2016

Development of controlled release formulations of imidacloprid for canegrub control: final report 2014/006

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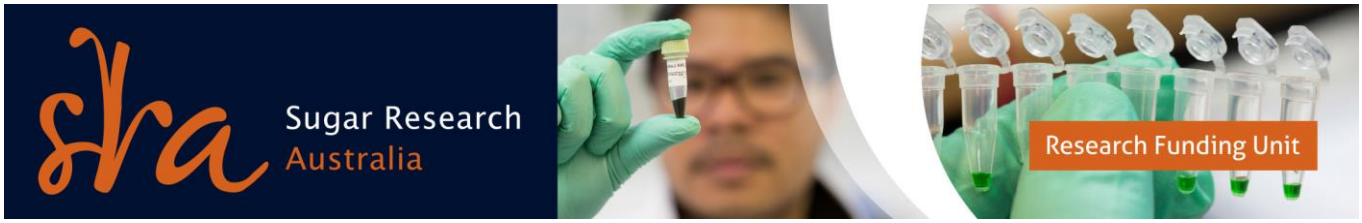
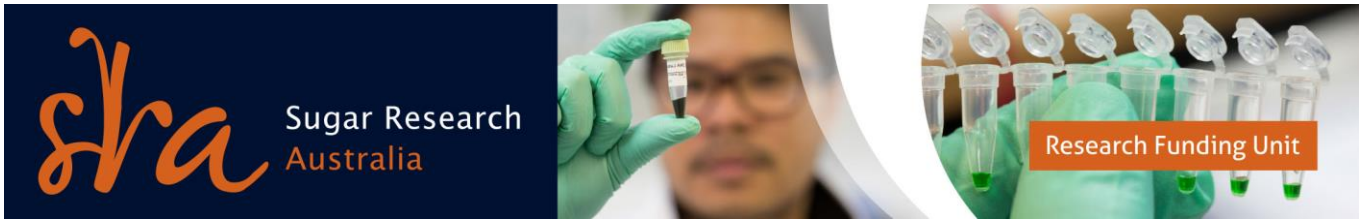
Sugar Research Australia



SRA Research Project Final Report

Development of controlled release formulations of imidacloprid for canegrub control

SRA Project Code	**2014/006**		
Project Title	Development of controlled release formulations of imidacloprid for canegrub control		
Key Focus Area in SRA Strategic Plan	3		
Research Organisation(s)	SRA		
Chief Investigator(s)	Andrew Ward		
Project Objectives	To develop controlled release insecticides for the extended control of a range of canegrub pests		
Milestone Number	Final Report		
Milestone Due Date	1 April 2016	**Date submitted**	1 April 2016
Reason for delay (if relevant)			
Milestone Title	Final Report		
Success in achieving the objectives	☒ Completely Achieved ☐ Partially Achieved ☐ Not Achieved		
SRA measures of success for Key Focus Area (from SRA Strategic Plan)	Capability to provide entomology, pathology, and weed expertise to meet the pest, disease and weed diagnostic and management needs of industry		



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PART A

Section 1: Executive Summary

Canegrub damage resulting from a variety of scarab species is a major productivity constraint for about 50% of Australian sugarcane farmers. Affected growers are spread across all cane growing districts and across all farming systems. Effective insecticides are the major tools used by growers to limit damage, with significant benefit for both growers and millers.

Sugar Research Australia have had a formal collaboration with Crop Care Australia since 1992 that has sought to develop controlled release insecticides that by their nature, when applied at planting, provide protection to sugarcane crops for a number of years. This long term collaboration has resulted in the registration of a number of controlled release products based on the active ingredients chlorpyrifos and imidacloprid, the most recent of which is marketed under the trade name suSCon maxi *Intel*.

To measure the effectiveness of suSCon maxi *Intel* relative to four other candidate formulations and the standard, 30 field trials were established between 2010 and 2013 across far north Queensland, the Burdekin, Central and southern production districts. These trials were monitored for infestation and the control efficacy recorded. The data from these trials supported the initial registration of suSCon maxi *Intel* in 2015. Since then observations of these trials have continued in an attempt to determine if sufficient data exists to support further label extensions providing even longer protection from grubs.

