IPM AND AVOCADOS IN AUSTRALIA

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Abstract
A successful IPM program has been developed for the Queensland citrus industry. Since it was first established more than 20 years ago the program has been steadily accepted by an increasing number of growers to the point where almost all of the Central Burnett growers are now practising IPM. The Central Burnett district represents about 70% of Queensland's citrus production and the IPM program developed here has been used as a stepping stone for other citrus growing areas in Queensland.
This presentation looks at key points from the Queensland citrus IPM program to highlight elements that may be useful in meeting the challenge of furthering IPM for avocados.

Introduction
In the 1978-79 growing season an IPM program was commenced on the 'Golden Mile Orchards' property at Mundubbera (Smith, D. and Papacek, D. F. (1985). At that time the orchard was privately owned by the late Jack Parr who was widely regarded as an industry leader and innovator in the Queensland citrus industry.
Dan Smith, senior entomologist with the Queensland Department of Primary Industries, had performed preliminary research to demonstrate the potential for an IPM program. Most importantly, he demonstrated that effective control of the key pest red scale, *Aonidiella aurantii* could be achieved by existing natural enemies especially *Aphytis lingnanensis* (Smith, D. (1978). He had also been either directly or indirectly instrumental in facilitating the introduction and assessment of a number of highly successful biological agents for the control of a range of other important pests of citrus. Some of these included *Aphytis holoxanthus* for control of Florida red scale, *Chrysomphalus aonidum*, *Anicetus beneficus* for pink wax scale, *Ceroplastes rubens* and *Leptomastix dactylopii*, for citrus mealybug, *Planococcus citri*. These early developments laid the foundations for the commencement of a fully integrated pest management package.
Dan Papacek, an entomology graduate of the University of Queensland, was engaged by the Golden Mile Orchards P/L to collaborate with Dan Smith to initiate the IPM program for that company.
An insectary for mass rearing of *A. lingnanensis* was established at the Golden Mile Orchard to develop an augmentative release program for improved management of red scale.

Acceptance by industry
The evolution of the IPM package for the Queensland citrus industry has been described in previous publications (Smith, D and Papacek D.F. (1985), Papacek, D. F. and Smith, D. (1992). Adoption by the industry has taken place at a steady rate over a period of 20 years and has been influenced by certain significant milestones.

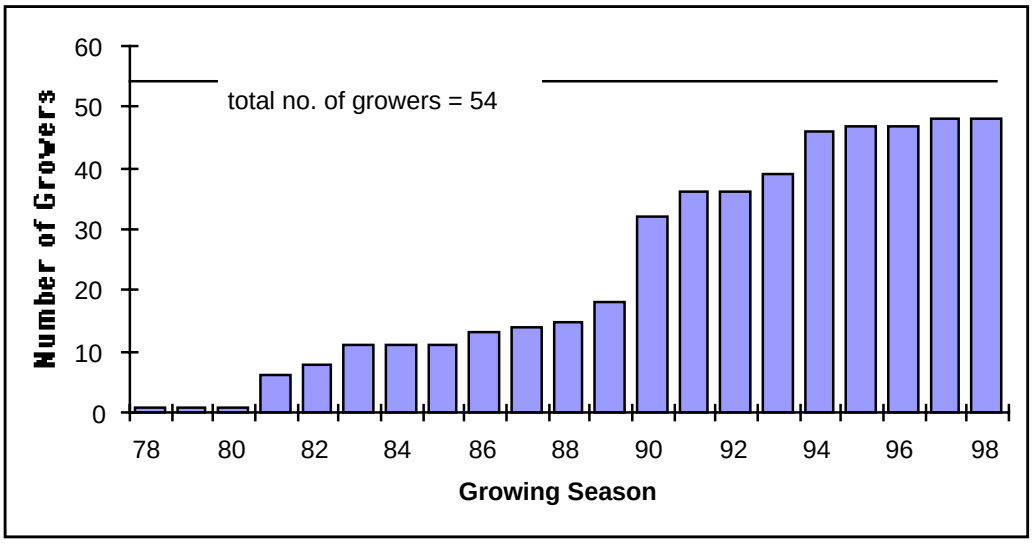

Figure 1. Adoption of IPM by the Central Burnett Citrus Industry

In 1980, following the second year of IPM, a field day at the Golden Mile Orchards was able to demonstrate to other members of the industry that IPM was feasible and that significant reductions in conventional pesticide usage were possible. In the following season, six more growers adopted the new service which was now offered on a consultancy basis to all interested growers

Over the next 8 years there was a steady increase in adoption by the larger and more progressive growers so that, by the 89/90 season, approximately 40% of growers were practising IPM.

