Hort Innovation

Final Report

National Banana Development and Extension Program

Project leader:

Tegan Kukulies

Delivery partner:

Department of Agriculture and Fisheries

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National Banana Development and Extension Program BA16007

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Level 7
141 Walker Street
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Telephone: (02) 8295 2300

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Content

Summary

The National Banana Development and Extension program continued to ensure that banana growers were equipped with the latest knowledge from industry research and development (R&D) to make the most informed business decisions. This was achieved through a range of extension activities including the National Banana Roadshow Series, the industry's 'flagship' extension events, which were attended by over 140 growers and industry stakeholders across six locations around Australia in 2018. R&D activities were represented and showcased at the 2017 and 2019 Australian Banana Industry Congress events. Growers and industry stakeholders around Australia now also have access to information about recently completed or on-going R&D, 24 hours a day via the Better Bananas website, which was developed as part of this project. This user friendly website has been visited by over 3200 users and hosts 28 R&D activity updates, provides links to 14 videos and features an updated pest, disease and disorder identification guide.

To streamline communication with growers in north Queensland, linkages and networks were built and maintained with other key information providers. This included continuing to facilitate meetings to provide regular R&D activity updates, foster two-way conversations with consultants, agricultural retailers and service providers, and by attending the Cassowary Coast Banana Growers Association meetings. Networks with key personnel in post-farm gate supply chain businesses were also maintained and built upon to improve communication and understanding of current and emerging supply chain issues amongst project staff, researchers and growers.

Extension activities were timed to fit in with other project and industry activities. Nearly 50 people participated in a field walk to inspect the plant crop of the variety evaluation trial and nutrient rate trial at the South Johnstone research facility in June 2019. Later that year over 40 people attended a novel and interactive extension activity, the 'Banana R&D speed dating event'. On-farm biosecurity has remained a high priority for industry and has been integrated and promoted both directly and indirectly at all activities within the project.

The project continued to support the momentum of the NextGen growers group by organising meetings, and facilitating larger activities driven by the growers involved in the group. This included looking outside the box by visiting various businesses in Sydney prior to the 2017 Australian Banana Industry Congress, and visiting various farming enterprises on the Atherton Tablelands in 2019. At the end of 2017 and 2019 the project organised short trips to the Northern Territory, where growers gained a new appreciation for the impacts of Panama disease tropical race 4 on banana production and the efforts involved in screening and developing a variety with resistance to the disease.

Innovation trials conducted in this project have provided insights into practices that growers may not be willing to trial on their own properties. The trials showed that early de-suckering in the plant crop of plant derived from tissue culture can result in increased production. The examination of different living and non-living ground cover treatments resulted in very few significant impacts, however generally the living ground covers tended to negatively impact production characteristics. Further innovation trials showed that entomopathogenic nematodes have potential as a biological control for Banana weevil borer and this warrants further investigation.

Most activities were evaluated for impact and results show that the project methodology, resources and networks built and maintained by the project team have successfully coordinated the delivery of R&D outcomes to the Australian banana industry. There is evidence that this will help growers make more informed business decisions that may lead to adoption of new and emerging technology and practices. The good attendance and the very positive feedback to the project's interactive approach at events and activities demonstrates that growers have been well engaged in the program with flow-on impacts for the wider industry.

Keywords

Banana, extension, growers, roadshows, NextGen, innovation, on-farm biosecurity

Introduction

The National Banana Development and Extension Program ensures that banana growers are equipped with the latest knowledge from industry research and development (R&D) so that they can make the best business based decisions. There has now been a National Banana Development and Extension project for the banana industry since 2013 (BA13004), which has been complemented by regionally specific extension initiatives. As banana growers are typically time poor due to the non-seasonal nature of production, the coordinated approach taken in these projects (BA13004 and BA16007) has allowed growers to access information and gain a better understanding of multiple R&D activities/topics at events such as Roadshows and field walks. In addition, information is now readily available on a dedicated R&D website developed as part of the project (BA16007).

The Australian banana industry is geographically spread across three main production regions – the wet tropics of north Queensland, the humid sub-tropics of the east coast from Bundaberg to Nambucca, and the arid sub tropics of the west coast based in Carnarvon. North Queensland produces approximately 95%, New South Wales 4% and Western Australia 1% of all bananas sold in Australia. This project focused on providing the latest R&D outcomes and driving innovation in north Queensland where the majority of bananas are grown. However, the project also delivered extension initiatives nationally through the National Banana Roadshow series in 2018, Banana industry congresses in 2017 and 2019, the Better Bananas website and industry communication channels (e.g. e-bulletins, Australian Bananas magazine).

The project team kept the Australian banana industry informed of the latest national and international R&D developments by maintaining regular contact with Australian researchers and key international scientists, and interpreting their research for Australian relevance. The project also collaborated with the Subtropical Banana Development and Extension Program (BA16007) by maintaining communication and sharing outcomes from R&D projects.

At the start of this project, the activities directly supported objective 3 in the Banana industry strategic investment plan (2013-2017): Improve industry capacity and R&D adoption and demonstrate ROI of levy investment by engaging >50% production acreage in technical update series (roadshow events). In the current Banana strategic investment plan (2017-2021), project activities closely aligned with achieving outcome 2: increased adoption of the industry's BMP plan that improves industry sustainability, biosecurity and environmental stewardship. It also complemented outcomes 1 and 4 which relate to new varieties, improved pest and disease management and increased adoption of continuous improvement and automation technology.

Methodology

Project Reference Group

The project reference group (PRG), which was retained from the previous National Banana Development and Extension project (BA13004), again provided on-going support and helped steer the direction of the project. Similarly, the PRG was responsible for setting the priority development and extension topics for the project along with providing guidance on the strategies for delivery. The PRG members were:

- Tegan Kukulies (Project leader, DAF)
- Stewart Lindsay (Project team member, DAF)
- Kris Horsford (north Queensland banana grower)
- Gavin Devaney (north Queensland banana grower)
- Peter Molenaar (New South Wales banana grower)
- Chaise Pensini (Supply chain representative, Nutrano Produce Group)
- Dr. Rosie Godwin (ABGC R&D Manager)
- Matt Weinert (New South Wales Department of Primary Industries)
- Bianca Cairns (Project manager, Hort Innovation)

Methodology to deliver latest R&D

National Banana Roadshows (Appendices 1 to 3)

The National Banana Roadshows that banana growers and industry stakeholders have become familiar with, are a series of events showcasing the latest R&D in a fast paced, interactive manner. The roadshows, which featured nationally relevant and regionally specific updates, were held in mid-2018 in the main banana production areas: Innisfail (QLD), Mareeba (QLD), Tully (QLD), Coffs Harbour (NSW), Murwillumbah (NSW) and Carnarvon (WA). Appendix 1 outlines the full agendas of the six 2018 Roadshow events. The events comprised four key elements which are described in Figure 1 below.

10 minute presentations by researchers (including video)

Speed dating session - researchers who presented spent 5 minutes at each table (4-6 growers) then rotated between tables.

Interactive session – hands on demonstration and discussion about a research area (e.g. tasting varieties, seeing impact of crown end rot, marketing). Attendees were broken into three groups and spent 15 minutes at each of the 3 interactive stations.

Static displays (QLD only) – During morning tea and lunch breaks researchers which didn't feature in the structured agenda had posters on display and where possible made themselves available to discuss their research with the attendees.

Figure 1: Interactive elements included in Roadshow events

Australian Banana Industry Congress (Appendix 4)

The Australian Banana Industry Congress events were held in Sydney in 2017 (22 – 24 June) and at the Gold Coast in 2019 (22 – 24 May). The project played an important role in assisting with the R&D activities at both events. The project leader, together with the Australian Banana Growers Council (ABGC) R&D Manager Rosie Godwin and the NSW Industry Development Officer Matt Weinert, organised the "Science Snapshots" session which consisted of 6, 3 minute presentations by researchers followed by a panel discussion, as well as a poster session at both events. The project team also coordinated a showcase of banana R&D at a booth in the exhibition, and facilitated discussion between attendees and researchers during the exhibition times and during breaks.

Better Bananas website – (Electronic R&D update portal) (Appendix 5)

The information database review conducted as part of the previous National Banana Development and Extension Program (BA13004) revealed that growers and agribusiness providers liked the concept of a banana specific webpage or database to host past and current R&D outputs. Following recommendations derived from this process, reviewing features and impacts of other industry websites and in consultation with the PRG and growers of the NextGen group, a list of requirements and features for the Better Bananas website was developed.

The ABGC commissioned the services of Morgan Rural Tech through their subcontractor agreement in the project and the project team members managed and guided the overall development of the website. The content on the website is managed by the project team with approvals in place from DAF, other contributing agencies and Hort Innovation prior to publication. The website was launched in mid-2018 at the National Banana Roadshow Series and new content on the website is promoted via industry communication channels (e.g. ABGC e-bulletins). A review of the website usage was conducted in April 2019 and further information about the resource and results are included in Appendix 5.

Maintaining networks

Service providers (Appendix 6): The Banana Agribusiness Managers (BAGMan) group is chaired and facilitated by the project team, and consists of consultants, resellers, agronomists and other service providers in north Queensland. The group meets twice a year for updates on the latest R&D, to discuss topical events and identify emerging issues.

Banana grower association groups: These grower associations historically provide a communication and networking opportunity to keep growers updated on project activities and receive feedback on emerging issues. There are two groups in north Queensland, the Cassowary Coast Banana Growers Association (CCBGA) and the Mareeba and District Banana Growers Association (M&DBGA). CCBGA meetings are now held every second month and there has not been a M&DBGA meeting over the duration of this project. Regular attendance at the CCBGA by project team members has allowed those in attendance to hear about research updates, upcoming events and also facilitate grower feedback on any emerging issues. Project team members also attended the three industry meetings (Tully, Innisfail and Mareeba) held following the detection of Panama disease Tropical Race 4 (TR4) on the second property in north Queensland. Similarly, project team members attended the majority of the Banana Women's Network activities organised by ABGC.

Key supply chain member visits: The project team continued to develop and maintain networks and linkages with supply chain businesses to facilitate improved communication between growers, R&D providers and supply chain personnel in the banana industry. Relationships were built and regular communication was maintained with staff of key market suppliers: Costa Group, Mackays Marketing, Nutrano, Tropicana and LaManna Premier Group. Throughout the project, extension staff welcomed visits from supply chain personnel when they travelled to north Queensland. Project members also strengthened relationships with members of the supply chain with a visit to the Brisbane markets in January 2018 and a visit in November 2019 to the Sydney markets, the Coles distribution and ripening facility (Eastern creek) and various retail outlets (Coles, Aldi, Woolworths, Harris Farms and several independent retail stores).

Australian Banana Growers Council (ABGC): Regular communication was maintained with the peak industry body ABGC, particularly the communications team, the R&D Manager and the Industry Strategy Manager.

Field days/events (Appendix 7 & 8)

To complement other extension activities in this project, as well as other industry events (e.g. Australian Banana Industry Congress), two extension events were organised and facilitated by the team in 2019. In June, growers and industry stakeholders took part in a field walk at the South Johnstone Research Facility to inspect bunches in the plant crop of the variety evaluation trial and also a banana nutrient rate trial (Appendix 7). Later in 2019 (October), the team organised a 'Banana R&D speed dating' event designed to facilitate interaction between researchers and growers and to promote grower-to-grower learning (Appendix 8).

On-farm biosecurity extension and On-farm biosecurity best management practices (BMP) (Appendix 9)

It has now been 5 years since the detection of Panama disease tropical race 4 in north Queensland. Keeping on-farm biosecurity as a priority for growers is challenging and for this reason our strategy to keep the topic on growers' radars has been to integrate on-farm biosecurity into each project extension activity that has focused on other priority topics and research of interest to growers (e.g. Roadshow events, variety field walks, NextGen activities and the Banana R&D speed dating event).

The hard copy and pdf of the On-farm biosecurity best management practices guideline has been distributed to growers at every extension activity within this project, and has been promoted electronically via various industry communication channels as part of Biosecurity Queensland (BQ) Panama TR4 program. An online system of the On-farm biosecurity BMP has now been developed and promoted at various extension events (2019-2020) via a flyers, discussions and presentations.

Offers to growers by the project team for tailored one-on-one on-farm biosecurity extension were made throughout the project and targeted promotion of support services available to growers followed any new disease detections on new properties. This was communicated via industry (e.g. e-bulletins), BQ Panama TR4 program communications (e.g. newsletters) and also directly via networks maintained within this project (e.g. NextGen).

Methodology to drive innovation

NextGen (Appendices 10 to 14)

The NextGen group consists of young growers (typically under 40, however not limited by age) who are proactive, positive and willing to be innovative and share their experiences. The project facilitated 2-3 group meetings and a larger activity each calendar year in this project. Meeting content and other activities are guided by group members who nominate topics/areas that they would like to investigate, with activities and content then organised and facilitated by the project staff. The larger activities in the project consisted of visits to businesses in Sydney prior to the 2017 Australian Banana Industry Congress (Appendix 10), trips to the Northern Territory in 2017 and 2019 (Appendices 12 & 13) and a local tour of farming enterprises on the Atherton Tablelands in 2019 (Appendix 12). The group's most recent activity involved a field walk at the South Johnstone Research Facility to observe first-hand the progress being made in the banana variety screening trials (Appendix 14).

Innovation trials (Appendices 15 to 17)

Guided by growers (particularly those in the NextGen group) the innovation trials investigated a series of 'out of the box' concepts on which growers may not be willing to take the financial risk or have time to trial on their own farms. Consisting of 390 'Williams' Cavendish banana plants grown in 3 double rows at planting densities used in commercial production, the 'innovation trial' block was established on the South Johnstone Research Facility in November 2017. The replicated trial investigated the agronomic effect of five different living and non-living ground cover treatments (conventional bare-earth, weed gunnel matting, chemical soil stabilizer, Pinto peanut and Mint) in combination with two different de-suckering treatments (de-suckering approx. 3 months after planting vs at bell emergence) over plant and first ratoon crop cycles. Plants in this block were also used to assess a biological insecticide product for bunch pest control, applied via bell injection. The trial was also used to conduct preliminary investigations into entomopathogenic nematodes as a control for Banana Weevil Borer (*Cosmopolites sordidus*). Comprehensive details about this trial are included in appendix 17.

Outputs

National banana roadshows

The quick paced interactive one day events designed to deliver the latest R&D results to growers and industry stakeholders were again successfully delivered in six locations around Australia in 2018. Table 1 below shows the attendance numbers at each of the six events.

Table 1: Attendance at the 2018 Banana Roadshow Series

Roadshow location	**Number of attendees (Growers, service providers and industry representatives only)**
Murwillumbah (Murwillumbah service club, Tuesday 24 July)	21
Coffs Harbour (Coffs Harbour Showgrounds – Norm Jordan Pavilion, Thursday 26 July)	21
Tully (Tully Senior Citizens Hall, Thursday 9 August)	17
Innisfail (Innisfail Showgrounds, Friday 10 August)	37
Mareeba (Department of Natural Resources, Mines and Energy, John Charles room, Friday 17 August)	24
Carnarvon (Carnarvon Yacht Club, Thursday 30 August)	21*
**The Australian Banana Growers Council board meeting was held in conjunction with the Roadshow event in Carnarvon and therefore north Queensland and a New South Wales grower were in attendance.*	

Appendices 1 & 3 detail the full agendas for each location and the promotional material associated with each event. In total 141 growers, service providers and industry representatives (excluding researchers) attended the six events.

Australian Banana Industry Congress

The Australian Banana Industry Congress (ABIC), held in Sydney (22 – 24 June 2017) was attended by 353 delegates, 80 of which were banana growers. The event held at the Gold Coast (22 – 24 May 2019) was attended by 373 delegates, 103 of which were banana growers. The project's contribution to the ABIC events is detailed in Appendix 4. The project team facilitated a booth representing banana R&D in the exhibition space, and helped organise the 'Science Snapshots' session in the agenda at both events. Additionally, the project helped guide the overall format and agenda by having a team member contribute via the congress planning committee, and two posters presenting on project activities were also included in the scientific poster display at the 2019 ABIC.

Better Bananas website - (Electronic R&D update portal)

The Better Bananas website provides banana growers and industry stakeholders with a central go-to location for R&D information. The website is simple and intuitive, featuring easy-to-use drop down menus and a comprehensive search function. The website consists of 7 key menu tabs with emphasis placed on the research section, which currently hosts 28 updates of recently completed or on-going R&D activities. The website is also home to an updated pest, disease and disorder identification guide which is derived from the problem solver section of the Tropical Banana Agrilink resource. The website also hosts industry R&D videos, four of which have been developed and published as part of this project (Table 2), and a page which profiles researchers involved in banana R&D. Figure 2 below lists all the content which has been published on the website as at 30 April 2020. Additional information is included in Appendix 5.

Content on the Better Bananas website (all text is hyperlinked to the direct page on the website)

1) **Home**
2) **About**
3) **Research**
   a) Banana variety research
      i) Agronomic evaluation of new varieties (South Johnstone)
      ii) Panama TR4 variety screening trial (Coastal Plains Research Farm, Northern Territory)
      iii) Panama TR4 variety screening trial (Coastal Plans Research Farm, Northern Territory)
      iv) Panama R1 variety screening trial (Duranbah, NSW)
      v) Developing new resistant varieties (GCTCV119 mutagenesis trial)
      vi) Developing new resistant varieties (Goldfinger mutagenesis trial)
      vii) Developing resistant varieties (Dwarf Nathan mutagenesis trial)
      viii) Developing new resistant varieties (CJ19 mutagenesis trial)
   b) Panama disease
      i) Disinfectants
         (1) How can I test my QA disinfecting products?
         (2) How long are disinfectant products effective for?
         (3) Are cleaning and disinfectant products corrosive?
      ii) Reducing inoculum from infected plants
         (1) Lab trials
         (2) Field trials
   c) Crown end rot
      i) Guide to Crown end rot identification
      ii) Resistance to current post-harvest chemical trials
      iii) Time in supply chain studies
      iv) Alternative post-harvest product testing
      v) New test helps product screening for Chalara management
   d) Innovation field trials
      i) Trial layout
   e) Best management practices
   f) Bunch pests
      i) Bunch cover trial
4) **Problem solver**
5) **Videos**
   (Videos developed as part of BA16007)
   a) It's more than just bananas for our banana NextGen group (30 April 2019)
   b) Making biosecurity work for your farm (5 September 2018)
   c) Controlling burrowing nematodes in banana production (15 April 2018)
   d) NextGen report – Variety screening trial in the Northern Territory (16 November 2017)
6) **Events**
7) **Meet a researcher**
   a) Profile on Kathy Grice
   b) Profile on Jeff Daniells
   c) Profile on David East
   d) Profile on Katie Ferro
   e) Profile on Shanara Veivers

Figure 2: Content published on the Better Bananas website as at 30 April 2020

Table 2: List of videos produced as part of the project

Video Title *(All videos are linked to video page on the Better Bananas website)*	**Views** ***(as at 15 June 2020)***
NextGen Report: Variety screening trials in the Northern Territory	1 519
Controlling burrowing nematodes in banana production	2 677
Making biosecurity work for your farm – Mackay's experience of farming with Panama disease tropical race 4 (Also played at 2019 National Banana Roadshow events)	712
It's more than just bananas for our banana NextGen group	204
TOTAL	**5 112**

Maintaining networks

Service providers: The Banana Agribusiness Managers (BAGMan) group is facilitated and chaired by the project leader and consists of consultants, resellers, agronomists and service providers in north Queensland. The meeting agenda is driven by members of this group and typically consists of several researchers presenting updates on their work and group discussions about topical and emerging industry issues. Throughout this project the group met four times – 23 November 2017 (17 attendees), 1 November 2018 (25 attendees), 18 July 2019 (18 attendees) and 19 November 2019 (15 attendees). The agendas of these meetings are included in Appendix 6. To date no BAGMan meetings have been facilitated in 2020 due to social distancing restrictions associated with the risk of COVID-19, however it is hoped that two meetings can be facilitated later in the year (possibly one remotely as part of BA19004). The project team have also attended all of the Banana women's network (facilitated by ABGC) meetings and activities (e.g. tour of local chocolate factory, lunch meeting associated with the 2019 banana industry congress) which have been held during this project (2-3 meetings/activities per year).

Banana grower associations groups: Throughout the project, the team has attended the Cassowary Coast Banana Growers Association (CCBGA) meetings to communicate R&D project outcomes and updates, and to seek feedback on topical and emerging issues. In 2017 members of the project team attended six meetings: 11/05/2017, 08/06/2017, 06/07/2017, 10/08/2017, 12/10/2017 (where NextGen representatives presented) and 09/11/2017. Due to a decrease in attendance in late 2017, the CCBGA decided to reduce the frequency of their meetings to every 2nd month. In 2018 the project team attended five of the six meetings. Due to social distancing associated with the risks of COVID-19, only one meeting has been held in 2020, which was attended by project team members.

Key supply chain member visits: The two supply chain visits undertaken in this project have been very valuable in making new contacts at the market end of the supply chain, and reinforcing existing relationships to continue to promote and foster feedback from the marketplace. On 18 January 2018, the project leader visited the Brisbane markets and held discussions with people from key banana supply chain businesses including LaManna Premier Group, Nutrano and South Queensland Banana Ripeners. Three project team members travelled to Sydney from 20 – 22 November 2019, visiting various parts of the supply chain including the Sydney Markets (Nutrano, Tropicana, Costa Group, PW Chew & Co and Wing Chong & Co), the Coles distribution center (Eastern Creek) and the attached Mackays Marketing ripening facilities, and various retail outlets (Coles, Woolworths, Aldi and several independent stores).

Field days/events

Variety field walk: On 21 June 2019 nearly 50 people took part in a half day field walk which consisted of a tour and inspection of the plant crop of the BA16001 variety evaluation field trial and a banana nutrient rate field trial at the South Johnstone Research Facility. A summary of the event, including communication material pre- and post-field walk is included in Appendix 7.

Banana R&D Speed dating event: This extension event, named after the popular 'speed date a researcher' session at the 2018 Roadshow events, was held in Innisfail on the 3 October 2019. The event was attended by just over 40 people and was designed to facilitate more interaction between researchers and growers and to promote grower-to-grower learning. The late afternoon/evening event consisted of 6 x 3 minute

presentations by researchers followed by the 'speed dating' exercise (6 x 10 minutes), a grower report and Q&A panel from a recent NextGen trip to the Northern Territory and an on-farm biosecurity scenario activity. A summary of the event including pre and post communication material is included in Appendix 8.

On-farm biosecurity extension and On-farm biosecurity best management practices (BMP)

During this project, the strategy to maintain a level of awareness with growers of on-farm biosecurity practices has been to integrate on-farm biosecurity into extension activities that have focused on other priority topics and research outcomes of interest to growers. A comprehensive summary of the on-farm biosecurity extension effort as part of this project is included in Appendix 9.

The activities in this project which have included on-farm biosecurity extension elements include; Booth displays at both of the 2017 and 2019 Australian Banana Industry Congress's, NextGen activities (particularly Northern Territory visits in 2017 & 2019), National Banana Roadshows 2018 (which featured the '*Making biosecurity work for your farm*' video with Mackays), the variety field walks (2019 & 2020) and the Banana R&D speed dating event in 2019. Offers of one-on-one assistance have been made following each detection of Panama disease tropical race 4 on properties in Tully. This has included promoting resources available to growers via e-bulletins, Panama TR4 program and via networks within this project (e.g. NextGen). Growers who took up this offer received a visit from members of the project to assess the risks and risk pathways associated with each farm. This was followed up with tailored ideas, suggestions and maps where appropriate. The biosecurity BMP resource has been made available to all growers via hard copy and electronically (pdf). To date, four growers have completed the on-line on-farm biosecurity BMP system as part of the testing phase, which was finalised in early 2020.

NextGen

A promotional style video '*Its more than just bananas for our banana NextGen group*' was compiled and published in April 2019. As at 15 June 2020 it has had 204 views.

Sydney activity: This activity was organised prior to the 2017 ABIC in Sydney and consisted of visits to the Orora Botany Paper mill, the Australian Centre for Field Robotics at the University of Sydney, a pre-packaging facility owned by integrated business Hydro Produce and Integrated Plastics extrusion plant. These visits were conducted over consecutive half days (20- 21 June 2017) and were attended by up to 13 growers. An article summarising the activity was published in the September 2017 edition of the *Australian Bananas* magazine and a full summary of the activity is included in Appendix 10.

Northern Territory activity (2017): The project organised and facilitated a two day trip to the Northern Territory (19-22 September 2017) which consisted of a visit to the variety screening and development trials at the NTDPIR Coastal Plains Research Farm, a visit to one of the few remaining commercial banana farms in the Northern Territory growing Williams Cavendish and one day attendance at the 2017 Nuffield Australia conference.

Thirteen people (11 NQ growers and 2 industry stakeholders) participated in the activity . After the trip, a short testimonial style video '*NextGen report – Variety screening trials in the Northern Territory*' was produced giving an overview of what some of the attendees thought about the variety screening trial. This video has recorded 1517 views as at 15 June 2020. An article was published in the December 2017 edition of the *Australian Bananas* magazine and a 'teaser' to the article was also included in an ABGC e-bulletin (16 October 2017). In addition, five growers presented an overview of the trip at the Cassowary Coast Banana Growers Association meeting held on Thursday 12 October 2017. Further details about the 2017 Northern Territory activity is included in Appendix 11.

Tablelands activity: On Friday 12 May 2019, 11 banana growers participated in a three-stop tour on the Atherton Tablelands. The trip consisted of visiting Nuffield scholar Matthew Fealy (Blue Sky Produce) who produces mangoes, avocados and Tahitian limes just outside of Mareeba, Serra Farming's avocado production followed by a visit to Serra Farming's banana operations. A summary of the visits was published in an ABGC e-bulletin (26 April 2019). Appendix 12 includes more details of the visits.

Northern Territory activity (2019): The NextGen group ventured back to the Northern Territory from 4- 6 November 2019, again visiting the banana variety and TR4 resistance evaluation and development trials at the Coastal Plains Research Farm. The trip to the Northern Territory also saw the group visit two Asian vegetable growers (loofa, chili, bitter melon and okra) and a high-tech mango packing shed. Sixteen people participated in the trip, which included 10 growers, 1 from New South Wales. Learnings from the trip were

shared by several growers at the Banana R&D speed dating event held on 3 October in Innisfail, and by the New South Wales grower at the Tweed Banana Growers Association meeting (24 October). An article about the trip was also published in the December edition of the *Australian Bananas* magazine. Further details about the trip are included in Appendix 14.

Variety field walk (2020): On 6 March members of the NextGen group, the Banana Variety Subcommittee of BA16001, and growers involved in the pre-commercialisation variety trials (as part of BA16001: Improved plant protection program for the banana industry) were invited to attend a tour and inspection of the second crop cycle of the variety evaluation trial block at the South Johnstone Research Facility. Offers were also made for those unable to attend the event to visit the trial block in the two weeks following the field walk. Collectively 22 growers and industry stakeholders viewed the progress of the first ratoon plants in the trial.

Innovation trials

The results and outputs of the innovation trials are detailed in Appendices 15 to 17. The key results and outputs are summarised below:

Early vs late de-suckering of Williams Cavendish tissue-cultured plants

- Removing the first flush of suckers by de-suckering early (approx. 3 months after planting) significantly increased plant growth and yield in comparison to de-suckering later (closer to bell emergence).
- Plants which were de-suckered late were significantly shorter in both the plant and first ratoon crop.
- The first ratoon crop was significantly faster cycling in plants which had been de-suckered early (43 weeks) compared to late de-suckering (45.5 weeks).
- Plants that were de-suckered early produced significantly heavier bunches in both the plant and first ratoon crops.

Ground cover trial

- In this trial the main agronomic characteristic impacted by the different ground cover treatments was cycle time. The living ground covers (Pinto peanut – *Arachis pintoi* and mint – *Mentha* sp) and weed gunnel tended to be slower cycling than the soil stabiliser and conventional bare-earth (control) treatments. However, these differences were not statistically significant in both the plant and first ratoon crops.
- In the plant crop, plants in the conventional bare-earth, soil stabiliser and weed matting treatments were significantly taller than plants grown in the living ground covers. However this reduction in plant height was not observed in the first ratoon crop.
- Although there were no significant differences in the mean bunch weights in the plant crop, bunches tended to be heavier in the weed matting treatment (23.4kg) compared to bare (20.7kg), soil stabiliser (20.3kg), Pinto peanut (19.7kg) and Mint (19kg). Similarly in the plant crop, plants in the weed matting, soil stabiliser and conversation bare-earth treatments produced significantly more total hands than plants grown in the living ground cover treatments. These difference were not observed in the first ratoon crop.

Entomopathogenic Nematodes (*Steinernema feltiae and S. carpocapsae*) *to control Banana weevil borer* (*Cosmopolites sordidus*)

- Entomopathogenic nematodes (EPN) showed promise for biological control of adult banana weevil borer in a preliminary laboratory experiment.
- Both EPN rates trialed (1 and 2 million EPN) resulted in over 88% death of adult banana weevil borers after 32 days (91% in 2 million EPN rate and 88% in the 1 million EPN rate).
- The greatest number of banana weevil borer deaths occurred between 5-10 days after application of the entomopathogenic nematodes.

Communication outputs from innovation trials

- Poster presentation at the 2019 Australian Banana Industry Congress
- Updates on the Better Bananas website
- Articles in the *Australian Bananas* magazine

    - April 2018 – Field trials at South Johnstone
    - December 2018 – One year into the innovation field trial
- NQ NextGen field walk 2018 & 2019
- NSW NextGen field walk 2019
- H&FS Tropical Fruit focus team field walk 2019

Outcomes

This project successfully facilitated a coordinated and comprehensive extension program for banana growers and industry stakeholders around Australia. On a national level the project delivered the latest results and progress updates from key industry funded projects, as well as projects funded from other sources, at the six National Banana Roadshow events in 2018. These events were attended by 141 growers covering at least 45% of national production. Growers in north Queensland were also kept informed of additional and priority research via extension events such as the Variety field walk and Banana R&D speed dating events in 2019, and exhibition booths and poster presentations at the 2017 & 2019 Australian Banana Industry Congresses. The Better Bananas poster presented by the project's extension team was awarded best poster presentation at the 2019 congress.

The networks of key information providers maintained and built throughout this project were also leveraged to disseminate timely and accurate information to banana growers and industry stakeholders (e.g. BAGMan group - consultants, agronomists, chemical representatives; key members of the supply chain). The Better Bananas website has enabled communication of progress and results of research projects to growers and industry stakeholders, available at their fingertips 24/7. The website has also proved to be a valuable resource for extension staff for referring grower enquiries on specific issues.

The industry communication channels (e.g. e-bulletins, Australian Bananas magazine and SMS distribution) maintained through the Banana industry communication program (BA15001, then BA18001) managed by ABGC, have played a key role in disseminating information and promoting the Better Bananas website. These channels are used to publicise extension events and are useful for reminding growers when extension events are occurring. Complementary extension activities were delivered for regionally specific issues in New South Wales as part of the Subtropical banana extension project (BA16007) managed by NSW DPI. All of these interrelated networks, mechanisms and approaches have continued to provide growers and the Australian banana industry with the latest R&D information and results in a timely, integrated manner, so that both growers and industry can make more informed business decisions.

The NextGen group has been a driving mechanism to encourage growers to think 'outside the box' and promote innovative thinking. The series of NextGen activities organised in this project have been largely directed by growers in the group with the project team facilitating a diverse range of visits/activities and discussions in response to grower ideas. This included:

- Visiting non-banana enterprises (such as Asian vegetable and avocado farms).
- Attending the Nuffield Australia conference to hear from a large range of growers sharing their global agricultural findings.
- Seeing Panama disease TR4 first-hand.
- Discussing the experience of growing in the presence of Panama disease TR4 with a Northern Territory grower to gain a better appreciation for the R&D effort to evaluate, screen and develop varieties with resistance to Panama disease TR4.

The activities and meetings organised with this group have promoted stronger grower-to-grower connections as well as networks outside the industry with growers and managers of other horticultural and non-horticultural enterprises.

In 2015 Panama disease TR4 was confirmed on a commercial banana property in north Queensland. This disease is one of the most devastating soil borne diseases in banana and on-farm biosecurity remains the best approach to limiting and slowing the spread of the disease. This project has continued to provide on-farm biosecurity extension to growers by implementing integrated extension strategies to keep on-farm biosecurity on growers' priority lists. These strategies are detailed in Appendix 9.

Evaluation shows that project activities have further equipped growers with knowledge to implement or improve their on-farm biosecurity practices. For example, following the 2019 NextGen visit to the Northern Territory, 75% of those that participated said they would change something in regards to on-farm biosecurity. Similarly, 68% of those that attended the Banana R&D speed dating event in 2019 gave a rating of a 4 or 5 out of 5 when asked how confident they were about implementing or improving their on-farm biosecurity practices, and 58% said that the on-farm biosecurity element at this event helped them identify on-farm biosecurity practices that they hadn't

previously thought about.

The On-farm biosecurity BMP resource has been made available at all industry events facilitated by this project. While there has not been significant grower demand for the on-line functionality of the BMP, released in early 2020, it is seen as a valuable tool for growers to use if there are future requirements to provide documentation of their on-farm biosecurity practices.

A small number of growers took up the offer of farm visits to discuss their on-farm biosecurity practices with project team members, seeking individualised suggestions about their farm layout and practices. Feedback from growers during these visits was that they are not at the point of needing to document their on-farm biosecurity practices, or actively develop an improvement plan (which is what the on-line system offers), however this tool is likely to be a useful resource for their business in the future.

The innovation trials offered growers insights into practices for which they either don't have the time to trial on their own properties or were unwilling to trial due to complexity and/or financial risk. As a result of field walks to observe and discuss trial results, growers who use tissue culture plants may want to revisit the timing of their de-suckering as the trial results showed that this practice can have significant effects on productivity. Although trial results of ground cover treatments showed that there were reduced productivity trends (cycle time, bunch weight etc.), there were very few significant differences, which can give growers confidence that trialling living ground covers in their banana blocks, would not come at a significant agronomic penalty in plant and first ratoon crops.

Banana weevil borers, have the potential to cause damage and significant production losses (plant roll-outs) and are typically controlled with chemical options. Biological or 'softer' chemical options are of interest to growers (particularly organic growers) and the results from preliminary entomopathogenic nematode trials were very positive. In a controlled environment, entomopathogenic nematodes were able to infect and kill banana weevil borer (>88% death in 32 days), and therefore this control option warrants further investigation in the field.

Monitoring and evaluation

Banana farmers/managers are very time conscious as bananas are non-seasonal, and crop 52 weeks of the year. To make the most of their limited time, this integrated and prioritised banana extension program has ensured that growers and industry stakeholders have various opportunities to see, hear about and discuss a range of R&D projects and outcomes at targeted industry extension events and activities. This dedicated banana extension program also allows for a multitude of approaches to be implemented including written, visual, audio and interactive techniques to facilitate better uptake and understanding of information from new and emerging R&D.

Real time quantitative evaluation was conducted at both the commencement and completion of major activities within the project, using tools such as TurningPoint™, Google forms, SurveyMonkey™ and paper based surveys. For some activities evaluation was conducted only at the completion of events with qualitative feedback sought from participants.The following discussion reports project activities and impact using the key evaluation question shown in the Table 3 below which were determined at the start of the project and recorded in the project M&E plan.

Table 3: Key evaluation questions

Domain	
Effectiveness	Has the overall program successfully coordinated the delivery of R&D outcomes to the Australian banana industry and facilitated the adoption of new and emerging technology and practices?
Relevance	To what extent has the project met the needs of delivering priority R&D outcomes to industry levy payers and industry stakeholders?
Process appropriateness	How well and to what extent have growers and industry stakeholders been engaged in the program?
Efficiency	Were the delivery methods of R&D outputs efficient? Were further efficiencies employed were appropriate?

The impact of the 2018 National Banana Roadshows was evaluated using the electronic polling system TurningPoint™. Attendees at the six events conducted around Australia were asked to rate their level of understanding of current R&D projects at commencement and completion of the day using a scale of 1 = nothing to 5 = I'm across them all. As Figure 3 shows, of the 141 growers and industry stakeholders that participated in the Roadshows, the majority of responses had shifted towards a better understanding of current R&D projects as a result of participating in the day-long event.

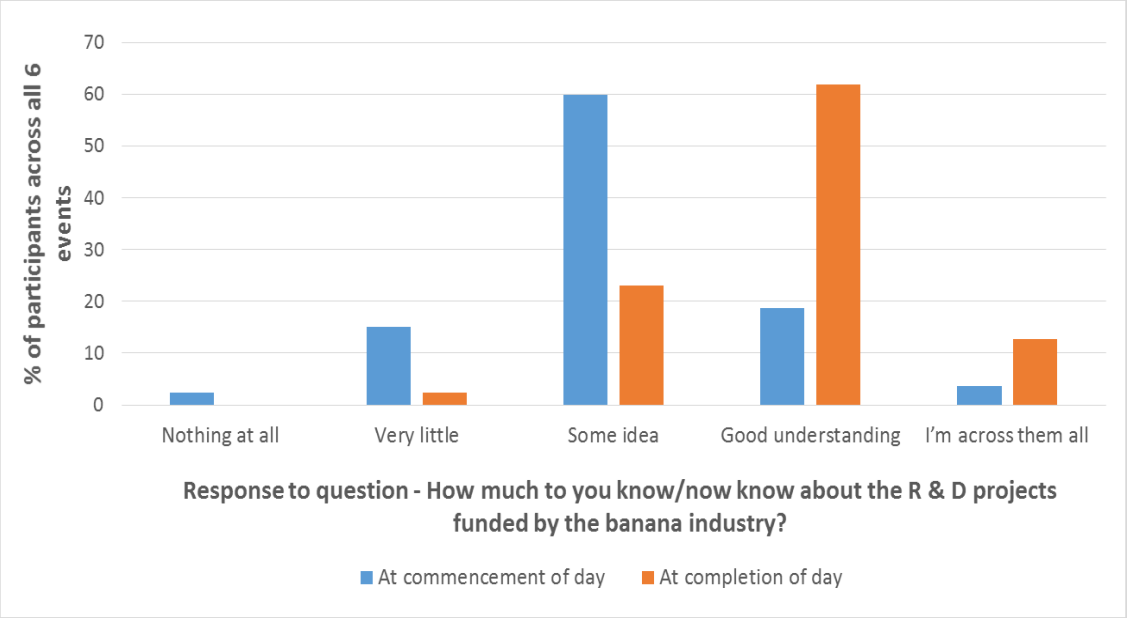

Figure 3: Evaluation results showing level of attendees' knowledge of R&D projects at the beginning and end of the day.

Attendees were also asked if they would change anything as a result of attending the roadshow events. Overall 61% said they would change something, with a further 27% indicating they might change something, and only 12% indicating that they wouldn't change anything. This shows that the majority of attendees gained knowledge of outcomes and results of R&D projects and that this may translate into practice change on their farms. Appendix 2 provides further detail on the evaluation of these events.

Evaluation was also conducted at the variety field walk (June 2019) and the Banana R&D speed dating event (October 2019) which are included in Appendices 7 & 8. Overall both of these events were rated very highly (Variety field walk – 93% rated a 7, 8 or 9 out of 9; Banana R&D speed dating event - 96% rated a 7, 8 or 9 out of 9). Evaluation results also showed that attendees' knowledge of R&D activities had improved and that they would consider implementing practice changes as a result of attending these events. Additionally, at all of these industry-wide activities, growers reported the value of talking with and learning from other growers, and having the time to interact with the researchers rather than activities which are focused presentation style. This supports the value of the project's interactive approach to delivering extension activities.

The majority of the more substantial NextGen activities were evaluated using quantitative and some qualitative data collection. The full evaluation results from the NextGen activities are detailed in Appendices 10 to 14. As an example, SurveyMonkey™ was used to evaluate the NextGen 2017 and 2019 trips to the Northern Territory. In 2017, 86% of participants rated the trip as excellent and the remaining 14% rated it very good (Scale: poor, fair, good, very good, and excellent). When asked how the trip helped participants further appreciate the potential impact of Panama disease TR4, 86% responded with a 5 and 14% responded with a 4 (on a scale of 1-5, 1 being not at all and 5 being I now understand and appreciate the full potential). This was an excellent result and demonstrated the value in providing the opportunity for growers to see the disease first-hand and talk to people who have had experience with the disease.

