The effects of different species of true bugs on strawberries

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Purpose of the Report:

The aim of this project was to help strawberry growers in Victoria, and other States, to know which species of true bugs cause damage, so that they can minimise insecticide use and improve sustainability.

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Media Summary

The Victorian Strawberry Industry began to change to using an Integrated Pest Management (IPM) approach to invertebrate pests as a result of an industry and HAL funded project that commenced in 2008. As a result there was vastly improved control of key pests (western flower thrips and two-spotted mite) and a greatly reduced reliance on insecticides to achieve control of pests.

However, in 2009 an insect that had not previously been recognised as a pest (crop mirids) caused severe damage to Victorian strawberry crops. This outbreak of damage raised many questions about which species of bugs occur in strawberries and which of these species cause economic damage.

It is certain that a reduction in broad spectrum insecticide use as a result of the adoption of IPM combined with seasonal changes in weather means that some true bugs are now becoming more common in Victorian strawberry crops. Whilst information is available from overseas the species referred to do not occur in Australia. This project aimed to provide a clearer understanding of which species of true bugs are most likely to cause an economic loss. The results are to be delivered to the industry in an identification guide.

The main driver for needing this information is that there are currently no control measures for bugs other than the use of insecticides that can disrupt the biological control of major pests. Obviously the application of disruptive insecticides targeting species that are not actually economic pests should be avoided.

The results of this project show that Rutherglen bugs can cause some minor damage but species of mirid bugs usually cause severe damage. Lygaeid bugs were found to cause no damage to berries.

It is recommended that the industry considers trialling trap crops as a possible cultural control method for managing bugs.

Technical Summary

The Victorian Strawberry Industry began to change to using an Integrated Pest Management (IPM) approach to pests as a result of an industry and HAL funded project that commenced in 2008. As a result there was vastly improved control of key pests (western flower thrips and two-spotted mite) and a greatly reduced reliance on insecticides to achieve control of pests.

However, in 2009- 2010 an insect that had not previously been recognised as a pest (crop mirids) caused severe damage to Victorian strawberry crops. Many Victorian strawberry growers reported up to 80% yield loss for several weeks due to distorted berries strongly suspected to be caused by Crop Mirids - *Sidnia kingbergii* – (F. Miridae) a pest that had not previously been known to the industry. However, which other bugs may have caused the same damage was not known, and growers were nervous about the presence of any bugs in their crops.

This outbreak of damage raised many questions about which species of bugs occur in strawberries and which of these species cause economic damage. Some of the true bugs noticed after that time (but for which no information is available concerning strawberry damage) are listed below:

* 2011 saw huge numbers of Green Potato Bugs (*Cuspicona simplex*)

*2012 there was a large movement of Coon Bugs (*Oxycarenus arctatus*)

*2013 there were many Brown Mirids (*Creontides pacificus*)

* and every year there have been Rutherglen Bugs (*Nysius vinitor*) and other lygaeid bugs (F. Lygaeidae).

Although some of these species are unlikely to cause any economic injury, this information is either extremely difficult to find or is unknown.

The insecticides currently registered for control of bugs in strawberries are Maldison and Pyrethrum. Both are broad spectrum insecticides which means they will not only kill the target bug species but also many beneficial species as well. Their use in an IPM system has a serious impact on the control of other (major) pests such as two-spotted mite and Western flower thrips.

Some species of bugs can be sporadic pests only occurring in large numbers every few years. This project aimed to rank the most common bug species present in Victorian strawberries according to the distortion caused to the developing fruit. The species tested in this trial were

Rutherglen bug - *Nysius vinitor*

Green mirid – *Creontides dilutes*

Brown mirid- *Creontides pacificus*

Crop mirid – *Sidnia kinbergi*

Lygaeidae spp.

The results of this project show that Rutherglen bugs (*Nysius vinitor*) can cause some minor damage but species of mirid bugs (Family Miridae) usually cause severe damage. Lygaeid bugs (Family Lygaeidae) were found to cause no damage in our trials.

