SRDC Grower Group Innovation Project

Final Report

SRDC project number:	GGP029
Project title:	Mulgrave cane growers strategic grub management implementing BSES decision-making tools.
Group name:	Mulgrave Cane Grub Management Group
Contact person:	Jeffrey Day
Due date for report:	1 February 2010
Funding Statement:	This project was conducted by Mulgrave Cane Grub Management Group in association with the Sugar Research and Development Corporation (SRDC). SRDC invests funds for sugar R&D derived from the sugar industry and the Australian Government.

Executive Summary:

This project was a continuation of previous SRDC/BSES GrubPlan projects in which the importance of a thorough grub monitoring program was highlighted. Essentially, the need for more grower involvement led to the creation of the Mulgrave Cane Grub Management Group through this Grower Group project, and this concept has proven to be very successful due to the active involvement of interested growers in actual data gathering and result interpretation which facilitated adequate decision making.

20 Mulgrave growers participated in this monitoring project, of which 4 growers were heavily involved (Jeff Day, John Ferrando, Jim Dillon and Ron Downing). Christine Hancock from Mulgrave CANGROWERS was also involved, as well as staff from Mulgrave Productivity Service (Allan Hopkins, Richie Falla and David Wallis). The actual field work and data gathering were mainly conducted by BSES entomologist Dr Nader Sallam and the entomology research team at BSES Meringa.

42 sugarcane plots were used to monitor and predict greyback cane grub population dynamics and potential damage in Mulgrave over two consecutive seasons (2008-2009). Particular emphasis on “Whole Farm Planning” was given to the farms of the 4 previously mentioned growers, where prediction of future population dynamics and potential damage levels were conducted for the whole farm not only the plots monitored. This was also carried out with other keen growers who expressed high interest in this work, where a “Whole Farm Plan” could be drafted and recommendation for pesticide application and other activities were discussed with the grower on a ‘plot-by-plot’ basis. Predicting future grub dynamics and damage levels was made possible through prediction models that were developed by Dr. Frank Drummond, Maine University, USA. Dr. Drummond who used monitoring results generated through previous GrubPlan projects to build forecast models.

During the 2 seasons, the selected farms were dug for grubs and all grubs collected were bred in the laboratory at Meringa and checked for diseases. Several factors were also monitored and recorded (these are mentioned in detail under the methodology section) and results were entered into the prediction models. Model-generated predictions and damage estimates for the following season were conveyed to growers through GrubPlan meetings and face-to-face discussions. Growers’ actions and whether they accepted BSES’s recommendations or not were all recorded.

This project has been very successful in the sense that, through work experience and previous research, it has been noticed that growers response to grub dynamics has always been reactionary, where the rise and fall of insecticide treatment always followed the rise and fall of grub populations. This is the first time growers’ reactions have been proactive, where treatment rates rose simultaneously with the expected (predicted) rise in grub numbers. Most Mulgrave growers could see the benefit in this project to the extent that the Mulgrave Cane Grub Management Group has succeeded in raising funds to keep the grub monitoring activity going for another year after the conclusion of this project.

Background:

Geyback canegrub (*Dermolepida albohirtum*) is the most damaging sugarcane pest in Australia, with estimated annual losses of up to $10 million and with periodic outbreaks where losses may reach $40 million in damage and management expenses. The Mulgrave area (growers, harvesters, millers) has suffered heavy financial losses from outbreaks in the past. Applying chemicals with a ‘just in case’ system to prevent grub outbreaks without first determining if there is a need is costly, unnecessary and wasteful, and may lead to reduced chemical effectiveness in the longer term. The BSES/SRDC GrubPlan initiative was initially implemented to highlight the role of a range of management practices including the strategic application of insecticides. A key component of the GrubPlan program relied on pest monitoring with the aim of predicting future infestation rates, hence enabling growers to make well informed grub management decisions. GrubPlan is viewed by growers as a comprehensive decision-support system for canegrub management.

This Grower Group project was conducted to actively involve Mulgrave growers in actual grub monitoring and data interpretation that allow decision making that is based on solid field data. This approach is likely to build growers' confidence in research results. It is envisaged that grub monitoring could be an ongoing activity in Mulgrave, depending on availability of funds.

Aims:

The main aims of the project were:

- Implementation of a regional grub monitoring system developed in Mulgrave during 2003-2006 by BSES, with improvements in the accuracy of predictions;
- Provision of advice on district-wide grub trends to group members to assist with grub management decisions;
- Testing of a farm-level monitoring and prediction service that could be used to make field-by-field decisions, by interested growers;
- Implementation of a regional approach to managing the grub problem by participating growers in addition to individual efforts;
- Increased adoption of grub IPM strategies in Mulgrave;
- Participating growers making well-informed decisions on when, where and what to treat, thus minimising pesticide use and crop losses.
- Increased revenue plus reduced input costs with environmental and social benefits (reduction of chemical use in a Wet Tropics Region).

Methodology:

A total number of 42 plots belonging to 20 Mulgrave growers were monitored for 2 consecutive seasons (2008-2009). The plots were chosen because they all had a history of grub infestation and they are located in areas known to experience frequent canegrub problems. The following table lists all monitoring activities and the method by which they were carried out:

Month	Activity	Methodology
December	• Measuring of canopy height • Assessment of gaps in crop • Information on cultivar, fallowing strategy and history of insecticide application sourced.	Canopy height in all study plots and a number of adjacent plots is determined using a staff. Gaps in plots were determined by randomly inspecting five 10-metre sections in each plot and recording the number of gaps wider then 60 cm in each section.
January	"Tree damage index" compiled on main host trees to judge regional beetle activity.	Feeding symptoms by greyback beetles and degree of damage on fronds of coconut and alexandria palms assessed on selected groups of trees around Mulgrave. Damage is ranked from 0 (no damage) to 3 (heavy damage).
March	Grub monitoring.	In each plot, 4 cane plants are dug up in each corner and in the middle, making a total of 20 plants per plot. The plants are chosen to be 10, 20, 30 and 40 m into the paddock in each corner, with 2 rows separating each sampling row. The entire plant is dug up and a volume of 30 x 30 x 30 cm of soil is removed and checked for grubs, then the plant is placed back into the soil. Any grubs found are collected, placed in peat in plastic containers labelled with the date, farm number, plot number and