When asked how much the trip helped improve their understanding of the investment in variety resistance screening and development (on a scale of 1-5, 1 being not at all and 5 being quite a lot) there were some mixed responses. One person answered a 1, however the remaining respondents answered 3-5. This indicated that more and improved communication is required to help growers better understand the strategies being taken both in Australia and internationally to develop a Panama disease TR4 resistant variety. In contrast, two years later in 2019 when representatives from the NextGen group ventured back to the Northern Territory, 90% of participants said they improved their understanding of investment in variety screening and development 'quite a lot' as a result of attending the trip (Scale 1 = Not at all to 5 = quite a lot). Another very positive outcome from the 2019 visit was that 75% of attendees indicated they would

improve their on-farm biosecurity practices. The increased focus on extension of variety R&D (e.g. 2018 Roadshows, 2017 & 2019 Australian Banana Industry Congress, and variety field walk) in the two year period between the Northern Territory trips most likely also contributed to this positive outcome.

The qualitative feedback on the benefits of attending NextGen activities facilitated by the project team have yielded statements from growers such as "*Good to see another industry and get some insight into innovative ideas and understand the challenges they may face*" and "*Overall challenges that you face as a business are the same e.g. energy savings, excited to see future of robotics and tech in bananas but feel it hasn't come a long way in recent times*". This provided further evidence and confidence on the value of spending time looking outside the realms of banana businesses and learning from others.

Usage of the Better Bananas website developed as part of this project has been monitored using Google Analytics. From 1 July 2018 – 30 April 2020 (22 months) the website has been accessed by 3230 users. The target audience for the website is Australian banana growers (approximately 220 in the main production region in Far North Queensland), service providers (less than 100 in Far North Queensland) and industry stakeholders. Figure 4 below shows a breakdown of Australian users by state, with approximately 60% from Queensland which suggests that the website has been visited by a high proportion of the target audience.

Figure 4: Australian users of the Better Bananas website by state

A total of 4721 sessions were recorded for the period with 3358 originating from within Australia. The total number of page views was 10 659 of which 8776 page views were from Australian users, averaging 2.6 pages per session. This suggests that users of the website view approximately two to three pages per visit. The website had a return visitor rate of 24.5% for Australian users with average 1.8 sessions per user. This rate has increased since a review of the website in April 2019 that showed a return visitor rate of 21.9%. Detailed information about the website including data about how users are accessing the site (e.g. devices, referrals etc.) to help inform the recommendations for future improvements of the resource are included in Appendix 5.

These evaluation results show that the project methodology, resources and networks built and maintained within this project have successfully coordinated the delivery of R&D outcomes to the Australian banana industry to help growers make more informed decisions about their businesses. There is some evidence that activities have also enouraged the adoption of new and emerging technology and practices. The good attendance at the various events and activities and very positive feedback to the project's interactive approach demonstrates that growers have been well engaged directly in the program.

Recommendations

The recommendations from this project collectively reflect and build on the learnings of the previous National Banana Development and Extension Project (BA13004):

- Banana production occurs 52 weeks of the year and banana growers are time poor. It is important that a coordinated approach continues to be taken to delivering the latest R&D updates and outputs to growers and industry stakeholders to maximise engagement opportunities with growers.
- Growers learn and communicate differently and therefore a range of extension tools in different formats should be utilised to encourage uptake of new and emerging practices. Similarly, new and emerging extension tools and techniques should be considered to both facilitate information uptake and drive innovation among banana growers as their demographic shifts.
- Continued guidance from a project reference group made up of growers from different growing regions, a supply chain representative, industry and the project manager is essential to ensure the success of future projects.
- The National Banana Roadshow series has once again been an extremely successful platform to deliver prioritised and regionally specific information to growers around Australia, and should continue to be part of future National Banana Extension Programs. The events have been successful due to their prioritised agenda topics, short professional presentations, as well as the facilitated interaction between researchers and attendees during panel style question opportunities as well as the 'speed date a researcher' element. Growers have commented highly on the reduction of more 'formal' presentations and the integration of more interactive elements, therefore activities which promote even more interaction between researchers and growers and between growers should be explored and integrated into future Roadshow events.
- The promotion of events (e.g. Roadshow events and field days) should continue to be conducted across several channels. The ability to utilise existing industry communication channels namely: e-bulletins, *Australian Bananas* magazine, and text messaging established through the Banana Industry Communications Program is vital. The ABGC social media platforms are other communication mechanisms which can be further leveraged to promote research progress, outcomes and extension activities. Personalised mailed letters have not resulted in more growers attending events so emphasis should remain on the other communication channels mentioned.
- Future extension projects should continue to have dedicated resourcing to foster and build upon the successful NextGen young banana growers group. The flexibility for activities to be self-driven by growers in the group is vital to grower participation and successfully achieving the desired outcome of driving innovation.
- The innovation field trials have been an important component of the project in fostering innovation and exploring possible opportunities to improve current banana production systems. For this reason, it is recommended that the innovation trial is supported in future extension programs, either at the South Johnstone Research Facility or via on-farm trials. Managing the current project's innovation trial required a lot of time and resources from the project team. It is therefore recommended that future innovation trials (whether they are conducted at the South Johnstone Research Facility or on-farm in collaboration with growers) be focused on short researchable topics with a defined timeframe of no more than 12 weeks. Lastly, the project reference group, as well as NextGen group provided important ideas and guidance on research topics. It's therefore recommended that this consultation and collaboration to define priorities and the scope of the trials continues as part of any future extension program.
- The Better Bananas website is an important information resource for Australian banana growers and industry stakeholders. It's also an important resource in the extension toolbox, as the extension team can directly refer growers, agribusiness and supply chain personnel to information on the site. However, there are opportunities to further increase the number of new users as well as returning visitors to the website. This includes improving promotion through industry communication channels and including increased promotion via industry social media platforms. Content should be published on topical

research and the continued use of video should be utilised. Future extension projects should support the management of the website (more specific recommendations include in Appendix 5). Overall it is recommended that the industry continues to support the management of the website through future extension projects.

- On-farm biosecurity is an industry priority and keeping this issue at the top of growers' priority lists is challenging. Therefore extension of on-farm biosecurity either indirectly (e.g. a demonstration as part of an activity) or directly (e.g. a specific on-farm biosecurity activity) should be carefully considered and integrated into all future industry events, workshops and activities. Integrating on-farm biosecurity into individual conversations with growers during farm visits (associated with high priority topics) is likely to be an effective means to tailor information to each grower and make individualised suggestions for their farming situation. The On-farm biosecurity BMP is a great practical resource for growers, including the recently developed online system. It is recommented that resourcing should be built into any future extension program to allow project staff to be able to step growers through biosecurity options for their farm, as well as show them the online BMP system. This will be important for any growers ready to plan and implement on-farm biosecurity and/or document their biosecurity practices through developing a more formal biosecurity management plan.
- Field day events held in banana paddocks offer a great opportunity to extend outcomes from field based activities to growers and also adds a unique social setting for growers to discuss the outcomes of R&D activities. Careful on-farm biosecurity practices need to be adhered to, to facilitate these events and therefore information should be sought from the On-farm biosecurity BMP and those with a high level of knowledge about on-farm biosecurity systems prior to holding a field event.
- Future banana extension programs should continue to work closely with the industry's communication project. The relationship between the two projects to distribute written information about R&D project updates and outputs, event promotion, promotion of videos etc. is vital to the success of future extension projects. Similarly, it is equally important to remain in close contact with project leaders and staff working in other banana R,D&E projects to ensure accurate project updates and outcomes are delivered to growers and industry stakeholders in a timely manner.
- It is vital that future extension projects have the flexibility to address emergent industry priorities.

Intellectual property, commercialisation and confidentiality

Better Bananas website: The domain name betterbananas.com.au is registered under Horticulture Innovation Australia. The Department of Agriculture and Fisheries has registration of the trademark 'Better Bananas National Development and Extension Program' name and logo.

Acknowledgements

I would like to sincerely like to thank all the research staff in the banana scientific community which have given their time to showcase their work at events and activities in this project (Roadshows, field days, better bananas website etc.). I would also like to acknowledge the project reference who generously gave up their time and provided honest and timely input into project activities. Thanks to the staff of the ABGC, especially Rosie Godwin (R&D Manager) and the communications team Sonia Campbell, Amy Spear and Lea Coghlan. Also thanks to the NSW Industry Development Officer Matt Weinert, followed by Tom Flanagan, who supported, promoted and guided activities in NSW (Roadshows). Special thanks to the project team Stewart Lindsay, Shanara Veivers and Ingrid Jenkins for their hard work, dedication and support. Last but not least to all the banana growers and industry stakeholders who have contributed to and attended activities and events organised and facilitated as part of this project.

Appendices

Appendix 1: 2018 National Banana Roadshow Series - Agendas

Appendix 2: 2018 National Banana Roadshow Series - Attendance and Evaluation Summary

Appendix 3: 2018 National Banana Roadshow Series - Communication material

Appendix 4: Australian Banana Industry Congress (2017 & 2019)

Appendix 5: Information at your fingertips - the Better Bananas website

Appendix 6: BAGMan meetings

Appendix 7: Variety Field walk (2019)

Appendix 8: Banana R&D Speed dating event (2019)

Appendix 9: On-farm biosecurity extension

Appendix 10: NextGen - Sydney activity (2017)

Appendix 11: NextGen – Northern Territory activity (2017)

Appendix 12: NextGen - Tablelands activity (2019)

Appendix 13: NextGen – Northern Territory activity (2019)

Appendix 14: NextGen – Variety field walk (2020)

Appendix 15: Innovation trial

Appendix 16: Innovation trial – Bell injection

Appendix 17: Innovation trial – Entomopathogenic nematodes

National Banana Roadshow Series 2018

MURWILLUMBAH Tuesday 24 July
Murwillumbah Services Club

9 AM - Program Starts	
Welcome, overview of the day	
Session 1	
Introducing the new banana R&D website	Ingrid Jenkins (DAF)
Variety importation and development overview	Stewart Lindsay (DAF)
Results from the variety/mutagenesis trials	Jeff Daniells (DAF)
QUESTIONS	
Morning Tea	
Session 2	
Living with TR4 (video)	Stewart Lindsay (DAF)
Update on the Duranbah trial	Matt Weinert (NSW DPI)
How to ensure inoculum is kept to a minimum	Wayne O'Neill (DAF)
QUESTIONS	
Session 3	
Nematodes	Jenny Cobon (DAF)
Advances in bunch pest management	Richard Piper (DAF)
Reject analysis	Matt Weinert (NSW DPI)
QUESTIONS	
Speed dating session	
Researchers spend 4-5 minutes at each table with growers, then researcher moves to next table	
Lunch	
Interactive session	
Station 1 - Nematodes	Jenny Cobon (DAF)
Station 2 - Crown end rot	Kathy Grice (DAF)
Station 3 - Marketing	Kylie Drumond (Hort Innovation)
Guest Speakers	
Benchmarking	Howard Hall (Pinnacle Agribusiness)
Panel discussion with researchers	Researchers
Wrap up and Evaluation	
3:10 PM - Program finish	

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National Banana Development and Extension Program

National Banana Roadshow Series 2018

COFFS HARBOUR Thursday 26 July
Coffs Harbour Showgrounds – Norm Jordan Pavilion

9AM - Program Starts	
Welcome, overview of the day	
Session 1	
Introducing the new banana R&D website	Ingrid Jenkins (DAF)
Variety importation and development overview	Stewart Lindsay (DAF)
Results from the variety/mutagenesis trials	Jeff Daniells (DAF)
QUESTIONS	
Morning Tea	
Session 2	
Living with TR4 (video)	Stewart Lindsay (DAF)
Update on the Duranbah trial	Matt Weinert (NSW DPI)
How to ensure inoculum is kept to a minimum	Wayne O'Neill (DAF)
QUESTIONS	
Session 3	
Nematodes	Jenny Cobon (DAF)
Advances in bunch pest management	Richard Piper (DAF)
Reject analysis	Matt Weinert (NSW DPI)
QUESTIONS	
Speed dating session	
Researchers spend 4-5 minutes at each table with growers, then researcher moves to next table	
Lunch	
Interactive session	
Station 1 - Nematodes	Jenny Cobon (DAF)
Station 2 - Crown end rot	Kathy Grice (DAF)
Station 3 - Marketing	Kylie Drumond (Hort Innovation)
Guest Speakers	
Benchmarking	Howard Hall (Pinnacle Agribusiness)
On-farm biosecurity Q&A	Researchers
General discussion/questions	Researchers
Wrap up and Evaluation	
3:25 PM - Program finish	

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National Banana Roadshow Series 2018

TULLY Thursday 9 August
Tully Senior Citizens Hall

9 AM - Program Starts	
Welcome, overview of the day	
Session 1	
Introducing the new Banana R&D website	Ingrid Jenkins (DAF)
Variety importation and development overview	Stewart Lindsay (DAF)
Results from the variety/mutagenesis trials	Sharl Mintoff (NT DPIR)
QUESTIONS	
Morning Tea + Static Displays	
Session 2	
Soil health and disease suppression	Tony Pattison (DAF)
Advances in bunch pest management	Richard Piper (DAF)
QBAN	Rosie Godwin (ABGC)
QUESTIONS	
Session 3	
Minimum standards	TBC (ABGC)
Benchmarking (economics)	Howard Hall (Pinnacle Agribusiness)
Benchmarking (environmental and biosecurity)	Howard Hall (Pinnacle Agribusiness)
QUESTIONS	
Speed dating session	
Researchers spend 4-5 minutes at each table with growers, then researcher move to next table	
Lunch + Static Displays	
Interactive session	
Station 1 - Varieties	Jeff Daniells (DAF)
Station 2 - Crown end rot	Kathy Grice & Peter Trevorrow (DAF)
Station 3 - Marketing	Kylie Drumond (Hort Innovation)
Guest Speakers	
Living with TR4	Mackays representative
TBC	TBC
Panel discussion with researchers	Researchers
Wrap up and Evaluation	
3:15 PM - Program finish	

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National Banana Roadshow Series 2018

INNISFAIL Friday 10 August
Innisfail Showgrounds

9 AM - Program Starts	
Welcome, overview of the day	
Session 1	
Introducing the new Banana R&D website	Ingrid Jenkins (DAF)
Variety importation and development overview	Stewart Lindsay (DAF)
Results from the variety/mutagenesis trials	Sharl Mintoff (NT DPIR)
QUESTIONS	
Morning Tea + Static Displays	
Session 2	
Soil health and disease suppression	Tony Pattison (DAF)
Advances in bunch pest management	Richard Piper (DAF)
QBAN	Rosie Godwin (ABGC)
QUESTIONS	
Session 3	
Minimum standards	Michelle McKinlay (ABGC)
Benchmarking (economics)	Howard Hall (Pinnacle Agribusiness)
Benchmarking (environmental and biosecurity)	Howard Hall (Pinnacle Agribusiness)
QUESTIONS	
Speed dating session	
Researchers spend 4-5 minutes at each table with growers, then researcher move to next table	
Lunch + Static Displays	
Interactive session	
Station 1 - Varieties	Jeff Daniells (DAF)
Station 2 - Crown end rot	Kathy Grice & Peter Trevorrow (DAF)
Station 3 - Marketing	Kylie Drumond (Hort Innovation)
Guest Speakers	
Living with TR4	Mackays representative
TBC	TBC
Panel discussion with researchers	Researchers
Wrap up and Evaluation	
3:15 PM - Program finish	

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National Banana Development and Extension Program

National Banana Roadshow Series 2018

MAREEBA Friday 17 August
Department of Natural Resources, Mines and Energy, John Charles room

9 AM - Program Starts	
Welcome, overview of the day	
Session 1	
Introducing the new Banana R&D website	Ingrid Jenkins (DAF)
Variety importation and development overview	Stewart Lindsay (DAF)
Results from the variety/mutagenesis trials	Sharl Mintoff (NT DPIR)
QUESTIONS	
Morning Tea + Static Displays	
Session 2	
Soil health and disease suppression	Tony Pattison (DAF)
Advances in bunch pest management	Richard Piper (DAF)
QBAN	TBC (ABGC)
QUESTIONS	
Session 3	
Minimum standards	Michelle McKinlay (ABGC)
Benchmarking (economics)	Howard Hall (Pinnacle Agribusiness)
Benchmarking (environmental and biosecurity)	Howard Hall (Pinnacle Agribusiness)
QUESTIONS	
Speed dating session	
Researchers spend 4-5 minutes at each table with growers, then researcher move to next table	
Lunch + Static Displays	
Interactive session	
Station 1 - Varieties	Jeff Daniells (DAF)
Station 2 - Crown end rot	Kathy Grice & Peter Trevorrow (DAF)
Station 3 - Marketing	Kylie Drumond (Hort Innovation)
Guest Speakers	
Living with TR4	Mackays representative
TBC	TBC
Panel discussion with researchers	Researchers
Wrap up and Evaluation	
3:15 PM - Program finish	

National Banana Roadshow Series 2018

CARNARVON Thursday 30 August
Carnarvon Yacht Club

9 AM - Program Starts	
Welcome, overview of the day	
Session 1	
Introducing the new Banana R&D website	Shanara Veivers (DAF)
Variety importation and development overview	Stewart Lindsay (DAF)
Results from the variety/mutagenesis trials	Jeff Daniells (DAF)
Update on the Duranbah trial	Matt Weinert (NSW DPI)
QUESTIONS	
Morning Tea	
Session 2	
Nematodes	Jenny Cobon (DAF)
Nematodes	Annie Van Blommestein (Carnarvon Growers' Association)
Learnings from the Crown end rot research	Peter Trevorrow (DAF)
QUESTIONS	
Session 3	
On-farm biosecurity in NQ	Shanara Veivers (DAF)
Benchmarking video	Howard Hall (Pinnacle Agribusiness)
QUESTIONS	
Speed dating session	
Researchers spend 4-5 minutes at each table with growers, then researcher move to next table	
Lunch	
Guest Speakers	
Banana Irrigation	Scott Brain (Field Capacity)
Learnings from International Horticultural Congress	Doriana Mangili (Sweeter Banana Co-operative)
Marketing	Kylie Drumond (Hort Innovation)
Panel discussion with researchers	Researchers
Wrap up and Evaluation	
2:40 PM - Program finish	

Appendix 2: 2018 National Banana Roadshow Series - Attendance and Evaluation Summary

Attendance

The 2018 National Banana Roadshow Series was successfully conducted in Murwillumbah (24 July), Coffs Harbour (26 July), Tully (9 August), Innisfail (10 August), Mareeba (17 August) and Carnarvon (30 August).

Overall, 141 growers, service providers and industry representatives attended the six events. Tables 1 and 3 provide a breakdown of the number of attendees at each location and their role within the industry. Please note, roadshow organisers and presenters are not included in the attendee numbers presented in Table 1. Across all locations, over 40% of people that attended in 2018 had not previously attended a Roadshow event (Table 2) which is a very encouraging result.

Table 1: Attendance at the 2018 National Banana Roadshow Series

Location	**Number of attendee's (Growers, service providers and industry representatives only)**
Murwillumbah	21
Coffs Harbour	21
Tully	17
Innisfail	37
Mareeba	24
Carnarvon*	21
Total Attendance	141

**The Australian Banana Growers Council board meeting was held in conjunction with the Roadshow event in Carnarvon and therefore north Queensland and a New South Wales grower were in attendance.*

Table 2: Have you attended a Roadshow event in previous years?

	Murwillumbah	**Coffs Harbour**	**Tully**	**Innisfail**	**Mareeba**	**Carnarvon**	**Overall percentage across all locations**
Yes	52%	71%	57%	52%	36%	82%	57%
No	48%	29%	43%	47%	64%	18%	43%

Table 3: How best describes your role in the banana industry?

	Murwillumbah	**Coffs Harbour**	**Tully**	**Innisfail**	**Mareeba**	**Carnarvon**	**Overall percentage across all locations**
Grower	43%	65%	30%	38%	32%	43%	41%
Reseller	3%	5%	0%	12%	0%	0%	4%
Service provider	7%	0%	17%	18%	28%	10%	13%
Post farm gate supply chain member	0%	0%	0%	3%	0%	0%	1%
Researcher/project leader	27%	5%	33%	12%	16%	24%	20%
Other	20%	25%	20%	18%	24%	24%	21%

Evaluation

Turningpoint™ is an interactive electronic polling system and was used to capture real-time evaluation data from Roadshow attendees on the day. A series of questions were asked of the audience, with responses to those questions providing valuable information on both improving future Roadshow events and helping evaluate the impact of the Roadshow as a key extension activity for industry.

Questions were asked at the beginning of the day to determine how attendees found out about the Roadshow events and what their existing level of understanding of current banana R&D projects was. At the end of the day, a second series of questions were asked to evaluate the effectiveness of the day's activities on increasing attendee's knowledge of R&D projects and strengthening industry networks.

How people found out about the National Banana Roadshows

Table 4 summarises how attendees found out about the event. Unlike the 2016 Roadshow events, very few attendees said they were informed via a letter in the mail. Government staff (30%), e-mail (27%), and the ABGC e-bulletin (23%) were identified as the most common methods of finding out about the events. Although text messages were not the main way attendees found out about the events, they were a very cost-effective reminder for attendees.

Table 4: Summary of how attendees found out about the 2018 National Banana Roadshow event

Location	Mail out	ABGC e-bulletin	e-mail	Text message	Government staff	Word of mouth
Murwillumbah	4%	14%	25%	4%	37%	14%
Coffs Harbour	0%	44%	6%	6%	22%	22%
Tully	6%	23%	29%	0%	35%	6%
Innisfail	0%	24%	35%	6%	24%	12%
Mareeba	4%	19%	27%	0%	31%	19%
Carnarvon	0%	22%	30%	0%	30%	17%
Overall percentage of each means of finding out about the events	3%	23%	27%	3%	30%	14%

Impact of the National Banana Roadshows on attendee's knowledge of R&D projects

Attendees were asked at the beginning of the day to rate their level of understanding of current banana R&D projects on a scale of 1 to 5, with 1 = nothing at all, 2 = very little, 3 = some idea, 4 = a good understanding and 5 = I'm across them all. This question was again asked at the end of the day. Figure 1 shows the percentage of attendees in each of these categories at the beginning and at the end of the day, demonstrating that attendees had strongly increased their knowledge of banana R&D projects by participating in the Roadshow events.

To illustrate, at the beginning of the day 60% of attendees indicated they had "some idea" about the different banana R&D projects, whereas by the end of the day, there was a significant shift from "some idea" to a "good understanding", with 62% of attendees indicating they had a good level of understanding of current R&D projects following the Roadshow event. The significant outcome is the degree to which people's knowledge had improved, shown by the increase in the percentage of attendees rating their knowledge as a 4 or 5 at the completion of the event. Initially only 11% of respondents rated their knowledge of banana R&D as a 4 or above, but by the end of the event this

had increased to 75% of respondents, indicating a significantly increased depth of knowledge of banana R&D activities and results as an outcome of attending the Roadshow.

Table 5 gives a breakdown of the comparison of responses (%) at each location and while there was some variation in the level of increased R&D project knowledge achieved at individual roadshow events, the trend was improved R&D knowledge across all six events.

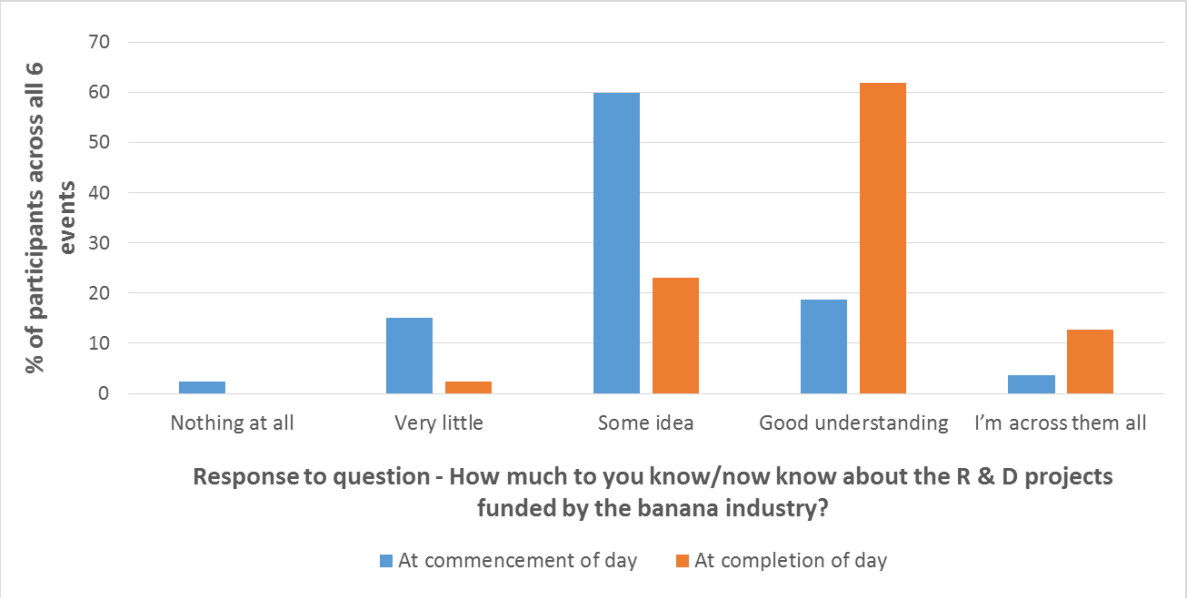

Figure 1: Comparison of the % of attendee's responses (across all 6 Roadshow locations) to the question – How much do you know about the R&D projects funded by the banana industry, asked at the beginning and at the end of the day.

Table 5: Percentage of before and after responses for each Roadshow event based on the question – How do your rate your current level of knowledge of the latest R&D projects?

		None/Nothing at all	Limited/ Very Little	Okay/Some Idea	Great, I know about most/Good understanding	I know so much I should be running the show/I'm across them all
Murwillumbah	Beginning	3%	7%	70%	17%	3%
	End	0%	4%	22%	67%	7%
Coffs Harbour	Beginning	10%	30%	30%	30%	0%
	End	0%	6%	17%	67%	11%
Tully	Beginning	0%	3%	70%	23%	3%
	End	0%	0%	23%	58%	19%
Innisfail	Beginning	0%	33%	52%	15%	0%
	End	0%	0%	29%	71%	0%
Mareeba	Beginning	0%	8%	76%	16%	0%
	End	0%	0%	20%	40%	40%
Carnarvon	Beginning	4%	13%	54%	13%	17%
	End	0%	5%	25%	65%	5%

Indication of practice change as a result of attending the National Banana Roadshows

Attendees were asked if they would change anything on farm as a result of attending the Roadshow events. A total of 61% of attendees said they would change something, 27% indicated that they might change something, and only 12% said they wouldn't change anything (Table 6). This shows that majority of attendees gained knowledge from the Roadshows which could potentially translate into practice change on their farms.

Table 6: Will you change anything after today?

	Murwillumbah	Coffs Harbour	Tully	Innisfail	Mareeba	Carnarvon	Overall percentage across all locations
Yes	48%	75%	58%	60%	75%	58%	61%
No	26%	5%	4%	20%	6%	8%	12%
Maybe	26%	20%	38%	20%	19%	33%	27%

Perceived benefits of attending Roadshow events

As Tables 7 and 8 show, most attendees were likely to attend future National Banana Roadshow events (92%) and were likely to recommend the Roadshows to others (99%). This is a very promising outcome.

Table 7: Would you attend an event like this again?

	Murwillumbah	Coffs Harbour	Tully	Innisfail	Mareeba	Carnarvon	Overall percentage across all locations
Yes	85%	95%	88%	90%	100%	96%	92%
No	8%	0%	4%	0%	0%	0%	2%
Maybe	8%	5%	8%	10%	0%	4%	6%

Table 8: Would you recommend this event to others?

	Murwillumbah	Coffs Harbour	Tully	Innisfail	Mareeba	Carnarvon	Overall percentage across all locations
Yes	96%	100%	100%	100%	94%	100%	99%
No	4%	0%	0%	0%	6%	0%	1%

Overall rating

On a scale of 1-9, one being the lowest and 9 being the highest, attendees were asked to provide an overall rating of the day. Overall, 89% of attendees rated the day a 7, 8 or 9 with Figure 2 showing the distribution of ratings that were given across all six Roadshow events. Table 9 provides a breakdown of the overall ratings at each Roadshow location.

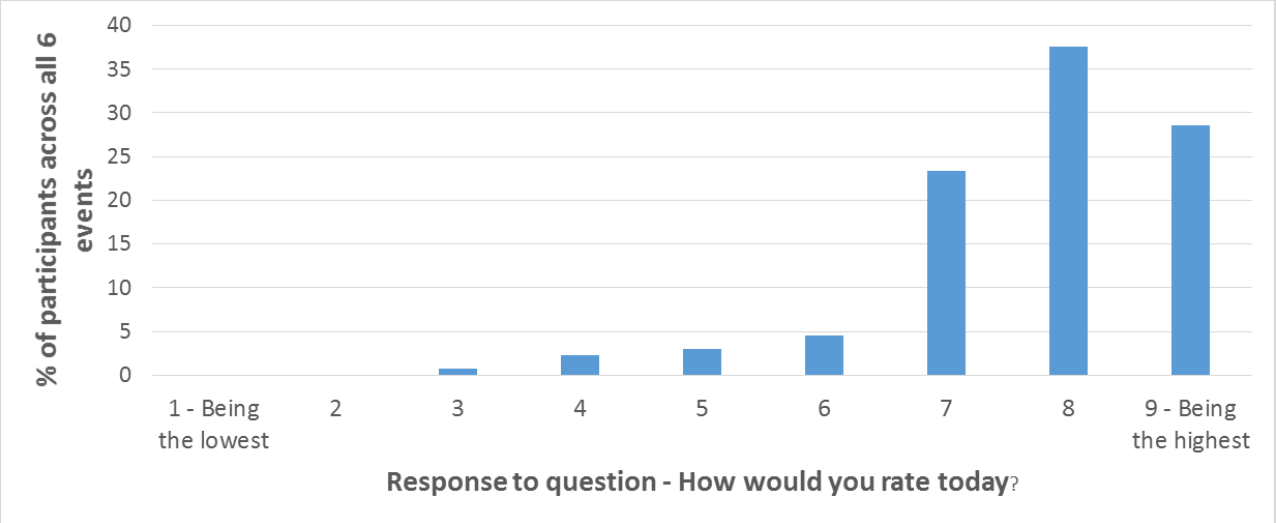

Figure 2: Overall rating (1-9) given at the 2018 National Banana Roadshow events.

Table 9: How would you rate today?

	Murwillumbah	Coffs Harbour	Tully	Innisfail	Mareeba	Carnarvon	Overall percentage across all locations
1 – (being lowest)	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%
3	0%	5%	0%	0%	0%	0%	1%
4	11%	0%	0%	0%	0%	0%	2%
5	4%	0%	0%	5%	0%	9%	3%
6	7%	5%	0%	14%	0%	0%	5%
7	21%	10%	23%	24%	13%	45%	23%
8	43%	20%	50%	48%	50%	14%	38%
9 - (being highest)	14%	60%	27%	10%	38%	32%	29%

Appendix 3: 2018 National Banana Roadshow Series - Communications

ABGC e-bulletin 8 June 2018

Roadshows: Save the Dates!

The six-stop National Banana Roadshow Series is again touring the country during July and August 2018. The fast-paced events will feature the latest research and development including information on banana varieties, soil health, pest and disease management, QBAN, environmental practices, benchmarking and marketing.

The events will feature several short, sharp 10 minute presentations from researchers, a 'speed meeting' session with the presenters and interactive displays.

Dates are –

New South Wales

- Murwillumbah, Tuesday 24 July, Murwillumbah Services Club

- Coffs Harbour, Thursday 26 July, Coffs Harbour Showgrounds

Far North Queensland

- Tully, Thursday 9 August, Tully & District Senior Citizens Hall

- Innisfail, Friday 10 August, Innisfail Showgrounds

- Mareeba, Friday 17 August, Dept. of Natural Resources, Mines and Energy - John Charles room

Western Australia

- Carnarvon, Thursday 30 August, Carnarvon Yacht Club

Event organisers are urging growers and industry stakeholders to RSVP for these events. **These are your levies at work! Come along and see how the latest research applies to your business.**

You can register for the events through Eventbrite or by contacting your local industry extension officers.

For Queensland and WA events contact Shanara Veivers (DAF) at shanara.veivers@daf.qld.gov.au or phone/text 0400 870 731.

For NSW events contact Matt Weinert (NSW DPI) at matt.weinert@dpi.nsw.gov.au or phone/text 0438 664 136.

ABGC e-bulletin 21 June 2018

For the diary: National Banana Roadshow

The six-stop National Banana Roadshow Series is again touring the country during July and August 2018. The fast-paced events will feature the latest research and development including information on banana varieties, soil health, pest and disease management, QBAN, environmental practices, benchmarking and marketing.

The dates are:

New South Wales

- Murwillumbah, Tuesday 24 July, Murwillumbah Services Club

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For NSW events contact Matt Weinert (NSW DPI) at matt.weinert@dpi.nsw.gov.au or phone/text 0438 644 136.

ABGC e-bulletin 6 July 2018

Reserve your spot at the 2018 banana roadshows

The countdown is on for the start of the 2018 National Banana Roadshow Series. Event organisers are urging growers and industry stakeholders to RSVP to the fast-paced events.

Dates and locations include:

- **Murwillumbah**, Tuesday 24 July, Murwillumbah Services Club (9 am – 3:30 pm)

- **Coffs Harbour**, Thursday 26 July, Coffs Harbour Showgrounds (9 am – 3:30 pm)

- **Tully**, Thursday 9 August, Tully & District Senior Citizens Hall (9 am – 3:30 pm)

- **Innisfail**, Friday 10 August, Innisfail Showgrounds (9 am – 3:30 pm)

- **Mareeba**, Friday 17 August, Department of Natural Resources, Mines and Energy - John Charles room (9 am – 3:30 pm)

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For NSW events contact Matt Weinert (NSW DPI) at matt.weinert@dpi.nsw.gov.au or phone/text 0438 644 136.

ABGC e-bulletin 17 July 2018

Are you ready for the Roadshow?

With just over a week until the National Banana Roadshow begins, we urge growers to come along and take up the opportunity to hear about the latest research and development.

The first roadshow presentation will kick off in NSW and will be held in Murwillumbah on Tuesday 24 July, with Coffs Harbour to follow on Thursday 26 July.

Full list of locations, dates and venues below:

- **Murwillumbah**, Tuesday 24 July, Murwillumbah Services Club (9 am – 3:30 pm)

- **Coffs Harbour**, Thursday 26 July, Coffs Harbour Showgrounds (9 am – 3:30 pm)

- **Tully**, Thursday 9 August, Tully & District Senior Citizens Hall (9 am – 3:30 pm)

- **Innisfail**, Friday 10 August, Innisfail Showgrounds (9 am – 3:30 pm)

- **Mareeba**, Friday 17 August, Department of Natural Resources, Mines and Energy - John Charles room (9 am – 3:30 pm)

- **Carnarvon**, Thursday 30 August, Carnarvon Yacht Club (9 am – 3 pm)

These are your levies at work! Come along and see how the latest research applies to your business. Register now through Eventbrite or contact your local industry extension officers:

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For NSW events contact Matt Weinert (NSW DPI) at matt.weinert@dpi.nsw.gov.au or phone/text 0438 644 136.

ABGC e-bulletin 23 July 2018

Banana science on tour

It's the eve of the 2018 National Banana Roadshow, with a jam-packed day of science and research kicking things off in Murwillumbah tomorrow (July 24).

Coffs Harbour will follow on Thursday (July 26), with North Queensland under way from early next month.

Dates and locations:

- Murwillumbah, Tuesday 24 July, Murwillumbah Services Club (9 am – 3:30 pm)

- Coffs Harbour, Thursday 26 July, Coffs Harbour Showgrounds (9 am – 3:30 pm)

- Tully, Thursday 9 August, Tully & District Senior Citizens Hall (9 am – 3:30 pm)

- Innisfail, Friday 10 August, Innisfail Showgrounds (9 am – 3:30 pm)

- Mareeba, Friday 17 August, Department of Natural Resources, Mines and Energy - John Charles room (9 am – 3:30 pm)

- Carnarvon, Thursday 30 August, Carnarvon Yacht Club (9 am – 3 pm)
Register now through Eventbrite or contact your local industry extension officers:

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For NSW events contact Matt Weinert (NSW DPI) at matt.weinert@dpi.nsw.gov.au or phone/text 0438 644 136.

ABGC e-bulletin 3 August 2018

North Queensland next Roadshow stop

Growers and industry stakeholders take in the information at Murwillumbah on July 24.

With less than a week until the Far North Queensland banana roadshows kick off, we urge growers to come along and take the opportunity to hear about the latest research and development.

Following the success of the New South Wales roadshow held in July, the first of the Far North Queensland leg will kick off in Tully next week.

Dates and locations:

- Tully, Thursday 9 August, Tully & District Senior Citizens Hall (9 am – 3:30 pm)

- Innisfail, Friday 10 August, Innisfail Showgrounds (9 am – 3:30 pm)

- Mareeba, Friday 17 August, Dept. of Natural Resources, Mines and Energy - John Charles room (9 am – 3:30 pm)

- Carnarvon, Thursday 30 August, Carnarvon Yacht Club (9 am – 3 pm)

These are your levies at work! Come along and see how the latest research applies to your business.

Register now through Eventbrite or contact your local industry extension officer:

For Queensland and WA events contact Shanara Veivers (DAF) at shanara.veivers@daf.qld.gov.au or phone/text 0400 870 731.

ABGC e-bulletin 20 August 2018

Banana Roadshow heads West

The National Banana Roadshow in Mareeba, on Friday August 17.

After a successful run in Far North Queensland and Northern New South Wales, the National Banana Roadshow is heading West.

The Roadshow provides a great opportunity to hear about the latest research and development.

The WA event will be held at Carnarvon Yacht Club, 9am-3.30pm, Thursday August 30.

All growers and industry stakeholders are welcome to take part.

Register now through Eventbrite or contact Shanara Veivers (DAF) at shanara.veivers@daf.qld.gov.au or phone/text 0400 870 731.

ABGC e-bulletin 31 August 2018

Go West: Board and Roadshow in WA

The ABGC Board headed west this week, holding their quarterly board meeting at Carnarvon and bringing with them some welcome rain! The previous board meeting was held here in 2012.

The WA visit coincided with the final leg of the National Banana Roadshow, which the Board participated in.

The National Banana Roadshow at Carnarvon Yacht Club

While in Carnarvon the board visited several growers on their farms and the Sweeter Banana Co-operative packing shed.

L: The Board, ABGC staff members and the Roadshow crew at the packing shed. R: ABGC Board members in Carnarvon.

During the board meeting, directors discussed a range of issues, including benchmarking data, workplace health and safety, HARPS, banana levies, R&D gaps, Congress, chemical issues and current biosecurity levels on North Queensland farms.

Data collected by ABGC and through the Banana Benchmarking Project, conducted by Howard Hall, has revealed some considerable room for improvement in biosecurity adoption on many farms.

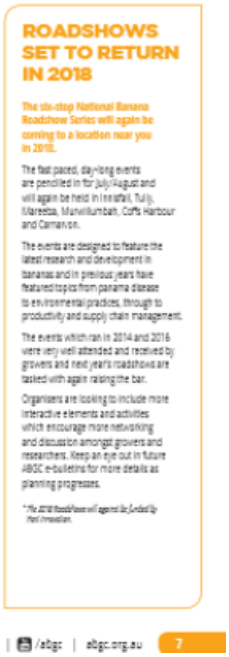
The ABGC encourages all growers who have minimal on-farm biosecurity protocols to consider improving their biosecurity measures, including staff training, footbaths, vehicle wash-down and effective zoning.

Having good biosecurity measures in place will not only help reduce the further spread of Panama TR4, but will also greatly assist a grower to return to production in the event they have a positive TR4 detection on their property.

Thank you Carnarvon
The directors would like to thank the Carnarvon industry for their hospitality during this week's visit. It was great to meet and discuss issues with growers from this part of our fantastic industry.

Australian Bananas - Issue 51, December 2017, Page 7

https://abgc.org.au/wp-content/themes/abgc/assets/lib/magazine/magazine.html?file=https://abgc.org.au/wp-content/uploads/2017/12/Australian-Bananas-Magazine-December-2017-web.pdf#magazineMode=true



ROADSHOWS SET TO RETURN IN 2018

The six-step National Banana Roadshow Series will again be coming to a location near you in 2018.

