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AVANEX™ endophyte-infected grasses for the aviation industry now a reality

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Abstract:
Bird numbers over a 12 month period were reduced by an average of 87% in large scale demonstration sowings that compare AVANEX™ tall fescue with existing airport vegetation at three New Zealand airports: Christchurch, Hamilton and Auckland.

Scientific data from trials comparing AVANEX™ tall fescue and perennial ryegrass with unselected wild-type fungal endophytes in the same cultivars show a significant reduction of 69% for above ground insects and 88% for below ground insects, over three seasons.

Key Words: bird numbers, AVANEX™, tall fescue, perennial ryegrass, airports, wild-type endophytes

Introduction:
The advantages of fungal endophyte-enhanced grasses for bird management at airports have been discussed now for some years. The concept of a grass harbouring fewer insects that also induces avoidance behaviour by birds grazing the forage due to a unique fungal endophyte is now being exploited as an effective enhancement to wild-life management.

We first introduced the concept at this conference in Minneapolis 1999. As a consequence some airports have used unselected wild-type endophytes in tall fescue cultivars but the results have been unspectacular with sometimes poor plant survival levels (10-70%) and no convincing bird data. This paper explains some of the reasons why airport managers that use off-the-shelf unselected wild-type endophyte-infected grasses may become disillusioned by its impact on bird numbers.

The use of these grasses at airports is dependant solely on the production of good seed that contains the appropriate selected endophyte with a high level of viability. Obtaining such seed lines is not easily achieved and is the result of a new science that has had considerable research over the last 25 years in New Zealand and the USA. Knowledge of how to maintain endophyte viability in all phases: seed production, harvesting, drying, storage and distribution in the wholesale/retail chain, are now understood.

Grass renewal is a long term strategy of controlling wild-life at airports that must be based on reducing the attractiveness of the area so there are fewer bird visitations. Airport managers need to be sure their choice of grass/endophyte has had the

appropriate research undertaken to provide data to give them confidence of a reliable proven product. The AVANEX™ product, a novel endophyte-infected grass that deters birds, has been tested and shown to be reliable. It is now available through PGG Wrightson Seeds.

The knowledge required to improve plant germplasm through selection in plant breeding has been well developed and exploited by man to improve the efficiency of food production. What is less well known is the selection of endophytes from wild-types to improve the expression of alkaloids to deter insects and reduce bird grazing, and to inoculate these endophytes into plant genetic material for a specific purpose. The development of AVANEX™ is the result of over 12 years of selecting and testing prototypes of grass-endophytes to produce a unique product for airports in temperate areas. Pennell & Rolston (2010) describe the process of the development and selection of this material. A continental-type turf tall fescue grass cultivar "Jackal" was identified as ideal for airports, having tough wearing characteristics for wheel braking and able to withstand low fertility, drought-prone and compacted soils once established. A selected fungal endophyte (*Neotyphodium coenophialum*) called AR601 was inoculated into 60 seedlings of Jackal. These plants were then further selected for high levels of alkaloid expression (lolines as an insect deterrent and ergovaline as a bird deterrent) with 20 plants selected for further multiplication. The resulting grass-endophyte combination was named AVANEX™. Once sufficient seed was available plants were tested on an active airfield for endophyte plant density, alkaloid expression and insect presence compared with a cultivar infected with an unselected wild-type endophyte (Table 1). A similar programme was completed for a continental perennial ryegrass cultivar 'Colosseum' which is now also marketed under the AVANEX™ brand. It has been developed for wild-life management at parks, reserves and recreational areas.

Table 1: Percent endophyte-infected tillers, insect weight (mean of four assessments), plant density, loline and ergovaline concentrations at Christchurch International Airport comparing AVANEX™ with Currowong tall fescue with an unselected wild-type endophyte.

		6 Sep 06	2006/07	12 Sep 07	2007	2007
Tall fescue cultivar	Endophyte	Endophyte (%)	Insect dry weight (gm)	Plant density (%)	Loline (ppm)	Ergovaline (ppm)
AVANEX™	AR601	95	41	87	2604	33-53
Currowong	Wild-type	75	95	59	297	0

Seed was sown in large trials to provide information on bird numbers from comparable areas at three active airfields in New Zealand: Auckland and Hamilton in the North Island and Christchurch in the South Island.

Data obtained from actual bird counts on plots of the same area (37 acres) at Christchurch International Airport observed daily morning and evening comparing the AVANEX™ product in tall fescue with existing airport vegetation *(broadleaf weeds and grasses)* and adjoining farmland *(variable cropping)* showed a significant reduction in bird numbers in the area sown to AVANEX™ (Fig 1).