		grub species and age. All grubs collected are taken to the laboratory at BSES Meringa and fed weekly on pieces of carrots.
April-October	• Grub breeding and assessment of disease levels. • Grub damage assessment.	Grubs are checked in the laboratory for infection with *Adelina*, *Metarhizium*, milky disease or unknown pathogens. Disease levels recorded. Damage assessment is done during June-July through aerial photography and groundtruthing on a plot-by-plot basis.
November	• Damage and population dynamic predictions made for the following season. • Prediction results conveyed to growers for decision making.	All needed information is entered into a spreadsheet and the model is run for each plot. The data are entered into 3 main predictive models, two of which calculate a likelihood of low, moderate and high greyback grub damage in the following season based on data collected in the current season (Table 1), while one model gives an estimation of grub numbers in the following season (Table 2). If the models predict a 50% probability or more that a particular plot will sustain moderate or heavy damage in the following year then the grower is advised to treat. This is done through GrubPlan workshops. Of equal importance, other farming practices such as zonal tillage, manipulation of planting and harvesting dates, biological control using BioCane and the use of trap cropping are all encouraged and discussed with growers where and when applicable. Growers actions are recorded in January the following year after they had either followed BSES's recommendations or not and reasons for not following the recommendations are discussed with the grower.
June-July in Year 1	Damage assessment in year 1 (the following year).	During June-July, a flight is conducted to examine and document regional grub damage (Fig. 1). This is further "ground truthed" through on-ground surveillance on a plot-by-plot basis. Damage is ranked into 4 "colour coded" categories (no damage, light, moderate or high damage). Results are then plotted on the Mulgrave map using a GIS program. Actual field results are compared with prediction results made the previous year.

Results and Outputs:

Project milestones reported on project results in detail. The following points summarize these and also include the latest prediction data and growers response to BSES recommendations.

Aerial survey and mapping of grub damage in year 0

Aerial surveying and mapping of grub damage are very powerful and useful tools in the fight against canegrubs. Mapping of canegrub damage provides a ‘short and snappy’ way of conveying information to growers, where they could quickly examine areas harbouring most of the damage and compare that to previous years. Mapping is also a very useful tool in predicting future damage on farm and regional level, and provided good tools for discussing the reasons for expression of damage in a particular area with affected growers. Appendix 1 and 2 show damage distribution in Mulgrave for the 2008 and 2009 seasons. Results from this and other GrubPlan projects indicate that the level of insecticide application is the most significant factor governing grub dynamics. Other factors, such as levels of *Adelina* disease, farm management, soil types, vicinity to grub damage and crop age, also play a role, but it has become clear that consistency of insecticide application is the most significant.

Fig. 1. Grub damage in Pine Ck, Mulgrave, 2009

Grub population and damage prediction for year 1

Table 1 shows the data entry process into the model and an example is given using data from plot 17-1 on farm 94 (property of Mr. Jeff Day). The first model (model 5) requires average grub number/stool, severity of damage in plot and adjacent plots, regional average of grubs/stool, and regional percentage of *Adelina* infection in the current year (Yr 0). Model 10 requires the same information but doesn’t require a precise grub/stool figure in plot but rather a (presence/absence) result. Prediction results for plot 17-1 – Farm 94 are shown in Table 1, where model 5 predicted a probability of 20%, 75% and 5% low, moderate and high damage probabilities respectively, while model 10 predicted 34%, 62% and 4% for the same damage levels in (Yr1).

Table 1. Greyback grub damage prediction for 08 - 09 season for plot 17-1 – Farm 94, Mulgrave

Predictor variables	Model 5	Model 10
Protected (suSCon 3 yrs, Confidor 1 yr) = 1, Unprotected = 0	0	0
Grubs/stool Yr0	0.45	
Grub presence Yr0 (present = 1, absent = 0)		1
Severity of damage (0-3) Yr0	1	1
Max severity within 400 m (0-3) Yr0	1	1
Grubs/stool regional average Yr0	0.17	0.17
% *Adelina* regional average Yr0	17.74	17.74
Probability (low)= %	**20**	**34**
Probability (moderate)= %	**75**	**62**
Probability (high)= %	**5**	**4**

Table 2 shows predicted number of grub/stool in Yr 1 for the same plot (17-1 – Farm 94). The model predicts an average number of 0.37 grub/stool in 08-09 season.

Table 2. Greyback grub number prediction for 08 - 09 season for plot 17-1 – Farm 94, Mulgrave

Predictor variables	model 3
Fallow = 1, Replant = 0	0
Ratoon=1, Plant crop = 0	1
Protected (suSCon 3 yrs, Confidor 1 yr) = 1, Unprotected = 0	
Grubs/stool Yr0	0.45
Severity of damage (0-3) Yr0	1
Max severity within 400 m (0-3) Yr0	1
Grubs/stool regional average Yr0	
% *Adelina* regional average Yr0	17.74
Predicted grubs/stool Yr1	**0.37**

Growers' advice and following action (level of take up recommendation assessed)

Table 3 shows predictions for 2009 and growers' actions in 2008 based on BSES's recommendations and Table 4 shows prediction for 2010 and growers' actions in 2009. Results were very encouraging as they showed that all growers (with the exception of one in 2008 and two in 2009 – highlighted in yellow in tables 3 and 4) trusted BSES's recommendation. It was not feasible for some growers to treat their plots when they should have according to BSES's recommendation but that was due to reasons other than lack of trust. For example, several growers refrained from treating a plot when they should have treated because they had intended not to ratoon the crop any further, therefore decided not to invest in it. This is acceptable because growers usually ensure that the following plant crop is protected. Other growers had intended to treat according to BSES's recommendations but "got caught" with other activities and by the time they were ready to treat the crop was too large. Those growers acknowledged that the BSES recommendation was the correct thing to do.

Grub dynamics and growers' reactions

As shown in Figure 2, growers' responses to grub numbers have always been reactionary, but in 2009, a rise in the number of plots protected was simultaneous with the gradual rise of grub numbers, indicating that growers acted proactively in anticipation of the predicted rise in grub numbers in 2009. This is a major outcome of this project and it demonstrates the value of this study in achieving a good level of strategic insecticide application.

Dynamics of grub pathogens

Figure 2 also shows that Adelina levels rise following a rise in grub numbers and vice versa, which confirms previous results by Robertson *et al.* (1998) and Sallam *et al.* (2003). Results on levels of other, less significant diseases are mentioned in detail in previous milestone reports.

