Fungal endophyte – a novel biocontrol option

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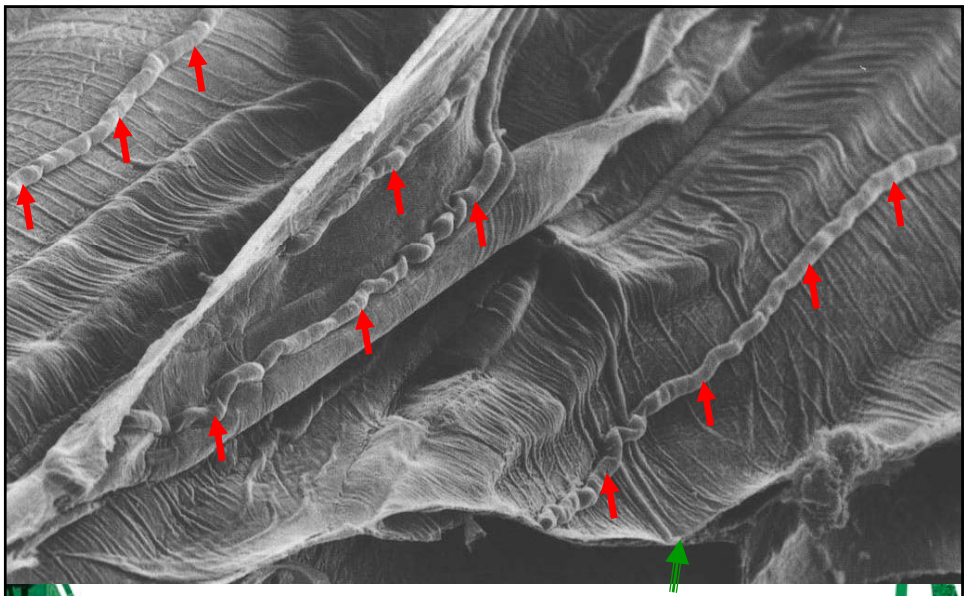
On behalf of a very big team of people

grasslanz
unique plant opportunities

Content

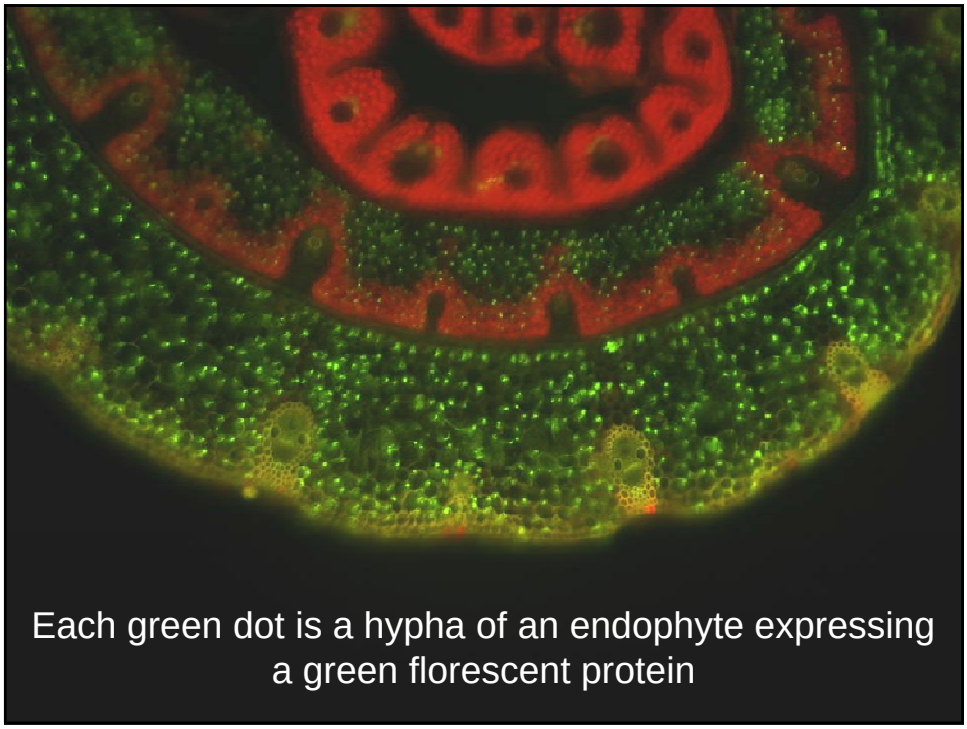
1. What are fungal endophytes?
2. What is the biocontrol issue?
3. What has been achieved?
4. How was this achieved?
5. What is next – other uses of endophytes?

