

## **Final Report**

# **Integrated management of yellow Sigatoka and other diseases in north Queensland**

**Project leader:**

Jim Pekin

**Delivery partner:**

Australian Banana Growers' Council

**Project code:**

BA15003

**Project:**

Integrated management of yellow Sigatoka and other diseases in north Queensland BA15003

**Disclaimer:**

Horticulture Innovation Australia Limited (Hort Innovation) makes no representations and expressly disclaims all warranties (to the extent permitted by law) about the accuracy, completeness, or currency of information in this Final Report.

Users of this Final Report should take independent action to confirm any information in this Final Report before relying on that information in any way.

Reliance on any information provided by Hort Innovation is entirely at your own risk. Hort Innovation is not responsible for, and will not be liable for, any loss, damage, claim, expense, cost (including legal costs) or other liability arising in any way (including from Hort Innovation or any other person's negligence or otherwise) from your use or non-use of the Final Report or from reliance on information contained in the Final Report or that Hort Innovation provides to you by any other means.

**Funding statement:**

This project has been funded by Hort Innovation, using the Banana research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

**Publishing details:**

ISBN 978 0 7341 4550 5

Published and distributed by: Hort Innovation

Level 7

141 Walker Street

North Sydney NSW 2060

Telephone: (02) 8295 2300

[www.horticulture.com.au](http://www.horticulture.com.au)

© Copyright 2019 Horticulture Innovation Australia

**Content**

<b>Content</b>	<b>3</b>
<b>Summary</b>	<b>4</b>
<b>Keywords</b>	<b>4</b>
<b>Introduction</b>	<b>5</b>
<b>Methodology</b>	<b>6</b>
<b>Outputs</b>	<b>8</b>
<b>Outcomes</b>	<b>10</b>
<b>Monitoring and evaluation</b>	<b>11</b>
<b>Recommendations</b>	<b>13</b>
<b>Refereed scientific publications</b>	<b>13</b>
<b>Intellectual property, commercialisation and confidentiality</b>	<b>13</b>
<b>Acknowledgements</b>	<b>14</b>
<b>Appendices</b>	<b>15</b>

## Summary

BA15003 commenced in January 2016 and has supported the work of the Yellow Sigatoka Liaison Officer of the Australian Banana Growers' Council (ABGC), Mr Louis Lardi over the last three years. The Liaison Officer's North Queensland (NQ)-based role included educating growers on yellow Sigatoka and leaf speckle ('leaf spot') symptoms and integrated control; and assisting growers to voluntarily keep levels of leaf spot disease on their plantations below recommended levels (less than five per cent).

The liaison officer undertook leaf spot inspections on all NQ commercial farms and in some backyards, and was responsible for alerting Biosecurity Queensland (BQ) if any other suspected banana diseases were found. A key part of the role was the sharing information with and between growers, aerial operators, chemical sellers, government and university research staff. The officer also supported NQ banana growers in best-practice disease management.

The project was highly successful with comprehensive disease surveillance data collected from all farms in the NQ region. Biosecurity Best Management Practice Manual (BMP) for disease control was promoted through a wide range of educational material and activities as well the dissemination of information through various media channels to growers and the communities of NQ. Leaf specimens were taken which allowed the confirmation of leaf spot diagnosis and some testing for fungicide resistance. Complaints of excessive disease levels were also investigated and acted upon within 48 hours.

Through the work of the Liaison Officer, 97% compliance with relevant leaf spot requirements was achieved in NQ through a voluntary industry approach. This meant greater biosecurity for the banana industry as a whole. Low disease levels help maintain a consistent quality and supply of bananas, minimise production costs and are beneficial to the environment and workplace safety through the reduced need for chemical spraying.

Data generated during the project is an important resource to monitor and understand disease outbreaks in the target region and assess compliance levels with legislation. Professional working partnerships with BQ and AgriScience Queensland (ASQ) were facilitated through the Liaison Officer, which enhanced biosecurity for the banana industry. These features are of key importance for the ongoing management and containment of TR4 and assisting growers to meet their biosecurity obligations. Containment of TR4 is critical to reducing the impact of this disease on banana production in Australia's largest production area.

Owing to the success of the project, it was recommended that a similar project be continued to provide effective disease surveillance, biosecurity extension advice and integrated disease management in NQ.

## Keywords

Banana; leaf spot; Yellow Sigatoka; *Pseudocercospora*; *Mycosphaerella*; Leaf Speckle; Integrated Pest Management; surveillance; monitoring; biosecurity.

## Introduction

Both yellow Sigatoka and leaf speckle, commonly referred to as “leaf spot” are established and serious foliar diseases of bananas in the NQ production area. Uncontrolled leaf spot causes significant economic losses from reduced yield, premature ripening and reduced market access. Importantly, if it is left untreated it is highly likely to affect the productivity of neighbouring plantations.

The Banana Industry Biosecurity Guideline established under the Biosecurity Act 2014 provides guidance to persons who cultivate bananas on discharging their general biosecurity obligation (GBO). This includes the management of leaf spot in plantations.

Leaf spot management should be undertaken if infestation  $\geq 5\%$  is present on any leaf on a property within the Northern Banana Biosecurity Zone. Effective control of leaf spot is important to reduce production costs but also because leaf spot has the potential to mask an outbreak of the similar looking but far more destructive exotic disease, black Sigatoka.

The aims of this project included:

- providing a resource (an industry liaison officer) to assist growers achieve less than 5% leaf spot on a voluntary basis. (Rather than police growers, the role’s intention was to educate and help growers access information to improve their integrated leaf spot management).
- educating growers on the symptoms of leaf spot.
- undertaking leaf spot inspections.
- sharing information with and between growers, aerial operators, chemical sellers, government and university research staff.
- surveying farms for other banana diseases and alerting BQ and relevant scientists in ASQ when any suspect other exotic banana diseases are found.
- Supporting NQ banana growers in best practice disease management.

The previous related project (BA12007) was expanded in BA15003 to provide banana biosecurity extension advice to farmers, so was not only focused on leaf Spot. The liaison role in BA12007 project also changed as a result of the Panama TR4 incursion (of March 2015) requiring elevated farm biosecurity measures, which BA15003 has supported.

## Methodology

The project engaged a Liaison Officer to work closely with commercial banana plantations and the community in NQ, and BQ. The Liaison Officer had limited inspector powers and conducted regular in-field surveys across NQ production areas (from Rollingstone in the south, to Lakeland and Hopevale, including Mareeba in the north) to assess the levels of both yellow Sigatoka and Leaf Speckle.

The intention of the project was to encourage more active and voluntary compliance concerning disease levels through having a visible surveillance presence on the ground. Leaf spot management should be undertaken if infestation  $\geq 5\%$  is present on any individual leaves (Appendix 1) of a property within the Northern Banana Biosecurity Zone in order for growers to meeting their General Biosecurity Obligation under the Biosecurity Act (2014).

