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EFFECT OF RYEGRASS CONTAINING THE ENDOPHYTE (*ACREMONIUM LOLII*), ON THE PERFORMANCE OF ASSOCIATED WHITE CLOVER AND SUBSEQUENT CROPS

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Abstract

Ryegrass seed lines with (+E) and without (-E) the fungal endophyte *Acremonium lolii were* **sown with white clover. Fewer clover seedlings survived under +E ryegrasses irrespective of whether the plots were mown or grazed. The dominant contrast was an inverse competitive relationship between grass yield and clover seedling survival. A further component unexplained by effects of defoliation or competition is interpreted as an allelopathic effect.**

Two pot trials, using wheat, were established to determine if there was any residual effect of +E wards on following crops. Wheat grown in soil with a history of +E or-E ryegrass with clover produced higher yields from the-E than the +E soil. However, wheat grown on soil from previously clover-free pastures showed no difference between +E and -E. Residual effects on wheat crops are therefore interpreted as being related to lower nitrogen fertility, as a result of reduced clover growth in +E pastures.

Keywords: Ryegrass, endophyte, white clover. competition, vigour, allelopathy, soil nitrogen, wheat yield, *Acremonium lolii*

INTRODUCTION

Since the establishment of the link between the ryegrass-specific fungal endphyte (Acremonium *lolii*) and ryegrass staggers in sheep by Fletcher 8 Harvey (1981), considerable research effort has gone into investigating the full agronomy of ryegrasses with (+E ryegrasses) the endophyte. Subsequent trials have identified Argentine stem weevil resistance (Prestidge et *al.* 1982), increased persistence and yield, but reduced stock performance (Fletcher 1986), as characteristic of +E ryegrasses. Field observations made during recent endophyte trials at Lincoln indicated that white clover probably yielded less under +E than -E lines of the same ryegrass cultivar.

Because of the agronomic importance of any adverse interactions between endophyte ryegrass and white clover and especially their implications for soil nitrogen (N) fertility, the following trials were carried out.

The first trial was set up to establish if the clover content of a sward is influenced by the endophyte status of the ryegrass. It was considered possible that endophyte toxins could reduce ryegrass palatability and cause selective grazing of clover seedlings; or that the endophyte may impart greater competitive vigour in the endophyte ryegrasses; or that the endophyte could have a direct allelopathic affect on the clover seedlings.

Two pot trials investigated the implications of +E and -E ryegrass pastures on soil N fertility and possible toxic residues, both of which could reduce the performance of following crops.

METHODS

Grazing trial

Two perennial ryegrasses (‘Grasslands Ariki’ and ‘Grasslands Nui’) and two white clover (‘Grasslands Huia’ and ‘Grasslands Kopu’) cultivars were used. Both +E

(Ariki = 56% infected, Nui = 73% infected) and-E (ryegrass without endophyte) lines of each ryegrass cultivar were precision sown in October 1985 at Lincoln into cultivated Wakanui silt loam, previously in wheat. Ryegrasses were sown at20 kg/ ha and white clovers at 3 kg/ha (with rates corrected for viability and weight, and with 150 kg ha reverted super into 10 x 15 m plots. The 8 sward types (2 ryegrasses x 2 endophyte x 2 clovers) were replicated 3 times resulting in 24 plots. Each plot was further subdivided into 10 x 1.5 m mown and 10 x 13.5 m grazed plots to test the selective grazing hypothesis. All plots were chemically treated to reduce selective grazing by grass grub and porina. Ten 0.5 m permanently marked drill strips were set out diagonally across each plot for seedling counts. Before the first defoliation (December 1985), both ryegrass and clover seedlings were counted. Thereafter clover seedlings only were counted, before each of the 6 defoliations through to June 1986. A 0.75 m^2 strip was cut from each plot to determine dry matter yield and pasture composition. All plots were then either mown or hard grazed over a period of 24 hours. and left to regrow to 100-l 50 cm.

Pot trials

Two wheat trials were established in pots (150 mm cubed) containing soil taken from adjacent plots with a 5-year history of +E or -E ryegrass. The first pot trial used soil from under pastures previously sown with white clover, and included a treatment which excluded the turf, to test if allelopathic toxins were contained in the litter. A second trial used soil from pastures grown without legumes and included a treatment where soil N was supplemented with a weekly application of 10 kg N, as ammonium nitrate solution, to avoid the possiblity of N deficiency suppressing the expression of endophyte toxins. Kotare wheat seedlings (25 and 20 respectively for first and second trials) were established per pot.

RESULTS AND DISCUSSION

Grazing trial

At the initial seedling count in December, 43% more ryegrass seedlings had established in +E than -E treatments. There was no significant difference in clover seedling density or vigour of either clover cultivar with the different +E and -E ryegrass cultivars (Fig. 1).

