ADAPT, DEVELOP AND INTEGRATE A VARIABLE AND SECTIONAL RATE CONTROL BOOMSPRAY FOR THE PINEAPPLE INDUSTRY

Research Topic 3 and 4: Pre and post plant nutrition and pest management

Trial number: 03-SEQ-04

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INTRODUCTION

Boom spraying is a common practice employed in pineapple production internationally. It is used for pesticide application to manage diseases, insect pests and weeds and for post-plant fertiliser applications.

Sectional and variable rate control on the boom sprayer for more precise application of chemicals and fertilisers is attracting interest due to its economic and environmental benefits.

The main aim of automated sectional and variable rate control systems is to reduce over-spray of crop inputs by turning off boom sections as they pass over previously treated areas or areas that don't need spraying. Some systems have the capability to only spray within pre-loaded GPS field boundaries or boundaries recorded by the operator during an initial pass around the field of the block using manual entry of GPS co-ordinates. This map-based function ensures that boom sections are automatically turned off when passing over areas outside cropped regions of the field. An added benefit of this boundary mapping feature is that some systems allow the operator to map interior field areas to prevent application into environmentally sensitive areas such as grassed waterways or stream buffers.

Another important requirement for automatic boom sectional control systems is to maintain application rates by regulating flow to the boom. Current spray rate controllers attempt to compensate for changes in speed which control pump output based on feedback from a sensor continually scanning the ground. Similarly, sectional control systems require an integrated spray rate controller to adjust total flow to compensate for boom sections as they are switched on or off.

All auto-sectional control systems use GPS to work out the precise point at which boomsprayer sections should be switched on and off to minimise overspray and avoid any misses. There are several spraying systems available, either as options on new sprayers or as retrofits to existing sprayers.

HYPOTHESIS

An automated GPS guided sectional and variable rate control system can be developed for a pineapple boom spray to make spraying operations more efficient for the grower and better for the environment.
In addition, aerial imagery can be used on a pineapple farm to improve on-farm decision making.

OBJECTIVE

The primary objective is to adapt, develop and integrate variable and sectional rate boomspray application equipment and aerial imagery into a pineapple production system.

1) To adapt, develop and construct a variable and sectional rate boomspray.
2) To integrate Global Positioning Systems (GPS) technology into a pineapple boomspray operation to enable the variable and sectional rate boomspray to function.
3) To integrate imagery into pineapple operations and utilise the data for better agronomic decision making.

METHOD

The development of a variable and sectional rate control boomspray technology was undertaken in two phases:

<u>Phase 1:</u>

- Integrate GPS based technology into a pineapple boomspray system.
- Develop, integrate and build a variable and sectional rate control boomspray.

<u>Phase 2:</u>

- Incorporate aerial or satellite imagery into a pineapple production system.
- Implement a process to utilise the imagery for better agronomic decision making.

Location and grower

The demonstration was undertaken in collaboration with Fullerton Farms located in Elimbah South East Queensland and Amaryllis Farming Company located in Goomburrum, Bundaberg.

Fullerton Farms, currently managed by Ken, Chris and Scott Fullerton, have been growing pineapples in South East Queensland for over 100 years. They are third generation pineapple farmers and have played a major role in developing the Australian pineapple industry.

Amaryllis Farming Company, owned and managed by Jay Hubert, has been growing pineapple for ten years. The Hubert family have been farming for three generations in the Goomburrum area and have played a major role in developing the sugarcane industry in Bundaberg.

Dates

Phase one

- April 2019 - variable and sectional rate boomspray designed.
- June 2019 - growers identified, tractor fitted with GPS, variable rate boom spray constructed and field tested.

Phase Two

- April – July 2020 - imagery of field taken and data analysed.
- December 2020 - satellite vs drone imagery compared and ground truthing completed.
- January 2022 – field tested a process to support agronomic decision making

Crop details

The site on Fullerton Farms was planted with Smooth Cayenne and hybrid 73-50 pineapple varieties. Previously, the site was planted with the Smooth Cayenne variety which was taken to ratoon crop harvest. The soil was a sandy loam on a 2-3% slope with a southerly aspect.