([https://www.daf.qld.gov.au/\\_\\_data/assets/pdf\\_file/0003/378471/Banana\\_Industry\\_Biosecurity\\_Guideline.pdf](https://www.daf.qld.gov.au/__data/assets/pdf_file/0003/378471/Banana_Industry_Biosecurity_Guideline.pdf)).

Where levels were found to be approaching critical levels affecting  $\geq 5\%$  of the area of a leaf, the liaison officer worked with growers to ensure they managed the disease and voluntarily met the guideline. When growers failed to respond to the voluntary approach and take appropriate action to manage the disease, the property was reported to senior plant health inspectors from BQ for action through the regulatory system.

In addition to the surveillance role, the Liaison Officer engaged with growers regarding best management practice for biosecurity in an effort to lift awareness and adoption of good on-farm practices. It was required that the Liaison Office have a banana production background, experience with disease control and surveillance.

The Australian Banana Growers' Council (ABGC) with Hort Innovation Funding employed Mr Louis Lardi into the role of the Liaison Officer. Mr Lardi had effectively conducted this role during the previous two projects (HAL-BA09055 and BA12007) and had extensive experience in the areas outlined above. In addition, he had built strong relationships with the NQ growers and BQ, and was able to provide advice to growers in a practical and authoritative manner. These skills were considered central to the adoption of good on-farm practices.

The types of activities the Liaison Officer was required to perform included farm visits including inspection of plantations, the development and dissemination of extension material related to pests and diseases, input and representation at banana growers association meetings, local and community group meetings and events. Regular liaison with BQ and consultation with relevant scientific and technical experts when required.

### 1. Inspection of farms

There are currently 268 farms in the northern pest quarantine area which were to be visited at least annually.

The Northern pest quarantine area is divided into:

- Kennedy Valley area including Ingham and Rollingstone
- Murray Upper area
- Mission Beach area
- Tully El Arish area
- Silkwood north to Innisfail area
- Innisfail north to Cairns area
- Tableland area
- Julatten to Daintree
- Lakeland
- Cooktown and Hopevale

The order in which the Liaison Officer undertook farm inspections was determined by the most efficient way to cover the production area as areas were reached by road. If a revisit to a farm was required, it was scheduled in a way to make the most efficient use of resources.

The inspection process was as follows:

- The Liaison Officer phoned farms a few days ahead of when he knew he would be in the area to arrange appointments.
- On the appointed day, the Liaison Officer arrived at the appointed pick-up point where he left his vehicle (preferably outside the farm gate on bitumen road).
- Before entering the farm, the Liaison Officer sprayed his boots with an appropriate disinfectant e.g Sterimax.

- The Liaison Officer then adhered to all biosecurity practices of each individual farm and traveled the plantation with the grower. This had two purposes: 1) to reduce the risk of transmission of plant diseases by the Liaison Officer's vehicle and 2) enable the Liaison Officer to talk to the grower about the disease issues he/she may have been having. If the grower required information on leaf diseases, the Liaison Officer was able to provide it.
- The Liaison Officer and the grower drove slowly through the plantation inspecting the plants for leaves which might be showing  $\geq 5\%$  leaf area affected by yellow Sigatoka or leaf speckle.
- Where there were leaves with  $> 5\%$  area affected by yellow Sigatoka, the Liaison Officer verbally directed the grower to undertake de-leafing (removing the leaf from the banana plant and placing on the surface of the soil to rot) and a regular fungicide spray program. The grower had 14 days to comply with this direction before the Liaison Officer returned to inspect if de-leafing operations had been undertaken. Each visit was recorded in specific App which made data management very easy.
- If a grower did not comply with the direction, the Liaison Officer then issued a Corrective Action Request (CAR) to undertake de-leafing operations.
- If the grower failed to comply with the CAR within 14 days, Biosecurity Queensland (BQ) were notified. BQ officers would then visit the property, collect leaf samples and take over the corrective action process.
- BQ then notified the Liaison Officer of the outcomes of the process.
- Upon leaving a farm, the Liaison Officer always followed strict biosecurity practices and sprayed his boots with Sterimax when he returned to his vehicle.
- The Liaison Officer's vehicle was decontaminated weekly by pressure spray, cleaning with Farmclense then the tyres were treated with Sterimax.

During each reporting period, a selection of leaf spot samples were taken to confirm the diagnosis of leaf spot and a small number of samples were tested for resistance to fungicides. These tests were undertaken by Kathy Grice from ASQ. Samples were tested to confirm that the leaf spots were yellow Sigatoka and not the exotic black Sigatoka. This activity is important to the exotic disease surveillance program.

#### **Data collection:**

Data was collected for the project using a specific Biosecurity App called Konect via the Liaison Officer's phone. This facilitated the speed and ease with which data could be recorded and downloaded and allowed the generation of area maps. The types of data collected include farm details, location, size of farm and types of bananas grown, dates of inspections, leaf spot status and number of visits required for the grower to meet the guidelines. IT support for the App, data analysis and mapping of inspection sites and status were out-sourced to specialist Biosecurity consultant Barry Sullivan, Lagom Agriculture.

#### **2. Biosecurity engagement and extension.**

In addition to the surveillance role, the Liaison Officer engaged growers on best practice for biosecurity to improve their awareness and adoption of good on-farm practices. Mr Lardi educated growers on the symptoms of leaf spot, shared information between growers, aerial operators, chemical sellers, government and university research staff. His role was to educate and assist them access information for improving integrated leaf spot control. The Liaison officer used a range of extension and communication activities to accomplish the project goals. These included individual meetings, organization and attendance at growers meetings, field days, radio interviews, and the dissemination of knowledge through leaflets, posters and articles published industry-related magazines, e-bulletins and news.

Since the detection of Panama Disease Tropical Race 4 (TR4) in Tully (March 2015), the Liaison Officer has been a key resource in helping growers manage TR4 and to meet their biosecurity obligations.

## Outputs

### 1. Comprehensive disease surveillance data from farms in the north Queensland production area.

#### Leaf Spot

Comprehensive disease surveillance data was collected from Jan 2016-Nov 2018 from 99% farms in the NQ production area (Table 1). This included:

- the number of farm inspections.
- the number of farms with leaf spot above prescribed levels where the grower then received a verbal directive from the Liaison Officer to undertake voluntary control measures and necessitated a revisit to check for compliance.
- the number of farms with leaf spot above prescribed leaf spot levels which failed to undertake voluntary control measures and were subsequently referred to BQ.
- maps were generated showing location of farms inspected and the leaf spot infections recorded in each 6 monthly period for the life of the project (Appendix 2).