The fast paced, day-long events are pencilled in for July/August and will again be held in Innisfail, Tully, Mareeba, Murwillumbah, Coffs Harbour and Carnarvon.

The events are designed to feature the latest research and development in bananas and in previous years have featured topics from panama disease to environmental practices, through to productivity and supply chain management.

The events which ran in 2014 and 2016 were very well attended and received by growers and next year's roadshows are tasked with again raising the bar.

Organisers are looking to include more interactive elements and activities which encourage more networking and discussion amongst growers and researchers. Keep an eye out in future ABGC e-bulletins for more details as planning progresses.

Australian Bananas - Issue 51, April 2018, Page 9

https://abgc.org.au/wp-content/themes/abgc/assets/lib/magazine/magazine.html?file=https://abgc.org.au/wp-content/uploads/2018/04/Magazine-April-2018-for-Web.pdf#magazineMode=true

ROADSHOWS—SAVE THE DATE

The six-stop National Banana Roadshow series is again coming to a location near you in July/August 2018. Make sure you save the date for one of these important industry events.

These fast paced day-long events will showcase the latest banana research and development results on:

- Panama disease Tropical Race 4 research;
- Farm production and environmental practices; and
- Aspects of supply chain management.

The roadshows will again feature the short, sharp 10 minute presentations from researchers, but this year may also include a 'speed meeting' session with the researchers and also interactive presentation displays. These are your levies at work! Come along to see how the results from the latest research applies to your business.

DATES & LOCATIONS

- **Murwillumbah:** Tuesday 24th July, Murwillumbah Services Club
- **Coffs Harbour:** Thursday 26th July, Coffs Harbour Showgrounds
- **Tully:** Thursday 9th August, Tully Senior Citizens Hall
- **Innisfail:** Friday 10th August, Innisfail Showgrounds
- **Mareeba:** Friday 17th August, Department of Natural Resources, Mines and Energy John Charles room
- **Carnarvon:** Thursday 30th August, Carnarvon Yacht Club

Keep an eye out over the coming months for updates via e-bulletins, e-mails, letters and text messages, for information on how to make sure your spot is reserved at these events.

** The strategic levy investment project National Banana Development and Extension Program BA16007 is part of the Hort Innovation Banana Fund. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Queensland Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.*

ONE-STOP R&D SITE

The latest advances in banana research will soon be available at the click of a button via the Australian Banana Growers Council website. The dedicated electronic R&D resource features easy to navigate menus and also a comprehensive search function which was considered a 'must' amongst growers.

The website has been developed by the Department of Agriculture and Fisheries in collaboration with ABGC. It is an initiative of the National Banana Development and Extension Project which is funded by Hort Innovation with co-investment from the Department of Agriculture and Fisheries and contributions from the Australian Government.

The website is due to be launched later this month and will be easily accessible via the ABGC website or directly by typing www.betterbananas.org.au in your internet browser.

** The strategic levy investment project National Banana Development and Extension Program BA16007 is part of the Hort Innovation Banana Fund. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Queensland Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.*

Australian Bananas - Issue 52, August 2018, Page 16-17

https://abgc.org.au/wp-content/themes/abgc/assets/lib/magazine/magazine.html?file=https://abgc.org.au/wp-content/uploads/2018/08/ABG6837_Magazine_FINAL_WEB_SPREADS.pdf

HIT THE ROAD, RESEARCHERS

"Speed dating" – but not as you know it. Growers have the opportunity to talk to researchers in small groups.

Wayne O'Neil (DAF) during the interactive session on nematodes.

The latest banana research has been on tour, bringing valuable science and new on-farm strategies to growing regions around Australia.

The 2018 National Banana Roadshow began in Murwillumbah on July 24, making its way down the Pacific Highway to visit Coffs Harbour on July 26, before heading to Far North Queensland for shows in Tully (Aug 9), Innisfail (Aug 10) and Mareeba (Aug 17).

Well over 140 growers and industry representatives took in the presentations across the five days.

Snappy, 10 minute speeches on topics including new varieties, Panama disease, nematodes and marketing were followed by interactive sessions and opportunities to ask questions.

Speed dating was also on the agenda – not a low-budget version of Farmer Wants A Wife – but rather time to speak with researchers in much smaller groups.

"Traditionally we've had the short, sharp presentations but this allows for more interaction and it's a great networking opportunity," Shanara Vellers, research horticulturalist with the Department of Agriculture and Fisheries, said.

Ms Vellers was one of the organisers of the event, along with DAF colleagues Ingrid Jenkins, Stewart Lindsay and Tegan Kukulies.

Vicky McCudden attended the Coffs Harbour event and said she enjoyed the variety of information.

"I loved the short session times and the opportunity to ask questions."

Results from research into the effect of bag colours on bunch management, reject analysis and a video featuring Maroly's Bananas were also among the presentations.

Colin Singh, a Northern NSW grower said the Roadshow had been very useful.

"It's great to see so many other growers here," he added.

Guest speaker was Howard Hall, from Pinnacle Agribusiness, who shared insights from the latest industry benchmarking.

His data provides a range of interesting comparisons when it comes to profit, yield, biosecurity implementation and environmental management.

"Howard has recently completed his benchmarking project and this is a good chance to deliver this relevant information to as many growers as possible," Ms Vellers said.

The Roadshow also marks the launch of a new website specifically designed for growers: www.betterbananas.org.au.

At the time this edition of the Australian Bananas Magazine was going to print the National Banana Roadshow was headed to Western Australia.

Steven Atwell and Richard Fiyer (DAF) at the Murwillumbah event.

Researchers are quizzed on their presentations at the Coffs Harbour event.

Getting hands-on during the interactive sessions, which focus on nematodes, marketing and crown rot.

Time for "speed dating" discussion at Tully roadshow.

Jeff Daniels talks variety research during the interactive session at Tully.

"Speed dating" session at Innisfail Roadshow

Roadshow organisers Shanara Vellers (right) and Ingrid Jenkins (left) of DAF

Mareeba roadshow.

The strategic levy investment project National Banana Development and Extension Program BA16007 is part of the Hort Innovation Banana Fund. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Queensland Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Banana growers will get an insight into the latest research and developments affecting their industry. Photo: Lee Constable

Banana Roadshow hits Coffs

BANANA growers on the north coast are invited to attend the National Banana Roadshow to be held in Coffs Harbour on Thursday.

As part of the Hort Innovation banana fund National Banana Extension and Development project, the free workshop will profile the latest industry research, keeping growers up to date on banana varieties, soil health, pest and disease management, benchmarking and marketing.

NSW Department of Primary Industries banana development officer Matt Weinert said the presentations would allow growers to hear directly from specialists about these important issues that affected their industry.

"The roadshows occur every two years and provide a great opportunity for growers to ask specific questions to the researchers," Mr Weinart said.

"Participants will get an update on all new research trials including those underway in partnership with the Queensland Department of Agriculture and Fisheries aimed to make a range of banana varieties with desirable pest, disease, agronomic and consumer preference traits for subtropical growers.

"The trial site at Duranbah on the state's north coast was planted earlier in the year and is well established, so growers will learn about the future plans for this trial.

"Information will be provided on the first results from a NSW DPI-led Subtropical banana development and extension project, which aims to identify the causes of fruit downgrade or rejection.

"This project aims to work with growers to identify the cause of rejected and downgraded fruit and to ensure fruit sent to local ripeners matches retail specifications."

The National Banana Roadshows will be held on July 24 at Murwillumbah Services Club from 9am, and July 26 at Coffs Harbour Showgrounds from 9am.

RSVP at nbrs.eventbrite.com.au, email matt.weinert@dpi.nsw.gov.au or phone 0438 644 136.

Tablelands Advertiser – 27 July 2018

Lastest news on bananas

NEXT month the National Banana Roadshow will hit Mareeba to help inform local growers on the latest research and developments in the industry.

The session will be held at the Department of Natural Resources, Mines and Energy - John Charles Room on Peter Street, Mareeba on Friday, August 17.

The six-stop National Banana Roadshow Series is touring Australia during July and August.

The fast-paced events will feature the latest research and development including information on banana varieties, soil health, pest and disease management, QBAN, environmental practices, benchmarking and marketing.

It will feature several short, sharp 10-minute presentations from researchers, a 'speed meeting' session with the presenters and interactive displays.

To register for the National Banana Roadshow Queensland events contact Shanara Veivers (DAF) at shanara.veivers@daf.qld.gov.au or phone/text 0400 870 731.

Cassowary coast independent – 11 August

RURAL REPORT

National Banana Roadshow rolls into Innisfail and Tully

MARIA GIRGENTI/ SARI HYYTINEN

INNISFAIL and Tully were two of six stop-overs for The National Banana Roadshow last week, and the Innisfail Showgrounds event was attended by 60 people, which included 20 growers, 14 researchers, and other industry representatives.

The Tully event last Thursday drew 45 participants to the Tully & District Senior Citizens Hall.

"The day is designed to be as interactive as we possibly can. It's not just a sit and listen we make people go through a speed dating session where the researchers go around to each table and the growers get to ask them questions in a very fast paced 7-minute period," said Stewart Lindsay from the Department of Agriculture and fisheries.

The roadshow, which also visited Murwillumbah, Coffs Harbour, Tully, Mareeba and Carnarvon, is held every two years and 2018 is the third time the event has been run.

Growers were introduced to the new banana research and development website followed by an overview of variety importation and development and results from variety/ mutagenesis trials.

All of the researchers delivered short, sharp 10-minute presentations. They were mainly from Department of Agriculture and Fisheries in Queensland with a couple from Australian Banana Growers' Council, one from Pinnacle Agribusiness, one from Hort Innovation and one from Northern Territory Department of Primary Industries and Resources.

Hot topics on the agenda included the latest information delivered by expert speakers on Panama TR4, industry benchmarking results (economic, environmental and biosecurity), soil health and disease suppression, and advances in bunch pest management.

Contrary to popular perceptions, Stewart Lindsay said Panama Disease has been spread by humans more than feral pigs.

"There is a Chance that Panama disease can be transferred by feral pigs because they move soil. However, humans are the main factor in transferring Panama," he said.

"It is because you only need a teaspoon of soil to spread the disease, and farms have workers that go on and off every day and they have people that drive trucks on and off every day."

There are varieties of Bananas that are resistant to Panama disease. "I think one of the things that we need to understand is that when we talk about bananas being susceptible to Panama, it's probably a bit inaccurate because Cavendish isn't just one variety, it's many different varieties and some are quite resistant," said Stewart Lindsay. "

Static displays on many aspects of the industry were 'available during morning tea and lunch, with different varieties of bananas supplied by Jeff Daniells from Department of Agriculture and Fisheries for tasting.

Interactive sessions were held on varieties, crown end rot and marketing, with a video by a Mackays representative on making biosecurity work on farms and exporting for a future presented by Mr Pekin.

Stewart Lindsay from Department of Agriculture and Fisheries said the roadshow is aimed at promoting the banana industry and providing the latest research and development information to growers and is designed to give all people involved in the industry the opportunity to discuss high-priority issues.

"As research is an investment in the future, it's important people know where those dollars are going and it gives those in the industry an idea of where things are at in terms of results," said Mr Lindsay.

The roadshow is funded by Hort Innovation Strategic Levy Investment project using the banana research and development levy, co-investment from the Queensland Department of Agriculture and Fisheries, as well as contributions from the Australian government.

Ingrid Jenkins, Stewart Lindsay and Shanara Veivers from the Department of Agriculture and Fisheries came and hosted the Banana Roadshow in Tully.

Western Australia Country Hour – 3 September 2018

http://www.abc.net.au/radio/programs/wa-country-hour/wa-country-hour/10171962

(42min 30 seconds)

Appendix 4: Australian Banana Industry Congress (2017 & 2019)

2017 Australian Banana Industry Congress—Sydney, 22–24 June

The project played an important role in assisting with the R&D program for the 2017 Australian Banana Industry Congress (ABIC). The project leader together with the ABGC R&D Manager, Rosie Godwin and the NSW Industry Development Officer, Matt Weinert successfully organised and ran an R&D session at the congress called 'Science Snapshots'. The one-hour session consisted of six 3-minute presentations followed by a panel discussion with the six scientists to engage the audience. These six presentations were selected from a pool of applicants who applied for a presentation spot. Feedback was provided to each presenter prior to the congress and their presentations were practiced and polished to ensure the best delivery on the day. Below is a link to an article published by Fresh Plaza of the highlights of the Science Snapshots session using the lead in line "Australia has some of the world leading researchers when it comes to banana diseases" http://www.freshplaza.com/article/177888/AU-Leading-the-way-in-Australian-banana-research.

The project leader also helped organise the scientific poster display for the congress, which was available for attendees to view over breaks, along with a dedicated time slot within the agenda where researchers (who attended) were available to discuss their research.

The project team also organised and facilitated a booth in the exhibition which was dedicated to showcasing recent banana R&D. The booth (3m x 3m) included visual and interactive elements such as disinfectant test strip kits which could be demonstrated and petri-dishes with photographs of *Fusarium* growth under different treatments. Information including the Banana on-farm biosecurity best management practices (BMP) and factsheets on the latest R&D were also available for attendees to take with them. The booth used the 'Ask a researcher' tag line to stimulate discussion with congress attendees. Elements of the booth (e.g. back and side walls) were designed in a generic manner which would allow them to be used in future congress booths and/or other extension events. Pictured below is project leader, Tegan Kukulies at the DAF booth talking with congress attendees. The 2017 Australian Banana Industry Congress was attended by 353 delegates, 80 of which were banana growers.

2019 Australian Banana Industry Congress—Gold Coast, 22–24 May

The project played an even more active role in steering the agenda for the 2019 congress, with project team member Shanara Veivers representing the project on the congress program committee. Meetings were held monthly via teleconference with Shanara attending nine meetings in total and offering suggestions and contributing to decision making about guest speakers, the nature of the program and the pre-congress tours. The 2019 Australian Banana Industry Congress was well attended by 373 delegates, 103 of which were banana growers.

Similar to the 2017 event, the project leader collaborated with the ABGC R&D Manager Rosie Godwin and the NSW IDO Matt Weinert to organise the 'Science Snapshot' session and the poster display. The project team played a more active role in assisting researchers with feedback on their posters and co-ordinating printing for researchers. The project had two posters on display (below), with the Better Bananas poster awarded the best poster at the congress which was great promotion for the project.

The project team again organised and facilitated a booth in the exhibition designed to showcase banana R&D. The project team collaborated with Biosecurity Queensland to represent the Panama TR4 program and on-farm biosecurity. Using resources (e.g. back wall, pop up table) from the 2017 ABIC, the booth acted as a point of contact where researchers were available to discuss their work with growers and other delegates. The booth also helped initiate and facilitate interactions between growers and industry stakeholders. Pictured below is DAF researcher Hazel Gaza at the 2019 booth talking with congress delegates.

Posters presented at the 2019 ABIC

Department of Agriculture and Fisheries

Better bananas

R&D information at your fingertips

Tegan Kukulies, Shanara Velvers, Ingrid Jenkins, Stewart Lindsay

Aim

The Better bananas website provides Australian banana growers and industry stakeholders with the latest information and results from research and development (R&D) projects. It provides a central go-to location to equip banana businesses with the latest R&D information.

Features

- Information on current and recently completed research projects
- Pest and disease identification tool
- A one-stop location for Better bananas videos
- Advertisement of upcoming banana R&D events
- Information about our banana researchers
- Mobile friendly
- Updates via ABGC e-bulletins and social media
- Enquiries email betterbananas@daf.qld.gov.au

Usage

A recent review of the website using Google Analytics looked at its usage from when the website was launched in July 2018 to April 2019.

Key findings

- 670 users
- Over 4000 page views
- Return visitor rate of 21.9%
- Over 1300 sessions (Number of times users actively engaged with the website)
- 2.92 pages viewed per session
- Average session duration 3 min 32 s
- Social media and industry communication channels are important for directing traffic to the website

www.betterbananas.com.au

Visit the website and keep up to date with the latest R&D

Supported by:

Better bananas is an initiative of the Australian Banana Development and Extension Program (BANDEP). The 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, non-profit research and development corporation for Australian horticulture. The Queensland Government has also contributed to the project through the Department of Agriculture and Fisheries.

Banana innovation – Keep your eyes peeled

Shanara Veivers, Regan Kukulies, Ingrid Jenkins and Stewart Lindsay
Queensland Department of Agriculture and Fisheries, South Johnstone

Aim

Established in November 2017, the innovation trial which is located at the South Johnstone Research Station aims to investigate 'out of the box' concepts that banana growers may not be willing to take the financial risk, or have the time and resources to trial on their own farms. The field trial has a focus on those practices that may increase agronomic performance or have environmental benefits.

Trial design

- ❑ 3 double rows
- ❑ 390 *Williams* Cavendish tissue-cultured plants
  - 330 datum plants
  - 60 guard plants
- ❑ 5 living and non-living groundcovers
  - replicated 3 times
- ❑ 2 de-suckering treatments
- ❑ Preliminary bell injection trial (in progress)

Current innovations

De-suckering

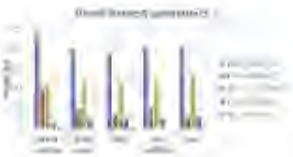
Bell injection
'soft' options

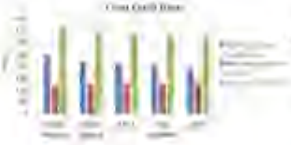
Ground covers

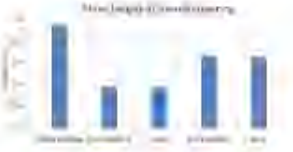
Results

Plant crop

- ❑ Early de-suckering produced a significantly higher number of total leaves, average plant height and total bunch weight.
- ❑ Regardless of de-suckering treatment, plants in the black weed matting
  - had a higher average plant height (258cm) compared to bare (251cm)
  - took longer to reach bell emergence (248 days) compared to bare (194 days)
  - had a higher average number of hands (7 hands) compared to bare (6 hands)







Future innovations

- ❑ Investigate 'soft' options for control of bunch pest management and banana weevil borer.
- ❑ Canopy and/or bunch management to reduce finger length of XXL fruit during certain times of the year.

If you have an innovative idea, get in touch today!

Hort Innovation
BANANA FUND

Appendix 5: Information at your fingertips—the Better Bananas website

Background

The 21st century continues to see rapid advances in technology, including new ways we can access large volumes of information quickly and conveniently. In fact it's so easy, that many of us turn to our smart phones multiple times in a day to source information online.

This is no different for Australia's banana industry, which identified the need to make information on current research and development (R&D) projects accessible online.

In response to this need the Better Bananas website, *www.betterbananas.com.au* was developed as part of the National Banana Development and Extension Project (BA16007), and was launched in mid-2018 at the National Banana Roadshow Series. It was created to provide banana growers and other industry stakeholders with a central go-to location for R&D information and equips banana businesses with the latest research results and recommendations.

The website is simple and intuitive, featuring easy-to-use drop down menus and a comprehensive search function. The website consists of 7 key menu tabs with emphasis placed on the research section, which currently hosts 28 updates of recently completed or on-going R&D activities. The website is also home to an updated pest, disease and disorder identification guide which is derived from the problem solver section of the Tropical Banana Agrilink resource. The website also hosts industry R&D videos, four of which have been developed and published as part of BA16007, and a page which profiles researchers involved in banana R&D. A full list of content currently published on the website is included at the end of this Appendix.

Updates made to the website are promoted through industry communication channels, including the e-news bulletin and social media. The aim is to continually update the website so that growers can keep their finger on the R&D pulse and ensure they are equipped with the latest information on industry R&D.

Website development

The information database review conducted as part of the previous National Banana Development and Extension Program (BA13004) revealed that growers and agribusiness providers liked the concept of a banana specific webpage or database to host past and current R&D outputs. Following recommendations derived as part of this review, an investigation of the features of other industry on-line resources (e.g. websites), and in consultation with the project reference group and growers of the NextGen group, a list of requirements for an on-line R&D resource was developed. This process helped guide the development of the Better Bananas website which was commissioned under the National Banana Development and Extension Project (BA16007).The Australian Banana Growers' Council (ABGC) directly commissioned the services of Morgan Rural Tech (a Queensland based web solutions consultancy) through their sub-contractor agreement with BA16007. Ongoing maintenance to the web server and content management system is managed by Morgan Rural Tech and charged on an hourly rates basis as required.

As the site was developed under a levy funded project, the domain name betterbananas.com.au is registered under Hort Innovation Australia. To protect the Better Bananas brand, The Department of

Agriculture and Fisheries (DAF) registered the trademark 'Better Bananas National Banana Development and Extension Program' name and logo.

Website content continues to be fully managed by banana extension personnel from DAF and is approved by DAF and Hort Innovation prior to publication.

Google Analytics

Google Analytics captures and analyses usage and tracking data for websites and was linked to the Better Bananas website when it was first developed. These statistics help gain a better understanding about the users and identify opportunities for further improvement. There are many different types of measures in Google Analytics and those that are relevant to an information-based website have been included in this review. The statistics reported as part of this final report is for the period 1 July 2018 to 30 April 2020 (22 months).

Google Analytics data

Audience

In the 22 months since its launch, the Better Bananas website has been accessed by 3230 users. The website is hosted in Australia, with access available within Australia and the United States. All other countries have been restricted from accessing the site. The United States is not restricted to ensure search engines such as Google are functional. This ensures the website and its content are included in Google search results. This has proved to be an important functionality of the website with Google Analytics showing 22% of the website's traffic coming from organic searches (Figure 3) such as Google. WordFence is the software that is used to restrict other countries through geo-blocking. However, geo-blocking can be deliberately bypassed, with analytics showing access by users from other countries. Of the 3230 users, 1836 (~56.8%) are from within Australia, with the balance of overseas users mainly from the United States (≈38%).

The target audience for the website is Australian banana growers (approximately 220 in the main production region in Far North Queensland), service providers (less than 100 in Far North Queensland) and other industry stakeholders. Figure 1 shows a breakdown of Australian users by state, with approximately 60% from Queensland. This suggests that the website has been visited by a high proportion of its target audience.

Figure 1: Australian Better Banana website users by State (1 July 2018 to 30 April 2020)

Usage

A total of 4721 sessions were recorded for the period, of which 3358 originated from within Australia. The total number of pageviews was 10 659 of which 8776 pageviews were Australian users, averaging 2.6 pages per session. This suggests users visiting the website are viewing approximately two to three pages per visit.

Each individual webpage is designed to relay key messages in a short and concise format. Therefore many of the pages, particularly the summary pages, only take approximately one to three minutes to read. With this in mind, the average time Australian users spent per session was just under 3 minutes (02:55 minutes), suggesting that users are reading the information in full.

The website had a return visitor rate of 24.5% for Australian users, with an average 1.8 sessions per user (Table 1). This rate has increased since a review that was carried out in April 2019 which at that time showed a return visitor rate of 21.9%. A target return rate closer to 30% is our aim.

Table 1: Google analytics usage data for Australian users of the Better Bananas website (1 July 2018 to 30 April 2020)	
Usage by Australian users	
Total users *(An individual user browsing the website, a unique browser cookie per device)*	1836
Returning visitor rate *(User with existing Google Analytics cookies returns to website)*	24.5%
Pageviews *(When a page on the website is viewed by a user)*	8776
Sessions *(A single visit to the website, consisting of one or more pageviews)*	3358
Sessions per user	1.8
Pages per session (All users)	2.6
Pages per session (Return visitor)	2.7
Average session duration (All users)	2:55 min
Average session duration (Return visitor)	3:34 min

Table 2 shows a list of the top 15 pages accessed by Australian users and the corresponding data for the reporting period. The home page is the most viewed page on the website, with 2463 pageviews. The second page most viewed was videos. This supports the proposition that video is a popular medium to share information with banana growers, both as a standalone resource and as tool used at extension events. The visual nature of video is engaging and has been found to be an effective way to relay key messages in a concise manner.

Also included in the top five most viewed pages were meet a researcher, the Goldfinger mutagenesis trial and the problem solver landing page. A number of pages hosting information on banana variety research also feature in the top 15 most viewed pages, with users tending to spend a longer period of time viewing these pages. This is not surprising as the development of new disease resistant varieties is highly topical within industry, following the detection of Panama disease tropical race 4 in Far North Queensland in 2015.

Devices

Figure 2 shows the breakdown of the different devices used to access the website. Interestingly desktop computers were used by over two-thirds (69%) of users, followed by mobiles (27%) and tablets (4%). With collectively 31% of users accessing the site from mobile devices and with this percentage likely to grow into the future, it is important to ensure the website continues to be 'mobile friendly'.

Table 2: Top 15 pages viewed and average time spent on page for the Better Bananas website (1 July 2018 to 30 April 2020)

Top 15 pages viewed		
Page	**Pageviews Australian pageviews (Total pageviews in brackets)**	**Average time of page**
Total pageviews	8776 (10 659)	2:55
Home page	2463 (2844)	1:29
Videos	531 (600)	3:14
Meet a researcher	511 (554)	2:20
Developing new resistant varieties - Goldfinger mutagenesis trial	304 (340)	3:37
Problem solver - landing page	292 (335)	1:34
About us	213 (243)	1:35
Research	208 (212)	1:22
Developing new resistant varieties – Dwarf Nathan mutagenesis trial	189 (246)	5:32
Disinfectants	179 (233)	2:36
Events	178 (190)	0:59
Best Management Practices	152 (224)	3:00
Banana variety research	151 (213)	3:33
Panama disease R & D	130 (132)	2:10
Agronomic evaluation of new varieties – South Johnstone	117 (143)	6:27
Innovation field trials	113 (123)	2:24

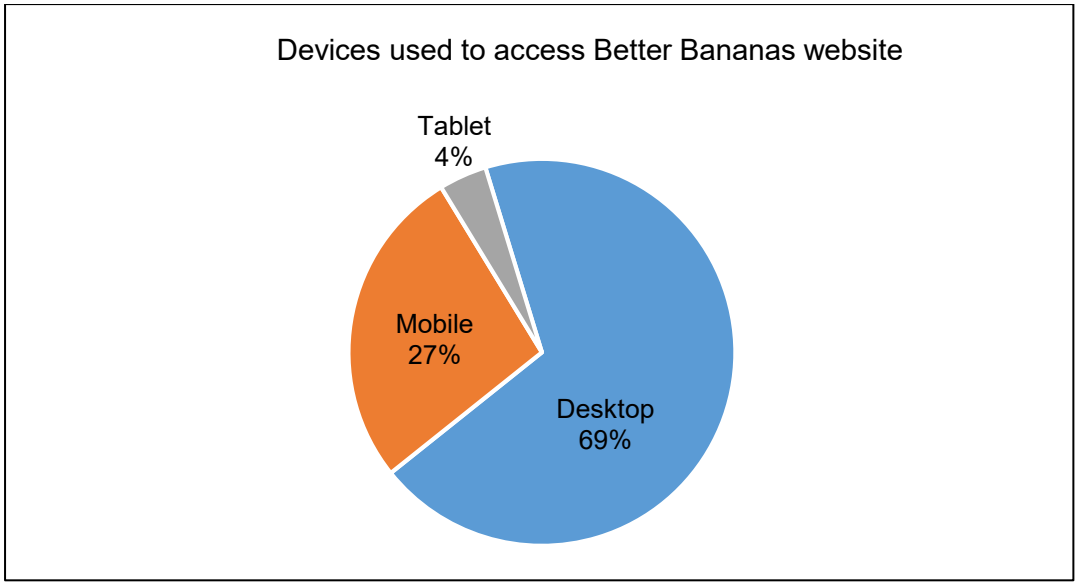


Figure 2: % of users accessing the website from different devices (1 July 2018 to 30 April 2020)

Referrals

Figure 3 lists the traffic sources for the website. Direct traffic remains the predominant source of traffic, with 60% of users accessing the website by either typing the website's URL into a web browser or via clicking on an email link (e.g. ABGC e-news bulletin). This data does highlight the opportunity to further increase traffic to the website via social media sources.

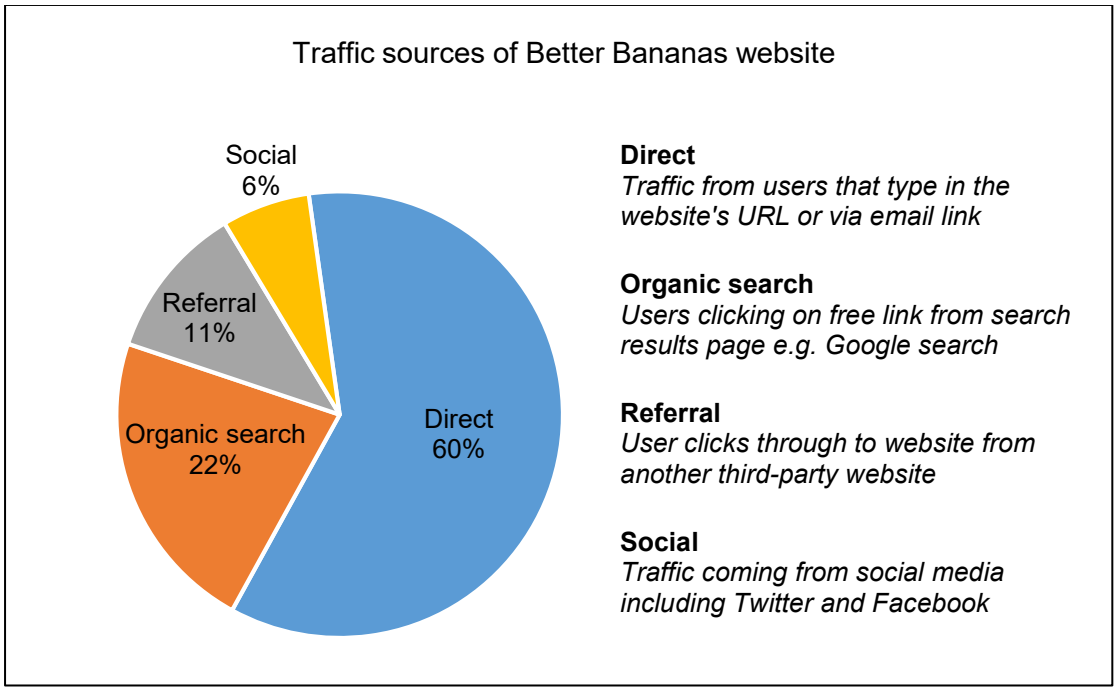


Figure 3: List of traffic sources for the Better Bananas website (1 July 2018 to 30 April 2020)

Promotion of the website

The website was promoted as part of its launch at the National Banana Roadshow series (six locations around Australia) in July and August 2018. This provided the opportunity to promote the website with growers and industry stakeholders. This included a 10 minute presentation and also discussion through participation in the popular 'speed dating' session at each of the six Roadshow events.

Further promotional opportunities since its launch have included a poster presentation (Figure 4) at the Banana Congress held in May 2019. Our poster was awarded 'best poster' at the event. The website was also promoted through a short presentation and discussion with growers at the Banana Speed Dating Night held in October 2019 in Innisfail. Promotional pens listing the website address were also given to growers attending these events. Remaining pens will continue to be given out to promote the website at future extension events.

Figure 4: Poster presentation at the Banana Congress (May 2019)

The website leverages off established industry communication channels including the Australian Banana Growers' Council (ABGC) e-bulletin, magazine, website and Facebook page, delivered as part of the Banana Industry Communication Project (BA18001). Overall ABGC's e-bulletins and Facebook page are the biggest referral for the site.

Website content continues to be promoted through the e-bulletin, which is sent out to over 1200 growers and industry stakeholders every 2-3 weeks. Each topic in the e-bulletins by nature contain short summaries of articles hosted on the website and offer the opportunity to further engage readers by linking them directly to the Better Bananas website. As an example, the disinfectant research to support on-farm biosecurity practices was promoted in the e-bulletin on 27 March 2019 (Figure 5). This research had already been widely distributed to growers, however in the week following distribution of this e-bulletin, there were 36 views with average time spent of 1:11mins on the disinfectant research summary page. We estimate it would take 1 minute to read the page and therefore assume that the majority of those directed to this page would have read the summary in full. Given that the disinfectant content on the website was not promoted through any other channels at that time, these views are likely to be directly attributed to the e-bulletin distribution. This demonstrates the value to continuing to promote new and existing content on the website via the ABGC e-bulletins.

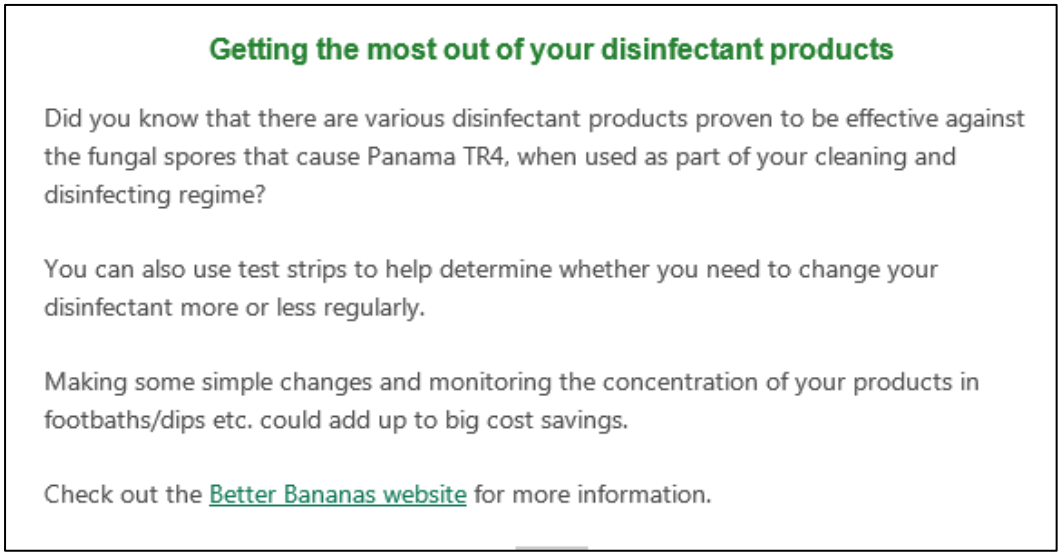


Figure 5: ABGC e-bulletin referral to disinfectant content on the Better Bananas Website (27 March 2019)

Figure 6 shows the performance details of a sponsored post that ran via ABGC's Facebook page from 28 September to 13 October 2018 at a cost of $100. The post reached 17 032 people, with an estimated recall lift (people) of 1240. This is an estimate of the number of additional people who remember seeing the ad within two days. During this period, there were 115 users, equating to 17.2% of the total users. Also during this period, there were 426 pageviews and 169 sessions. Apart from this one sponsored post of the website, this technique has not yet been heavily promoted on the ABGC Facebook page. These impact statistics however show that there could be more focus on promoting content of the site via social media to increase the reach of R&D project communication.

The website has also been promoted via the NextGen growers group. One post per week over a four-week period (23 August to 20 September 2018) was added to the closed WhatsApp NextGen group (24 people) to show them features and content on the website. New posts uploaded to the website are promoted to the group and views and users derived from these WhatsApp links contributed to the 17.3% of users sourced via social media. This existing NextGen WhatsApp group is a simple and easy way to promote new content directly with the website's target audience.

The website was also promoted to banana researchers at the Banana Scientific Symposium held in Cairns in November 2018 (BA16001). The main aim of this promotion was to make researchers aware of the resource and encourage them to engage with the extension team when they have outcomes or research updates that are relevant to banana growers.

Figure 6: Facebook performance statistics of the sponsored post (28 September – 13 October 2018)

Key points and recommendations

Since its launch in July 2018, the Better Bananas website has successfully provided banana growers and industry with the latest information on research and development activities. There are opportunities however to further increase the number of new users as well as returning visitors to the website.

This includes continuing to publish content on topical research, which is a key to maintaining interest and engagement in the website. Further, a focus on developing video content is recommended, with Google Analytics showing that the use of video continues to be popular with users.

Promotion of the website is also key to its success. To date this is largely due to the integration and promotion through existing ABGC communication channels. It is critical that this close relationship with the Banana Industry Communication Project is maintained and strengthened to ensure the ongoing success of the website.

Social media has shown to be effective in increasing the reach and promoting the website as a whole. However, specific content has not yet been promoted on the ABGC Facebook page. Future emphasis needs to be placed on promoting new and existing content on the website via social media. Sponsored posts where budget permits should be considered for topical content to reach new and existing website users.

Direct promotion of the website should continue and build upon the existing networks that are facilitated and/or supported by the National Banana Development and Extension project. This includes the NextGen group, BAGMan group, local banana grower associations, banana researchers and the Banana Women's Network.

The website should also continue to be promoted at banana industry events, including congress and extension events. Similarly, growers and industry stakeholders should continue to be directed to the website when questions or interest in a specific topic arise from one-on-one communication.

The Better Bananas website is an important information resource for Australian banana growers and industry stakeholders. It's also a key tool in the extension toolbox and is useful for our extension team to refer growers and agribusiness personnel to information on the site. For these reasons, it is recommended that industry continues to support the management of the website through future industry development and extension projects.

Better Bananas website – List of content

1) **Home**
2) **About**
3) **Research**
   a) Banana variety research
      i) Agronomic evaluation of new varieties (South Johnstone)
      ii) Panama TR4 variety screening trial (Coastal Plains Research Farm, Northern Territory)
      iii) Panama TR4 variety screening trial (Coastal Plans Research Farm, Northern Territory)
      iv) Panama R1 variety screening trial (Duranbah, NSW)
      v) Developing new resistant varieties (GCTCV119 mutagenesis trial)
      vi) Developing new resistant varieties (Goldfinger mutagenesis trial)
      vii) Developing resistant varieties (Dwarf Nathan mutagenesis trial)
      viii) Developing new resistant varieties (CJ19 mutagenesis trial)
   b) Panama disease
      i) Disinfectants
         (1) How can I test my QA disinfecting products?
         (2) How long are disinfectant products effective for?
         (3) Are cleaning and disinfectant products corrosive?
      ii) Reducing inoculum from infected plants
         (1) Lab trials
         (2) Field trials
   c) Crown end rot
      i) Guide to Crown end rot identification
      ii) Resistance to current post-harvest chemical trials
      iii) Time in supply chain studies
      iv) Alternative post-harvest product testing
      v) New test helps product screening for Chalara management
   d) Innovation field trials
      i) Trial layout
   e) Best management practices
   f) Bunch pests
      i) Bunch cover trial
4) **Problem solver**
5) **Videos**
   (Videos developed as part of BA16007)
   a) It's more than just bananas for our banana NextGen group (30 April 2019)
   b) Making biosecurity work for your farm (5 September 2018)
   c) Controlling burrowing nematodes in banana production (15 April 2018)
   d) NextGen report – Variety screening trial in the Northern Territory (16 November 2017)
6) **Events**
7) **Meet a researcher**
   a) Profile on Kathy Grice
   b) Profile on Jeff Daniells
   c) Profile on David East
   d) Profile on Katie Ferro
   e) Profile on Shanara Veivers

Appendix 6: Banana Agribusiness Managers' Group (BAGMan) meetings

The banana agribusiness managers' group (BAGMan) is an important target audience for BA16007 as agribusiness staff are part of the banana industry network, often communicate with growers on a day to day basis and so have some influence on growers' decision-making on various issues.

