

## SUMMARY OF KEY POINTS

# ryegrass endophyte issues and options for merino pastures

## WHAT ARE ENDOPHYTES?

Endophytes are fungi that exist inside ryegrass plants originating from seed, or from tillers of infected plants. Most perennial ryegrass-based merino pastures will contain endophytes.

## WHAT ARE THE ISSUES WITH ENDOPHYTES IN RYEGRASS?

Endophytes naturally produce a range of chemical compounds. Some of these cause problems for sheep including:

- depressing feed intake and liveweight gain
- causing scouring and dags.

However, endophytes also have a beneficial relationship with ryegrass, protecting it from insect attack and offering other advantages, such as discouraging overgrazing by stock, and possibly improving drought tolerance.

The compounds produced by endophytes include peramine, lolitrem B and ergovaline. Their characteristics include:

- Peramine offers significant protection to the plant from insect attack, especially Argentine stem weevil, and to a lesser extent black beetle
- Lolitrem B is a neurotoxin<sup>1</sup> that causes ryegrass staggers in grazing animals, but also prevents damage by Argentine stem weevil
- Ergovaline lowers blood prolactin<sup>2</sup> levels in sheep and causes heat stress, but also contributes to ryegrass resistance to black beetle.

## WHAT ARE SOME POSSIBLE SOLUTIONS?

- Replacing toxic ryegrass with a perennial ryegrass sward using non-toxic endophyte strains is the only sure way to prevent problems. The most promising strain is AR1, which is available commercially. AR1 produces peramine which protects the plant from insect attack with no ill effects on grazing animals, but doesn't contain ergovaline or lolitrem B.
- Use crop rotations or double spray/fallow to reduce viable toxic ryegrass seed in the soil and help establish a safe sward. This could take two years.
- Prevent wild-type endophyte seed entering new pasture from sources such as hay, straw, dung, fleeces or machinery.
- A good long-term strategy is to select for animal resistance to staggers.
- Reducing the intake of toxic perennial ryegrass using feed supplements or crops such as brassicas or annual ryegrass is beneficial.
- Absorbent yeast compounds administered to sheep may reduce ryegrass staggers and improve health.

<sup>1</sup> neurotoxins harm nerve tissue

<sup>2</sup> blood prolactin is a natural hormone

# summary of ryegrass endophyte issues and options for merino pastures

**merino inc.**

PO Box 13646 Christchurch  
phone: 0800 MERINO  
email: admin@merinoinc.co.nz

BY DR PETER RATTRAY, 2003

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This leaflet was prepared by Meat and Wool Innovation Ltd under contract to Merino Inc. It summarises a more detailed report (35 pages) "Ryegrass Endophyte: An up-to-date Review of its Effects" by Peter Rattray (2003). Copies of this report are available from Merino Inc.

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## introduction

Endophytes are fungi that grow inside plants in a symbiotic (i.e. mutually beneficial) relationship, and affect their host grasses in various ways. Many effects are desirable, such as protecting grasses from attack by some insects, nematodes, and plant diseases; making their hosts more drought tolerant and, in some plants, enhancing growth and tillering. However, there are also undesirable aspects in that infected grasses can produce chemical compounds called alkaloids which affect the health and production of grazing animals. Thus the benefit of having endophytes in pastures is debatable.

Perennial ryegrass has evolved over a long period in association with endophytes. Most mature ryegrass pastures grazed by merinos will contain endophytes, which protect the plants from pests, but can have detrimental effects on grazing sheep. Sown fescue swards have nil or low endophyte, but wild (roadside) fescues may have high levels.

Endophytes are concentrated in the seed heads, older leaves and lower stem and leaf sheaths, and the toxins are higher following stress on the plant.

## effects on pasture growth and yield

Endophyte is essential to the thrift of perennial ryegrass pastures in NZ because it protects ryegrass from pests, notably Argentine stem weevil. Endophyte deters feeding by the Argentine stem weevil adults, and egg and larval numbers are reduced. In 1991, pasture damage by Argentine stem weevil was estimated as costing NZ \$46 – \$200m annually.

Endophyte also protects perennial ryegrass from other invertebrates, such as black beetle, which is intermittently a serious pest in northern NZ. Endophyte-free ryegrass can be quickly destroyed by black beetle, but endophyte presence deters feeding by the adults, and egg and larval numbers are reduced.