**Table 1** Disease surveillance data for 6 monthly intervals in the northern banana production area between Jan 2016 and Nov 2018.

Time Period	Number of Inspections	Number Re-visited	Number referred to BQ	% Growers Voluntarily Compliant /year
Jan -Jun 2016	240	30	3	
Jul - Dec 2016	209	28	0	99.9
Jan-Jun 2017	197	26	0	
Jul - Dec 2017	249	36	1	99.9
Jan -Jun 2018	252	40	4	
Jul - Nov 2018	302	66	0	98.5
Totals	1449	226	8	

There are 268 commercial farms in the northern production zone. Each year the liaison officer visited 99% farms at least once. Only two growers out of the 268 refused the Liaison Officer access to their farms and hence BQ staff surveyed those farms. Maps showing the location of farms visited and places where leaf spot infection was observed in 6 monthly reporting period is shown in Appendix 2.

The total number of farm inspections undertaken during the three year project was 1449, of which 26 were non-commercial farms and 1,423 to commercial farms (Table 1).

Of the 1,267 initial/routine inspections, 90.5 % were compliant after the first visit. The remaining 121 farms had more than 5% yellow Sigatoka infection and required follow up visits. Fifty-one of these required a second warning but only eight farms received third warnings and were referred to BQ for intervention.

Overall this demonstrates continued excellent voluntary compliance by the banana industry and highlights the enduring success of the Liaison Officer in assisting growers to understand and manage leaf spot disease.

As mentioned above, the Liaison Officer also conducted 26 inspections of non-commercial farms, 14 of which had leaf spot levels above 5%. He then either spoke to or left educational material for owners, or arranged for any feral or abandoned bananas to be injected. Follow-up visits were conducted as required.

### 2. Education material developed and activities promoting on-farm best management practice for disease control conducted

A wide range of educational material and activities that promoted on farm best management practice for disease control was distributed:

- Leaflets/ posters were provided to new growers and those experiencing problems with leaf disease. Hard copies of the biosecurity BMP were distributed to growers during normal farm visits. These are excellent educational tools that assist growers to understand leaf spot disease, pests and disease and biosecurity best management practice.

- General extension advice was provided on the use of BQ-approved sanitizers, spray schedules and biosecurity and other on-farm practices e.g. nurse suckering.
- Assisted Department of Agriculture and Fisheries (DAF) staff to learn about banana farming practices, provided video links to new education videos e.g. on management of burrowing nematodes in banana plantations; also assisted DAF staff with location of banana farms in the northern zone. Provided input into the development of BQs 'Trapping Feral Pigs on the Cassowary Coast guide'. Feral Pigs are a hazard for spreading Panama TR4 since they seek food in banana farms, habitually wallow in wet soil, are hence a vector of soil born disease such as Panama TR4.
- Regularly attended NQ Banana Growers' Association (BGA) and Banana Agribusiness Managers (BAGMAN) meetings and also encouraged attendance by relevant participants. These meetings were a good forum for the Liaison Officer to discuss issues concerning leaf spot, Panama, other pests and disease and raise any other biosecurity issues.
- Assisted with the preparation and promotion of the TR4 field days, biannual Banana Road Shows, at which biosecurity information and research outcomes were communicated to growers.
- Also participated in community activities to promote the industry and provide biosecurity information to the public e.g. Agriculture Field Days, Tully Show etc. An advantage of attending community events was the opportunity to network further with growers.

### 3. Development of new procedures in line with the Biosecurity Act

The Liaison Officer received training and revised Standard Operating Procedures and Work Instructions associated with conducting inspections as an Authorised officer under the Biosecurity Act 2014. The Liaison Officer possessed limited powers as an inspector, which fitted within and complemented the scope of this project. He liaised closely with BQ staff when necessary.

### 4. The collection of voucher specimens

A total of 17 leaf samples were submitted for testing by ASQ during the life of the project. Results showed the number of samples that were positive for the following diseases:

- Yellow Sigatoka (*Mycosphaerella musicola*)= 14
- *Cordana musae* = 7
- Speckle (*Mycosphaerella musae*) = 3
- Speckle (*Metulocladosporiella musicola*)=2
- Tropical speckle (*Ramichloridium sp.*) = 1
- No resistance testing was conducted on these samples.

### 5. TR4 and other disease

- Participation in weekly TR4 Situation reports to the end of June 2016
- Regular liaison with BQ and AGBC on TR4 compliance activities.
- Assisting BQ with farmer issues, conflict resolution and negotiating access for BQ to enter farms.
- General surveillance across the northern growing region for pest and disease problems.
- Assistance to BQ on mapping of the Northern banana growing area.

## Outcomes

### Leaf Spot

The northern banana industry achieved 97% compliance with relevant legislation through a voluntary industry approach between 2016 and 2018. This is substantially higher than the project's goal of 80% compliance and continues the achievements of the previous related projects. This high level of compliance may be directly attributable to the work of the Liaison Officer with the following project outcomes:

- Visual surveillance at least annually, on all farms in the northern production region for early detection and management of leaf spot. Only eight growers in the entire region over the three years of the project were referred to BQ intervention in securing cooperation in leaf spot control.
- Increased the knowledge and awareness in the region of the importance of effective control of endemic pests and diseases among all growers and local communities.
- Greater preparedness for the increased disease pressure associated with the wet season in late spring/summer.
- Better understanding and awareness among growers of how to manage leaf spot disease on their farms.
- A significant reduction in regulatory intervention was achieved for leaf disease control as only 3% of growers required notifications to the regulatory authority. This resulted in greater biosecurity for the banana industry as a whole.
- The lower levels of leaf spot achieved through the voluntary industry approach assisted in reducing production costs and contributed to maintaining a consistent quality and supply of bananas.
- The comprehensive database of banana farms generated from data collected during the project is an important resource for ABGC to monitor and understand the location, distribution and frequency of disease outbreaks in the target region and assess compliance levels with legislation.
- A professional working partnership achieved through the Liaison Officer with BQ and ASQ in NQ enhanced awareness, communication and understanding between government departments and banana growers. This facilitated coordination and enhanced biosecurity outcomes for the banana industry.
- Collection and testing of leaf disease samples by ASQ contributed to accurate disease diagnosis and the exotic disease surveillance program. This monitoring is critical for the early detection of exotic disease.
- A working relationship was established with aerial fungicide spray operators to monitor their observations regarding disease pressure, fungicide resistance and any other issues they may have.

### TR4

- Growers have been more able to manage their response to TR4 and meet their biosecurity obligations as a direct result of the strong relationships that Mr Lardi has built, liaising between growers, state departments and other stakeholders.
- Greater understanding about TR4 management and containment has been achieved within the industry and the community by the educational talks and extension activities Mr Lardi has conducted in consultation with BQ and ASQ. This has improved the adoption of biosecurity best management practice in relation to TR4.
- Containment of TR4 to the existing infected properties is critical to reducing the impact of this disease on banana production in Australia's largest production area.

