Farming for the future
On-farm demonstration program
Project number 97PR13

# Endophyte content of turf grass seed stands in the Peace River region
Final Report, 1999

D.T. Fairey & J. A. C. Lieverse

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# Endophyte content of turf grass seed stands in the Peace River region
# Final Report

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## ABSTRACT

Amenity grass varieties often contain an endophyte that gives the plant greater resistance to environmental stress and pests and, as a consequence, provides an attractive ground cover. In addition, seed yields of these varieties are usually higher. However, endophytes produce the toxin ergovaline and/or lolitrem B that cause disorders in livestock fed the straw, seed screenings and regrowth.

At present, there is an increasing interest in contract seed production of amenity grasses in the Peace. The removal of crop aftermath is essential to maintain the productivity of stands. This crop residue and aftermath could be a valuable source of livestock feed if safe levels of ergovaline/lolitrem B are present in this material.

During the 1997 and 1998 growing seasons, plants from various seed fields were sampled for toxic levels. The ergovaline and lolitrem B content of these samples were quantified to determine whether toxic levels were present. In most cases, the endophyte content of the seed that planted was related to the toxin content of the plant that emerged from it. However, the location of the crop and the species were important factors that influenced the toxin content. Straw samples from 1998 were also analysed for feed value. The effects of variety and endophyte content in the seed planted in relation to the feed value of the straw and toxin levels in the straw and seed harvested were examined.

## PURPOSE OF THE PROJECT

There is an increasing interest in contract seed production of amenity grasses such as fescues, Kentucky bluegrass and perennial ryegrass in the Peace River region. The seed produced is used for golf courses, lawns, bowling greens, roadside vegetation etc. Most amenity varieties produce both large quantities of seed and herbage. After seed harvest, there is abundant straw and aftermath that could be used for livestock feed. In addition, the recent introduction of a value-added industry in the Peace, fibre board used in making furniture, offers the grower an alternative market for the straw.

Many of these grasses contain an endophyte that makes them drought tolerant, resistant to insects and diseases and consequently, an attractive ground cover. In addition, seed yields are also higher.

An endophyte is a fungus that lives inside a grass plant. Endophyte contents of infected varieties are different for each batch of seed and can vary from 0 to 100%. The endophyte does not harm the grass plant but it produces a chemical (ergovaline or lolitrem B) that is toxic to livestock.

## OBJECTIVES

To determine the amount of toxins in the straw, regrowth and seed residues in amenity grass seed fields in the Peace to permit the safe use of these products. To examine the feed value of the straw.

## METHODS TO ACHIEVE OBJECTIVES

Samples were taken from a number of fields planted since 1994 as follows (Table 1 ).

(I) Straw baled up after seed harvest.
(ii) The fall re-growth in fields harvested for seed.
(iii) The seed harvested.
(iv) The fall growth from fields planted in the spring of the same year.

The ergovaline or lolitrem b levels were determined in these samples. The feed quality of the straw was assessed in the second year of the study.

**Table 1. Samples taken in 1997 and 1998 from fields established since 1994**

| Year of establishment | Number of Fields sampled in: | |
|---|---|---|
| | 1997 | 1998 |
| **1994** | **2** | **0** |
| **1995** | **8** | **3** |
| **1996** | **10** | **4** |
| **1997** | **17** | **9** |

A total of 53 fields at various locations, of different varieties and stand ages were sampled over two growing seasons. It should be noted that the species varied with the field harvested. Furthermore, equal number of varieties within each species could not be obtained. The 1998 growing season was one of the driest on record; some fields were not harvested while others were plowed up. Samples of fall regrowth from harvested stands and those established in 1998 were not taken because the stands were too sparse to be harvested. Age of stand between sampled varieties was not uniform. However, this study provides data that could be a starting point for understanding the changes in concentrations of the toxins ergovaline and lolitrem B and feed values of amenity grass seed stands in the Peace.

**Table 2. Tissue samples taken from fescue* seed fields (creeping red, *Festuca rubra*; hard *F. longifolia*; tall *F. arundinacea*)**

| Tissue | Number of Samples | |
|---|---|---|
| | 1997 | 1998 |
| Seed | 15 | 17 |
| Straw | 12 | 27 |
| Fall regrowth | 17 | 0 |
| Fall growth | 16 | 0 |

*Slender creeping fescue (*Festuca rubra*) was originally included in this study, but has been excluded from the final report because no data were available in both years.