Evidence shows that ryegrass has greater growth or stress tolerance (e.g., drought tolerance) when infected with endophyte. High endophyte ryegrass may be less severely grazed than uninfected swards as, given a choice, sheep graze uninfected swards closer to the ground than infected ryegrass swards. Whether due to reduced pest pressure, drought tolerance or other mechanisms, endophyte-infected ryegrass pastures produce more dry matter than endophyte-free pastures.

A trend for poorer clover growth occurs in endophyte-infected pasture. The effect is not always observed and maybe an inverse effect of ryegrass vigour, although direct inhibitor effects on white clover have been documented. Livestock may preferentially graze clover in a mixed sward and actively avoid the infected ryegrass.

Neurotoxin<sup>1</sup> intake is substantially less on day 1 than on days 2 and 3 of a grazing period; and the aim is to prevent overgrazing of the lower parts of the plant which have higher levels of the toxin. A rapid rotation can reduce the severity of ryegrass staggers.

Topping or cross grazing with less susceptible animals, such as cattle, to decrease the amount of seed head is also beneficial, as the endophyte reaches high levels in the seed head. However, while cattle are more tolerant or resistant to endophyte toxins, they may also suffer from ryegrass staggers, reduced liveweight gains, or production.

## replacing toxic ryegrasses

The most reliable method is to replace toxic ryegrass, and prevent recontamination of the new pasture. AR1 endophyte ryegrass is the obvious choice as a replacement at present. Other novel endophytes are under research.

Prevention of contamination by good preparation of the paddock before sowing is key, as for the establishment of any pasture. Kill all existing vegetative ryegrass plants, either by repeated cultivations and/or herbicides which will prevent natural reseeding and deplete buried ryegrass seed. Providing a seedbed that favours rapid establishment of the sown pasture (e.g. fertile, moist, fine, weed-free) will reduce contamination of the new pasture.

The time taken and methods to achieve pasture establishment will vary. Paddock preparation over two years may be needed to ensure that natural reseeding is prevented and that buried seed is reduced, particularly in summer-dry environments.

Comprehensive re-sowing strategies were studied at Dexcel, to evaluate how pre-sowing management and establishment methods influenced the contamination of a newly sown AR1 ryegrass with wild endophyte. Hay, silage, grazing, grazing/topping and a turnip crop pre-sowing resulted in 2555, 747, 348, 391 and 25 wild type seeds/m<sup>2</sup>, respectively, remaining on the soil surface after natural reseeding.

Spray/cultivation and double-spray/fallow reduced contamination with volunteer ryegrass plants to 8 and 34 plants/ m<sup>2</sup>, respectively, compared to direct-drilling AR1 seed into hard-grazed existing pasture (581 plants/ m<sup>2</sup>). The spray/cropping or double spray methods are recommended, but there are concerns about the success of these methods on hill country. However, on-farm trials in the northern North Island have shown that a spraying/cropping regime by helicopter can be quite successful.

### PERSISTENCE OF AR1 RYEGRASS

Management techniques can minimise ingress of high endophyte ryegrass into new AR1 pastures. Prevent seed entering via dung, in fleeces, hay/straw, sown seed or machinery. The grazing rotation is important. Avoid grazing high endophyte ryegrass pasture, especially if it is seeding, just prior to grazing the new AR1 pasture. In addition, ensure that contamination from headlands, and from adjacent paddocks is minimized.

# effects on animals

Before 1980, it was thought that a fungus was involved with ryegrass staggers, and research aimed to isolate the chemical(s) responsible. The discovery of ryegrass endophyte hastened this process. Several related compounds produced by the endophyte were identified. Lolitrem B is the most abundant and most potent. Paxilline is similar to lolitrem B, but is much milder. Ergovaline was also found. It causes a wide range of animal health problems by lowering blood prolactin<sup>2</sup> levels causing symptoms such as heat stress. The main compound responsible for protection from Argentine stem weevil is peramine but ergovaline and lolitrem B also protect against insect pests.

The co-evolution of endophyte and its host is reflected in the large array of compounds occurring in endophyte-infected grasses. Many of these have yet to be isolated and identified, but, by themselves or in combination with the identified toxins, may cause scouring, dags and other symptoms of ill-thrift.