These trials have demonstrated that suSCon Maxi Intel provides protection from greyback, negatoria, consobrina and Bundaberg canegrubs for three years and Childers and southern one year grubs for four years, representing an increase by one year for all species over that provided by suSCon Maxi. This data has been used to register suSCon maxi *Intel* providing Australian cane farmers with between 33 and 50% longer protection from canegrubs depending on species for the same upfront cost. Unfortunately the data collected since 2015 has not supported the further extension of label claims from 3 to 4 years in the case of greyback, negatoria, consobrina and Bundaberg canegrubs and from four to five years in the case of Childers and southern one year grubs.

This project has delivered specifically against SRA KFA 3: Pest, Weed and Disease management and the deliverable's "pest and weed control strategies and technologies" and "alternative chemical treatments". It also contributes to SRA's measures of success in the areas of "development and adoption of SRA developed packages for integrated management of key, pests, diseases and weeds".

This project has also delivered significant social, environmental and economic benefits to the Australian sugar industry. In an economic sense growers have a control method that is "essentially set and forget" ensuring that for growers that have a high risk of grub damage that this risk is largely alleviated. Equally importantly, suSCon maxi Intel is being marketed for the same cost as suSCon Maxi meaning that the cost of control per crop-year has been reduced by between 33 and 50%. If the cost of additional control with a liquid product in the final year is included the total cost of management falls further. In an environmental sense the total amount of imidacloprid applied has similarly been reduced through extending the protection provided from a single application of controlled release

product. This also has social implications, firstly through reducing the potential impact from sugarcane farming on the environment and secondly through reducing the time required for growers to manage canegrubs on their properties.

Section 2: Background

suSCon® Maxi (50 g/kg imidacloprid), developed through several formulations with collaboration between Crop Care and SRA from 1992, provided commercial control of canegrubs far superior to any previous options from 2003-2014. suSCon Maxi is registered for application to plant cane to control greyback canegrubs for 2 crop-years, negatoria and southern one-year canegrubs for 3 crop-years, and Childers canegrubs for 4 crop-years.

Our aim in this and previous projects has been to identify and prove CR imidacloprid formulations with better performance relative to the standard Maxi formulation. Primary relative assessments were:

- Doses of insecticide in granules and in soil over the life of the product.
- Effects on canegrub populations and on sugarcane growth and subsequent ratooning ability, and the duration of cropping cycles for which the products are effective.

This R&D program has also addressed secondary objectives that indirectly influence performance and/or suitability of CR granule products such as

- Influence of manufacturing process (e.g. 'particle-cut') on performance;
- Influence of particle size (3 mm vs 2 mm) on performance;
- Influence of the different sources of active ingredient on performance;

In field trials the CR formulation variant suSCon® Maxi Intel has consistently provided control better than or equal to the standard suSCon® Maxi and controls canegrub populations for at least one crop-cycle more than Maxi. This product also has manufacturing advantages with less hazardous ingredients. Registration of Maxi Intel for commercial use in sugarcane was granted by the Agricultural Pesticide and Veterinary Medicine Authority (APVMA) in April 2015.

Experimentation reported here completes outstanding sets of results from field trials; particularly for the biodegradable CR formulations in the program.

Section 3: Outputs and Achievement of Project Objectives

Project objectives, methodology, results and discussion

Project Objective

This project was established with the primary objective of determining whether suSCon maxi Intel has the ability to control greyback, negatoria, consobrina and Bundaberg canegrubs for three to four years and Childers and southern one year grubs for four to five years.

Methodology

A series of field trials were established between 2010 and 2013 across far north Queensland, the Burdekin, Central and southern regions to evaluate the effectiveness of a range of formulations to provide control of a number of regionally specific canegrub species. The trials established and species targeted were as follows:

CR imidacloprid applied at 'fill-in' by rates versus greyback canegrub

Code	Site	Plots*
EC10-03	Pace, Dawlish Rd, Sarina	rfp
EC10-04	Lay, Homebush, Mackay	rfp
EC11-01	Sammutt, Homebush, Mackay	rfp
EC11-02	Camilleri, Stamford Rd, Oakenden, Mackay	rfp
EC12-01	Ribaldoni, Turners Rd, Homebush, Mackay	rfp, mp
EC12-02	Reed, Bruce Hwy, Sarina	rfp, mp
EC13-01	Borg, Mt Ossa, Mackay	rfp, mp
EC13-02	Davies, Balnagowan Mackay	rfp, mp
EA13-01	Marano, Jarvisfield* (CCA staff)	rfp, mp
EA13-02	Lyon, Giru (CCA staff)	rfp, mp
EN10-02	Crema, Meringa, Gordonvale	rfp
EN10-03	Arcidiacono, Sandy Crk, Gordonvale	rfp
EN11-02	Rossi, Bruce Hwy, Gordonvale	rfp
EN11-03	Cecchi, Pin Gin Hill , Nerada	rfp
EN12-01	Thomas, Sandy Creek, Gordonvale	rfp, mp
EN12-02	Castini, Green Hill, Gordonvale	rfp, mp
EN13-01	Downing, Peets Bridge, Gordonvale	rfp, mp
EN13-02	Thomas, Gordonvale	rfp, mp

CR imidacloprid applied in plant-cane furrow versus Childers canegrub

Code	Site	Plots*
ES09-03	Webb, Cordalba	rfp mp
ES10-03	Kingston, Claytons Rd, Cordalba	rfp, mp
ES11-06	Cocco, Elliot Heads Rd, Bundaberg	rfp, mp
ES12-01	Bund. Sugar Ltd, Church Rd, South Kolan	rfp
ES13-02	LaRocca, Cordalba	rfp

CR imidacloprid applied in planting furrow versus southern 1-year canegrub

Code	Site	Plots*

ES10-04	Garrad, Garryowen Rd, Redridge	rfp, mp
ES11-05	Halpin, Alloway	rfp, mp
ES12-03	Chapman, Langbecker Rd E, Alloway	rfp, mp
ES13-01	Fritz, Dahl's Rd, Alloway	rfp, mp

CR imidacloprid in open planting furrow versus Bundaberg canegrub

Code	Site	Plots*
ES10-02	Zunker, Poulsen's Rd, Sharon	rfp
ES12-02	Francis, Moore Pk Rd, Meadowvale	rfp, mp
ES13-03	Zunker, Henricksens Rd, Sharon	rfp, mp

*rfp = randomised field plot,
mp = microplots

These trials were monitored annually for grub infestation and where infestations warranted further assessment, yield and ratooning was assessed. This monitoring continued until trials were ploughed out or were deemed to no longer be providing valuable data.

To support the registration of new controlled release products and obtain a better understanding of how imidacloprid is released from different granule formulations a series of microplots (small open containers containing known doses of insecticide products) were also established at each site at the time of trial establishment. These microplots were removed periodically between 3 and 39 months after establishment and the soil and granules analysed to determine the concentration of imidacloprid in the soil surrounding the granules and the amount of imidacloprid remaining in the granules to develop a picture of release rates from different formulations. These microplots were also used to develop bioassay methods that could be utilised to screen a series of new actives.

Results

A milestone variation was requested (and granted) to report the Milestone four outcomes as a component of the final report. Specifically these achievement criteria have been met as follows:

a) Trials harvested according to decisions of June 2015 meeting: All trials were harvested according to the decisions of the meeting held in June 2015. These results are included in Appendix 1

b) Cane vigour and grub assessments completed: All cane vigour and grub assessments were completed as determined at the June 2015 project team meeting. These results are included in full in Appendix 1

c) Analysis of granules and soil from micro plots completed: All granule and soil analyses have been completed and are reported in Appendix 1.

d) Project results for 2015 reported and reviewed: A review meeting was held at SRA 15 March 2016 involving SRA and Crop Care personnel. At this meeting Appendix 1 was tabled and the results discussed along with their implications. These are discussed further in the Discussion below.

e) Decision reached on time line for submission to APVMA for 4-5 year canegrub control using suSCon Maxi Intel: See Discussion below

This project represents an accumulation of data over a number of years from 30 field trials. The results of these trials are reported extensively and chronologically in the Milestone reports submitted throughout this project and are outlined in full in Appendices 1 to 3

Discussion

This project set out with the specific objective of "research collaboration to extend control for three or four years for greyback canegrub and four or five years for other species with one application in the plant crop using Imidacloprid with new CR formulation technology (suSCon maxi Intel)".