**Table 3. Threshold levels of ergovaline and lolitrem B that are harmful to animals**
(Source: Oregon State University Extension Service)

| Animals | parts per billion | |
|---|---|---|
| | Ergovaline | Lolitrem B |
| Horses | 300 - 500 | not determined |
| Cattle | 400 - 750 | 1800 - 2000 |
| Sheep | 800 - 1200 | 1800 - 2000 |

**Table 4. Ergovaline levels in 1997 and 1998 in some fine fescues in relation to endophyte content (EC%) of seed planted**

| Variety (Species) | EC % | Field | Age of stand | Ergovaline (parts per billion) | | | |
|---|---|---|---|---|---|---|---|
| | | | | straw | seed | fall regrowth | fall growth |
| Shademaster II creeping red fescue | 0 | 1 | 97:1<br>98:2 | 97:10<br>98:10 | 97:10<br>98:10 | 97:0 | 97:0 |
| | | 2 | 97:1<br>98:2 | 97:*<br>98:* | 97:*<br>98:10 | 97: na [2] | 97:* |
| Discovery hard fescue | 40 | 1 | 97:1<br>98:2 | 97:na[1]<br>98: 10 | 97:na[1]<br>98:47 | 97: na[1] | 97:0 |
| | | 2 | 97:2<br>98:3 | 97:10<br>98:* | 97*<br>98:* | 97:26 | 97:na[2] |
| | | 3 | 97:1<br>98:2 | 97:na[1]<br>98:50 | 97:na[1]<br>98:92 | 97:na[1] | 97:10 |

na[1] = not applicable because the stand was seeded in the same year; no seed to harvest.
ns = not sampled - insufficient plant growth.
na [2] = not applicable because the stand was seeded in a previous year and therefore there was no new growth to harvest.
* missing

Ergovaline levels were not toxic in both varieties of fine fescue included in this study despite a 40% endophyte level in the Discovery seed planted.

**Table 5. Ergovaline in tall fescue in relation to endophyte (E%) of seed planted**

| Variety | E% | Field | Age of stand | Ergovaline (parts per billion) | | | |
|---|---|---|---|---|---|---|---|
| | | | | straw | seed | FRG** | FG*** |
| Apache II | 40 | 1 | **97**:2 **98**:3 | **97**:119 **98**:222 | **97:3481[T]98:1242[T]** | **97**:116 | **97**: na [2] |
| | | 2 | **97**:1 **98**:2 | **97**:na[1] **98**: na[1] | **97**:na[1] **98:3259[T]** | **97**: na[1] | **97:422[T]** |
| Coronado | 99 | 1 | **97**:3 **98**:4 | **97**:131 **8:411[T]** | **97:3789[T] 98:7830[T]** | **97**:131 | **97**:na [2] |
| | 74 | 2 | **97**:2 **98**:3 | **97**:374 98:368 | **97:5426[T] 98:6240[T]** | **97**:147 | **97**:na [2] |
| | | 3 | **97**:2 **98**:3 | **97:545[T]98:459[T]** | **97:3408[T] 98:7884[T]** | **97**:260 | **97**:na [2] |
| | | 4 | **97**:2 **98**:3 | **97**:s **98**:368 | **97:2307[T] 98**:* | **97**:232 | **97**:na [2] |
| | | | **97**:1 **98**:2 | **97**: na[1] **98**:278 | **97**:na[1] **98**: **5295[T]** | **97**: na[1] | **97:424[T]** |
| Eldorado | 0 | 1 | **97**:2 **98**:3 | **97**:13 **98**: 10 | **97**:23 **98**:* | **97**:10 | **97**:na [2] |
| | | 2 | **97**:1 **98**:2 | **97**:na[1] **98**: 10 | **97**:na[1] **98**:46 | **97**:na[1] | **97**:0 |
| | | 3 | **97**:1 98:2 | **97**:na[1] **98**: 10 | **97**:na[1] **98**:23 | **97**:na[1] | **97**:0 |
| | | 4 | **97**:1 98:2 | **97**:na[1] **98**:10 | **97**:na[1] **98**:10 | **97**:na[1] | **97**:0 |
| Safari | 34 | 1 | **97**:3 **98**:4 | **97**:10 **98**:10 | **97**:s **98**:10 | **97**:0 | **97**:na [2] |
| | | 2 | **97**:3 **98**:4 | **97**:31 **98**:10 | **97**:s **98**:10 | **97**:10 | **97**:na [2] |
| | | 3 | **97**:3 **98**:4 | **97**:* **98**: * | **97**:143 **98**:* | **97**:0 | **97**:na [2] |
| | | 4 | **97**:2 **98**:3 | **97**:* **98**:* | **97**:10 **98**:* | **97**:0 | **97**:na [2] |
| | | 5 | **97**:1 **98**:2 | **97**:na[1] **98**:10 | **97**:na[1] **98**:10 | **97**:na[1] | **97**:0 |
| | | 6 | **97**:1 **98**:2 | **97**:na[1] **98**:* | **97**:na[1] **98**:10 | **97**:na[1] | **97**:0 |
| TarHeel | 100 | 1 | **97**:1 **98**:2 | **97**:na[1] **98**:* | **97**:na[1] **98**:* | **97**:na[1] | **97:494[T]** |
| Tomahawk | 0 | 1 | **97**:3 **98**:4 | **97**:* **98**: 10 | **97**:* **98**:* | **97**:0 | **97**:na [2] |
| | | | **97**:1 **98**:2 | **97**:na[1] **98**:10 | **97**:na[1] **98**: 10 | **97**:na[1] | **97**:0 |
| | | 2 | **97**:3 **98**:4 | **97**:0 **98**: 10 | **97**:10 **98**: 10 | **97**:0 | **97**:na [2] |
| | | | **97**:1 **98**:2 | **97**:na[1] **98**: 10 | **97**:na[1] **98**:* | **97**:na[1] | **97**:0 |
| | | 3 | **97**:3 **98**:4 | **97**:* **98**:* | **97**:17 **98**:* | **97**:0 | **97**:na [2] |