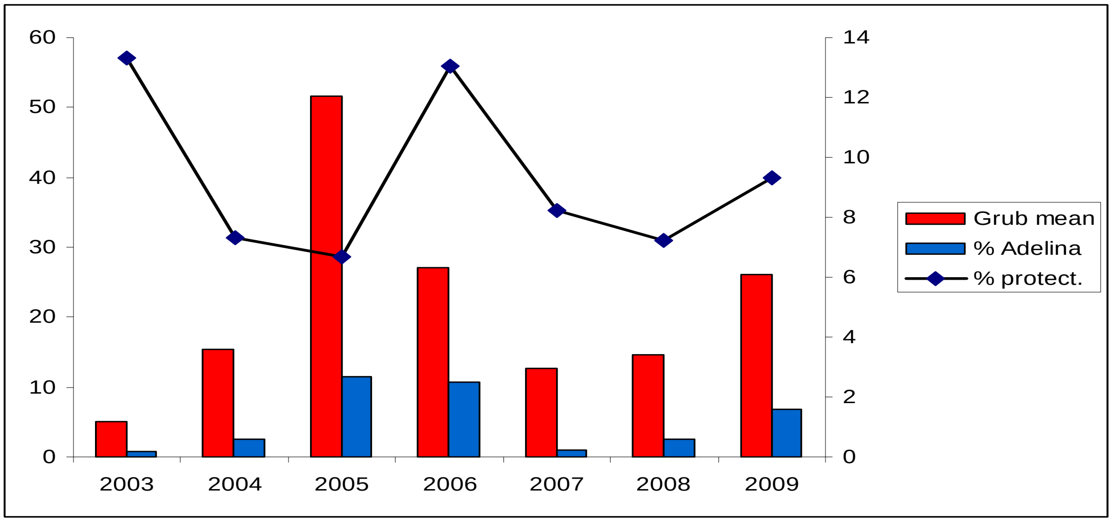


Figure 2. Grub numbers and Adelina infection levels

Communication of results

Several GrubPlan workshops were conducted throughout the region during the project. During GrubPlan workshops, model predictions and BSES recommendations are communicated to growers with advice on the need for treatment highlighted. In December-January of the following year, all growers were contacted and requested to inform BSES of their management decisions. Results for 2008 and 2009 are presented in Tables 3 and 4.

During the most recent GrubPlan workshop (25 August 2009), growers were requested to fill in a questionnaire on the value of the monitoring program (Appendix 3). Results from this survey are very encouraging, where some growers estimated their savings due to this program to potentially be up to $20,000 (Appendix 4). Growers feed back was very impressive and confirms the success of this project.

Intellectual Property and Confidentiality:

Growers agreed to provide other organizations with their farm maps. The distribution of farm maps is restricted.

Capacity Building:

Growers were happy for BSES to handle the scientific part of the project, while they were involved in discussing the results and adopting recommendation if they see the logic behind it. Growers were also happy to establish trap crops on their farms and try BioCane™ as an alternative biocide. It is clear from the results that this project enhanced growers' confidence in BSES's capacity to conduct sound and applicable research. In addition, this project introduced growers to the complexity of scientific research - those involved appreciated that there is no easy answer or 'silver bullet' for any pest problem. Growers took it upon themselves to source extra funds to ensure the continuation of the monitoring program for another year. Several growers now are also capable of identifying grub species and many of them are engaged in monitoring beetle flights and in some cases join in with the grub digging work.

Outcomes:

- Early warning system established for grub dynamics and damage levels in Mulgrave
- Confidence building between growers and research providers
- Strategic application of insecticides
- More adoption of alternative management methods such as biological control, zonal tillage and trap cropping
- Introduction of mapping and GIS systems in grub management
- Success of project led by Herbert growers to seek funds for a similar monitoring program

It is evident that this project has succeeded in meeting all proposed criteria, and a major outcome is confidence building between the usually sceptical growers and research providers.

Environmental Impact:

Strategic application of pesticides and adopting zonal tillage and biological control strategies reduce pollution and soil run off, therefore have a positive environmental impact.

Communication and Adoption of Outputs:

Several GrubPlan workshops and face to face meetings with growers have been carried out, with SRDC's input acknowledged at the beginning of any workshop. Several articles were also published in the *BSES Bulletin* and *Australian Canegrower* (See below).

Recommendations:

It is recommended that a regional grub monitoring program should always be an ongoing activity that involves active grower participation. The following are some suggested areas for future research:

- Implementation of remote sensing in grub management
- Adopting Near Infrared (NIR) technology to forecast grub outbreaks and a range of other disorders early in the crop cycle before they build up to alarming proportions

Other more points that need research can be summarized as follows:

- Emergence rate of adults under different climatic conditions and rainfall.
- Reasons why adult beetles are attracted to certain fields and not others.
- Dispersal distance and direction of beetles (and what proportion oviposits in the same field from which they emerged).
- Egg and larval survival rates under different soil moistures, temperatures and soil types.
- Identification of unknown mortality factors.

Publications:

Sallam N. 2008. Trap cropping in far north Queensland. *BSES Bulletin* 19, 5-7.

Sallam MN. 2007. Grub monitoring – an essential task for cost-effective management. *BSES Bulletin* 13, 10 -11.

Sallam MN & Samson P. 2007. Grub monitoring continues in the Central District and in the Far North. *BSES Bulletin* 15, 27.
Sallam MN. 2007. No silver bullet for sugar's greatest foe. *Australian Canegrower* 29(3), 14-15.

References cited

Robertson LN, Dall DJ, Lai-Fook J, Kettle CG and Bakker P. 1998. Key factors in control of greyback canegrub populations. BSES Publication SD98014.
Sallam MN, Bakker P and Dall DJ. 2003. Prevalence of soil-borne diseases of greyback canegrubs with special reference to *Adelina* sp. Conference of the Australian Society of Sugar Cane Technologists, Townsville, Queensland, Australia, 6-9 May. CD.

Table 3. BSES's advice for 2009 and growers' actual action in 2008. Actions highlighted in green agree with BSES's recommendation, while those highlighted in red do not agree.