In the late 80's, biological control of white louse scale, *Unaspis citri*, was achieved with the predatory coccinellid *Chilocorus circumdatus* (Smith, D., Papacek D., and Smith N. (1995)) This significant pest had previously been regarded as something of a stumbling block to IPM, as no satisfactory alternatives to chemicals were available. Its biological control was considered a major breakthrough and led to a significant increase in adoption in the 1990/91 seasons.

In 1992 an economic study of the citrus IPM program was able to show that growers were able to make significant savings when compared with a conventional, pesticide-based strategy (Hardman, P., Papacek, D. and Smith D. (1992)).

It is interesting to note that the progressive adoption of IPM by the industry was started initially by one large entrepreneurial grower (the largest grower in the Australian industry at the time) and was subsequently taken up by smaller and more conservative growers. In the time since commencement of the program, IPM has gone from being regarded as something of an oddity to acceptance as the industry norm.

Critical components of citrus IPM

Research

Good research will always be an essential component of any IPM program. Research must be well directed and practical and aim to generate a sound base of knowledge especially in the following areas:-

1). pests and their status
2). beneficials and their capabilities
3). soft pesticides that can be used with minimum disruption when necessary

It is folly to delay the implementation of IPM until the biological system is fully understood - it will never be fully understood. Research should tackle the major issues first, to provide a platform for early trials into IPM.

The research commitment needs to be ongoing because biological systems are dynamic. The status of various pest species will change and new invaders will need to be dealt with.

Classical Biological Control

The potential for classical biological control should always play an important role in IPM programs. The rewards for this sort of research can be immense, and effective biological control of one important species can make the difference between success and failure of an IPM program. Research efforts directed at classical biological control can be expected to span several years in some cases and this time frame will often not suit the standard 'three year' project. Nevertheless efforts at classical bio-control should remain focused and not abandoned in favour of 'quick fix' alternatives.

Services provided to the industry by IPM p/l

The service provided to the citrus industry by Integrated Pest Management P/L (which also trades as Bugs for Bugs) has evolved over time to include the following:-

1). A comprehensive monitoring service which involves an inspection of each individual block of citrus for pest and beneficial species. Where possible inspections include assessment of disease incidence such as alternaria brown spot of Murcott mandarins. The inspections commence with the timing of fruit set and continue until the crop is harvested (about 9 months on average). A detailed report is provided to the grower at each visit and includes suggested action(s) that may be deemed necessary.

2). An annual visit to plan the program for the coming season. This is usually made one or two months before the commencement of the new season and looks especially at planning a preventative disease control program. Specific problem areas from the previous season are addressed with options for those blocks discussed.

3). Growers are supplied with a package for recording any treatments applied to each block throughout the season. This encourages a uniform recording system across the industry and is useful in interpreting results at the end of the season.

4). Copies of all monitoring reports are retained by IPM p/l and the data is entered into a computer database along with spray and release records, to generate a graph for each block for the season.

These graphs are used to assess

i) performance of the IPM program during the season
ii) interactions between chemical treatments and both pest & beneficial species

iii) interaction between beneficial organisms and their natural prey.

5). Production of beneficial organisms for release into orchards to supplant the need for synthetic pesticides.

6). A post harvest fungicide monitoring service to assist in the management of citrus post harvest treatments.

7). An irrigation scheduling service.

Beneficial Organisms

Bugs for Bugs (the insectary at IPM p/l) produces a range of beneficial organisms which are used for biological control of selected pests as part of the IPM package. Of interest to the citrus industry in particular are:-

1). *Aphytis lingnanensis* - a wasp parasitoid of red scale, *Aonidiella aurantii*. In the 2000/2001 season 180 million mass reared Aphytis were released into citrus orchards in the Central Burnett.

2). *Cryptolaemus montrouzieri* - a coccinellid for control of citrus mealybug is released into blocks of citrus where monitoring indicated worrying levels of mealybugs.

3). Other species such as *Chilocorus circumdatus* - a predatory coccinellid beetle - are released in selected blocks to give improved control of certain pests such as white louse scale, *Unaspis citri*.

The availability of beneficial organisms is considered to be an important component of the IPM package provided to the citrus industry. Research conducted in trials at Tiaro in 1990 demonstrated that releases of Aphytis early in the season were able to advance the levels of parasitism of red scale by up to 6 weeks.(Smith, D. and Papacek, D. F. (1991))

