BSES Limited

FINAL REPORT - SRDC PROJECT BSS300

FEASIBILITY OF ACOUSTIC DETECTION OF CANEGRUBS FOR BETTER MANAGEMENT DECISIONS

by

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SD07003

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SUMMARY

Monitoring of pest populations is a key to effective management of insects in many crops, allowing pest-control treatments to be applied when needed, and only when needed. Monitoring should be relied on more for management of canegrubs in sugarcane, but its widespread adoption is held back by the laborious task of digging up cane stools to assess grub populations. This project aimed to assess the feasibility of detecting grub populations by the sounds that they make below-ground.

A researcher experienced in acoustic detection of hidden insects, Dr Richard Mankin from the United States Department of Agriculture in Florida, worked with BSES entomologists near Mackay and Bundaberg for 2 weeks in April-May 2007, using equipment that he brought with him. The investigations demonstrated that canegrubs can be detected readily in Queensland sugarcane fields during a time when worthwhile decisions could be made about future grub management. However, more work is needed to develop a system that could be deployed as a practical monitoring tool.

Recommendations for further development of the system are to:

- Carry out more extensive field-testing of a commercially available unit,
- Fund a student to learn more of the sounds that canegrubs make and the way they could be used in detection, and
- Develop equipment that is optimised to detect canegrub sounds and that is more robust and portable than what is currently available.

1.0 BACKGROUND

Canegrubs feed on the root system of sugarcane and cannot be easily detected before the plant shows visible signs of stress. A critical decision for cane growers is when and where to use available canegrub control options. Decision-support systems are being developed for greyback and Childers canegrubs, based on monitoring of fields for grubs, but growers and advisors are not keen to dig cane stools and it may not be economically feasible for a commercial consultancy to undertake this work. Less arduous and more time-efficient methods of monitoring canegrubs are being sought. Acoustic detection (without digging) has been used to detect white grubs in soil overseas, and could enable widespread adoption of monitoring and rational decision-making for grub management in sugarcane in Australia.

An experienced insect acoustic detection researcher, Richard Mankin, agreed to work with BSES Limited to determine the feasibility of such techniques in canefields. Dr Mankin has used acoustic methods to successfully detect related whitegrub species in turf grass. He was willing to bring his equipment to Australia and conduct a short series of monitoring tests on local canegrub species under realistic environmental conditions, thus providing an opportunity to evaluate, at minimal cost, the feasibility of acoustic techniques and the desirability or otherwise of further research.

2.0 OBJECTIVES

Specific objectives of the project were to:

- Assess whether canegrubs can be detected in the soil using acoustic methods in sugarcane-growing regions of central and southern Queensland;
- Define the current limitations and benefits of the technique, its applicability to two problematic canegrub species, and its potential role in IPM programs to control canegrubs in the region;
- Develop recommendations for further research needs and/or further testing and canegrub monitoring.

3.0 OVERVIEW OF KEY LEARNINGS AND KNOWLEDGE GAINED

Dr Mankin brought two acoustic detection systems from Florida, a general-purpose accelerometer system and an AED-2000, a commercially available insect acoustic detection device. He worked with Peter Samson at Mackay (22-29 April) and Keith Chandler at Bundaberg (29 April – 5 May), targeting greyback canegrub and various southern species (Childers, southern one-year and crinita canegrubs) in the respective regions. The team inserted acoustic probes from both devices into or adjacent to stools at targeted sites and recorded sounds for periods of at least 2 minutes, listening with headphones to assess the likelihood of soil-arthropod presence. The stools then were excavated to compare the assessed likelihoods with the actual presence or absence of different grub species, and to identify potential signal features that might be used in automated digital signal analyses or assessments of experienced listeners to discriminate among different pest and non-pest arthropods. Altogether, 98 recordings were taken from 62 sites (see attached CD for an example). Interference from wind and other background noises was evaluated, and tests were conducted to identify the distances over which canegrubs could be detected in field environments. Finally, the cooperators considered procedures and device modifications that could optimise the usability of these or similar acoustic devices for canegrub monitoring.