Site	Farm No	Blk	Var	Class	Prediction1			Prediction2			Recommendation	Grower's action
					%Low	%Mod.	%High	%Low	%Mod.	%High		
1	106	7-1	Q200	2R	55	39	7	46	47	7	Don't treat	Did not treat
2	106	8-1	Q186	4R	77	20	4	71	24	5	Don't treat	REPLANTED
3	856	5-1	Q220	1R	33	66	1	52	48	0	Treat	Treated
4	231	3-1	Q166	1R	68	31	0	52	48	0	Don't treat	Did not treat
5	231	1-1	Q186	1R	60	40	0	52	48	0	Don't treat	Did not treat
6	73	17-2	Q200	1R	64	31	5	46	47	7	Don't treat	Did not treat
7	33	4-1	Q200	2R	80	19	0	76	23	0	Don't treat	Did not treat
8	78	8-1	MXD	2R	43	53	4	34	62	4	Treat	Treated
9	94	17-1	Q200	2R	20	75	5	34	62	4	Treat	Did not treat*
10	94	17-2	Q167	2R	53	44	3	34	62	4	Treat	Treated
11	82	1-2	Q186	2R	28	71	1	46	47	7	Treat	Treated
12	67	4-3	MXD	1R	68	30	2	60	36	4	Don't treat	Did not treat
13	270	5-5	Q200	2R	77	20	4	71	24	5	Don't treat	Did not treat
14	313	19-5	Q200	2R	53	46	0	52	48	0	Don't treat	Did not treat
15	313	10-1	Q218	1R	80	19	0	76	23	0	Don't treat	Did not treat
16	58	3-2	Q166	6R	55	39	7	46	47	7	Don't treat	FALLOWED
17	17	12-2	Q174	3R	55	39	7	46	47	7	Don't treat	FALLOWED
18	17	14-5	MXD	2R	17	78	5	34	62	4	Treat	Treated
19	434	22-1	Q229	1R	53	46	0	52	48	0	Don't treat	Did not treat
20	64	6-1	Q200	1R	68	31	0	52	48	0	Don't treat	Did not treat
21	413	8-1A	Q200	2R	15	22	63	20	22	58	Treat	Treated
22	413	8-1B	Q200	2R	7	25	68	20	22	58	Treat	Treated
23	413	8-2	Q186	2R	14	22	64	20	22	58	Treat	Treated
24	779	19-1	Q186	1R	68	31	0	52	48	0	Don't treat	Treated**
25	220	6-1	Q200	1R	32	66	2	23	75	2	Treat	Treated
26	18	1-1	Q200	1R	16	79	5	34	62	4	Treat	Did not treat***
27	18	2-1	Q200	1R	20	75	5	34	62	4	Treat	Did not treat***
28	827	8-3	Q200	PLT	92	8	0	90	10	0	Don't treat	Did not treat
29	827	5-1	Q127	1R	60	40	0	52	48	0	Don't treat	Did not treat
30	853	22-2	Q200	1R	71	29	0	52	48	0	Don't treat	Did not treat

BSES's advice and growers' actual action in extra monitoring plots

Site	Farm No	Blk	Var	Class	Prediction 1			Prediction 2			Recommendation	Grower's action
					%Low	%Mod.	%High	%Low	%Mod.	%High		
31	94	6-1	Q200	3R	24	71	5	34	62	4	Treat	Did not treat*
32	78	11-1	Q200	3R	77	20	4	71	24	5	Don't treat	Did not treat
33	78	13-7	Q200	1R	36	55	9	46	47	7	Treat	Treated
34	82	1-3	Q186	3R	44	55	0	52	48	0	Treat	REPLANTED
35	82	8-5	MXD	2R	53	46	0	52	48	0	Don't treat	Did not treat
36	82	8-6	Q186	2R	53	46	0	52	48	0	Don't treat	Did not treat
37	67	8-1a	Q174	2R	77	20	4	71	24	5	Don't treat	FALLOWED
38	67	8-2b	Q200	3R	55	39	7	46	47	7	Don't treat	FALLOWED
39	67	4-1	MXD	2R	64	31	5	46	47	7	Don't treat	Treated****
40	270	4-4	Q186	1R	71	29	0	64	35	0	Don't treat	Did not treat
41	270	4-5	MXD	3R	64	31	5	46	47	7	Don't treat	Did not treat
42	270	4-7	Q138	4R	77	20	4	71	24	5	Don't treat	Did not treat

* Grower left plots untreated to provide BSES with the opportunity to validate model predictions for 2009.

** **Applies a blanket treatment of bifenthrin**

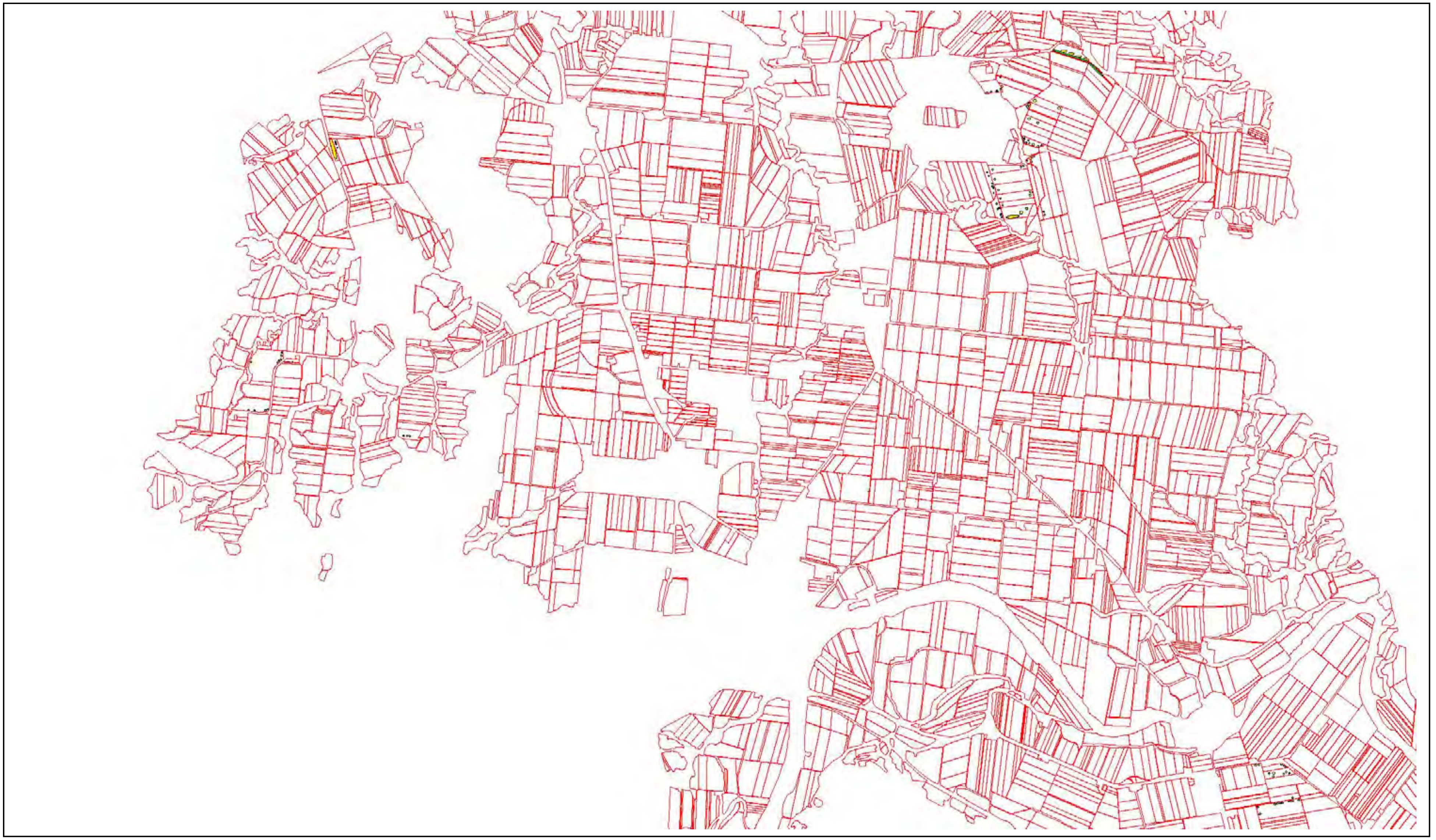
*** LATE: cane too big

**** Mainly suffers *L. frenchi* problem not greyback.

Table 4. BSES's advice for 2010 and growers' actual action in 2009. Actions highlighted in green agree with BSES's recommendation while those highlighted in red do not agree.