It is recommended that the industry considers trialling trap crops (such as lucerne) as a possible cultural control method for managing bugs.

Introduction

For many Victorian Strawberry growers, using IPM has become a necessity due to insecticide resistant mites and thrips. Project BS08011 (May 2011) *Develop an effective IPM strategy to deal with pests in the Victorian Strawberry industry*, has led to IPM being adopted rather than reliance on insecticides to control insect and mite pests.

Similarly, in other states such as Queensland, Western Australia and South Australia, effective control of two-spotted mites on many farms can only be achieved by using predatory mites within an IPM system. Because of this relatively new approach to pest control, information about other pests and how to control them has now become far more important.

It is certain that a reduction in broad-spectrum insecticide use as a result of the adoption of IPM combined with seasonal changes in weather means that some true bugs (Hemiptera) are now becoming more common in Victorian strawberry crops. Some appear to be important pests but for others there is little or no information. Whilst information is available in books (eg. Integrated Pest management for Strawberries - University of California, 2008) and "Fact Sheets"- from overseas the species referred to (usually "Lygus Bug") do not occur in Australia. Conversely, the bugs found in Australian crops are not likely to be found in European or North American crops as they are native to Australia. This project aimed to provide a clearer understanding of which species of true bugs are most likely to cause an economic loss. The results are to be delivered to the industry in an identification guide in 2014 at the conclusion of this project.

This project looked at what damage, if any, some different species of bugs caused to strawberries but it is well known that there are non-insect causes for distortion to strawberries, including poor pollination, cold, nutrient deficiencies and fungal diseases (Hancock, 1999; University of California, 2008). So this project was aimed at providing clarifying information on true bugs for Australian growers about which was the damaging insect component of a larger problem.

The main driver for needing this information is that there are currently no control measures for bugs other than the use of insecticides that can disrupt the biological control of major pests. Obviously the application of disruptive insecticides targeting species that are not actually economic pests should be avoided.

True Bugs

There is a group of insects called "True Bugs", which are sucking insects in the insect Order Hemiptera. While "bugs" is a common term for any insect, true bugs are a taxonomically identifiable group of insects. True bugs include both pest and beneficial insects. Some commonly recognised pest bugs include insects such as aphids, Rutherglen Bugs, Harlequin Bugs and Vegetable bugs. Some beneficial bugs that are well known in horticulture include Damsel bugs (*Nabis*), Shield bugs (*Oechalia* spp) and *Orius*.

Rutherglen bug (*Nysius vinitor*) is perhaps the most visible of the true bugs because it often occurs in high numbers in Victorian crops, but the association with damage in strawberries has been inconsistent. The typical "cat-face" distortion that has been blamed on Rutherglen bugs in the past may in fact be due to other species of true bugs. In New Zealand a related species of Nysius (*N. huttoni*) causes damage to young seedlings, especially brassicas, and this pest has recently become a new pest in Europe! (Reid and Eyre, 2010).

Cotton growers in Australia have considered Rutherglen Bug to be an occasional pest that attacks the seedlings and it is known to be a contaminant in canola. However, cotton producers know that mirid bugs are serious pests of their crop

(http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/mirids). During feeding mirids pierce the plant tissues with their mouthparts and release a chemical which destroys the plants cells. The berry then continues to grow around the damaged cells resulting in distorted fruit. In cotton the entire boll is often lost.

Prior to this project different species of mirids were known as pests in cotton, legume crops and other field crops but in Australia they have not been listed as pests in strawberries.

