Endophytes and pasture—a complex relationship

**Key messages**

- Endophytes are naturally-occurring fungi that exist in a symbiotic (win–win) relationship with a host plant, such as perennial ryegrass and tall fescue.
- Endophytes draw on nutrients from the host plant and in return help protect plants from insect pests and in some cases from overgrazing by animals by producing alkaloids — some of which are toxic to livestock.
- A range of ‘novel’ endophytes, is commercially available, which are safer for stock than the old ‘standard’ (or wild-type) endophyte.
- Choosing the right novel endophyte (paired with the right pasture grass) for a farm system can provide a more productive, palatable pasture, which is safer for grazing livestock.

Endophytes are naturally-occurring fungi that exist in a symbiotic (win–win) relationship with a host plant, such as perennial ryegrass and tall fescue. The host plant supplies the fungus with nutrients, protection and a method of reproduction; in return the fungus produces unique alkaloids. This relationship, and the resulting alkaloids, increase the plant’s pest and drought resistance, improving persistence.

The old ‘standard’ (also sometimes called wild-type) endophyte has always been present in Australian ryegrass and some tall fescue pastures, producing alkaloids that could cause a range of health issues including:

- ryegrass staggers
- heat stress
- a range of subclinical disorders which include:
  - summer ill thrift
  - reduced live weight gain or weight loss
  - reduced milk production
  - reduced appetite or feed intake
  - scouring/dags

The incidence of problems is seasonal, usually occurring in summer and autumn, and the severity is highly variable between years. In some years no problems are encountered but in other years severe problems may occur.

The exciting development in endophytes during the past 30 years has been the understanding of their link to insect control and animal health; and more recently the discovery and release of ‘novel’ or new endophytes, which provide better animal health and pasture performance.

### Alkaloid production

Endophytes produce a range of alkaloids, but five key alkaloids are of significant interest to livestock producers — ergovaline, lolitrem B, peramine, janthitrems and lolines. The alkaloids are unique to either perennial ryegrass or tall fescue (see Table 1).

<table>
<thead>
<tr>
<th>Alkaloid</th>
<th>Plant impact</th>
<th>Animal impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ergovaline*</td>
<td>Provides good control of African black beetle and moderate control of root aphid.</td>
<td>Can contribute to heat stress in sheep and cattle, particularly in tall fescue</td>
</tr>
<tr>
<td>Lolitrem B</td>
<td>Provides low-level control of Argentine stem weevil</td>
<td>Ryegrass staggers (sheep and cattle)</td>
</tr>
<tr>
<td>Epoxy-janthitrems</td>
<td>Provides very-good-level control of Argentine stem weevil (larvae only), pasture mealy bug, root aphid, and good control of African black beetle</td>
<td>Ryegrass staggers (sheep — no reported cases in cattle)</td>
</tr>
<tr>
<td>Peramine (tall-fescue and ryegrass)</td>
<td>Provides very-good-level control of Argentine stem weevil and pasture mealy bug. It deters adult Argentine stem weevil feeding at low concentrations and deters larvae at moderate concentrations.</td>
<td>Nil</td>
</tr>
<tr>
<td>Lolines (tall-fescue)</td>
<td>At a high level, lolines provide very-good-level control of mealy bug and African black beetle. High-level control of Argentine stem weevil and root aphid, with some evidence of resistance against red-headed cockchafer and black field cricket.</td>
<td>Nil</td>
</tr>
</tbody>
</table>

* Another fungus can be found within the seed head of perennial ryegrass or tall fescue. The fungus, called ‘ergot’, can produce a range of ergot—alkaloid toxins, which have similar effects to ergovaline. This may explain the cause of ergovaline symptoms even if a pasture contains nil or a novel endophyte that produces little or no ergovaline.

* Pest control ratings have been taken from NZGA (2014) Pasture and forage plants for New Zealand. Note: Ryegrass ratings for control of Argentine stem weevil (ASW) are for diploid cultivars, and are lower in tetraploids, which are preferred by ASW.
Endophytes (and the associated alkaloids) are predominantly found at the base (crown) of the plant. When the plant matures, the endophyte will elongate along the stem and grow into the developing seed. When the host plant goes to head, high alkaloid concentrations can be found in the reproductive tiller and seed head.

The fungus spreads to the next plant generation by infecting the seed.

