

## **PGG Wrightson fact sheet: 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 toxic 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 kill or deter a range of insects, birds and mammals that try to feed on the grass.

Alkaloids are nerve toxins. Plants already produce their own alkaloids, especially when they are being attacked by an insect or grazing animal. Natural plant alkaloids include caffeine, nicotine, opiates and cannabinoids (nerve toxins can have stimulatory effects in small doses, but they are actually designed to kill or deter any animals that feed on the plant). So plants produce their own alkaloids, but 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* can produce a wide range of different alkaloids such as ergovaline, lolitrem B, loline, janthitrem and peramine. Each alkaloid has a different effect on the insects, birds or animals that eat the foliage. In livestock, the effects can range from heat stress, odd behaviour, unthriftiness, low productivity and low fertility, through to death. For example, the alkaloid lolitrem B causes a condition known as 'Ryegrass Staggers' which can kill thousands of sheep in seasons where ryegrass is particularly productive. Most alkaloids are less dramatic, however, and work by deterrence. The alkaloid within the plant material will cause digestional upset, and the animal will learn to look elsewhere for food. With respect 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 loline and peramine, for insect pest control. Working with PGG Wrightson 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, AR95, AR501 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, to be toxic to all creatures, great and small. AgResearch scientists focussed on finding these 'hot' endophyte strains and inoculating them into superior turfgrass cultivars. The result is the 'Avanex' range of grasses, which includes Avanex Colosseum perennial ryegrass. Bird deterrence on airports is a huge potential market for such a grass, hence the name 'Avanex'. 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. And raptors are reduced, due to the lack of bird and small mammal prey. Several airports throughout the world are using Avanex grasses, and although it is early days the technology is proving very successful.

All of the Mediterranean turf-type perennial ryegrass cultivars PGG Wrightson has developed and sold since the 1980s have had high-endophyte levels, but Avanex Colosseum now combines the hottest novel endophyte strain 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 ensure a high endophyte viability when the seed is established by the Turf Manager.