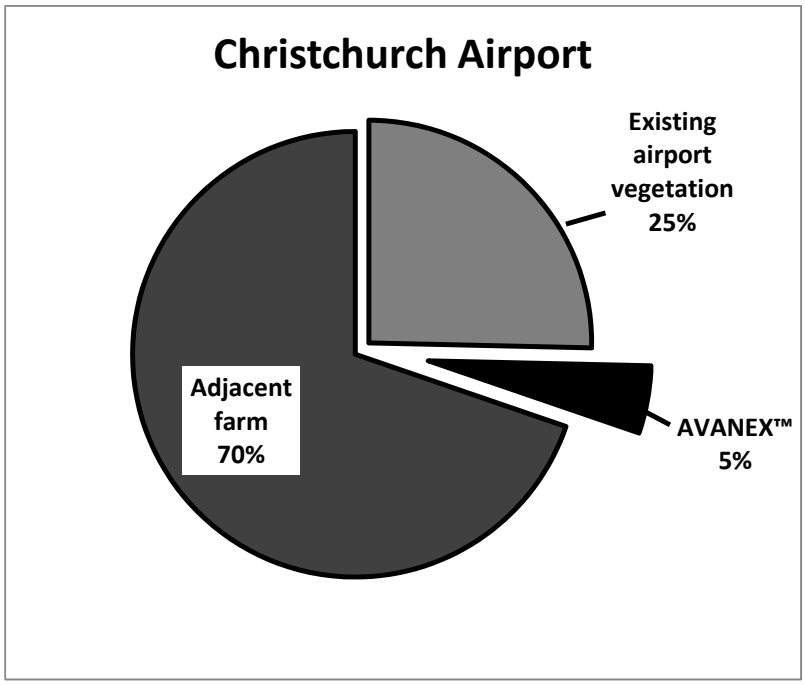

Fig 1: Average numbers of birds visiting 3 areas of Christchurch Airport over 12 months, expressed as percentage of total.

Bird distribution data off three 25 acre plots obtained from Hamilton airport has also offered encouraging results. The lucerne (alfalfa) crop also on the airfield is now being replaced with AVANEX™ tall fescue (Fig 2). Overall bird numbers have been reduced by 88% at Hamilton and 85% at Christchurch in the AVANEX™ area compared to the other monitored areas.

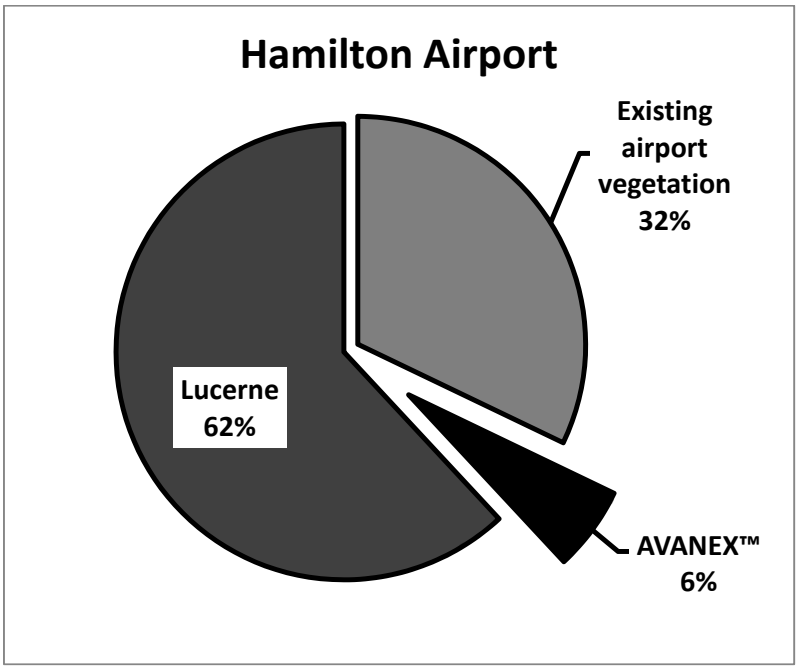

Fig 2: Average numbers of birds visiting 3 areas of Hamilton Airport over 12 months, expressed as percentage of total.

At both these airports ground staff management teams are keen to establish more of the AVANEX™ tall fescue as soon as is practicable. Ground preparation to remove buried seed from years of mowing grass and broadleaf weeds is an issue on airfields and must be dealt with before considering any grass re-vegetation.