In 2009 this changed with the arrival of crop mirids which caused significant economic loss to the Victorian strawberry industry. The crop mirids distorted the fruit, making the fruit unsellable. Prior to this, Rutherglen bugs were the only bug species nominated by the Victorian strawberry industry to be of any importance. Rutherglen bugs were associated with distortion to the fruit but the type of distortion was unclear. Each year since 2009 the arrival of bugs in December has caused varying degrees of damage and each year has seen a different species as a potential problem. The reason for this is most likely a combination of seasonal differences as well as the reduction in broad-spectrum insecticide use as a result of the industries uptake of IPM.

A complicating factor in the control of many bug species is that there are currently no biological or cultural control options that can effectively prevent damage from an influx of adult bugs. Control is primarily based on the use of insecticides that disrupt the biological component of IPM strategies. These strategies are necessary for the management of the two key pests, two-spotted mite (*Tetranychus urticae*) and Western flower thrips (*Frankliniella occidentalis*), both of which are insecticide resistant. The impact of the insecticides used for bug control are costly in terms of potential losses caused by flaring the two key pests and also the direct costs of re-establishing commercially available biological control agents.

Typically the arrival of bugs coincides with a critical time for the establishment of biological control agents for two-spotted mite and Western flower thrips, which is around mid- to late- December. If biological control is not established or is disrupted at this time it becomes increasingly more difficult to control these pests in January because of hot, dry conditions. There is also considerable pressure on growers at this time of year because of the high value of strawberries over the Christmas period.

In the absence of an alternative to insecticide control, this project aimed to assist growers in being able to differentiate between bugs that cause little or no damage and ones that cause major damage allowing for a more strategic use of insecticides.

To assess the impact of each species of true bug on the formation of strawberries, this project aimed to expose developing flowers and fruit to individual bugs and follow the fruit through to harvest stage. This project is closely linked to BS12003: Thresholds for Plague Thrips in the Victorian Strawberry Industry. In that project an assessment was made using the same methods for some common species of thrips (especially Plague thrips, *Thrips imaginis*).

The aim of this project was not to determine a threshold or action level at which different species of true bugs become damaging. The aim was to give a relative ranking of the severity of damage that different species may cause to strawberries and so allow growers to assess the relative risk of different bugs that may be present in their crops.

Materials and Methods

Trials were carried out during only one growing season (2013 – 2014). Due to the use of some insecticides on commercial strawberry farms (over which we had no control) we decided that the best way to conduct this trial was by using potted strawberry plants. Fifty *Albion* plants were grown in pots at the IPM Technologies research facility in Hurstbridge.

The impact of different species of true bugs on strawberry formation was assessed by caging flowers with known numbers and species of true bugs. Assessments were made when the fruit was fully developed and had turned red.

Figure 1: A flower caged and a berry tagged using our method.

Figure 2: A plant caged for trials with true bugs

For the initial trials the fifty potted plants were checked twice a week when we had suitable bugs, in order to find the appropriate stage of flowers (just open). We aimed for a minimum of 10 flowers at a time, but this was not always possible as the plants have flushes of growth and flowering. Sometimes there were two suitable flowers on one plant, but usually just one flower per plant was available. Each flower that was caged was individually identified and tagged with surveyors flagging tape. When the cage containing the flower was removed (after petal drop) each developing berry was followed until it ripened. Then a photograph was taken of each berry when it was ripe. The berry was then scored for damage, and rated as either "No Distortion", "Some Distortion", "Severe Distortion or "Aborted Flower""

The initial trials with all species were set up on individual flowers caged with small mesh bags as done for trials with thrips (Figure 1). Known numbers of bugs were placed inside the bags and the bags were then placed on new flowers. The bags were removed when the petals had fallen and the assessment was made when the fruit turned red. In subsequent trials entire plants were caged in mesh bags so that flowers and different sized fruit could be exposed to the different species of bugs (Figure 2).

