

# Effects of the MaxP™ endophyte in tall fescue on pasture production and composition, and sheep grazing preference, in a dryland environment

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## Abstract

Pasture growth, botanical composition and sheep grazing preference were measured over 20 months in tall fescue (cultivar Advance), without endophyte (Nil) or infected with AR542 (MaxP™) endophyte, and clover pastures sown into a dryland soil, Canterbury, New Zealand. Pastures were rotationally grazed with sheep, with grazing preference for the two endophyte treatments measured in late autumn and early spring. Annual dry matter production from April 2004 to April 2005 was not significantly different between AR542 (6293 kg DM/ha) and Nil (5864 kg DM/ha) tall fescue. The number of tall fescue plants/m<sup>2</sup> and their basal diameter was greater for AR542 (35 plants/m<sup>2</sup>, 7.5 cm diameter) than Nil endophyte tall fescue (28 plants/m<sup>2</sup>, 6.8 cm diameter). AR542 endophyte tall fescue pastures had fewer weeds, mainly annual grasses, than Nil endophyte pastures throughout the trial. Grazing preference, measured by the number of sheep grazing each plot, and decline in pasture height did not differ between Nil and AR542 tall fescue.

**Keywords:** tall fescue, novel endophyte, AR542, botanical composition, weed, grazing preference

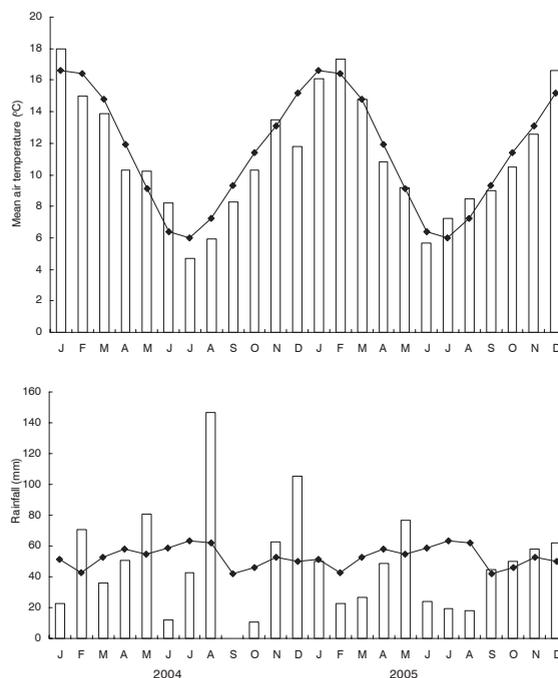
## Introduction

Tall fescue (*Festuca arundinacea*) is a useful pasture grass in New Zealand that is suited to regions of high summer temperature and moisture stress, where perennial ryegrass (*Lolium perenne*) struggles to persist (Milne *et al.* 1998). Tall fescue pastures can have higher summer pasture growth rates than perennial ryegrass (McCallum *et al.* 1992) and often have higher perennial clover content than perennial ryegrass infected with wild-type endophyte (Exton *et al.* 1996). Compared to perennial ryegrass, tall fescue is noted as being more tolerant of grass grub attack (Kain *et al.* 1979) and less susceptible to Argentine stem weevil (Prestidge *et al.* 1986), but is still prone to black beetle attack.

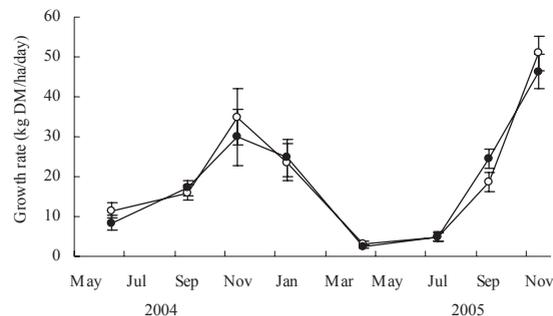
In the USA, tall fescue is an important cool season grass in humid regions, with much of the tall fescue sown infected with the fungal endophyte *Neotyphodium coenophialum*. The endemic *N. coenophialum* is important for the persistence and production of the pasture through the production of alkaloids which reduce insect pressure (Breen 1994) and give improved tolerance of drought (West 1994). However, one protective alkaloid produced, ergovaline, also causes fescue toxicosis in livestock. To resolve this dilemma, a non-toxic *Neotyphodium* AR542 (MaxQ™) was released onto the US market and has been shown to give similar levels of agronomic performance to wild-type endophyte with no negative effects on livestock (Bouton *et al.* 2002; Parish *et al.* 2003). The same endophyte AR542 (marketed as MaxP™) has been released in the New Zealand market, but there is little information to date on its effect on pasture production and composition, and grazing preference. From choice trials in a glasshouse, Popay *et al.* (2005) reported reduced feeding by adult Argentine stem weevil and black beetle on tall fescue infected with AR542 than Nil endophyte tall fescue. Tiller damage to tall fescue in paddocks on two Northland, New Zealand farms was

also consistently lower in AR542 than Nil endophyte pastures (Popay *et al.* 2005).

