WINE INDUSTRY ASSOCIATION WESTERN AUSTRALIA

Australian Government
Grape and Wine Research and Development Corporation

Understanding the biology and improved management of longtailed mealybug in WA.



A crawler (top) and adult longtailed mealybug.

FINAL REPORT to

GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION
Project Number: **RT04/06-2**

Principal Investigator: **Stewart Learmonth**
Department of Agriculture, Western Australia

Research Organisation: **Wine Industry Association, Western Australia**
Date: **31 August 2005**

1. Executive summary:

Longtailed mealybug has become a more important pest in an increasing number of winegrape vineyards in south west Western Australia. This study was concerned with their management and sought to clarify the role of predators and insecticides.

This study was not able to quantify the role of naturally occurring or introduced predators. The abundance of naturally occurring predators was usually too low to expect they would reduce pest populations to satisfactory levels. With respect to the role of the introduced predators *Cryptolaemus* beetles and green lacewing, it was noted that claims as to their effectiveness by vignerons varied from almost no effect to very worthwhile. Detailed monitoring in field trials would be required to clarify their role.

The results of an insecticide screening trial indicated that the abundance of longtailed mealybug could be reduced during the season by pre bud burst sprays of chlorpyrifos and bifenthrin. The growth regulator insecticide buprofezin also reduced pest numbers but at a slower rate. Multiple applications of paraffin oil may be the only way this product may help control mealybug. Carbaryl resulted in short term reduction of mealybug numbers only.

Large plot field studies would help to clarify some of the unknowns regarding the role of predators and impacts of insecticide applications on management and pest status of longtailed mealybug.

2. Background:

Longtailed mealybug (LTMB) occurs in WA vineyards, usually at low levels, but over the past 5 years has becoming increasingly abundant. More vineyards are becoming affected by "outbreaks" of the insect manifested as premature leaf loss, excess amounts of sooty mould, which can stop wine fermentation, and the reluctance of some wineries to accept grapes with LTMB present. Apart from these direct effects, concern about any level of mealybug infestation is increasing because it has been shown they are capable of transmitting leafroll virus.

There are two main causes of such LTMB outbreaks – 1. Use of synthetic insecticides to protect vines from garden weevil because these insecticides selectively kill more of the beneficial agents, and 2. Because not all LTMB problems result from spraying for garden weevil, unexplained "season conditions" may have also played a role.

Management practices adopted by growers to control mealy bug have been varied:
a. Importation of commercially available predators which appears to provide some control;
b. Broad-spectrum insecticide with varying success – from good results to almost no effect;
c. Use of more selective Horticultural Spray Oils.

Previous studies in WA have shown that:
1. leaf sampling is a reliable indicator of the potential for LTMB problems;
2. natural enemies are almost absent from LTMB outbreak areas;
3. timed insecticide sprays based on leaf sampling have not always resulted in good control;
4. the reason for poor control from spraying is likely to be because adults are feeding/sheltering on the trunk of vines during the season and not contacted by sprays.
5. this poor control can be overcome by high volume spraying aimed at cordons.

This project is a continuation of studies on the biology of LTMB and measure the impact of commercially reared and released natural control agents. Providing quantitative confirmation of the value of such beneficials would encourage their greater use and reduced reliance on insecticides.

With improved knowledge of the biology of LTMB, assessment of the impact of pre bud burst spraying in infested vineyards to prevent outbreaks could be made. We would monitor the effect of such spraying on beneficial agents in vineyards.

These investigations will help the WA winegrape industry manage what has become an important pest. Situations where damage occurs would be reduced markedly, by the adoption of environmentally safe methods.

Such studies are considered more urgent with the loss of prothiophos (Tokuthion) and pressure on carbaryl to be withdrawn from use – two insecticides that had been used with some confidence by the industry previously.

The Western Australian Department of Agriculture has agreed to provide supervisory support for this project.

3. Objectives:

This project had the objectives of:

assessing the role of mass reared and released natural enemies in managing longtailed mealybug with a view to encourage their wider adoption if determined to be successful and

assessing the effectiveness of early season preventative broad spectrum and soft insecticides on managing the pest to provide industry with confidence to adopt this approach.

4. Method:

The role of natural control agents

The aspect of assessing the role of natural enemies was investigated by leaf sampling vineyards infested with LTMB to assess abundance of pest and any natural enemies. The vineyards selected included sites either where natural enemies had been introduced or not. Also, in one case, some potentially disruptive insecticide spraying was carried out in a vineyard where release of predators had been made to clarify any adverse effects.

The role of early season pesticide applications

A block of Chardonnay in a vineyard at Northcliffe, WA that had been heavily infested with LTMB in the previous season was selected for this study. The presence of mealybug was confirmed by an examination of the butts of vines on 13 September 2004 before bud burst.

The vines were planted in rows 2.5m apart with five vines per panel and 1.5m between vines. The range of insecticide spray treatments applied to the vines is listed in Table 1. As well as including different insecticides, the timing of application ranged from prior to bud burst to 80% capfall. Insecticides were applied using a Hardi backpack sprayer. Treatments were laid out as a randomised complete block design with four replications of one panel plots.

The pre bud burst treatments were applied on 15 Sept 2004 as a drench. This was applied using a single hollow cone nozzle. To maximise coverage of cordons and butts, the spray was applied to each side of the vine - spraying was undertaken by commencing at the end of a cordon, proceeding down one quarter of the butt, up the other side of the butt and along the second cordon. About 0.5L spray solution was applied to each vine; a rate equivalent to approximately 1,333L/ha.

The foliar spray on 19 Oct was applied to runoff to both sides of each plot of vines with the Hardi backpack sprayer at approximately 230 L/ha with 2 hollow cone nozzles. The insecticide was applied to both sides of the vine canopy. This low volume was a reflection of the early stage of canopy development at this time of the season.

The foliar spray on 4 Nov was applied in the same way as the previous foliar application except that to cover the extra foliage, three nozzles were used and the spray was applied at approximately 576 L/ha.