Ten Rutherglen bugs were used in each bag, but 3 individuals of each species of mirid were used per bag in experiments on these species. Two separate sets of trials were done with Rutherglen bugs, simply due to availability. One experiment was started in late 2013, and the other commenced in early 2014. The same numbers of bugs were used in the small caged flowers as well as the caged plants. Due to the limited number of flowers available at the same time, as well as the availability of different bug species, the trials were repeated over time. It was aimed to conduct 50 trials with each species and although this number of trials was established for Rutherglen bugs, there was not a result for all replicates due to weather conditions. The bugs used were mostly field collected, though small laboratory colonies of Rutherglen bug and brown mirids were established, and the nymphal stages were used in trials.

Berry ratings were as follows:

Note: These photos depict damage or distorted strawberries, but the damage is not necessarily caused by insects. They are simply to provide a reference for our assessments.

No distortion; these berries had seeds which were distributed evenly over the berry.

Some distortion; these berries had slight unevenness in the seed distribution but could still be sold.

Severe distortion; these berries had very uneven seed distribution and could not be sold

The distortion to the berry shown at far right is typical of mirid damage, but the other two photos are not necessarily caused by insects.

Extreme temperatures meant that some of the trials had to be repeated because of the high number of damaged or aborted flowers in the controls. This damage was caused by the extreme heat that occurred in the summer of 2013-14. As the trials relied on the flower progressing through to ripe fruit, or at least fully formed fruit, for a result to be made, anything that affected the progress would disrupt the assessment of that particular berry.

Results

The results of the different trials with the different species of bugs are summarised in Figures 2 to 7. The results shown are those from the most complete sets of individual trial where there were at least 10 replicate plant available.