1. What are fungal endophytes?



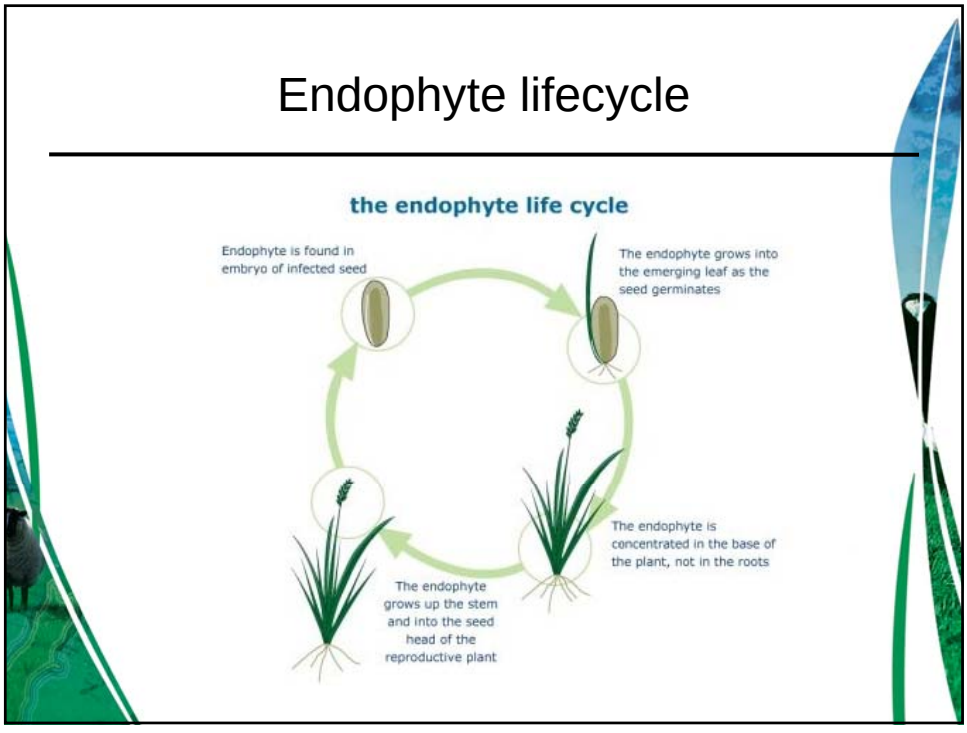
Fungal **endophyte** + **Grass Plant**

Endo = within - **Phyte** = plant



Each green dot is a hypha of an endophyte expressing a green florescent protein

Endophyte lifecycle



Diversity in endophytes

- *Neotyphodium* fungal endophytes are not all the same, there is considerable diversity in their biochemical profiles
- Europe has a wide diversity of grass endophytes
- AgResearch has the largest collection of grass endophytes in the world
- New Zealand is the recognised world leader in grass endophyte technology and its commercialisation

What fungal endophytes do ?

- Protect host plants against biotic and abiotic stresses
- Biotic stress protection
  - Insects
  - Nematodes
  - Plant pathogens
- Abiotic stress protection
  - Drought
- Protection increases plant production and persistence

Endophyte chemistry

- Endophytes are all about chemistry
- They produce a range of bioactive secondary metabolites (alkaloids)
- The type of alkaloids produced depends on the strain of fungus present
- The host plant has a major effect on the quantity of alkaloids
- The chemistry of endophytes is diverse and complex

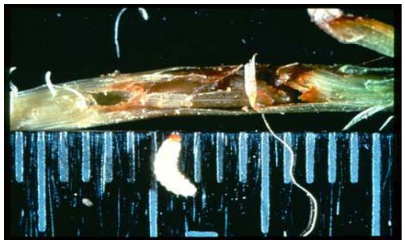
Endophyte alkaloids

- Four main groups identified
  - Peramine
  - Ergovaline
  - Indole diterpenoids
    - Lolitrems
    - Epoxy janthitrems
  - Lolines
- All are active against insects
  - Toxic
  - Deterrent
- Unknowns

