Performance of dairy cows grazing pastures with or without ergovaline and lolitrem B in Northland

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ABSTRACT

Ergovaline and lolitrem B are alkaloids produced by Neotyphodium endophytes in ryegrass. These toxins are associated with poor animal performance in many situations but influences on milk production by dairy cows had not been determined in NZ except for short-term trials. An on-farm trial was set-up at Te Hana to measure milk production responses in 2 groups of 16 cows which were maintained on a) ryegrass-based pastures which contained wild-type endophytes which produced ergovaline and lolitrem B [+Ev] or on b) ryegrass pastures that were either free of endophyte or contained a novel endophyte which did not produce ergovaline or lolitrem B [-Ev]. The trial ran from October 1997 til mid-April 1998 and milk production was recorded for each cow at each milking for 10 consecutive days per month culminating in a herd test. There was no difference in milk production in October and November, but a difference of 25% developed in December in favour of the -Ev group and substantial differences in production were maintained until the trial was terminated. Effects of ergovaline on cow performance are discussed in relation to environmental and behavioural factors.

Keywords: ergovaline; lolitrem B; milk production; Northland.

INTRODUCTION

New Zealand dairy pastures are based predominantly on ryegrass and white clover cultivars. The perennial ryegrasses generally contain strains of the fungal endophyte, *Neotyphodium lolii*, and the non-selected or wild-type strains produce secondary metabolites which have biological activity. Of these metabolites, the neurotoxins and the ergopeptine alkaloids are known to affect the behaviour, physiology, and performance of mammals including ruminants (Oliver, 1997). Ergovaline, the main ergopeptide which is present in wild-type endophyte-infected ryegrass, has been linked to outbreaks of hyperthermia in livestock in NZ (Easton *et al*., 1996) but although there are many farmer observations which indicate that drops in milk production are often associated with severe hyperthermia, trials to examine this association have not been done.

The influence of endophytic ryegrass pastures on milk production of dairy cows has been examined in a series of short-term trials in NZ (McCallum & Thomson, 1994; Thom *et al*., 1997), but the results were inconsistent and only pointed to small effects. These trials were conducted in the Taranaki and Waikato regions of the North Island where conditions favourable for the occurrence of hyperthermia are less likely than occurs in the Northland region. The aim of this on-farm trial was to monitor regularly the milk production, body temperatures, and prolactin levels in cows maintained on pastures which differed in ergovaline and lolitrem B levels.

METHODS

Pastures

The plus ergovaline (+Ev) pastures used were high endophyte ryegrass cultivars that were sown about 4 years previously in mixtures also containing red and white clovers. The minus ergovaline (-Ev) pastures comprised a) a 1.3 ha 2-year old low endophyte pasture sown with ryegrass seed that had been stored for >1year in a farm shed at ambient temperatures; b) a 1.4 ha pasture sown the previous autumn with ryegrass seed containing a novel endophyte which produced neither ergovaline nor lolitrem B, the main neurotoxin responsible for ryegrass staggers; c) endophyte–free tall fescue based pastures, which did not contain ergovaline or lolitremB, were grazed outside of the 10-day monitoring periods; d) a 2.3 ha spring sown pasture was also grazed in the non-measurement phase from February onward.

Animals and management

Two groups of 16 3-year old, 2nd calving cows, balanced for production worth and calving date, were put on the respective pasture treatments in early October 1997 and remained there until the trial was ended in mid-April 1998. The aim of grazing management was to ensure that pasture allowances were similar for both groups throughout the period of the trial. In February a maize- based supplement (free of ergovaline) was fed to both groups so they could be maintained on the treatment pastures during a very dry period when pasture availability was low. During the February measurement period supplement was fed at 1kg per cow daily. Supplementation ended before the March measurement period as sufficient pasture was available following rain in early March.

Measurements

Milk volume was determined for each cow in the 2 groups for 10 consecutive days every month from October to March, followed by a herd test. In April milk volumes were determined for 5-day periods in the 1st and 3rd weeks.

Body temperatures were recorded and blood samples taken at afternoon milkings the day before herd testing each month. Serum prolactins and gamma glutamyl transpeptidase (GGT) were determined and serum samples were also assayed for lysergol levels.