Site	Farm No	Blk	Prediction1			Prediction2			BSES recommendation	What growers actually did	Justification
			%Low	%Mod.	%High	%Low	%Mod.	%High			
1	106	7-1	FALLOW								
2	106	8-1	REPLANT								
3	856	5-1	79	19	2	71	27	2	Don't treat	Treated	LATE: cane too big
4	231	3-1	46	53	1	36	64	0	Treat	Treated	
5	231	1-1	68	31	1	33	65	1	Treat	Treated	
6	73	17-2	35	65	0	47	51	2	Treat	Didn't treat	LATE: cane too big
7	33	4-1	30	70	0	50	50	0	Treat	Treated	
8	78	8-1a	79	19	2	74	26	0	Don't treat	Didn't treat	
9	94	17-1	40	57	2	47	51	2	Treat	Treated	
10	94	17-2	85	14	1	71	27	2	Don't treat	Didn't treat	
11	82	1-2	91	8	1	88	11	1	Don't treat	Treated	REPLANTING
12	67	4-3	62	38	0	47	51	2	Treat	Didn't treat	REPLANTING
13	270	5-5	70	30	0	50	50	0	Treat	Didn't treat	TO BE FALLOWED
14	313	19-5	82	18	0	76	24	0	Don't treat	Grower unavailable to comment	
15	313	10-1	49	51	0	36	64	0	Treat		
16	58	3-2	FALLOW								
17	17	12-2	FALLOW								
18	17	14-5	91	8	1	71	27	2	Don't treat	Treated	REPLANTING
19	434	22-1	21	78	1	33	65	1	Treat	Treated	
20	64	6-1	59	39	2	47	51	2	Treat	Didn't treat	No reason given
21	413	8-1A	67	31	2	71	27	2	Don't treat	Treated	Conducting Independent Experiment and had to standardize methodologies
22	413	8-1B	67	31	2	71	27	2	Don't treat	Treated	
23	413	8-2	70	28	2	71	27	2	Don't treat	Treated	
24	779	19-1	81	19	0	74	26	0	Don't treat	Treated	Applies a blanket treatment of Bifenthrin
25	220	6-1	77	23	0	74	26	0	Don't treat	Treated	LATE: cane too big
26	18	1-1	5	94	1	22	77	1	Treat	Treated	
27	18	2-1	7	73	20	26	57	17	Treat	Treated	
28	827	8-3	80	19	1	73	26	1	Don't treat	Didn't treat	
29	827	5-1	40	57	2	47	51	2	Treat	Didn't treat	LATE: cane too big
30	853	22-2	13	87	0	36	64	0	Treat	Treated	
31	94	6-1	8	91	1	33	65	1	Treat	Treated	
32	78	11-1	91	8	1	88	11	1	Don't treat	Didn't treat	
33	78	13-7	91	8	1	88	11	1	Don't treat	Didn't treat	
34	82	1-3	REPLANT								
35	82	8-5	24	76	0	50	50	0	Treat	Treated	
36	82	8-6	50	50	0	50	50	0	Treat	Treated	
37	67	8-1a	REPLANT								
38	67	8-2b	FALLOW								
39	67	4-1	79	19	2	71	27	2	Don't treat	Treated	Mainly suffers *L. frenchi* problem not greyback
40	270	4-4	82	18	0	76	24	0	Don't treat	Didn't treat	
41	270	4-5	82	18	0	76	24	0	Don't treat	Didn't treat	
42	270	4-7	62	38	0	50	50	0	Treat	Didn't treat	TO BE FALLOWED
43	58	1-3	91	8	1	88	11	1	Don't treat	Didn't treat	
44	66	4-3	86	13	0	81	18	1	Don't treat	Didn't treat	
45	17	7-2	40	57	2	47	51	2	Treat	Didn't treat	LATE: cane too big
46	78	8-1b	37	62	2	47	51	2	Treat	Treated	

APPENDIX 1. Grub damage 2008.



APPENDIX 2. Grub damage 2009

APPENDIX 3

GROWERS' SURVEY FORM

On a scale from 1 – 10, how would you rank the value of this grub monitoring program so far?

1 2 3 4 5 6 7 8 9 10
Useless --------------------------- Just OK ---------------------------------- Very useful

On a scale from 1 – 10, how would you rank the importance of or the need for a regional grub monitoring program?

1 2 3 4 5 6 7 8 9 10
Useless --------------------------- Just OK ---------------------------------- Very useful

If you are a member of this project, could you place a value on how much money this project had saved you?

- In pesticide costs ________
- In fuel__________________
- Labour (if any)_______________
- Other___________________

If you are not a member of this project, could you place a value on how much money this project could potentially save you?

- In pesticide costs ________
- In fuel__________________
- Labour (if any)_______________
- Other___________________

Comments

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APPENDIX 4

RESULTS OF A SURVEY CONDUCTED ON THE MULGRAVE GRUB MANAGEMENT PROGRAM DURING 2008-2009 SEASON

The results of the survey were completed by 15 growers at the conclusion of the "assessment of the 2009 grub status and prediction trends" workshop. The following are the overall results:

- Growers ranked the value of the project on a sliding scale of 1-10 (1 = useless; 5 = OK; 10 = very useful). A total of 9 growers rated the monitoring program as very useful, 3 growers rated the monitoring program as useful and 3 growers rated the monitoring program as just ok.
- Grower ranked the importance or the need for a regional grub monitoring program on a sliding scale of 1-10 (1 = useless; 5 = OK,; 10 = very useful). A total of 11 growers rated the monitoring program as very useful, 2 growers rated the monitoring program as useful and 2 growers rated the monitoring program as just ok.