Basic science

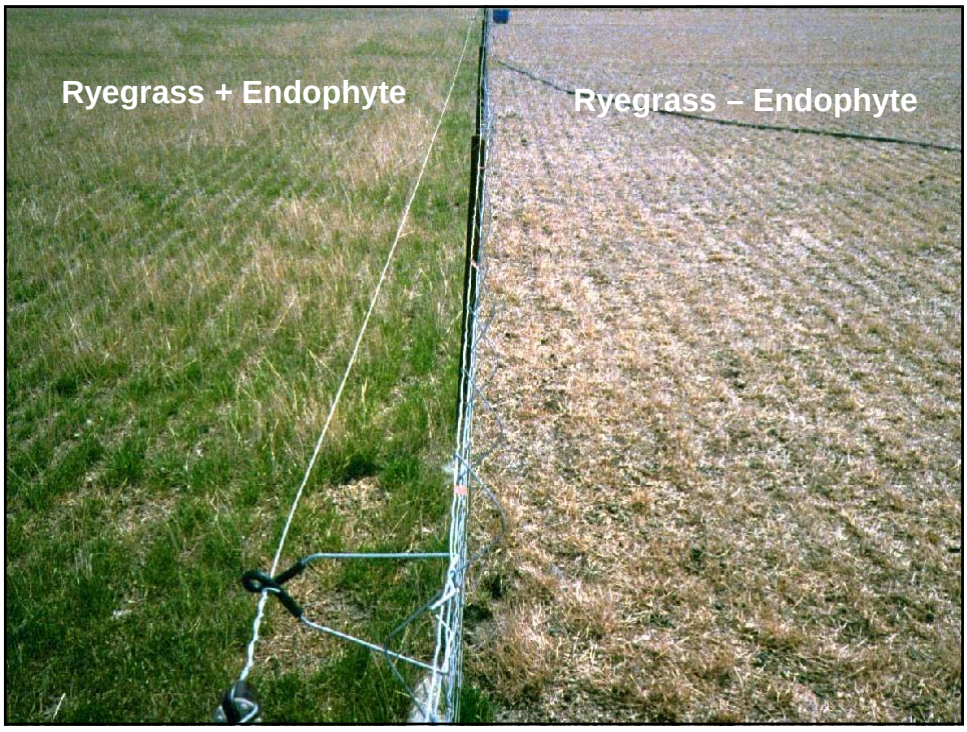
- Understanding the life cycle of *Neotyphodium* endophytes
- Isolation from grasses and growth ex plant
- Inoculations challenges – into the plant
- Transmission challenges – into the seed
- Understanding the chemistry – discovering unknown alkaloids
- Understanding the genes controlling alkaloid expression
- Endophyte viability in seed

2. What is the biocontrol issue?



Pests of endophyte-free ryegrass

- **Porina**
- **African black beetle**
- **Argentine stem weevil**
- **Pasture mealy bug**
- **Grass grub**
- **Root aphid**



Tall fescue at Bega, NSW, Australia

Tall fescue + with Endophyte

Tall fescue – minus Endophyte

But….

- While endophytes alkaloids do have powerful insecticidal properties some can also have serious affects on ruminants
  - Ergovaline **-** a vaso-constrictor that causes heat stress, and reduces live weight gains and serum prolactin
  - Lolitrem B **-** a tremorgen that causes the neuro-muscular disorder ryegrass staggers
  - Epoxy janthitrems - a tremorgen
- It is a case of balancing the upside of insect resistance with the downside of animal health and welfare

3. What has been achieved?

Tall Fescue Endophytes

MaxQ™ A Nutritional and Health Enhancement for Livestock

MaxP®

Ryegrass Endophytes

AR1® grasslanz endophyte

AR37® grasslanz endophyte

ENDO 5

Timeline for ryegrass endophyte understanding and development

1980	Endophyte linked with - insect resistance - ryegrass staggers, then production
1980 - 90	Development of High Endophyte lines (containing a wild-type endophyte)
1992	First novel endophyte released – partially withdrawn
2000	AR1 novel endophyte
2003	NEA2 novel endophyte
2006	Endo5 novel endophyte
2007	AR37 novel endophyte
2010	>80% seed sales of proprietary cultivars have novel endophytes
2011- 2020	Novel endophytes with better insect resistance and drought tolerance

Ryegrass endophyte

AR1 grasslanz endophyte

AR1 endophyte

- Ryegrass endophyte that does not cause ryegrass staggers but provides Argentine stem weevil resistance
- Non-exclusive release
- Initially targeted for Australasia
- Uptake rate has been high