Pasture samples were taken monthly to determine herbage mass before and after grazing, botanical composition, endophyte status, ergovaline and lolitrem B concentrations.

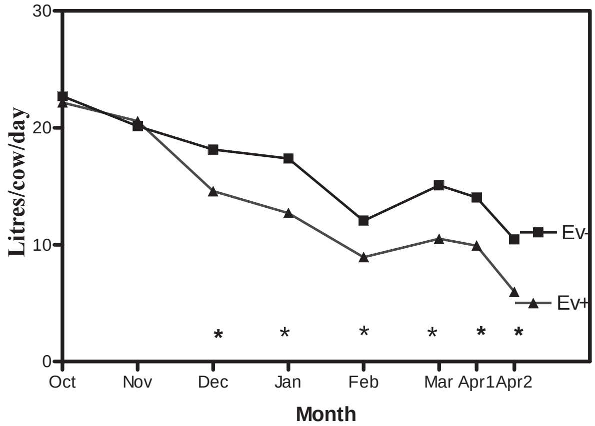
Daily maximum and minimum temperatures and relative humidities were monitored from January to April.

RESULTS

Milk production

Milk production was similar for both groups in October and November, and in December a difference in favour of the –Ev group occurred and this was maintained until the trial ended in April.

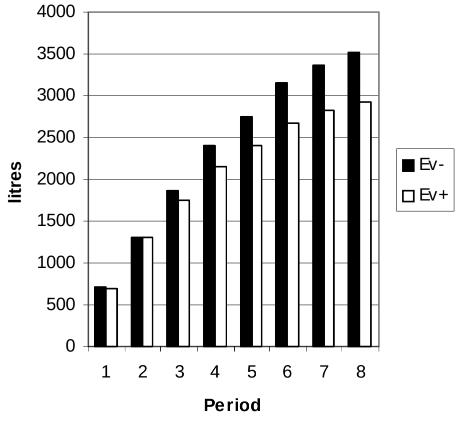
FIGURE 1: Mean daily milk production (litres/cow) from October until April



* means significantly different p<0.05

Although differences in milk production ranged from 24% in December to 70% in April, the overall difference for the trial period was 23% in favour of the –Ev group (figure 2).

FIGURE 2: Cumulative milk production (litres)



Milk solids production derived from monthly herd tests followed a similar trend to that shown for milk volume. The difference in milk solids for the October to April period was 19% in favour of the –Ev group.

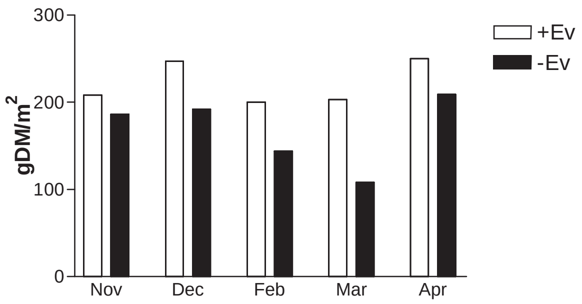
There were no differences detected in body temperatures from measurements made at afternoon milkings.

There were also no differences between +Ev and –Ev groups in liveweight at weighings pre-trial and in January and April.

Data on serum prolactin levels is only available for the November to February period during which the mean values for the –Ev group ranged from 50 to 100% higher than those of the +Ev group.

From Nov until April the grazing residues were consistently lower for the –Ev than for the +Ev pastures (figure 3).

FIGURE 3: Grazing Levels (g/m²)



Ergovaline and lolitrem B levels in ryegass

Apart from 1 sample from a –Ev pasture in December, neither ergovaline nor lolitremB were detected in the –Ev pastures. All samples from the +Ev pastures contained both ergovaline and lolitrem B and levels were lower in leaf blade than in leaf sheath components of ryegrass (table 1). Levels were higher in late-summer and autumn than in spring.

TABLE 1: Ergovaline and lolitrem B concentrations (ppm) in leaf blade and leaf sheath components of +Ev pastures

	Ergovaline		Lolitrem B	
	Blade	Sheath	Blade	Sheath
Oct. – Nov.	0.15	0.3	0.5	1.5
Dec. – Feb.	0.25	1.00	1.7	5.0
Mar. – Apr.	0.33	0.78	2.75	8.3

Facial eczema

GGT levels were within the normal range in January, but were elevated in 4 cows in each group in February. Two cows in the +Ev group were replaced after clinical signs of photosensitisation appeared.