The implication is that despite the substantial differences in the +E and -E ryegrass establishment, early seedling survival or vigour of clovers was not affected. However, clover seedling numbers were reduced by approximately half after the initial defoliation, and by June 1986 numbers had declined to about 15% of those originally established (Fig. 1). Clover seedlings were lost under both mowing and grazing treatments.

Comparison of the +E and-E swards revealed 56% greater mortality (Fig. 1) and 40% loss in vigour of clover seedlings sown with +E ryegrass. This ‘endophyte’ effect resulted in the +E swards producing 72% less clover DM than the-E swards in the first year, irrespective of defoliation treatment. More seedlings were lost from grazed than from mown swards, but this extra loss under grazing occurred in both the +E and -E plots. This lack of interaction between defoliation method and endophyte status, and the absence of ryegrass and clover cultivar effects, support competition as the major factor reducing clover survival and discounts the hypothesis that clover was grazed selectively in the less palatable +E ryegrass swards.

On average, ryegrass yields from +E plots (8112 kg/ha) were 16% greater than from -E plots (6995 kg/ha). In both +E and -E swards the dominant effect on clover seedling survival was a strong inverse competitive relationship between clover seedling survival and grass yield (Fig. 2). A further decrease in clover seedling

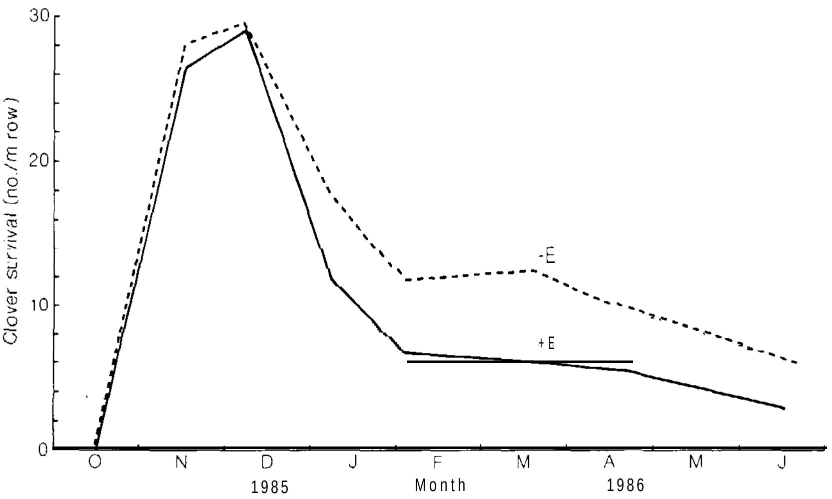

Figure 1: Clover establishment and survival with endophyte (+E) and non-endophyte (-E) ryegrass. (Combined data from mown and grazed treatments).

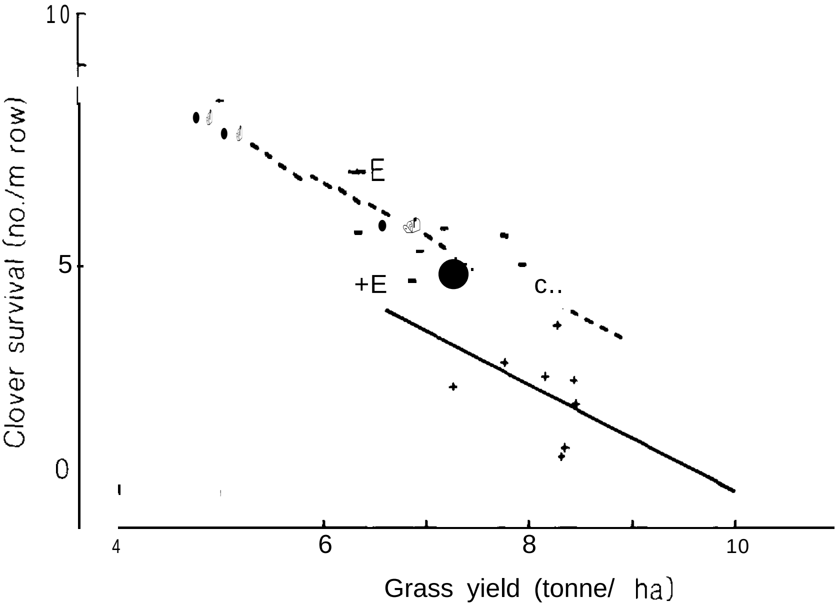

Figure 2: Clover survival as affected by yield and 'allelopathy', with endophyte (+E) and "on endophyte (-E) ryegrass, June 1966. The plotted points are the means of 3 replicates, with the length of the regression lines indicating the data range.