Meetings were held at the South Johnstone Centre for Wet Tropics Agriculture on the 23 November 2017, 1 November 2018, 18 July 2019 and 19 November 2019. These meetings take approximately two hours and consist of presentations and discussions on topics driven by feedback from group members and industry priorities. In 2018, due to timing commitments with Roadshow preparations only one meeting was held, however it had an increased level of content and contribution compared to other meetings. Below are the agendas and attendance record for each of these meetings:

23 November 2017 (attended by 17 people)

- Welcome/introduction – Tegan Kukulies (Department of Agriculture and Fisheries)
- Crown end rot research - Peter Trevorrow (Department of Agriculture and Fisheries)
- Update on disinfectant research for TR4 - Shanara Veivers (Department of Agriculture and Fisheries)
- Discussion: Better Bunch App + proposed reef regulations - Robert Mayers (Australian Banana Growers Council)
- Discussion: Omethoate permit
- Open discussion

1 November 2018 (attended by 25 people)

- Welcome/introduction – Tegan Kukulies (Department of Agriculture and Fisheries)
- 'Chloro vs Oil' in managing yellow Sigatoka - Lynton Vawdrey (Department of Agriculture and Fisheries)
- Bunch pest management trials and other entomological issues - Richard Piper (Department of Agriculture and Fisheries)
- Discussion – proposed reef regulations - Robert Mayers (Australian Banana Growers Council)
- Open discussion

18 of July 2019 (attended by 18 people)

- Welcome/introduction – Tegan Kukulies (Department of Agriculture and Fisheries)
- Yellow Sigatoka trials – David East (Department of Agriculture and Fisheries)
- Crown end rot research – Peter Trevorrow & Kathy Grice (Department of Agriculture and Fisheries)
- Update on the status of chemicals in the Banana Industry – Rosie Godwin (Australian Banana Growers Council)
- Discussion about reef regulations and nutrient rate trials - Robert Mayers (Australian Banana Growers Council) & Curtis Lanham (Department of Agriculture and Fisheries)
- Open discussion

19 of November (attended by 15 people)

- Welcome/introduction – Tegan Kukulies (Department of Agriculture and Fisheries)

- Mites - Richard Piper (Department of Agriculture and Fisheries)
- Reef regulations and grants - Robert Mayers (Australian Banana Growers Council)
- Keeping exotic diseases on your radar - Carl Rickson (Australian Banana Growers Council)
- Open discussion

The group was also kept up to date on key industry issues and invited to events throughout the year via e-mail and text message.

Appendix 7: Variety field walk (2019)

On 21 June 2019 nearly 50 people took part in a field walk at the South Johnstone Research Facility. As part of the project 'Improved Plant Protection for the Banana Industry' (BA16001), newly imported varieties are being evaluated for agronomic traits in a field trial at South Johnstone. BA16001 is currently the largest RD&E investment program made by Horticulture Innovation and the Department of Agriculture and Fisheries (DAF) for the banana industry.

Jeff Daniells (DAF), who leads this evaluation trial, provided banana growers and industry stakeholders with a tour of the 32 different cultivars included in the trial. The trial was planted in September 2018, so the timing of the variety field walk nine months later ensured participants could see many of the plant crop bunches. Fruit was ripened from a selection of the varieties in the trial and was available on the day for participants to taste.

The event also included a walk-through of the Banana Nutrient Trial (RP191) located at the research facility. This trial is funded by the Queensland Government through the Queensland Reef Water Quality Program. The project is investigating how different nitrogen rates affect the agronomic characteristics of banana crops, as well as quantifying nitrogen losses, to help determine the optimum nitrogen rate for banana production in the wet tropics.

A layered on-farm biosecurity system was implemented to ensure safe entry and exit from the research facility. This consisted of changing shoes and using footbaths. Participants also signed a visitor register prior to entering the farm and were asked to list the last property they visited. Apart from protecting the research station from soil borne disease, this sign-in process provided a practical, hands-on demonstration of how a farm might manage biosecurity issues such as Panama disease TR4.

Table 1 provides a summary of the field walk activities.

Table 1: Variety field walk agenda

Time	Activity
9am	Start
9am – 9:30am	Sign in and complete pre-field walk evaluation Introduction to the field walk and summary of the "Improved Plant Protection for the Banana Industry Project" – *Stewart Lindsay (DAF)* Step through on-farm biosecurity procedures and walk to variety evaluation trial block
9:30am – 11:15am	Tour though variety evaluation block – *Jeff Daniells (DAF)*
11:15am – 11:30am	Walk to nutrient trial block
11:30am -12:00pm	Tour of nutrient trial block - *Curtis Lanham and Rebecca Murray (DAF)*
12:00pm – 12:15pm	Exit farm & complete post field walk evaluation
12:15pm onwards	Lunch and further discussion

Evaluation

Evaluation was conducted at the commencement and completion of the field walk to measure impact. As participants signed the biosecurity visitor register, they were asked three questions (Table 2) to gain an understanding who had attended (grower/farm manager, service provider, industry representative etc.) and also determine whether they were aware of the project 'Improved Plant Protection for the Banana Industry' (BA16001) and the role of the project in importing and testing varieties.

The evaluation showed that 94% of the participants were aware of the project and 90% of participants were aware of the important role the project plays in importing and testing banana varieties. Since the detection of Panama disease TR4 in 2015, varieties have remained a hot topic in the industry. As a result, information and progress on variety R&D has featured heavily at industry extension events and activities. Furthermore, industry communication channels have also contributed to growers' increased awareness about the progress, process and challenges of variety evaluation and development.

Table 2: Results of the evaluation completed at the start of the variety field walk (upon sign-in).

Question	**Options for Responses**	**Percentage for each response**
What best describes your role in the banana industry?	Grower/farm manager	36%
	Industry representative	8%
	Service Provider	32%
	Supply chain member	4%
	Government	20%
Are you aware of the industry funded project "Improved plant protection for the banana industry"	Yes	94%
	No	6%
Are you aware of the role the industry funded project "Improved plant protection for the banana industry" in importing and testing banana varieties with improved disease and/or pest tolerance?	Yes	90%
	No	10%
Percentages are rounded. Total of 49 participants included in this evaluation.		

The post-field walk evaluation was conducted on two iPads using Google Forms. Participants were handed an iPad after they had exited the farm (walked through the footbath and changed back into their shoes) and were asked to complete the four evaluation questions electronically. This process was easy to undertake as growers were exiting the farm, and replaced a traditional paper based evaluation, and close to 80% of the participants took part in this process. A MS Excel table of the responses can be exported from Google Forms to analyse the data and a summary of the results is shown in Table 3.

Overall, 84% of participants rated the field walk an 8 or higher out of 10, with the remaining 16% of participants rating the event a 7. As a result of attending the field walk, 92% of participants indicated they had either a good or very good understanding of the 'Improved Plant Protection of the Banana Industry' project (BA16001). When participants were asked how much they now knew about the banana variety trials 45% of respondents indicated they knew quite a bit (rating 3 out of 4) or a lot

(rating 4 out of 4). Similarly, as a result of walking through the banana nutrient rate trial and discussing the trial with team members, when asked how much their knowledge of the nutrient rate trial work had increased, 56% of respondents indicated that they knew either quite a lot (3 out of 4) or a lot (4 out of 4) about the trials.

Table 3: Results of the evaluation completed at the end of the variety field walk

Question	**Options for responses**	**Percentage for each response**
As a result of today, in regards to the "Improved Plant Protection for the banana industry" do you?	Have a very good understanding	18%
	Have a good understanding	74%
	Have a limited understanding	8%
	Still not know much about it	0%
How much do you know about the trials to evaluate alternative banana varieties for improved disease and or pest resistance?	1 - A little bit	5%
	2 - Some	50%
	3 - Quite a bit	34%
	4 - A lot	11%
How much has your knowledge about the nutrient trial work increased?	1 - A little bit	8%
	2 - Some	37%
	3 - Quite a bit	45%
	4 - A lot	11%
On a scale of 1-10 how would you rate today's event?	0 – 6	0%
	7	16%
	8	42%
	9	26%
	10	16%

Percentages are rounded. Total of 38 participants included in this evaluation.

Variety field walk – Communication material

ABGC e-bulletin 5 June 2019

Take a walk on the trial side!

Are you interested in seeing and hearing first-hand about the progress of newly imported varieties being trialled at the DAF South Johnstone Research Station?

This unique opportunity will be available to you on 21 June, when Jeff Daniells gives a tour of the trial site, inspecting plant crop bunches of each variety. Many of these varieties are also being screened against Panama disease tropical race 4 in the Northern Territory.

There will also be an opportunity to see the new nutrient rate trials which are aiming to determine the optimal range of nitrogen fertiliser rates, taking into consideration agronomic and environmental factors.

The field walk will commence at 9am and finish with lunch. Gumboots will be provided to enter the research station therefore RSVP is essential – Tegan.Kukulies@daf.qld.gov.au – 0459 846 053 or click here (https://www.eventbrite.com.au/o/department-of-agriculture-and-fisheries-15500522411?s=99575449)

This field walk is being organised by the National Banana Development and Extension Program BA16007. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Queensland Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Text message to north Queensland growers sent 17 June 2019

Reminder: This Friday, 21 June, variety field walk at South Johnstone Research Station, 9am. For more info and to RSVP contact Tegan 0459846053.

ABGC Facebook page post – 17 June 2019

Statistics at the day of the field day: 619 views

ABGC e-bulletin 18 June 2019

REMINDER: Take a walk on the trial side!

Far north Queensland growers - are you interested in seeing and hearing first-hand about the progress of newly imported varieties being trialled at the DAF South Johnstone Research Station?

This unique opportunity will be available to you this Friday (June 21), when Jeff Daniells gives a tour of the trial site, inspecting plant crop bunches of each variety. Many of these varieties are also being screened against Panama disease tropical race 4 in the Northern Territory.

There will also be an opportunity to see the new nutrient rate trials which are aiming to determine the optimal range of nitrogen fertiliser rates, taking into consideration agronomic and environmental factors.

The field walk will commence at 9am and finish with lunch. Gumboots will be provided to enter the research station therefore RSVP is essential – Tegan.Kukulies@daf.qld.gov.au– 0459 846 053 or click here.

This field walk is being organised by the National Banana Development and Extension Program BA16007. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Queensland Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

ABGC e-bulletin 26 June 2019

New trials spark interest among growers

More than 50 people attended a field walk at the South Johnstone Research Station last Friday, with participants intrigued by the variation in the plant crop bunches of the different varieties being trialled.

Jeff Daniells, who gave a guided tour of the 32 varieties said, "Growers were interested in the origin, agronomic observations and also the disease resistance of the varieties".

Taste buds were tantalised with a selection of varieties on offer to try, and growers also had the chance to view new nutrient rate trials, which are trying to find the optimal range of nitrogen rates, taking into consideration agronomic and environmental factors.

If you missed this field walk there will be more opportunities to see the trials as they progress.

For more information about the trials at the South Johnstone research station, contact the better bananas team – betterbananas@daf.qld.gov.au

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Queensland Government

Hort Innovation BANANA FUND

Article in August edition of the Australian Bananas magazine - https://abgc.org.au/2019/08/20/new-varieties-on-show/

NEW VARIETIES ON SHOW

More than 50 people got a taste – literally – of new varieties being trailed at the South Johnstone Research Station in June.

Participants in a field walk organised as part of the National Banana Development and Extension Program were intrigued by the variation in the plant crop bunches of the different varieties.

"Growers were interested in the origin, agronomic observations and also the disease resistance of the 32 varieties," Principal Horticulturalist Jeff Daniells said.

A number of varieties were on offer for taste testing.

Growers also had the chance to view new nutrient rate trials, which aim to find the optimal range of nitrogen rates, taking into consideration agronomic and environmental factors.

For more information about the trials at South Johnstone Research Station, including the varieties, visit www.betterbananas.com.au or contact the Better Bananas team – betterbananas@daf.qld.gov.au

Keep an eye out for more opportunities to see the trials as they progress.

Principal Horticulturalist Jeff Daniells takes participants through the field walk, answering many questions including the origin, agronomic observations and disease resistance of varieties currently being trialled at the South Johnstone site.

Those attending the field walk at South Johnstone research station were able to taste test some of the 32 different varieties currently being trialled for disease resistance.

FERAL PIG FIGHT GETS FINALIST NOD

Appendix 8: Banana R&D speed dating event (2019)

About the event

The project team organised a 'Banana R&D speed dating' event which was held in Innisfail on 3 October 2019. The event was named with a little humour in mind after the popular 'speed date a researcher' session at the 2018 National Banana Roadshows. The overall format of the 3 hour event was designed to provide a small number of short and snappy presentations followed by discussions. The aim was to facilitate more interaction between researchers, growers and agribusiness staff, as well as promoting grower-to-grower learning. Table 1 shows the event program. The evening consisted of three key elements:

Researcher speed dating: Six researchers gave 3 minute presentations on their work. These short presentations were designed to set the scene for the discussion for the 'speed dating' exercise. The six researchers and their presentations were as follows:

- Ingrid Jenkins *(DAF)* – On-line resources
- Richard Piper *(DAF)* – Bunch pest management
- Peter Trevorrow *(DAF)* – Erwinia corm rot
- David East *(DAF)* – Yellow Sigatoka
- Jeff Daniells *(DAF)* – Variety evaluation
- Stewart Lindsay *(DAF)* – Variety development

The researchers practiced their presentations to ensure information was well and timely. The presentation slides are included in Figure 1.

Once all the researchers had given their 3 minute presentations they each spent 10 minutes at each table discussing their research with participants, moving through each of the 6 tables of attendees in turn. Researchers were given a 2 minute warning to start to wrap up their conversations at each table, and were encouraged to move at the 10 minute mark when upbeat music started to play. This ensured that the session ran to time.

Grower report: NextGen NT trip: One of the drawcards of the event was hearing first-hand from three of the growers who attended the NextGen trip to the Northern Territory, which had been facilitated by the project a few weeks prior (Appendix 11). During this trip the group visited the Coastal Plains Research Farm to take a look at the banana variety evaluation and development trials that are screening varieties for resistance to Panama disease tropical race 4 (TR4). Growers also visited Asian vegetable and okra growers and a large high-tech mango packing shed. At the banana speed dating event, three growers formed a panel and stepped through a PowerPoint presentation of images from each of the visits during the trip, each sharing their observations and learnings, and answering questions from the audience. This method of peer-to-peer sharing was a success and the growers in attendance enjoyed the session.

On-farm biosecurity session: This was an exercise to engage participants in positive discussion about on-farm biosecurity. Two on-farm biosecurity scenarios were given to each of the 6 tables on A3 paper, with 3 tables receiving scenario 1 and 3 tables receiving scenario 2 (Figure 2). Each table was given 15 minutes as a group to discuss the issues the 'hypothetical' grower was facing in their scenario and come up with some suggestions for improving their on-farm biosecurity practices. Working through one scenario at a time, each table nominated a spokesperson who shared recommendations from their table with the rest of the audience. PowerPoint slides with the full suite of possible recommendations were pre-prepared for each scenario. After each table had contributed their ideas and discussions these slides were presented and worked through with the whole audience to ensure no obvious management options were overlooked.

After the evening's main extension activities had finished, a light meal was provided to encourage further social interaction between those that attended. The venue also provided the opportunity to display several posters previously prepared for the Australian Banana Industry Congress. The posters presented various aspects of Banana R&D to spark further discussion amongst attendees and researchers. Similarly, personnel from BQ's Panama TR4 program, as well as ABGC's reef extension team had resource material available for growers to view and take away.

Table 1: Agenda of Banana R&D speed dating night (4-7pm)

Welcome		4:10pm – 4:15pm
3min researcher presentations	Ingrid Jenkins *(DAF)* – On-line resources	4:15pm – 4:20pm
	Richard Piper *(DAF)* – Bunch pest management	4:20pm – 4:25pm
	Peter Trevorrow *(DAF)* - Erwinia	4:25pm – 4:30pm
	David East *(DAF)* – Yellow Sigatoka	4:30pm – 4:35pm
	Jeff Daniells *(DAF)* – Variety evaluation	4:35pm – 4:40pm
	Stewart Lindsay *(DAF)* – Variety development	4:40pm – 4:45pm
Speed dating researcher session	6 x 10 minutes	4:45pm – 5:45pm
NextGen NT Report + Q & A		5:45pm – 6:05pm
Explain biosecurity planning session		6:05pm – 6:15pm
Time to discuss scenario's		6:15pm – 6:30pm
Discuss scenario's with all attendees		6:30pm – 6:50pm
Evaluation and wrap-up		6:50pm – 7:00pm
Stand up food and drinks, posters on display for viewing and discussion		7:00pm - Onwards

Figure 1: Presentation slides

Researcher speed dating

Grower report: NextGen NT trip

On-farm biosecurity session

Why are you here?

- Latest R&D updates
- Making new connections
- Building relationships
- Networking
- Sharing knowledge

Researcher speed dating

Grower report: NextGen NT trip

On-farm biosecurity session

On-line resources

Ingrid Jenkins

BA16007, BA14014

Hort Innovation

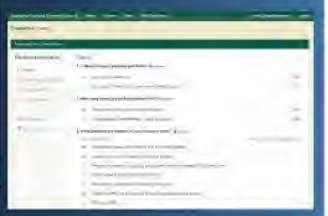
BANANA FUND

Queensland Government

Better bananas website – betterbananas.com.au

Queensland Government

Online biosecurity best management practices



Queensland Government

Bunch Pest Management

Richard Piper

BA16001

Hort Innovation

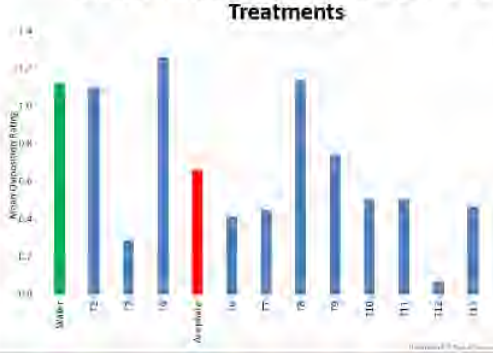
BANANA FUND

Queensland Government

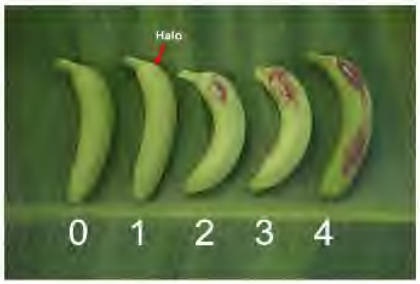
Assessment of flower thrips damage

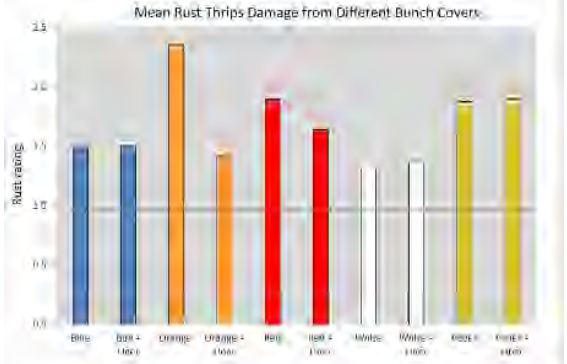
Ratings	Number of Dimples (oviposition marks)
0	0
1	1 – 10
2	11 – 25
3	26 – 50
4	>50

Flower Thrips Oviposition Ratings for 13 Treatments



Assessment of Rust Thrips Damage





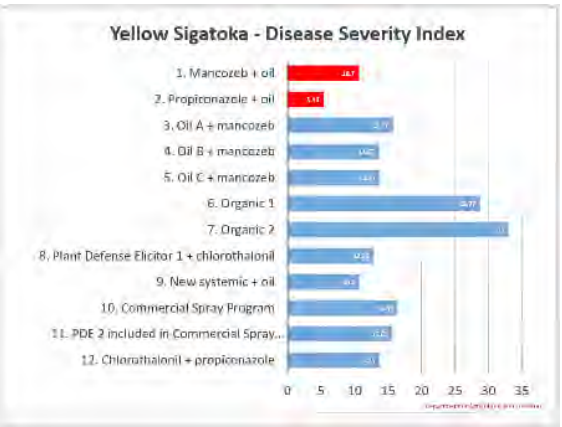
Symptoms

Banana Corm Rot

Yellow Sigatoka

David East

BA16001



Variety Evaluation

Jeff Daniells

BA16001

TR4 Focus

South Johnstone, NQ

Taiwan Cavendish Selections

Rahan Meristem Selections

SJRS Field Walk - 21 June

Pre-commercialisation Trials

Variety Development

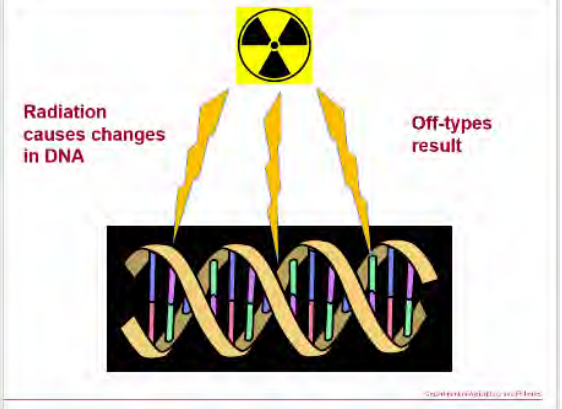
Stewart Lindsay

BA14014

Hort Innovation
Strategic levy investment

Queensland Government

Department of Agriculture and Fisheries



Department of Primary Industries

22 May 2019

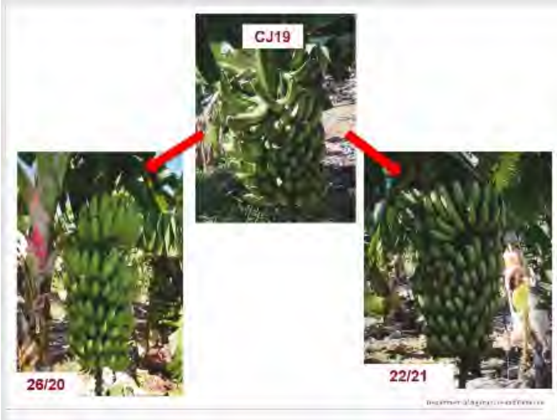
Duranbah, NSW

Pre-commercialisation Trials

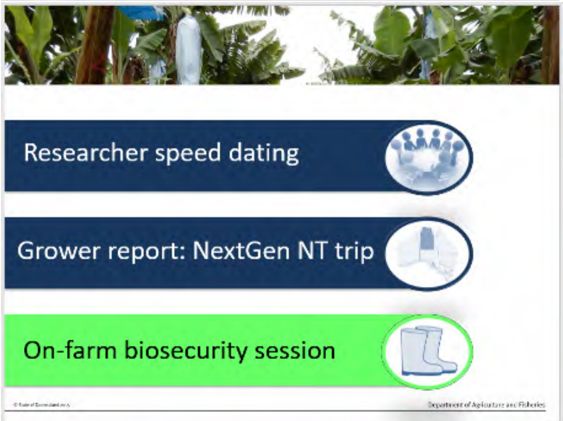
CJ19

Previous success


Story so far.....
CJ19
Dwarf Nathan
GCTCV 119
GCTCV 215
Goldfinger


CJ19
26/20
22/21


Researcher speed dating
Grower report: NextGen NT trip
On-farm biosecurity session
Department of Agriculture and Fisheries


Researcher speed dating
Grower report: NextGen NT trip
On-farm biosecurity session
Department of Agriculture and Fisheries


How Panama disease moves?
Plant Material
Soil
Water
Department of Agriculture and Fisheries


Scenario 1
Jack is a neighbour of yours in Innisfail and owns a 50 ha banana farm. He is looking to start putting in place some on-farm biosecurity. Cash flow is tight, so he is specifically after simple and cost effective solutions to make a start. You know Jack well as you have supplied him with bits and suckers in the past. What advice would you give him to help get him started?
Department of Agriculture and Fisheries


Scenario 2
TOYOTA
Department of Agriculture and Fisheries


Scenario 1
Jack is a neighbour of yours in Innisfail and owns a 50 ha banana farm. He is looking to start putting in place some on-farm biosecurity. Cash flow is tight, so he is specifically after simple and cost effective solutions to make a start. You know Jack well as you have supplied him with bits and suckers in the past. What advice would you give him to help get him started?
Department of Agriculture and Fisheries

Scenario 1

Planting Material

- ✓ Use QBAN certified tissue culture
- ✓ Bits and suckers from your own nursery

Scenario 1

Zoning

Scenario 1

1) Dedicated footwear

2) Treat footwear

Scenario 1

Restrict vehicle movement

Scenario 1

Location of fuel & waste

Scenario 1

Scenario 2

Your neighbours Donna and Tony read in a recent e-bulletin that Panama disease TR4 is spreading on the infected properties in Tully. They are reviewing the problem biosecurity they put in place in 2015 and have asked your advice. Here are some photos of the practices they currently have in place.

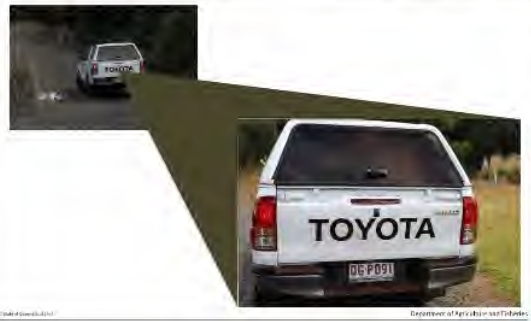
Entrance to property

Entrance to facility via dual wheel shed

Scenario 2

Scenario 2

Scenario 2



Scenario 2

Managing footwear

"Exclude first treat second"

Scenario 2

Managing footbaths

- ✓ Use DDAC or BZK based product @ label rates
- ✓ Keep clean < 5% soil
- ✓ Keep topped up
- ✓ Check concentration with test strips

Scenario 2

Footbaths placement & design

- ✓ Undercover
- ✓ Place between zones (following footwear exchange)
- ✓ Make them unavoidable
- ✓ Long enough for 2 foot steps
- ✓ Hard surface approach and exit

On-farm Biosecurity - Farm Visits

Biosecurity Queensland

- Rebecca, Zero & Sarah
- 07 4091 8140
- panamatr4@daf.qld.gov.au

Better Bananas Extension Team

- Tegan, Stewart, Shanara & Ingrid
- (07) 4220 4152
- betterbananas@daf.qld.gov.au

Hort Innovation
Strategic levy investment

BANANA FUND

Queensland Government

Australian Banana

Figure 2: On-farm bisoecurity scenarios

Scenario 2

Your neighbours Dennis and Irene read in a recent e-bulletin that Panama disease TR4 is spreading on the infested properties in Tully. They are reviewing the on-farm biosecurity they put in place in 2015 and have asked your advice. Here are some photos of the practices they currently have in place.

Entrance to property

Entrance to farm via the packing shed

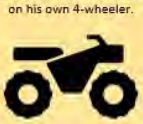
Scenario 1

Jack is a neighbour of yours in Innisfail and owns a 50 ha banana farm. He is looking to start putting in place some on-farm biosecurity. Cash flow is tight, so he is specifically after simple and cost effective solutions to make a start. You know Jack well as you have supplied him with bits and suckers in the past. What advice would you give him to help get him started?

Jack's farm manager is of the belief that Panama TR4 only affects Tully growers. He is not sure why Jack wants to incorporate biosecurity.

Jack has 5 full-time employees and hires another 11 staff on a casual basis. He thinks some of his casual staff may be working on other farms but isn't sure.

Contract bell injector brings on his own 4-wheeler.

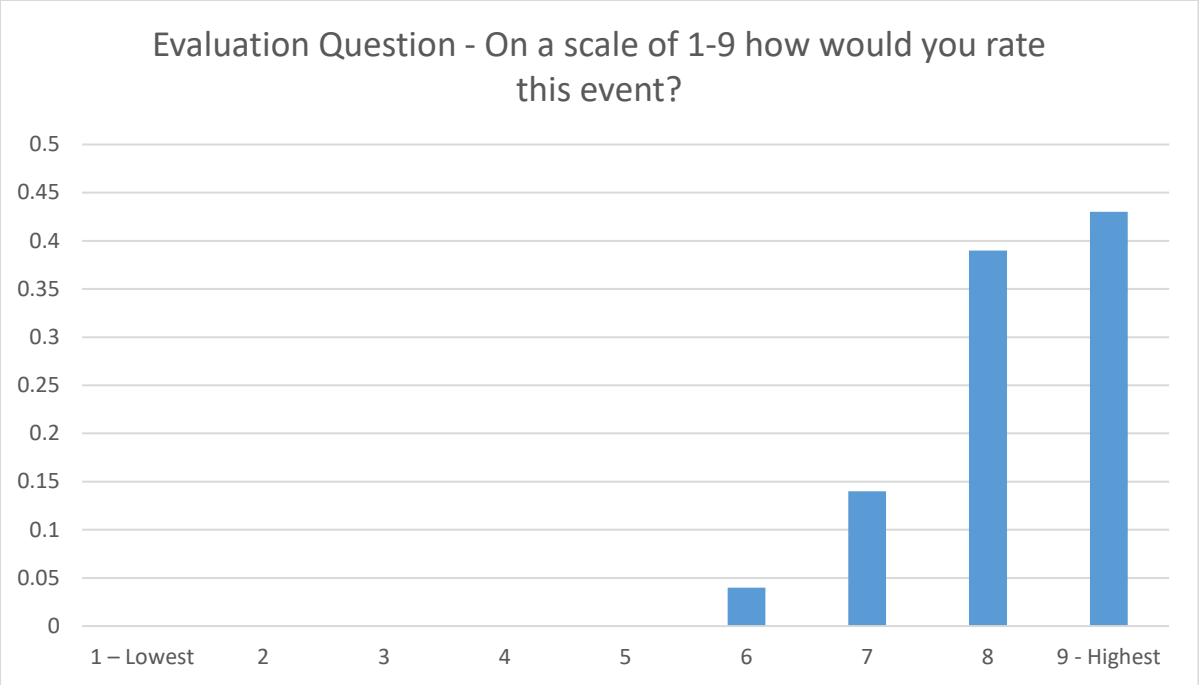


Employees wear their own shoes on the farm.

Evaluation

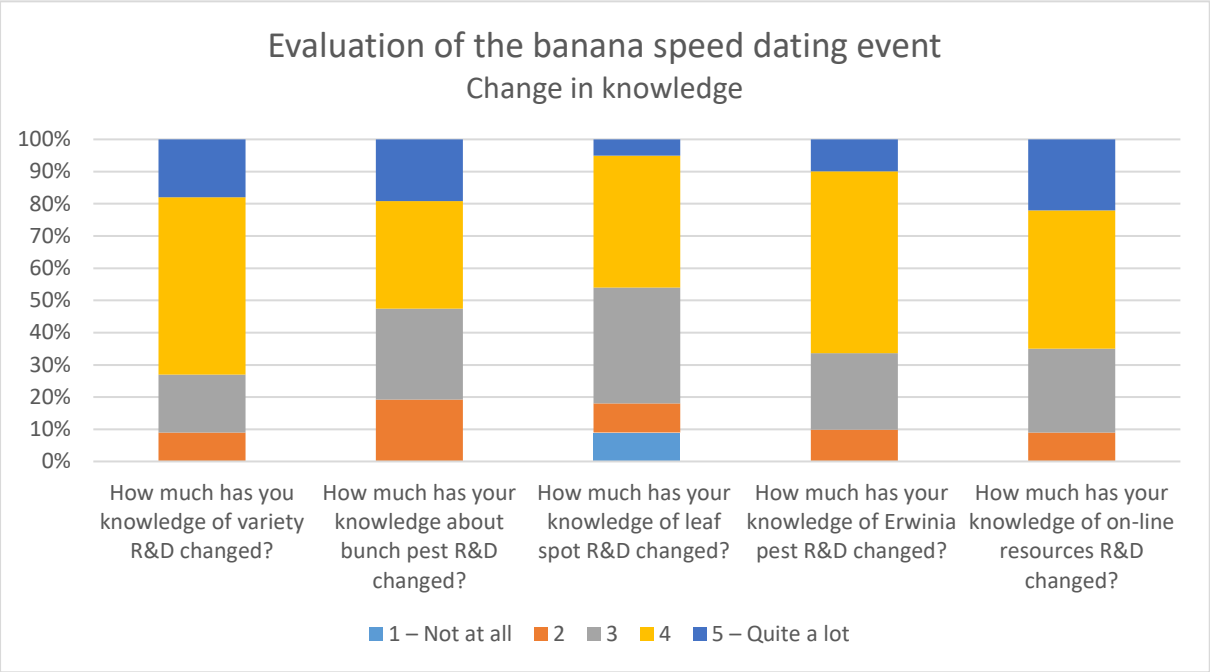
TurningPoint™, is an electronic polling system that was used to gain real time responses to the Banana R&D speed dating event. Questions and results are detailed in Table 2. In summary, those that attended rated the event highly. Using a rating scale of 1 = lowest to 9 = highest, 96% of attendees gave an overall rating oft least 7 with 82% rating it an 8 or 9 out of 9. As shown in Figure 3, this is an excellent result and supports our interactive approach to extension activities.

Figure 3: Results of evaluation of value of event



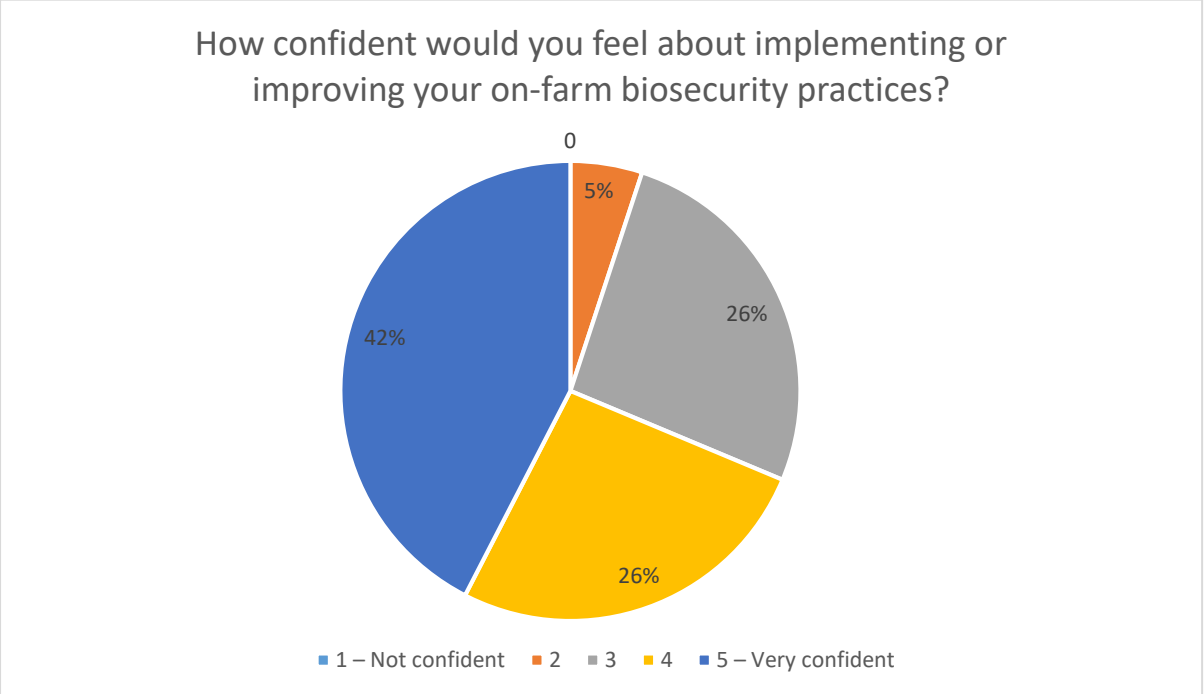
More specific evaluation questions were also asked. This included evaluating their knowledge gained on specific R&D topics presented in each of the 3 minute presentations and subsequent group discussions. On a scale of 1 to 5 (1=not at all, 5=quite a lot) close to 50% of attendees rated their knowledge gain as a 4 or 5 out of 5, indicating their knowledge of R&D activities featured in the presentations had increased ‘a lot’ or ‘quite a lot’ (Figure 4). Where participants indicated that their knowledge had only slightly changed, this could be attributed to attendees already having a good level of knowledge of some R&D topics before participating in the speed dating evening. Many of these R&D topics have formed part of previous extension activities such as the variety field walk, the Banana congress, NextGen activities and various industry communications.

Figure 4: Results of evaluation of change in knowledge



The discussion about on-farm biosecurity (on-farm biosecurity scenario exercise) resulted in 58% of attendees indicating that it helped them identify on-farm biosecurity practices that they hadn't thought about previously. Similarly, on a scale of 1 to 5 (1=not at all and 5=very confident), 68% of attendees gave a rating of 4 or 5 when asked how they felt about implementing or improving their on-farm biosecurity practices (Figure 5). Both of these are promising outcomes in regards to encouraging growers to implement or continue to strengthen their on-farm biosecurity practices.

Figure 5: Results of evaluation of confidence on biosecurity practices



This event also focused on facilitating networking and fostering social linkages both between researchers, growers and industry stakeholders, and between growers themselves, rather than just focusing on information delivery. Ultimately the networks established and strengthened as a result of this event will contribute to maximising the benefits of R&D outcomes, and facilitating adoption of best practice in the future.

Table 2: Evaluation results from the Banana R&D speed dating event		
Evaluation question	**Response options**	**Percentage responses**
On a scale of 1-9 how would you rate this event?	1 – Lowest	0
	2	0
	3	0
	4	0
	5	0
	6	4%
	7	14%
	8	39%
	9 - Highest	43%
How much has you knowledge of variety R&D changed?	1 – Not at all	0
	2	9%
	3	18%
	4	55%
	5 – Quite a lot	18%
How much has your knowledge about bunch pest R&D changed?	1 – Not at all	0
	2	19%
	3	28%
	4	33%
	5 – Quite a lot	19%
How much has your knowledge of leaf spot R&D changed?	1 – Not at all	9%
	2	9%
	3	36%
	4	41%
	5 – Quite a lot	5%
How much has your knowledge of Erwinia pest R&D changed?	1 – Not at all	0
	2	10%
	3	24%
	4	57%
	5 – Quite a lot	10%
How much has your knowledge of on-line resources R&D changed?	1 – Not at all	0
	2	9%
	3	26%
	4	43%
	5 – Quite a lot	22%
Did talking with other growers help you identify on-farm biosecurity practices you hadn't thought about previously?	Yes	58%
	No	42%
How confident would you feel about implementing or improving your on-farm biosecurity practices?	1 – Not confident	0
	2	5%
	3	26%
	4	26%
	5 – Very confident	42%

Communication Material

e-bulletin: 26/08/2019

Planning for QLD banana speed dating night commences

Help set the agenda by nominating topics you're interested in.

Let us know what research you would like to hear about! In early October, you will have the opportunity to talk with researchers about their recent banana R&D work. The early evening event will be held in Innisfail and will feature the popular speed dating format from the Banana roadshows. Researchers will give a 3 minute presentation, followed by time spent moving between tables networking with attendees. Some of the research areas that might interest you include yellow Sigatoka, nematode and bunch pest management, nutrient rate trials, variety development or on-farm biosecurity. **Contact Tegan Kukulies to nominate topics you would like to hear about** on 0459 846 053 or betterbananas@daf.qld.gov.au.

Keep an eye out for details about the night on the better bananas website betterbananas.com.au, as well as future e-bulletins and posts on ABGC Facebook page.

The upcoming networking evening in October will follow a similar format to the popular speed dating session held as part of last year's Banana Roadshow series.

This event will be organised as part of the National Banana Development and Extension Program (BA16007). The 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. The Queensland Government has also co-funded the project through the Department of Agriculture and Fisheries.

e-bulletin: Monday 16th September 2019

Speed dating is back!

A banana extension event featuring the popular speed-dating researcher session from last year's Roadshows is set to take place on October 3 from 4-7pm at Brothers Leagues club in Innisfail.

The session gives you the opportunity to talk directly with researchers and ask targeted questions. Researchers you'll be 'speed dating' include Jeff Daniells (variety evaluation), Stewart Lindsay (variety development), Richard Piper (bunch pest management), David East (Yellow sigatoka), Ingrid Jenkins (Better Bananas website and online on-farm biosecurity BMP) and Peter Trevorrow (Erwinia).

The afternoon will also feature:

· **Observations from banana varieties trials in the Northern Territory:** Ten growers who recently visited the variety trial site near Darwin will share their reaction to Panama disease tropical race 4 in the NT. They also visited an Asian vegetable grower and a mango grower. Hear about what their impressions where and take the opportunity to ask questions.

· **On-farm biosecurity scenario session:** letting banana growers share ideas about getting started or improving your practices

RSVP is essential for catering purposes, as a light meal will be provided following the event. Beverages will be available to purchase at the venue. RSVP by Thursday 26th September by contacting Tegan Kukulies on 0459 846 053 or email tegan.kukulies@daf.qld.gov.au, or via Eventbrite here.

This event is organised as part of the National Banana Development and Extension Program BA16007. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Queensland Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

e-bulletin: Tuesday 24th September 2019

Reserve your spot for R&D speed dating

It's speed dating – but not as you know it!

This short, sharp extension event is your chance to chat face-to-face with some of the banana industry's leading researchers, in a format made popular at last year's National Banana Roadshow.