Milk production did not appear to have been affected within the groups as a result of the changes in GGT levels (figure 4).

Lysergol

Lysergol values for composite samples were higher for +Ev than –Ev, and markedly higher for the March samples (table 2).

Figure 4. Regressions of GGT on milk production.

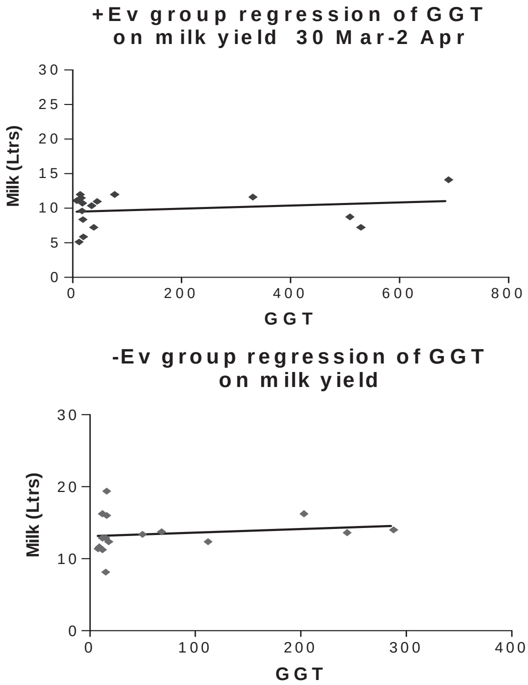


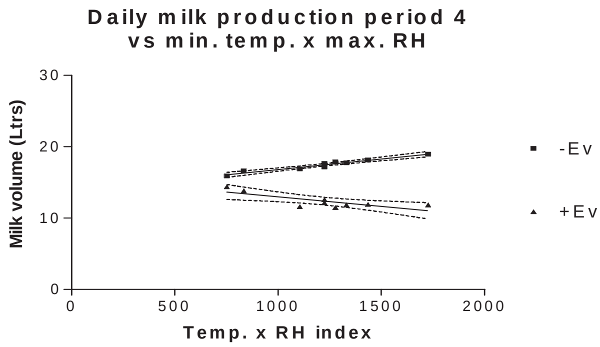
TABLE 2: Lysergol (pg/ml) levels in composite samples of serum as determined by ELISA (Garthwaite pers. com)

	-Ev	+Ev
October	6.3	9.8
January	6.3	17.5
February	5.0	55.0

INTERACTIONS OF ENVIRONMENTAL FACTORS AND MILK PRODUCTION

The only period for which temperature and relative humidity (RH) data were available when intakes were solely from pasture was January. There was no relationship between daily maximum temperatures or minimum %RH and daily milk yields. There were relationships, however, between daily minimum temperatures and maximum %RH and daily milk yields. Linear regressions for milk yield and an index of daily minimum temperature and maximum %RH are presented (figure 5). The regression coefficients (r^2) were .942 for –Ev and .603 for +Ev

FIGURE 5:



DISCUSSION

The +Ev group produced substantially less milk from the December measurement period onward than the –Ev group. Milk production peaked for both groups early in lactation and averaged more than 20 litres per cow daily over the October and November measurement periods. The more rapid decline in production of the +Ev group is typical of the lactation performance of Northland herds in general. The decline has been associated with the elevation of ryegrass seedheads so that they are able to be eaten by cows and a common effect noted has been a decline in serum prolactin levels (Keogh – unpublished results). A decline in prolactin production is a common response to ergovaline intake (Fletcher 1993) and is not considered to have a direct effect on milk secretion *per se* at this stage of lactation. The serum lysergol values are indicative of the presence of ergopeptides and are an indirect indicator of the intake of this class of compound. As ergovaline is the principle ergopeptide produced by wild-type *N. lolii* endophytes it is likely that the differences noted in lysergol levels are also indicative of relative differences in ergovaline intake.

