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## Effects of ergovaline in endophyte-infected tall fescue on ewe fertility

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### ABSTRACT

Ergovaline is one of the major toxins produced in tall fescue and perennial ryegrass pastures infected with wild-type endophyte fungi. Animals grazing these pastures often have reduced productivity and in some cases lower reproductive performance. To date very little is known about the effects of ergovaline on sheep and in particular sheep fertility.

A trial was conducted consisting of two groups (n = 20) of synchronised, Finnish landrace x Romney 2-tooth ewes. The groups were grazed on either of two lines of endophyte-infected tall fescue, one producing ergovaline (EV+) and the other ergovaline free (EV-) for two weeks and then mated on the treatments.

Ovulation rate, conception rate, and numbers of lambs carried were recorded. Levels of serum prolactin and ergovaline in the pasture were determined.

Ergovaline levels in the herbage were  $3.30 \pm 0.60$  mg/g and 0mg/g in the EV+ and EV- pastures, respectively. Ewes grazing the EV+ treatment had significantly lower (P<0.05) ovulation rates and number of lambs carried to 90 days of pregnancy than the EV- group. Serum prolactin was significantly (P<0.001) reduced in the EV+ group.

These results indicate that similar effects could be exhibited in ewes grazing endophyte-infected perennial ryegrass pastures containing ergovaline and further trials are being undertaken to examine this possibility.

**Keywords:** ewe; fertility; ergovaline; endophyte; tall fescue.

### INTRODUCTION

Grazing tall fescue (*Festuca arundinacea*) infected with wild-type endophyte fungus (*Neotyphodium coenophialum*) has caused reductions in weight gain, milk yield, and fertility in horses (Putnam *et al.*, 1991), cattle (Paterson *et al.*, 1995) and sheep (Bond *et al.*, 1988). Mechanisms by which endophyte-infected (EI) tall fescue reduce animal performance are not clearly understood but seem to involve alkaloid compounds. The endophyte fungi in tall fescue produce toxic ergopeptine alkaloids, with ergovaline the major one (Rottinghaus *et al.*, 1991). It is believed that these compounds may be the major toxic agents involved in reproductive dysfunction in animals grazing EI tall fescue. The ergopeptine alkaloids are dopamine agonists and animals grazing EI pasture often have reduced serum prolactin levels. Prolactin is important in the control of reproduction and lactation and the effects on levels of this hormone due to endophyte toxins may be important in determining causes of reduced fertility in grazing animals. All tall fescue seed sold in New Zealand is endophyte-free, however, most of New Zealand's perennial ryegrass (*Lolium perenne*) pastures are infected with an endophyte fungus (*Neotyphodium lolii*) which is capable of producing ergovaline (Rowan *et al.*, 1990). The fertility of sheep flocks in New Zealand is well below their potential (Knight, 1990). The presence of these toxic compounds in New Zealand pastures and the possible effects on fertility could explain the reduced reproductive performance in some ewe flocks. This study was conducted to evaluate the effects of ergovaline in EI tall fescue on ewe fertility at mating.

### MATERIALS AND METHODS

#### Animals and treatments

Forty Finnish landrace X Romney 2-tooth ewes were treated with a synchronisation device (CIDR-G $\hat{O}$ ) inserted into the vagina, and randomly allocated to two even treatment groups. Ewes in group 1 grazed a tall fescue (*Festuca arundinacea*) line infected with wild-type (high ergovaline, EV+) endophyte fungus (*Neotyphodium coenophialum*) and group 2 grazed a tall fescue line infected with an endophyte which produced no ergovaline (EV-).

The groups were maintained on their respective treatments for two weeks beginning on 1<sup>st</sup> March 1995 after which CIDRs were removed and rams (1 per group) with harness and crayon were introduced. The ewes remained on the treatments with a ram for a further three weeks after which the crayon colour was changed and both groups were removed from the treatments and grazed together on ryegrass-dominant pasture.

#### Measurements

All ewes were checked for mating marks and ovulation rates were determined by laparoscopic examination of the ovaries seven days after mating. Ewes which returned to oestrus were recorded and all ewes, including those which returned, were ultra-sound scanned at ninety days after the start of mating to determine the number of lambs carried. Blood samples were taken by jugular venipuncture pre-treatment and at mating for serum prolactin determination and herbage samples were taken during the treatment period for ergovaline analysis. All ewes were weighed pre-treatment, at mating, and at the conclusion of the trial.

### Analysis of data

Differences in liveweight were analysed by t-test. Ovulation rate, number of lambs carried at scanning and number of returns to oestrus were analysed by Mann-Whitney test.

## RESULTS

### Herbage ergovaline levels

The levels of ergovaline in the pastures during the trial period were  $3.3 \pm 0.60$  mg/g (SEM) and 0 mg/g for the Ev+ and Ev- tall fescue lines, respectively.

### Animal performance

The liveweight changes, ovulation rates, number of animals that returned to oestrus, and the number of lambs carried per ewe are given in Table 1. There was significantly ( $P < 0.05$ ) more weight lost in the Ev- group. The ovulation rate of ewes in the Ev- group was higher than that in the Ev+ group ( $P < 0.06$ ). The number of lambs carried/ewe at scanning was significantly higher ( $P < 0.05$ ) in the Ev- group. There was no significant difference in the number of returns to oestrus.