The efficacy of the insecticides was assessed by the abundance of LTMB on leaves, butts and bunches, scoring the level of sooty mould on bunches and yield assessment.

For leaf sampling, five leaves were collected near the crown of vines in each plot every two to four weeks commencing when the first fully expanded leaf was present, to maturity. Leaves were examined in the laboratory using a 20 cm diameter 10X magnifier with fluorescent ring tube.

Confirmation that very small insects were mealybugs was made with the aid of a dissecting microscope. Also, numbers of mealybugs on butts and in bunches were assessed in the field. All mealybugs were assumed to be female and categorised to small, medium, large and adult based on body length to correspond with the three immature stages and mature adult females. The length ranges used were: small = 0.4 to 1 mm; medium = 1.1 to 2.1 mm; large = 2.2 to 2.9 mm; adult, = greater than 2.9 mm. More work is required on this matter for more reliable differentiation to instar.

Table 1. The list of insecticides their rates and time of application to grapevines to assess their efficacy in controlling longtailed mealybug in the 2004/05 season. Details of sprays applied and cost of product are also given in Appendix 2.

Insecticide	Product	Rate	Method	Timing
untreated	-	-	-	-
chlorpyrifos	Chlorfos 50%EC	100ml/100L	cordon/butt drench	dormant spray before bud burst
chlorpyrifos + paraffin oil	Chlorfos 50%EC+ Biopest Paraffin Oil	[1.] 100ml/100L + 2L/100L		
paraffin oil	Biopest Paraffin Oil	2L/100L		
carbaryl	Carbaryl 500	200ml/100L		
bifenthrin + paraffin oil	Talstar 100EC + D-C-Tron Plus Spray Oil	25ml/100L + 1L/100L		
buprofezin	Applaud 44% EC	60ml /100L		
carbaryl	Carbaryl 500	200ml/100L	foliar	on demand after monitoring but before 80% capfall
paraffin oil	Biopest Paraffin Oil	2L/100L		on demand after monitoring and 2 weeks later but both sprays applied before 80% capfall
buprofezin	Applaud 44% EC	60ml /100L		

[1.] The rate of insecticide and oil for this treatment should have been 50ml + 1L/100L.

The abundance of live LTMB on the butts of vines either untreated or treated with chlorpyrifos or bifenthrin was assessed by examination in the field of four vine butts per treatment plot 34 days after drenching.

The abundance and effects of LTMB in relation to grape bunches were assessed on 16 December 2004, 22 February 2005 and at harvest on 15 March 2005. For the effects of LTMB on bunches, scoring systems were used. These are described in the Results section.

A hand harvest of all treatment plots was undertaken on 21 March 2005. All bunches were harvested irrespective of honey dew/sooty mould infection levels and weighed. Bunches badly affected with sooty mould and botrytis were discarded before return to the vigneron. For each treatment, 15 bunches were randomly selected and scored for LTMB infestation level and extent of sooty mould. A simplified scoring system was used for both insect and fungus – 0 = no apparent LTMB or sooty mould, 1 = LTMB and sooty mould present at low levels, 2 = LTMB and sooty mould obvious and present at high levels. The presence and identification of natural enemies thought to be able to feed on LTMB were noted also as bunches were examined.

Technology transfer

A summary of the main findings of the project were reported in the WA department of Agriculture Wine Industry Newsletter:

> Learmonth, S.E. (2005). Insect pest round-up – the 2004/05 season. WA Dept Agriculture Wine Industry Newsletter April 2005: 3-4.

A seminar on longtailed mealybug was given to an industry grower group at their pre-season pest and disease update:

Learmonth, S.E. (2005). Management of longtailed mealybug in winegrapes. Pre-season growers' day, Broadwater Resort, Busselton, WA. 19 Aug 2005. PowerPoint presentation.

5. Results/Discussion:

The role of natural control agents

The role of natural control agents in managing populations of LTMB was assessed by leaf and on some occasions bunch sampling in six commercial vineyards in the south west of WA during the 2004/05 season with a known history of pest problems. The abundance of LTMB and any predatory insects was based on assessing 25 leaves at approximately fortnightly intervals.

In general, predators were not observed associated with the mealybug infestations consistently until March. Prior to his time, the pest was present and often in high numbers but almost devoid of any natural enemies. The main natural enemies observed were hover fly larvae, green lacewing and *Cryptolaemus* larvae. No parasite activity was observed.

In one vineyard where the predatory beetle *Cryptolaemus montrouzieri* was released, small plots of vines were treated with esfenvalerate and indoxacarb insecticides used in relation to control of garden weevil. Results of the abundance of LTMB on leaves in each of the treatment areas and in an untreated area are shown in Fig. 1. Although the treatments were not replicated, the results broadly indicate that these insecticides do not have a detrimental effect of the abundance of the pest by way of killing predators. However, no larvae of *C. montrouzieri* were observed during the monitoring.

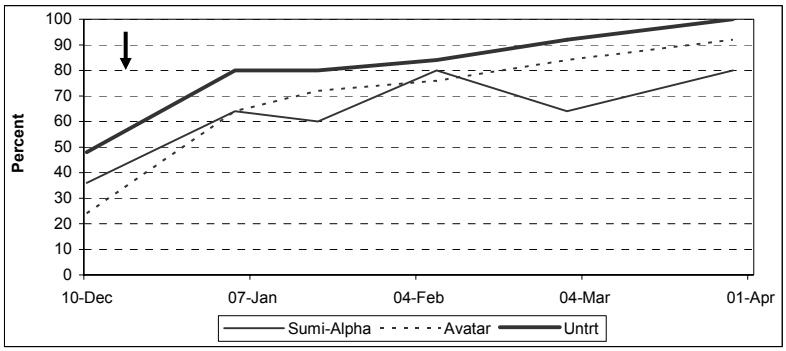


Fig. 1. The abundance of longtailed mealybug on grapevines leaves where the predatory beetle *Cryptolaemus montrouzieri* was released and in plots either treated with insecticides esfenvalerate, indoxacarb or untreated. The timing of the insecticide application is indicated by the arrow.