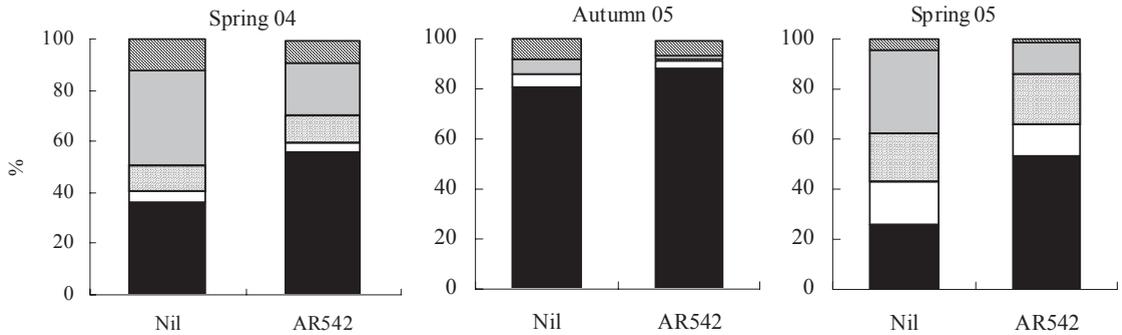
**Figure 1** Monthly rainfall (mm) and air temperature (°C) during the experimental period (bars) collected 1 km from the experimental site. Long-term (40 year) average values (lines) are from the Broadfield weather station, located at Lincoln 7 km from the experimental site.



**Figure 2** Pasture growth rate (kg DM/ha/day) in Nil (●) or AR542 (○) endophyte tall fescue-perennial clover pastures. Data are averaged across white and Caucasian clover treatments. Error bars indicate SED at each date.



**Figure 3** Botanical composition (% of dry matter) in Nil or AR542 endophyte tall fescue (codes: ■ tall fescue, □ sown perennial clover, ▨ annual clover (not sown), ▩ weeds and ▧ dead) in spring 2004 (20 September), autumn 2004 (29 April) and spring 2005 (15 September). Data are averaged across white and Caucasian clover treatments.



The objective of this study was to determine the effect of tall fescue endophyte AR542 on dryland pasture production and composition, and sheep grazing preference in Canterbury, New Zealand.

## Materials and Methods

### Experimental site

The experiment was conducted in a 4 ha tall fescue-perennial clover pasture at Ashley Dene, the Lincoln University dryland research farm located near Lincoln, Canterbury, New Zealand. The soil type was a Lismore very stony silt loam. Soil tests taken at the start of the experiment gave: pH (in water) = 6.4, Olsen P = 28, Ca = 10 m.e./100 g, K = 20 m.e./100 g, Mg = 20 m.e./100 g, Na = 6 m.e./100 g and S = 6 m.e./100 g. Ashley Dene has a mean annual rainfall of 629 mm. Rainfall and air temperatures at Ashley Dene during 2004 and 2005 are given in Fig. 1. Monthly rainfall was below the long-term average in winter and spring 2004 and winter 2005.

### Experimental design

The experiment was four replicates of a 2 x 2 factorial laid out in a randomised block design. The treatments were endophyte infection (Advance tall fescue sown at 10 kg/ha without endophyte (Nil) or with Max P (AR542) endophyte) and perennial clover species (Caucasian clover, *Trifolium ambiguum* cultivar Endura sown at 8 kg pelleted seed/ha or white clover, *T. repens* cultivar Demand sown at 3 kg bare seed/ha). Each plot was 0.25 ha, giving 1 ha per block. The paddock containing the plots was cultivated in September 2002 and pastures were sown on 1 October 2002. Overall, tall fescue establishment was poor (< 35 plants/m<sup>2</sup>). The presence of endophyte in aniline blue stained leaf sheaths was determined by microscopic examination of 100 tillers collected at random from the AR542 tall fescue plots on 16 October 2005. Examination showed 63% of the tillers were infected with endophyte.

### Grazing management and preference trials

The paddock was rotationally grazed in common to a pasture mass of 1200 to 1400 kg DM/ha over the first 18 months and no measurements were made until April 2004. Following this, the paddock was fenced into the four blocks and for the next 20 months pastures were rotationally grazed (4-5 grazing events per year) with Coopworth sheep to a residual pasture mass of 1000 to 1200 kg DM/ha. Two grazing preference studies were conducted from 2 to 9 May and 1 to 8 September 2005. For these, each

block of four plots was stocked with 30 Coopworth ewe hoggets (mean liveweight = 40 kg) for 8 days.

