive performance	encompasses all aspects of ewe reproduction including milk production, and growth rate and health of offspring.
Reproductive rate	number of offspring born per female.