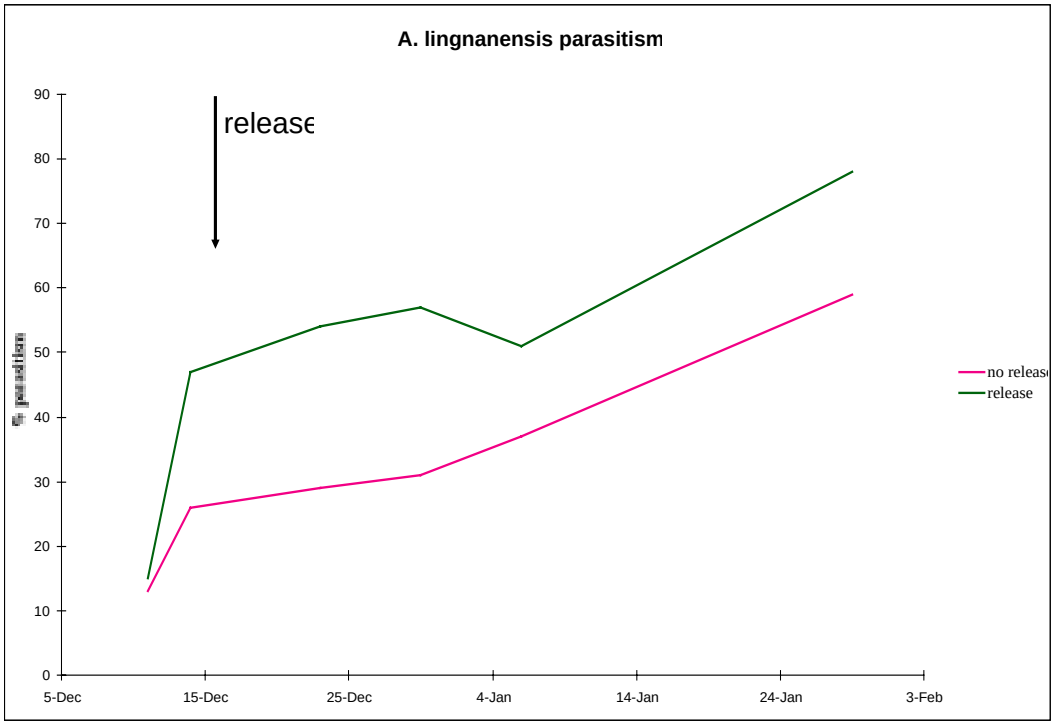

Figure 2. Mean percentage parasitism by *Aphytis lingnanensis* of virgin third instar female red scale in an augmentative release trial at Tiaro, Qld, 1990-91

In the absence of augmentative releases, Aphytis will recover following the natural depletion of numbers during winter but equivalent levels of parasitism may not be achieved until much later in the season. The availability of beneficial insects for mass-releasing gives the growers greater control and more confidence to ensure a better quality product at harvest.

Industry Commitment

IPM will only work if the industry wants and supports it. In the example in the Central Burnett district, initial suspicion was followed by interest and eventually widespread adoption and commitment. IPM has now evolved to the point where it is regarded as the industry norm and indeed growers who are not practising IPM are seen to be 'behind the times'. Most growers have become reliant upon the regular and valuable service provided by a complete pest management package and could not imagine doing without it.

No grower has ever been approached with a view to convincing them that they should adopt IPM practices. Each grower receiving the service has approached the service provider when they have been ready. This is usually as a result of becoming convinced that IPM is able to provide the pest management that the grower is looking for. If there is any doubt in the grower's mind that IPM is the way to go, then we

would always suggest that they wait until they are fully convinced. It is important that the grower has made the decision to adopt IPM because he/she believes it to be the best course of action rather than have them 'talked into it'. The latter approach will lead to great resentment at the first sign of problems whereas a grower who has personally elected to adopt IPM practices is much more likely to 'stick with it'.

The Central Burnett citrus industry is also characterised by growers who have a high standard of education, are cohesive as an industry and demonstrate a business-like approach to producing citrus. The industry has a history of commitment to research to the extent where it has voluntarily adopted an additional levy to contribute to a local research fund.

The industry is also reasonably compact so that it is economically serviceable. Most of the orchards fall within a radius of approximately 80 km.

It is also important for effective IPM that the crop is grown under good horticultural conditions. It is very difficult to manage pest and disease problems with trees that are suffering from disorders such as malnutrition, and poor growing conditions.

Other management aspects are also likely to impact on the relative success of an IPM program. For example a grower should have well maintained and effective spray equipment and a well pruned orchard. This ensures that if chemical spray treatments are necessary, the application is made thoroughly with the best possible chance of success and the time between repeat applications is maximised.

Discussion

In assessing which aspects of the citrus IPM program have most contributed to its success, the following points are emphasised:-

Research

There has been a sustained research effort even before the program was initiated commercially. This research has been practically aimed at resolving real world problems.

Commercial basis to IPM

The establishment of commercial consultants and an insectary have been able to provide a complete package in IPM to the citrus industry. Integrated pest management will always involve more complexity that a conventional pesticide approach and it is important that suitably trained personnel are available to make a career of IPM. It takes at least 6 weeks before a new scout is reasonably proficient at monitoring and around 2 years of full time monitoring before he/she is able to make good decisions based on the results of field counts.