The event will be held on Oct 3, 4-7pm, at Brothers Leagues Club in Innisfail.

Growers will hear about the latest progress towards new varieties, bunch pest management and chemical control, Erwinia and Yellow sigatoka. You will also hear about the newest online resources.

RSVP by **this Thurs Sept 26** is essential, as a light meal will be provided following the event. Contact Tegan Kukulies on 0459 846 053 or e-mail tegan.kukulies@daf.qld.gov.au or use this Eventbrite link.

This event is organised as part of the National Banana Development and Extension Program BA16007. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Queensland Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

e-bulletin: Thursday 10th October 2019

R&D speed dating a success

More than 40 people took the opportunity to speed-date some of the banana industry's top researchers last week.

There was no awkward small talk on these dates, with plenty of information shared on topics including bunch pest management, variety development, online resources, Erwinia and yellow sigatoka.

Those that attended heard first-hand from some of the growers who participated in the recent NextGen trip to the NT about the variety trials for Panama disease TR4 and they re-enforced that seeing the disease first hand is a reminder of how devastating it is. They also shared some interesting observations from the visits to Asian vegetable and mango production systems that were organised as part of the trip.

Growers also participated in a grower-to-grower chat about on-farm biosecurity practices.

Keep an eye on the Better Bananas website and the ABGC e-bulletin for future developments, as well as more opportunities to see and hear about banana research face-to-face.

This event was organised as part of the National Banana Development and Extension Program BA16007. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Queensland Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Australian Bananas magazine article (December 2019 edition)
https://abgc.org.au/2019/12/16/banana-rd-speed-dating-night-a-hit/

BANANA R&D SPEED DATING NIGHT A HIT

A playful title for this R&D event, held in October, gave attendees a good indication of what they could expect when hearing about the latest banana research from the Department of Agriculture and Fisheries (DAF).

The event, organised by the DAF banana extension team, was attended by more than 40 people and was more about conversation than presentations. With presenters given only 3 minutes to give their pitch, Jeff Daniels (variety evaluation), Stewart Lindsay (variety development), Richard Piper (bunch pest management), David East (yellow sigatoka), Ingrid Jenkins (online resources) and Peter Trevorrow (Erwinia) set the scene, then participated with their colleagues in 10 minute round-the-table discussions with growers and industry stakeholders.

Those that attended also heard first-hand from growers Shannon Paton, Gavin Devaney and Parmjeet Tut, along with ABGC's Research and Development Manager Rosie Godwin, all of whom participated in a recent NextGen trip to the Northern Territory, where they visited variety trials screening for resistance to Panama disease tropical race 4. The growers reinforced that seeing the disease first hand is a reminder of how devastating it is. They also shared some interesting observations from visits to Asian vegetable and mango production systems that were organised as part of the trip.

Growers and researchers participate in round-the-table discussions on a range of R&D topics.

The Speed Dating night concluded with a grower-to-grower chat about on-farm biosecurity practices followed by light refreshments and further discussion amongst those that attended.

"Hearing how much positive conversation was being had not only between the researchers and the growers, but also between the growers themselves, was so uplifting," Tegan Kukulies, from the DAF banana extension team, said.

Shannon Paton, DAF's Tegan Kukulies, Gavin Devaney and Parmjeet Tut at the event. Shannon, Gavin and Parmjeet shared their experience from the NT.

"The relaxed nature of the event certainly helped stimulate the conversations and I think the growers really got a lot from it."

The extension team thanked all growers who attended and supported the event.

This event was organised and funded as part of the strategic levy investment project National Banana Development and Extension Program - BA16007. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Appendix 9: On-farm biosecurity extension

Background

Panama disease tropical race 4 (TR4) is one of the most devastating soil borne diseases in bananas. On 3 March 2015, Panama disease TR4 was confirmed on a commercial banana property in Tully, located in the main growing region of Australia in Far North Queensland.

With no available treatment or 'cure' for the disease, implementing on-farm biosecurity practices remains the approach to limiting and slowing the spread of the disease. The extension response, aimed to provide growers with the information and guidance to make informed and individualised decisions about on-farm biosecurity for their properties, has spanned over several projects (BA13004 and BA16007). The extension response has been predominantly delivered by the Department of Agriculture and Fisheries (DAF) and the Australian Banana Growers Council (ABGC), in consultation with Biosecurity Queensland (Panama TR4 Program).

Following the initial detection, ABGC and DAF (as part of BA13004) developed and delivered a comprehensive 18-month extension program to growers in Far North Queensland through a series of small regionally based workshops. These were delivered to equip growers with the knowledge to identify the risks, and to assist them in developing practical solutions for implementing effective on-farm biosecurity practices on their properties. This was followed by individual farm visits to discuss the implementation of biosecurity practices on their farms in further detail.

As part of the collaborative effort, a Panama disease TR4 field day was held on 13 November 2015 at the Wangan Hall for growers and industry stakeholders. This event aimed to give an update of results from emerging research (e.g. disinfectants), provide an update on the response program and showcase and share some of the on-farm biosecurity practices already implemented by growers. By the end of this program 246 people representing 228 farms (82% of Far North Queensland banana production) had attended the biosecurity planning workshops, and there were less grower-initiated requests for one-on-one farm visits. Evaluation of the program showed that the two biggest barriers to adopting on-farm biosecurity measures were cost and time, which extension alone has limited ability to address. However, the evaluation also showed that 96% of growers surveyed (n = 97 growers) said that knowledge about on-farm biosecurity wasn't a limiting factor to adopting on-farm biosecurity practices. This suggests that the overall extension response has been successful in distilling information and improving knowledge of the disease and on-farm biosecurity.

From 2017 onwards the National Banana Development and Extension program (BA13004 & BA16007) has driven the extension of on-farm biosecurity, with input and collaboration from ABGC and Biosecurity Queensland. Since growers had indicated that knowledge about on-farm biosecurity practices wasn't a limiting factor, and grower demand for farm visits that solely centred around on-farm biosecurity practices was low, an integrated extension approach has since been taken.

The first integrated initiative was the Panama R&D open day held in May 2017 at the South Johnstone Research Facility (organised as part of BA13004). This was the first industry event which involved moving a large number of attendees into the paddock under strict on-farm biosecurity practices. These practices not only protected the research facility resource but also acted as a demonstration of best practice for on-farm biosecurity, especially in regard to managing people and footwear (changing footwear and using an effective footbath). The interactive field day event saw over 100 attendees move between demonstrations and information sessions about soil health, remote and proximal sensing, research into destruction of infected plants, resistant varieties and

disinfectant research. The extension event also served as a good opportunity to launch the hard copy of Banana best management practices for on-farm biosecurity (produced as part of BA14013).

On-farm biosecurity extension as part of BA16007

Keeping on-farm biosecurity at the top of growers' priority list is challenging, especially in an intensive crop like bananas where there are many competing priorities (e.g. economic viability, environmental practices etc.). To address this challenge, the strategy to keep on-farm biosecurity on growers' radars has been to integrate on-farm biosecurity into extension activities focused on other priority topics and research that growers have shown an interest in.

Similarly, when visiting grower's properties about issues unrelated to on-farm biosecurity the topic of on-farm biosecurity is raised. For example, extension staff scope what biosecurity procedures the grower would like them to follow when visiting the farm prior to the farm visit. While visiting a grower, often the topic of on-farm biosecurity is dropped into the conversation with some basic questions; for example - what disinfectant product are you using in your footbath (if they have one)? This often leads to discussion either in a general context about the spread of Panama disease TR4 or more targeted conversation about their on-farm biosecurity practices, in both cases raising the profile and awareness of on-farm biosecurity.

Throughout this project on-farm biosecurity extension has been carefully considered as part of each extension activity. Below is a summary of how on-farm biosecurity extension strategies have been integrated into the project activities.

Australian Banana Industry Congress (2017 & 2019): The project organised and facilitated a booth in the exhibition at both the 2017 & 2019 events (Figure 1 & 2). On display and demonstrated at the 2017 booth were test strip kits which can be used to measure the concentration of disinfectant in footbaths and spray shuttles etc. Also available for attendees to take away were copies of the on-farm biosecurity best management practices guidelines. In addition to this, on-farm biosecurity practices featured in the artwork which was displayed on the walls of the booth.

In 2019 the project team collaborated with Biosecurity Queensland (Panama TR4 program) with the aim of bringing more awareness to Panama disease TR4 and on-farm biosecurity. As in 2017, there were hard copy materials available for attendees to take away (on-farm biosecurity BMP, grower's kits etc.). A flyer was also developed and made available to promote the on-line biosecurity BMP and display the features of the system. This was also complemented by a *Living and Farming with TR4 session* in the congress program featuring Mark Smith (Manager of the Darwin Fruit Farm) and Gavin and Stephen Mackay (Mackays), which was organised by members of the Banana Industry Communications Project (BA18001). These strategies, although not the sole intent of the booth or congress, led to the topic of on-farm biosecurity becoming part of the conversations with growers and industry stakeholders in attendance.

Figure 1: 2017 ABIC - Booth exhibit

Figure 2: 2019 ABIC - Booth exhibit

NextGen activities (2017 & 2019): In both years, growers and industry stakeholders involved in the NextGen group participated in visits to the Northern Territory. At the heart of both of these trips were visits to the banana variety evaluation and variety development (mutagenesis) trials for Panama disease TR4 resistance at the Coastal Plains Research Farm (managed by the Northern Territory Department of Primary Industries as part of BA16001).

In 2017 the group also visited one of the few remaining commercial banana farms in the Northern Territory (Darwin Fruit Farm) with the group gaining invaluable first-hand knowledge of farming in the presence of the disease from discussions with the farm manager. Following strict on-farm biosecurity practices during these visits was paramount, and an extreme example of demonstrating and carrying out on-farm biosecurity practices given that the group was travelling in the Northern Territory where there are no biosecurity containment measures in place. This was especially important during the inspection of the trial site where the plants were inoculated with the disease.

During these trips, several layers of on-farm biosecurity procedures and practices were implemented including changing shoes several times, having dedicated hats, dedicated clothing, using footbaths, spraying shoes and using disinfectant on surfaces such as phones and sunglasses. The growers in attendance were hyperaware of the risks associated with visiting locations in the Northern Territory, and putting these biosecurity procedures in place not only mitigated the risks but served as an excellent demonstration of on-farm biosecurity practices. The visits to the research field trials (Coastal Plains Research Farm) were first-hand reminders of how serious Panama disease TR4 is to *Williams* Cavendish plantations and many other varieties, given there are no commercially suitable resistant varieties currently available.

A diverse range of growers from different growing regions and social groups were supported to participate in both of these visits. The aim of the visits was promotion of grower-to-grower learning within the study group members and to share this learning with the broader banana industry upon returning to their farms and social circles. Following the 2017 trip, participants were asked how the trip helped further their understanding of the potential impact of Panama disease TR4. Ranked on a scale of 1 to 5 (1 = 'not at all' and 5 = 'I now understand/ appreciate the full potential'), 86% responded with a 5 and 14% a 4. This was an excellent result and demonstrated the value in providing an opportunity for growers to see the disease impact first-hand and talk to people who have had experience managing the disease. Further to this, 75% of participants in the 2019 trip indicated they would change something in regards to on-farm biosecurity as a result of the trip, with the remaining 25% indicating they wouldn't make changes as they were already happy with the level of on-farm biosecurity implemented on their farm.

National Banana Roadshows 2018: On-farm biosecurity was part of the agenda at all six of the National Banana Roadshow events in 2018. The format of delivery differed between locations, however overall, it leveraged the experiences of the second infected farm in Tully and utilised peer-to-peer learning methods. A video titled *'Making biosecurity work for your farm: Mackay's experience of farming with Panama disease tropical race 4'* was specifically developed for Roadshows and was played at all six events. For those events outside of NQ (Coffs Harbour, Murwillumbah, and Carnarvon), project team member Stewart Lindsay introduced the video and gave an introduction and overview prior to the video being played. On-farm biosecurity was also part of the discussions included as part of the Q&A sessions at the end of these events. For the NQ events (Tully, Innisfail, Mareeba) a representative from Mackays was available for the Q&A session to answer questions and share experiences with the attendees.

Variety field walk (2019 & 2020): On 21 June 2019 nearly 50 people participated in a field walk of the variety evaluation block (plant crop) and nutrient rate trial block at the South Johnstone Research Facility. Further to this in March 2020, 22 growers and industry stakeholders (predominantly those involved in the NextGen group) toured the same variety evaluation block to see the first ratoon bunches of some of the varieties. For both of these activities strict on-farm biosecurity practices were followed to ensure safe entry and exit of the farming area. This included providing clean and disinfected gumboots to all participants (changed in a manner that didn't allow for cross contamination) followed by the use of a footbath. Participants also signed a visitor register prior to entry and upon exit, and were asked to list the last property they had visited. Implementing these practices also served as a demonstration of on-farm biosecurity best management practices and reminded attending growers of the importance of managing access on and off their properties.

Industry communications: The extension project works in a complementary role with the Banana Industry Communications Project (BA15001 & BA18001), which manages important channels of communication to banana growers and industry stakeholders via the *Australian Bananas* magazine, regular e-bulletins and ABGC social media platforms. Throughout this extension project, numerous articles, reporting on project activities have included elements of on-farm biosecurity (e.g. field days, events, NextGen activities etc.), and were published in editions of the magazine and ABGC's e-bulletins. This is important as it shares the knowledge, outputs and grower experiences with the wider growing community (unable to attend an activity) and industry stakeholders. Another good example was the "Kick-start your biosecurity for under $1000" information that was collectively developed with ABGC and published as an advertisement-style page in the April 2019 edition of the *Australian Bananas* magazine.. This collaborative working relationship between the extension project and the Banana Industry Communications Project has been vital in reinforcing the importance of on-farm biosecurity.

Collaboration with Biosecurity Queensland (Panama TR4 program): The extension project has also worked in a complementary role and maintained close communication with the Panama TR4 program managed by Biosecurity Queensland (BQ). This has ensured there is no duplication of grower extension and communication efforts and that project and program activities complemented each other. For example, BQ program personnel have been responsible for engaging with growers classified as 'highest at risk' and the extension project staff have assumed responsibility for contact with all other growers seeking assistance for on-farm biosecurity. The Panama TR4 program also puts out a newsletter, communication via their social media pages and hosts a range of information to the program's campaign website. The on-farm biosecurity BMP resource and other extension material produced as part of this project (e.g. *Making biosecurity work for your farm* video) are often linked and promoted to growers and industry stakeholders via the program's communication channels.

In July 2019 BQ commissioned an independent qualitative study to provide DAF with insights into the attitudes, motivations and barriers to grower engagement, adoption and adherence to on-farm biosecurity best management practices. While project team members were not involved in undertaking the work (interviewing growers etc.), we collaborated with BQ and ABGC in planning and managing the study and were privy to the study results.

Although many of the barriers, drivers and learnings from by this study were already realised through the series of extension activities it was good to have them confirmed independently (e.g. "small changes are easy and relatively cost effective and grower should start there", "having a plan of attack lessens the angst associated with implementing on-farm biosecurity measures", "supporting growers with advice and a tailored implementation for their farm is the way to go"). Some other interesting outcomes/recommendations from the study were that in order to "affect change, industry culture should not be approached from a top-down approach (i.e. from an 'authority' source), it needs to come from the grass roots and work its way up slowly and organically". This confirms that our participative approach with growers and industry stakeholders is likely to be the most effective method for achieving positive change.

Banana R&D speed dating event (2019): On 3 October 2019 the project held a Banana R&D speed dating evening in Innisfail. The event was designed to facilitate more interaction between researchers and growers, and promote grower-to-grower learning. A dedicated on-farm biosecurity session was an agenda item as part of this event. This session took the form of an interactive exercise designed to promote positive discussion about on-farm biosecurity, in keeping with the recommendations from the BQ social research study. Two on-farm biosecurity scenarios (Figure 3) were used in small group settings to encourage attendees to discuss the issues the 'hypothetical grower" was facing in each of the scenarios and then to share their learning with the larger group. For a more detailed description of this activity please see Appendix 8.

As a result of attending the evening, 58% of attendees indicated that the on-farm biosecurity session helped them identify on-farm biosecurity practices that they hadn't thought about previously. In addition, 68% of respondents gave a rating of 4 or 5 out of 5 when asked how they felt about implementing or improving their on-farm biosecurity practices. Overall, these are promising outcomes in regard to encouraging growers to implement or continue to strengthen their on-farm biosecurity practices.

Figure 3: On-farm bisoecurity scenarios

Scenario 2

Your neighbours Dennis and Irene read in a recent e-bulletin that Panama disease TR4 is spreading on the infested properties in Tully. They are reviewing the on-farm biosecurity they put in place in 2015 and have asked your advice. Here are some photos of the practices they currently have in place.

Entrance to property

Entrance to farm via the packing shed

Scenario 1

Jack is a neighbour of yours in Innisfail and owns a 50 ha banana farm. He is looking to start putting in place some on-farm biosecurity. Cash flow is tight, so he is specifically after simple and cost effective solutions to make a start. You know Jack well as you have supplied him with bits and suckers in the past. What advice would you give him to help get him started?

Jack's farm manager is of the belief that Panama TR4 only affects Tully growers. He is not sure why Jack wants to incorporate biosecurity.

Jack has 5 full-time employees and hires another 11 staff on a casual basis. He thinks some of his casual staff may be working on other farms but isn't sure.

Contract bell injector brings on his own 4-wheeler.

Employees wear their own shoes on the farm.

On-line On-farm Biosecurity Best Management Practices (BMP) resource: The On-farm biosecurity BMP resource was developed as part of the Fusarium Wilt tropical race 4 – Biosecurity and Sustainable Solutions project (BA14013). Since then, an on-line system has been developed from the hard copy resource as part of the Fusarium Wilt Research Program (BA14014). While the on-line system has been available in a testing format for growers (4 growers participated) it was only finalised in early 2020.

At this stage, there has been very limited demand from growers to use the functionally of the on-line system to develop improvement and management plans, as the tool has only been available for a short time. There is also a lack of a clear external driver for growers to document current practices or develop a plan to improve practices. In practice, the process of discussing a grower's individual risks, and potential options for implementing different on-farm biosecurity practices, has been done on a one-on-one basis where growers have approached the extension team for input and advice.

Following the 2nd, 3rd and 4th detections of the disease on banana properties in Tully, offers of one-on-one assistance were made via e-bulletins, BQ's Panama TR4 communications team as well as grower networks that are facilitated as part of this project (e.g. NextGen). Similarly, personnel involved in the key market groups (e.g. Mackays Marketing, LaManna Premier Group, Nutrano, DBM, & Costa's) who are in contact with their grower suppliers were contacted after each new detection to offer tailored assistance to their grower suppliers. Only a few growers have taken up the offer for personalised visits for the sole purpose of discussing a plan for preparing, implementing, or improving their on-farm biosecurity systems in the event there is a positive detection on their properties.

Recommendations & learnings

In the first 12-18 months following the detection of Panama Disease TR4 in Far North Queensland, growers rapidly adopted on-farm biosecurity practices and required focused extension support throughout this time. During this period the good working relationships and collaboration between DAF (extension projects), ABGC and Biosecurity Queensland have underpinned the success in providing extension support and communication to growers and industry stakeholders. The disease has now been detected on a total of four properties in Tully. Following the announcement of each detection there has been an increase in discussion about the disease and on-farm biosecurity in the growing community, however this hasn't resulted in a rapid increase in demand for extension support.

When using the market group networks to reach growers, one of the recommendations was to; *'find what the grower is interested in, needs assistance with, or information about, engage them on that topic then diverge or drop-in the topic of on-farm biosecurity'*. This has broadly been the strategy used in the project in respect to integrating on-farm biosecurity into events and activities facilitated and organised as part of this project. Moving forward, the extension team intends to take a more structured pro-active approach by directly contacting growers and building stronger relationships with a wider range of growers. The aim is to encourage more open conversations with growers on what is needed for them personally to review, implement or improve their on-farm biosecurity practices.

On-farm biosecurity is an industry priority and therefore extension of on-farm biosecurity either indirectly (e.g. a demonstration as part of an activity) or directly (e.g. a specific on-farm biosecurity activity) continues to be important. A better understanding of grower attitudes and needs through one-on-one discussions will help to better tailor extension efforts and methods best suited for integrating biosecurity into all future industry extension events, workshops and activities.

Appendix 10: NextGen - Sydney activity (2017)

Trip overview

The Australian Banana Industry Congress (ABIC) was held in Sydney (22-24 June 2017). The NextGen group saw the opportunity to add value to the trip and step outside of banana production to broaden their knowledge of other industries. The project facilitated two half-day agenda's (20-21 June 2017) prior to the commencement of the ABIC. Due to time restrictions, visits were arranged at locations relatively close to the city centre. The first day saw 10 growers visit the Orora Botany Paper Mill and the Australian Centre for Field Robotics at the University of Sydney. On the second day 13 NextGen participants visited a pre-packaging facility owned by integrated business Hydro produce and Integrated Plastics extrusion plant.

Evaluation

Following the visits, qualitative feedback on the four visits was facilitated over lunch on 21 June. In this discussion, each of the growers shared what they had observed and taken away from each of the visits. Following this group discussion and sharing the learnings gained from visiting the different facilities, it was recommended that future opportunities to value add to activities such as ABIC are considered. Below are comments/feedback from the growers that participated:

- I really enjoyed Orora and seeing the overall process, impressed that they are 100% recycled. Excited to see the future of robotics and tech in bananas. Impressed with business at Hydroproduce especially the focus on customers and delivering product. Was interesting to see the plastic making process and overall great to see Australian manufacturing.
- Overall challenges that you face as a business are the same e.g. energy savings, excited to see future of robotics and tech in bananas but feel it hasn't come a long way in recent times.
- A real eye-opener to see factory systems and the scale of them.
- Great to see Australian manufacturing and appreciate the need to support it.
- Great to see the process of making bunch bags. Overall great to talk with other growers and commented on how friendly they were irrespective of the size of their farms.
- Was really impressed with Hydroproduce and the robotics.
- Orora – was interesting that as a business they are relying on recycled product and not putting any new paper fibres into the system. Interesting to see that the pre-pack facility had little focus on their own brand as most emphasis was on the end customer (e.g. Woolworths). Didn't really enjoy the robotics visit.
- Robotics was interesting and would be good to establish more relationships with people working in tech to start more banana specific work.
- Was interested and impressed with the business model at Hydroproduce
- Need to weigh up the options of Australian versus imported bags, hadn't considered the risks associated with UV stabilisation in the plastics till the visit.
- Plastics was interesting to see the processing.
- Great to see manufacturing in Australia.
- Interesting to see the manufacturing processes.

Communications

The following article was published in the September 2017 edition of the Australian Bananas Magazine - https://abgc.org.au/2017/08/28/next-generation-look-outside-the-box/

NEXT GENERATION LOOK OUTSIDE THE BOX

By Tegan Nikolitos, DAF

Interest in looking at different production systems was first sparked when the group decided to visit production in their own backyard, seeing coffee, blueberries and papaya on the Tablelands.

Late last year some of the NextGen group travelled to the Bowen/Gumlu area to see how large operations grow, harvest and pack melons and vegetables and also talk to an innovative young mango grower. Growers who attended the trip were impressed with how high tech and automated the shed systems were. They were also interested in the mechanised harvesting of some crops.

Innisfail grower Matt Abbott said "I was impressed by the state-of-the-art technology and level of automation implemented in the tomato packing shed. The shed had two computerised colour grading systems that automatically graded each tomato on colour and size."

Prior to the commencement of the recent Australian Banana Industry Congress in Sydney there was interest from growers to use the trip to again broaden their knowledge of other industries. The four-stop tour included visits to Gunnai Botany Paper Mill, The Centre for Field Robotics at the University of Sydney, a pre-packaging facility owned by integrated business Hydro Produce and Integrated Plastics' extrusion plant.

Lakeland grower Paul Inderbitzin said "I really enjoyed seeing the overall process of cardboard recycling at the Gunnai paper mill and was impressed that they use 100 per cent recycled material.

Paul was also impressed with the visit to Hydro produce, noting the businesses focus on delivering quality product to customers.

Tableland grower Andrew Serra commented on that factor "the overall challenges that you face as a business are the same – such as energy savings."

"I was also impressed to see the future of robotics and tech in bananas and felt that targeted work in bananas would be interesting," Andrew said.

Other growers agreed it would be good to establish closer relationships with people working in the tech space to start more banana specific work.

Colin Singh, a grower from Coffs in New South Wales commented on how interesting it was to see and understand how bunch covers were made at the plastic extrusion plant.

The NextGen group would sincerely like to thank all the businesses and people who have generously given up their time to facilitate the group's visits. The NextGen banana growers' initiative continues to be a strategic levy investment under the Hort Innovation Banana Fund. It is part of the National Banana Development and Extension Program (BA16007), funded by Hort Innovation using the banana research and development levy with co-investment from the Queensland Department of Agriculture and Fisheries (DAF) and contributions from the Australian Government.

NextGen encourages young growers to become more involved in the future of the banana industry and inspires them to "think outside the box" and try different practices on their farms. Growers who would like to get involved in the group should contact Tegan Nikolitos from the Department of Agriculture and Fisheries on (07) 4220 4452.

Hort Innovation
Strategic levy investment

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Appendix 11: NextGen - Northern Territory activity (2017)

Trip overview

The project organised and facilitated a 2 day trip to the Northern Territory from 19 -22 September 2017. The trip aimed to help growers gain a greater understanding of current research to screen and develop banana cultivars resistant to Panama disease TR4, and to understand the impacts the disease can have on commercial production of 'Williams' Cavendish.

The two day trip covered three key activities, starting with a visit to the variety screening and development trials at the Northern Territory Department of Primary Industries and Resources (NTDPIR) Coastal Plains Research Farm. This was followed by a visit to one of the only remaining commercial banana farms in the Northern Territory growing 'Williams' Cavendish. On the second day the project provided a day registration for growers to attend the 2017 Nuffield Australia Conference, where the 2015 banana industry supported scholar Matthew Abbott, presented his learnings.

The project supported, by covering approximately 50% of costs, the attendance of 11 growers and 2 commercial stakeholders.

Sharing learnings with the rest of industry

One of the key expectations of the project supporting growers to attend the trip was that they would collectively and individually share their learnings, experiences and observations with others in the industry. A short you-tube style video was produced giving an overview of what growers thought about the variety screening trial at the Coastal Plains Research Farm. An article on the trip appeared in the December 2017 edition of the *Australian Bananas* Magazine sharing the learnings and experiences of growers from the visit. A mention of the visit and 'teaser' to this article also appeared in an ABGC e-bulletin (16 October). A copy of the article and e-bulletin can be found at the end of this report. In addition to this, five of the participants presented an overview of the trip and held a stimulating discussion with attendees at the Cassowary Coast Banana Growers Association meeting, held on 12 October 2017.

Evaluation

An evaluation of the activity was conducted following the visit to Darwin using SurveyMonkey™. Overall, 86% of survey respondents rated the trip as excellent, and 14% rated it as very good (Scale: poor, fair, good, very good, and excellent). When asked how this trip helped participants further appreciate the potential impact of Panama disease TR4 (scale of 1 ='not at all' to 5 = 'I now understand/appreciate the full potential'), 86% responded with a 5, and 14% responded with a 4. This was an excellent result and demonstrated the value of providing the opportunity for banana growers to see Panama disease first-hand, and to talk to growers who have had experience with the disease on a commercial farm.

When asked how much the trip helped improve their understanding of the investment in variety screening and development (on a scale of 1 = not at all and 5 = quite a lot), there were some mixed responses. One person responded with a rating of 1, however the remaining respondents rated it 3 to 5. This could indicate that more frequent and improved communication is required to help growers better understand investment strategies for R&D in this area, or that some participants already have a significant understanding of the R&D activities for variety screening and development.

The participants also found it valuable to attend the 2017 Nuffield Conference. When asked how they would rate the day spent at the conference (Scale: poor, fair, good, very good, and excellent), 66% indicated that it was very good, and 33% indicated it was excellent.

When asked what the participants liked most about the overall activity, and what the highlights were, the visit and discussions with the Darwin Fruit Farm was rated very highly. Below are some of the responses from growers:

- Travelling to the Darwin Fruit Farm and speaking with the farm manager
- Farm tour at the Darwin Fruit Farm
- Very well co-ordinated trip with all relative content. Highlights were seeing a commercial farm operating with TR4
- The farm visit to the commercial banana farm, seeing Panama disease first-hand and talking to the manager who was very open about his experience in dealing with it. It was well worth the trip
- There was a lot to take out of all the trip but the highlight for myself was going to the Darwin Fruit Farm and seeing the effects of TR4 on a commercial farm and how they are dealing with it.

Overall, when asked if they were likely to participate in future NextGen activities (Scale: not likely at all, not so likely, somewhat likely, very likely and extremely likely) 100% of respondents said they were either very likely or extremely likely to continue their participation. This demonstrates that the participants perceived a significant positive value in the trip and are supportive of further activities that continue to drive communication and self-directed activities within the group.

Communications

ABGC e-bulletin October 16, 2017

Next Gen NT tour

A group of enthusiastic, young growers recently took part in a three-day visit to the Northern Territory, as part of a fact-finding Next Gen tour. Participants have reported gaining a host of knowledge from the trip, which included a tour of the Panama disease Tropical Race 4 variety trial site and the opportunity to network at the Nuffield Australia National Conference in Darwin.

Article submitted to the summer edition of the Australian Bananas magazine

NextGen growers venture to Darwin

Tegan Kukulies
Department of Agriculture and Fisheries, South Johnstone

Thirteen young banana growers from the NextGen group participated in a study tour to the Northern Territory. The two day trip covered three key activities starting with a visit to the variety screening and development trials at the Coastal Plains Research Station. This was followed by a visit to one of the only remaining commercial banana farms in the NT growing Williams Cavendish. On the second day of the trip growers took the opportunity to attend the 2017 Nuffield Australia conference.

At the Coastal Plains Research Station, growers saw two variety initiatives that are underway aiming to develop a Panama resistant variety. The first initiative is a trial consisting of 27 varieties, predominantly from international breeding efforts which are being screened for Panama disease tropical race 4 resistance. The second newer initiative includes nearly 800 GCTCV 119 plants which have undergone mutagenesis, a process which essentially generates greater off-type variation in the tissue culture process in an aim to develop an off-type resistant to Panama disease.

There was lots of discussion about the variety screening trial as growers were able to see how the varieties were performing. Adam Gilbert a grower with family owned properties on the Tablelands

and in Tully said his first impression of the Williams was “Heartbreaking…… to see such a productive plant and to see that they aren’t going to stand up to TR4. They may stand up for 12 months but after a couple of ratoons they are going to be all dead!”

Peter Inderbitzin, a grower at Lakeland commented on the different Cavendish lines “It was interesting to see the variation in the different Cavendish lines. I was impressed with Formosana and CJ19 and I think they are two options which could be explored further.”

Innisfail grower Kris Horsford said “It was interesting to see many of the FHIA lines surviving under high disease pressure. These aren’t Cavendish lines so I’m not sure what the future of them would be commercially but some appear to be producing decent bunches”.

The second stop was to the Darwin Fruit Farm which has a long history of Panama disease and is one of the only remaining farms in the area growing Williams in the presence of the disease.

“It was a valuable experience to see a commercial farm growing Williams in the presence of TR4. We saw what was honestly one of the best plant blocks I have seen and you didn’t have to look too far to find plants with symptoms of TR4,” Luke Gilbert commented.

Farm manager Mark Smith and the team at LaManna Premier Group generously gave their time by sharing their experiences of commercial banana production in the presence of TR4. The group gained great value out of the visit and were sincerely thankful to Mark and the LaManna team for their contribution.

The trip coincided with the 2017 Nuffield Australia National Conference held in Darwin. Presenting at the conference was the banana industry’s 2016 Nuffield scholar Matthew Abbott. Matthew, who is also a NextGen member, presented findings from his Nuffield study that focussed on opportunities for organic banana production, particularly sustainable practices in Australia.

Innisfail grower Gavin Devaney said “attending the conference was really valuable. We heard from a large range of people from different industries and it didn’t take long to appreciate that all agricultural industries have very similar issues and therefore a lot of knowledge and learnings can be drawn from these other industries. Listening to other grower’s talk first-hand about their experiences was a real highlight”

The group was very conscious of the biosecurity risks associated with visiting the NT and followed stringent procedures - personal items and bags were not taken into the field, shoes, clothes and hats worn in the field were disposed of in the NT and phones were sanitised.

This successful young banana growers group, commonly termed in the industry as the NextGen group, is part of the three year National Banana Development and Extension Program (BA16007) funded by Hort Innovation with co-investment from the Queensland Government Department of Agriculture and Fisheries (DAF). Growers who would like to get involved in the group should contact Tegan Kukulies from the DAF on (07) 4220 4152.

The group at the 2017 Nuffield Australia Conference. *Back Left to Right:* Adam Gilbert, Stephen Lowe, Matthew Abbott, Luke Gilbert, Andrew Serra, Gavin Devaney, Peter Inderbitzin, Kris Horsford. *Front Left to Right*: Naomi Abbott, Michael Horsford, Alex Pope, Shannon Paton, Tegan Kukulies

Left to Right: Andrew Serra, Alex Pope, Peter Inderbitzin, Luke Gilbert

Left to Right: Gavin Devaney, Kris Horsford, Ben Abbott

Left to Right: Chaise Pensini, Stephen Lowe, Shannon Paton

Nuffield Scholar Matthew Abbott and Naomi Abbott.

The group at the Darwin Fruit Farm. *Back Left to Right:* Stephen Lavis, Chaise Pensini, Ben Abbott, Derek Pregl, Adam Gilbert. *Middle Left to Right*: Alex Pope, Andrew Serra, Kris Horsford, Stephen Lowe, Luke Gilbert. *Front Left to Right*: Tegan Kukulies, Glen Thompson, Peter Inderbitzin, Gavin Devaney, Mark Smith, Mick Horsford, Shannon Paton, Patrick Marzano.

Appendix 12: NextGen – Tablelands activity (2019)

“Working on your business as much as in your business” was the theme of this NextGen activity. On Friday 12 May 2019, 11 banana growers and extension staff participated in a three stop visit on the Atherton Tablelands.

The first visit was to a forward-thinking and innovative grower Matthew Fealy (Blue Sky Produce) located outside of Mareeba, producing mangoes, avocados and Tahitian limes for both domestic and international markets. Matthew was a 2017 Nuffield scholar who investigated the use of robotics and automation in horticulture as part of his scholarship. During the visit he not only showed the group his farming operations, but captured the group’s attention with discussions about technology and issues with on-ground application of these technologies, as well as emphasizing the importance of working on your business and finding ways to improve efficiencies. He also shared his experiences with using simple technology to record and benchmark farm activities to support decision making.

After following strict on-farm biosecurity practices, the next visit was to Serra Farming, first stopping at the avocado operation, where the group was able to see younger plants growing on a different soil type and under different management practices, compared to Blue Sky Produce. The final visit, was to Serra Farming’s banana operations, where Andrew Serra and his team shared their experiences on monitoring and applying benchmarks to the outputs of their packing shed team. Overall, there were three key learnings from the visits:

1. On-ground application of technology is incremental, and bridging the gap between technology developers and farmers is crucial
2. Working on your business is just as important as working in your business
3. Measuring and benchmarking farm activities is important to improve efficiencies

A summary of the visits were published in an ABGC e-bulletin on 26 April 2019 (below).

NextGen gets taste of tech future

Working ON your business as much as in your business was the hot topic from recent NextGen visits.

Growers visited Blue Sky produce, engaging in conversation with Matthew Fealy who is a passionate avocado, mango and Tahitian lime grower. Matt shared his learning from his recently completed Nuffield scholarship which investigated the use of robotics, automation and emerging technology in horticultural crops. He also shared some simple record keeping tools for monitoring farm inputs and outputs which help him benchmark farm activities.

The group then inspected avocado production at Serra Farming, followed by discussions about their banana operations. Similarly, recording and setting benchmarks for farm activities was the hot topic of these visits. The group is gearing up for a bigger activity later on in the year.

If you are interested in getting involved in NextGen or have a suggestion for things you would like to learn or visit contact Tegan Kukulies (DAF) – tegan.kukulies@daf.qld.gov.au or 0459 846 053

Appendix 13: NextGen - Northern Territory activity (2019)

Trip overview

The NextGen group returned to the Northern Territory as their main annual activity in 2019. Sixteen people involved in the banana industry including 10 growers (1 from NSW) participated in the tour from 4-6 September. The trip was an opportunity for the participating growers to step away from their businesses and gain a better understanding of the breadth of banana variety research activities taking place in the Northern Territory, as well as looking at other industries to see how they manage similar issues and challenges. It also served as a reminder of the importance of on-farm biosecurity.

The tour featured an inspection of the banana variety evaluation and variety development (mutagenesis) trials for Panama disease TR4 resistance at the Northern Territory Department of Primary Industries and Resources (NTDPIR) Coastal Plains Research Farm. The trial visits allowed growers to evaluate the progress and provide feedback on the agronomic characteristics of plants in the CJ19 mutagenesis trial to help inform the decisions around which plants are selected for further assessment. The visit to Coastal Plains Research Farm remained a confronting reminder that there is currently no 'silver bullet' solution to Panama disease TR4, and that keeping their farms free from the disease with effective on-farm biosecurity systems is the best option.

In keeping with the theme and nature of the NextGen group to look outside the world of bananas, visits were organised with the assistance of the Northern Territory Farmers Association to Asian vegetable growers (loofa, chili, bitter melon and okra) and a high-tech mango-packing shed. In keeping with previous NextGen activities looking beyond the banana industry, the growers were again intrigued by the similar challenges faced by other horticultural industries e.g. labor efficiencies and succession in farming businesses.

An invitation was also extended to growers on the Banana Variety Subcommittee (BA16001), who help guide the direction of variety R&D investment, to join the NextGen growers on these farm and research station visits.

The project supported the attendance of nine Queensland growers and one New South Wales grower by covering their airfares and accommodation costs, bus hire, and miscellaneous on-farm biosecurity expenses. Participating growers were required to cover all other expenses associated with the trip (e.g. meals, airport parking etc.). Four commercial and industry stakeholders also attended the trip; however, they were not financially supported by the project.

Sharing learnings with the rest of industry

The learnings from this activity have been shared via several platforms.

The New South Wales grower that attended, reported back to the Tweed Valley Banana Growers Association meeting (24 October), sharing not only how confronted he was to see the disease first hand, but his learnings from the variety trials and the visits to the other horticultural businesses.

The extension team organised a 'Banana R&D speed dating' event which was held in Innisfail on 3 October and was attended by over 40 people (Appendix 8). One of the drawcards of the event was hearing first-hand from three of the growers who attended the NextGen trip. Using a PowerPoint presentation of images from the trip, the growers stepped through each of the activities, shared their observations and learnings and answered questions from the audience. This method of peer-to-peer sharing was a success and the growers in attendance enjoyed this session.

An article was published in the December 2019 edition of the *Australian Bananas* magazine about the NextGen trip. Additionally, an article about the Banana R&D speed dating event was also included in this edition of the magazine.

Evaluation

Evaluation of the activity included a short on-line survey that was conducted following the trip using SurveyMonkey™. The full feedback is included in Table 1 below.

Overall, the group really enjoyed the trip and gave it a rating of 4.8 out of 5. The outstanding result was that 90% said the trip improved their understanding of investment in variety screening and development quite a lot as a result of attending the trip.

Another positive outcome of the trip was that 75% of participants indicated they would improve their on-farm biosecurity practices, with the remaining 25% indicating their on-farm biosecurity practices were already appropriate.

Not only were the outcomes from this activity of benefit to growers that attended, but also for the growers and industry stakeholders that the information reached via the more formal extension channels (magazine article and the Banana R&D speed dating extension event that followed).

Another important aspect of the activity were the social networks it built between the participants. There was a good cross section of growers who attended, from smaller growers to those that operate larger enterprises, from regionally diverse locations (NSW, Innisfail, Tablelands and Tully growers) as well as cultural diversity. One of the benefits of having such a diverse range of growers in attendance is the discussions of their learnings and observations with their respective professional and social networks (e.g. at meetings within their supply chains, and fellow growers), potentially reaching a wider section of banana growers.

Additional comments from the growers as part of the survey indicated that they came back with a new or improved appreciation for the variety R&D effort and a renewed focus on keeping their farms disease free with good on-farm biosecurity practices.