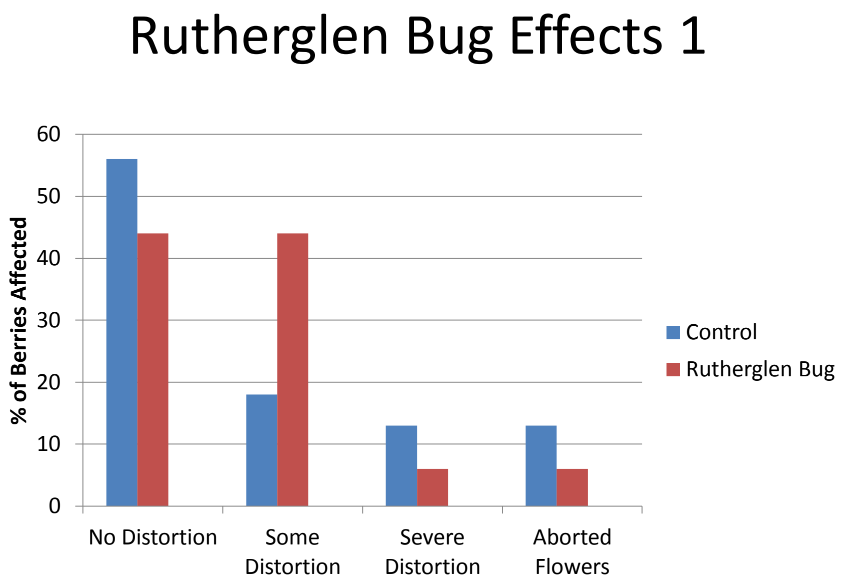


Figure 3: The effects of Rutherglen Bugs on berries

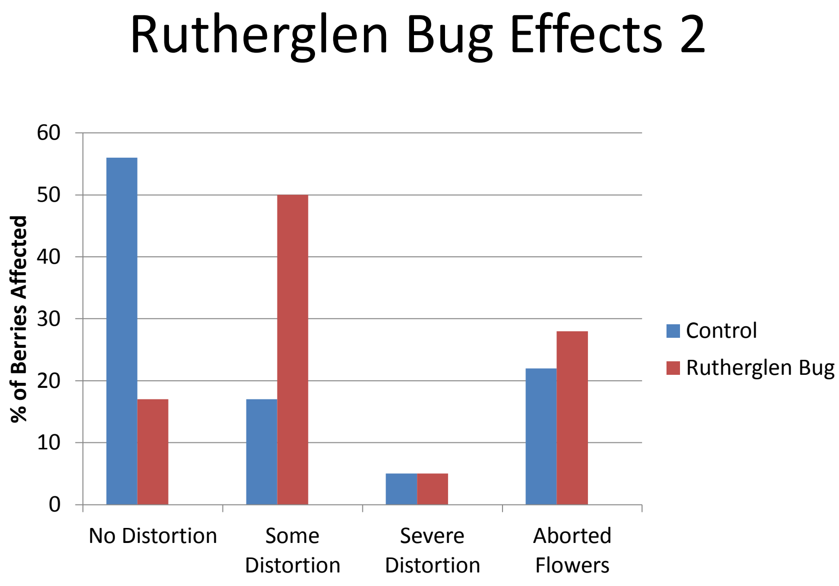


Figure 4: The effects of Rutherglen Bugs on berries (trial 2)

