

SEED PRODUCTION OF BIRD DETERRENT GRASS FOR USE AT AIRPORTS

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ABSTRACT

Grass swards can deter birds by either deterring feeding of herbivorous birds or reducing insect populations for insectivorous birds causing them to relocate to other areas to feed. The deterrent properties of the grass are provided by endophytic fungi specifically selected for these characteristics. These endophytic fungi grow within the host plant into the developing seed and when the seed is sown develop with the new grass seedling conferring bird deterrence to the developing sward.

Producing seed lines with high levels of viable endophyte and maintaining endophyte viability in storage requires very specialised seed crop production, harvesting and drying. A wide range of management practices influence the development and survival of endophyte within the seed. These practices have been evaluated in a large number of experiments to develop practices best suited to high quality seed production with guaranteed high levels of viable endophyte. Key factors that can influence endophyte, such as fungicide use and harvest management will be discussed. For example, fungicides used for disease control in the developing seed crop can significantly impact on the endophyte survival in the host plant. Storage conditions are also very important to ensure both the seed and endophyte remain viable and of high quality. The impact of different storage conditions has been evaluated and effective storage practices developed for the production of bird deterrent endophyte seed in the New Zealand industry will be discussed.

Grass seed production is a long-term cycle. The endophyte infected seed sown on airports today is the result of a 8 year breeding and selection programme for the cultivar of grass and a screening and selection programme for suitable endophytes. From this, seed will be bulked up before sowing commercial crops of bird deterrent grass seed. A bird deterrent grass seed crop may need to be sown in the spring and not harvested until eighteen months later in the following summer. Supply of high quality bird deterrent grass seed to airports requires significant lead times and specialist seed production in suitable environments.

Key Words: Bird deterrent grass, endophyte, fescue, ryegrass, seed production, airport

INTRODUCTION

Grass swards can deter birds by either deterring feeding of herbivorous birds or reducing insect populations for insectivorous birds causing them to relocate to other areas to feed. The deterrent properties of the grass are provided by endophytic fungi specifically selected for these characteristics. These endophytic fungi grow within the host plant into the developing seed and when the seed is sown develop with the new grass seedling, conferring bird deterrence to the developing sward.

Endophyte fungi in grass seed usually lose viability more rapidly than the seed germination declines (Rolston *et al*, 1986, Hume *et al* 2010), thus the developing seedling could be endophyte free. Losses of endophyte viability can occur at every step of the production-retail chain; in the seed growers field during production, with seed drying and processing, in seed storage and during transport between retail and end user (Rolston & Agee 2007). This paper examines the issues faced by the seed

industry in delivering a quality grass seed endophyte product to airports and other turf users and outlines the timelines for seed production from field selection until seed supply

BREEDING ENDOPHYTIC GRASSES

The selection and development of a suitable grass-endophyte association ('Jackal' AR601 turf tall fescue and 'Colosseum' AR95 turf perennial ryegrass) have taken six years from inoculation to having seed available for large trial and demonstration areas in airports, parks and reserves. A further two years is needed to increase seed production so commercial seed is available. From the point that the breeder has a handful of seed to the sale of commercial First Generation certified seed involves at least three and usually four generations of multiplication.

SEED PRODUCTION CYCLE

In New Zealand grass seed crops are either autumn or the previous spring sown and the plants have to experience low winter temperatures, followed by increasing day length to flower. Tall fescue is slower to establish and only autumn/early emerged tillers produce seed. Typically they are sown in spring or summer 15 to 18 months before harvest. After harvest seed must be dried, cleaned to remove weed seed, straw and leaf contaminants and then tested for physical purity, germination and endophyte. Commercial seed can take two to six months to pass through post harvest processing and testing. Thus seed supplied for sowing is the result of a decision made at least 15 to 20 months earlier with the selection of suitable fields.

DELIVERING A QUALITY ENDOPHYTE PRODUCT

There are three aspects to quality in the production of endophytic seed (i) the endophyte type is maintained during the seed production steps and is not contaminated by other endophyte types; (ii) the chemical alkaloid profile of the endophyte is maintained during production; (iii) endophyte viability is maintained during seed production harvest and storage.

Ten years of experience in delivering forage type endophytes in New Zealand and the USA have demonstrated that the traditional Seed Certification, standards to maintain grass cultivar genetic purity, can be effective for ensuring that the endophyte type and alkaloid profile are maintained. However, high grade seed (Breeders and Basic/Registered) should still be laboratory tested to ensure the alkaloid profile is not contaminated.

Seed testing used in Certification Schemes measures seed germination under laboratory conditions at a point in time. It does not guarantee seed germination at a future date, because seed germination declines in time and at a rate influenced by the storage environment. Thus the date of the last test is critical, as is knowledge of the storage environment. The same applies with endophyte.