Table 1: Evaluation of the 2019 NextGen activity (Northern Territory trip)

Evaluation Question	Responses options	Responses (%)
Overall, how would you rate the trip?	☆ - Poor	0%
	☆☆ - Fair	0%
	☆☆☆ - Good	0%
	☆☆☆☆ - Very Good	20%
	☆☆☆☆☆ - Excellent	80%
How much did this trip help improve your understanding of the investment in variety screening and development?	1 – Not at all	0%
	2	0%
	3	0%
	4	10%
	5 – Quite a lot	90%
Would you be interested in contributing to the development and or evaluation of new varieties?	Yes	100%
	No	0%
Will you change anything in terms of on-farm biosecurity on your farm because of attending the trip?	Yes	75%
	No - because you are already happy with the level of on-farm biosecurity you have implemented	25%
	No	0%
How would you rate the visits to the Asian vegetable and mango grower?	1 – Poor	0%
	2 – Fair	0%
	3 – Good	20%
	4 – Very good	20%
	5 - Excellent	60%

Is there anything that you took away from these visits?	Good extension provides good results
	There are other opportunities also available for you farmers other than banana
	Good to see another industry and get some insight into innovative ideas and understand the challenges they may face
	Hearing from the first young farmer talk about how they prioritise the local bee population. Hearing from the okra grower that spraying a lot less can have a beneficial result on the predatory bugs and mites to provide more natural controls
	Layout and structure was good
	Huge expenditure for such a short season (mango)
	It was really good to see something different other than bananas, always reckon that it's good to see something different than what you do every day because you can always judge them what is happening in your own industry
	The lateral thinking of those producers applied to solve their specific issues.
Can you please provide a comment about what your main benefit from the trip was?	Better understanding of how BA16001 and BA14014 interact
	Seeing first-hand the mutagenesis trials
	Got knowledge about banana varieties which can be useful in Panama infected land and some crops other than banana, inspirational trip.
	The overall trip was great. It allowed me to see first-hand the variety development work that is happening as well as gain a better understanding of where we are at in terms of R&D. Also it was good to catch up with other growers in the industry as we don't get to do as much as before TR4. Another very well organised trip, thanks again Tegan and the team.
	CJ 19 trial
	Seeing first hand again the devastation that TR4 brings, and the massive priority that good on-farm biosecurity needs to have in your daily business activities.
	Keep TR4 away as long as possible!
	How serious TR4 is and how difficult it is to solve this disease
	Once I seen the TR4 I didn't want to be there for me to tell the New South Wales growers. I told them you don't want to be up there.
	Networking and having the opportunity to build effective relationships with our growers so as to understand the challenges they face in their businesses.

NextGen Northern Territory trip article: December edition of the Australian Bananas Magazine

NextGen Top End Tour: A reminder we need to buy more time for TR4 variety R&D

NEXT GEN NEWS

NEXTGEN TOP END TOUR

Sixteen people involved in the banana industry - including ten banana growers - made time in their busy schedules to participate in a two day NextGen tour to the Northern Territory.

Sixteen people involved in the banana industry including 10 banana growers, made time in their busy schedules to participate in a 2-day NextGen tour to the Northern Territory, held in early September. The trip organised by Tegan Kukulies as part of the National Banana Development and Extension Project, featured visits to inspect the banana variety evaluation and development (mutagenesis) for Panama disease tropical race 4 (TR4) resistance trials at the Northern Territory Department of Primary Industries and Resources - Coastal Plains Research Farm, as well as visits to Asian vegetable and okra growers and a large high-tech mango packing shed.

Tegan said “those that participated really enjoyed the whole trip. For those that had not seen Panama disease TR4 in the flesh before it was a confronting experience and for those that had previously visited, it was a reminder of how devastating the disease can be”.

With the main focus of the trip to spend time looking at the progress of the variety evaluation and mutagenesis trials Tegan said “growers were impressed that there were a few varieties that were holding up to the disease, however they also noted that these varieties were either not Cavendish types or not as productive as Williams (cycle time, stature, bunch characteristics, etc).”

The growers also saw the progress on some of the Cavendish varieties which have undergone mutagenesis particularly the CJ19 plants which where bunching at the time of our visit. The growers were impressed at the size and characteristics of some of the bunches. This feedback on particular plants within the trial block was noted and will be considered when deciding which plants should be investigated further.

Overall, the trip to Coastal Plains Research Farm was again, a reminder that although the research is progressing there is currently no ‘silver bullet’ solution to Panama disease TR4, and that keeping banana farms free from the disease with effective on-farm biosecurity systems is the best option.

As part of the tour, the Northern Territory Farmers’ Association helped to organise some ‘non-banana’ visits to Asian vegetable growers and a large high-tech mango packing-shed. “As we’ve found on previous tours, the growers were intrigued by some of the similar challenges faced by other horticultural industries such as labour efficiencies and succession in farming businesses.”

Just ask any grower who attended; biosecurity was a top priority during the trip! 32 pairs of shoes, 16 hats, 16 pairs of clothes were all left in the NT and copious amounts of disinfectant applied to footwear, phones and glasses on multiple occasions as part of the biosecurity procedures that the group undertook. Some of the growers that attended the tour shared their experiences, learnings and some laughs from the trip at the Banana R&D speed-dating event, which was held at Innisfail in early October.

This NextGen activity was organised and funded as part of *the strategic levy investment project National Banana Development and Extension Program BA16007. The project is funded by Hort Innovation using the banana research and development levy, co-investment from the Department of Agriculture and Fisheries and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.*

Hort Innovation Strategic levy investment | BANANA FUND | Queensland Government

Images from the NextGen activity

Appendix 14: NextGen - Variety field walk (2020)

Grower interest in varieties, especially those with disease resistance, has increased in importance with growers since the detection of Panama disease tropical race 4 (TR4) in Tully in 2015. In response to the risk that Panama disease TR4 poses to industry, there has been a substantial increase in investment of R&D funding for banana variety screening and development. Currently the largest R&D investment is project (BA16001) 'Improved Plant Protection for the Banana Industry' which has key research activities centred around the importation, screening and evaluation of banana varieties from international breeding programs. As part of this project DAF researcher Jeff Daniells and his team are screening selected varieties for their agronomic performance at the South Johnstone Research Facility. Some 17 of the 26 varieties in this field trial have reported levels of resistance to Panama TR4 and others are included due to grower interest and potential improved agronomic characteristics (e.g. Rahan Meristem selections). Details about this trial, including the varieties being assessed and results so far, have been published in the *Australian Bananas* magazine and also on the Better Bananas website.

On the 6 March 2020, members of the NextGen group, growers involved in the Banana Variety Subcommittee of BA16001, and growers involved in the BA16001 pre-commercialisation trials were invited to attend a tour of the variety block with Jeff Daniells. Offers were also made for those that couldn't attend to visit the trial block in the two weeks following the field walk. This activity was held to provide these key industry project participants with the opportunity to inspect first ratoon bunches of particular varieties of interest, specifically some of the TBRI TR4 resistant Cavendish selections, as well as high productivity Cavendish varieties belonging to Rahan Meristem.

Evaluation

Collectively 22 growers and industry stakeholders participated in a tour of the varieties to see the progress of the first ratoon plants (17 on the 6 March and 5 more in the two weeks following). Seventeen of these were growers, 3 were people involved in banana tissue culture production and 2 were supply chain members. The 17 growers and industry stakeholders who participated in the field walk on 6 March participated in a paper-based survey at the completion of the event. The evaluation questions and responses are included in Table 1. In summary:

- Overall those that attended indicated they had a reasonably good knowledge about the project (BA16001) activities to evaluate banana varieties (average rating 3.9 out of 5) and the majority agreed with the approach being taken to access and import new banana varieties into Australia (average rating 4.4 out of 5).
- Knowledge of the results of the project's activities was slightly lower (average rating 3.6 out of 5). However, many of the variety evaluation activities in the project are reaching a point where more complete results of crop stages are being finalised, analysed and results made available to growers. For example, the plant crop results from this variety screening trial at South Johnstone were published in the *Australian Bananas* magazine a few weeks after this event.
- Nearly 60% of those in attendance said they had made changes as a result of activities in the project (BA16001). This figure also represents those growers who are trialling two of the Taiwanese varieties in the 'pre-commercialisation trials' as part of the project.
- When asked to give an overall rating of the event, participants rated it a 7.9 out of 9.

Table 1 – Evaluation questions and results from the NextGen field variety field walk (6 March 2020)

Question	Response	Percentage (%)
What best describes your role in the industry?	Grower/farm manager	86%
	Service provider (e.g. reseller, agronomist etc)	14%
	Supply chain	0%
	Industry body	0%
	Government staff	0%
Do you agree with the planned approach to accessing and importing new banana varieties in Australia?	1 - Not at all	0%
	2	0%
	3	7%
	4	43%
	5 – Very much	50%
Rating knowledge of project activities to evaluate banana varieties	1 – None	0%
	2 – A little bit	14%
	3 – Some	14%
	4 – Quite a bit	43%
	5 – A lot	29%
Rating knowledge of results of project activities to evaluate banana varieties	1 – None	0%
	2 – A little bit	14%
	3 – Some	21%
	4 – Quite a bit	50%
	5 – A lot	14%
Have you made changes as a result of project activities?	Yes	57%
	No	43%
How would you rate today's event overall?	1 – No value	0%
	2	0%
	3	0%
	4	0%
	5	0%
	6	7%
	7	36%
	8	14%
	9 – Extremely valuable	43%

Figure 1: Field walk participants in the field, seeing first-hand bunched first ratoon plants

Figure 2: Jeff Daniells presenting results of plant crop to field walk participants

Figure 3: Upon completion of the field walk, participants discussed as a group the variety trial and provided feedback on the event.

Appendix 15: Innovation trial

Background

Banana growers are responsible for many practice innovations, but the non-seasonal nature of the crop means growers often lack the time and resources to pursue their ideas. Guided by growers, the innovation trial aimed to investigate out of the box concepts with significant financial risks or time commitments that would prevent growers from trialling on their own farms. The innovation trial has a focus on those practices that may increase agronomic performance and/or have environmental benefits. Practices that have shown to have a significant difference or positive impact within the innovation trial may be explored further in future trials and research activities.

Methodology

Determining practices to trial

Through consultation with growers, the concept of conducting an innovation trial formed part of the agenda for the first two NextGen grower meetings which were held on 27/07/2017 and 04/08/2017 upon commencement of the new National Banana Development and Extension Project (BA16007). Various ideas had been raised at the NextGen meetings which consisted of growers from the Innisfail, Tully and Tableland regions. These ideas included: trialling unique living and non-living ground covers, interrow cropping, use of tissue culture plants vs bits, drip vs sprinkler irrigation systems, managing de-suckering of tissue culture, bird and bat management, economics and environmental impacts (erosion) of using ladders or machinery for bunch covering, and plant density impacts on productivity. Following these initial scoping meetings and conversations with growers, the innovation trial was established at the South Johnstone Research Facility in November 2017 (Figure 1 and 2).

Figure 1: Innovation trial planted at the South Johnstone Research Facility 01/11/2017

Figure 2: Drone footage of the innovation trial 24/01/2020

Trial design and practices

Consisting of 390 'Williams' Cavendish banana plants, the innovation trial was established in early November 2017 with tissue-cultured plants, planted as a double row "tram line" configuration (1.7m spacing). The block consisted of three double rows, with each double row representing one replicate. The trial investigated the effect of five different living and non-living ground cover treatments in combination with two different de-suckering treatments. Each ground cover combination was replicated 3 times across the 3 double rows following a randomised complete block design (Figure 3). The ground cover treatments included in the trial were a conventional bare-earth (control), weed gunnel matting, chemical soil stabiliser, *Arachis pintoi* (Pinto peanut) and *Mentha cordifolia* (Mint). The ground cover treatments were the first treatments to be applied to the trial and were applied to whole plots which consisted of 22 datum plants and 4 guard plants (26 plants per whole plot).

Each 'whole' plot was then split into two sub-plots for the de-suckering treatments (Figure 4), with each sub-plot comprising 11 plants (randomised split plot design). The de-suckering treatments were applied at two different time periods. The purpose of the de-suckering treatments was to investigate whether timing of de-suckering of tissue-cultured plants in the plant crop has an effect on plant growth and vigour of the following ratoon crops. The two treatments were early de-suckering and late de-suckering (control). For the early de-suckering treatment, all of the first 'flush' of suckers were removed approximately 3 months after planting, and then selection of the single "following" sucker for the next crop cycle from a second "flush" of suckers occurred at the commencement of bunch emergence, as per standard practice. For the late de-suckering (control) treatment, no removal of suckers occurred prior to the selection of the single "following" sucker at the commencement of bunch emergence. The timing of this single de-suckering activity is representative of conventional practice applied on commercial farms.

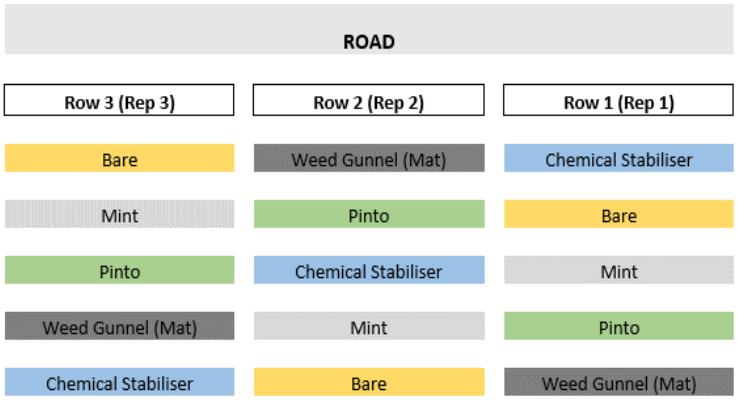


Figure 3: Each double row representing a single replicate and each ground cover treatment was replicated 3 times

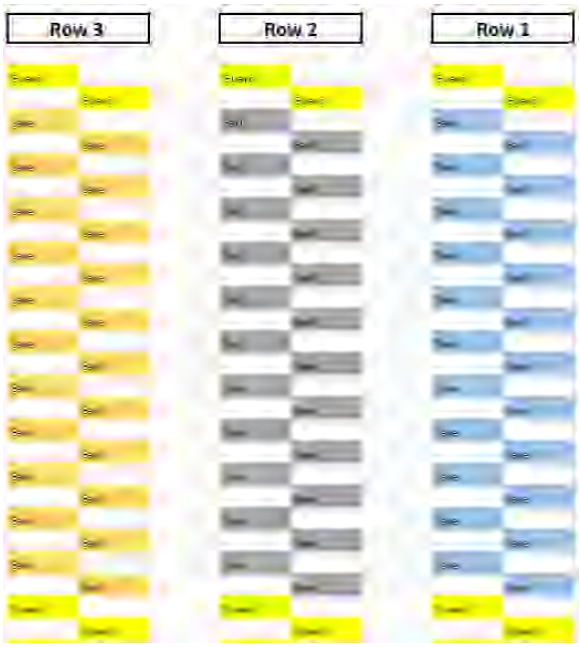


Figure 4: The two de-suckering treatments were applied to each ground cover plot - 11 plants received early de-suckering, and the remaining 11 received late de-suckering

Sacrificial tissue-culture plants were planted in vacant space at the end of the double rows and were treated with the two different de-suckering timing treatments (Figure 5 and 6). This was conducted to visually observe if there were potential differences in sucker connection to the corm following treatment application. These plants were later dug up (Figure 7), the corms were washed free of soil (Figure 8) and inspected to visualise sucker connection.

Figure 5: Sacrificial plant that received early de-suckering

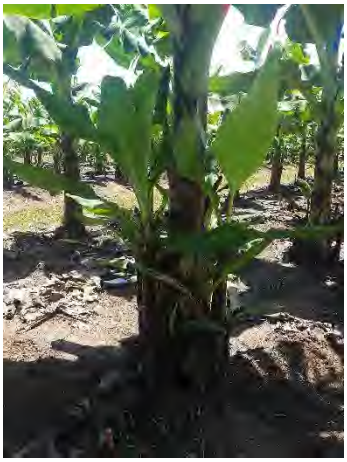


Figure 6: Sacrificial plant that was receiving later de-suckering

Figure 7: Sacrificial plants being dug up for visual observation

Figure 8: Sacrificial plants being washed for visual observation

Throughout the duration of the innovation trial other pilot trial experiments were conducted which included investigating biological insecticide options for bunch pest management (Appendix 16) and the use of entomopathogenic nematodes (Appendix 17) to control common pests of banana.

Fertiliser program

The innovation trial consists of a planting density of 1 809 plants/ha. Using the fertigation system (sprinklers), nutrients were applied directly to the plants fortnightly, at a rate of 200kg/ha/year nitrogen and 500 kg/ha/year potassium for the plant crop (applied using potassium nitrate and urea).

Soil and leaf diagnostic samples were taken regularly during the trial to provide accurate information on plant nutrient status so that appropriate application rates of required nutrient were supplied. Leaf nutrient analysis conducted prior to bunch emergence (25/05/2018) from each ground cover treatments showed that total nitrogen was below the optimum range (2.8-3.5%): conventional bare-earth (2.3%), chemical soil stabiliser (2.5%), weed matting (2.6%), Pinto peanut (2.4%) and mint (2.5%). Levels of potassium and phosphorus were within the optimum ranges however, the leaf analysis had also shown sub-optimal levels of sulphur for all treatments. Following results from the leaf tissue analysis, the fertiliser program for the innovation trial was adjusted to 300 kg/ha/year N

and 100 kg/hectare/year S (K_2SO_4) for the ratoon crops. The rate of 500 kg/ha/year K remained the same in the ratoon.

Management practices

As per commercial practice, at bract fall the banana bell, false hand and bottom two hands were removed from the bunch (to remove unwanted smaller grades of fruit). At this stage of development bunch covers were placed on bunches as per commercial practice. This was standard management practice for all plants in the innovation block. In the plant crop, Starbunch™ banana bags were used for bunch protection (Figure 9). These bunch covers are insecticide-impregnated single use bunch covers containing the active ingredient 1g/kg bifenthrin, and are used to control common bunch pests, including the banana rust thrips (*Chaetanaphothrips signipennis).* For optimum control the Starbunch™ covers are used in conjunction with a registered bell injection treatment. However, for the purposes of this trial, bell injection was not carried out, as fruit quality assessments were not conducted on fruit at harvest. It was decided to not use the Starbunch™ covers in the first ratoon crop as they were very thin and tore very easily requiring regular replacement during the plant crop.

Rat activity was also high during the plant crop and contributed towards increased damage to these bunch covers. Furthermore, qualitative observations indicated that there was minimal rust thrips control when using the covers alone without bell injection. It was decided in the first ratoon crop to use thicker, reusable, insecticide free bunch covers (Figure 10).

Figure 9: Single use Starbunch banana bags used in plant crop

Figure 10: Reusable insecticide free bunch covers used in first ratoon crop

Assessing bunch maturity

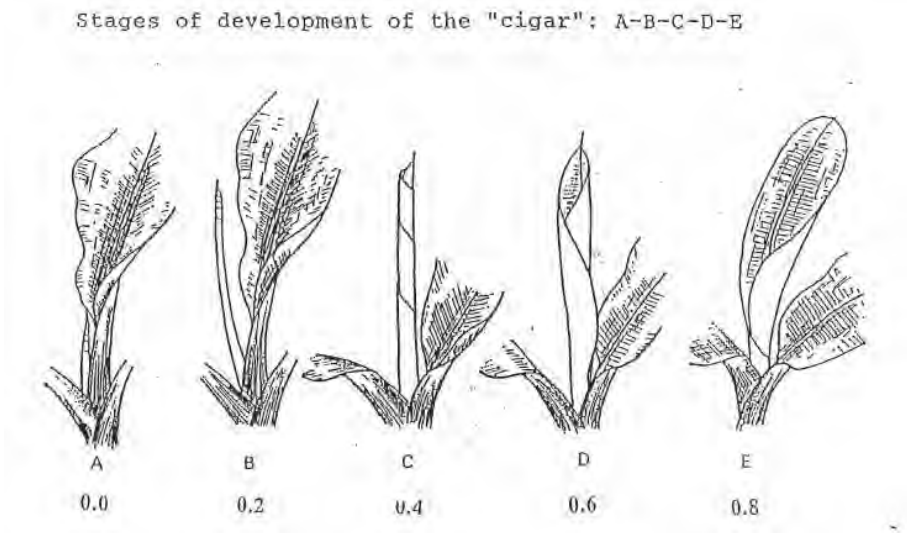
Bunch maturity in any single planting of bananas is not uniform, and harvesting is spread over two to three months in the plant crop, becoming progressively more spread with each crop cycle. At the time of bunch emergence, each banana plant was marked with a number representing the week of bunch emergence. For example, if a banana bunch emerged in week 10 (of the calendar year), the plant's pseudostem was marked with '10' using fluoro paint. Assessment and recording of bunch emergence was conducted weekly. The time taken for a bunches to fill from bunch emergence to harvest generally takes approximately 14-21 weeks depending on seasonal effects, with harvest determined by the achievement of a specified diameter for a standard indicator fruit on the bunch. Therefore, identifying the correct harvest maturity was determined by assessing finger diameter weekly from approximately 10 weeks after bunch emergence. A bunch was considered ready to harvest when the three middle fingers on the outer whorl of the third hand (from the top) measured 34mm (+/- 2mm).

Agronomic measurements

Data was collected from the plant and first ratoon crops. Agronomic measurements collected during the trial included:

- Plant height.
- Bunch weight.
- Total hand count (after trimming the false hand, plus two).
- Total number and weight of XXL hands (>261mm), XL hands (221mm – 260mm), L hands (201mm – 220mm), and M hands (<200mm).
- Finger length and diameter of hand 3 and the bottom hand at bunch harvest.
- Finger count of hand 3 and the bottom hand.
- Crop cycle.
- Leaf emergence rate and total number of leaves emerged.

Leaf emergence rate (LER) is the total number of leaves produced over a given period of time. In the innovation trial this was conducted monthly in the plant crop and every other month in the first ratoon. The development of a leaf can be divided into five different stages (Figure 11). For leaves that were not fully unfurled and were not considered to be fully developed, the diagram below was used to determine what stage the young developing cigar leaf was at. When monthly leaf emergence was conducted in the innovation trial and a cigar leaf was not fully developed, it was rated between 0.0 and 0.8. For example, the monthly leaf count may have been 3.4 leaves produced for plant A and 4.2 leaves produced for plant B.



Stage A = Rated as 0.0. Cigar leaf is still joined to the previous leaf.
Stage B = Rated as 0.2 growth. Cigar leaf has grown but has not yet reached its full length.
Stage C = Rated as 0.4 growth. Cigar leaf is completely free.
Stage D = Rated as 0.6 growth. The left side of the leaf has unfurled and it's beginning to open.
Stage E = Rated as 0.8 growth. The upper part has unfurled and the base is an open cone shape.

Figure 11: Five stages of leaf development rating system used to conduct leaf counts over a given period of time, (Brun, 1963). The cigar leaf that was not considered fully emerged was rated between 0.0 to 0.8 growth

A leaf is considered fully functional when leaf development transitions from a narrow 'sword' like leaf to a broader, larger leaf. The start point of the total leaf count was determined when the

diameter of the leaf lamina at the broadest part was 10 cm or greater, and each leaf was then recorded up until bunch emergence, after which leaves are no longer produced.

Ground cover treatments

The five ground cover treatments trialled were weed gunnel matting, chemical soil stabiliser, Pinto peanut (*Arachis pintoi*), Mint (*Mentha cordifolia*) and conventional bare-earth.

*Weed gunnel matting***:** The black weed gunnel matting is a permeable and degradable weed blocking fabric which has a variety of applications and has been used in agricultural industries, nurseries and revegetation activities. The weed matting was applied before planting (Figure 12). This was done by rolling out the matting to the length of the subplot and securing it in place. Small cuts were made in the weed matting to allow for the tissue-cultured banana plants to be planted in (Figure 13).

Figure 12: Weed matting laid out in each plot before planting

Figure 13: Tissue culture plants were planted into slits within the weed matting

Chemical soil stabiliser: The chemical soil stabiliser used in the innovation trial was the Vital Bon-Matt Stonewall™ product. This product is a water-based co-polymer that binds to the soil surface, formulated by Vital Chemical Pty Ltd. The product is used as a dust suppressant and an erosion/sediment control agent in various industries including mining, construction and agriculture. Prior to application of the chemical soil stabiliser product, these plots were treated with glufosinate-ammonium (Basta®) to control germinated weeds. Following planting, the chemical soil stabiliser was applied as a 10% solution using a 15L knapsack sprayer. To ensure a consistent amount of product was applied to the sub plot, each sub plot was divided into smaller more manageable plots where the treatment was applied in batches to allow for a consistent application (Figure 14 & 15).

The chemical soil stabiliser plots were replaced with mulching hay after harvest of the plant crop. This was because the soil stabiliser had deteriorated quite rapidly following treatment application, as it was applied during the summer leading in to the wet season. Upon application, visual observations had shown that the product had bound well to the soil, however, the product appeared to have broken down following the wet season and it was very difficult to differentiate between the conventional bare-earth and chemical soil stabiliser plots (Figure 16 & 17). For this reason and for the purpose of the innovation trial, it was decided to replace the chemical soil stabiliser treatment with mulching hay as a demonstration of a non-living ground cover in the first ratoon crop.

Figure 14: Each plot divided into smaller plots to allow for consistent application of soil stabiliser

Figure 15: Soil stabiliser binding to soil

Figure 16: Soil stabiliser plot 21/08/2018

Figure 17: Conventional bare-earth 21/08/2018

Pinto peanut (Arachis pintoi): Pinto peanut is a low growing perennial forage legume. The seed stays connected to the plant and germinates on a runner, forming a thick vegetative mat. Pinto peanut grows well in partial shade and full sun and has shown to be an effective ground cover due to its ability to fix nitrogen, and its deep tap roots and interwoven stems which create a thick vegetative mat reducing sediment loss. The Pinto peanut was established in the innovation trial by planting runners. Pieces of Pinto peanut were collected from the South Johnstone Research Facility and planted in seedling trays and allowed enough time to establish and form runners (Figure 18).

Following planting of the bananas, the Pinto peanut was removed from the seedling trays and planted between the tissue-culture banana plants as runners (Figure 19). To allow the Pinto peanut to establish, the plots were hand weeded approximately 2.5 months after planting. No further weeding was carried out thereafter and other ground cover species were allowed to grow as this would likely represent a commercial practice. Other weed species that had grown within the Pinto peanut plots throughout the duration of the trial included common sensitive weed (*Mimosa pudica*) and Sourgrass (*Paspalum conjugatum*).

Figure 18: Pinto peanut runners planted in seedling trays

Figure 19: Pinto peanut being planted in between tissue-culture

Mint (Mentha cordifolia): Mint is a fast growing perennial herb that grows on the soil surface through a network of runners. Mint grows well in partial shade and full sunlight and was suggested as a potential out of the box ground cover treatment during initial discussions with growers.

Mint seeds were planted in seedling trays and allowed sufficient time to establish before being replanted in the trial block (Figure 20 & 21). The mint plots were weeded once following planting, to allow the mint to establish properly without competition from other weeds. Like the Pinto peanut plots, no further weeding was carried out and other species were allowed to grow after initially weeding the mint plots. Initially the Mint appeared to establish well, forming runners and a ground cover within the plots. However, over time other weed species began to dominate these plots and eventually crowded out the mint. By the end of the innovation trial (plant and first ratoon), these plots no longer contained mint and consisted of a number of different weed species which reflected the natural seed bank of the soil. The dominant species included Common sensitive weed (*M.* pudica) along with Sourgrass (*P. conjugatum*) and Pennywort (*Centella asiatica*).

Figure 20: Mint seeds planted in seedling trays

Figure 21: Mint being planted in between tissue-culture

Bare-earth (conventional): A conventional bare earth treatment was included in the innovation trial as a comparison to the other living and non-living ground cover treatments (Figure 22). The conventional bare-earth plots were considered control treatments. To control broadleaf and grass weeds, these plots were maintained with the use of glufosinate-ammonium (Basta®).

Figure 22: Conventional bare-earth treatment

Erosion peg measurements

Erosion pegs were installed in each of the ground cover treatments (and replicates) upon establishment of the innovation trial. The erosion pegs were used to measure potential soil deposition and/or erosion of the banana bed following harvest of the plant crop. As shown in figure 23 below, three erosion pegs were placed on the southern side of the banana bed for each ground cover treatment (and replicate). One erosion peg was placed on the inner part of the bed, near the irrigation line (highlighted in blue), the middle of the southern side of the bed (highlighted in yellow) and the outer shoulder of the bed (highlighted in red). The erosion pegs consisted of a steel threaded rod which was inserted into the soil upon establishment of the trial. A washer was then placed on the steel rod (level with the soil), followed by the placement of a nut, which was then threaded onto the rod, sitting flush on top of the washer.

Figure 23: Three erosion pegs were installed on the southern side of each ground cover treatment and replicate. One peg near the irrigation line (highlighted blue), one in the middle of the southern side (yellow) and another peg installed on the outside shoulder of the bed (highlighted in red)

Statistical analysis

Plant crop - The mean for each subplot was calculated and analysed using analysis of variance (ANOVA). No data transformations were required. For all analyses significance testing was conducted at the 0.05 level. Where a significant effect was found, pairwise comparisons were performed using Fisher's protected 95% least significant difference (lsd). Twenty-two of the 390 plants were identified as tissue culture off-types or suffering from environmental stresses and were excluded from all analyses in the plant crop.

First ratoon crop – The same agronomic measurements collected in the plant crop were also collected in the first ratoon, and the same statistical analysis was conducted on first ratoon data. Plants were excluded from the analysis if they had rolled-out/fallen over (as a result of Banana weevil borer damage and/or Bacterial corm rot), were considered off-types, had a bunch emergence date later than week 42 or had poor bunch development (plants with <5 hands after trimming). Eighty-two plants were excluded from the analysis in the first ratoon. The number of plants included in the analysis from each sub-plot ranged from 3 to 11. The count for each replicate and sub-plot is shown in Table 1 below.

Table 1: Total number of plants from first ratoon crop that were included in the analysis. Plants that had rolled out/fallen over, had a bunch emergence date later than week 42 or had poor bunch development were excluded from analysis

Rep	**Ground cover Treatment**	**De-suckering treatment**	
		Early	**Late**
1	Bare	6	7
	Mint	10	10
	Pinto peanut	10	10
	Soil stabiliser/ Mulching hay	10	7
	Weed matting	7	7
2	Bare	3	4
	Mint	9	10
	Pinto peanut	9	5
	Soil stabiliser/ Mulching hay	9	10
	Weed matting	11	8
3	Bare	3	8
	Mint	8	9
	Pinto peanut	11	9
	Soil stabiliser/ Mulching hay	10	10
	Weed matting	9	9

Results and discussion

The innovation trial, which was planted in early November 2017 at the South Johnstone Research Facility demonstrated timing of de-suckering in a plant crop established with tissue cultured plants is important for improved agronomics. Analysis of the plant crop and first ratoon data shows that the interaction of ground cover and de-suckering treatment combined was not significant on trial plants for the majority of growth and yield parameters cycles. Furthermore, few significant agronomic differences were found between the different ground cover treatments in the plant and first ratoon crops. Regardless of ground cover treatment, the two different de-suckering treatments demonstrated the greatest effect on the agronomic performance of the trial plants throughout the duration of the plant and first ratoon crop.

As there was no significant interaction between ground cover treatment and de-suckering treatment, the following results and discussion on plant and first ratoon de-suckering and ground cover treatments will be presented separately from one another.

Effect of de-suckering treatment on agronomic performance

Growth parameters (height, leaf count)

Tissue cultured banana plants begin to produce suckers, which develop from the base of the mother rhizome, within two months of planting. These young, developing suckers are physiologically dependent on the mother plant, competing for essential nutrients and water which is thought to impact on productivity. This was confirmed in this trial as late de-suckering (around bunch emergence) significantly reduced plant growth and yield in comparison to the early de-suckering treatment (3 months after planting). Late de-suckering produced significantly shorter plants in both the plant crop (p = <0.001) and first ratoon (p=0.001) (Figure 24 & 25).

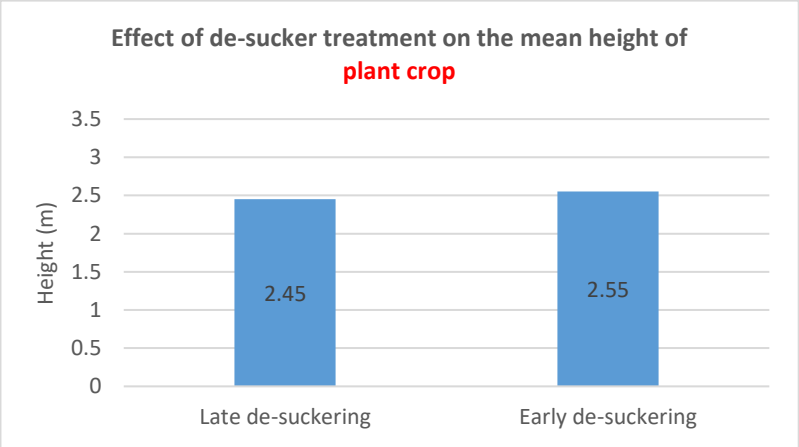


Figure 24: Eeffect of de-suckering on mean plant height of the plant crop

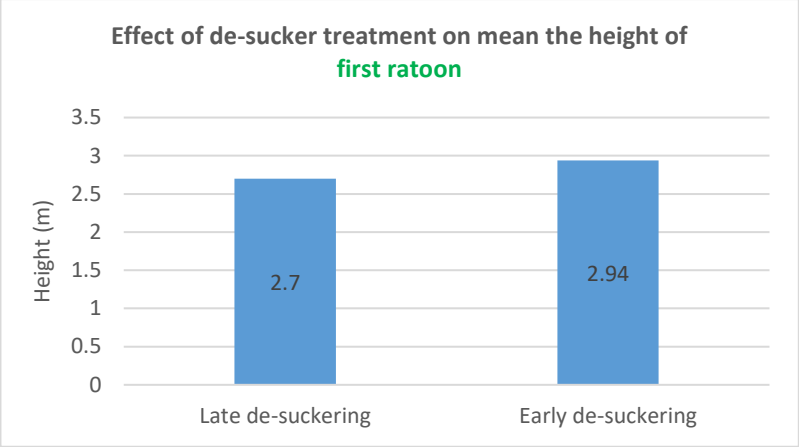


Figure 25: Effect of de-suckering on mean plant height of the first ratoon crop

Furthermore, in the plant crop, the mean leaf emergence rate (LER) (calculated as a per month basis), and total leaves produced was significantly lower for plants that received late de-suckering (3.2 LER & 19.4 total leaves) compared to early de-suckering (3.3 LER & 20.5 total leaves), (Figure 26). However no significant differences were found with monthly LER (p=0.077) or total leaves produced (p=0.215) between the de-suckering treatments in the first ratoon crop, (Figure 27).

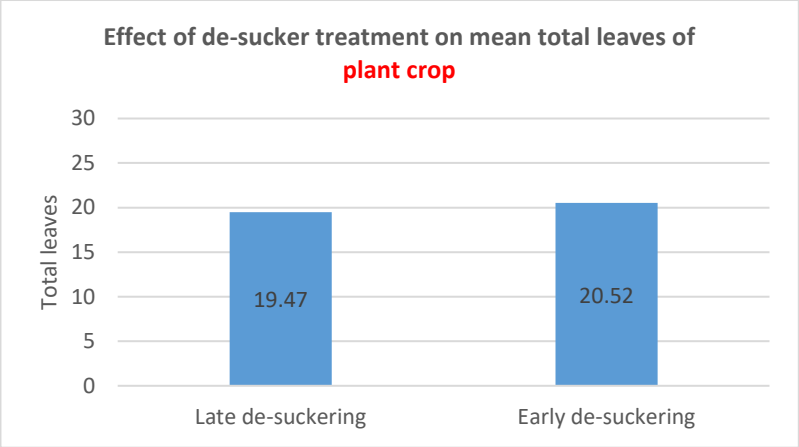


Figure 26: Effect of de-suckering on mean total leaves in the plant crop

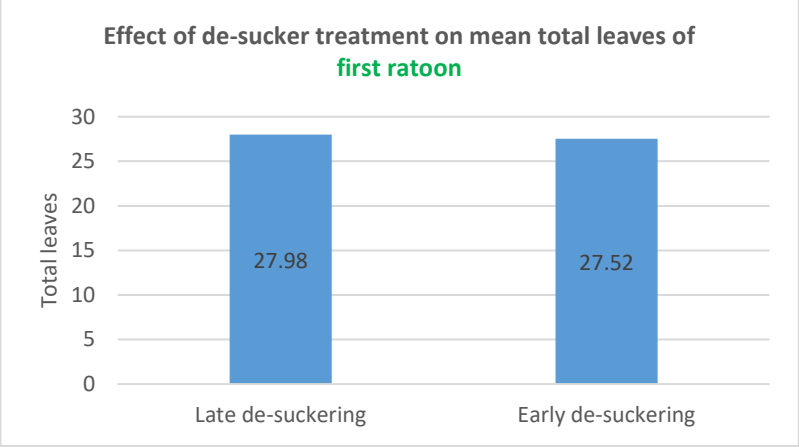


Figure 27: Effect of de-suckering on mean total leaves in the first ratoon crop

Crop cycle duration

The de-suckering treatments did not significantly affect the cycle time of the plant crop (p=0.096), (Figure 20). However, the mean number of weeks for the first ratoon crop cycle was significantly faster for early de-suckering (43 weeks) compared to late de-suckering (45.5 weeks), (Figure 28).

Overall, no significant differences were found over the whole crop cycle (plant crop and first ratoon crop) between the two de-suckering treatments (p=0.084). However there was a trend for earlier de-suckered plants to have faster cycle times as the mean crop cycle (plant and ratoon) for plants that received early de-suckering was 91.6 weeks and the mean crop cycle for plants that received late de-suckering was approximately 94 weeks in total (Figure 29).

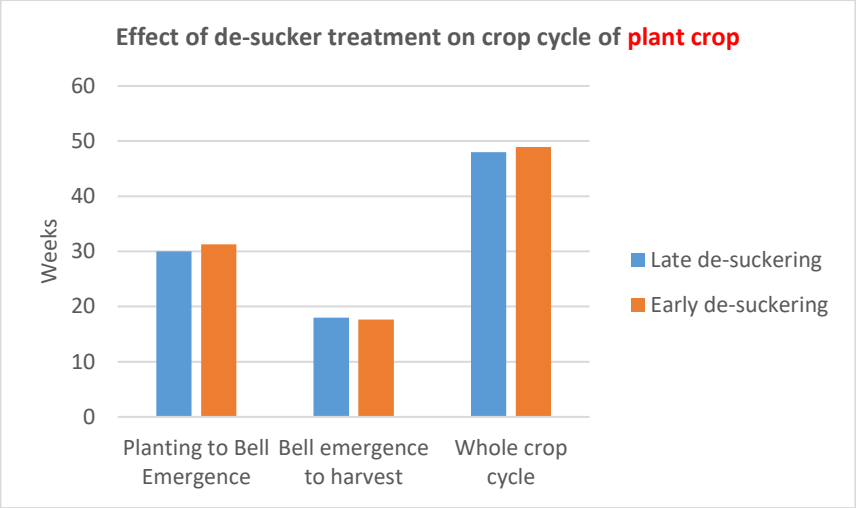


Figure 28: Effect of ground cover treatments on cycle times of plant crop

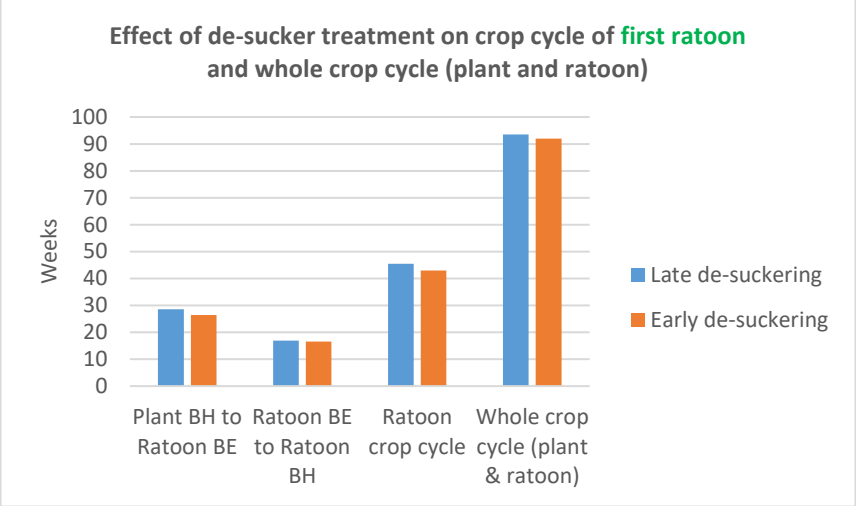


Figure 29: Effect of ground cover treatments on cycle times of first ratoon and whole crop cycle

Yield and yield components

Plants that received early desuckering produced significantly heavier bunches in both the plant and first ratoon crop (Figure 30 & 31).