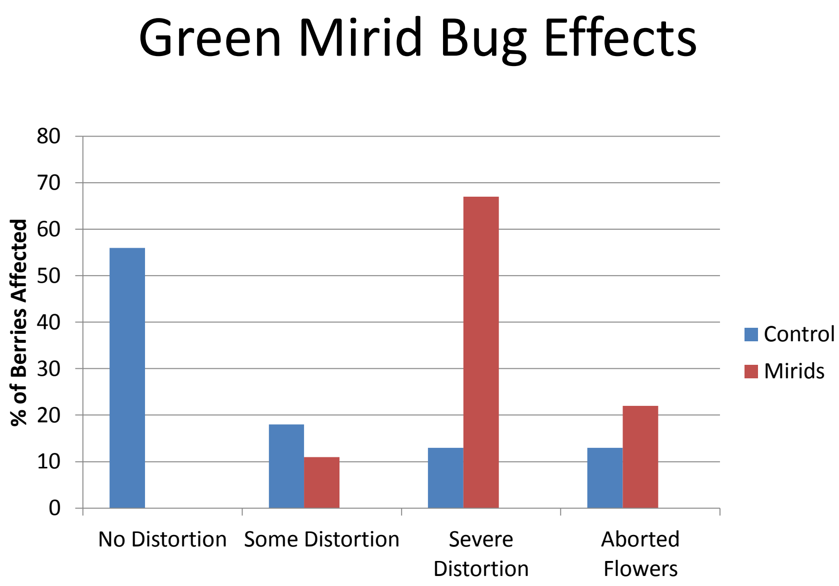


Figure 5: The effects of Green Mirid Bugs on berries

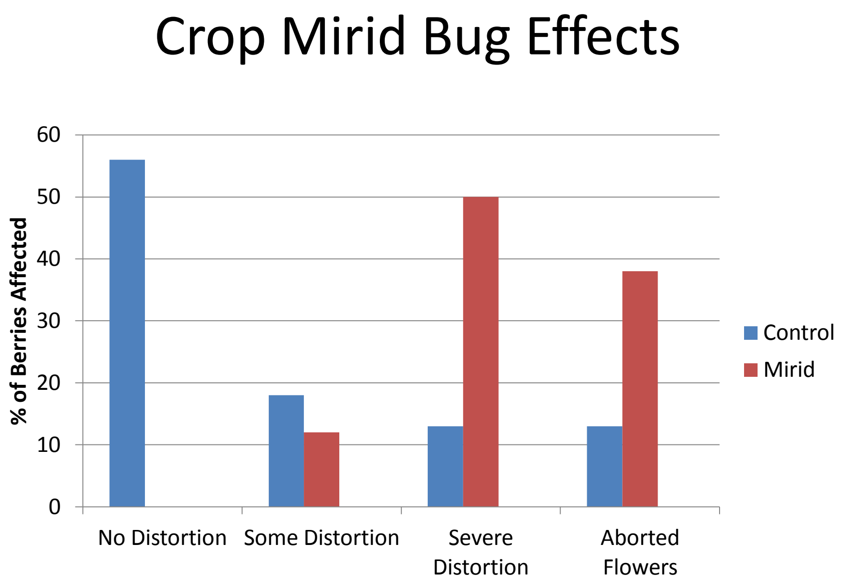


Figure 6: The effects of Crop Mirid Bugs on berries