Growers currently participating in the monitoring program estimated the financial savings resulting from this project as follows:

Activity	No. of farmers commenting on that activity	Cost in savings $$$	No. of farmers
Pesticide	5	1500-2000	4
		3000-5000	1
Fuel	5	100-300	2
		500-600	2
		1000-2000	1
Labour	4	300-1000	2
		2000-3000	2
Increased Yield	2	Y	1
		8000	1

Growers not participating in the monitoring program estimated the potential financial savings this project could provide as follows:

Activity	No. of farmers commenting on that activity	Cost in savings $$$	No. of farmers
Pesticides	5	1500-2000	3
		10000-20000	2
Fuel	4	300-500	2
		1000-2000	2
Labour	3	400-1000	2
		6000	1
Increased Yield	1	Y	1

General Comments

- Willingness to provide support for monitoring program to be ongoing, with all growers participating,
- This project could be valuable in relation to reducing chemical use,
- The ability to predict grub numbers aids in decision making, for pesticide application and extra ratoons, resulting in savings across the farm.
- A levy per tonne applied at Mulgrave mill would provide sufficient funding for the monitoring program to continue.
- Good monitoring contact- Bayer.

Trap cropping in far north Queensland

Besides insecticides, the options to combat the greyback canegrub include biological control such as the use of BioCane™, farming practices such as zonal tillage and green cane trash blanketing. Another strategy involves the manipulation of planting and harvesting dates, a management practice that relies on the fact that the majority of female beetles ready to lay eggs choose the tallest, lushest and healthiest crop in sight. From this idea evolved the trap crop management option outlined in this article by Dr Nader Sallam, BSES Entomologist based in Gordonvale.

A trap crop is simply a section of a field that was either planted or harvested earlier than the rest of the crop, therefore it stands out in comparison to the rest of the crop at the time beetles are flying. As far back as 1918 it was observed that egg-laying females may be preferentially attracted to tall and dense crops, and this was confirmed by later observations in 1949. Then in 2002 researchers detected that trap crops harbour more grubs per stool than adjacent blocks in selected areas in the Burdekin and the Herbert regions, and in 2003 a clear negative relationship was confirmed between planting or harvesting dates and subsequent damage in the Burdekin. It was therefore established that cane height is one important factor that determines where adult beetles lay their eggs.

The greyback beetle, being a generalist feeder in its grub (and adult) stages, can survive under a wide range of plant species, and can lay eggs under crops such as sorghum, corn, bananas, pawpaws, peanuts, legumes, nearby lawn or even fallowed fields. With this in mind, Jumbo sorghum was selected as a vigorous, fast growing plant that can act as a suitable trap crop. Trap cropping using sorghum as the attracting plant was tested in 1999 in Far North Queensland (FNQ), when entomologist Keith Chandler (based at Meringa station at the time) planted a crop of Jumbo sorghum on an elevated ridge at Mr John Dockery's farm in Goldsbrough. By the time adult beetles were flying, the sorghum was standing out as the tallest crop in the whole area. The crop did attract most if not all egg-laying females; at that time regional grub numbers were high, and the sorghum crop was totally decimated under the massive grub pressure that it had attracted.

Interest in trap cropping is being revived, especially now that grub populations are slowly regaining momentum in FNQ. In an attempt to re-introduce trap cropping in the far north, three trap crops were established in Mulgrave, Wangan and Mena Creek. The only sorghum trap crop was planted in Mulgrave on Mr Mark Rossi's farm, where with help from Mr Derek Sparkes (QDPI&F) eight rows of Jumbo sorghum were planted on 25/10 using a Covington planter. At Wangan and Mena Creek a section of a selected paddock with history of grub damage was harvested well before the rest of the paddock and the adjacent crops.

Planting the sorghum trap crop, Chris Rossi and Derek Sparkes from left to right.

Researchers collected results in March 2008 by digging cane (or sorghum) stools and calculating average grub numbers per plant. Table 1 summarises the results from the three trials.

It is clear that in all cases, grub numbers were higher under the trap crop section compared with the adjacent crop. Even when the trap crop had been treated (i.e. in Wangan) a section of the crop sustained noticeable damage under the very heavy grub pressure. However, the overall average grubs/stool in the treated trap crop was less than half of that in the untreated section (0.9 compared to 2.0 grubs/stool), while the treated rows of the "non-trap" section had virtually no grubs, with the untreated two rows showing a very low number of grubs compared with the untreated trap crop (2.0 grubs/stool), which indicates that the majority of egg-laying females must have flown to the trap crop section.

Growers who establish trap crops on their farm may choose to sacrifice the trap crop section by spraying it out to starve grub hatchlings, or only treat the trap crop section proactively, provided that by the time the beetles are flying it will be well advanced compared to adjacent crops. One thing we learnt during this work is that we could achieve better results if the height variance between the trap and the adjacent crop is significant.

Table 1. Results of three trap crop trials in FNQ.

	Grub number/stool – March 08			
	Average grub number/stool in trap crop & (approximate crop size)		Average grub number/stool in adjacent crop in non-trap crop & (approximate crop size)	
Mena Ck	0.98 (10 rows – approx 0.5 ha)		0.18 (4 ha)	
Mulgrave	2.3 (8 long rows of sorghum – 1 ha)		**Treated***	**Untreated***
			0.2 (2.8 ha)	0.9 (2.6 ha)
Wangan	**Treated****	**Untreated****	**Treated****	**Untreated****
	0.9 (14 rows)	2.0 (2 rows)	0.0 (3 ha)	0.25 (2 rows)

**A section of the adjacent "non-trap" cane crop was treated with Confidor Guard in 2007 while another section was left untreated for comparison. This was a 2nd ratoon crop of Q200Ⓟ.*

***A section of the 16-row trap crop was treated with Senator® and the rest of the trap crop left untreated. The rest of the paddock (non-trap crop) was also treated with Senator® with 2 rows left untreated for comparison. This was a 3rd ratoon crop of Q187Ⓟ, with 5 rows of Q186Ⓟ comprising the outer edge of the trap crop.*

Above: Sorghum trap crop damaged by grubs on the left.

Even though the difference in height was noticeable shortly after the establishment of the trap crop (July–October), in some cases that difference was less noticeable in January, which is when beetles are ready to lay their eggs. In such cases, it might not be enough to only plant or harvest a section of the crop early, but the trap crop may need to receive a higher fertiliser rate or perhaps more frequent irrigation if the grower has access to irrigation.

One frequently asked question here is: How big or how many trap crops do we need per farm? The answer to this question is not really known – it may not be possible to establish a precise number. However, in an average size farm, it is probably appropriate to establish two or three trap crops of 10 or 15 rows each. Still, the best answer to this question will come from the growers themselves who can experiment with this methodology and judge its feasibility on a case-by-case basis.

In conclusion, we now know that the trap cropping theory has merit, but good timing and management of the trap crop are essential to obtain the best outcome for farmers in areas and years of high grub pressure.

Above: Trap crop at Mena Creek, where10 rows were cut second round (on the right) and the rest of the crop was cut fourth round.