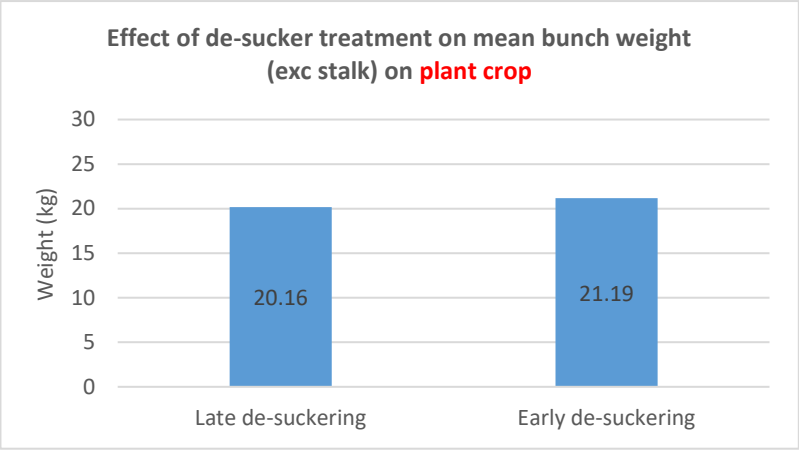


Figure 30: Effect of de-suckering on mean bunch weight on plant crop

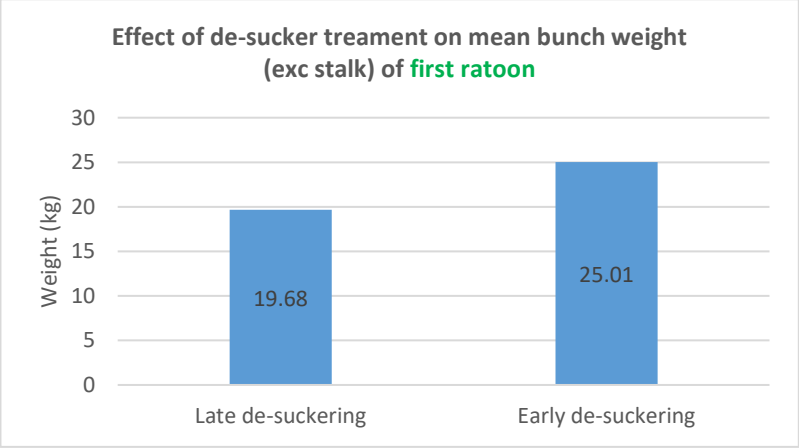


Figure 31: Effect of de-suckering on mean bunch weight on first ratoon crop

In the plant crop, the mean bunch weight was significantly higher for plants that received early de-suckering (21.19kg) compared to late de-suckering (20.16kg). Although there was a significant difference in bunch weight, the mean number of hands was not significantly different for the de-suckering treatments in the plant crop (6.8 hands early de-suckering, 6.6 hands late de-suckering), nor were the mean finger length and mean number of fingers on hand 3 and the bottom hand at harvesting significantly different (Table 2). No significant differences were found with the main effect of de-suckering treatment and the mean number of hands for the different fruit length categories. For both de-suckering treatments, the majority of hands within a bunch fell in the XL (221-260mm) fruit length specification, (Table 3).

Table 2: Effect of de-suckering treatment on plant crop yield and yield components

	Weight (kg)	No. hands	Hand 3 finger length (cm)	Hand N finger length (cm)	Hand 3 no. fingers	Hand n no. fingers	Est. fingers per bunch
Early	21.1	6.8	25.4	21.6	16.6	14.8	107.3
Late	20.1	6.6	24.9	21.4	16.7	14.5	104.8

Table 3: Effect of de-suckering treatment on plant crop mean number of hands in each fruit length specification

	XXL	XL	L	M
Early	1.5	4.0	1.0	0.1
Late	1.1	4.0	1.2	0.2

In the first ratoon crop, the difference in bunch weight and hand count was much greater, where the mean bunch weight for plants that received early de-suckering was 25.01kg compared to late de-suckering which was 19.68kg. The heavier bunch weight is a result of improved bunch characteristics including higher mean number of hands per bunch, finger length of hand 3 and hand n (bottom hand), as well as the mean number of estimated fingers per bunch (Table 4). For example, the mean number of hands was significantly higher for early de-suckering (7.9) compared to late de-suckering (6.8) in the first ratoon.

The mean number of fingers on hand 3 and the bottom hand (n) were significantly higher for early de-suckering (H3=17.8 and Hn=14.9) compared to late de-suckering (H3=15.9 and Hn=14.0). The estimated finger count per bunch was again significantly higher for early de-suckering (132.0) compared to late de-suckering (103.7). Furthermore, early de-suckering had a greater number of hands in all fruit size categories compared to late de-suckering (Table 5), and the early de-suckering also had a significantly higher number of hands that fell in the most preferred fruit size specification XL category (221-260mm). Overall, the results show that a greater number of hands, longer finger lengths and a greater mean number of estimated fingers per bunch are contributing factors for a higher yield.

Table 4: Effect of de-suckering treatment on first ratoon crop yield and yield components

	Weight (kg)	No. hands	Hand 3 finger length (cm)	Hand N finger length (cm)	Hand 3 no. fingers	Hand n no. fingers	Est. fingers per bunch
Early	25.0	7.9	25.5	33.5	17.8	14.9	132.6
Late	19.6	6.8	25.1	33.8	15.9	14.0	103.7

Table 5: Effect of de-suckering treatment on first ratoon crop mean number of hands in each fruit size specification

	XXL	XL	L	M
Early	1.6	4.7	1.3	0.2
Late	1.3	4.0	1.2	0.1

The difference in hand count from 6.8 to 7.9 in the first ratoon is an increase of 1.1 hands per bunch. A 1.1 hand increase may not appear significant, however after doing the cost benefit analysis below, a 1.1 hand increase per bunch as a result of de-suckering early could equate to an increase in production of approximately $1,910 per hectare.

Cost benefit analysis

Innovation trial planting density = 1 809 bunches per hectare

1.1 hand increase calculated as 4kg (estimated weight of 1.1 hands)

1 809 * 4kg = 7 236 kg / ha. 7 236 kg / 15 kg (carton) = 482 carton increase per hectare

482 cartons * $25/carton (approx. current prices) = $12, 050

482 cartons * $20/carton (approx. cost of production) = $9, 640

Cost of an addition de-sucker treatment as a result of early de-suckering = $500 per hectare (spading)

Increase in production = $12, 050 - $9, 640 - $500 = $1, 910 per hectare

Visual observation of early de-suckering compared to later de-suckering on sacrificial plants

After applying early de-suckering and no de-suckering to two sacrificial plants, observations had shown a stronger sucker connection to the mother plant with the early de-suckering compared to the plant that received no de-suckering (as it was going to be de-suckered closer to bunch emergence), (Figure 32).

Figure 32: Sacrificial plants demonstrating relative size of cross-sectional area of attachment for the sucker to the mother plant. 1 – First 'flush', small & weak connection. 2 – Second 'flush'. 3 – Third 'flush', bigger & strong connection

Effect of ground cover treatment on agronomic performance of trial plants

The concept of using living and non-living ground cover crops grown in and amongst banana plants sparked interest amongst growers and researchers. The biological benefits of establishing living ground cover crops amongst the banana bed bas been further investigated following the detection of Fusarium wilt (Panama disease) Panama disease Tropical Race 4 in Queensland in March 2015. Increasing species diversity in banana plantings by establishing living ground covers (e.g. *Leucena leucocephela, Chloris gayana and Arachis pintoi*) to break the traditional banana monoculture, has been shown to increase soil biological activity and biodiversity, which has the potential to suppress soil borne diseases such as Panama disease. Furthermore, the use of cover crops such as *Arachis pintoi* (Pinto peanut) has been shown to assist with controlling erosion and the movement of valuable surface soil and fertilisers from the banana bed into the interrow, and potentially impacting on environmentally sensitive areas such as the Great Barrier Reef.

In this trial the main difference observed resulting from different ground cover treatments was crop cycle time. The living ground covers slowed down the cycle time of the banana plants compared to the conventional bare earth and soil stabiliser (later replaced with mulching hay) treatments. Over the whole crop cycle plants in the weed matting were not as slow to complete their crop cycle as the living ground covers, however, they were not as fast as plants in the conventional bare earth and soil stabiliser/mulching hay plots.

Growth parameters

The main effect of ground cover treatment on mean plant height was significant (p=0.007) on trial plants in the plant crop, where plants were significantly taller in the weed matting treatments compared to plants in the mint and Pinto peanut living ground covers. However, the weed matting treatment was not significantly different from plants in the conventional bare-earth or chemical soil stabiliser plots in the plant crop (Figure 33). Conversely, in the first ratoon crop (Figure 34) there were no significant differences (p=0.960) in plant heights observed between the ground cover treatments. The mean plant heights ranged between 2.8 – 2.9m for all ground covers in the first ratoon.

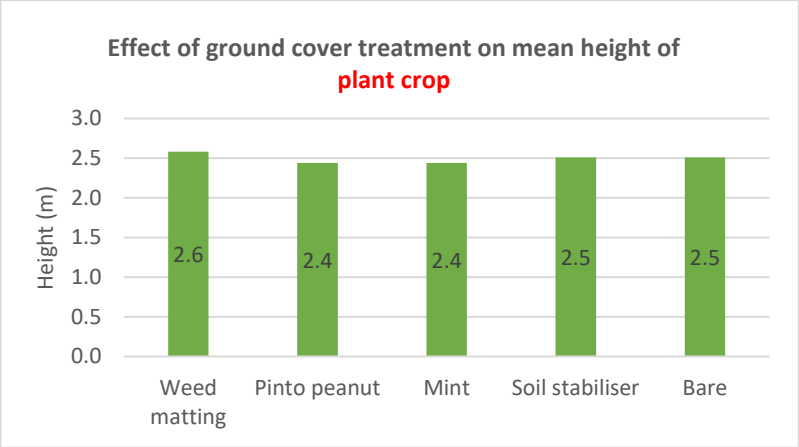


Figure 33: Effect of ground cover treatment on mean height of plant crop

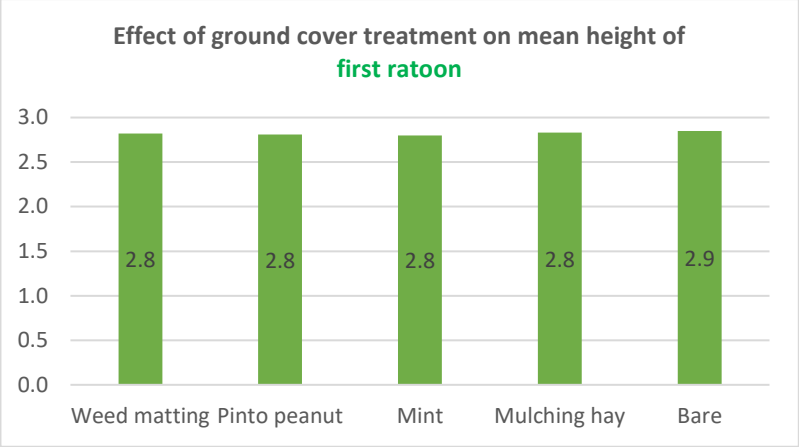


Figure 34: Effect of ground cover treatment on mean height of first ratoon crop

Although the effect of ground cover treatment on mean total leaves was not significant (p=0.058) there were trends in the mean number of total leaves produced between the different ground cover treatments in the plant crop. On average, plants in the weed matting treatment produced more leaves (mean of 3-4 additional leaves) than all other treatments (Figure 35). However, there was no perceivable trend or statistical difference in total leaves produced in the first ratoon crop, (Figure 36), with the mean number of leaves produced between 27-28 leaves for each ground cover treatment.

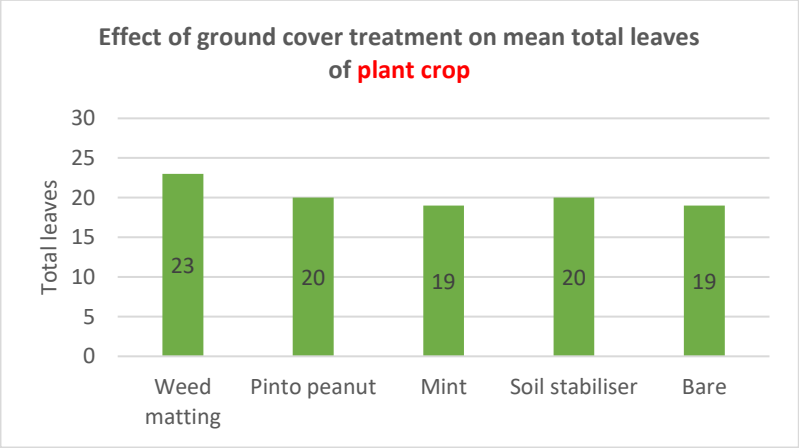


Figure 35: Effect of ground cover treatment on mean total leaves of plant crop

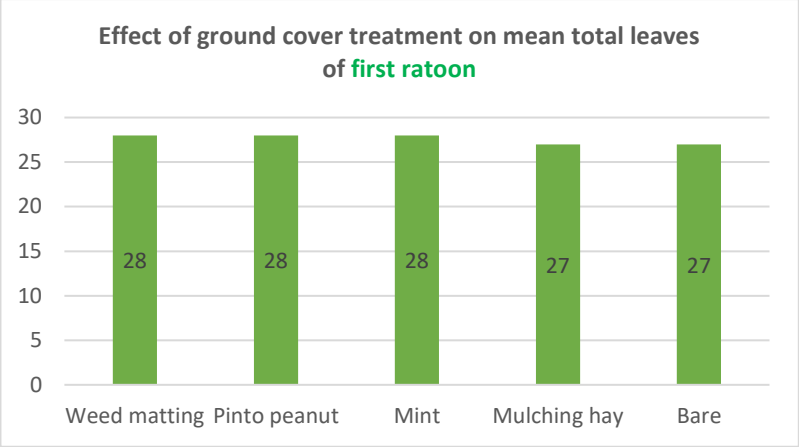


Figure 36: Effect of ground cover treatment on mean total leaves of first ratoon crop

Crop cycle duration

Plant crop

Although not statistically significant (p=0.067), plants in the weed matting treatment took longer to reach bunch emergence in the plant crop than all other treatments (highlighted in blue in Figure 37). The mean number of weeks from planting to bunch emergence was 35 weeks for the weed matting treatment compared to Pinto peanut (31 weeks), Mint (30 weeks), soil stabiliser (29 weeks) and conventional bare-earth (28 weeks). However, the mean number of weeks from bunch emergence to bunch harvest, known as the bunch filling period (highlighted in orange below in Figure 37) in the plant crop was faster for plants in the weed matting treatment (16 weeks) compared to all other ground cover treatments (Pinto peanut =18, Mint = 18, soil stabiliser = 18, bare = 19).

Although plants in the weed matting were faster to fill, when looking at the whole crop cycle of the plant crop, it is evident that plants in the conventional bare earth treatment were the fastest to cycle and plants in the weed matting were the slowest (highlighted in grey in Figure 37 below). Although the difference was not significant (p=0.096), it took plants in the conventional bare earth treatment a mean of 47 weeks to reach harvest, whereas the chemical soil stabiliser and mint plots took 48 weeks, Pinto peanut 49 weeks, while plants in the weed matting took 52 weeks to reach harvest. The results indicate that the chemical soil stabiliser product, which was applied to the soil surface following planting, appeared to have little to no impact on performance of trial plants in the plant crop.

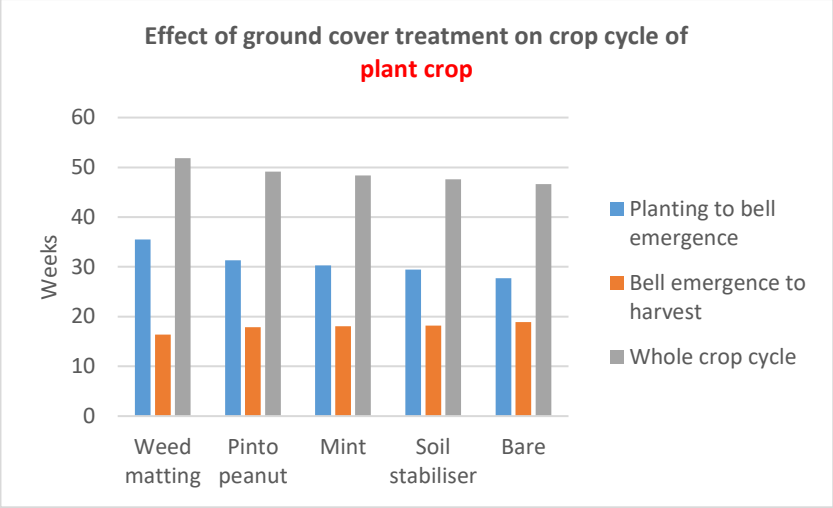


Figure 37: Effect of ground cover treatments on cycle times

A possible explanation for the longer crop cycle in the weed matting treatments is based on its thermal properties. The black gunnel weed matting was established in each of the plant plots on the day of planting. The trial was planted leading in to the warmest time of the year where maximum monthly temperatures reached up to (29.5° C) in November, (31.5 ° C) in December and (31 ° C) in January. Tissue culture plants have more critical water needs as they do not have a well-established root system, or a significant rhizome acting as a water and nutrient reserve like bits and suckers, and are more susceptible to the elements. It's suggested that the delay in bunch emergence and the crop taking longer to complete its cycle was a potential result of the effects of heat being trapped by the black gunnel weed matting particularly while the young suckers were in the early stages of growth, where a vigorous root system and leaf canopy was not yet established, causing additional heat related stress on plants that resulted in slower growth.

High levels of spider mite infestation on the underside of leaves of the young developing suckers was observed within the first few months following planting, particularly those plants in the weed matting treatments (Figure 38). Spider mites thrive under hot and dry conditions, and establish readily on plants experiencing stress, and it is suggested that heat related stress on plants as a result of the weed matting may have been a contributing factor to higher spider mite numbers and longer crop development period. Predatory mites*, Neoseiulus californicus* were used as biological control within the innovation trial to manage the high spider mite populations (Figure 39). While plants in the weed matting were slower to reach bunch emergence and harvest, it is suggested that this was a contributing factor as to why plants were taller overall and produced more leaves than all other ground cover treatments in the plant crop, as they were slower growing.

Figure 38: Heavy spider mite damage to young developing plants

Figure 39: *Neoseiulus californicus* being released throughout the trial to control future outbreaks

Erosion peg results

The erosion pegs (Figure 40) were measured in the plant crop only and not in the first ratoon crop due to various factors including the banana stool and/or following suckers growing into and around the erosion pegs, which compromised the effectiveness of the measurements. Following harvest of the plant crop measurements were conducted to identify potential differences in soil deposition and/or erosion between the different ground cover treatments (Figure 41 & 42).

Figure 40: Three erosion pegs were installed on the southern side of each ground cover treatment and replicate. One peg near the irrigation line (highlighted blue), one in the middle of the southern side (yellow) and another peg installed on the outside shoulder of the bed (highlighted in red)

As shown in Table 6, the majority of soil loss occurred on the outside shoulder (south side highlighted in red in Figure 40) of the banana bed for all ground cover treatments, with the conventional bare-earth plots having the most (mean of 22mm soil loss on outside shoulder). Whereas deposition of soil (ranging from 6mm to 36mm) occurred across all groundcover treatments in the middle of the southern side of the banana bed. As shown in the Table 6, the weed matting ground cover had the least amount of erosion and/or deposition than all other treatments, and this demonstrates that the weed matting was able to do a good job at retaining the shape of the banana bed with reduced soil loss in the plant crop. Furthermore, upon completion of the trial, the weed matting had been removed from the plots and visual observations had shown that the weed

matting appeared to hold the shape of the banana bed throughout the duration of the trial compared to all other ground cover treatments.

Table 6: Mean deposition (d) and/or erosion (e) within each ground cover treatment at different points on the banana bed after harvest of the plant crop. Measure in mm

	North side (blue)	Middle (yellow)	South side (red)
Soil stabiliser	25 d	36 d	13 e
Bare	7 d	49 d	22 e
Mint	9 e	42 d	7 e
Pinto peanut	6 e	6 d	12 e
Weed matting	0.8 e	No change	4 e

Figure 41: Image capture of erosion pegs following completion of the plant crop harvest. The amount of erosion was recorded by measuring the distance between the washer and nut

Figure 42: Image capture of erosion pegs following completion of the plant crop harvest. The level of deposition was recorded by measuring the distance between the washer and soil surface (using a skewer)

First ratoon

In the first ratoon crop, time to bunch emergence was calculated from the time period between bunch harvest of the plant crop and bunch emergence of the first ratoon crop. Time from bunch

harvest of the first ratoon was selected as the start point as this was a consistent starting point for all plants in the trial, and it is the point at which a large amount of nutrients are released from the freshly harvested mother plant and transferred into the ratoon sucker. Similar to the plant crop, no significant differences were found in cycle time between the ground cover treatments from bunch harvest of the plant crop to bunch emergence of the first ratoon crop (highlighted in blue below in Figure 43). However, there was a trend for plants in the living ground covers, where the mint (30 weeks) and Pinto peanut (29 weeks) ground covers were slower to reach bunch emergence in the first ratoon crop than weed matting (26 weeks), conventional bare-earth (26 weeks) and mulching hay (previously soil stabiliser) (25 weeks).

No significant differences were found with the mean number of weeks from bunch emergence to bunch harvest (highlighted in orange in Figure 43) in first ratoon plants in each of the ground cover treatments (p=0.197). It took approximately 16 weeks for conventional bare-earth and mulching hay bunches to fill, 17 weeks for plants in the weed matting and mint ground covers and 18 weeks for plants in the Pinto peanut ground covers (highlighted in orange).

Although statistical analysis shows no significant differences (p=0.104) were found between the ground cover treatments in the first ratoon crop cycle (the time from bunch harvest of plant crop mother plant to bunch harvest of first ratoon plant), it is evident that there were notable differences between the ground cover treatments. For example, figure 43 shows that the crop cycle was longer for plants in the Pinto peanut (47 weeks) and mint (47 weeks) living ground cover treatments as opposed to weed matting (44 weeks), conventional bare-earth (42 weeks) and mulching hay (41 weeks). Although plants in the weed matting treatment were slower to reach harvest in the plant crop, they were faster to reach harvest in the first ratoon.

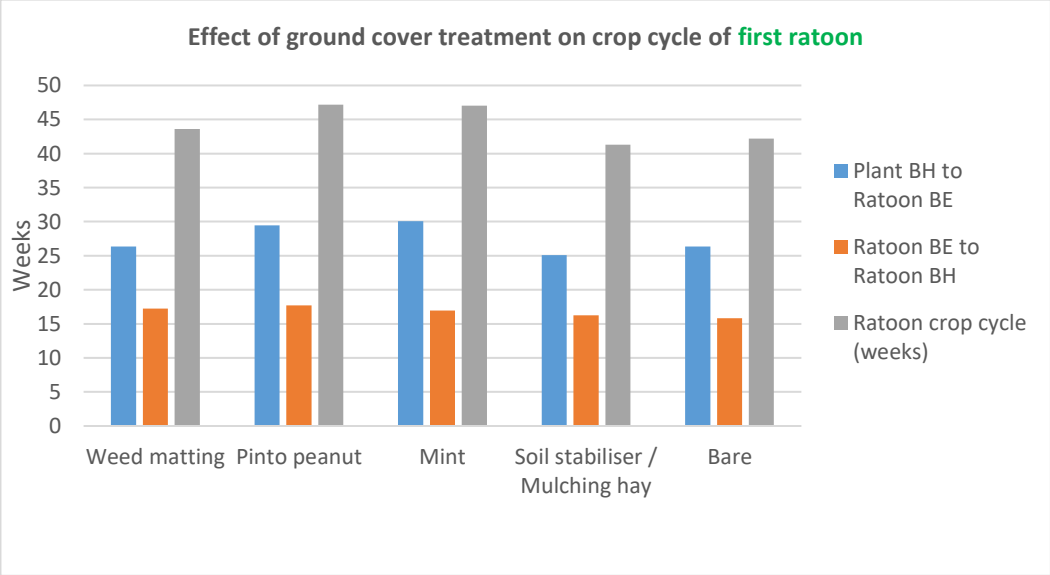


Figure 43: Effect of ground cover treatments on ratoon cycle times

After analysing the data across both crop cycles, that is the duration of the entire trial, from planting through to completion of bunch harvest of the first ratoon crop (highlighted in dark blue below), there were no significant differences in cycle times between each of the ground cover treatments (p=0.055). However, the effect of ground cover treatment on trial plants was just outside the 0.05 level of significance. Overall, the Pinto peanut living ground cover had the highest mean number of weeks to bunch harvest for the whole crop cycle (96.3 weeks) as opposed to the conventional bare-

earth (88.8 weeks) and soil stabiliser/chemical soil stabiliser (88.9 weeks) which were the fastest to complete the crop cycle (Figure 44). Plants in the weed matting and mint ground covers were also slower than conventional bare-earth and chemical soil stabiliser plots, both taking 95 weeks to compete the whole crop cycle (Figure 44).

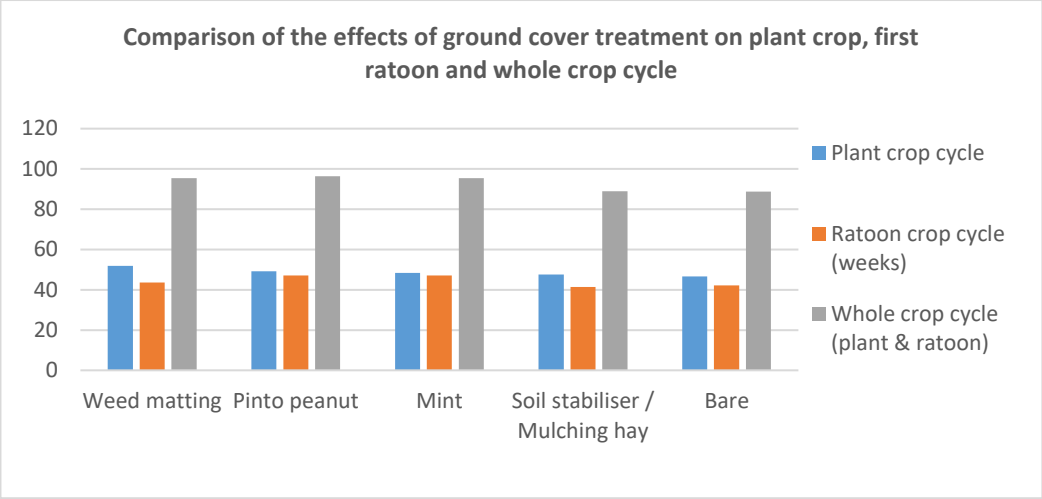


Figure 44: Effect of ground cover treatments on crop cycle times

Yield and yield components (bunch weight, hand count, fruit specifications)

Plant crop

The effect of ground cover treatment on mean bunch weight was not significant (p=0.075) for plants in the plant crop, however there were important differences (Figure 45). Bunches tended to be heavier in the weed matting treatment (23.4kg) compared to bare (20.7kg), soil stabiliser (20.3kg), Pinto peanut (19.7kg) and mint (19kg).

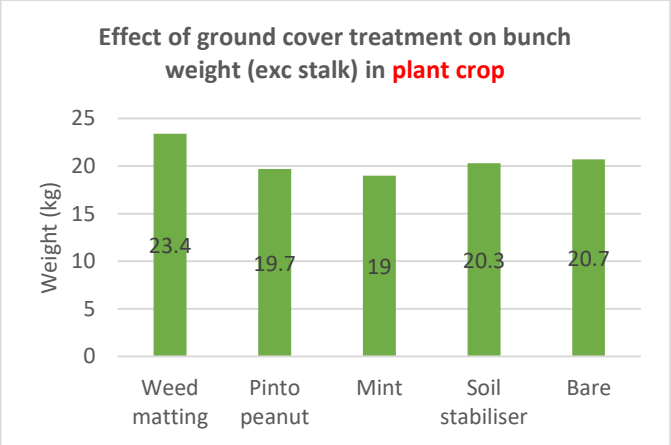


Figure 45: Effect of ground cover treatments on crop cycle times

Table 7 shows that bunches in the Pinto peanut and mint ground cover treatments had significantly fewer hands compared to the non-living ground cover treatments (weed matting, bare and soil stabiliser). The majority of hands found within the bunch for all ground cover treatments fell in the XL (221mm – 260mm) fruit length specification (Table 7 & Figure 46). Plants in the conventional bare-earth treatment tended to produce the most XL hands compared to all other treatments, however, this was not a significant difference. Plants in the weed matting produced the largest

proportion of XXL (>261mm) hands compared to all other ground cover treatments, although this was also not significant.

When comparing finger length of hand 3 and the bottom hand between ground covers, plants in the weed matting treatment tended to produce longer fruit compared to all other ground cover treatments, however, this difference was not significant. Furthermore, the mean number of estimated fingers per bunch was significantly higher for plants in the weed matting and conventional bare earth treatment.

Table 7: Effect of ground cover treatment on bunch characteristics in plant crop

	Weight (kg)	Total hands	% XXL Hands	% XL Hands	% L Hands	% M Hands	Est finger count	Finger length (mm) H3	Finger length (mm) Hn
Weed matting	23.4	7.2b	42.2	49.5	6.5	1.7	113b	262.4	223.1
Pinto peanut	19.7	6.5a	23.3	61.3	13.8	1.5	101a	250.2	216.1
Mint	19.0	6.4a	18.2	63.9	15.4	2.5	100a	248.2	214.4
Soil stabiliser	20.3	6.8b	21.6	61.2	14.7	2.4	107ab	250.8	213.8
Bare	20.7	6.9b	12.5	67.0	17.3	3.2	111b	247.6	209.4

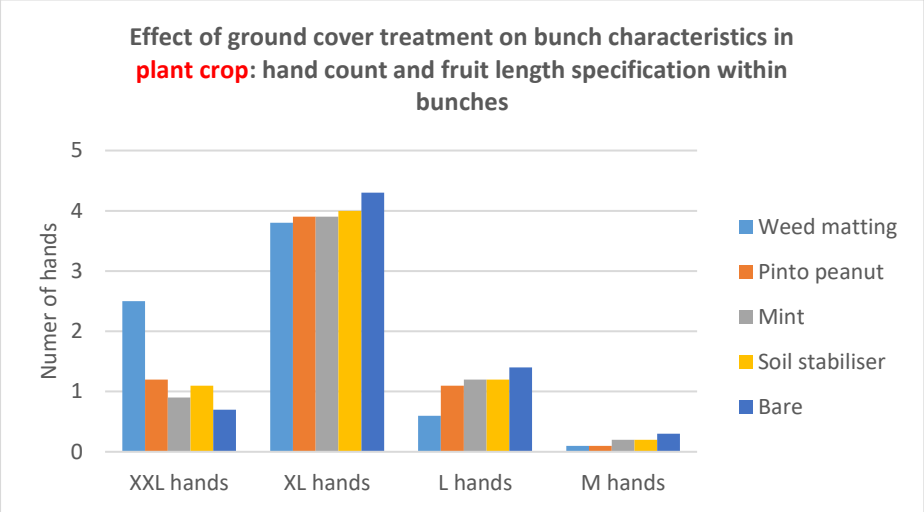


Figure 46: Effect of ground cover on hand specifications within bunches

It is suggested that the increase in XXL hands in the weed matting treatments was due to seasonal influences experienced mainly by that treatment as a result of the delay in bunch emergence of the plant crop. The model below (Figure 47) is fitted with separate Gompertz curves (adjusted R^2 of 99.3%) and shows the proportion of bunches emerged over time for each ground cover treatment. This model (Figure 47) demonstrates that the weed matting was later to start bunch emergence than all other treatments. A similar graph was produced for bunch harvest (99.1% variability) and also shows a later bunch harvest for weed matting as a result of the delay in bunch emergence (Figure 48).

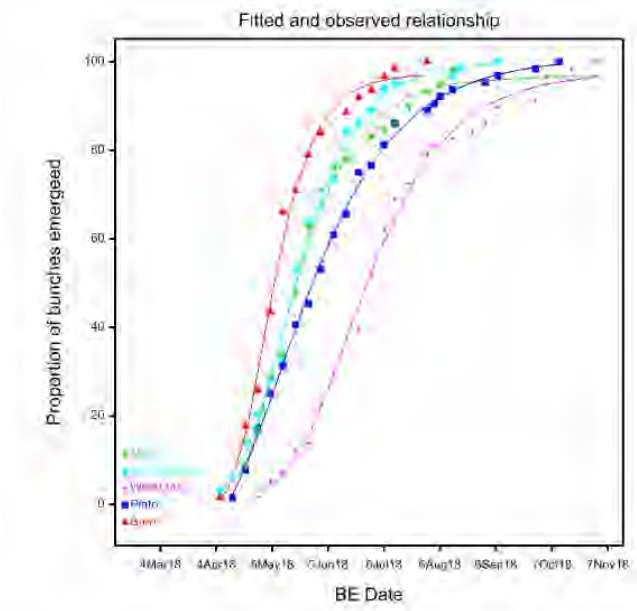


Figure 47: Plants in the weed matting later to start bunch emergence than all other treatments. Conventional bare-earth and chemical soil stabiliser were faster to start bunch emergence

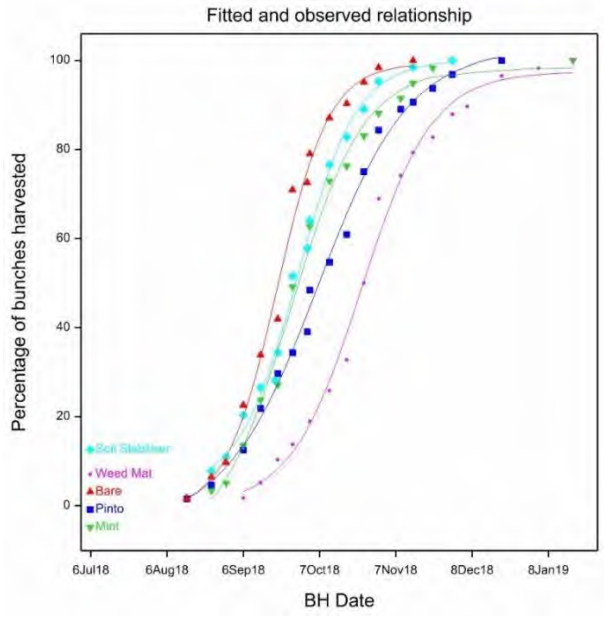


Figure 48: Plants in the weed matting later to reach bunch harvest. Conventional bare-earth and chemical soil stabiliser were faster to reach bunch harvest

When the cumulative number of XXL (Figure 49) and XL (Figure 50) category hands for each ground cover treatment is modelled over time, there is clearly more XXL category hands harvested from the weed matting treatment than any other ground cover, as a result of the delay in bunch emergence. Conventional bare earth and chemical soil stabiliser produced the most XL and L category hands over time, and the weed matting treatment produced the least XL (Figure 50) and significantly fewer L category hands (Figure 51) over the duration of the plant crop harvest.

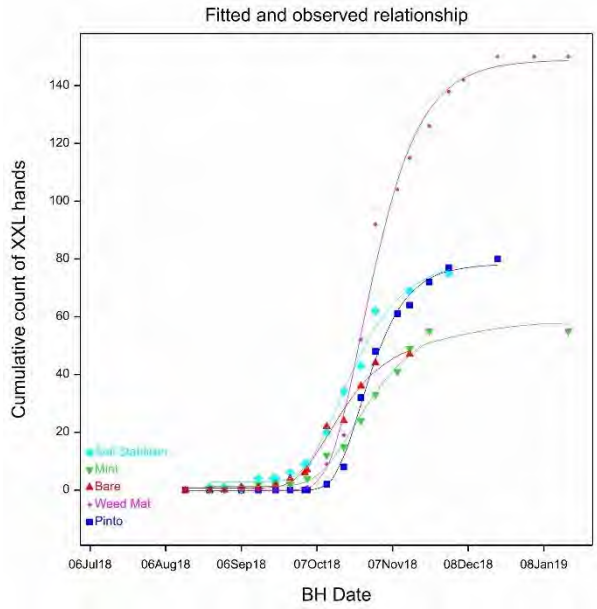


Figure 49: Weed matting produced more XXL hands than all other treatments over time

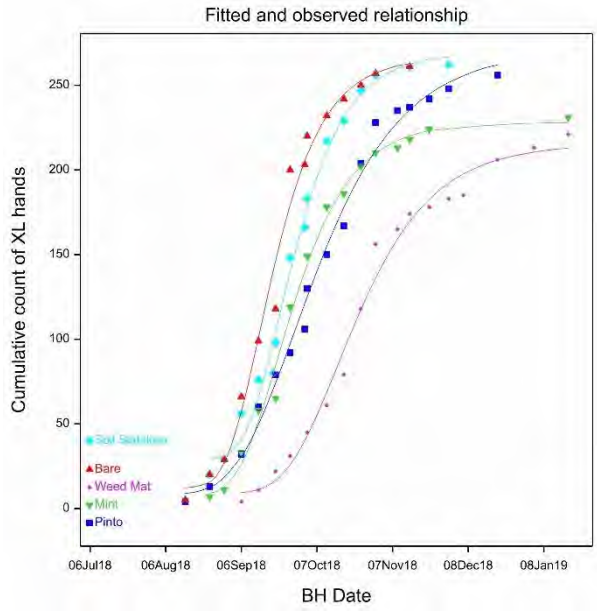


Figure 50: Weed matting produced the least XL hands than all other treatments over time

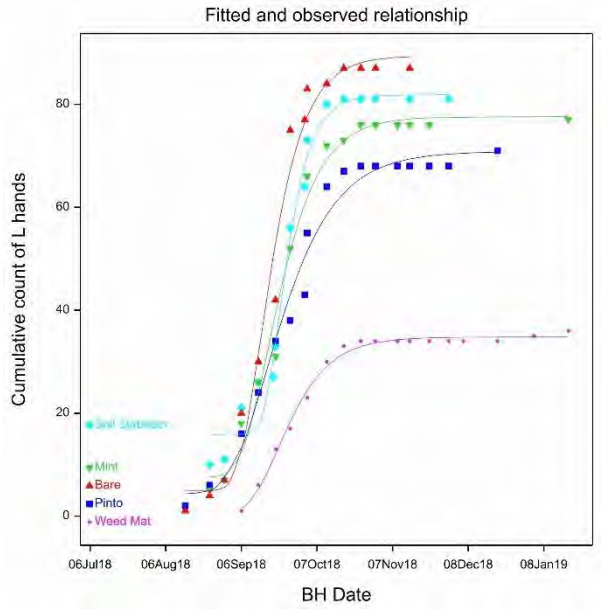


Figure 51: Weed matting produced significantly less large category hands over time, with conventional bare-earth producing the most

First ratoon

As with the plant crop, the effect of ground cover treatment on bunch weight of trial plants was not significant in the first ratoon (p=0.658). Although plants in the weed matting treatment produced larger bunches in the plant crop than all other ground cover treatments this was not the case in the first ratoon crop. Plants in the conventional bare earth plots tended to produce slightly larger mean bunch weights (23.3kg), as opposed to chemical mulching hay (22.8kg), mint (22.5kg), weed matting (21.6kg) and Pinto peanut (21.6kg), however, this difference was not significant (Figure 52).