**TABLE 1:** Ewe liveweight change, ovulation rate, number of returns to service and number of lambs/ewe carried at pregnancy scanning (Mean  $\pm$  SEM) in the Ev+ and Ev- groups.

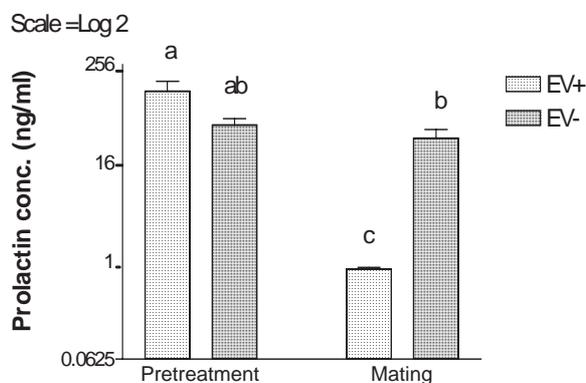
	Ev+	Ev-
Weight change (kg)*	$-0.40 \pm 0.41$	$-1.95 \pm 0.48$
Ovulation rate*	$1.71 \pm 0.10$	$2.16 \pm 0.12$
Number of returns to oestrus/group	8	5
Lambs/ewe at scan*	$1.25 \pm 0.18$	$1.90 \pm 0.12$

\* Means were significantly different ( $P < 0.06$ )

### Serum prolactin

There were no significant differences in the levels of serum prolactin in the ewes between treatment groups before introduction to the grazing treatments. At mating (after 14 days grazing) serum prolactin levels were severely depressed ( $P < 0.01$ ) in ewes grazing the Ev+ tall fescue, whereas there was no change in ewes grazing Ev- tall fescue (Fig. 1).

**FIGURE 1:** Levels of serum prolactin (Mean  $\pm$  SEM) in ewes grazing tall fescue either with or without ergovaline.



Bars with different letters differ significantly ( $P < 0.05$ )

## DISCUSSION

There were differences in pasture availability to the ewes between the two treatments that may have caused the liveweight differences. Both groups lost weight over the trial period before mating with the ewes on the ergovaline-free treatment losing significantly more weight. This is in conflict with previous investigations into the effects on animal performance which have shown that ergovaline depressed weight gains in animals (Debessai *et al.*, 1993). The loss of weight prior to mating may have affected the subsequent ovulation rates and, therefore, the difference in ovulation rates between the two groups may have been greater had the liveweight changes been the same.

It is possible that ergovaline affects some of the hormones which control ovulation. Ergovaline has been found to have serotonergic properties (Dyer *et al.*, 1993). Serotonin has a role in luteinizing hormone (LH) release in the ewe (Deaver and Daily, 1983). Mizinga *et al.*, (1992) found that there was no reduction in serum LH in cyclic cows. However, Browning *et al.*, (1997) was able to reduce serum LH in steers by administering ergotamine or ergonovine which are related ergopeptine alkaloids. The reduction in hormones controlling ovulation may be one mechanism by which ergopeptine alkaloids affect fertility, however, little is known about the effects of ergovaline on the secretion of these hormones.

It has been established that ergovaline depresses serum prolactin in sheep (Debessai *et al.*, 1993). Results in this trial support this with a large reduction in prolactin recorded in ewes grazing the ergovaline treatment. The effects of this depression of prolactin on ewe fertility are unclear. Prolactin has a vital reproductive role in rats by regulating corpus luteum function and gonadotrophin secretion (Smith, 1980). Chandrashekar *et al.*, (1987) demonstrated that subnormal concentrations of prolactin reduce the sensitivity of the hypothalamic-pituitary system to feedback inhibition by testosterone in male rats. It is possible that prolactin may have similar roles in the ewe and therefore a severe depression in serum prolactin could disrupt the reproductive system and reduce fertility.

Although there were more returns to oestrus in the Ev+ group this was not significant. However the significantly lower number of lambs carried per ewe at scanning in the Ev+ group indicates that there is reduced conception and/or increased embryonic mortality. The ergopeptine alkaloids cause vasoconstriction (Rhodes *et al.*, 1989). This raises body temperature under conditions of high ambient temperature (25-30°C) due to an inability by the animal to dissipate excess heat (Fletcher, 1993). An increase in body temperature has been shown to reduce fertility in ewes affecting conception and increasing early embryonic mortality (Cockrem and McDonald, 1969). It is therefore possible that high ambient temperatures during mating, as was the case in this trial, may have interacted with ergovaline and resulted in reduced fertility and embryo survival in the ewes.

The results presented in this trial have implications for the sheep industry in New Zealand. Perennial ryegrass infected with wild-type endophyte is the most common and widely grown pasture grass in New Zealand. Levels of ergovaline above 0.5 mg/g may be commonplace in New Zealand ryegrass pastures (Easton *et al.*, 1996). Therefore, the fertility of sheep grazing these pastures may suffer. Further grazing trials with endophyte-infected perennial ryegrass are being undertaken to determine possible effects on sheep fertility.

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