The role of early season pesticide applications

An indication of the progress of the infestation of longtailed mealybug in the vineyard where the insecticide trial was conducted is given by the number per leaf and percentage of leaves infested in the untreated treatment plots (see Fig. 2). Leaves were infested with crawlers (small) as soon as leaf development commenced after budburst. The percentage of leaves infested was near 100% in spring, dipped in early summer before reaching high levels in late summer. The number of mealybugs per leaf did not reach their maximum until near crop maturity in February. During the trial the most abundant stage on leaves was crawlers. Very few adults were found on leaves during the trial. This was most evident from early January; after this time the numbers of small longtailed mealybug rose to their greatest level.

The abundance of longtailed mealybugs on the leaf samples for each treatment together with $LSD_{0.05}$ values for each sampling occasion are shown in Fig. 3 and the actual data in Table A1 of Appendix 1. The percentage of leaves infested with longtailed mealybug is shown in Fig. 4 and the actual data in Table A2 in Appendix 1. A cost comparison of the spraying, excluding application costs, and details of sprays applied for each treatment is included in Appendix 2.

The abundance of LTMB remained low in the chlorpyrifos and bifenthrin drench treatments until early January. After this time both the number per leaf and percent leaves infested increased to levels similar to untreated vines.

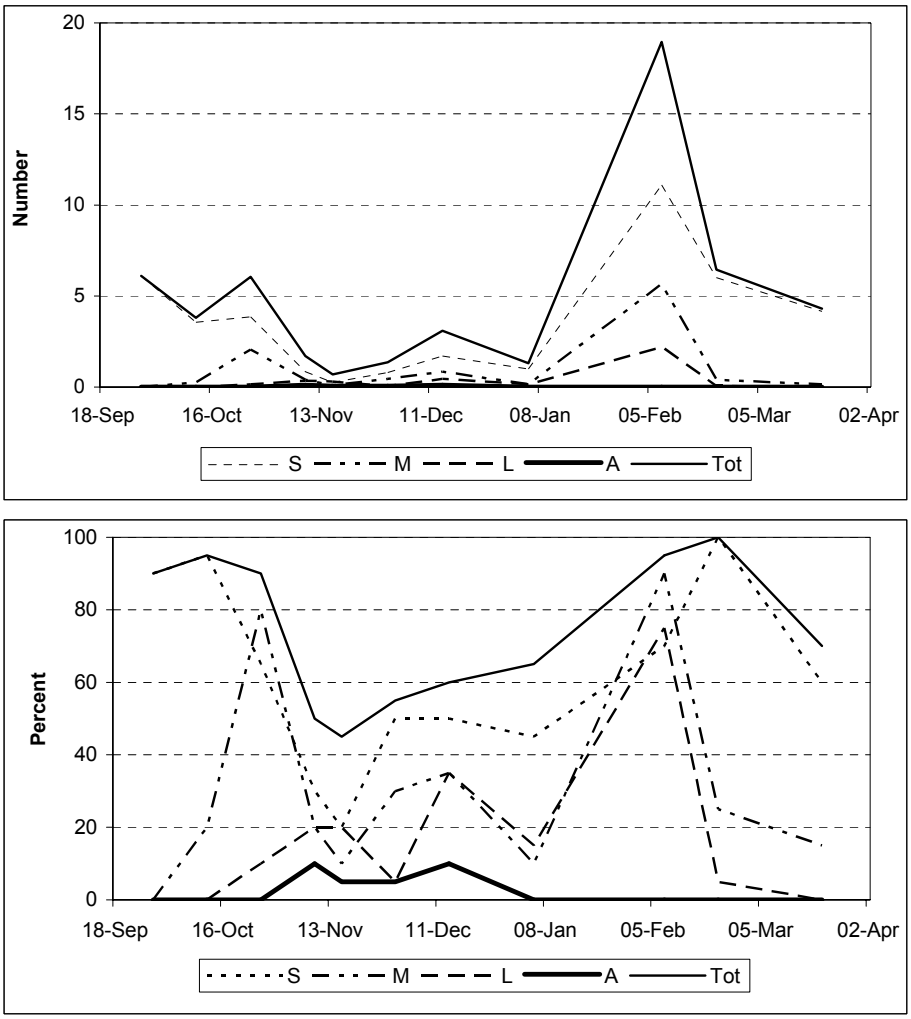


Fig. 2. The number of longtailed mealybugs per leaf and the proportion of leaves infested expressed as a percentage of all stages of mealybugs in untreated plots in a vineyard where an insecticide trial was conducted, Northcliffe, WA 2004/05. Sizes of mealybug were classified as small (S), medium (M), large (L) or adult (A) depending on body length (see text for details).

The oil drench treatment initially reduced LTMB numbers before they increased to be similar to untreated vines (see Fig. 3). When these plots were resprayed with oil in early November, numbers fell again but increased in mid summer to levels equivalent to untreated vines. A similar result occurred for oil applied as two foliar sprays.

Carbaryl treated vines, both when applied as a drench and a foliar resulted in LTMB numbers that were similar to the oil treatments.

Two treatments involving buprofezin were applied – one involved an early drench followed by an unplanned foliar spray after it appeared the drench had little effect. The second treatment was two foliar sprays. The date of the second foliar spray was the same for the vines that had received the pre bud burst drench. Both buprofezin treatments reduced LTMB abundance significantly below untreated vines in mid summer. The abundance of LTMB on the treated vines was intermediate to that on vines treated early with chlorpyrifos or bifenthrin and untreated vines (Fig. 3).