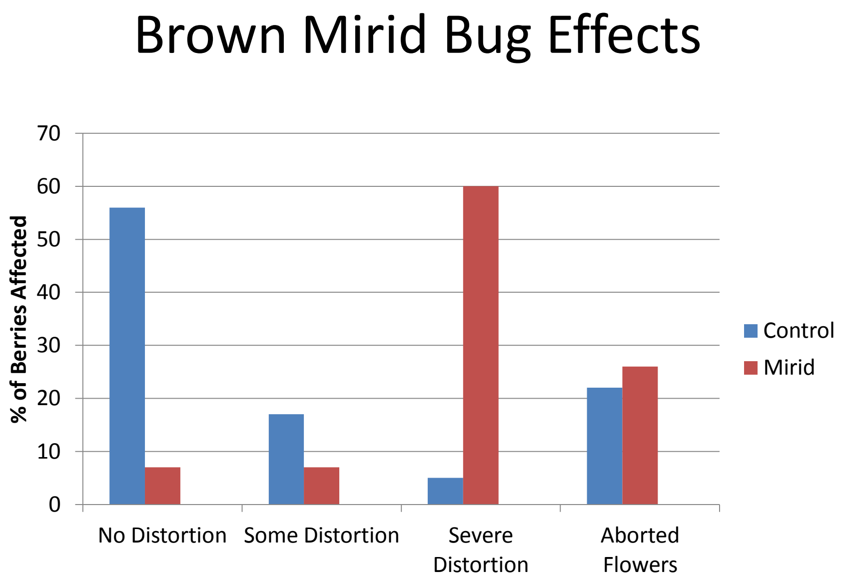


Figure 7: The effects of Brown Mirid Bugs on berries

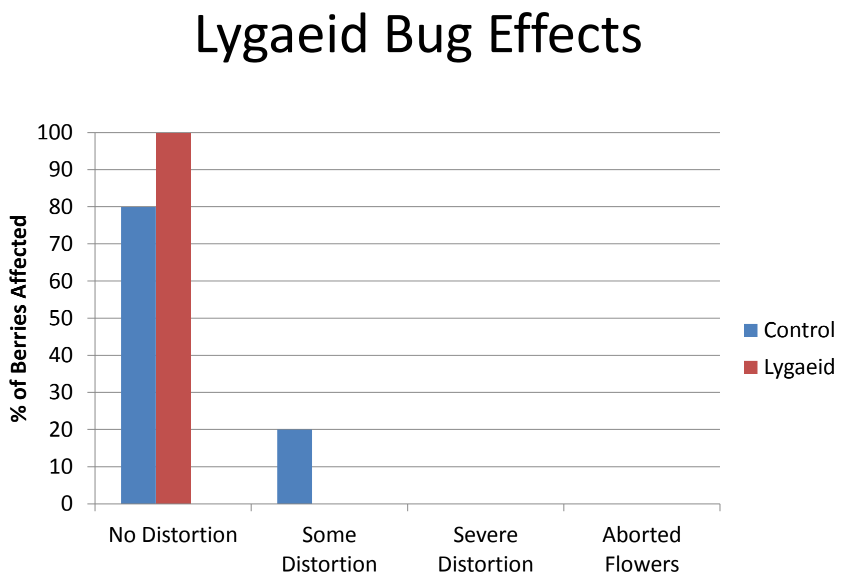
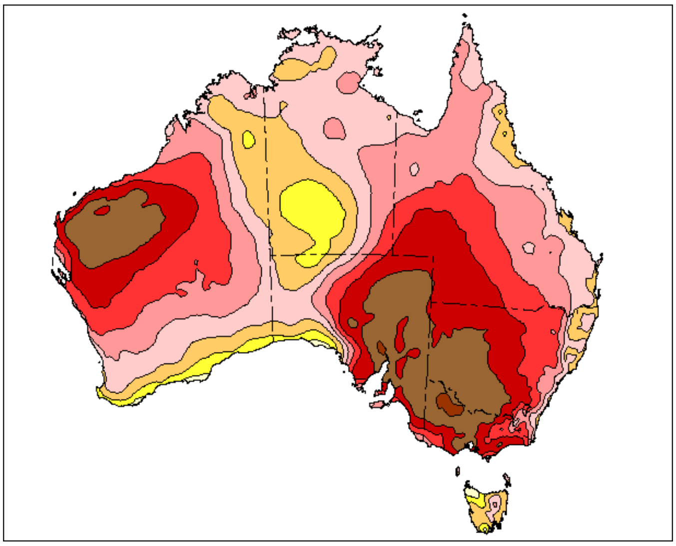