Description

Phase One

Under the guidance of a John Deere expert, a tractor from Fullerton Farms was fitted with GPS guidance and a standard industry boomspray was modified to have variable and sectional rate control capabilities.

Amaryllis Farming Company designed and built a boomspray using their own expertise.

Both boomsprayers were retrofitted with variable and sectional rate control systems.

Each boomsprayer was divided into four different sections, each of which can operate independently, and it had the following capabilities:

1) Automatic turn on or off at the edge of blocks, over headlands or drains, or according to differences in agronomic requirements, etc.
2) Precise volume application per area of land.
3) Sectional turn on and shut off over angled fields.

Phase Two

The demonstration area was located on Fullerton Farms, Elimbah on Smooth Cayenne and hybrid varieties at different stages of growth within the cropping cycle including plant and ratoon crop. Both satellite and drone imagery of designated blocks were taken and compared to identify variations in crop growth and health. Drone images were taken at a height of 60m

above the crop from 11 am to 1 pm under full sunlight. Satellite images were collected every 11 days when passing overhead.

The imagery was compared and analysed to identify variations in crop growth and health. These variations were then individually assessed through 'ground truthing' by the industry agronomist. Recommendations from the industry agronomist allowed the grower to better understand the crop requirements and enable more informed decision making for fertiliser and pesticide programs.

RESULTS

Phase One

The integration of GPS into a pineapple operation was successful. It used the John Deere Star Fire™ 7000 system. The Star Fire™ 7000 receiver is the current technology from John Deere and has great accuracy, faster data upload times with strong repeatability.

Real time kinematics (RTK) GPS receiver takes in the normal signals from the Global Navigation Satellites System (GNSS) which includes satellites from GPS (USA), GLONASS (Russia), Beidou (China), and Galileo (Europe). This system can achieve accuracy of ± 2.5 cm without the need for additional hardware.

The total cost required to install a GPS based variable rate and sectional control system into a current existing tractor and boomspray is approximately $25,000 - $30,000 depending on the internal operating systems of the tractor and size of the boomsprayer. In this demonstration the grower had one of the longest boomsprayers (14 metres) in the industry which cost $30,000. Currently, all new tractors are 'GPS ready' with built in GPS functionality as a standard feature.

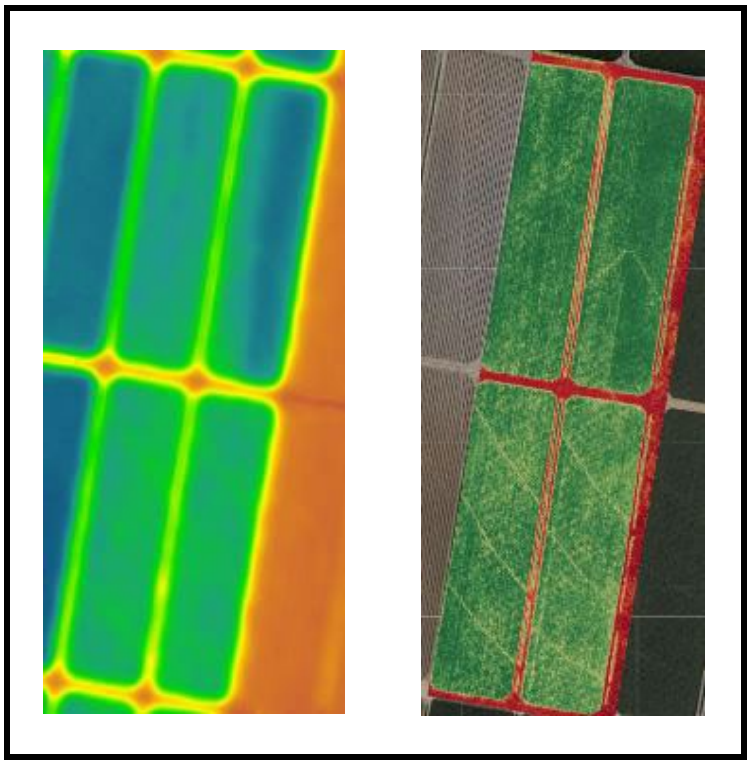
Figures 1-3: (Fullerton Farms) Variable rate and sectional control boomspray (left), boomspray plumbing (middle), automated sectional controls (right).