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"How big or how many trap crops do we need per farm?"

Above: Still planting the sorghum trap crop.

Grub monitoring—an essential task for cost-effective management

> Mohamed Sallam

The BSES/SRDC initiative GrubPlan has gained popularity among canegrowers. This district-wide grub monitoring work is designed to advise growers on regional grub trends and, ultimately, on how to predict future infestation rates. Thus GrubPlan will help growers to make better-informed grub management decisions.

The monitoring work relies on extensive greyback grub sampling from several farms in a region. All grubs collected are taken to the insect pathology laboratory in Tully, placed individually in plastic containers, and fed until they either emerge as beetles or die from disease. Grub numbers are assessed in light of information on pesticide application in the area under study, proximity to infested fields, and crop age. At the end of a year, a picture emerges on the regional grub status and the dynamics of their pathogens.

Grub monitoring for the last four years has found that grub numbers were very low in all districts when the study commenced in 2003. They remained so for the three following years in the Herbert, but increased in the Mulgrave and the Innisfail-Tully regions. Grub numbers eventually declined in far north Queensland (FNQ) in 2006, and this coincided with an increase in chemical application in the Mulgrave and the Innisfail-Tully regions as growers responded to the escalating grub densities.

The monitors also recorded variable mortality rates in the laboratory due to the protozoan *Adelina* sp., the fungus *Metarhizium anisopliae* and the bacterium *Paenibacillus popilliae* (which causes milky disease). Other causes of grub death in the laboratory remain unknown, and this opens the door for future interesting work to identify these pathogens and quantify their impact on grub populations.

> *Grub monitoring for the last 4 years has found that grub numbers were very low in all districts when the study commenced in 2003.*

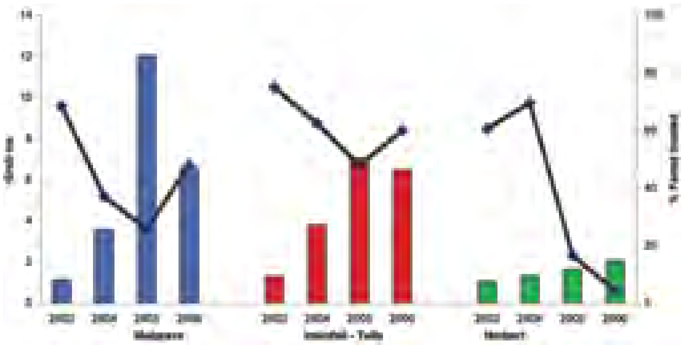
Far fewer FNQ growers attended GrubPlan workshops in 2004, 2005 and 2006 (96, 71 and 48 respectively) compared with earlier figures (506, 164 and 103 in 2001, 2002 and 2003, respectively). This decline in interest may well be due to the belief that grubs had been largely controlled after the significant population crash in the 2002–2003 season. However, GrubPlan workshops alerted growers, pointing to the fact that, even though grub densities through 2002–2005 have not been as high as previous years, they were on the increase—mainly in the Mulgrave and the Innisfail-Tully regions.

Data collected from chemical companies and productivity services indicate that the insecticide-protected areas increased in 2005 in the Mulgrave and Innisfail-Tully regions, suggesting that several growers responded to the increase in grub densities, and this helped foil an expected outbreak in 2006. It is important to realise that, without a pre-warning system in place, uninformed growers are likely to neglect signs of grub build up and they may not react until an outbreak of grubs is imminent.

While they have access to a good monitoring system, growers are bound to make correct decisions regarding their management practices. By doing this they are likely to save money by treating high-risk fields and leaving low-risk fields untreated, or by refraining from treatment during low-risk years. Growers are encouraged to participate in grub-monitoring groups and to get involved in the surveillance activities carried out by BSES and productivity services. Canegrub populations fluctuate in nature; their numbers will definitely surge again one day. However, we can do our best to keep their numbers down, and be ready to combat them when they return.

Figure 1: Grub numbers and insecticide treatment.

Grub no. (columns) refers to mean number of greyback grubs collected by digging 20 plants/field. Broken lines refer to the annual proportion of protected farms (out of the total number of monitored farms) in each region.



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Left: Greyback grub damaged cane.

Grub monitoring continues in the Central district and in the Far North

> Mohamed Sallam and Peter Samson

Growers and researchers are working hand-in-hand in a BSES/SRDC initiative to implement the results of research into greyback canegrub management on their farms. Two grower groups funded by SRDC Grower Group Innovation Projects have been formed in the Central district and Mulgrave, with the aim of conducting thorough greyback canegrub monitoring at a district or farm level.

Every year, growers with properties prone to canegrub attack are faced with a tough choice: to treat or not to treat? If greyback beetles fly to an unprotected paddock then the grower may lose that crop. However, treatment of a paddock that was unlikely to be invaded by beetles results in an expense that the grower could have avoided. With sugar prices fluctuating and the cost of production always rising, growers need to make correct decisions that will save both their money and their crops.

Short of treating every paddock every year, there is always an element of risk when making treatment decisions. The aim of this latest research is to minimise the chances of getting it wrong.

Well-informed decisions require several things:

- information on the current canegrub status at district and farm level;
- a system to use that information for predicting the likely status of canegrubs in individual fields next year;
- an economic analysis to determine whether the likely benefits of treating a particular field will justify the cost of insecticide.

BSES has been monitoring greyback canegrubs in selected canefields in central and northern Queensland each year since 2003, as part of the GrubPlan initiative. We now have a large data set on the history of canegrub damage and treatment, field location, harvest dates, levels of canegrub pathogens, and canegrub population trends. Patterns have emerged that can help predict the likelihood of canegrub infestations next year, based on recent history and on factors that can be measured in the current year; for example, whether or not canegrubs are currently present in the field and whether there is any damage this year in nearby fields.

The Grower Group projects follow on from the GrubPlan program, which established a good, solid base of cooperation between researchers, growers and productivity service staff. Results from the GrubPlan work will now be put to the test. This exercise will see greater grower involvement in the work, as they must ultimately be the ones to implement research recommendations if that research is to benefit the industry.

In Mulgrave, the canegrub monitoring work will continue on about 25 farms and on selected paddocks within these farms. A picture will then emerge on canegrub damage dynamics between and within farms. The information accumulated since 2003 will help to assess whether the risk of canegrub attack is likely to be more or less in the coming year.

Near Mackay, the 10 members of the Mount Kinchant Growers Group will work together to combat their common canegrub problem. They will employ a consultant to help them monitor and develop canegrub management plans. The group members will then test the recommendations by implementing them on their farms. Records will be kept of the costs and benefits of the monitoring: the time spent, the amount of insecticide used and estimated canegrub losses. Ultimately, the growers want to determine if this pro-active and flexible type of canegrub management is a worthwhile investment.