This project has achieved this objective in full with sufficient data collected to enable Crop Care Australia to successfully apply to APVMA to have suSCon Maxi Intel registered for three year control for greyback, negatoria, consobrina and Bundaberg canegrubs and four year control of Childers and southern one year grubs. Unfortunately the data collected to date does not support further label extensions for any species at this point.

The label extensions achieved as a result of this project represent a significant advancement at a number of levels. Importantly growers can now apply an insecticide at planting and protect their crops for 33 – 50% longer depending on species. Given that suSCon maxi Intel is being marketed at the same price as the predecessor product suSCon Maxi, and that additional control using liquid products is not required in the extra year of protection the cost of control on an annual basis has been reduced by an even greater margin. Further, significant environmental benefits are likely to accrue from the reduction in the amount of the active ingredient imidacloprid applied over a crop cycle which in the case of three year control species such as greyback is as much as 60% or 500g ai / ha.

An objective of this project was to develop an understanding of accumulations of imidacloprid in soil under the range of field conditions, and the relevance of this to canegrub control. Although all samples were processed and analysed, concentrations in soil surrounding the granules were inconsistent (and often unexpected) making the interpretation of this data difficult. The associated data measuring the amount of imidacloprid retained in granules was more consistent and supported what would be expected from the targeted products, to deliver control.

The project has also yielded a bioassay method that can be used to screen non-acute toxicants (such as imidacloprid) that could be of value in the management of canegrubs. This method has proven to be reasonably reliable at discriminating between CR formulations; at least for imidacloprid and will provided a method to evaluate other actives. Recent refinements to technique as described in Appendix 1 should further improve this capability and provide a method to determine doses, and persistence with ageing, of other products and formulations.

Section 4: Outputs and Outcomes

This project has produced the following outputs:

1. The sugar industry now has an insecticide that controls greyback, negatoria, consobrina and Bundaberg canegrubs for three years and Childers and southern one year grubs for four years representing an increase by one year for all species over that provided by suSCon maxi.
2. The sugar industry now has a proven bioassay methodology that can be used to test new compounds that are either acute or chronic toxicants against a range of canegrub species under laboratory conditions

The project has produced the following outcomes:

1. The relationship that exists between SRA and CCA has been strengthened considerably leading to the potential to collaborate further on a range of additional actives.

2. The extended registration of suSCon maxi Intel has resulted in a reduction in the likely annual application of imidacloprid on a per ha basis with the potential outcome of improved water quality
3. suSCon maxi Intel is currently being marketed at the same price as suSCon maxi. As a result an outcome of this project will be a significant reduction in the cost of canegrub control.

Section 5: Intellectual Property (IP) and Confidentiality

This project has collected the data required to support extending the registration of suSCon maxi Intel to provide protection from canegrubs in sugarcane from two years to three years for greyback, negatoria, consobrina and Bundaberg cane grubs and from three years to four years for Childers and southern one year grub. **All of this information is protected from general disclosure by background confidentiality agreements that exist between SRA and CCA and as such the contents of the appendices attached to this report should not be made publically available.** All formulation data remains the exclusive property of CCA.

Section 6: Industry Communication and Adoption of Outputs

The most significant outcome of this project has been the registration of suSCon maxi *Intel* which provides an extension of control from two years to three years for greyback, negatoria, consobrina and Bundaberg cane grubs and to four years for Childers and southern one year grub. This outcome has been communicated extensively to industry by Crop Care Australia in advertising in cane industry media as well as by SRA in publications such as Cane Connection. Phil Ross from the Adoption group has been actively involved in this communication.

a) What new information, if any, is available on the adoption of project outputs?

Sales figures for suSCon maxi *Intel* are commercial-in-confidence in nature and are not shared by Crop Care Australia with SRA. Verbal indications from Crop Care Australia suggest that suSCon maxi *Intel* has been well received by the market and that sales have increased significantly over that of suSCon maxi.

b) List any newsletters, fact sheets or any other media coverage.