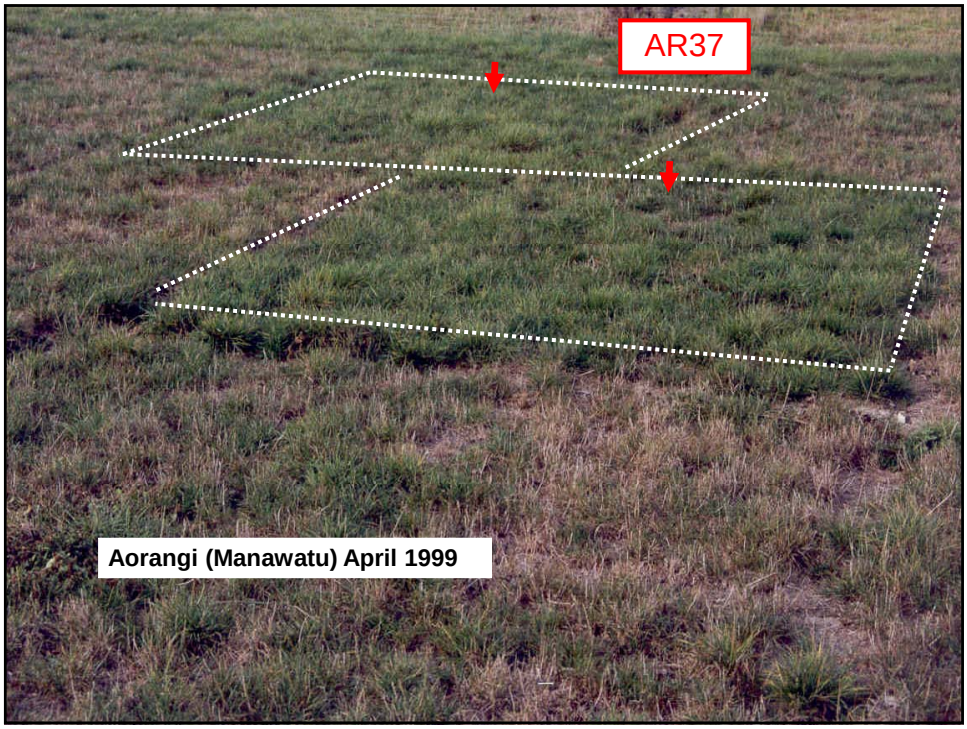
AR1 - Pastoral industry benefits

AR1 a technological breakthrough

- Prevents ryegrass staggers
- Does not cause heat stress
- Reduces fly strike
- Increases live weight gain >10%
- Increases milk solids 9%