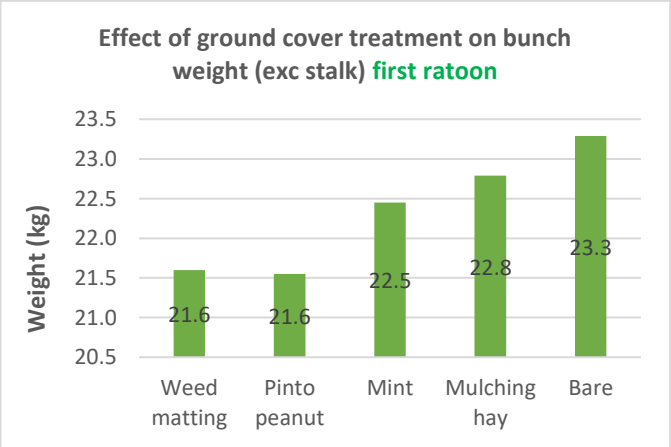


Figure 52: Effect of ground cover treatments on bunch weight

There were no significant differences in total hand count between the different ground covers (p=0.875). There were also no significant differences in fruit length of hand 3, fruit length of the bottom hand, total estimated number of fingers per bunch or different fruit length categories between the ground cover treatments. Similar to the plant crop, the majority of hands fell in the XL (221mm – 260mm) fruit length category, with few hands in the M (<200mm) specification (Table 8 & Figure 53).

Table 8: Effect of ground cover treatment on first ratoon bunch characteristics

	Weight (kg)	Total hands	% XXL Hands	% XL Hands	% L Hands	% M Hands	Est finger count	Finger length (mm) Hand 3	Finger length (mm) Hand n
Weed matting	21.6	7.3	21.8	63.6	12.7	1.8	119	252.6	211.5
Pinto peanut	21.6	7.1	28.0	59.0	10.7	2.2	113	253.3	214.0
Mint	22.5	7.1	23.9	60.4	13.7	1.9	112	254.0	214.3
Mulching hay	22.8	7.6	23.3	58.8	15.3	2.5	123	253.0	212.3
Bare	23.3	7.5	21.6	65.2	12.1	1.0	124	255.6	215.8

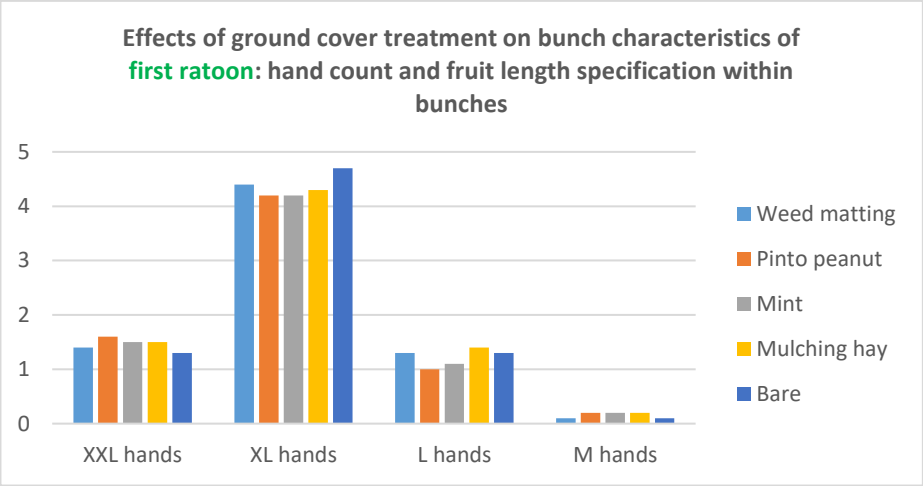


Figure 53: Main effect of ground cover treatments on hand specification within bunches

Conclusions and recommendations

In terms of agronomic performance of the ground covers, the results indicate that plants in the conventional bare earth and soil stabiliser/mulching hay plots (soil stabiliser was replaced with mulching hay in first ratoon crop) were overall faster to cycle with the highest yields compared to all other ground cover treatments. Plants growing in the living ground covers were slower cycling and did not have increased yield as a result of the longer crop cycle.

The chemical soil stabiliser product deteriorated quite rapidly after application. This was potentially due to the concentration trialled as well as the environmental conditions such as high temperatures, humidity and rainfall. Since the chemical soil stabiliser had deteriorated quickly, it was decided to not replace this non-living ground cover until harvest of the plant crop (to reduce potential impacts on plant characteristics). Following harvest of the plant crop it was decided to trial a different ground cover treatment instead, which is why the mulching hay was chosen and applied to the chemical soil stabiliser plots as a replacement non-living ground cover treatment.

Overall there was no interaction between the ground cover treatment and de-suckering treatment in both the plant and first ratoon crop. Overall, the results have shown that early de-suckering had the greatest effect on the agronomic performance of trial plants. Early de-suckering produced significantly taller plants in both the plant and first ratoon crop. The mean crop cycle (plant and first ratoon crop) was 91.6 weeks for plants that received early de-suckering compared to 94 weeks for

plants that received late de-suckering. Furthermore, plants that received early de-suckering produced significantly heavier bunches in both the plant and first ratoon crop. However, the difference in bunch weight was more substantial in the first ratoon crop where the mean bunch weight was 25.01kg for early de-suckering compared to 19.68kg for late de-suckering. This result supports the hypothesis that selecting the following sucker from a later flush of suckers with greater cross-sectional attachment to the parent rhizome results in better growth than for suckers with a smaller attachment.

The outcomes of this trial suggest that further investigation into alternative de-suckering treatments not only in tissue culture plants but also on bits and suckers, which are commonly used to establish a new banana crop, is conducted in future research trials. Furthermore, although there were notable differences between the main effect of ground cover treatment on growth parameters, crop cycle and yield, the majority of these differences were not significant.

As the chemical soil stabiliser product had never been trialled previously, the treatment application rate of 10% may not have been a strong enough solution for the tropical environmental conditions the plots were exposed to. It's suggested that if the chemical soil stabiliser product or a similar product were to be trialled in future, a solution >10% is recommended. Moreover, it is suggested that other erosion control/soil stabiliser formulations such as hydro-mulch, hydra-mulch, hydro-seeding etc. are considered in future trials as these formulations may have greater longevity in high rainfall environments and be better suited for banana production systems.

Visual observations

Below is a summary of qualitative observations of the different ground cover treatments taken during the innovation trial.

Mint ground cover - The living ground cover mint appeared to be growing well upon establishment of the trial, however, it eventually became crowded out from the other species over time. Since other weed species started to grow and compete with the mint, weeding (by hand) was conducted approximately 4 months after planting to give it the best shot at establishing and to reduce impacts of crowding out from other weed species. Hand weeding was conducted once only, as weeding the block by hand would not reflect a commercial practice. Unfortunately, the mint eventually became crowded out from competing weed species and the former 'mint' plots were considered to be living ground cover plots with a variety of weed species naturally occurring.

De-suckering the mint plots was more time consuming than conventional bare earth and chemical soil stabiliser/mulching hay ground covers, as the mint/weeds were growing around the base of the banana plants (sometimes creeping up the base of the plants), making it difficult to identify and remove all unwanted suckers.

Mint growing well following establishment of the trial

Weed species competing with mint. Weeding conducted approx. 4 months after planting

Very small number of mint plants still persisting in the ground cover plots in the plant crop

First ratoon crop showing a weedy plot with no mint persisting

Pinto peanut ground cover – The Pinto peanut living ground cover established well and grew successfully during the trial. Upon establishment of the trial, some weed species such as sensitive weed, Sourgrass and Pennywort competed with the Pinto peanut. As for the mint ground cover, to give Pinto peanut the best chance at establishing, weeding (by hand) was conducted approximately 4 months after planting to reduce potential impacts of crowding out from other weed species (and to keep consistency with both living ground covers).

For the duration of the trial, the Pinto peanut maintained dominance against other weed species and successfully formed a thick low growing ground cover between the banana plants. Common sensitive weed persisted in and around the Pinto peanut, however, this weed was unable to dominate. The Pinto peanut formed a thick vegetative ground cover within the banana bed, however, it was also creeping into the interrow (although this was managed with herbicide to keep consistency in the trial). However, if given the opportunity the Pinto peanut has the ability

to form a thick vegetative cover within the interrow, having various environmental benefits including reduced soil movement.

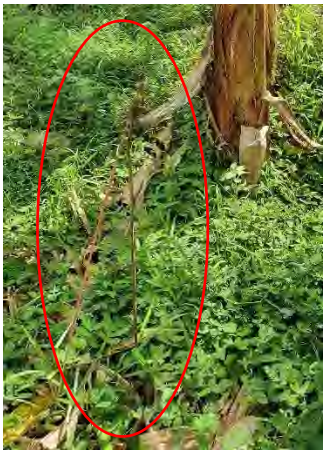
Similarly to the Mint ground cover, de-suckering plants in the Pinto peanut plots required more time than conventional bare-earth and chemical soil stabiliser/mulching hay plots, as the Pinto peanut grew around the base of the banana plants, making it difficult to identify suckers.

Pinto peanut growing in and around base of bananas

Thick low growing vegetative mat of Pinto peanut

Sprinkler systems - Sprinklers had to be replaced during the plant crop as the living ground covers grew beyond the height of the original sprinklers, reducing the effectiveness of the fertigation system. To allow for consistent fertigation, the sprinklers were placed on flexible fibreglass rods (approximately 1m in height)

Original sprinklers (approx. 30cm high) used throughout trial. Ground covers growing beyond sprinklers affecting irrigation and fertigation



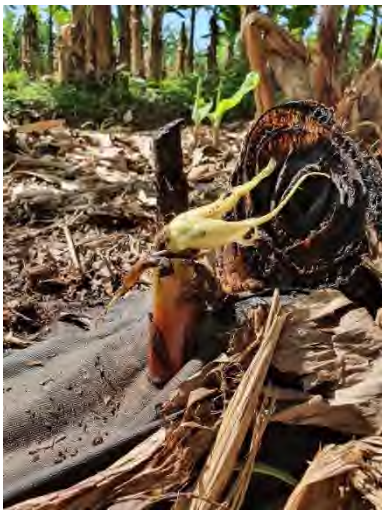
Sprinklers placed on rods (approximately 1m high) to allow for consistent irrigation and fertigation

Weed matting ground cover – Over the duration of the trial, the weed matting maintained a very good level of weed management without the use of herbicides. Upon completion of the trial, the weed matting was removed from the plots and visual observations showed that it appeared to hold the shape of the banana bed for the duration of the trial compared to all other ground cover treatments. The majority of the weed matting was still intact (the slit around the base had increased considerably to allow for growth of following suckers) at the end of the trial, and visually the weed matting had not appeared to break down into smaller unmanageable pieces of fabric throughout the plots. These are promising observations in regards to environmental benefits of using less herbicide to manage weeds and in reducing soil movement and degradation of the banana bed as a result of high rainfall and erosion over time.

In the plant crop the weed matting had lifted around the base of the banana plants due to young developing suckers growing off the mother plant, which caused the matting to lift. This was an issue for the next crop to follow (following suckers) as the weed matting squashed the sucker as it was growing, potentially affecting growth in the early stages of development. Furthermore, the weed matting provided a suitable environment for wildlife such as rats and snakes to inhabit. For the duration of the trial, a large number of rats were found living within the bunches, irrespective of the ground cover treatment. Due to the weed matting lifting as following suckers grew, more time and effort was required to tear the weed matting around the base of the banana plants to ensure that young developing suckers were not impacted by the matting. Furthermore, more time was required for de-suckering plants in the weed matting compared to the conventional bare earth and chemical soil stabiliser/mulching hay plots, (mint and Pinto peanut required the most time de-suckering due to the thick vegetation around the base of plants).

Weed matting in the plant crop holding the shape of the bed and limiting growth of weed species

Lifting around the base of the plant as young suckers grow



Sucker damaged by weed matting

Weed matting managing weed species in first ratoon

Chemical soil stabiliser/mulching hay – The chemical soil stabiliser product used in this trial deteriorated quite rapidly following application, potentially due to high rainfall, and the concentration not being strong enough to bind the product to the soil for the tropical environment experienced. As the results of the plant crop had shown no significant agronomic differences between conventional bare earth and chemical soil stabiliser, it was decided to replace the chemical soil stabiliser plot with mulching hay in the first ratoon crop as a demonstration.

The mulching hay maintained a very good level of weed management without the use of herbicides, however over time it began to break down and towards the completion of the trial weeds began to grow within the plot. Visual observations from inspecting the mulching hay during warm and dry periods showed that the mulching hay retained more soil moisture during drier periods compared to conventional bare earth. More time was required to apply the mulching hay to plots (which was conducted by hand) and if the mulching hay were to be used in future trials, it would need to be replaced every 6 to 12 months to ensure consistent ground cover. Application of hay on commercial farms has been done mechanically which would be more labour efficient and make reapplication feasible. De-suckering the mulching hay plots did not take any more time than the conventional bare-earth treatments.

Applying mulching hay to plots

Mulching hay managing weed species and maintaining soil moisture

Conventional bare earth – The conventional bare earth plots were treated with herbicide regularly for the duration of the trial to maintain weed freedom. Less time was required for trial maintenance activties in the bare earth plots (and chemical soil stabiliser/mulching hay plots) in terms of de-suckering, harvesting and checking irrigation lines as there was very little vegetation growing around the base of the banana plants. Furthermore, less wildlife inhabited these plots as there was a lack of vegetation/weed matting providing harbourage. Visual observations had shown that the conventional bare earth plots did not maintain the original shape of the bed and soil movement from the banana bed into the interrow was evident for the duration of the trial.

Conventional bare earth plots. Weeds maintained by use of herbicide

Conventional bare earth plot losing the shape of the bed over time due to rainfall and soil movement

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Appendix 16: Entomopathogenic fungi for control of banana bunch pests (bell injection trial)

Aim

Currently there are three registered or permitted insecticide active ingredients commonly used to control pests at the flowering stage in the banana industry. This includes products that contain the active ingredient: acephate, bifenthrin or spinetoram. The application of insecticide to the emerging bunch (commonly referred to at this stage as the "bell") in banana production is referred to as "bell injection", and involves the injection of product mix into the inflorescence. With the risk of insecticide resistance, de-registration and a growing interest for softer and more environmentally friendly options, this trial investigated an alternative biological product to protect young developing bunches from a range of insect pests including banana scab moth (*Nacoleia octasema*), flower thrips (*Thrips hawaiiensis*) and banana rust thrips (*Chaetanaphothrips signipennis*).

Trial design

Two different ground cover plots that were already established as part of previous innovation trial work were used to trial the biological product. This included the weed matting and Pinto peanut ground cover plots in rep two (Figure 1). These two plots were selected as they were located next to one another and had the most bells available for the trial.

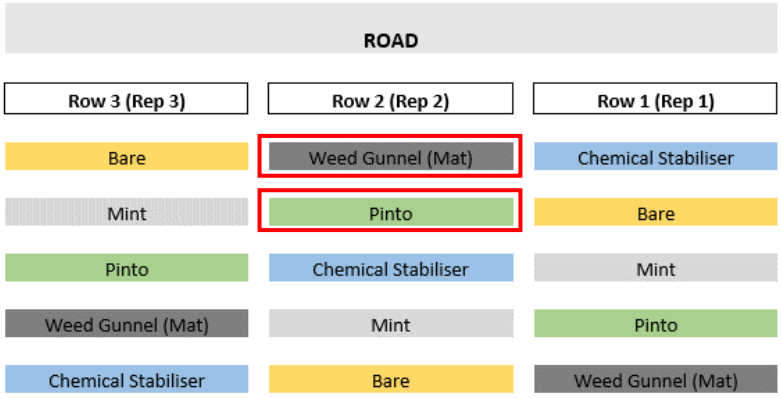

Figure 1: Treatments were applied to emerging bells of plants in the weed matting and Pinto peanut plots in rep 2.

Each plant within the two ground cover plots was considered a single replicate. Three treatments were applied as a bell injection to newly emerged banana bells. The three treatments included:

Nutri-life Myco-Force™ (40g/1000mL de-ionised water, 60 mL injection applied) - The Nutri-life Myco-Force™ product trialled in this experiment is an Australian Certified Organic microbial talc-based formulation, containing various entomopathogenic fungal species including *Beauveria bassiana, Metarhizium anisopliae, and Lecanicillium lecanii.*

Eraser 750 Insecticide™ (1.7g/1000mL de-ionised water, 30ml injection applied) - This product is an industry standard insecticide (Group 1B) containing acephate as the active ingredient, and is registered for the control of insect pests on bananas (banana scab moth and rust thrips) as well as other crops including macadamias, potatoes and tomatoes.

Water (60mL injection applied) – de-ionised water was used as the control to compare against the other treatments included in the bell injection trial.

Each treatment was applied to 4 individual plants within each ground cover plot. For example, the biological product was applied to four plants within the weed matting ground cover and four plants within the Pinto peanut ground cover (8 plants between two ground cover plots for each treatment). This was the same for the water and acephate treatments.

Due to the asynchronous nature of the crop, banana bells do not all emerge at the same time, and for this reason, the treatments were applied in turn as bells emerged over time. For example, in the weed matting plot when the first bell emerged it was injected with the biological product (Nutri-life Myco-Force™), when the second bell emerged it was injected with the industry standard product (Eraser™), when the third bell emerged it was injected with the control (water) treatment and when the fourth bell emerged in the weed matting it was injected with the biological product and so on. This process of selecting plants to treat was the same for bells emerging in the Pinto peanut plot.

Application method

A knapsack and hand operated injector gun were used to inject the required volume of each treatment into the banana bell as per commercial practice. The designated volume of each prepared treatment solution was applied into the upper one-third of the emerging bell, while the bell was still in the upright position in the throat of the plant (Figure 2 & 3). If the bell had developed too much and started to bend over it was not selected for treatment. To remove potential impacts of cross contamination between treatments, a separate knapsack (purchased new) was used for application of each treatment. The same injector gun was used between treatments however, the gun and injecting line was thoroughly rinsed between treatment applications.

Figure 2: Knapsack used to inject treatments into the banana bells.

Figure 3: Treatment applied to the upper one-third of the newly emerged banana bell.

Fruit assessments

Following treatment application, a standard bunch pruning treatment was applied (removal of the banana bell, false hand plus two) and bunch covers were placed on bunches at bract fall, which was approximately two weeks after bell emergence. At this point of bunch pruning and covering, flower thrips, rust thrips and banana scab moth damage was assessed for each of the treated bunches.

Flower thrips - Flower thrips causes damage to the fruit as a result of adults laying their eggs into the skin of the banana peel. This causes slightly raised 'pimples' with a blackened centre which are called ovipositions. These marks don't affect fruit pulp, however they can be visually unappealing and can lead to downgrading of the fruit. Flower thrip assessments were conducted at bract lift when the female flowers are exposed and the male flowers have started to appear (point of bunch pruning and covering). Five central fingers in the inner whorl of the top, middle and bottom hands of the bunch (Figure 4) were assessed for flower thrips damage. The number of oviposition marks on a single surface of the finger were recorded using the rating scheme in Table 1.

Table 1: Rating scheme used for flower thrips assessments

Rating	Number of Ovipositions on surface of finger
0	0
1	1 – 10
2	11 – 25
3	26 - 50
4	>50

Rust thrips – Banana rust thrips are a significant pest for banana growers. The thrips cause damage by feeding on the skin of immature green banana fruit, which causes reddish-brown marks on the fruit. If damage is severe it can cause fruit splitting. Rust thrips assessments were undertaken at the same time flower thrips assessments were conducted (point of bunch pruning and covering). Five central fingers in the inner whorl of the top, middle and bottom hands of the bunch (Figure 4) were assessed for rust thrips damage (the same fingers that were assessed for flower thrips damage). Rust thrips damage was rated using the scale shown in Figure 5. If damage is greater than a rating of 1 fruit can become unmarketable, as this is considered the maximum damage level that is commercially acceptable.

Figure 4: Position of fingers within bunch assessed for flower and rust thrips damage.

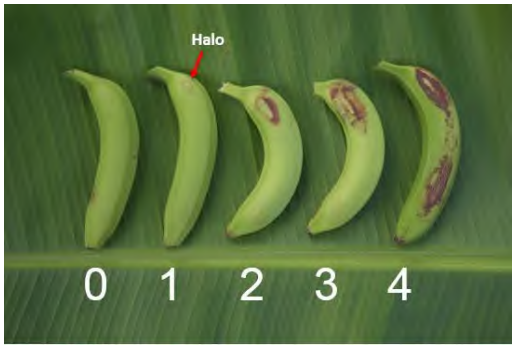

Figure 5: Rating scale used to assess level of rust thrips damage.

Banana scab moth – Damage caused by banana scab moth is confined to the 'flowering' period, where young scab moth larvae feed on the skin of the banana fruit (Figure 6). Severity of the damage increases as the larvae grow and they migrate down the bunch as subsequent bracts begin to open. Scab moth damage assessments were conducted at the same time as flower and rust thrips

assessments (point of bunch covering). Assessments for the presence or absence of scab moth larvae were conducted by inspecting each hand within the bunch.

Figure 6: Banana scab moth damage to the hands of young developing bunches.

Statistical analysis

The data has been analysed using two approaches. The first uses analysis of variance (ANOVA) to analyse the mean thrips ratings. The ANOVA assumes the ratings are on a linear scale and this assumption is checked by looking at the residual plots. The data is analysed as a split-plot design, with plant as the main plot and hand position as the subplot.

The second approach considers the proportion of fingers with thrips present. A rating of 0 corresponds to the absence of damage and any positive rating suggests the presence of damage. A generalised linear mixed model (GLMM) assuming a binomial distribution was initially used to analyse the proportion of fingers with thrips damage present. The GLM was not able to converge for the majority of analyses, and therefore a generalised linear model (GLM) was applied. The ANOVA and GLM were performed on each ground cover separately and also by combining the data, effectively ignoring ground cover type. The fixed effects model for both analyses included the main effects and interaction of treatment and hand position.

The presence of phytotoxicity and scab moth larvae was also recorded. This data has also been analysed using a binomial GLM. For all analyses, the pairwise 95% least significant difference (lsd) was used to make pairwise comparisons if a significant effect was found ($p<0.05$).

Results and discussion

Regardless of ground cover treatment, pairwise comparisons indicated that the industry standard (acephate) had a significantly lower mean rating (1.0a) of flower thrips damage compared to , whereas the water treatment (1.9b) and biological product (2.7c) had a significantly higher mean rating of flower thrips damage, with the biological product having the greatest. The mean proportion of fingers with flower thrips damage was significantly higher in the top hand compared to the bottom and middle hands.

Statistical analysis showed the mean rating of banana rust thrips damage found no significant effect of treatment ($p=0.076$), no significant effect of position ($p=0.370$) and no interaction of treatment and hand position ($p=0.532$). Potential possible explanation of this is because the banana rust thrips damage was only assessed at the time of bract lift, approximately two weeks after bell emergence.

Unlike flower thrips and banana scab moth, banana rust thrips have the potential to cause severe damage to fruit as it matures right through to bunch harvest. As banana rust thrips damage was not assessed at bunch harvest in this trial it is suggested that in future trial work, assessments for this damage is conducted at harvest as well as bunch covering.

Banana scab moth activity was only found to be present on bunches bell injected with the water treatment, however, its activity was low throughout the period of the bell injection trial. It's suggested that the biological product may have had some impact on banana scab moth activity, however due to the low incidence of banana scab moth across the water treated bunches, further work would be required to confirm this.

Overall the results indicate that the biological product trialled in this experiment was not suitable as a bell injection treatment for controlling common banana bunch pests. Bunches treated with the biological product had phytotoxicity damage to the fruit skin, peduncle and bunch stalk, and the carrier within the product (talc) was visible on treated bunches (Figure 7 & 8). Visible chemical residue is considered a major quality defect for banana fruit, with a zero tolerance in the market place. No phytoxicity damage was present on bunches treated with the industry standard (acephate) or the water treatments. As the biological product caused phytotoxicity damage to the treated bunches, and did not provide sufficient bunch pest management, it is recommended that other biological products such as entomopathogenic nematodes (*Steinernema carpocapsae* and *Steinernema feltiae*) are tested in future bunch pest management trials. It's suggested that consideration of suitable adjuvants are added to the solution to potentially enhance the effect of the product.

Figure 7: Black raised marks on fruit as a result of biological bell injection

Figure 8: Talc carrier visible on bunch stalk of bells treated with the biological

Appendix 17: Entomopathogenic nematode (EPN) trials

The banana weevil borer (BWB), *Cosmopolites sordidus*, is a significant insect pest of banana plantations throughout north Queensland and New South Wales. The BWB larvae tunnel within the corm of the banana plant which lies below the soil surface. Heavy infestations can result in damage extending from the corm into the pseudostem, reduced plant growth, plant losses due to snapping, choking of the bunch in the pseudostem, producing yellowing of leaves, and causing weak or dying suckers.

The purpose of the innovation trial was to investigate novel, innovative concepts that may improve agronomic performance and/or have environmental benefits. A pilot experiment within the laboratory and innovation trial using entomopathogenic nematodes for control of BWB were conducted as part of the National Banana Development and Extension Project (BA16007). Entomopathogenic nematodes belong to one of two genera, *Steinernema* or *Heterorhabditis.* They are called entomopathogenic nematodes as they penetrate the insect releasing a highly specialised symbiotic bacterium which is only found in entomopathogenic nematodes and can rapidly kill a wide range of insect pests.

Trial 1: In-vitro trial investigating potential use of EPNs as a biological control of BWB

Aim

The aim of this experiment was to investigate whether two different species entomopathogenic nematodes (*Steinernema carpocapsae and Steinernema feltiae)* have the ability to infect and kill banana weevil borer (*Cosmopolites sordidus*).

Materials and Methods

The experiment consisted of two different entomopathogenic nematode (EPN) rates compared to a control treatment (water), replicated three times. Fifteen living adult banana weevil borers (BWB) were used per replicate, with a total of 135 BWB used in the experiment, (3 treatments x 3 replicates x 15 BWB per container).

The 135 BWB used in the experiment were captured and collected from a banana trial plot located at the South Johnstone Research Facility using pitfall traps (Figure 1). The BWB were all placed in a ventilated container along with fresh pseudostem material for feeding and were visually inspected to ensure they were all living prior to establishment of the trial. Upon establishment of the trial, they were then transferred to nine clear 2.5L plastic containers with lids to contain and isolate the treated BWB (3 replicates of each of the 3 treatments). Upon establishment of the experiment, approximately 55g of fresh banana corm material collected from a single Ducasse (ABB Pisang Awak) banana plant was placed in each of the nine containers.

Fifteen living BWB were randomly selected from the initial holding container and placed in the corner of each of the 2.5L plastic containers and allowed sufficient time to physically move onto the fresh corm material before application of the respective treatment. This technique was used to ensure the BWB were all living before treatment application. Once the BWB had moved and were actively feeding on the corm material, the treatments were applied (Figure 2).

The treatments trialled in this experiment included:

Treatment 1: 2 million EPN (2.8g *S. feltiae* and *S. carpocapsae* mixed in 20ml de-ionised water per replicate).

Treatment 2: 1 million EPN (1.4g *S. feltiae* and *S. carpocapsae* mixed in 20ml de-ionised water per replicate).

Treatment 3: Control (20mL de-ionised water only)

To avoid cross contamination between treatments during application, three 20ml disposable syringes were dedicated to the application of each respective treatment. Twenty ml of each treatment was applied to the corresponding replicates by slowly applying releasing the EPN mixture over the corm material using the dedicated syringe.

As BWB are attracted to corm material, the technique of moving the BWB to the corner of the container (this was done in the morning) and allowing sufficient time (assessments conducted in the afternoon) for the BWB to move back onto the corm material was used throughout the experiment to assess the number of living and dead BWB each day. Clean tweezers for each treatment were used to dislodge the BWB from the corm material before placing in the corner of each container. In addition to placing the BWB in the corner of each container, they were also assessed as living or dead by pressing down on their abdomen. If the BWB legs did not clench they were considered dead. When dead BWB were identified in each treatment, they were collected from the corresponding container and placed in a clean petri dish. Each BWB was then washed under de-ionised water for 10 seconds and placed in a second clean petri dish, then dissected and inspected under a microscope for presence or absence of EPNs. Using microscopic examination, a BWB was considered infected when 1 or more EPNs were visually identified. The total number of nematodes observed in each BWB was not assessed in this experiment. Assessments were conducted 6, 7, 13, 14, 20, 21, 22, 24, 27 & 28 days after treatment application (assessments were not conducted on weekends and public holidays).

During the experiment 7 BWB escaped from the containers (1 BWB from treatment 1, 3 BWB from treatment 2 and 3 BWB from the control), due to the lid being left ajar. The escaped BWB were not included in the assessments and analysis.

Figure 1: Pitfall traps installed in the banana paddock to collect BWB

Figure 2: EPN treatments being applied to the living BWB

Figure 3: Assessments being conducted on BWB

Results and discussion

Overall, this experiment showed that EPNs have the potential to provide control of adult BWB. Both EPN rates used in this experiment resulted in over 88% death of BWB. Figure 4 shows that for the 2 million EPN rate, 91% (40/44 BWB) were recorded as dead after 32 days exposure to EPNs, and 88% (37/42 BWB) were recorded as dead for the 1 million EPN rate. By contrast, 93% of the BWB were recorded as living for the water control treatments.

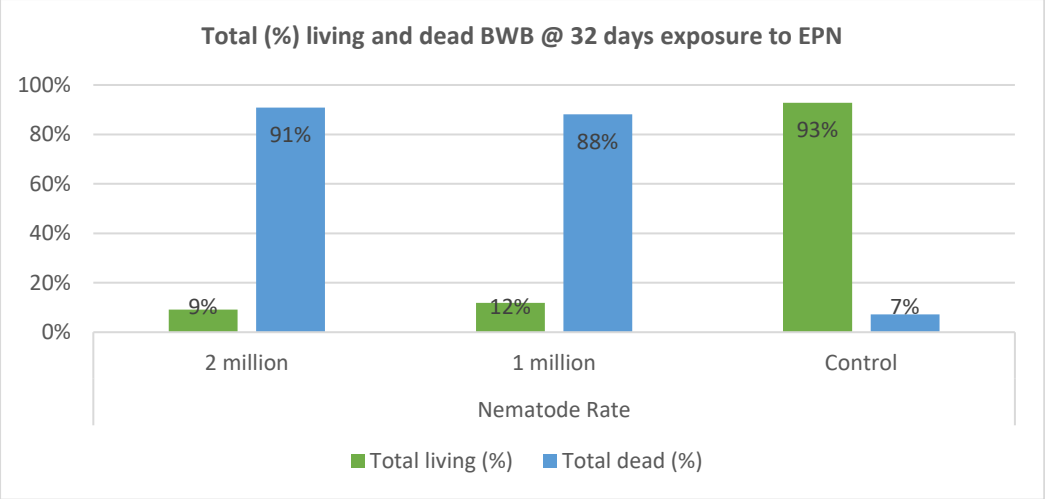

Figure 4: Total living and dead banana weevil borer after 32 days exposure to EPNs

Entomopathogenic nematodes were visually confirmed via dissection and microscopy. More than 50% of dead BWB were infected by EPNs for both rates used in this experiment (Figure 5). For the 2 million EPN rate, 59% of the 40 dead BWB were infected with EPNs. For the 1 million EPN rate, 51% of the dead BWB were confirmed with EPNs. Figure 6 below shows an EPN highlighted in yellow identified using the microscope. Microscopic identification for EPNs was not conducted on dead BWB in control treatments. Although EPNs were identified in more than 50% of dead BWB for both treatment rates, it's important to note that there may have been more BWB infected with EPNs, however they were not easily identified using the microscopic method.

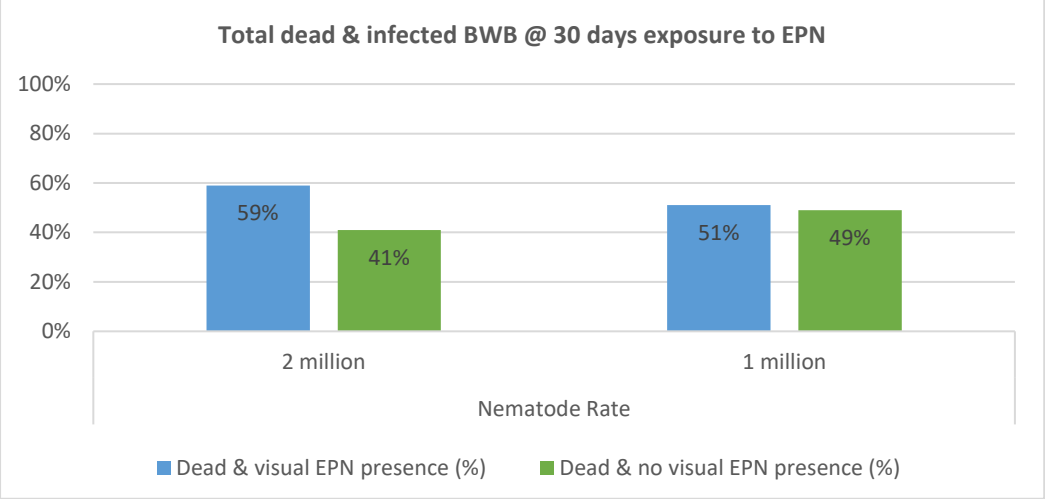

Figure 5: Total number of dead and infected BWB @ 32 days exposure to EPNs

Figure 6: Microscopic examination of dead BWB infected with EPNs. EPN highlighted in yellow.

Figure 7 below demonstrates that a significantly high number of BWB deaths (47.7% BWB) occurred on day 8 of the trial for both EPN treatment rates. However, days 6 and 7 fell over the weekend, where assessments were not conducted. Therefore, these deaths may have occurred at any time between the assessment conducted on day 5 (Friday) and day 8 (Monday).

Overall, the greatest number of BWB deaths were recorded between the assessments conducted on day 5 and day 10 for both EPN treatment rates. For the 2 million EPN rate, 61% of the total BWB were recorded dead during this period, and 50% of BWB were recorded dead for the 1 million EPN rate. Zero BWB deaths were recorded for the control treatments for this time period. Between days 1 and 10, 4% of the BWB (2/42 BWB) were recorded dead for the control treatments (due to other causes).

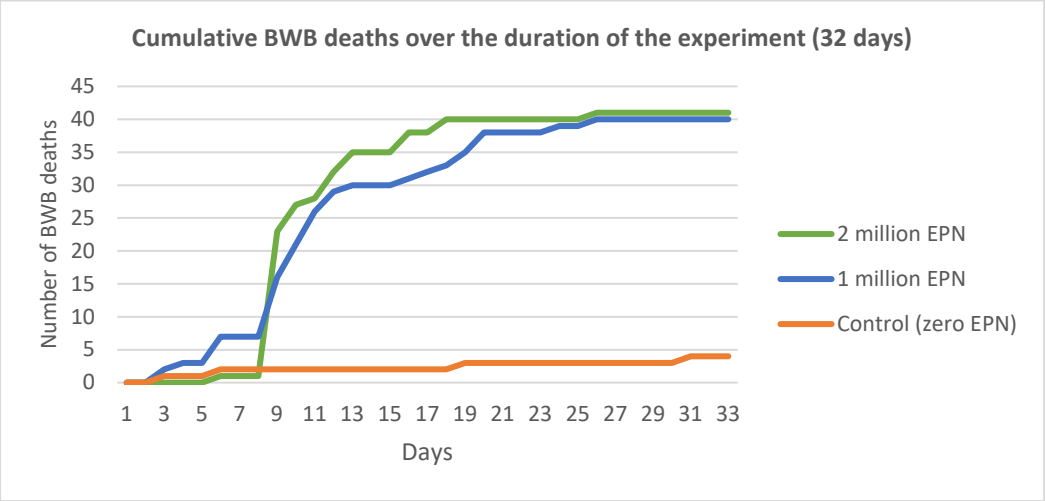

Figure 7: Cumulative BWB deaths over the duration of duration of the experiment

Trial 2: Application of EPNs as a potential field injection technique to control Banana Weevil Borer (*Cosmopolites sordidus)*

Aim

Throughout the first ratoon crop of the innovation trial, the population of banana weevil borer was beginning to increase and damage trial plants, causing some plants to break off/fall over. Entomopathogenic nematodes (*Steinernema carpocapsae* and *Steinernema feltiae)* were applied to all suitable decaying banana pseudostems within the innovation trial as a potential biological control of banana weevil borer (*Cosmopolites sordidus).* The EPNs were applied to plants in the innovation trial following success of the preliminary In-vitro trial conducted at the South Johnstone Research Facility, which demonstrated that EPNs have the ability to infect and kill banana weevil borer.

Methods and Materials

A single pitfall trap containing a BWB specific aggregation pheromone was installed in each ground cover treatment and replicate (total of 15 pitfall traps) within the innovation trial block on 6 July 2019, (Figure 8). BWB count data were collected from all pitfall traps over a period of approximately 12 weeks. The traps were checked regularly (1-2 times a week) and BWB collected, counted and recorded to determine whether there were differences in numbers between ground cover treatments.

The EPNs were applied approximately 4 weeks after the pitfall traps were installed in each of the ground cover treatments. The EPNs were applied to all harvested and decaying banana pseudostems within the innovation trial. No suitable plant material was left untreated, as the EPNs were applied as a novel BWB treatment. Following EPN treatment, the pitfall traps in each ground cover treatment continued to be checked and numbers of BWB recorded regularly up until 13 December 2019.

Figure 8: Checking pitfall trap for BWB

Application

The EPN treatment rate used within the innovation trial consisted of 2 million EPNs in a 20mL injection (2.8g *S. feltiae* and *S. carpocapsae* mixed with 20ml de-ionised water per individual piece of plant material). This rate was selected as it was the higher rate used in the in-vitro experiment which had shown success in infecting and killing treated BWB.

A knapsack and injecting gun was used to apply the EPN treatment (Figure 9). A 20mL injection (2 million EPN) was applied to all suitable plant material within the innovation trial. Material was considered 'suitable' when the pseudostems/corms were at a stage where the pseudostem was no longer green and had decomposed enough that it was soft to squeeze and beginning to bend over, or had started to break down (Figure 10 & 11).

Figure 9: Knapsack and injecting gun used to apply the EPN treatment

Figure 10: Example of plant material suitable for EPN treatment

Figure 11: Example of BWB aggregating in the pseudostem of a harvested banana plant

Results and Discussion

The total count of BWB in each ground cover plot was analysed using a generalised linear mixed model assuming a Poisson distribution and log link. Results indicate there was no significant difference in the total BWB count between the five ground covers treatments (p=0.249).

The BWB counts before and after the EPN treatment application were also compared. The BWB counts were converted to a per week basis as counts before EPN treatment were conducted for approximately 4 weeks, whereas counts after EPN treatment were conducted for approximately 8 weeks. Analysis of variance (ANOVA) was used to analyse this data. Results indicate that there was no significant interaction of ground cover treatment and pre/post nematode treatment (p=0.449), and that the main effect of ground cover treatment was also not significant (p=0.191). However, the main effect of pre and post nematode treatment was shown to be significant (p=0.031). The mean weekly count of BWB decreased significantly after the nematode treatment (2.85 before EPN treatment compared to 1.85 post EPN treatment).

The EPNs were applied to the innovation trial as a novel treatment only following success of the laboratory trial. There were no control treatments to compare against, and this was not a replicated, randomised and blocked trial. The purpose of the EPN field application was to have a 'look and see' as to whether BWB numbers in the pitfall traps had reduced post treatment, and whether there would be less plant roll-outs in future ratoons. Furthermore, the application of EPNs to the trial banana block also offered the opportunity to determine any visual detrimental impacts on plant development from the treatment. Quantitative assessments for presence/absence and living/dead BWB was not conducted on any treated plant material. Moreover, microscopic examination was not consistently conducted on BWBs that were collected in the pitfall traps following EPN treatment. Some living BWBs caught in the pitfall traps were inspected under the microscope on an ad hoc basis, however, it was not enough to report on. Also, some treated pseudostems were inspected on an ad hoc basis following EPN treatment and no visual presence of EPNs were identified, however, this was also not enough to report on.

Overall statistical analysis conducted on BWB counts pre and post EPN treatment shows promising results of this product as a potential biological control of banana weevil borer. Following outcomes of the in-vitro trial and field EPN treatment, it is highly recommended that future trial work using EPNs to control BWB is continued. Furthermore, it is suggested that the EPNs are also trialled against other common pests of banana including bunch pest management.