survival (Fig. 2), unexplained by defoliation or competition effects, is regarded as an allelopathic effect. Pederson (1986) reported allelopathic effects of extracts from tall fescue presumably with endophyte, on white clover germination and root growth, and similar effectsare common in a wide range of species (Scott 1974). The greater grass production of the +E swards, at the expense of the clover component,

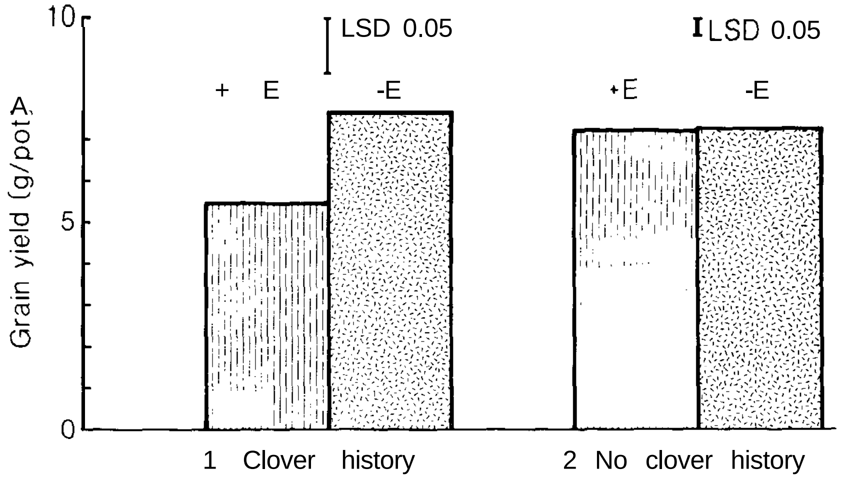

Figure 3. Grain yields from wheat pot trial using soils from endophyte (+E) and non-endophyte (-E) ryegrass. Right: Soils from pasture with no clover component. Left: Soils from pasture with clover component.

echoes a concern expressed by Harris & Hoglund (1980) that some ryegrass cultivars are too competitive with clover, possible resulting in reduced soil fertility.

Pot trials

In the first trial, where soil was taken from under ryegrass and white clover pasture, wheat seedlings in soil from -E swards grew more vigorously during the vegetative stages and at harvest produced 29% more grain than wheat in soil from under +E swards (Fig. 3).

The plants grown in the plus-turf plots produced more than those in the equivalent minus-turf pots, but the difference between -E and +E treatments was the same with and without turf. The increase in yield from turf plots was attributed to the supply of N from the breakdown of the turf. This result shows there is a substantial 'endophyte' effect on following crops, which could be due to lower N levels in +E soils, or to allelopathic toxins residual in the soil. The similarity of results for both turf treatments discounts the possiblity that allelopathic toxins, if present, break down from the litter only.

In the second trial, where soil was sampled from pastures maintained without clover, grain yields of wheat plants grown on +E and -E soils did not-differ (Fig. 3). The N-treated plots produced more than twice as much grain, but there was no interaction with endophyte status. Thus where the 'endophyte' effect on previous clover N fixation is eliminated wheat produced equally well on soil with a long history of +E or -E ryegrass, indicating no residual allelopathic effects. These results support the concept that the residual 'endophyte' effect on wheat growth is caused by a reduction in soil N-a result of the lower clover component in high endophyte ryegrass swards.

GENERAL DISCUSSION

The detrimental effect of ryegrass containing the endophyte *Acremonium lolii* on the performance of the white clover component of pastures and subsequently on soil N fertility and wheat yield, reported here, adds a new dimension to the understanding of the agronomy of ryegrasses containing endophyte.

This 'endophyte' effect is yet to be fully evaluated, but the steady increase in the percentage of pastures sown with ryegrasses containing endophyte, with their inherent penalties, could prove it to be of substantial economic significance to the New Zealand agricultural economy.

On the farm, the cost of the 'endophyte' effect will have to be measured against short-term increases in pasture production and persistence. At the national level, it must be remembered, white clover is sown in approximately 80% of New Zealand's pastures, and its value to the economy, including its contribution to N fertility, has been estimated at $2 billion annually. Thus any reduction in its vigour should be of concern.

The establishment of the links between *Acremonium lolii* and ryegrass persistence, vigour, and yield, and its detrimental effects on stock health, rendered the interpretation of many previous trials on ryegrass pastures uncertain. This additional 'endophyte' effect on white clover, which must affect long-term pasture trials, and could affect cropping, also requires the reappraisal of previous research on the white clover component of ryegrass pastures where the endophyte status of the ryegrass was unknown.

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