Ovulation rates in ewes selected for resistance to facial eczema and the effect of exposure to zearalenone

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ABSTRACT

In 1986 the ovulation rates of 21 Romney ewes selected for facial eczema (FE) resistance (R) and 27 selected for FE susceptibility (S) were recorded on day 5 of the cycle following synchronisation of oestrus with controlled internal drug releasers (CIDR) at the end of April. The ewes were then all dosed daily with 10ml of slurry of a culture of *Fusarium* containing 6mg zearalenone for 10 d. The ewes were re-examined for post-treatment ovulation rate.

The resistant ewes had a higher ovulation rate pre-treatment than did the susceptible ewes (R=1.90 and S=1.50). Both groups showed a decline in ovulation rate after zearalenone treatment (R=1.35 and S=1.22).

In 1987 Romney ewes from 4 FE resistance selection flocks (Model resistant (MR) n=148; Model control (MC), n=105; Resistant (R), n=110 and Susceptible (S), n=73) were examined by laparoscopy at the beginning of April. The ovulation rates were higher in the resistant flocks (MR = 1.73; MC = 1.55; R = 1.55; R = 1.42 and S = 1.29).

These data indicate that the higher reproductive performance of FE resistant ewes could in part be due to their higher ovulation rates but that resistance to FE confers no protection against the effects of zearalenone.

Keywords Facial eczema, ovulation rate, resistance, zearalenone, Romney.

INTRODUCTION

The recent findings that the mycotoxin zearalenone in pasture can detrimentally influence ewe reproductive performance (Smith *et al.*, 1986; Smith *et al.*, 1987; Jagusch *et al.*, 1986; Towers *et al.*, 1987; de Menna *et al.*, 1987) and the association of increased numbers of *Fusarium* spores at the same time of year as increased numbers of *Pithomyces chartarum* spores are seen (M.E. di Menna, pers. comm.) has somewhat confounded previously recorded effects of facial eczema (FE) (Clare *et al.*, 1969) on ewe reproduction (Smeaton *et al.*, 1985).

Ewes resistant to FE had a higher lambing performance than susceptible ewes (A.G. Campbell and C. Wesselink, unpublished). Thus a trial was set up to examine the possibility that this may be due to a difference in sensitivity to zearalenone.

Following the results of that first trial a larger number of ewes from additional flocks were examined for ovulation rate in a second trial.

MATERIALS AND METHODS

Trial 1

In April 1985 groups of ewes from the Ruakura FE resistant flock (R, n=21) and the Ruakura FE susceptible flock (S, n=27) were synchronised with controlled internal drug releasers (CIDR) (Alex Harvey Industries Ltd., Hamilton). At CIDR removal ewes were joined with vasectomised rams and 6d later were laparoscoped to determine ovulation rate. All ewes were then dosed daily with 10 ml of a slurry of a rice grain culture of *Fusarium crookwellense* isolate (9FA14) containing 6.0 mg zearalenone for 10 d (Smith *et al.*, 1986). Ewes were joined with entire Suffolk rams and 7d later ewes were again laparoscoped to determine ovulation rate. Records were collected at lambing of number of lambs born per ewe lambing (LB/EL) and the lambing date.

Trial 2

In March 1987 ewes from the same 2 flocks and from 2 additional flocks, Ruakura model resistant (MR) and the Ruakura model control (MC) flocks were laparoscoped to determine their ovulation rate at the end of the first cycle of entire mating. Lambing records were collected.

Origins of Flocks

(a) Ruakura resistant (R) and susceptible (S) flocks. These 2 flocks were established in 1974 (Campbell *et al.*, 1975) and used rams which were shown by

progeny test to be the most and least resistant available. Since 1982 the rams used have been selected by performance test based on plasma gamma-glutamyl transferase (GGT) levels following sporidesmin dosing. Ram and ewe sources were not balanced for these 2 flocks and foundation flock effects cannot be excluded.

(b) Ruakura model resistant (MR) and Model control (MC) flocks.

These 2 flocks were established in 1982 from a common base of Romney ewes purchased from industry resources and Romney ram hoggets from Rotomahana to measure the rate at which selection could increase resistance to FE. In the resistant flock, selection was applied to males by performance test each year. No selection for any trait, including FE resistance, was exerted on the random-bred control flock.