Although there were differences in ergovaline levels between the pastures grazed by the +Ev and –Ev groups, these were not the only differences which may have contributed to the differences in milk production. Other differences noted were: a) the presence of lolitrem B in +Ev pastures and consequent episodes of ryegrass staggers within the +Ev group in the February to April period. b) there was generally more clover present in the –Ev pastures in November and December but this difference was not present from January onwards due to the very dry conditions which resulted in little clover growth in any of the pastures. A December grazing of one –Ev pasture was deferred until most of the clover was removed by a group of calves c) The –Ev group had more recently sown pastures and this is likely to have resulted in a difference in nutritional value (see Blackwell 1999).

Such differences were also reduced in the February to April period by the use of supplements which effectively diluted the intake of endophyte toxins by the +Ev group.

The negative relationship noted for milk production and high daily minimum temperatures and maximum %RHs focusses attention on night-time when these conditions prevailed. A likely scenario is that the +Ev cows were heat stressed during the night rather than during the day when temperatures were higher but %RHs were relatively low. Under such conditions the cows would be unlikely to graze until conditions were more comfitable for them – usually with the increase in air movement which occurs after sunrise, and thus effectively after morning milking. The resultant of such a hypothesised change in feeding behaviour would be a reduction in intake of the order of 20 – 25%. The higher pasture residues noted on the +Ev pastures is also indicative that the ryegrass is less acceptable to stock than the –Ev pastures, for whatever reason. If such interactions (toxin levels, environmental conditions, feeding behaviour, intake, and milk production) are operating to cause lower levels of performance, then such effects are likely to occur more frequently and with greater severity in the more northern regions of NZ. The smaller and inconsistent results obtained in trials in the Waikato (Thom *et al.,* 1997) may be due to a combination of factors including lower toxin levels, less harsh environmental conditions, and the shorter trial periods.

No satisfactory explanation can be offered at this stage for the positive interaction between milk production and the night-time environmental variables.

Although it is not possible to ascribe the effects solely to endophyte toxins, and to ergovaline in particular, the magnitude of the difference in milk production between the +Ev and –Ev groups is such that further investigation is imperative. The extent to which milk production, and animal performance in general, may be limited by endophyte toxins is likely to vary considerably not only year to year, and region to region, but also farm to farm within a district. This is because variations in factors such as environmental conditions, soil types, and management, and interactions between these will impact not only on the production but also on the subsequent intake of toxins

Although these results indicate that +Ev pastures may limit performance of stock, markedly at times in summer – autumn periods in the Northland environment, it needs to be stated that this result has been obtained in a season which may not occur regularly. It is necessary, therefore, that such information is obtained for other years and indeed for other regions, before the full implications are able to be assessed and proper cost benefit analyses carried out.

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REFERENCES

Blackwell, M.B. 1999. Ergovaline and heat stress in Northland cows. *Dairyfarming Annual* in press

Easton, H.S.; Lane, G.A.; Tapper, B.A.; Keogh ,R.G.; Cooper, B. M.; Blackwell, M.; Anderson, M. & Fletcher, L.R. 1996. Ryegrass related heat stress in cattle. *Proceedings of the New Zealand Association* **57:** 37-41.

Fletcher, L.R. 1993. Grazing ryegrass/endophyte associations and their effect on animal health and performance. *In:* 'Proceedings of the Second International Symposium on Acremonium/Grass Interactions: Plenary Papers. pp 115-120. Eds D.E. Hume, G.C.M. Latch and H.S. Easton.

McCallum, D.A.; Thomson, N.A. 1994. The effect of different perennial ryegrass cultivars on dairy animal performance. *Proceedings of the New Zealand Society of Animal Production* **54:**87-90.

Oliver, J.W. 1997. Physiological manifestations of endophyte toxicosis in ruminant and laboratory species. *In:* 'Neotyphodium/Grass Interactions' pp311-346. Eds Charles W. Bacon and Nicholas S. Hill. Plenum Press.

Thom, E.R.: Clark, D.A.; Waugh, C.D.; McCabe, R.J.; van Vught, V.T. and Koch, B.J.L.1997. Effects of ryegrass endophyte and different white clover levels in pasture on milk production from dairy cows. *In:* 'Neotyphodium/Grass Interactions' pp 443-445. Eds Charles W. Bacon and Nicholas S. Hill. Plenum Press.