Observations on the role of endophyte in field performance of ryegrass and tall fescue in New Zealand

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New Zealand: Forest to farm;  
Changing climate;  
50 years ago with endophyte;  
Animal health disorders;  
Metabolic cost to the host;  
Insect protection to the host;  
Water balance benefits to the host;  
Transmission;  
What benefit to a farmer?
Endophyte distribution in the meristem region.

Confocal laser microscope image.

Photo courtesy of M Christensen, AgResearch.
Original ‘Podocarp’ temperate forest, central North Island, New Zealand.
A dairy farm today
Rainfall

The graph shows the average rainfall in various regions of New Zealand:

- Northland
- Waikato
- Taranaki
- Manawatu
- Canterbury
- Southland

The green bars represent annual rainfall, while the red bars indicate summer rainfall (Nov-March).
Cunningham, IJ

In-toxicity to animals of ryegrass endophyte and other endophytic fungi of New Zealand grasses.

New Zealand Journal of Agricultural Research
Volume 1(1958):489–497

Abstract: It is reported from the Animal Research Station, Wallaceville, that in feeding experiments on fowls, arrows, rats, mice, and sheep rye-grass [Lolium] infected by the blind seed fungus (Gloeotinia temulenta) and perennial rye-grass, tall fescue [Festuca arundinacea] and darnel [L. temulentum] carrying their endophytes were...

Farm hand” with Reg Keogh, DSIR Grasslands – ecology” approach – visit outbreaks, look for common actors, etc.;

Other active scientists Rex Gallagher (chemist) and Margaret di Menna - hypothesis: toxin produced by soil *Penicillium* spp and translocated from roots to leaves, candidate alkaloid verruculogen;

Test fungal isolates supplied by RG (intraperitoneal injection to mice) to assess tremorgenic activity & administer verruculogen to sheep;

Concluded verruculogen not ryegrass staggers causal agent (metabolic half life too short – hours not days).
1983; Endophyte identified as cause of ryegrass staggers

Identification of alkaloids;

Lolitrem  Bad
Peramine  Good
Ergovaline  Vasoconstrictor + Insect deterrence
Lolines  Good (Little in ryegrass)

Endophyte receives a Latin name;
Characteristically strong (highly significant) endophyte strain x plant genotype interactions
gy substrates for endophyte MUST come by ion from plant cells
Metabolic cost to the host plant (?)

- E+ 95% survival
- E- 85% survival
Endophyte-mediated feeding deterrence in AR1 endophyte, attributable to peramine alkaloid.

Photo courtesy Alison Popay.
-endophyte plants smaller
weaker effect in 3 plus-endophyte ryegrass plots, not seen every summer.
Endophyte effects on water balance

- Anecdotally widely agreed that endophyte enhances drought resistance;
- He (2013, NZGA in press) obtained $P < 0.10$ for endophyte x water interaction for LWP (MPa) (similar result for RWC):

<table>
<thead>
<tr>
<th>Osmotic Potential (Mpa)</th>
<th>ll watered</th>
<th>Stressed</th>
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</thead>
<tbody>
<tr>
<td>E+</td>
<td>E-</td>
<td>E+</td>
</tr>
<tr>
<td>-0.45</td>
<td>-1.29</td>
<td>-0.85</td>
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Transmission consistency in seed production a significant concern in some commercial strains;
Adds $NZ 2.00 to market value of seed;
Concluding Remarks

A 75 year technology development journey since first described in NZ by Neall (1939);
Likely will be major future developments (new secondary metabolites with antibiotic activity or development of drought resistance activity);
Commercial opportunities derive from endophyte technology;
Estimated 90% adoption by farmers in NZ (less needed in regions with cool moist summers).
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Matthew, C