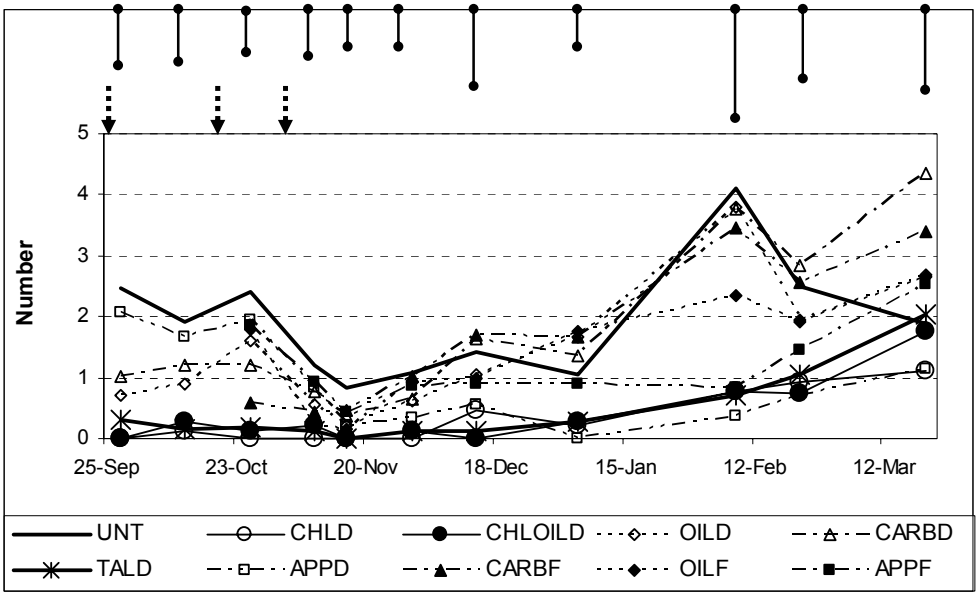


Fig. 3. The average number of total longtailed mealybugs per leaf in an insecticide screening trial at Northcliffe, WA, 2004/05. UNT = untreated; CHLD = chlorpyrifos drench before budburst; CHLOILD = chlorpyrifos plus oil drench; OILD = oil drench; CARBD = carbaryl drench; TALD = Talstar drench; APPD = Applaud drench; APPF = Applaud foliar spray; CARBF = carbaryl foliar spray; OILF = oil foliar spray; APPF = Applaud foliar spray. The bars over each date show the LSD $_{0.05}$ and the arrows indicate the times of insecticide application – the drenches (D) were applied on the first date, the foliar sprays (F) on the second date with repeat foliar sprays on OILF and APPF on the third date; foliar sprays of OILF on OILD plots and APPF on APPD plots were made on the third spray date.

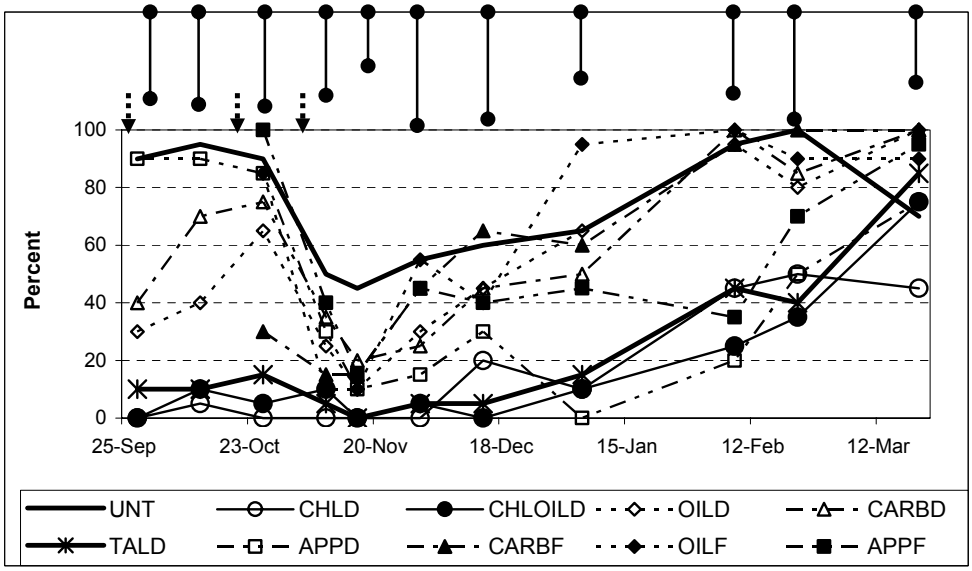


Fig. 4. The percentage of leaves infested with longtailed mealybugs in an insecticide screening trial at Northcliffe, WA, 2004/05. UNT = untreated; CHLD = chlorpyrifos drench before budburst; CHLOILD = chlorpyrifos plus oil drench; OILD = oil drench; CARBD = carbaryl drench; TALD = Talstar drench; APPD = Applaud drench; CARBF = carbaryl foliar spray; OILF = oil foliar spray; APPF = Applaud foliar spray. The bars over each date show the LSD $_{0.05}$ and the arrows indicate the times of insecticide application – the drenches (D) were applied on the first date, the foliar sprays (F) on the second date with repeat foliar sprays on OILF and APPF on the third date; foliar sprays of OILF on OILD plots and APPF on APPD plots were made on the third spray date.

The effect of the early drench of chlorpyrifos and bifenthrin was assessed by a check on the number of live LTMB under bark of two vines per plot for these treatments and for untreated vines

in mid October. The results are given in Fig. 5. For untreated vines, an average of more than five LTMB was found per vine. Of these, about one-quarter were crawlers and the rest equally divided between large and adult stages. In vines treated with chlorpyrifos and bifenthrin, averages of 0.13 and 0.38 LTMB per vine respectively were recorded.

