

## Endophytes in turf-type perennial ryegrass

Endophytes are naturally-occurring fungi that live inside various plant hosts, ranging from trees to grasses. In many cases the relationship has existed between the fungus and the plant for millions of years, and is mutually beneficial (i.e. symbiotic). The fungus derives its nutrition from the grass, and in return the fungus produces a range of alkaloids that improve the plants resistance to various abiotic and biotic stresses. The abiotic stresses can include heat and drought stress, but it is the biotic stress resistance that is most important. The toxic alkaloids deter a range of insect pests, birds and mammals that try to feed on the grass.

Plants already produce their own range of alkaloids, especially when they are being attacked by an insect or grazing animal. Natural plant alkaloids include caffeine, nicotine, opiates and cannabinoids (they can have stimulatory effects in small doses, but they are actually designed to deter any animals that feed on the plant). While it is true that plants produce their own alkaloids, symbiotic endophytes can bolster these defences even further.

Perennial ryegrass (*Lolium perenne*) is host to a particular endophyte species, *Neotyphodium lolii*. The fungal hyphae grow in the intercellular spaces of the leaf and sheath, although some of the alkaloids they produce are systemic and travel around the plant, including to the roots. The fungus does not produce spores. When the ryegrass produces its seedhead, fungal hyphae are deposited in the developing seed. When that seed germinates, the endophyte will infect the new seedling and start the process again. The dormant hyphae in seed can die out as the seed ages, especially if the seed is exposed to high temperature. Imported seed crossing the equator, for example, can lose its endophyte if not shipped in a cold container.

*Neotyphodium lolii* in perennial ryegrass can produce a wide range of different alkaloids such as ergovaline, lolitrem B, janthitrem and peramine. Each alkaloid has a different effect on the insects, birds or animals that eat the foliage. In livestock, the effects can include heat stress, odd behaviour, low productivity and low fertility. Most alkaloids work by deterrence. The alkaloid within the plant material will cause digestional upset, and the animal will soon learn to avoid the ryegrass. In relation to insect pests, endophytes have been found effective in every trial undertaken (on over forty different species) and no species has been found that is unaffected by endophytes. The main insect pests such as grass grubs, white grubs, root aphids and stem weevils are all well controlled by high endophyte levels in perennial ryegrass, and there is some evidence that parasitic nematodes are also reduced.

Different strains of *Neotyphodium lolii* produce different spectrums and concentrations of alkaloid. Each class of alkaloid can also differ in mobility within the plant. Ergovaline and lolitrem B are immobile, so the animal would need to consume the leaf to be affected. In contrast, lolines and peramines are systemic and travel within the plant, including to the root system. Lolines have also been found to leach from clippings into the soil, potentially reducing soil grubs, nematodes and even worm populations.

The science of endophytes is relatively recent. Researchers at AgResearch in New Zealand and at Rutgers University in New Jersey started a more intensive study of their effects in the early 1980s. In particular, the agricultural scientists were interested in *Neophytodium* strains that didn't produce ergovaline or lolitrem B, which cause the major problems in livestock, but still contained peramine, for insect pest control. Working with PGG Wrightson Seeds and Grasslanz in New Zealand, AgResearch released various cultivars of perennial ryegrass and tall fescue coupled with selected, patented strains of *Neotyphodium* (e.g. AR1, AR37 etc.) that had little or no toxicity to stock, yet retained good insect resistance. These cultivars have been tremendously successful in pastures, and dominate the grazing industries in Australia and New Zealand.

In turfgrasses, however, there is no need for stock-friendly endophyte strains. In fact it would be a huge benefit to have a *Neotyphodium* strain that produced the widest range of alkaloids at the highest concentration. AgResearch scientists focussed on finding these 'hot' endophyte strains and inoculating them into superior turfgrass cultivars. The result is the 'Avanex<sup>®</sup>' range of grasses, which includes Avanex<sup>®</sup> Colosseum perennial ryegrass. Bird deterrence on airports is a huge market for this grass, hence the name 'Avanex<sup>®</sup>'. Insectivorous birds are reduced due to the lack of insects attacking the grass. Herbivorous birds are deterred due to digestional upset from eating the foliage, which they learn to avoid. Birds of prey are reduced, due to the lack of small bird and small mammal prey. Several airports throughout the world are using Avanex<sup>®</sup> grasses and although it is early days the technology, is proving very successful.

All of the Mediterranean turf-type perennial ryegrass cultivars bred by PGG Wrightson Seeds have high-endophyte levels, but Avanex<sup>®</sup> Colosseum now combines the unique endophyte strain, AR95, with the best quality, winter-active perennial ryegrass. As well as a superior combination of endophyte strain and grass cultivar, the seed production, seed storage and quality control processes developed by PGG Wrightson Seeds ensure a high endophyte viability when the seed is established by the Turf Manager.