### Measurements

Pasture growth was measured in one 1 x 1 m enclosure cage per plot from April 2004 to November 2005. Caged areas were pre-trimmed with a lawnmower to a height of 3 cm and a cage was placed over top. One 0.2 m<sup>2</sup> quadrat was cut to 3 cm in each plot 1-2 months later (see Fig. 2 for cutting dates), and herbage was oven-dried at 65 °C for 48 h and weighed. The cage was then moved to a new pre-trimmed location. A sub-sample of the cut herbage from each quadrat was dissected to determine botanical composition before drying on 20 September 2004 (spring), 29 April 2005 (autumn) and 15 September 2005 (spring). On 31 May 2005, tall fescue plants were counted in five randomly placed 0.2 m<sup>2</sup> quadrats in each plot and the basal diameter and height of two randomly selected tall fescue plants in each quadrat were measured with calipers.

In the two grazing preference studies, the number of sheep grazing each plot in each block was recorded at 5-minute intervals for 2 hours in the afternoon (15:00 to 17:00 h in May, and 16:00 to 18:00 h in September) on days 1, 4 and 8 of each trial. As a measure of preference, the total number of sheep observed grazing on each plot summed over the 2 hours was calculated. As a further measure of preference, tall fescue height was measured with a sward stick in 30 locations per plot on day 1, 4 and 8.

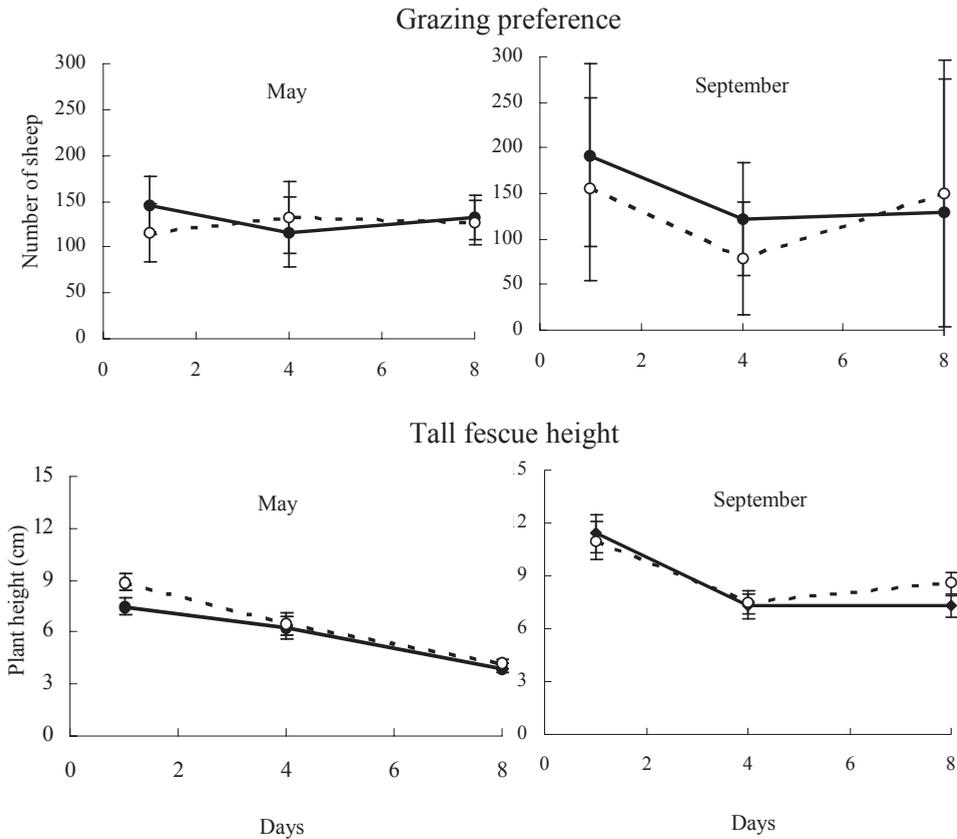
### Statistical analysis

All data were analysed by ANOVA for a 2 x 2 factorial design.

