

What are endophytes?

Endophytes are naturally occurring fungi that live between the cell walls of perennial, long rotation and hybrid ryegrass (*Neotyphodium lolii*) as well as some tall fescue cultivars (*Neotyphodium coenophialum*). An example can be seen in Figure 1. Most modern cultivars or older ryegrass based pastures will likely contain a high frequency of endophyte infected plants.

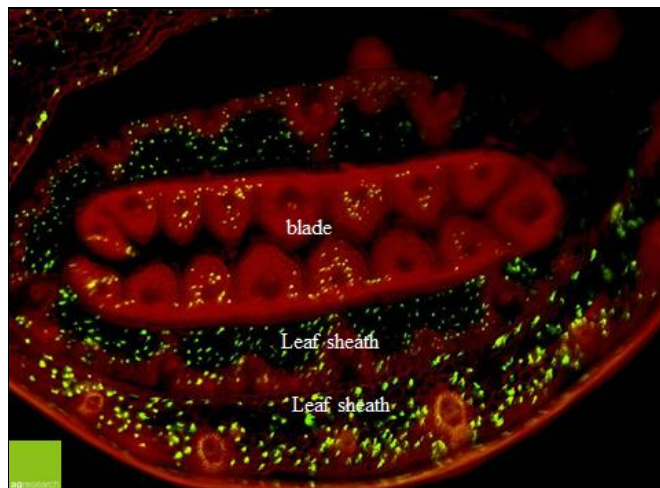


Figure 1: A cross section of a leaf blade treated with radioactive dye. The green dots are endophyte hyphae. Sourced from AgResearch Limited.

What is their purpose?

The host plant supplies the fungus with nutrition. In return the fungus produces unique protective alkaloids which are absorbed by the surrounding plant cells. This type of relationship is known as a *symbiotic relationship*. In the wild, this relationship and the alkaloids produced give the plant increased pest, grazing, and drought resistance, leading to improved plant persistence.

How does it spread?

The endophyte fungus emerges as the seedling begins to germinate. As this occurs, the endophyte establishes itself and sends hyphae (similar to plant roots) into the seedling.

As the plant matures, the endophyte will be predominately found at the base/crown of the plant. Therefore, the alkaloids produced are usually located in high concentrations at the base/crown of the plant within the leaf sheath.

Endophyte spreads to the next plant generation by infecting the seed. It does so by growing within the reproductive tiller and into the seed head. Figure 2 demonstrates the plant lifecycle.

A plant that has been sown and never originally contained the endophyte fungus (nil) will not get infected. Endophytes do not transfer from plant to plant by air or soil. The only way it is transferred is by seed from the mother plant.

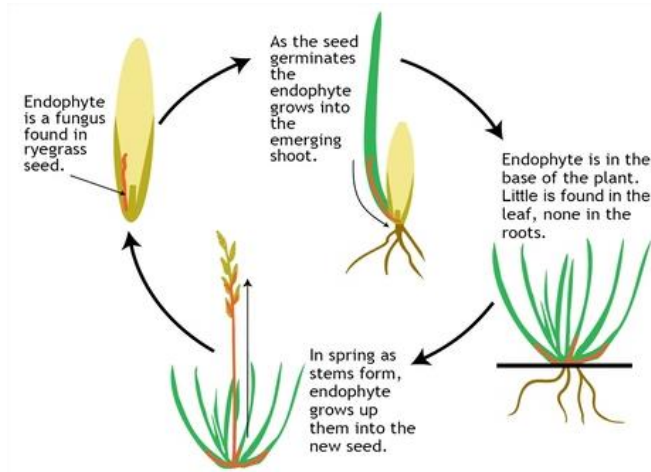


Figure 2: The endophyte lifecycle. Sourced from Heritage Seeds.

The main alkaloids

The natural purposes of the alkaloids produced are to control pest attack to the plant, with an outcome of better plant persistence. However, not all the alkaloids produced are harmless for grazing stock. Symptoms are normally seen in summer/autumn, when stock graze hard into the base of pasture.

There are five alkaloids or alkaloid groups that are produced by endophytes which are of interest to graziers. These are: Ergovaline, Lolitrem B, Peramine, Janthitrem and Lolines. The alkaloids are unique to either or both perennial ryegrass or tall fescue. Details of each main alkaloid are described below (effects on both insects and animals are subject to ongoing research and this knowledge may change in future).

