

## Effects of fungal endophyte on the persistence and productivity of tall fescue at 3 sites in eastern Australia

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### Abstract

Three small plot trials were sown in autumn 2000 with three tall fescue (*Schedonorus phoenix* syn. *Festuca arundinacea*) cultivars, each infected with a non-toxic fungal endophyte (*Neotyphodium coenophialum*) or endophyte-free. Over the first year, endophyte infection improved yields at Bega (South Coast, NSW) by an average of 113% compared with endophyte-free. The greatest differences occurred over summer/autumn and were associated with damage from African black beetle (*Heteronychus arator*) in endophyte-free plots. At Gatton (Southern Queensland) and Armidale (Northern Tablelands, NSW), endophyte infection increased annual yields 0 to 16%, with differences greatest in autumn (up to 20%). At these sites, insect populations did not appear to be at levels that would significantly affect grass productivity and persistence. Tall fescue hosting the non-toxic endophyte was free of ergovaline, the prime endophyte alkaloid associated with fescue toxicity in animals. These early results indicate potential agronomic advantages in using tall fescue infected with non-toxic endophyte.

### Key Words

tall fescue, endophyte, *Schedonorus phoenix*, *Festuca arundinacea*, *Neotyphodium coenophialum*, yields, African black beetle

### Introduction

In Australian pastures, extensive use of tall fescue (*Schedonorus phoenix* syn. *Festuca arundinacea*) is limited to the northern tablelands and slopes of NSW (3). This is despite good agronomic performance of tall fescue across a wide range of soil types, and tolerance of acidity, salinity, high Al, waterlogging and drought (3). In contrast, in the south-eastern USA, tall fescue is used extensively but is infected with a fungal endophyte (*Neotyphodium coenophialum*) that produces toxic alkaloids associated with poor animal health and productivity. In the USA, removal of the endemic 'wild-type' endophyte from tall fescue cultivars avoids these toxic effects, but results in reduced plant production and persistence. Tall fescue infected with a non-toxic endophyte has essentially eliminated this dilemma, with animal productivity similar to endophyte-free tall fescue and pasture persistence almost as good as tall fescue infected with wild-type endophyte (1). A different situation exists in Australia and New Zealand, where pasture cultivars of tall fescue are free of endophyte. This paper reports on an experiment to determine if plant persistence and productivity of tall fescue can be improved through infection with a non-toxic fungal endophyte.

### Methods

Three tall fescue cultivars (Grasslands Advance, Quantum, Resolute), each infected with a non-toxic endophyte (AR542) or endophyte-free, were sown in plots (10 or 15 m<sup>2</sup>) at three sites in April or May 2000 at 15-25 kg viable seed/ha. Irrigation was applied fortnightly when necessary from November to March at Bega and all year at Gatton. N fertiliser was applied after each harvest at a rate of 50 kg N/ha (Bega) (550 kg N/ha/year), equivalent to 3% of the dry matter (DM) yield of the highest yielding treatment (Armidale) (400 kg N/ha/year) or at 60 kg N/ha/month (Gatton) (720 kg N/ha/year). All treatments were replicated four times in a randomised block design.

DM yields were determined using a capacitance probe at Armidale, and from cut herbage at Bega and Gatton. Herbicides were used when necessary to control volunteer species, but at Bega it was still necessary to calculate yields of tall fescue after determination of botanical composition using the BOTANAL method (5, 6). After yields were measured, plots were trimmed and then grazed with dairy cows at Bega, while plots at Armidale and Gatton were cut and the herbage removed. In November 2000, 20 tillers per tall fescue plot were cut at ground level to determine endophyte infection using an immunoblot procedure (4). In summer/autumn 2001, a further 40 tillers were taken per plot, freeze-dried and analysed for endophyte alkaloids. All trials were examined for presence of insect pests and damage in April 2001.

## Results and Discussion

All endophyte-infected treatments at all sites had high proportions of tillers that were infected with endophyte (mean 91%), while endophyte-free treatments had < 1% endophyte-infected tillers. Herbage of tall fescue infected with AR542 contained no detectable ergovaline (detection limit < 0.1 ppm), the prime endophyte alkaloid associated with animal toxicity, but did contain peramine and N-acetyl norlooline (data not shown), endophyte alkaloids that are associated with insect resistance/tolerance.

Total yields of endophyte-infected tall fescue at Bega were markedly higher than endophyte-free, particularly for the summer dormant cultivar, 'Resolute' (Table 1). Differences were greatest in summer/autumn with endophyte-infected plots yielding 3-fold or more than endophyte-free. During this period severe African black beetle damage had occurred in endophyte-free plots. Adult black beetle are deterred by endophyte in tall fescue (2). Total yields at Armidale and Gatton were usually greater with endophyte infection but only for 'Quantum' was this significant (P<0.05) (Table 1). However, differences were significant (P<0.05) for the summer active cultivars 'Advance' and 'Quantum' in autumn at Armidale and summer at Gatton (both +20% with endophyte), but not different for 'Resolute' over these seasons (-4 to +11%). At these sites, insect populations in April could not account for differences in grass productivity but endophyte can improve production and persistence through increased tolerance to both drought and nematodes (1, 3). These early yield results indicate that there will be agronomic advantages in using tall fescue infected with non-toxic endophytes, similar to results gained in New Zealand (2) and the USA (1).

**Table 1: Cumulative tall fescue yields (kg DM/ha) for Year 1 (from sowing in autumn 2000 to the end of autumn (30 April 2001)) and relative increases in yields of AR542 compared with endophyte-free (Nil) for each cultivar.**

Cultivar	Endophyte status	Site				
		Bega	Armidale	Gatton		
Advance	Nil	9610	11780	19160		
	AR542	13260	+38%	12700	+8%	20020

Quantum	Nil	8130		11630		19970	
	AR542	12660	+56%	13470	+16%	21320	+7%
Resolute	Nil	2030		10870		17030	
	AR542	7016	+246%	11560	+6%	17050	+0%
LSD 5%		1393		1793		937	

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