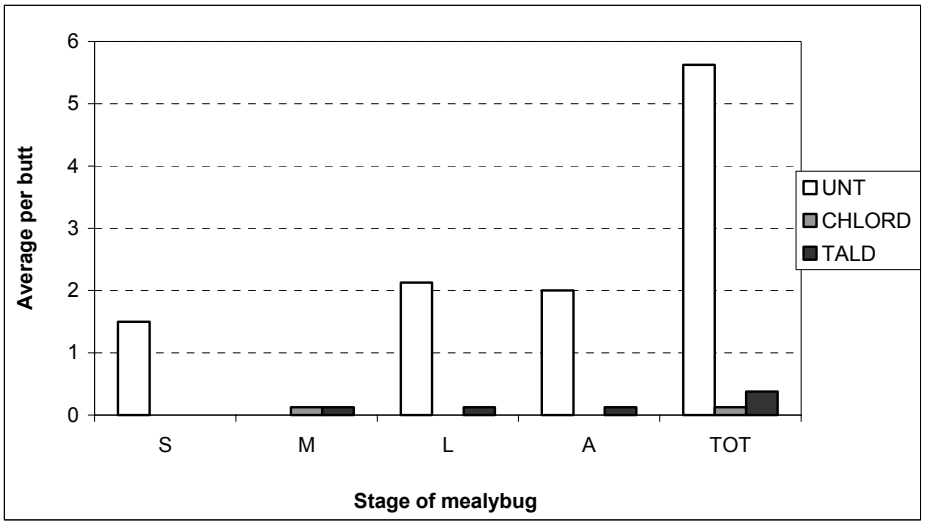


Fig. 5. The average number of live longtailed mealybugs per vine on the butts for untreated (UNT) vines or vines drenched before budburst on 15 September 2004 with either chlorpyrifos (CHLORD) or bifenthrin (TALD) assessed on 19 October 2005, Northcliffe, WA. See text for definition of LTMB stages – S = small, M = medium, L = large, A = adult.

The extent of LTMB infestation in bunches was assessed on 16 December 2004 for all plots by an in-field examination of ten bunches per plot. The average number of LTMB and percentage of bunches infested with LTMB are presented in Fig. 6.

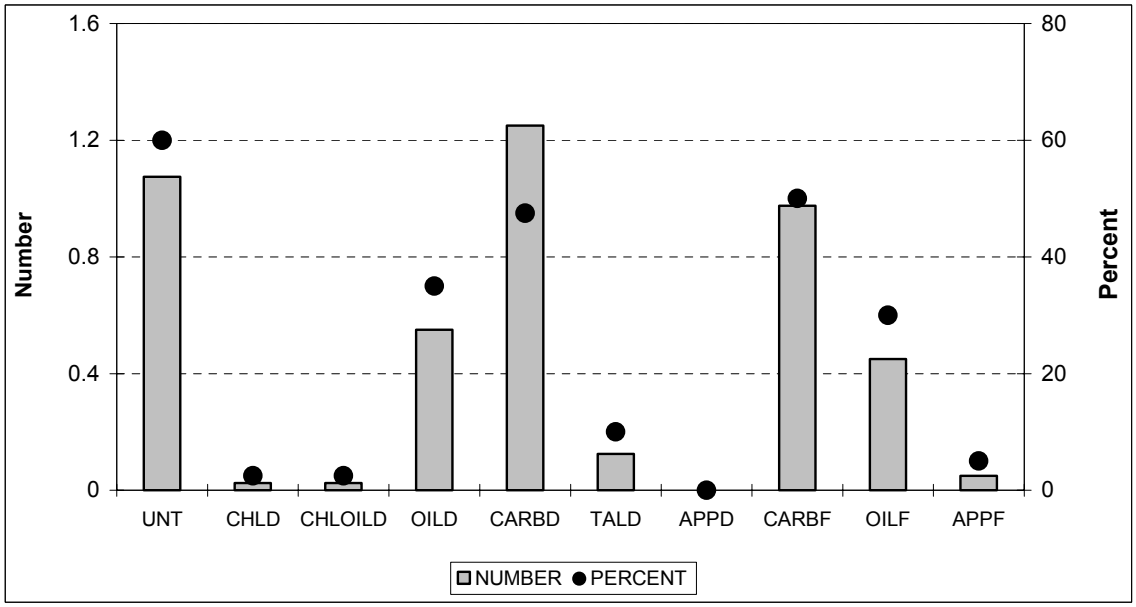


Fig. 6. The average number of longtailed mealybugs per bunch and percentage of bunches infested on 14 December 2004 for all treatments in an insecticide screening trial, Northcliffe, WA. Treatments were: UNT = untreated; CHLD = chlorpyrifos drench before budburst; CHLOILD = chlorpyrifos plus oil drench; OILD = oil drench; CARBD = carbaryl drench; TALD = Talstar drench; APPD = Applaud drench; CARBF = carbaryl foliar spray; OILF = oil foliar spray; APPF = Applaud foliar spray.

The highest infestation levels were recorded in untreated plots as well as those drenched or sprayed with carbaryl. Intermediate levels were recorded for vines treated with oil. The lowest infestation levels were recorded for those plots treated with chlorpyrifos, bifenthrin or buprofezin.

On 22 Feb 2005, 10 bunches in each plot were visually scored in the field for effects of longtailed mealybug. They were scored on the basis of presence of honey dew secretions, associated sooty mould and general bunch appearance. The presence and extent of garden weevil damage to bunches and botrytis disease presence was included in the assessment, but not differentiated. The score system adopted was: 0 = healthy/no obvious effect, 1 = slight presence of honey dew/sooty mould; 2 = obvious presence of honey dew/sooty mould; 3 = bunches adversely affected by honey dew/sooty mould. The average score for the bunches for each treatment is given in Fig. 7.

Bunches in untreated plots had the highest proportion adversely affected by mealybug, with around half the bunches in the two higher adverse effects categories. Bunches treated with oil as a drench plus foliar spray or carbaryl either as a drench or as a foliar application also showed 40 to 60% of bunches adversely affected. Bunches in plots treated with chlorpyrifos or bifenthrin early, showed the least signs of adverse effects. Adverse effects on bunches from buprofezin foliar spray treated plots showed intermediate levels of adverse effects. These results are consistent with the infestation levels of LTMB recorded on leaves during the season (see Figs. 3 and 4).