## Results

Total pasture grown during the first year (April 2004 to April 2005) was not significantly different ( $P=0.6$ ) between Nil (5864 kg DM/ha) and AR542 (6293 kg DM/ha) tall fescue. There was also no significant effect ( $P=0.8$ ) of endophyte infection on pasture production during the last 7 months of the trial (Nil = 3844, AR542 = 3789 kg DM/ha). Total pasture production was unaffected by perennial clover species or the interaction of clover species with endophyte. When each harvest was analysed individually, pasture growth rates (kg DM/ha/day) were significantly greater ( $P<0.05$ ) in AR542 than Nil endophyte tall fescue in May 2004 and greater in Nil than AR542 endophyte in September 2005 (Fig. 2). There was a higher percentage ( $P<0.05$ ) of tall fescue and a lower percentage ( $P<0.01$ ) of weeds (mainly

**Figure 4** Number of sheep grazing and pasture height during the two grazing preference trials in Nil (●) or AR542 (○) endophyte tall fescue-perennial clover pastures. Preference trials were undertaken from 2-9 May 2005 and 1-8 September 2005. Error bars indicate SED at each date.



annual grasses) in AR542 than Nil endophyte tall fescue pastures on the three dates sampled (Fig. 3). The percentage of sown perennial and annual, adventive clovers (mainly cluster clover (*Trifolium glomeratum*)) and dead material was unaffected by endophyte. There were no significant effects of clover species on botanical composition.

The number of tall fescue plants/m<sup>2</sup> in May 2005 was significantly greater ( $P < 0.01$ ) for AR542 (35 plants/m<sup>2</sup>) than Nil (28 plants/m<sup>2</sup>) endophyte. The basal diameter of tall fescue plants and plant height were also greater in AR542 tall fescue (7.5 cm diameter, 5.0 cm high) than in the Nil endophyte (6.8 cm diameter, 4.3 cm high,  $P < 0.05$ ).

There was no significant effect of endophyte infection, perennial clover species, or their interaction on grazing preference or pasture height of tall fescue on any of the assessment days in either grazing period (Fig. 4).

## Discussion

There were few significant effects of AR542 endophyte on pasture growth and dry matter yield over the 20 months studied. This was despite there being more and larger AR542-infected tall fescue in autumn 2005 and a higher percentage of these plants in the dry matter throughout the trial than in the Nil tall fescue treatment.

The exact reason for the failure to detect an effect of AR542 on pasture growth and dry matter, despite differences in plants

size, is unclear but may reflect the overall low production (<6.5 t DM/ha/year) of pastures in this dryland environment receiving less than 650 mm rainfall/year combined with a pasture sampling procedure (e.g. enclosure cage and a 0.2 m<sup>2</sup> sample size) that was insensitive to the sparse, tall fescue population. Alternatively, it may reflect a level of insect attack on the pastures that was too low for differences due to endophyte to emerge. Argentine stem weevil is an important insect pest in the Canterbury region, but even Nil endophyte tall fescue shows some resistance to the pest compared to other grasses (Prestidge *et al.* 1986). Popay *et al.* (2005) reported reduced feeding of adult Argentine stem weevil on tall fescue infected with AR542 than on Nil endophyte. However, they found no effect of endophyte in the cultivar Advance that was used in this study. AR542 can also limit damage by adult black beetle (Popay *et al.* 2005), but black beetle is restricted to the northern North Island. A further reason may be that the infection rate of tillers with endophyte (63%) was too low for differences in growth rates to be detected between infected and Nil endophyte pastures. Bouton *et al.* (2002) reported over 90% infection of tall fescue with AR542 endophyte resulted in a greater annual dry matter yield in AR542 than Nil endophyte pastures.

Previous studies indicate that livestock prefer endophyte-free over wild-type pastures in tall fescue (Santen 1992) and perennial ryegrass (Edwards *et al.* 1993). In this study, there were no detectable effects of AR542 infection on grazing preference in

the two periods studied. Grazing time on each plot, and decline in height of tall fescue were unaffected by endophyte infection. This may indicate that the loline alkaloids produced by AR542 do not affect preference, or that alkaloid levels were too low in late autumn (May 2004) and early spring (September 2005) to affect preference.

A feature of the results was the lower percentage of weeds in pastures infected with AR542 than Nil endophyte. This was mainly due to a decline in annual grass weeds (e.g. vulpia hair grass (*Vulpia bromoides* and *V. myuros*) and barley grass (*Hordeum murinum*)) as the abundance of dicotyledonous weeds was low (<5%). The most likely explanation for the endophyte effect is the greater competition associated with the higher percentage of tall fescue in AR542 plots (Fig. 3), and the greater basal diameter. Weeds, particularly annual grasses, are troublesome in many dryland pastures in New Zealand, reducing their productivity and causing animal health problems. AR542 tall fescue may thus be a useful addition to a suite of control methods (e.g. herbicides, grazing management) that assist with annual grass weed management in dryland pastures.

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