The different compounds, known as alkaloids, have separate biosynthetic pathways, allowing the selection or development of endophyte strains with different or nil levels of particular alkaloids. The fungus can be grown in culture, and young seedlings can be artificially infected with it. Endophyte strains have been identified which produce peramine, but are free of ergovaline and/or lolitrem B. Such a recent development is the novel endophyte (AR1) produced by AgResearch, which has been licensed to seed companies for use in commercial ryegrasses. AR1 significantly reduces the risk of animal health problems. Trials show animal performance on AR1 pastures to be similar to those on endophyte-free pasture.

In summary, the wild endophyte present in the perennial ryegrasses in most NZ pastures produces several alkaloids. Three of these are known to be significant to stock management:

- Lolitrem B: affects the nerves and muscles of grazing animals, leading to ryegrass staggers.
- Ergovaline: causes heat stress in grazing animals.
- Peramine: deters some insects, particularly Argentine stem weevil, from feeding on the ryegrass.

The effects on plant host and animals are summarised in Table 1, below.

Table 1:

## THE MAIN ALKALOIDS IN ENDOPHYTE, THEIR OCCURRENCE AND EFFECTS

Endophyte Option	Definition Produced	Main Chemicals	Properties
<b>Wild</b>	Naturally infected with an endophyte	Lolitrem B, Ergovaline, Peramine	Protects against ASW* and black beetle, can cause ryegrass staggers.
<b>Nil</b>	Contains no endophyte	Nil	No protection against insects, no ryegrass staggers.
<b>AR1</b>	Novel endophyte	Peramine	Protects against ASW <sup>a</sup> ; some protection against black beetle but not as much as wild endophyte. No ryegrass staggers.

\* ASW: Argentine stem weevil

# control of the animal health problems

There are a number of methods that reputedly reduce the toxic symptoms of ryegrass staggers, heat stress, scouring and dags.

## ABSORBENT COMPOUNDS

There are compounds that have tremendous surface area and the ability to strongly bind and absorb potentially harmful compounds within the digestive system, so that they are rendered inactive and pass through the digestive system unabsorbed.

There are yeast extracts such, as Mycosorb™ from Altech and Biomos™ produced by Nutritech. Both have yet to be fully tested but there are reports of marked improvements in stock health, especially from ryegrass staggers. Promotional material for Biomos™ claims a significant improvement in stock health in 5–7 days. Dose rates in ruminants are equivalent to 2g/50kg liveweight for 5–7 days for severe toxicosis reducing to 1g/50kg LW for mild cases, and eventually reducing to 0.5g/50kg LW.

Clay compounds such as zeolite and bentonite have also been used, but little success has been reported.

## OTHER REMEDIES

There are accounts of other remedies such as cider vinegar, potassium chloride/ magnesium sulphate mixture, Nutrimol™, seaweed extract and trace element/vitamin E supplements being used, but again generally with low success.

## DRUGS

Bomperidone is used successfully to treat horses, especially brood mares with fescue toxicosis in the USA, but there are no reports of its use with ruminants.

## IMMUNISATION

There are reports that passive immunisation for specific alkaloids has reversed signs of fescue toxicosis in grazing steers. There are no reports for ryegrass endophytes, but the array of toxins produced would make this a long hard road to success.

## GENETIC SELECTION

Ruakura ran a six-year selection trial for resistance or susceptibility to ryegrass staggers in sheep. There was a reasonable response with a 24% difference in clinical incidence between the two lines. Facial eczema resistant sheep are also resistant to ryegrass staggers. An explanation is that they may have a common biochemical pathway, or that both strains of sheep may have an enhanced detoxifying capacity of the liver.

## GRAZING MANAGEMENT AND SUPPLEMENTARY FEEDING

Reducing the intake of high endophyte perennial ryegrass is the only sure method of preventing stock problems. The aim is to reduce the intake of the toxins produced by the endophytes. For complete control of staggers, animals should be removed from all perennial ryegrass containing the wild endophyte.

An obvious approach is to dilute the ryegrass intake with supplements or remove the animals on to a ryegrass free pasture. Alternative feeds, such as low endophyte hay, silage, grain, forage crops, or annual ryegrasses, reduce the intake of fungal toxins. Ryegrass hay may contain the toxins, so lucerne or clover hay is preferred.