Ryegrass endophyte

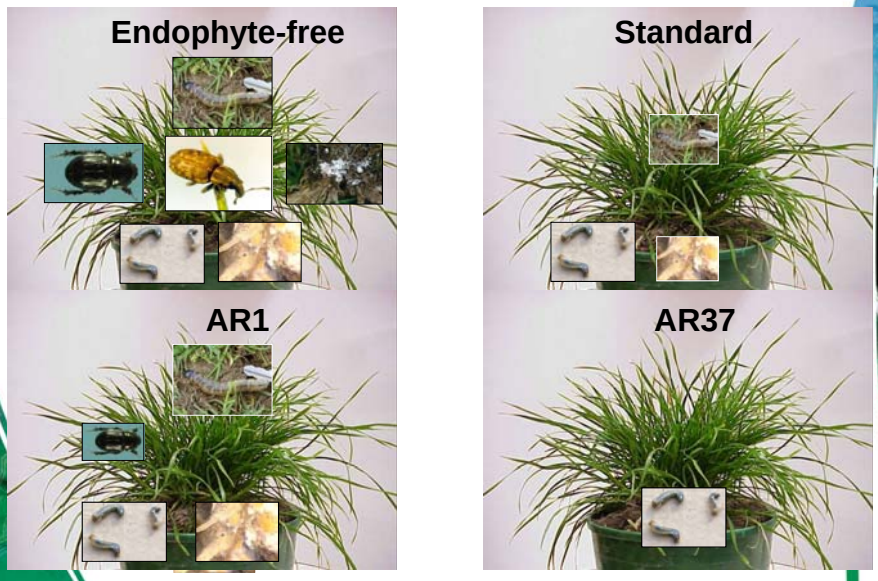
AR® 37
grasslanz endophyte



AR37(left) versus existing pasture

Photo taken at AgResearch Farm at Tokonui - 29 February 2008

Comparisons



Issues with AR37

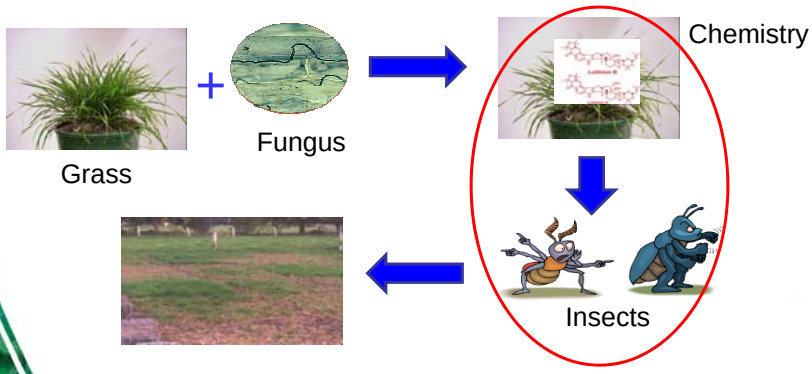
- Grass staggers can be experienced with AR37 – these are short lived and not normally as severe as those experienced on wild type endophyte.

Recommendation:

- If AR1 persists on your farm then sow AR1
- If AR1 does not persist then sow AR37 – not high endophyte wild type.

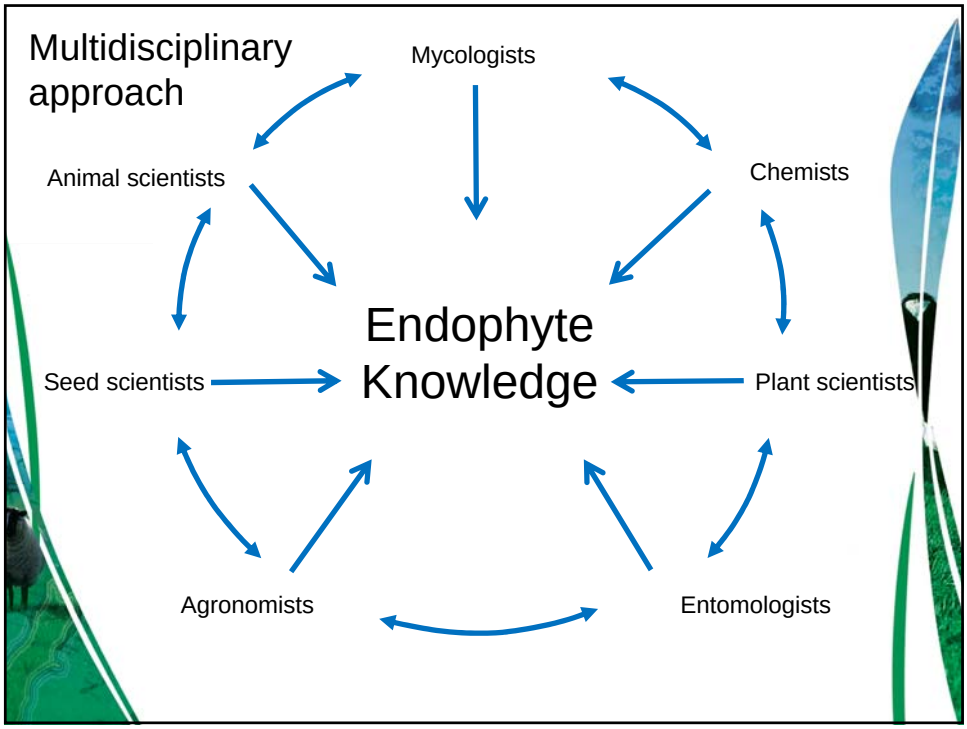
4. How was all of this achieved?

Understanding the process



Successful ingredients

- A great R&D team – multi-disciplined approach and very good science
- Strong international links
- Strong links to NZ industry – supported financially by seed companies and Beef and Lamb (when it was Meat and Wool)
- Strong commercialisation drive through Grasslanz Technology Ltd and commercial partners

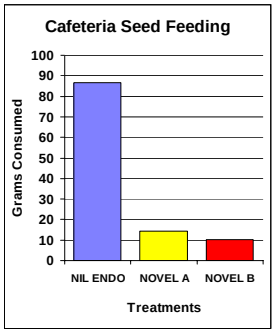


5. What is next – other uses of endophytes?

Current opportunities

- Wildlife deterrence

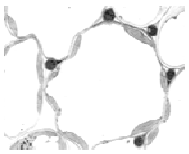
“Learned geese”



- Endophyte in cereals
- Pesticidal extract
- Use in other commercially significant plants, e.g. trees

Fungal endophytes

- A very successful method of biocontrol that is seed transmitted
- Based on excellent science
- Commercially successful and is being widely used



With endophyte Without endophyte