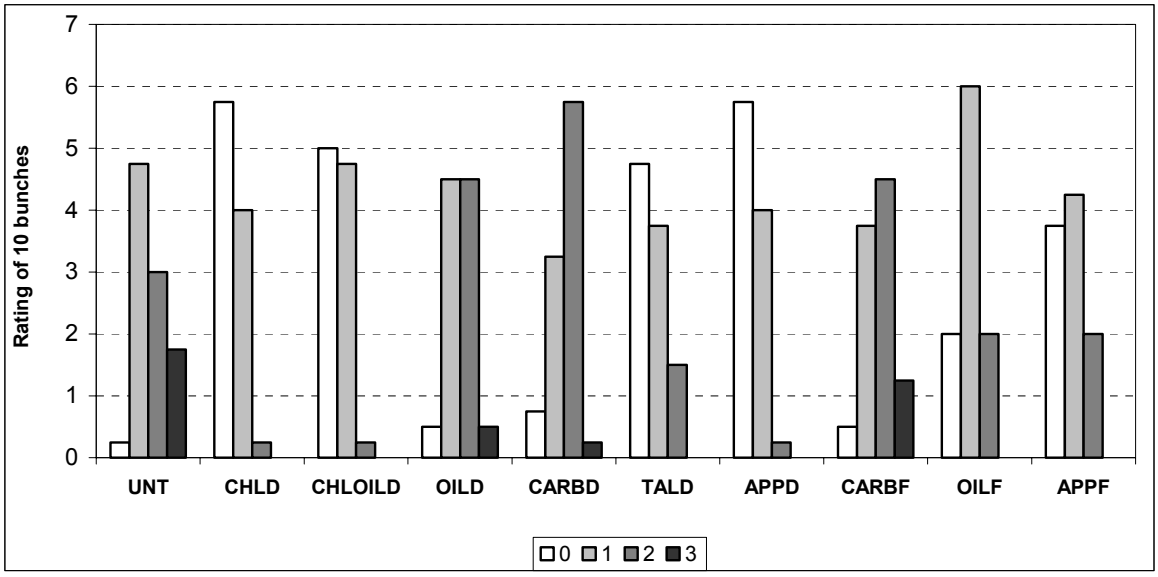


Fig. 7. The average score (see text for details) for presence of sooty mould and longtailed mealybug in 10 randomly selected grape bunches per treatment on 22 February 2005 in an insecticide screening trial, Northcliffe, WA 2004/05. Treatments were: UNT = untreated; CHLD = chlorpyrifos drench before budburst; CHLOILD = chlorpyrifos plus oil drench; OILD = oil drench; CARBD = carbaryl drench; TALD = Talstar drench; APPD = Applaud drench; CARBF = carbaryl foliar spray; OILF = oil foliar spray; APPF = Applaud foliar spray.

The levels of sooty mould and LTMB were assessed for 15 bunches randomly collected per treatment on the day of harvest, 21 March 2005. The levels were based on a scoring system: 0 = no effect; 1 = slight adverse effects and presence of LTMB; 2 = obvious/severe effect of LTMB. The average sore for bunches from each treatment are shown in Fig. 8. The highest scores of adverse effects were recorded for untreated plots and those treated with oil applied as a drench with an early follow up foliar spray and carbaryl. Lowest levels were recorded for vines treated with chlorpyrifos, bifenthrin and foliar applied oil. Intermediate levels of sooty mould and LTMB were recorded for vines treated with buprofezin.

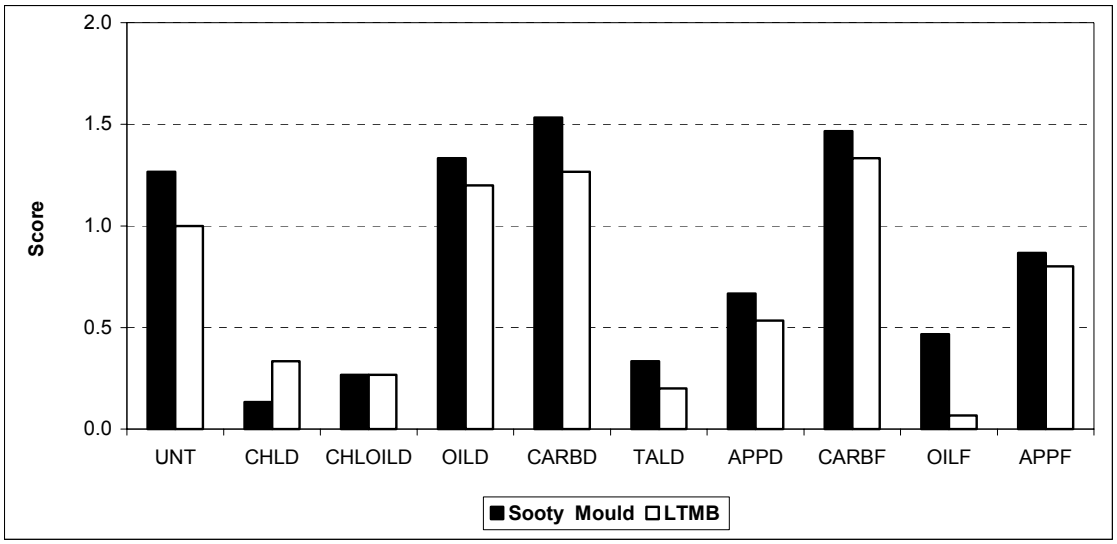


Fig. 8. The average score (see text for details) for presence of sooty mould and longtailed mealybug in 15 randomly collected grape bunches on the day of harvest 21 March 2005 in an insecticide screening trial, Northcliffe, WA 2004/05. Treatments were: UNT = untreated; CHLD = chlorpyrifos drench before budburst; CHLOILD = chlorpyrifos plus oil drench; OILD = oil drench; CARBD = carbaryl drench; TALD = Talstar drench; APPD = Applaud drench; CARBF = carbaryl foliar spray; OILF = oil foliar spray; APPF = Applaud foliar spray.

The hand harvest of grapes in all plots was carried out on 21 March 2005. Because there was an unequal number of vines across panels in the trial area, the statistical analysis of yield data performed was based on covariance. The corrected yield data taking into account the difference in vine numbers per panel are given in Table 2. No significant difference among means was found.