PRODUCTION

Endophyte are fungi which are in a symbiotic relationship with the grass host species. However, other fungi can also cause diseases in grass, and some fungi, especially rusts (*Puccinia* spp.), are a common problem in grass seed crops and can cause large seed yield depression (Table 1). Some cultivars of grass are very susceptible to rusts and fungicides are often used to control fungal diseases. Research has evaluated the efficacy of fungicide products, timings and rates for the control of diseases in grasses and a number of studies address these issues (Rolston *et al* 2002) In one study, four fungicides applications were more effective than one application in controlling the rust and increasing the relative seed yield. Thus fungicides are always used in turf grass seed crops.

The robustness of the endophyte relationship with the host grass and the effect of fungicides on the endophyte are difficult to predict and each endophyte type needs to be tested. While some fungicides do not impact on a particular endophyte (Rolston *et al* 2002) experience has shown this cannot be assumed to be true for a different endophyte. As new fungicides enter the market they also need to be tested. Both triazole and strobilurin fungicides (the major fungicide groups currently used for disease control in grass) reduced endophyte levels, but generally the more systemic a fungicide the greater the reduction in endophyte viability (Table 2). Strobilurin fungicides are less systemic than triazoles and the triazoles vary in the systemic nature.

Table 1. Number of fungicide applications and type (T=triazole and S=strobilurin), seed yield and relative seed yield (RSY) in turf ryegrass Methven 2009/10.

Application Frequency	Type	Seed Yield (kg/ha)	RSY
0	Nil	1380	100
1	T or S only	2070	150
1	T+S mix	2330	169
4	T or T+S mix	2830	205
	LSD 5%	198	

Table 2. Viable endophyte percent in tall fescue cv Flecha with AR542 endophyte treated with with two different strobilurin (S) and three different triazole (T) fungicides at Leeston 2004/05.

Fungicide	Endophyte (%)
nil	75 a*
S1+T1	75 a
S2+T1	59 ab
S1+T2	59 ab
T3	40 b

* Numbers with the same letter are not significantly different (LSD 5%).

HARVEST TIME AND METHOD

As seed develops and matures it undergoes changes to survive in a dehydrated state. Endophytes also have to change to survive in this dehydrated state and this requires the laying down of storage material and, possibly, changes in hyphal membrane structure to survive in the low moisture environment. Seeds are not all at the same physiological maturity at harvest because flowering and seed set is spread over approximately 14 days, the result of the hierarchy of tiller age, and a hierarchy of flowering within a seed head. Grass seed is commonly cut at about 40% Seed Moisture Content (SMC) and allowed to dry in a windrow for 7 to 10 days, then threshed with a combine harvester at 12-14% SMC. If the crop is cut early (>42% SMC) then fewer seeds will have endophyte that has entered a physiological state to survive well in storage. If cutting is delayed seed losses from shattering can become an issue.

The weather during harvest, especially rain events that delay harvest, can have a detrimental effect on endophyte viability. In years where seed is threshed at higher than desirable seed moisture for endophyte viability (> 11%) seed must be dried with low humidity air (achieved by heating the air). The effect of drying speed, air temperature and potential interaction with seed moisture on endophyte

viability has not been documented, but as poor drying practices can influence seed viability it is probable they will also impact on endophyte viability.

SEED STORAGE AND RETAIL

Seed viability is reduced by higher temperatures and higher SMC, which is in equilibrium with relative humidity (RH%) (Copeland & McDonald 1995). As a rule of thumb the life of seed is doubled for every 5°C decline in storage temperature or for every 1% decline in SMC (Copeland & McDonald 1995). These two effects are interdependent; thus a seed with low moisture content will survive higher temperature better than seed with high moisture. The two parameters (temperature and seed moisture) have an additive effect: thus a 5°C cooling and a drop of 10% RH, resulting in a 1% decline in SMC, increases seed viability by four times. Seed endophyte viability is also driven by both temperature and SMC (Rolston *et al* 1986); but the thresholds levels are much less and a decline in viability occurs after shorter exposure periods.

Typically grass seed viability in an ambient temperature store averaging 15°C and 70% RH will be maintained for 2 to 4 years. In contrast endophyte viability in the same seed is maintained for only 0.5 to 1.5 years. The management and delivery of a high viability endophyte seed (>70% viability) is difficult and many traditional turf seed companies do not have the experience and expertise to deliver a quality endophyte product. Companies that are serious about delivering quality endophyte are storing seed in controlled environments.

To reduce the potential of loss of endophyte in the retail chain most companies are adopting ship-to-order policies so that the seed is moved from controlled environment storage to the end user when drilling is about to commence.

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