### Training

Familiarisation and training in the role of the banana industry Liaison Officer was provided to Mr Lardi's successor in the last three months of the project. Mr Lardi retires at the completion of BA15003 and the valuable training given to the new Liaison Officer will ensure a seamless transition into a new surveillance and biosecurity project.

## Monitoring and evaluation

The focus of this project was the integrated management of leaf spot and other diseases, both on farms and on host plants which exist in the general community. This was achieved through surveillance and biosecurity extension advice which was provided to farmers and the broader community. This project was highly successful with delivered outcomes exceeding the original expectations.

The 97% compliance with relevant legislation which was achieved through a voluntary industry approach can be attributed directly to the Liaison Officer Mr Lardi, and the activities he conducted during the life of this project as well as the previous two projects. As the designated resource to achieve project outcomes, Mr Lardi had the right skills for the job being an ex-banana grower and an experienced authority on banana production and the control of diseases. His excellent interpersonal skills enabled him to gain the trust, confidence and cooperation of growers irrespective of their age, motivation, and cultural background.

Visual surveillance of banana farms in NQ including all major producers was also achieved by Mr Lardi since he ensured all farms in the target area were at least yearly. This high level of surveillance was made possible through the dedication of Mr Lardi to the extensive amounts of travel, cooperation of growers and the project having designated vehicle. In the previous project BA12007, Mr Lardi's knowledge enabled him to make a visual diagnosis of the first TR4 infected plants in NQ, follow correct biosecurity protocols to take samples and alert authorities. This was critical for initial diagnosis and containment of the disease. The industry therefore placed a high degree of confidence in Mr Lardi to notice and respond to plants showing unusual disease symptoms. This result was management of leaf spot but also a lowering of the risk threat concerning emergency plant pests such as Black Sigatoka and other exotic diseases.

Mr Lardi successfully raised the awareness of the importance of effective control of endemic pests and diseases in at least 97% of growers and the broader community. He achieved this using a range of extension and communication activities to accomplish the project goals. Providing information through a variety of means and pitched correctly, allowed him to reach large numbers of the target audience and facilitated uptake and adoption of best management practice across much of the industry.

The effective relationships Mr Lardi built between ASQ and BQ, enhanced biosecurity and assisted the action of government and other stakeholders to be more coordinated and efficient.

Since the implementation of the Biosecurity Act of 2014, regulations of leaf spot levels have been replaced by a guideline which recommends that NQ banana growers meet the 5% of leaf spot threshold to meet their General Biosecurity Obligation. It has therefore been even more vital to have a designated resource to facilitate biosecurity best management practice. Results of this project indicate that the investment has been well worthwhile for industry.

Although Mr Lardi was an Authorised Officer under the new Biosecurity Act, he rarely used his inspectoral powers to enter farms. Almost all farmers were cooperative with him and, in the case of the few recalcitrant growers, it was necessary to obtain assistance from BQ to gain entry or issue corrective action requests. In the future, it may not be necessary for the new Liaison Officer to become an Authorised Officer in order to effectively achieve the goals of the project.

Effective on-farm biosecurity is important for the prevention and containment of pests and diseases particularly with the threat TR4. There is the opportunity for both growers and the community to be better educated about banana diseases, their identification and prevention. If the industry can adopt best practice on-farm biosecurity, it is protecting itself from future exotic pest and disease incursions as well as endemic ones.

In the previous project, testing of leaf isolates for fungicide resistance indicated variable resistance to strobilurin and triazole exists in the environment. During this project, only minimal sampling was conducted because of the greater threat from TR4. However, it is still important to take leaf samples to check for exotic pathogens such as Black Sigatoka and monitor for fungicide resistance. With chemicals widely used for leaf diseases control under review (e.g. dithiocarbamates like Mancozeb), retaining future access to them may be problematic. Therefore there is a need for more intensive monitoring of leaf spot pathogens in the follow on project BA17005 to give an indication of the efficacy of currently available fungicides for leaf spot.

A dedicated resource linked closely to the industry and located within the region provides a significant advantage in industry adoption, with all major plantations participating in on-farm inspections. Critical to the successful adoption of biosecurity best practice was having a person with an understanding of banana production systems to engage with growers and work through issues to find potential solutions that are practical and realistic. The

banana industry via the R&D Strategic Investment Advisory Panel Committee rated the project highly and strongly supported the project to be re-established.

## Recommendations

‘Leaf spot’ is caused by a group of fungal pathogens and is a disease that can have devastating consequences to banana production if left unchecked. The cultural control method where infected leaves are removed is the best way of reducing inoculum levels. The resulting reduction in the incidence and severity of disease means the method is appropriate for the northern production zone. This is because the fungi depend on living plant material for survival, and spore dispersal is minimized if infected leaves are removed early before spores are produced. In the moist warm temperatures of NQ, conditions are conducive to rapid growth of fungi, which is why levels of leaf infection are recommended to be kept below 5% all year round. Without the help of the Liaison Officer, it is likely that many growers would have failed to meet the requirements and production losses from disease would be much greater.

De-leafing is also an appropriate control method for use in the northern production zone, as commercial plantations dominate the area with little interruption by residential areas. Residential banana plants are far less common, are less likely to act as reservoirs for disease and are easier to monitor and inspect than they would be in the more populated areas of SE Queensland.

Ongoing monitoring and extension of best management practice by a trained liaison officer provides invaluable biosecurity support for the northern production zone since it allows early detection and action when emerging plant pests occur such as black Sigatoka, Panama TR4 and Bunchy top virus.

For the reasons outlined above and the success of the current project in meeting its objectives, we therefore recommend that:

1. The work of a designated banana industry Liaison Officer for surveillance and the provision of banana biosecurity extension advice to farmers be funded for another three years.
2. The scope of new follow-on project be broadened to build and expand on outcomes of this project and provide some analysis of previously collected pest and disease data. This will assist in the optimization of future biosecurity surveillance and management strategies.
3. It is not necessary for the Liaison Officer to become an Authorised Officer under the Biosecurity Act in order to gain entry to farms, as this power does not add to the role.
4. More extensive sampling of leaves be taken each year to provide disease diagnosis and for fungicide resistance testing of isolates. This means representative samples should be taken from each NQ growing region each year.

Ongoing investment in a resource such as the Liaison Officer will facilitate the integrated disease management of yellow Sigatoka and other diseases in North Queensland and provide enhanced biosecurity for the banana industry.

## Refereed scientific publications

Not applicable

## Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialisation or confidentiality issues to report

## Acknowledgements

Firstly we would like to thank Mr Louis Lardi for his dedication and hard work in the role of the yellow Sigatoka Liaison Officer over the last 9 years. He has been an invaluable asset and we wish him well in his retirement.