Pasture Management and Fungal Control.

(a) Trial 1

All ewes were grazed together for 3 months prior to treatment on ryegrass (*Lolium spp.*) - white clover (*Trifolium repens*) pastures that had been regularly sprayed with benlate to inhibit both *Pithomyces* and *Fusarium*. Ewes were given an allowance of approximately 2.0 kg green dry matter/d.

(b) Trial 2.

During 1987 all ewes were rotationally grazed as 1 mob on unsprayed ryegrass-white clover pastures at no set allowance. During mating ewes were set stocked in single sire mating groups.

Data Analysis

For Trial 1 the distribution of ovulations was analysed by χ^2 test.

For Trial 2 a GENSTAT analysis was performed using a logit transformation of percentage of ewes having multiple ovulations (EMO). Factors such as flock, ewe age, and ewe live weight were examined. Lambing date was analysed by χ^2 test.

RESULTS

Trial 1

Table 1 presents the data on ovulation rates pre- and post-zearalenone treatment for both flocks.

There was a significant difference between flocks ($P<0.05$, $\chi^2 = 4.60$) with the R flock having a higher ovulation rate than the S flock (R = 1.63±0.09 and S = 1.36±0.07). Zearalenone treatment resulted in a marked drop in ovulation rate ($P<0.01$, $\chi^2 = 9.73$; pre = 1.68±0.09 and post = 1.28±0.07).

TABLE 1 Effect of facial eczema resistance and zearalenone treatment on ovulation rate (±SE).

Flock[1]	Zearalenone treatment Pre -	Post-	Overall
R	1.90±0.13	1.35±0.11	1.63±0.09
S	1.50±0.11	1.22±0.08	1.36±0.07
Overall	1.68±0.09	1.28±0.07	

[1] R Resistant; S Susceptible.

The difference in ovulation rate between the R and S flocks was greater prior to treatment than after, and the R ewes showed a greater relative decline following exposure to zearalenone. The absolute changes in ovulation rate from pre- to post-treatment did not differ significantly between the flocks.

Thirteeen (62%) of the R ewes lambed to the synchronised mating, producing 16 lambs (1.23 LB/EL, while 16 (59%) of the S ewes lambed to the synchronised mating producing 19 lambs (1.19 LB/EL).

Trial 2

Table 2 presents the raw data means for ovulation rate and live weight for each of the 4 flocks. Two separate analyses were performed in which the R and S flocks were compared in 1 and the MR and MC flocks in the other.

TABLE 2 Effect of resistance to facial eczema (FE) on ovulation rate and ewe live weight. (Uncorrected mean values ±SE)

Flock[1]	Number of ewes	Ovulation rate	Live weight (kg)
R	110	1.42±0.05	44.0±0.6
S	73	1.29±0.05	46.2±0.7
MR	148	1.73±0.05	49.5±0.5
MC	105	1.55±0.05	48.2±0.8

[1] R Resistant; S Susceptible; MR Model resistant; MC Model control.

(a) Comparison of R and S

The R flock had a significantly higher ($P<0.05$) EMO than did the S flock. There were also significant effects of ewe age ($P<0.05$) and ewe live weight ($P<0.001$) on EMO. There was an ($P<0.001$) increase in logit EMO (%) = 0.228±0.033 for each kg effect of live weight. Thus the EMO increased by a maximum of 3.0% per kg increase in live weight with maximum response in the vicinity of 50% EMO.

The S flock was on average 1.2 kg heavier, after adjustment for age distribution, than the R flock and

live weight increased with ewe age. However, there were no significant interactions between age, live weight and flock effects on EMO%.

Table 3 presents mean logit values and the retransformed EMO% values for the R and S flocks adjusted to a constant live weight of 50 kg.

Table 4 presents the logit values and retransformed EMO (%) for each age group at either a weight adjusted to 50 kg or at a weight adjusted to the age group mean.

TABLE 3 Difference between resistant and susceptible flocks in proportion ewes multiple ovulating (EMO) (logit values and retransformed EMO (%) adjusted to live weight of 50 kg).

Parameter	R	S	MR	MC
Logit	0.223	-0.618	0.683	0.151
SED	0.359		0.278	
EMO(%)	56	35	66	54

[1] R Resistant; S Susceptible; MR Model resistant; MC Model control.

