Studies on Dieback of Buffel Grass (*Cenchrus ciliaris*) in Central Queensland

A thesis by:

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Abstract

Buffel grass (*Cenchrus ciliaris*) is an introduced, summer growing, perennial tufted tussock grass which is used extensively in improved pastures in the grazing industry. Since 1993 there has been an increasing level of dieback in buffel grass in districts of Central Queensland districts, involving red leaf symptoms and occurring in roughly circular patches. There is a potential for this condition to destroy large areas, ultimately resulting in loss of production for beef, dairy and sheep farmers who use this grass in improved pastures.

This is the first multifaceted study of buffel grass dieback (BGD). Areas showing signs of dieback have previously been the subject of extensive testing for soil fertility factors, soil chemistry, nematodes and phytoplasmas, with few conclusive results. Therefore, one of the aims of this project was to find the cause of buffel grass dieback. Specific objectives included describing the plant and field symptoms, determining factors responsible for plant death, and determining the method of spread.

A complete description of the symptoms was made at plant, patch and paddock levels. Symptoms of Buffel Grass Dieback (BGD) presented as a reddening of the leaves starting from the tip and progressively moving towards the ligule. The red symptoms range from bright red, to dark red, to bronze (RHSPCC red group 45: A, B; 46: A, B; greyed-orange group 166: A; 177; A) (The Royal Horticultural Society, 2001). Symptoms first appeared on the tips of the older leaves and progressively moved down the leaf. The next oldest leaf then showed symptoms, and so on, with the youngest leaf showing symptoms last. Any tillers followed the same pattern, regardless of whether symptoms on the primary shoot had progressed past the point at which the tiller was produced. The amount of time from new growth to the appearance of the red symptoms seemed to be directly proportional to the amount of rainfall. That is, the more rain, the longer it took for symptoms to develop. The amount of subsequent rainfall seemed to influence the time it took for plants to succumb to the condition. That is, when there was adequate water and lush growth plants grew faster than the spread of the condition. When plants became water stressed, the condition overtook growth and the plants succumbed.
Symptomatic leaves did not always have a clear red-green boundary. Occasionally, BGD symptoms progressed faster down one half of the leaf. Red symptoms were invariably more vivid on the adaxial surface of the leaves than on the abaxial surface. Roots of affected plants appeared stunted compared to roots of unaffected plants. Roots of affected plants often displayed soft, darker, ovoid sunken regions, which were possibly lesions.

The BGD condition appeared to become dormant as buffel grass became dormant. That is, if the dieback condition killed the plant before the onset of dormancy, no new shoots were produced subsequent to a rainfall event. However, if dormancy occurred before the plant succumbed to the condition, new shoots were produced after rain, and the cycle repeated with symptoms first appearing in the oldest leaf.

Patches were roughly circular and ranged from 2 m diameter to over 60 m diameter. Adjacent patches often coalesced and further enlarged. Symptoms first appeared on the periphery of an existing patch, where during the last cycle the plants had become dormant before succumbing to the condition. Symptoms progressively moved outwards from the periphery of the patch, at a rate of approximately 5 cm per week. Patch spread was irregular and did not correspond with soil compaction or land slope, though the condition may spread more rapidly downhill due to runoff.

BGD affected plants weighed approximately two thirds that of unaffected plants. They were noticeably shorter and had shorter leaves and internodes, with the difference in height attributed to internodes rather than leaf length. BGD affected plants also had fewer tillers than unaffected plants of the same age. Although the numbers of leaves per tiller were the same as unaffected plants, the overall result was a decreased amount of foliage available for grazing, thereby decreasing productivity of livestock. In fact, the loss of productivity was twofold, since cattle had been observed to selectively graze unaffected plants.

BGD affected plants had fewer seed heads, shorter seed fascicles, and a higher proportion of non-viable embryos compared to unaffected plants. Therefore, not only did BGD affected plants succumb and die, but there were fewer seedlings to replace them. This could have detrimental consequences for the sustainability of an improved pasture.
At the cellular level, there was no discernable difference in cell size between BGD affected plants and unaffected plants in either roots or leaves. However, the roots of BGD affected plants were more damaged at the cellular level, with the cortex mostly sloughed off and the mesophyll cells disrupted.

The bulliform and mesophyll cells of BGD affected leaves were more irregular in shape. The bundle sheath cells of BGD affected leaves appeared disrupted, with chloroplasts not in their usual alignment. There also seemed to be a breakdown of chloroplasts.