Comparing pesticide and fertiliser savings with and without the sectional and variable rate capabilities, the grower saved 8% on input volume using the sectional and variable rate boomsprayer. This equates to $1,976 / ha reduction in pesticide and fertiliser costs over a full plant and ratoon crop cycle.

Figures 4-5: (Amaryllis Farming Company) Variable rate and sectional control boomspray set up showing plumbing (left) manual sectional controls (right).

Phase Two

The integration of aerial imagery into a pineapple operation compared both satellite and drone imagery over a pineapple crop. It was found that the clarity and definition within the drone images was substantially better. The drone images were superior for highlighting variations in crop uniformity, weeds in the field, headlands and cross drains and changes in soil type when compared to satellite images. The detail and clarity from the drone imagery enabled more targeted 'ground truthing' which would typically be limited from ground locations. With the drone imagery a more precise understanding of the extent and distribution of crop variations could be clearly observed. The information from the drone imagery can provide better management of agronomic issues in the field and assist more specific practices on the farm.



Figures 6 and 7: Comparative map - Satellite Imagery (left), drone imagery (right).

Figure 8: Satellite field map with GPS boundaries marked in yellow.

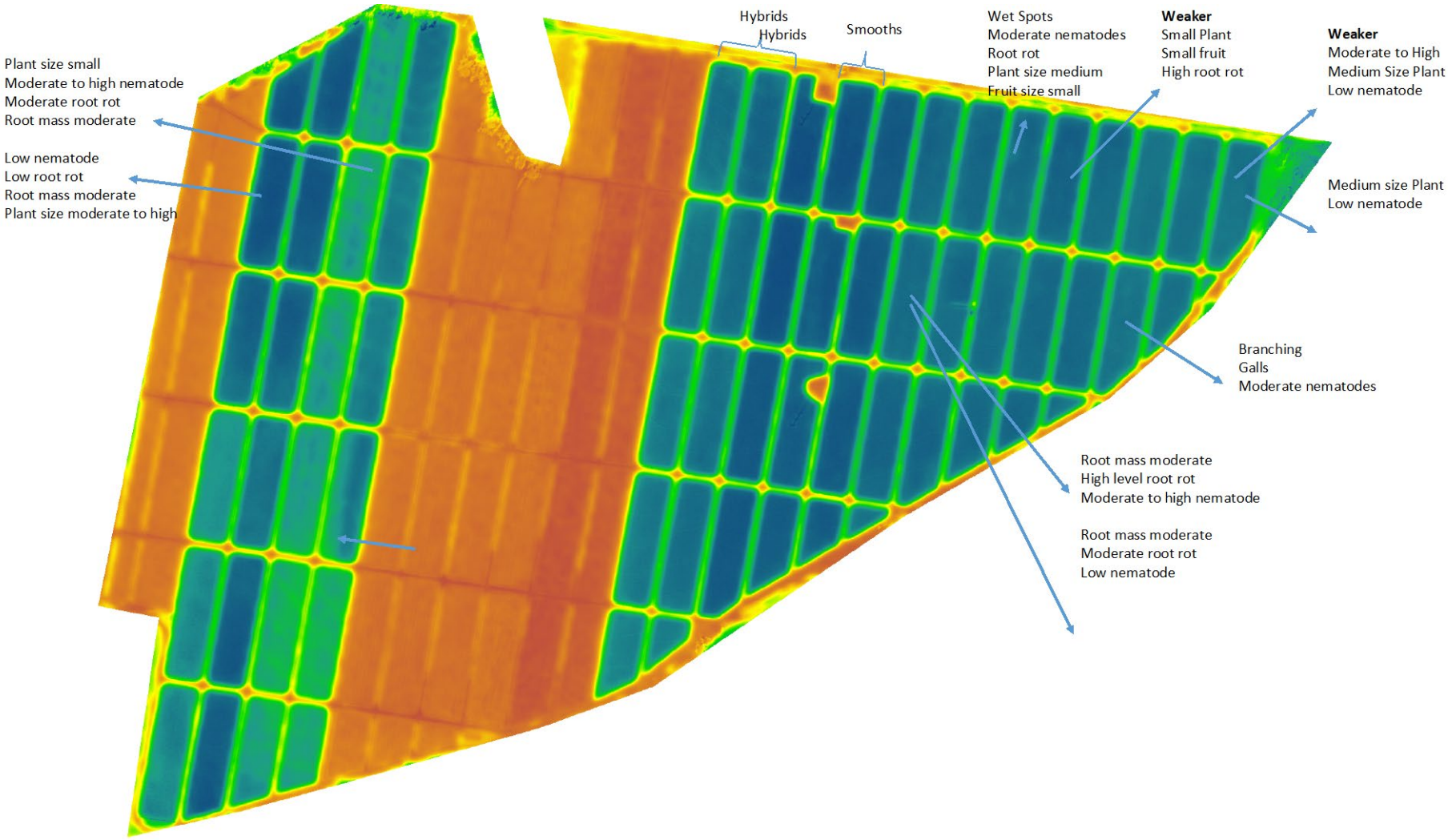


Figure 9: Ground truthing crop map from satellite image

Across the demonstration site the evaluation and analysis indicated the lighter coloured shades on the map as having lower crop growth and health. Results captured through 'ground truthing' from the industry agronomist, identified moderate to high levels of nematode and phytophthora root rot. These areas also reflected higher levels of soil moisture and reduced drainage. This information then enabled the agronomist and grower to implement more targeted management practices for their phytophthora root rot program. The sectional and variable rate boomsprayer provided the grower with the capacity to treat isolated areas rather than broadacre spray applications.

Field testing at Amaryllis Farming Company in Bundaberg utilised a manual sectional and variable rate boomsprayer on large, isolated areas of weed throughout a hybrid 73-50 pineapple plant crop. The sectional and variable rate boom spray was very effective in managing the weed using the sectional control function without broadacre application of herbicide. Here the boomspray operator manually opened and closed sections of the boomspray, spraying herbicide only in the weed affected areas of the fields without spraying areas of the field without weeds. In this situation sectional and variable rate boomspraying has reduced the amount of herbicide by 60% and limited the amount of crop damage saving approximately 10 – 20 tonnes / ha of pineapples when compared to broadacre application.