Figure 8: The effects of Lygaeid Bugs on berries

The trial shown coincided with one of the hottest periods of weather ever in Victoria (see Figure 9).

"One of the most significant multi-day heatwaves on record affected southeast Australia over the period from 13 to 18 January 2014. A dome of very hot air developed over Western Australia in the second week of January, setting a number of records in that state, before moving eastwards to be over the southeast of the continent. A high-pressure system remained near-stationary over the Tasman Sea from the 13th onwards, directing mainly northerly winds over southeast Australia (including Tasmania), before a trough moved across the region on the 17th and 18th, bringing cooler air and ending the heatwave there.

*The major area affected by the heatwave consisted of Victoria, Tasmania (particularly the western half), southern New South Wales away from the coast, and the southern half of South Australia. Over most parts of this region, it ranked alongside the heatwaves of January-February 2009, January 1939 and (from the limited information available) January 1908 as the most significant multi-day heatwaves on record". (**Australian Government, Bureau of Meteorology, January 22 2014**)*



Red and brown areas on the map indicate maximum temperatures of 40 - 45°C.

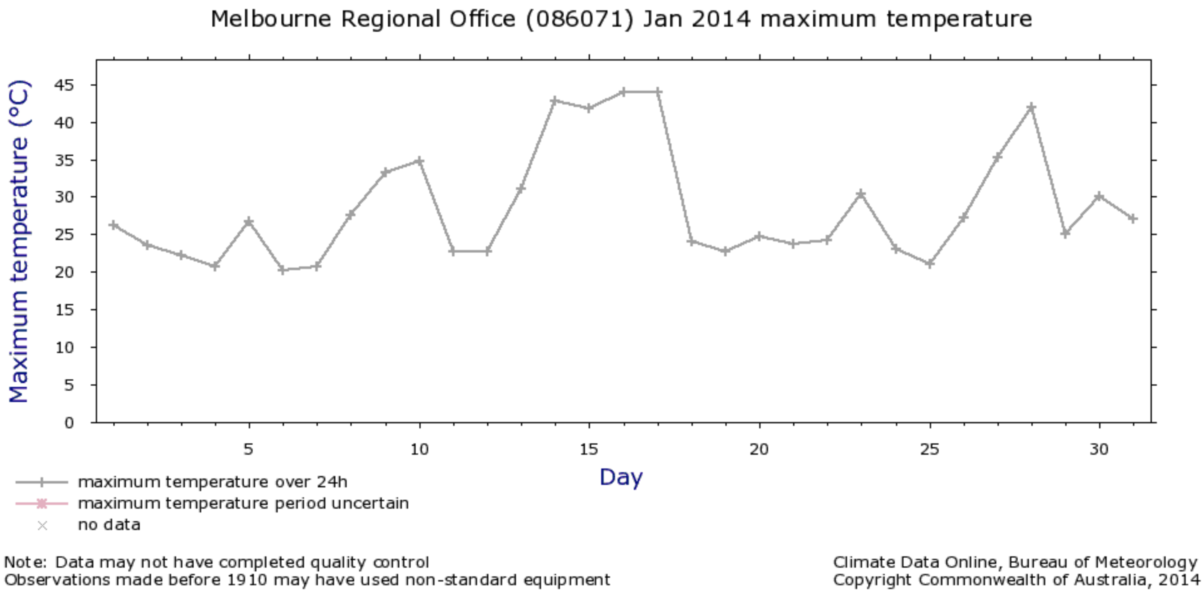


Figure 9: Temperature Map in Australia on January 17 and in Melbourne (daily) throughout January 2014

Discussion

In mosttrials there were distorted berries in the controls as well as aborted flowers. This indicates that bugs are just one of the many factors involved and that the development of perfect fruit depends on nutrition, climate, soil moisture and pollination. There were more aborted flowers and severe distortion of berries in January and February trials, which is no doubt due to some extremely hot days during this period. Hot dry conditions probably cause similar distortions to frost damage, and is a combination of damage to the flower and also poor pollination.

Rutherglen bugs caused little or no distortion. In most cases the fruit would have still been saleable but maybe as second grade. Any decision to spray an insecticide should take into consideration the impact of the insecticide on the biological control for other pests. In most cases spraying for this species is not likely to be economically viable, meaning that the potential loss caused by other pests as a result of the insecticides used is greater than the loss caused by Rutherglen bugs themselves. However, they may be a problem as a contaminant (which is an issue that is beyond the scope of this project and may involve disinfestation rather than within crop treatment).

Both adult and juvenile crop mirids, brown mirids and green mirids all cause very similar damage which can result in economic loss due to distortion of the berries. These insects are known pests in crops such as cotton where they can cause severe losses of the cotton bolls, and in legumes where they cause distortions to the growing tips . Again the decision to spray needs to take into account the impact on other pests and the costs involved in re-establishing biological control. All species cause damage to the flower which results in distorted fruit.

Lygaeid bugs caused no damage in our trials. Our field observations are that they are present at ground level and at times on ripe fruit, but not in flowers. This is different to the mirids, which we usually see in flowers and in the upper canopy of the plants. Therefore to spray an insecticide targeting lygaeid bugs is not going to improve the quality of the berries, but is likely to disrupt control of major pests which do actually cause significant damage.

Technology Transfer

The results of the project will be disseminated during 2014 to the Victorian Strawberry Industry by presentations to growers at meetings organised by the strawberry IDO and via the VSIDC.

Recommendations

It is possible that the use of permanent beds of Lucerne could be used as a trap crop for the bug species used in this trial. Work has been done in the cotton industry which has shown that Lucerne is a preferred host plant for mirids and Rutherglen bugs (Charles and Mensah (2008); http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/mirids) . It is strongly recommended that the industry consider this as an option. Bugs are likely to be a problem every season .

The combination of using trap crops such as Lucerne that can be sprayed with a broad-spectrum insecticide and allowing naturally occurring beneficial bugs that may help to control the level of pest species that breed within the crop would fit well within an IPM program and help to minimise the costs of spraying and the costs of buying biological control.

Acknowledgments

We gratefully acknowledge the VSIDC and Victorian strawberry growers in general for their support of this project.

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Commercialization & Intellectual Property Issues

There are no issues

Communication/Extension Activities

The results will be presented to the Victorian strawberry industry at a time when the VSIDC and the IDO agree is suitable in 2014.

Next Steps

The results of this project are applicable in other areas of Australia where there are similar species of true bugs (eg Tasmania). So extending the research to these areas is the next step.

If there is interest in the use of lucerne strips to control mirids then this would be worth evaluating.