The leaf pigment data concurred with the premise of a breakdown of chloroplasts. Red symptomatic leaves had lower concentrations of chlorophylls \( a \) and \( b \) compared to green leaves on the same plant. Red symptomatic leaves also had higher concentrations of anthocyanins and carotenoids. It appears that, in red symptomatic leaves, chlorophylls were being destroyed and anthocyanins were being excessively produced.

There was no discernible difference in the phloem vessels of BGD affected and unaffected plants, both in the roots and the leaves. However, the xylem of both roots and leaves was partially occluded by structures tentatively identified as tyloses. These structures could also have been local accumulations of phenols or polyphenols, or in some cases the remnants of partially decomposed cells. These occlusions seemed more severe in the roots than in the leaves. Possible inclusion bodies were also found in the mesophyll cells of BGD affected leaves. Inclusion bodies are usually a sign of pathogen infection. However, there were no pathogens detected in the histology work.

Chemical analyses were made of BGD affected plants, as well as of the soil in which they were growing, concluding that both plants and soil in the BGD affected paddock surveyed were deficient in nitrogen, phosphorus, sulfur and zinc.

A survey was made of other plant species present in the vicinity of the dieback condition, with particular attention given to those species which have reported allelopathic effects. In addition, a study was made on other plant species which also appear to be affected by the dieback condition. Microbial isolations were regularly made from both plant and soil material. The isolates obtained were tested for proof of pathogenicity using Koch’s Postulates, but none proved to be the causal agent of BGD.
The mode of transmission of the condition was studied, and BGD was found to be soilborne. Whether root contact is necessary for successful transmission was not established.

Possible methods of controlling the condition were investigated. While none of the treatments successfully controlled the condition, one of the treatments investigated, Amistar (a systemic fungicide), greatly reduced symptom severity.

Although the cause of BGD was not found, several important discoveries were made concerning its effect and spread, and many possible causes of the condition were eliminated. It is likely that BGD is caused by a disease complex, with potential pathogens including soilborne fungi and/or viruses. Several abiotic factors such as water and nutritional stress may be contributing causal agents, weakening the plants and making them more susceptible to a pathogen.

More work is needed to conclusively identify the primary causal agent of this potentially costly condition.
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Declaration

I declare that the main text of this thesis, unless otherwise stated, is my own work and has not been submitted in any other form at any University or institution. Information derived from other sources has been acknowledged in the text and a list of references is given.

Name: Sandrine Makiela

Signed:

Date:
# Table of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AS</td>
<td>Australian Standards</td>
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<tr>
<td>BGD</td>
<td>Buffel Grass Dieback</td>
</tr>
<tr>
<td>CEC</td>
<td>Cation Exchange Capacity</td>
</tr>
<tr>
<td>CQ</td>
<td>Central Queensland</td>
</tr>
<tr>
<td>CQU</td>
<td>Central Queensland University</td>
</tr>
<tr>
<td>CSBP</td>
<td>Cumming Smith British Petroleum (company)</td>
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<tr>
<td>cv.</td>
<td>Cultivar</td>
</tr>
<tr>
<td>DPX</td>
<td>Dibutyl phthalate, Polystyrene resin, Xylene</td>
</tr>
<tr>
<td>EC</td>
<td>Electrical Conductivity</td>
</tr>
<tr>
<td>ESP</td>
<td>Exchangeable Sodium Percentage</td>
</tr>
<tr>
<td>GLM</td>
<td>Generalised Linear Model</td>
</tr>
<tr>
<td>ICP</td>
<td>Inductively Coupled Plasma (Spectrophotometer)</td>
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<tr>
<td>ICP-AES</td>
<td>Inductively Coupled Plasma Atomic Emission Spectroscopy</td>
</tr>
<tr>
<td>ISTA</td>
<td>International Seed Testing Association</td>
</tr>
<tr>
<td>LSD</td>
<td>Least Significant Difference</td>
</tr>
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<td>RHS</td>
<td>Royal Horticultural Society</td>
</tr>
<tr>
<td>RHSPCC</td>
<td>Royal Horticultural Society Plant Colour Chart</td>
</tr>
<tr>
<td>SE</td>
<td>Standard Error (of the mean)</td>
</tr>
<tr>
<td>s.e.d.</td>
<td>Standard Error of Difference</td>
</tr>
<tr>
<td>TTC</td>
<td>1,3,5 triphenyl tetrazolium chloride</td>
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