We would also like to thank the many members of DAF for their assistance and support during the project, particularly Stewart Lindsay, Tegan Kukulies, Aaron Russel, Rhiannon Evans, Kathy Grice and Lynton Vawdrey.

Barry Sullivan is acknowledged for valuable assistance with data management and for building maps.

Rosie Godwin (R&D manager) also provided much support during the project as did all staff at ABGC.

We would also like to thank the banana growers of North Queensland who gave their cooperation and practiced good leaf spot control measures and biosecurity best management practice

## Appendices

Appendix 1: Image of a banana leaf showing 5% leaf area affected by yellow Sigatoka (a) and leaf speckle (b). Leaf spot is a significant endemic disease in north Queensland and it is recommended to growers that they keep infection levels below 5% of the leaf area to meet their General Biosecurity Obligation under the Biosecurity Act 2014.

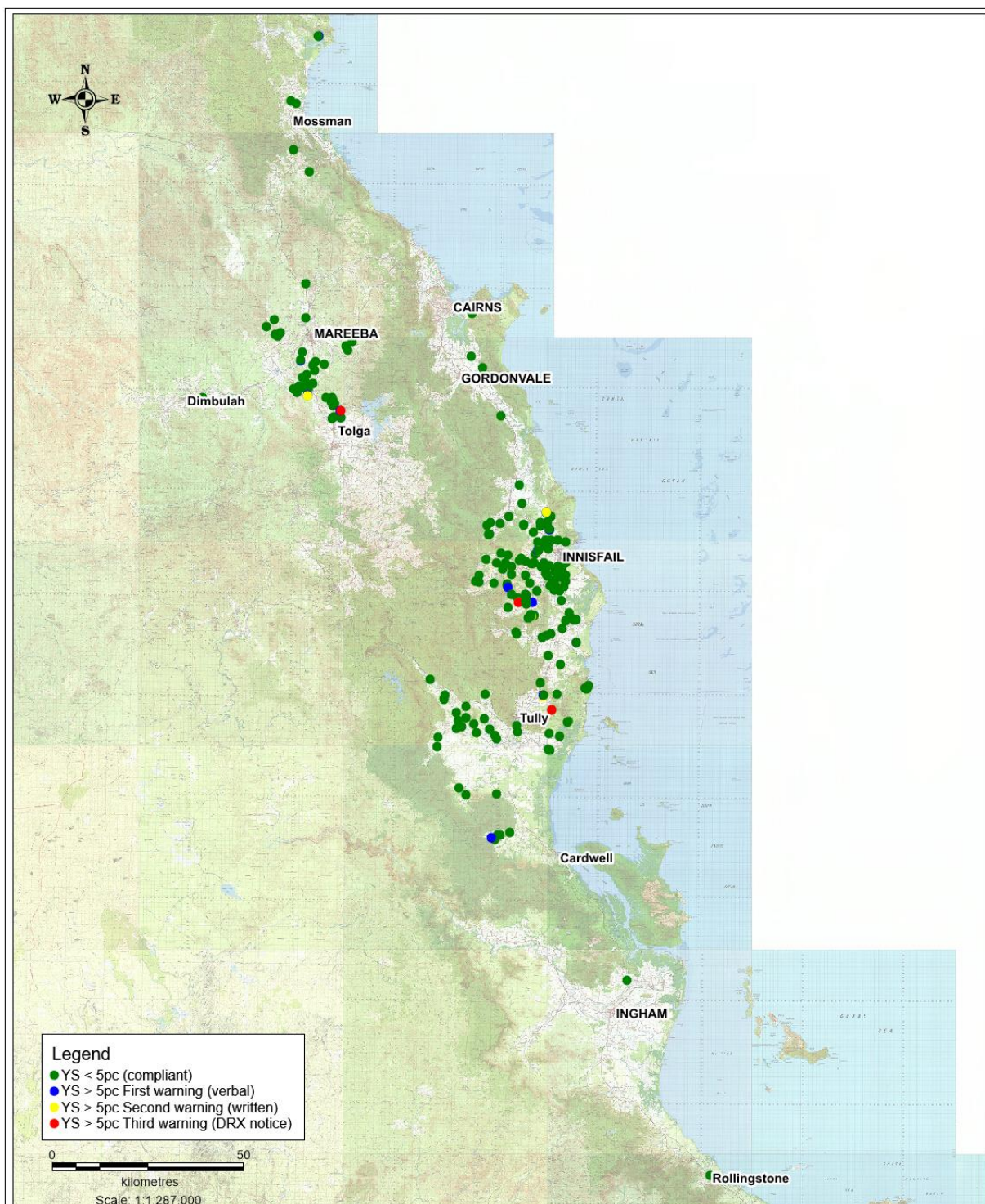
(a) 5 % Yellow Sigatoka



(b) 5 % Leaf speckle



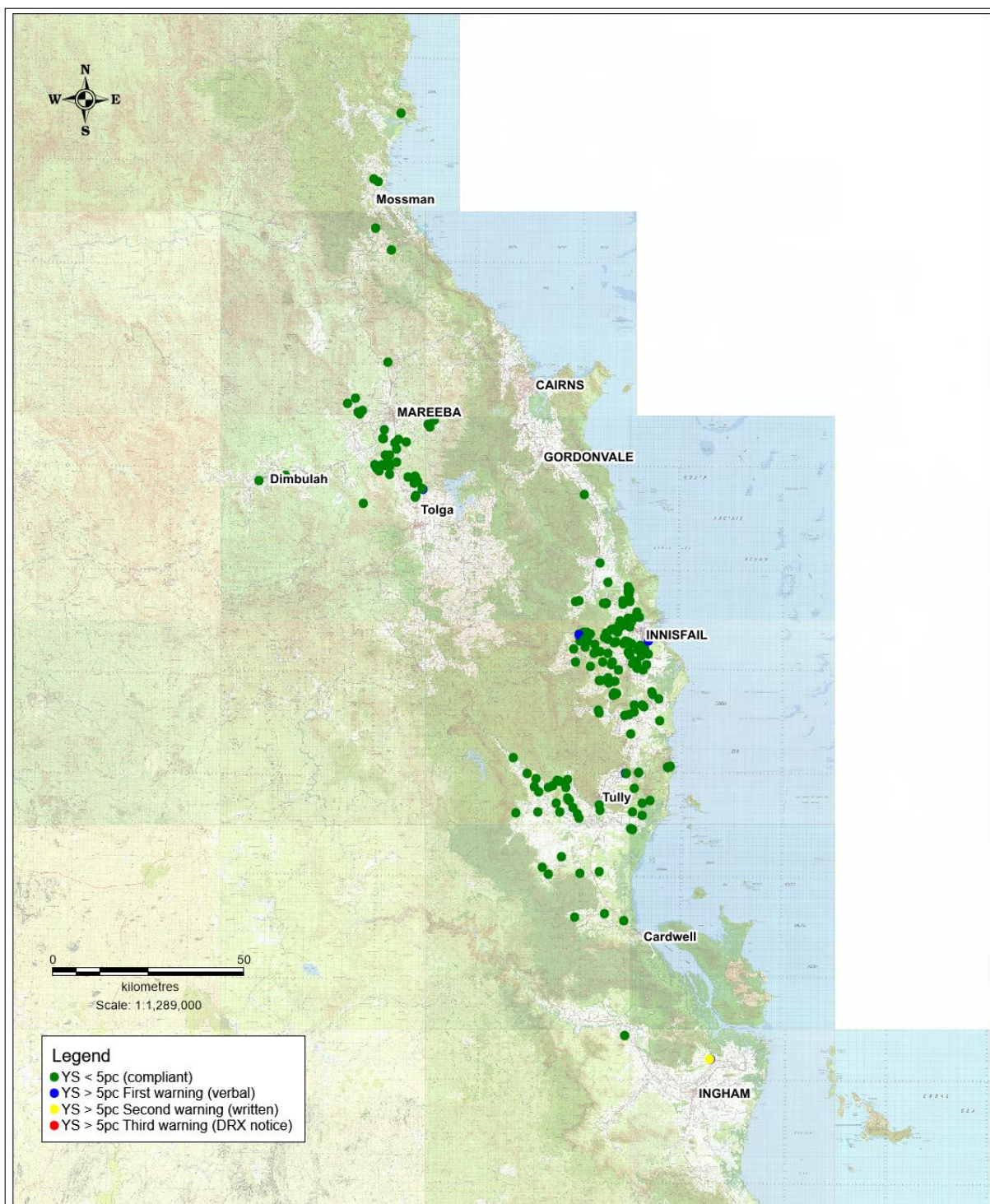
**Appendix 2** Leaf spot inspections conducted during six monthly intervals for the duration of the project. Green dots indicate compliant farms, blue and yellow indicate where warnings were issued and red dots indicate location of plantations requiring regulatory actions by Biosecurity Queensland.



## Yellow Sigatoka inspections January 2016 to June 2016

Digital data supplied by Australian Banana Growers' Council (ABGC). Projection and datum: Geographics, GDA94 Map produced by ABGC 2018.  