The only way an entire district can reduce canegrub damage is to follow a regional approach to monitoring and managing the problem. With a thorough monitoring program in place, growers are learning to judge the canegrub population trends so that they can ready themselves to tackle problems before they get out of hand.

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No silver bullet for sugar's greatest foe

By Laurie Mills

This aerial shot reveals the extent of devastating grub damage to a plant cane crop near Tully in 2001.

Growers will never eradicate their greatest nemesis – the canegrub – but BSES researchers are trying to limit the devastation they cause.

Research Officer at BSES Meringa, in far north Queensland, Mohamed Sallam, said that a combination of tactics, particularly chemical and biological agents, was the most effective method of limiting crop losses.

"They are native to Australia and they're not going away. You cannot eradicate them, you can only hope to keep them at manageable numbers," he said.

The grubs originally fed on native grasses such as blady grass and the introduced guinea grass, but quickly adapted to cane when it was introduced in south-east Queensland in the late 1800s.

They also thrive in other introduced crops, including bananas, pawpaws and peanuts.

The early control methods of soil fumigation were labour-intensive and not always effective.

Dr Sallam said BSES was now promoting a combination of control strategies which were being taken up by growers to achieve healthy success rates.

Research has shown that a variety of methods, including insecticides, trap cropping and other farming practices such as reduced tillage and manipulating of planting and harvesting dates were all part of a successful integrated pest management approach.

"After the banning of organochlorins, a newer generation of organophosphates followed, and the products belonging to this category are suSCon Blue and suSCon Plus, which are more environmentally responsible compared to organochlorins," said Dr Sallam.

"They are slow release products which will stay in the soil for two years and will result in 80-90% control after application.

'If you work the soil too much you exhaust its natural pathogens'

"SuSCon Blue will continue to give a control rate of about 50-60% in first ratoon, but you will get different levels of mortality depending on the pH level of your soil in later ratoons.

"It does not work well in alkaline soils but an application of sulphur will ensure longer action," Dr Sallam said.

Alternatively, suSCon Plus contains a sulphur coating and offers a good alternative to suSCon Blue in high pH soils.

An even newer generation of chemicals are now available, and these are the Imidacloprid-based products, such as SuSCon Maxi and Confidor Guard.

SuSCon Maxi is of the same slow-release family. It stays in the soil for two years and gives good control in high pH soils, while Confidor Guard is a liquid that will give at least one year of control and can be applied in ratoons.

Another option is a biological insecticide, *Metarhizium anisopliae*, a fungal disease which kills the grub in the soil and is currently available as BioCane.

Dr. Sallam said it could be applied the same way as slow-release chemicals either at planting or at the fill-in stage.

"It maintains a low population of grubs but is not a knock-down if there are high populations and is not as effective as chemicals in the short term," he said.

Dr Sallam said that BSES researchers had been working for the past four years on the industry's canegrub management initiative, GrubPlan, which includes input from growers and extension officers from cane productivity services. Large numbers of growers participated in GrubPlan sessions through studying their farm maps to investigate areas where grubs were prevalent.

"We are looking at integrated farm management and monitoring what individual growers do on their farms, who in turn are encouraged to participate in monitoring grub populations in their respective regions.

"You can fight insects but they always fight back, you spray them and they react and develop resistance if you use a particular method long enough, so we are looking at farm systems and how effective they are in reducing crop damage.

"There are natural pathogens in the soil, but if you work the soil too much you exhaust it. We have found that the more you reduce your tillage, the better it is for these pathogens.

"Manipulating harvest and planting times work well. We have found cane beetles flock to tall early cane, so if a trap crop is planted or harvested earlier than the rest of the paddock it is likely

Mohamed Sallam checks a cane root ball for grub infestation.

to attract most egg-laying beetles.

"That stand will have to be sacrificed to destroy the grubs, otherwise a chemical treatment could be applied only in the trap crop. We found that a high proportion of the beetles will fly to the trap crop, but you can never guarantee to get them all.

"Monitoring of crops on individual farms is an important way of keeping beetles and grubs under control, but neighbours also have an important role to play in this, everyone must work together. It is no good one farmer keeping pests under control if neighbours aren't doing the same, everyone must work together.

"The GrubPlan program hosts workshops every year to show growers the results and we are now involved on 75 farms from Mulgrave down to the Herbert and Mackay regions.

"When we started four years ago, grub numbers had started to climb to almost alarming levels and growers responded by using a range of chemicals and a combination of other methods and as a result, the grub population declined in 2006.

"So we think we are on the right track and can only hope that the good work continues to limit the crop damage done by grubs." ■

Growers find that legume rotation helps to manage cane pests

By Rebecca Thyer, of the Grains Research and Development Corporation

Change in the form of new crop rotations to break the sugarcane monoculture is sweeping across the cane farms of Bundaberg and Childers and Peter Russo **(right)** is one of a number of growers incorporating legumes into the rotation.

Farming in the Isis district with his four brothers Mr Russo started growing peanuts three years ago. The benefits have been a 20% increase in cane yields, a reduction in cane pests and diseases, improved soil quality, reduced fertiliser costs and an extra cash crop.

"Having peanuts in the rotation has helped kill cane pests, given the ground a break and encouraged the beneficials, like earthworms," Mr Russo says.

Bundaberg-Childers growers are also harvesting impressive peanut yields, some producing eight tonnes a hectare

Mr Russo says peanuts fit in well with sugarcane rotations.

"Peanuts give us the option to harvest cane, plough it out, plant peanuts and then have them out in time to plant cane again in March. And because the peanuts provide valuable nitrogen for the subsequent cane, we can use less fertiliser," says Mr Russo.

One of the drivers behind the break-cropping push is the Isis Target 100 program, an initiative implemented by the Isis sugar industry that aims to boost the area's mill average for cane productivity to 100 t/ha.

Isis Target 100 agronomist Judy Plath says that last year the district's mill average reached 92 t/ha. "If we can encourage more growers to include legumes in their rotation, we can hopefully go beyond 100t/ha," she said.

Working alongside the sugarcane industry is the grains industry, which aspires to boost peanut production through new growing areas.

Through a GRDC-funded project, the Queensland Department of Primary Industries and Fisheries and the Peanut Company of Australia are working with consultants to help growers develop peanut-growing skills.

Mr Russo says that with industry support, peanuts are just the beginning of changes ahead.

"We're adopting a whole new approach, like controlled traffic and minimum till. Each year we're bringing another 120 to 160 hectares of our farm into 1.8 m wheel spacings. It's putting the science back into farming," said Mr Russo. ■