TABLE 4 Effect of ewe age on proportion of ewes multipe ovulating (EMO) in the different flocks. (Mean logit values and retransformed EMO(%) values adjusted to the mean age group weight.

Flock[1]	Parameter	Age (years) 2	3	4+
R and S	Logit	-0.731	-1.352	0.363
	EMO(%)	33	21	59
MR and MC	Logit	0.119	0.315	0.834
	EMO(%)	53	59	70

[1] R Resistant; S Susceptible; MR Model resistant; MC Model control.

TABLE 5 Lambing performance to first cycle of mating in Trial 2.

Parameter	Flock[1] R	S	MR	MC
Number of ewes	110	73	148	105
Pregnant 1st cycle(%)	52.7	67.5	63.5	65.7
LB/EL	1.12	1.19	1.45	1.42
Embryonic loss[2]	17.7	10.1	20.5	9.3

[1] R Resistant; S Susceptible; MR Model resistant; MC Model Control.

[2] Number of ovulations — number of lambs of those ewes that lambed to the first cycle, expressed as a percentage of the number of ovulations.

(b)Comparison of MR and MC ewe flocks.
There were significant effects of flock ($P<0.05$) and live weight ($P<0.001$) but not of ewe age, after adjustment for live weight.

The MR ewes were on average 3.1 kg heavier, after adjustment for age distribution, than the MC ewes. The values for EMO (%) and logits adjusted to a constant 50 kg live weight are shown in Table 3. the older ewes were heavier and Table 4 presents the data for the different age groups. The live weight effect showed an increase in the EMO of 2.5% (logit = +0.0987) for each kg increase in live weight.

Table 5 presents the lambing performance to the first cycle of mating for the flocks in Trial 2. Fewer ewes in the R flock conceived to the first cycle of mating than did ewes in the S flock ($P<0.05$; $\chi^2 = 4.1$; R = 52.7 *v* S = 67.5). There were no differences in lambs born per ewe lambing between the R and S nor the MR and MC flocks. Examination of embryonic loss (difference between number of ovulations and number of lambs of those ewes that lambed to the first cycle, expressed as a percentage of the number of ovulations) showed this to be higher in the resistant flocks (R = 17.7% *v* S = 10.1%; MR = 20.5% *v* MC = 9.3%). This was only statistically significant in the case of the model flocks ($P<0.02$; $\chi^2 = 6.15$). Thus in this trial the increased ovulation rates were not reflected in increased lambing performance.

DISCUSSION

Resistance to facial eczema did not provide ewes with any protection against the oestrogenic effects of zearalenone. Both the R and S flocks showed a substantial decline in ovulation rate after dosing with zearalenone at 6.0 mg/ewe/d for 10 d. This decline in ovulation rate was similar to that reported for Coopworth ewes given the same dosage (Smith *et al.*, 1987).

The independence of sensitivity to sporidesmin and zearalenone agrees with the additive effects on ewe reproduction of exposure to both toxins reported by Jagusch *et al.* (1986). However as zearalenone acts as an oestrogen (Smith *et al.*, 1987) it is most probable that the 2 toxins have a synergistic effect; the liver damage produced by sporidesmin reducing the rate of metabolism and thus exacerbating the effect of zearalenone.

In selecting solely for a single trait such as FE resistance there is the possiblity of an adverse or negatively correlated response in some other important trait. The finding in Trial 1 that the initial ovulation rate of the resistant ewes was significantly higher than the susceptible ewes is most important in showing that this is not so for this trait. This was confirmed in both comparisons in Trial 2 and found to be independent of live weight effects. The higher

ovulation rate, in Trial 2, of ewes in the flocks selected for FE resistance could have been due to those ewes suffering less liver damage even though there were no clincial signs of FE present. However, this is unlikely to explain the results seen in Trial 1 where ewes were maintained on *Pithomyces* free pasture. Rather the data indicates that associated with the selection for FE resistance there has been a marked increase in the ovulation rate. This is all the more salient because all the selection has been on the male side.

The possibility that some linkage may exist between genes controlling ovulation rate and those influencing facial eczema resistance should be checked and animals selected for fecundity tested for their resistance to FE.

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