Table 2. Yield of grapes for each treatment in an insecticide screening trial, corrected for the number of vines per plot, Northcliffe, WA 2004/05. Covariance analysis of variance showed no significant differences among means. Treatments: UNT = untreated; CHLD = chlorpyrifos drench before budburst; CHLOILD = chlorpyrifos plus oil drench; OILD = oil drench; CARBD = carbaryl drench; TALD = Talstar drench; APPD = Applaud drench; CARBF = carbaryl foliar spray; OILF = oil foliar spray; APPF = Applaud foliar spray.

Treatment	Average Yield (t/ha)
UNT	7.7
CHLD	10.9
CHLOILD	9.5
OILD	12.0
CARBD	12.2
TALD	12.4
APPD	9.5
CARBF	11.1
OILF	11.1
APPF	11.1

6. Outcomes/Conclusions:

Describe the outcomes of your project:
Monitoring in commercial vineyards infested with LTMB where releases of laboratory reared predators either were or were not made was inconclusive as to their benefit. In all vineyards, few predators were found in association with mealybugs, suggesting a minor role of natural enemies in controlling LTMB. While some vignerons report natural enemies being important in LTMB management, this could not be supported by sampling conducted during this study. In one vineyard infested with LTMB, the effect of insecticides esfenvalerate and indoxacarb either currently or with potential for control of garden weevil, did not result in a resurgence of LTMB.

A range of responses in terms of LTMB abundance and pest effects on bunches was seen in an insecticide trial.

The lowest number of pests and least adverse effects on grape bunches were recorded where early vine drenches with chlorpyrifos and bifenthrin were applied.

The insect growth regulator chemical buprofezin resulted in delayed reduction in pest abundance and also resulted in bunches with less adverse mealybug effects than the worst treatments or untreated controls. This insecticide is registered for use against LTMB in New Zealand and on citrus in Australia. The company that holds the product is pursuing registration for its use in Australian vineyards.

The soft insecticide option of oils indicated some low level of control and more applications may be required to achieve results similar to the most effective chemical insecticide.

Use of carbaryl appeared to initially provide some control, but the pest numbers subsequently increased to be similar to untreated plots at crop maturity.

Did it achieve what you set out to do in your original application? If not, why?
Assessing the role of predatory insects requires much more intensive monitoring and treatments than was instigated in this study. Laboratory feeding trials would add to the information required to assess the role of predators in managing LTMB. This could be supplemented by closer observations in large scale field plot sampling.

A range of chemical controls was adequately assessed in this study. Their effect over larger areas and the possibility of pest resurgence with some of the insecticides used require studies of larger/ecological plot sizes.

Could changing anything you did have improved the outcome.
More detailed and carefully planned studies would be required to clarify the role of predators.

The results of the insecticide trial indicate that the trial protocol was appropriate to demonstrate statistically significant treatment effects. A more uniform trial site would have overcome the problem in large plot variability which could have masked yield effects among treatments. A study on the effect of sooty mould on wine fermentation would have added value to this project to clarify this area of uncertainty.

Identify any benefits from your project either in terms of economic returns to the participants, improvements in the quality of your product, environmental benefits or benefits to your community.
The dramatic early season reduction in LTMB abundance from pre bud burst insecticide drenching could lead to improved management of this pest in high pest density situations. The project indicated monitoring before bud burst may give a good indication of the need for such an early treatment. The positive effects of the “softer” insecticide buprofezin could further enhance the overall softer approach to LTMB management using chemicals. Repeat trials confirming these effects, possibly over larger areas, would provide more useful information to proceed to registration of these insecticides for LTMB control.

Describe what you did to let other growers know about your results.

A summary report on results was circulated to the WA winegrape industry through the WA Department of Agriculture's Wine Industry Newsletter. A seminar at a Growers' Day gave more detailed results of the insecticide trial and general information on the biology and monitoring of LTMB in WA.

If appropriate, describe what you think the GWRDC could do to maximise the benefits for others in your circumstances or the whole industry. If appropriate include any suggestions about future research which build on the work undertaken by your organisation.
Results of this project could be made available to the Australian winegrape industry through industry magazines.

Further studies on the role of natural control agents and the impacts of the more favourable insecticide treatments demonstrated in this project would give the industry confidence in using particular strategies to minimize the adverse effects of LTMB.

7. Budget reconciliation:

Budget	Funding required from GWRDC		Actual expenditure
Monitoring	9,600.00		11,200.00
Travel to monitoring sites	1,500.00		1,900.00
Monitoring gear	400.00		350.00
Lab rearing equipment	250.00		150.00
Insect identification	800.00		0.00
Purchase & apply sprays	500.00		250.00
Purchase predators	0.00		0.00
Seminars with vignerons	300.00		100.00
Final report	200.00		200.00
Total	**13,550.00**		**14,150.00**
Add 10 % GST	1,355.00		1,415.00
Total funds requested from GWRDC	**14,905.00**	**Total expended**	**15,565.00**
		Remitted to GWRDC	(-660.00)
			Extra funds provided by WA Dept. Agriculture

Appendix 1. Abundance of longtailed mealybug from leaf sampling in an insecticide trial.

Table A1. (a) The square root transformed average number of longtailed mealybugs of all stages per leaf in an insecticide trial testing the efficacy of a range of insecticides and time of application. Data for all dates were significantly different ($P< 0.01$) and $LSD_{0.05}$ values are included. (b) Backtransformed data.