Ergovaline:

Insect protection

Black beetle (adult only)
Root aphid (moderate level)
Fescue foot (tall fescue only)

Associated stock issues

Can contribute towards heat stress in sheep, depending on dose.

On occasions, another fungus can be found within the seed head of a range of grasses and cereals. The fungus, called "ergot", can produce a toxin called ergotamine which has similar effects to Ergovaline. This may explain the cause of Ergovaline symptoms even if your pasture contains nil or a novel endophyte that produces little or no Ergovaline.

Lolitrem B:

Insect protection

Argentine Stem Weevil (low control)

Associated stock issues

Ryegrass staggers

Be mindful when feeding out hay or silage harvested from pastures potentially containing high levels of Lolitrem B or Janthitrem. Stock may show symptoms of ryegrass staggers, even though they are not located on perennial ryegrass pastures.

Janthitrems:

Insect protection

- Argentine Stem Weevil (larvae only)
- Pasture Mealy Bug
- Root Aphid
- Black Beetle adult
- Porina

Associated stock issues Ryegrass staggers (sheep)

Janthitrems are only produced by AR37[®] novel endophyte. Although Janthitrems still have an effect on animal health, the effects are much lower than those found in the wild type endophytes and usually found to occur in sheep, not cattle. Argentine Stem Weevil control is better in diploid ryegrasses.

Peramine:

Insect protection

- Argentine Stem Weevil
- Pasture Mealy Bug

Associated stock issues N/A

Peramine is safe to all grazing stock types with no loss in animal production. Argentine Stem Weevil control is better in diploid ryegrasses.

Lolines:

Insect protection

- Argentine Stem Weevil
- Black Beetle
- Grass grub
- Porina
- Black field cricket
- Red Headed Cockchafer

Associated stock issues N/A

Lolines are non-toxic to animals and potentially provide a range of insect protection. However there are issues in providing loline-producing endophytes in ryegrasses. Issues include low transmission rates and reduced levels of alkaloid production. Lolines in fescues are translocated to the plant roots to protect from a range of root feeding pests.

The novel endophytes

To reduce the negative effects of alkaloids on grazing stock, plant breeders and mycologists developed a range of novel endophytes to improve on the Standard endophyte (or wild type endophytes) widely sown in Australia up until the 2000's.

These novel types produce varying levels of the different alkaloids, with the focus to reduce or eliminate ill effects on animal health (and therefore animal productivity), but still maintain insect resistance and plant persistence.

There are a small range of novel endophytes available on the market for both perennial ryegrass and tall fescue. These are commonly marketed as: ARI[®], AR37[®], Endo 5[®], NEA, NEA 2 and Max P[®]. Each have their own characteristics and careful selection is required for what suits your property and stock type. Table 1 and 2 provide a summary of the novel endophytes available and the alkaloids produced for perennial ryegrass and tall fescue respectively.

Table 1: The ticks correspond to the alkaloids produced by novel endophytes for perennial ryegrass and tall fescue

Endophyte	Peramine	Lolitrems B	Ergovaline	Janthitrem	Lolines
Perennial ryegrass					
Wild type	✓	✓	✓		
ARI[®]	✓				
AR37[®]				✓	
Endo 5[®]	✓		✓ (low)		
NEA 2	✓ (low)	✓ (very low)	✓ (low-medium)		
Tall fescue					
Max P[®]	✓				✓

Grazing management

Breeding has resulted in significantly improved endophytes for stock performance. However, there are potential risks at certain times of the year to grazing stock with pastures containing standard endophyte which can result in reduced productivity and animal health issues.

Firstly, if the host plant enters the reproductive stage, high alkaloid concentrations will be within the reproductive tiller and seed head. This is important to note when grazing infected pastures during the summer and autumn seasons.

Alkaloid levels are low within the leaves, with increasing levels towards the base of the plant to protect the grass plants' growing point. General grazing advice is you are likely to get few significant endophyte effects grazing leafy pastures, but not to graze the pasture hard, leaving enough post-grazing residual that the stock are not forced to graze the lower canopy or the crown.

Alkaloid concentrations are also known to increase when the host plant becomes exposed to moisture stress and high levels of soil nitrogen.

A method of reducing the negative effects of endophyte alkaloids is to dilute its effects by:

- including non-endophyte containing species in the sward. Examples of nil endophyte species include cocksfoot and coloured brome.
- supplementary feeding of grains etc. Endophyte issues are greatest in extended dry periods where animals have reduced intakes of poor quality pasture.

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