Data on comparing below and above ground insects on plots containing both ryegrass and tall fescue AVANEX™ products compared with unselected wild-type endophytes in the same cultivars are continuing. Interim data on the advantages of the AVANEX™ product over unselected wild-type endophyte grasses is shown in (Fig 3).

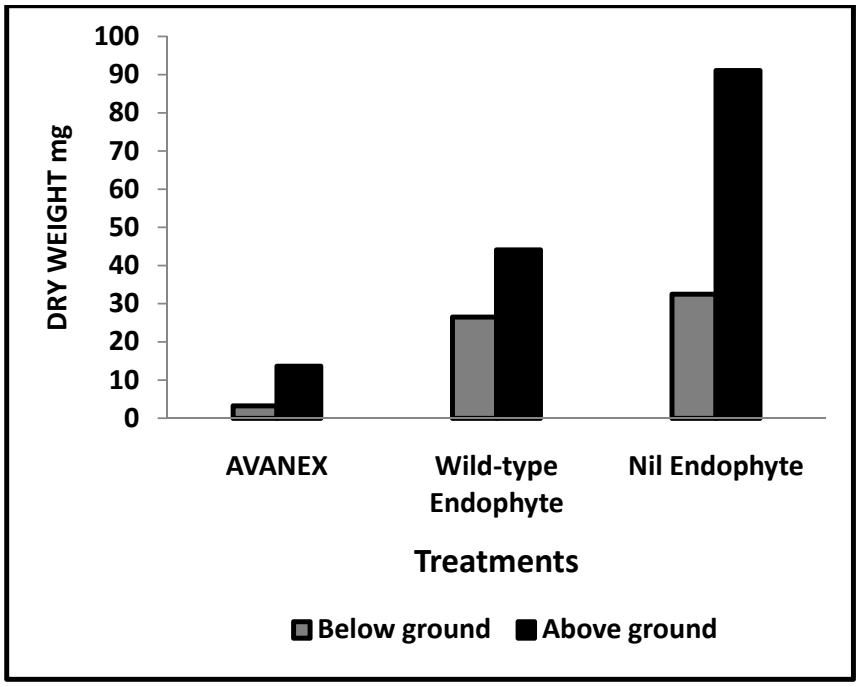

Fig 3: Dry weight of insects below and above ground for ryegrass and tall fescue containing the AVANEX™ compared with unselected wild-type endophytic grasses and grasses with no endophyte.

The testing of the AVANEX™ grasses in areas of high goose numbers continues. Data by Pennell & Rolston (2010) showed a strong negative relationship between mean ergovaline levels and mean grazing scores and reconfirms that the selection of the AVANEX™ grasses for high levels of ergovaline will deter geese.

The quality of the seed to achieve high levels of the selected endophyte in the field is essential. Our knowledge gained over the past 25 years working with selecting both forage and wild-life endophytes has confirmed that unless this specialty seed is grown, harvested, maintained, stored and distributed to the end user using best practices the results will be no better than the commercially available unselected wild-types already on the market. Rolston *et al.* (1986), Rolston & Agee (2007) and Hume *et al.* (2011) describe how the endophyte in seed can lose viability rapidly and seedlings become endophyte-free. Evidence from Washburn *et al*. (2007) of testing commercially available tall fescue varieties with variable levels of unselected endophytes for airfields has shown only average success. The paper by Washburn *et al.* quotes seed squash data for endophyte presence. However, seed squash data can not differentiate between viable and dead endophyte and is of no value in determining live endophyte level for airport sowings. Viable endophyte should be assessed in the basal stem tissue of germinated seedlings grown from the seed lot. These tests will allow airport managers to know that they are getting a product as specified. Hume *et al.* (2010) describe the effect of climatic conditions on endophyte and seed viability in stored ryegrass seed and showed that the endophyte declines in viability far faster than the viability of the seed itself. Pyke *et al.* (2010) describe seed production of bird-deterrent grass seed and describe seed quality and endophyte viability in grasses for the aviation industry. Walmsley *et al.* (2010) summarize the best practice guidelines for novel endophytic grass establishment at airports.

Conclusion:

We have demonstrated in three airports a convincing proof of concept that AVANEX™ grasses significantly reduce bird numbers. Best practice seed/endophyte management from paddock to sowing at airports is vital to ensure the product's success. Every effort must be made to ensure a successful establishment by removing all previous vegetation and reducing the impact of any accumulated seed bank.

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