(a)

Treatment	28-Sep	12-Oct	26-Oct	09-Nov	16-Nov	30-Nov	14-Dec	05-Jan	08-Feb	22-Feb	21-Mar
UNT	2.46	1.92	2.42	1.20	0.83	1.08	1.43	1.04	4.09	2.50	1.89
CHLD	0.00	0.11	0.00	0.00	0.00	0.00	0.45	0.22	0.78	0.92	1.11
CHLOILD	0.00	0.27	0.11	0.22	0.00	0.11	0.00	0.27	0.76	0.74	1.76
OILD	0.72	0.89	1.62	0.54	0.22	0.63	1.05	1.66	3.79	1.95	2.67
CARBD	1.03	1.21	1.19	0.77	0.38	0.64	1.65	1.34	3.78	2.84	4.36
TALD	0.32	0.16	0.19	0.11	0.00	0.11	0.11	0.27	0.70	1.06	2.04
APPD	2.06	1.67	1.96	0.82	0.22	0.34	0.56	0.00	0.38	0.72	1.15
APPF	*nd	nd	1.87	0.94	0.43	0.87	0.89	0.89	0.83	1.45	2.54
CARBF	nd	nd	0.58	0.42	0.47	1.02	1.71	1.67	3.45	2.57	3.40
OILF	nd	nd	1.78	0.22	0.16	0.92	0.98	1.76	2.36	1.92	2.65
LSD	***0.78***	***0.72***	***0.60***	***0.60***	***0.46***	***0.58***	***1.04***	***0.52***	***1.45***	***0.97***	***1.05***

*nd = no data collected on these dates.

(b)

Treatment	28-Sep	12-Oct	26-Oct	09-Nov	16-Nov	30-Nov	14-Dec	05-Jan	08-Feb	22-Feb	21-Mar
UNT	6.07	3.67	5.85	1.43	0.68	1.17	2.04	1.07	16.73	6.25	3.57
CHLD	0.00	0.01	0.00	0.00	0.00	0.00	0.20	0.05	0.61	0.85	1.23
CHLOILD	0.00	0.08	0.01	0.05	0.00	0.01	0.00	0.07	0.58	0.55	3.10
OILD	0.52	0.80	2.61	0.30	0.05	0.40	1.10	2.74	14.36	3.80	7.13
CARBD	1.06	1.45	1.41	0.59	0.15	0.41	2.72	1.81	14.29	8.07	19.01
TALD	0.10	0.02	0.04	0.01	0.00	0.01	0.01	0.07	0.49	1.12	4.16
APPD	4.23	2.80	3.82	0.67	0.05	0.11	0.31	0.00	0.14	0.52	1.32
APPF	nd	nd	3.48	0.88	0.18	0.75	0.79	0.80	0.69	2.10	6.45
CARBF	nd	nd	0.34	0.17	0.22	1.03	2.92	2.78	11.90	6.60	11.56
OILF	nd	nd	3.16	0.05	0.02	0.85	0.96	3.11	5.57	3.69	7.02

Table A2. The percentage of leaves infested with longtailed mealybugs of all stages in an insecticide trial testing the efficacy of a range of insecticides and time of application. Data for all dates were significantly different ($P< 0.01$) and $LSD_{0.05}$ values are included.

Treatment	28-Sep	12-Oct	26-Oct	09-Nov	16-Nov	30-Nov	14-Dec	05-Jan	08-Feb	22-Feb	21-Mar
UNT	90	95	90	50	45	55	60	65	95	100	70
CHLD	0	5	0	0	0	0	20	10	45	50	45
CHLOILD	0	10	5	10	0	5	0	10	25	35	75
OILD	30	40	65	25	10	30	45	65	95	80	100
CARBD	40	70	75	35	20	25	45	50	100	85	100
TALD	10	10	15	5	0	5	5	15	45	40	85
APPD	90	90	85	30	10	15	30	0	20	50	75
APPF	nd	nd	100	40	15	45	40	45	35	70	95
CARBF	nd	nd	30	15	15	45	65	60	95	100	100
OILF	nd	nd	85	10	10	55	40	95	100	90	90
LSD	***27.23***	***28.57***	***30.38***	***27.58***	***17.64***	***34.98***	***33.08***	***21.54***	***25.33***	***33.92***	***22.39***

Appendix 2. Comparison of costs of spraying longtailed mealybug in the insecticide trial.

A comparison of the cost of chemicals used in the insecticide trial in this project is given in Table A2. No detail is given on the cost of application. This would be different for drenching the vines pre bud burst, compared with foliar application. With the increase in use of "spray return" type sprayers for application of sulphur early in the season for mite control and use in applying butt drenches for control of garden weevil, a unit to apply sprays pre bud burst for controlling longtailed mealybug becomes a real possibility.

The volume of spray solution used in the calculations are meant to be a guide only and will vary for each vineyard depending on machinery available and canopy type.

Table A2. Details of the spray applications and costs of insecticides in a trial on controlling longtailed mealybug in winegrapes.

Insecticide	Product	Rate	[1.] Method of Application			[2.] Cost
			Drench	Foliar 1	Foliar 2	($/ha)
untreated	-	-	-	-	-	-
chlorpyrifos	Chlorfos 50%EC	100ml/100L	+	0	0	27
chlorpyrifos + paraffin oil	Chlorfos 50%EC + Biopest Paraffin Oil	[3.] 100ml/100L + 2L/100L	+	0	0	132
paraffin oil	Biopest Paraffin Oil	2L/100L	+	0	+	105
carbaryl	Carbaryl 500	200ml/100L	+	0	0	51
bifenthrin + paraffin oil	Talstar 100EC + D-C-Tron Plus Spray Oil	25ml/100L + 1L/100L	+	0	0	78
buprofezin	Applaud 44% EC	60ml /100L	+	0	+	252
carbaryl	Carbaryl 500	200ml/100L	0	+	0	9
paraffin oil	Biopest Paraffin Oil	2L/100L	0	+	+	60
buprofezin	Applaud 44% EC	60ml /100L	0	+	+	102

[1.] Method of application: - = untreated plots; 0 = not applied at this time; + = applied at this time.

[2.] Cost is for product only and is based on the following prices as at 29 August 2005 and uses the following rounded spray volume application rates: Drench @ 1,500 L/ha; Foliar 1 @ 250L/ha; Foliar 2 @ 600 L/ha:

chlorpyrifos 50% EC @ $90/5L.
paraffin oil (similar prices for D-C-Tron Plus and Biopest oils) @ $70/20L.
carbaryl 50% SC @ $85/5L.
bifenthrin 10% EC @ $68/1L.
buprofezin 44 % EC @ $200/1L.

[3.] The rate of insecticide and oil for this treatment should have been 50ml chlorpyrifos + 1L oil/100L.