**Grazing management**

When grazing stock on ryegrass and tall fescue with known toxicity problems, the key is to adjust summer – autumn grazing management. Alkaloids are found in the highest levels in the basal stem of plants, so hard grazing into the base of pastures increases the likelihood of endophyte-related animal health problems. Alkaloid levels are also higher in the seedhead and stem, so controlling late spring heading (e.g. through mowing, topping or making hay or silage) can greatly reduce potential issues.

Grazing the first ‘pick’ of fresh regrowth following summer rainfall and storms also is a classic risk factor for ryegrass staggers. This risk can be greatly reduced by deferring grazing until grass plants have three leaves per tiller, as plant growth will dilute the alkaloid levels in the pasture. (This is also recommended practice for grass plants to replenish reserves for best regrowth).

Alkaloid concentrations are lowest through winter and early spring, increasing during the reproductive phase and when the host plant becomes exposed to:

- high temperatures
- moisture stress
- high levels of soil nitrogen.

Be mindful when feeding out hay or silage harvested from pastures potentially containing high levels of lolitrem B or ergovaline.

Non-alkaloid containing feeds (e.g. grain, brassicas, chicory, lucerne) can be fed either as part of the diet — diluting the intake of endophyte alkaloids and minimising the likelihood of animal health issues — or as safe pastures through a problem period.

**Novel endophytes — safer pastures**

Plant breeders and mycologists have developed a range of commercially-available novel endophytes to reduce the negative effects on livestock of the standard endophyte. These novel endophytes produce varying levels of the different alkaloids, with the focus on reducing or eliminating any toxicity in livestock, while maintaining insect resistance and plant persistence.

Producers looking to establish new perennial ryegrass or summer-active tall fescue pastures have a choice when it comes to pasture species, cultivar and endophytes (see Table 2).

As part of choosing a pasture cultivar that will meet your expectations for persistence, production and animal performance, consider the most appropriate endophyte.

If persistence is critical, consider which endophyte provides the best protection against the insects likely to be an issue in your area, while keeping in mind the potential animal health implications (see Table 1).

Keep in mind that endophytes are not a ‘silver bullet’ in providing pasture persistence, but can be a key link in delivering this in tandem with the right farm system, stock policies and grazing management.

Other attributes within a variety worth considering are dry matter yield, persistence, heading date, ploidy and genetic origin.

**FURTHER INFORMATION**

More information about endophytes and their management can be found in the NSW primefact — *Endophytes of perennial ryegrass and tall fescue*.

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**Table 2 Types of alkaloids and their plant and animal impacts**

<table>
<thead>
<tr>
<th>Perennial ryegrass endophytes</th>
<th>Peramine</th>
<th>Lolitrem B</th>
<th>Ergovaline</th>
<th>Janithrem</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard (wild) type endophyte</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Standard endophyte (SE) is a naturally occurring-endophyte found in older (and some current) ryegrass cultivars. SE can cause severe ryegrass staggers, and has been shown to reduce both milk production in cows and liveweight gain in sheep.</td>
</tr>
<tr>
<td>AR1*</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Ryegrass with AR1 endophyte provides moderate insect control, but is safe for livestock. AR1 gives very good control of Argentine stem weevil and pasture mealy bug. AR1 pastures are susceptible to root aphid and black beetle.</td>
</tr>
<tr>
<td>AR37*</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>AR37 supports good animal performance but may cause ryegrass staggers in sheep, which on occasion can be severe if not managed carefully. AR37 provides very good insect control of Argentine stem weevil, pasture mealy bug, root aphid and good control of black beetle.</td>
</tr>
<tr>
<td>Endo 5*</td>
<td>✓ (low)</td>
<td>✓ (very low)</td>
<td></td>
<td></td>
<td>Endo 5 endophyte does not cause ryegrass staggers and has been selected for low levels of ergovaline. Endo 5 provides some protection against root aphid, black beetle, Argentine stem weevil and pasture mealy bug.</td>
</tr>
<tr>
<td>NEA 2</td>
<td>✓ (low)</td>
<td>✓ (very low)</td>
<td>✓ (low – medium)</td>
<td></td>
<td>NEA 2 endophyte supports good animal performance and does not cause ryegrass staggers in cattle, however there is a slight chance it could occur in sheep. NEA 2 provides good control of Argentine stem weevil, pasture mealy bug and black beetle, and moderate control of root aphid.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tall fescue endophytes</th>
<th>Peramine</th>
<th>Lolitrem B</th>
<th>Ergovaline</th>
<th>Lolines</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max P*</td>
<td>✓</td>
<td></td>
<td></td>
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