ABGC has prepared this map and retains all intellectual Property rights. No part of this map may be copied or reproduced in any form or by any means without ABGC's written permission. ABGC gives no warranty in relation to this map and its accuracy, reliability, completeness, currency or suitability for any particular purpose. ABGC, its officers and employees are not liable for any loss or damage, however caused (including but not limited to negligence) arising out of, or in any way relating to, the use of this map.  
Map compiled by Barry Sullivan.

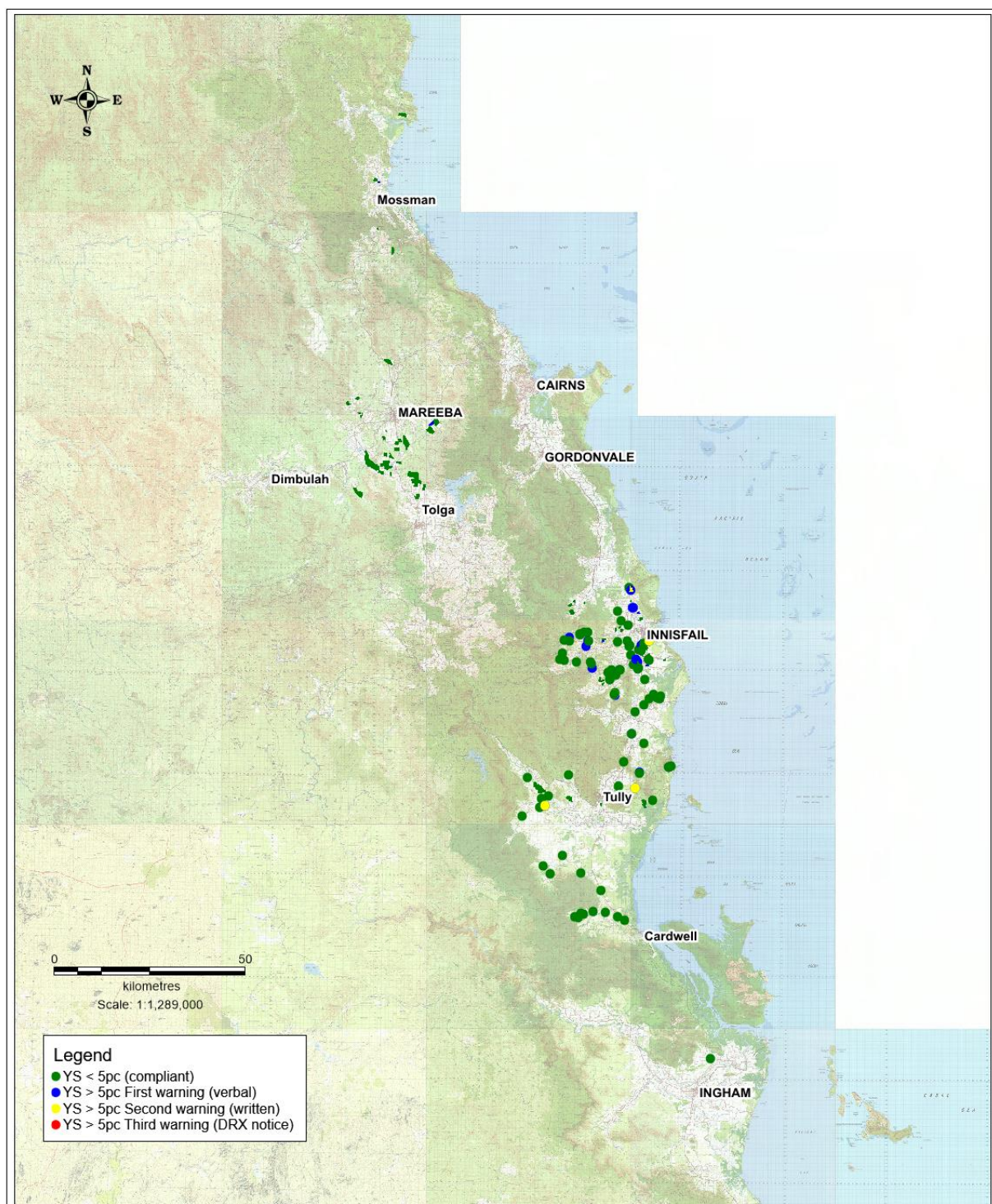




Digital data supplied by Australian Banana Growers' Council (ABGC). Projection and datum: Geographics, GDA94 Map produced by ABGC 2018. ABGC has prepared this map and retains all intellectual Property rights. No part of this map may be copied or reproduced in any form or by any means without ABGC's written permission. ABGC gives no warranty in relation to this map and its accuracy, reliability, completeness, currency or suitability for any particular purpose. ABGC, its officers and employees are not liable for any loss or damage, however caused (including but not limited to negligence) arising out of, or in any way relating to, the use of this map. Map compiled by Barry Sullivan.