As indicted above Crop Care Australia through their sales team have promoted the use of suSCon maxi *Intel* extensively through both advertising and through the interaction of their sales force with key growers and resellers. Given the commercial nature of the ag chemical industry this promotion will be ongoing as Crop Care seeks to grow their market share in this key market segment.

c) Identify any further opportunities to disseminate and promote project outputs at seminars, field days etc.

As grub populations fluctuate numerous opportunities will arise to continue to promote the value of suSCon maxi Intel at seminars and field days. These opportunities will be taken as they arise.

Section 7: Environmental Impact

Increasing the duration of protection from two to three years for Greyback canegrubs and from three to four years for Childers grub has the ability to reduce the environmental load of imidacloprid by up 50% through longer protection with the same amount of active ingredient resulting in a positive environmental outcome. When adding the requirement to retreat with liquid based products in the extra year this results in a reduction of 500g ai per hectare applied per crop cycle.

Section 8: Recommendations and Future Industry Needs

The experiences and learnings from this project have yielded a number of recommendations as well as insights into future industry needs:

Recommendation 1: This project has been built around a strong collaborative relationship between a commercial partner in the form of Crop Care Australia and the scientific expertise that exists within SRA. This has resulted in the development of a product that is market ready and that fits with the needs of the end user (levy payer). This commercial relationship is supported by cash contributions from both parties and as such there is a commercial imperative on the part of Crop Care to extract value from the investment should results support the registration of a product. As a result there is a well-defined path to market supported by formulation, regulatory, sales and marketing teams which are backed up by the strong technical and scientific expertise within SRA. This approach has yielded rapid adoption of the innovations delivered by this project and serves as a model of collaboration that could be utilised in future projects of a similar nature.

Recommendation 2: In recent years imidacloprid has been observed with increasing frequency and concentration in water quality samples taken from waterways in cane production areas raising the possibility of regulatory restrictions in the future. Data obtained from microplots in this project suggest that soil concentrations of imidacloprid are typically less in soils in which granular products are applied then where liquids are used in the period immediately following application (which in most cases relates to the onset of the wet season). This observation raises the possibility that granular (CR) formulations of imidacloprid could have less of an environmental impact than liquid products. Also incidental or secondary observations during this collaboration and project suggest other advances with significant environmental and unilateral economic benefits. As a result it is recommended that work should be commissioned that specifically explores:

- If granular (CR) formulations of imidacloprid could have less of an environmental impact than liquid products
- If it is possible to reduce off-site movement of imidacloprid with liquid formulations, and improve their efficacy and efficiency through reduced rates, through more effective placement techniques, which have never been fully explored.
- The possibility of applying CR based formulations to ratoon crops, which are over 75% of the industry, raises the potential for the industry to more effectively rely on control practices based on the GrubPlan concept of applying preventive treatments only when and where the needs are becoming apparent.

Recommendation 3: Historically insect management strategies that rely on single insecticides have been proven to be high risk in nature as a result of either insecticide resistance in the target population or through enhanced microbial degradation as was the case with chlorpyrifos (suSCon blue) in the sugar industry. As a result, work should be commissioned that seeks to develop alternatives to imidacloprid as a control strategy for canegrubs.

Section 9: Publications

Chandler KJ and Jennings J. 2015. Are Christmas grubs pests in southern Queensland sugarcane? Proceedings of the Australian Society of Sugarcane technologists 37: 112-120

Tucker GR, Chandler KJ, Stringer JK, Derby L Eaton A, Craddock A, Watkins S. 2015. suSCon Maxi Intel for extended control of greyback canegrub in sugarcane. Proceedings of the Australian Society of Sugarcane Technologists 37: 101-111.

Tucker GR, Chandler KJ, Stringer JK, Derby L Eaton A, Jennings J, Matthews N. 2015. Does imidacloprid provide abiotic benefits to sugarcane in the absence of canegrubs? Proceedings of the Australian Society of Sugarcane Technologists 37:121-131.

Keith Chandler, Jillian Jennings, Allen Eaton, Lisa Derby, Alison Jensen. 2016. Ranking varietal tolerance to canegrub damage Proceedings of the Australian Society of Sugarcane Technologists 38:(Poster)