na[1] = not applicable, stand seeded in same year; or a seed crop not harvested. * missing; **fall regrowth; *** fall growth; In 1998, fall growth and regrowth were not harvested in 1998 because of insufficient plant growth. [T] followed by values in bold = level toxic to cattle.

In tall fescue varieties where the seed planted had 40% endophyte or higher, ergovaline content in the lush fall growth of plants seeded in the spring of the same year were at toxic levels. Also, the seed and straw harvested from a first or second crop of these varieties contained toxic levels of ergovaline. Older stands appeared to have higher toxin levels.

**Table 6. Lolitrem B levels in perennial ryegrass in relation to the seed that was planted (sampled in 1997 only)**

| Variety | Endophyte (%) of seed planted | Lolitrem B (parts per billion) | | |
|---|---|---|---|---|
| | | straw | seed | fall re- growth |
| Brightstar | 97 | **2576$^{T}$** | * | **1000$^{T}$** |

* = could not obtain seed sample. $^{T}$ followed by values in bold = level toxic to cattle.

The by-products of a high-endophyte Brightstar seed stand are very toxic to livestock. Grazing of fall re-growth is not recommended as is the use for feed or bedding unless proper mixing with low endophyte material can be assured.

**Table 7. Feed value of the straw of some amenity fescues (sampled in 1998).**

| Variety | Percent dry matter | | | Megacalories / kg dry matter | | | |
|---|---|---|---|---|---|---|---|
| | protein | ADF | TDN | NEL | NEM | NEG | DE |
| Apache II | 11.5 | 41.1 | 53.1 | 1.05 | 1.16 | 0.46 | 2.33 |
| Coronado | 6.8 | 41.2 | 53.0 | 1.04 | 1.15 | 0.45 | 2.33 |
| Discovery | 4.3 | 45.0 | 47.2 | 0.85 | 1.01 | 0.31 | 2.08 |
| Eldorado | 7.7 | 39.3 | 55.6 | 1.13 | 1.22 | 0.52 | 2.45 |
| Safari | 8.0 | 40.6 | 54.8 | 1.08 | 1.19 | 0.49 | 2.39 |
| Shademaster II | 6.8 | 49.6 | 40.4 | 0.63 | 0.83 | 0.13 | 1.78 |
| Silverado | 10.0 | 36.7 | 59.6 | 1.26 | 1.32 | 0.62 | 2.62 |
| Tomahawk | 6.5 | 40.4 | 54.1 | 1.08 | 1.19 | 0.49 | 2.38 |

**Protein:** the total protein contained in feeds as determined by measuring nitrogen content. % protein = %N x 6.25

**ADF:** Acid Detergent Fibre - consists of lignin and cellulose, the least digestible portion of a roughage. ADF content of forages is used to determine digestibility and energies.