## Yellow Sigatoka inspections July 2016 to December 2016

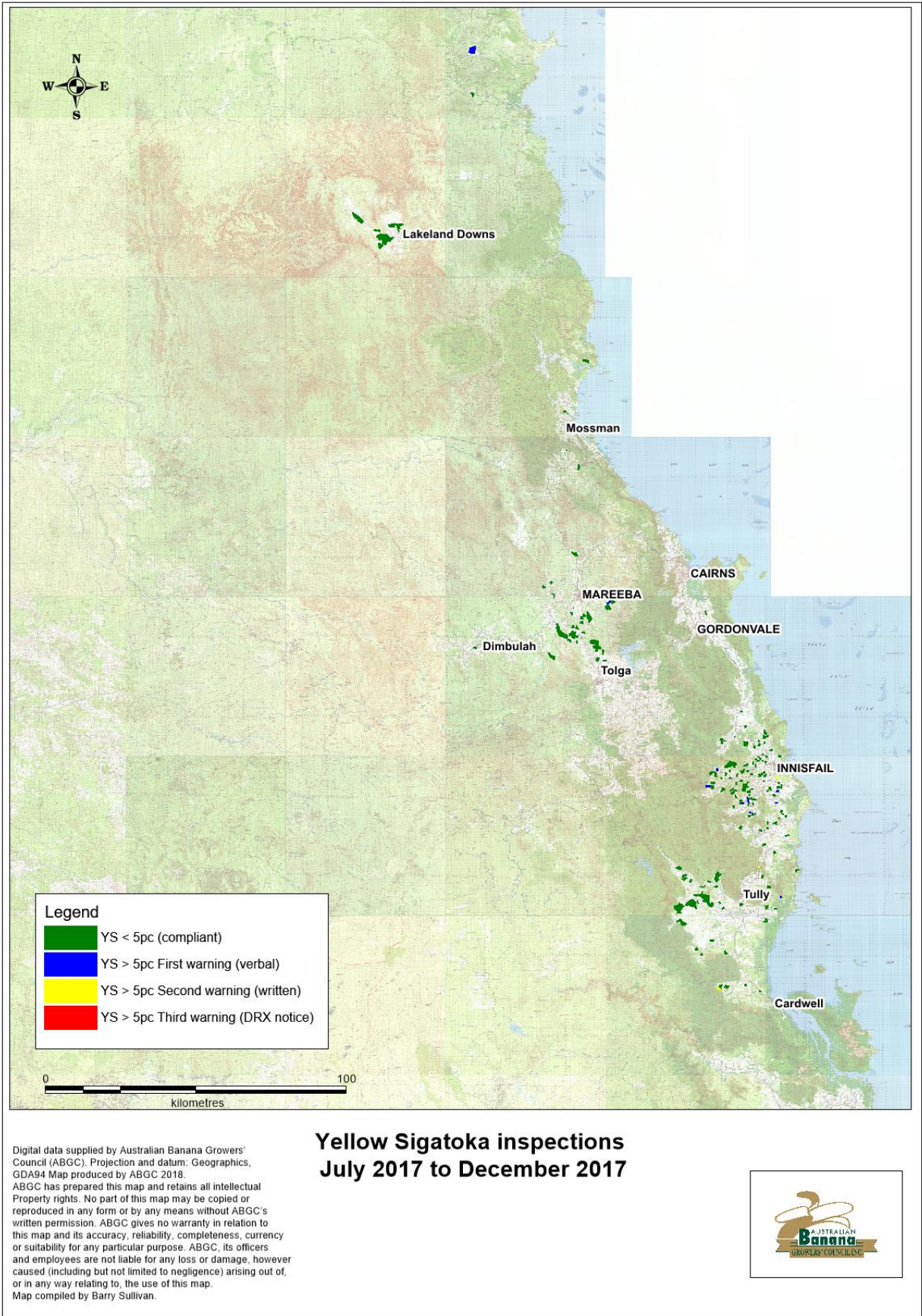


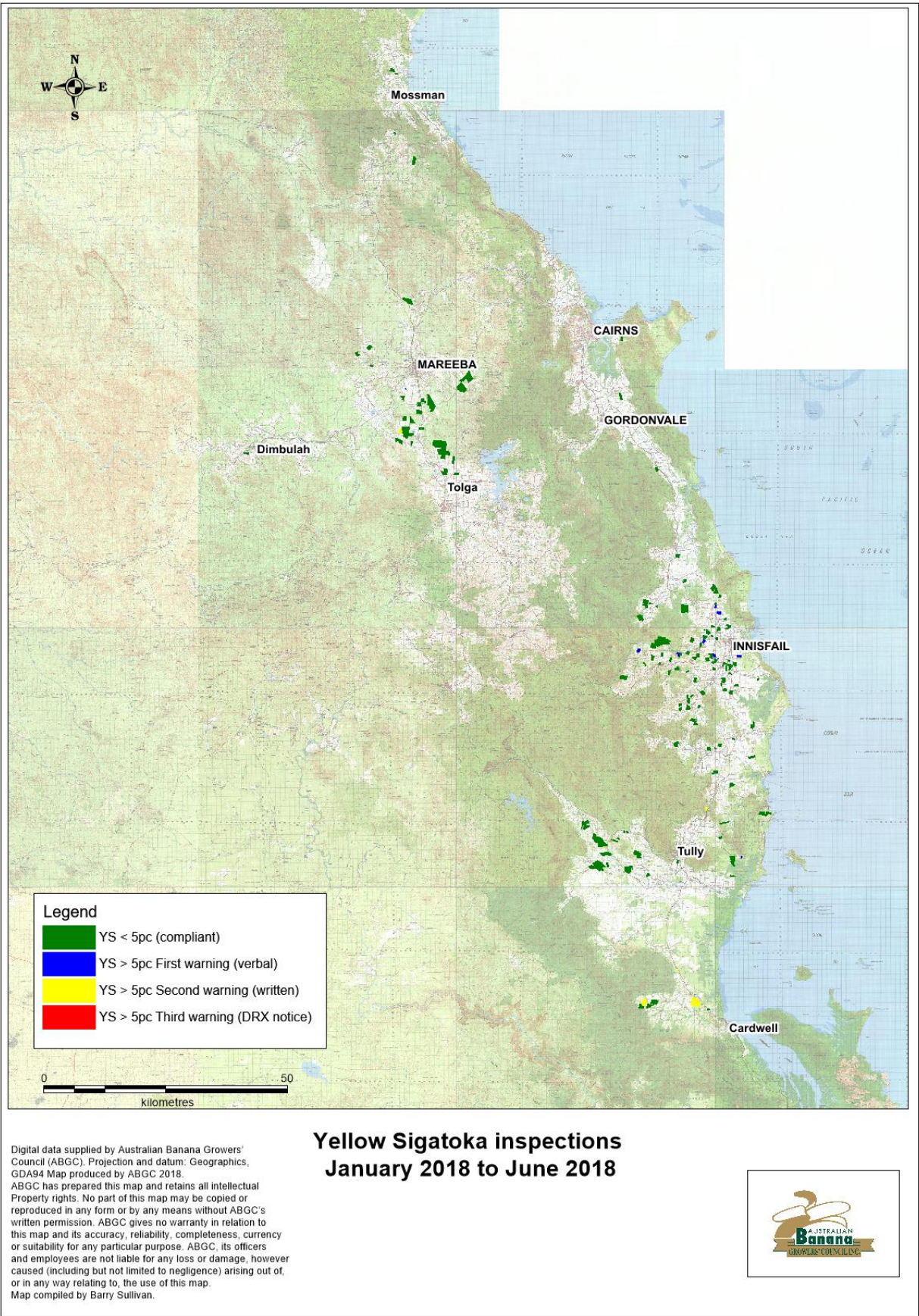


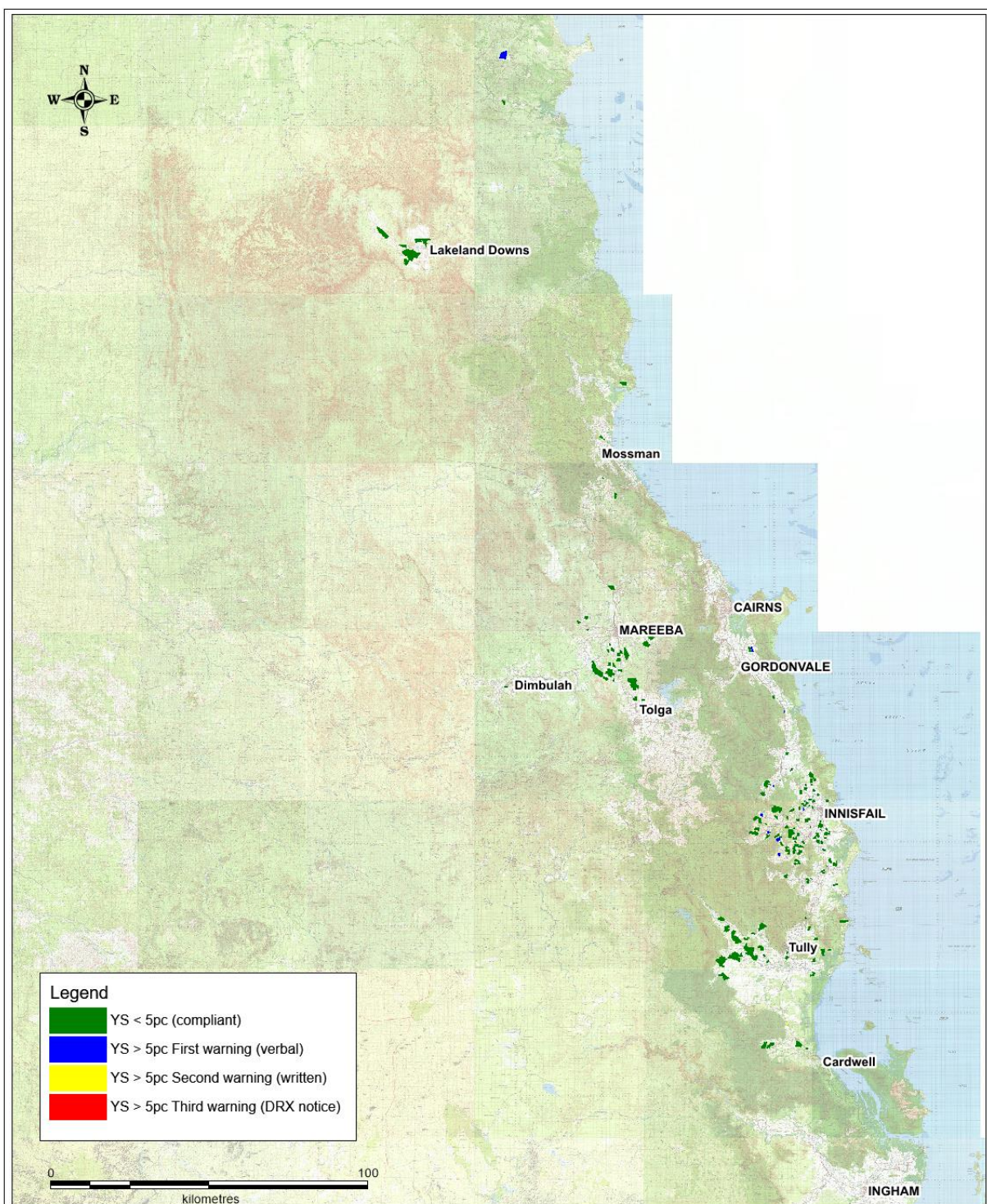
## Yellow Sigatoka inspections January 2017 to June 2017

Digital data supplied by Australian Banana Growers' Council (ABGC). Projection and datum: Geographics, GDA94 Map produced by ABGC 2018.  
ABGC has prepared this map and retains all intellectual Property rights. No part of this map may be copied or reproduced in any form or by any means without ABGC's written permission. ABGC gives no warranty in relation to this map and its accuracy, reliability, completeness, currency or suitability for any particular purpose. ABGC, its officers and employees are not liable for any loss or damage, however caused (including but not limited to negligence) arising out of, or in any way relating to, the use of this map.  
Map compiled by Barry Sullivan.









Digital data supplied by Australian Banana Growers' Council (ABGC). Projection and datum: Geographics, GDA94 Map produced by ABGC 2018.  
 ABGC has prepared this map and retains all intellectual Property rights. No part of this map may be copied or reproduced in any form or by any means without ABGC's written permission. ABGC gives no warranty in relation to this map and its accuracy, reliability, completeness, currency or suitability for any particular purpose. ABGC, its officers and employees are not liable for any loss or damage, however caused (including but not limited to negligence) arising out of, or in any way relating to, the use of this map.  
 Map compiled by Barry Sullivan.

## Yellow Sigatoka inspections July 2018 to November 2018