Figure 10: Random spread of bluetop in a pineapple field in Bundaberg (left and right)

DISCUSSION

Global Positioning Systems (GPS) in combination with satellite or drone imagery has the potential to become important technology for the Australia pineapple industry. This demonstration will be the starting point for further investigations evaluating the potential of precision guided farming operations and their application across the industry.

Sectional and variable rate spray control are attracting interest amongst pineapple growers as the cost of fertiliser and pesticide inputs increase rapidly post COVID-19 and with the global instability of fertiliser supply.

With the integration of imagery, the sectional and variable rate boomspray was able to substantially increase the capability of boomspraying equipment in the field. The potential economic and environmental benefits are driving these systems as they continue to gain the attention of growers looking to reduce their overall input costs and meet governance requirements such as Fresh Care and environmental certification.

There are several spraying systems available, either as options on new sprayers or as retrofits to existing sprayers. These options are relatively low capital outlays and simple for growers to integrate into the current boomspray systems. Some growers who have invested in this technology are utilising the sectional control to its full potential. Other growers have chosen not to automate their systems and are manually utilising this function for more basic boomspray operations.

ADOPTION AND IMPACT

With the successful development and construction of sectional and variable rate control boomspray equipment the adoption and impact from industry has been positive. Currently, six sectional variable rate boomspray machines are operating in the industry with further planned for construction. The rising costs of labour, fertiliser and pesticide inputs have slowed growers' capacity to upgrade equipment. Grant opportunities through Growcom's Farm Business Resilience (FBR) program or South East Queensland Water Quality project funded by the Department Environment and Science (DES) are leading the way in driving adoption within the pineapple industry.

CONCLUSIONS

There is great potential for further GPS guided farming practices within the pineapple industry. This may include land preparation, fumigation, bed forming and planting. Additional tools to support farm decision-making for example electro-magnetic (EM) scanning of the soil, crop imagery such as LiDAR, automated weed control and automated harvesting. Many of these precision guided applications are commercially available. However, further research is required to adapt, integrate and develop systems for pineapple farms. The technology has the potential to grow the industry, reduce its environmental footprint, improve profitability and sustain the pineapple industry into the future.

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