The investigations demonstrated that canegrub pests can be detected readily in Queensland sugarcane fields during a time when worthwhile decisions can be made about future grub management. It had been anticipated that windy conditions and loud external noises could interfere with detection, but, in these tests, such conditions did not prove to be of significant concern. It must be taken into account, however, that the detection devices must be protected from excessive heat, moisture, and shock. The general-purpose accelerometer system is highly sensitive and the signals it detects are easily interpretable after a small amount of training, but it is too clumsy for field use without modification. In addition, the wires connecting the sensor to the instrument must be arranged carefully to avoid damage or interference from undergrowth or debris. The AED-2000 is more robust and easily carried in the field, but its signals are more difficult to interpret than those of the accelerometer. We were unable to correlate the subjective intensity of sounds (rated by three listeners using the AED-2000) and the number of Childers grubs under stools, but we could identify that there was insect activity below-ground. Thus, the system may be better suited to detecting the presence or absence of grubs rather than estimating population density. Both instruments detected non-pest arthropods in addition to canegrubs, and this result must be taken into account when incorporating acoustic methods into a canegrub monitoring program. It should be noted, however, that we may be better able to discriminate between the sounds made by different insects when the analysis of recordings is completed (e.g. see Appendix 1).

Both devices tested could be optimised to improve their utility for canegrub monitoring. The accelerometer could benefit from a more portable carrying case and from development of a hollow-tube accessory that could be used to quickly insert a probe into the soil and then protect the sensor that is subsequently attached to the probe. The AED-2000 could benefit from an improved amplifier that could selectively amplify or filter out signals between 300-1000 Hz, depending on the background noise levels. Wireless transmission between the sensors and the detection systems, perhaps from multiple sample points, is feasible and would improve usability greatly.

4.0 IMPLICATIONS AND RECOMMENDATIONS

The study indicated that an acoustic device could considerably reduce the time involved in monitoring for canegrubs by enabling a surveyor to dig up only the stools where grub-like sounds have been detected. However, more work is needed to develop instrumentation and a sampling system that could be deployed as a practical monitoring tool. Acoustic detection may be better suited to presence/absence sampling rather than quantitative estimation of canegrub numbers, as an indicator of grub risk. Recommendations for further development of the system are as follows:

1. Purchase at least one currently available unit (AED-2000), and use it during 2007-9 in conjunction with conventional monitoring of Childers and greyback canegrubs to ground-truth its findings and assess its cost-effectiveness for detecting infestations (especially at low population densities). Conventional monitoring will take place anyway as part of other SRDC-funded projects (BSS266 plus GGIPs at Mackay and Mulgrave).
2. Obtain funding for a student to investigate the sounds produced by canegrubs – the nature of the sounds (chewing, movement, etc.), differences between species, and effects of environmental conditions (soil type, moisture, temperature, diurnal rhythms) – and purchase an accelerometer system and an audio digital recorder to collect and analyse the different signals.
3. Establish a research team to develop equipment that will be optimally configured for canegrub sounds and that will be suitably portable and robust.

These recommendations are not mutually exclusive. Which ones are followed, if any, must depend on the availability of suitable resources.

5.0 BENEFITS TO THE INDUSTRY, THE COMMUNITY AND/OR THE PARTICIPANTS THAT WILL ACCRUE FROM THE PROJECT

The results of this project will be used to assess the risks and benefits of further investment in acoustic detection.

6.0 COMMUNICATION OF THE FINDINGS OF THE PROJECT TO RELEVANT STAKEHOLDERS

The following communication activities were carried out:

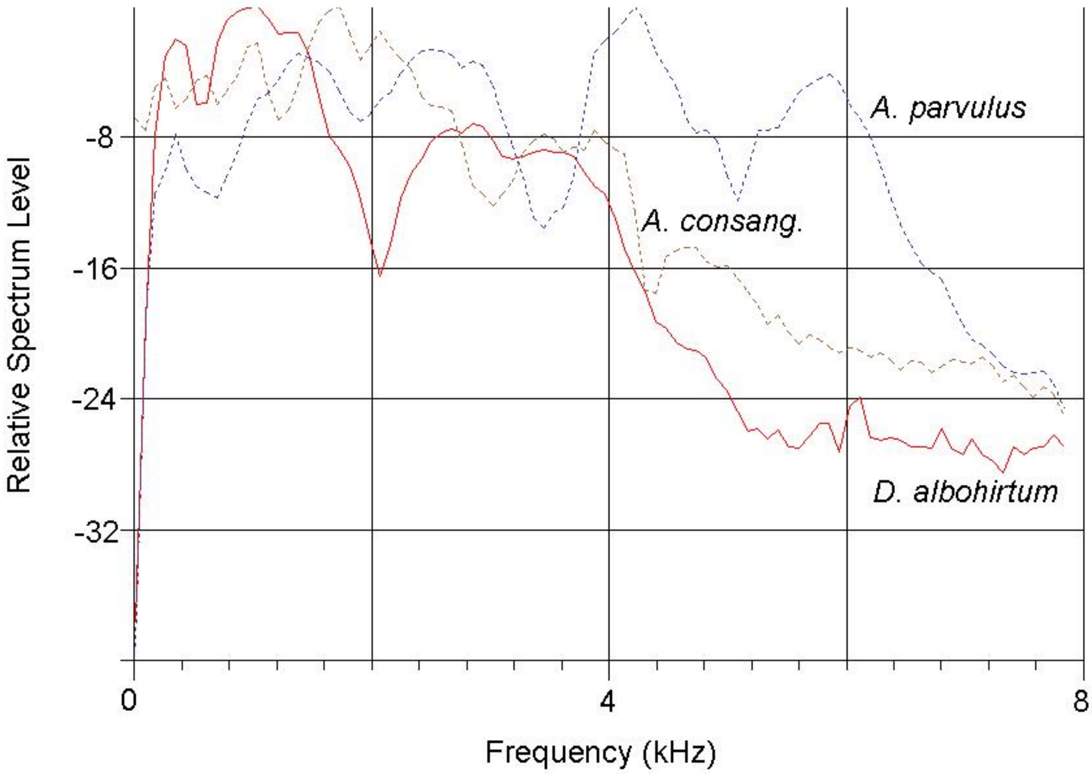
- Advisory staff from BSES Limited and productivity service companies were made aware of the work, and several advisors from Plane Creek, Mackay and Proserpine observed work in progress in the Central region and tried out the equipment in canefields.
- ABC rural radio interviewed Keith Chandler and Richard Mankin at Bundaberg and broadcast a sample of the canegrub sounds on public radio.
- A poster covering the work was on display at the Mackay BSES Field Day (Appendix 2).
- An article was published in the Field Day supplement to *The Daily Mercury*, the local Mackay newspaper (Appendix 3).
- An article was circulated in the newsletter of Bundaberg Canegrowers (Appendix 4).

7.0 HOW KNOWLEDGE OR INFORMATION GAINED CAN BE USED OR TRANSFERRED TO PROJECTS OR THE INDUSTRY

A more rigorous analysis of the sounds recorded during the project will be conducted by Dr Mankin as time permits. We are also rearing non-canegrub scarab larvae that were collected from beneath cane stools to confirm their identity to species level. We anticipate that this will lead to formal publication of the work in a recognised scientific journal.

APPENDIX 1 – AN EXAMPLE OF FURTHER ANALYSES

Sounds made by greyback and other grubs were easily distinguishable from background noise, and in some cases the sounds of different species could be distinguished due to differences in their relative amplitudes at different frequencies. An example of distinctively different sounds is shown in the figure below. The Childers grub, *A. parvulus*, had distinctively higher frequencies than its relative *A. consanguineous*, and the much larger greyback grub, *D. albohirtum*. Greyback and Childers grubs are not found together, but we are exploring the possibility that some grubs that are found together can be distinguished on the basis of differences in their frequencies or patterns of activity.



APPENDIX 2 – POSTER ON DISPLAY AT MACKAY BSES FIELD DAY

BSES QCROPS
Growing your bottom line

DETECTING CANEGRUBS

Peter Samson, BSES Limited

To make good decisions on grub management, growers must carry out some monitoring to determine where the grubs are, and in what numbers.

The traditional method, and still the best one, is the good old shovel; but digging in cane is not a lot of fun.

Some insects can be detected using the sounds they make – e.g. termites in wood. Maybe this would work for canegrubs?