**TDN:** Total Digestible Nutrients - a term which is estimated from the ADF content and is used to describe the digestible value of a feed.

**NEL:** Net Energy for Lactation - based on the ADF; it is used for dairy ration balancing.

**NEM:** Net Energy for Maintenance - amount of energy required to maintain an animal with no change in body weight or composition. It is based on the ADF and is used in ruminant ration balancing.

**NEG:** Net Energy for Gain - based on the ADF and is used for balancing rations for ruminants.

**DE:** Digestible Energy - the amount of energy consumed minus the amount of energy lost in faeces. DE is calculated based on ADF analysis.

**Table 8. Nutrient composition of typical feed sources (adapted from: Feed Reference Chart; Norwest Labs, Edmonton, Alberta, Canada**

| Feedstuff | Dry matter basis | | |
|---|---|---|---|
| | Protein % | Acid Detergent fibre % | Total digestible nutrients % |
| Barley straw | 3 | 55 | 46 |
| Oat straw | 4 | 48 | 48 |
| Wheat straw | 3 | 58 | 44 |
| Bromegrass hay | 10 | 41 | 55 |
| Grass hay | 12 | 40 | 58 |

The feed value of the amenity grasses used in this study (Table 7) compare favourably with grass hay and cereal straw (Table 8).

## SUMMARY

1. In tall fescue varieties where the seed planted had 40% endophyte or higher, ergovaline content in the lush fall growth of plants seeded in the spring of the same year were at toxic levels. Also, the seed harvested from a first or second crop of these varieties contained toxic levels of ergovaline. However, this was not the case with the hard fescue variety Discovery used in this study that had an endophyte content of 40%.

2. The by-products of a grass stand that is established with endophyte-infected seed should be tested for ergovaline or lolitrem b levels to determine their toxicity before use for livestock feed or bedding. The amount of toxins consumed by livestock can be controlled by diluting the affected feed with other non-infected feed.

3. Toxic levels can vary with field location even when the variety is established from the same seed.

4. Seed screenings are best avoided as a feed source for livestock, unless it is determined that the toxin concentration is below the critical value for the livestock being fed.

5. Straw and regrowth, provided they have zero or non-toxic levels of toxins, provide a similar level of nutrition as other grass or cereal straw.

6. The recent establishment of a fibre board plant in the Peace offers growers an alternative market for the straw removed from their grass seed fields.

## ECONOMIC RETURNS

Climatic conditions in the Peace region are particularly favourable to grass seed production because the requirement of day length and temperature for flowering are met. There is an increasing demand from overseas markets for seed of turf species. Contract seed production of these species provides a lucrative alternative to our growers. Notwithstanding the financial benefits, the value of forages in crop rotations and soil amelioration are well documented.

The continued seed productivity of grass seed stands can only be assured with the removal of straw and harvest aftermath. This plant material could provide livestock producers with alternative sources of nutritious feed either for grazing, or as conserved silage or hay, from the growth available by late summer or fall of the establishment year of the seed crop. In the seed-producing years, the straw remaining after harvest could be baled for winter feed and/or bedding.

Ascertaining the changes in toxin content in relation to field location and stand age will provide guidelines that will assist in reducing and/or eliminating the risk of livestock loss with endophyte-infected plant material. Livestock producers could then take advantage of a locally produced source of nutritious feed and provide the grass seed growers with an additional source of income. Another source of income has come on the scene in the last 18 months. Fescue straw is used to produce high quality fibre board for making furniture. This value-added industry is a new addition to the Peace and some growers have found a market for their straw from the 1998 harvest at the local fibre board plant. This is particularly suitable for straw residues that are likely to be high in endophyte toxins.

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