BSES, with assistance from SRDC, has been working with Dr Richard Mankin from the United States Department of Agriculture, to test acoustic detection of canegrubs.

Richard helped develop some of the original termite-detection equipment, and has worked on soil insects in the USA.

Richard brought his equipment to Mackay and we listened to grubs.

We can certainly hear grubs underground. There is some work to do – can we tell canegrubs from other insects in the ground? The method has promise, and could make the process of monitoring much more acceptable.

BSES
Sugarcane for the future

www.bses.org.au

Australian Government
Sugar Research and Development Corporation

APPENDIX 3 – NEWSPAPER ARTICLE IN THE *DAILY MERCURY*, MACKAY

BSES Field Day 2007 — *Advertising Feature*

Entomologists tune in to noisy grubs

CANEGRUBS continue to be the most important insect pests of sugarcane in Australia.

Nineteen species are known from sugarcane, but some are of little significance. Greyback and French's canegrubs are the major canegrub pests in this region.

A variety of control options are available, including chemical insecticides and biological control products, for both plant crops and ratoons. Growers can therefore be quite flexible with their grub management.

At one extreme is the option of treating plant crops routinely and then treating ratoons once the plant crop treatments have run out of steam. This should control grubs effectively (provided they don't become resistant to the chemicals) but will be expensive, particularly if the fields had a low risk of grub attack anyway.

Alternatively, growers can adopt a flexible management program, treating or not treating plant crops and ratoons depending on the annual risk of grub attack in individual fields. This should be the most cost-effective strategy, but it does require that some form of monitoring program is in place.

The most effective means of monitoring grubs is with the trusty shovel. No sensible person enjoys grub digging for any length of time. As an alternative method of monitoring, BSES with assistance from SRDC invited an expert on acoustic detection of insects, Richard Mankin (United States Department of Agriculture, Florida) to work with BSES entomologists in April of this year. Richard brought his detection equipment with him, including a commercial termite detection device that he helped develop.

We could certainly hear canegrubs using Richard's equipment. The technology is not ready to use yet as a monitoring tool, but does show promise.

Pest management staff (Peter Samson and Tim Staier) will be on hand to discuss your issues with grubs or other cane pests. — PETER SAMSON

AMERICAN developed detection equipment listens in to cane grub activity on a central district farm. Picture: Contributed

APPENDIX 4 – ARTICLE FROM THE *BUNDABERG DISTRICT CANEGROWER*

USING ACOUSTICS TO DETECT CANE GRUBS

By Trevor Willcox, Area Development Manager

BSES Sugarcane for the future

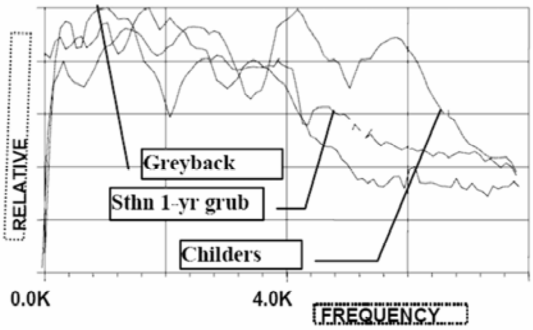
Recent research in the Bundaberg area has shown that monitoring for cane grubs may be as easy as inserting a probe into the soil and listening for their characteristic sounds.

BSES with assistance from SRDC recently sponsored a visit by Dr Richard Mankin from the United States Department of Agriculture, Florida, to Australia to test acoustic detection equipment. The tests showed considerable promise and different grubs emitted different sound frequencies when they chewed on cane roots (See graph). This equipment could become an integral part of a monitoring program for cane grubs.

BSES entomologist Keith Chandler is working on a monitoring program for cane grubs in the Bundaberg/Isis area. The program has shown that monitoring for grubs in autumn gives a good indication of whether damage is likely the next summer and therefore whether or not to treat fields. To date the only way of monitoring was to dig out stools of cane and check for grubs. When there are high numbers of grubs this is easy, but confirming there are no grubs takes much longer.

This acoustic equipment shows promise in identifying low grub numbers.

Now that the equipment has been demonstrated and shows promise, there will be further development.■



The Bundaberg District Canegrower - May 2007

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