Industry Commitment

The citrus industry has adopted a very mature approach to IPM, realising that it offers the only real answers for sustainable production and consumer acceptance in the future. The first commercial implementation of IPM in the citrus industry was in 1978, when there was little incentive for change due to the relative effectiveness of existing pesticides and a lack of concern from consumers.

Time frame

The citrus IPM program has evolved continuously over a period of more than 20 years. It started slowly and grew with the industry. IPM cannot be expected to happen quickly but it is worth the effort and the sooner started the sooner it will be established.

Cooperation

A platform of cooperation between researchers, consultants and growers has been developed and maintained throughout the evolution of the IPM program and remains probably the single most important contributor to the success of the program.

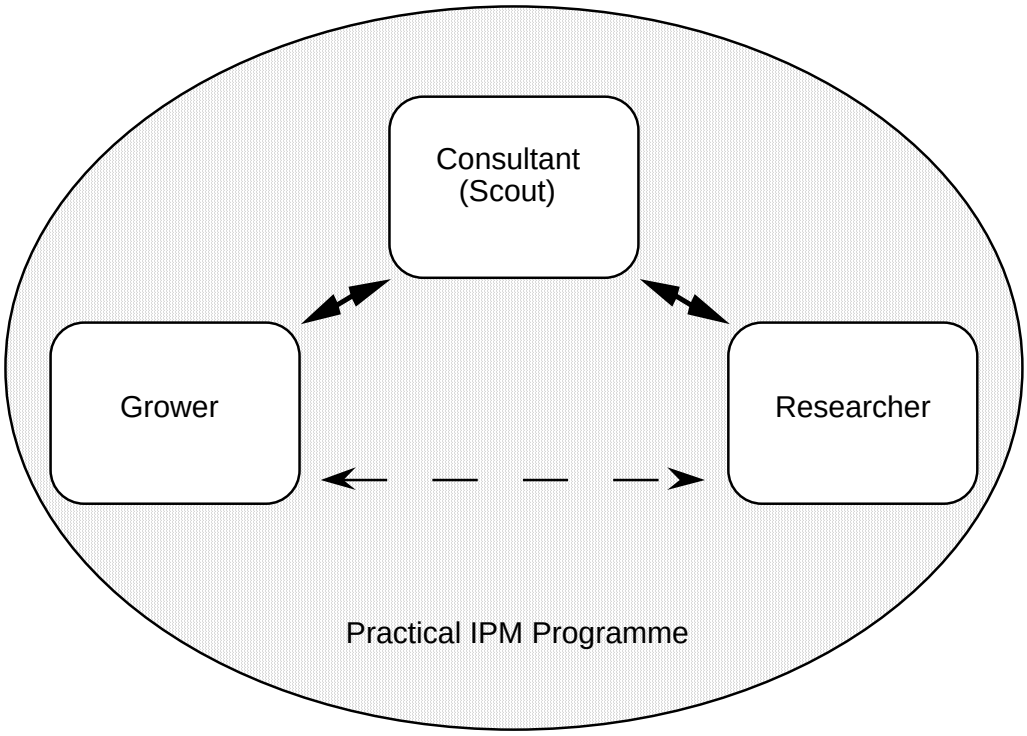

Figure 3 Triad of cooperation for effective IPM

Risk

IPM involves the acceptance of an element of risk. The conventional pesticide approach to pest management is often used as a form of insurance. Good IPM is possible only if difficult decisions are made. If the consultant and grower are never prepared to accept a level of risk then the easy option (i.e. to spray) will be taken prematurely and no forward progress will be made.

The levels of risk will be significantly reduced by:-

i) Sound monitoring practices.
ii) An improved understanding of biological systems that comes with experience.
iii) Development of a good knowledge base through effective research.
iv) Availability of a range of management options including:-
    a) mass reared beneficial insects
    b) soft pesticides and
    c) other strategies (e.g. cultural controls).

Monitoring

Monitoring is absolutely fundamental to IPM as it is simply not possible to make good pest management decisions without knowing what pest and beneficial species are active in the orchard. Monitoring must include assessment for beneficial species as well as for pests. An understanding of the role of beneficial species is essential when making decisions on pest management options.

To date, Integrated Pest Management p/l has helped to train more than twenty scouts. Some of these are now providing IPM to growers in other citrus growing districts of Queensland. These scouts continue to maintain a cooperative relationship with both IPM p/l and Dan Smith of QDPI.

Ultimately IPM will only happen when a package is developed which achieves good pest control with a worthwhile reduction in pesticide usage at an acceptable price.

Sustaining IPM

Once established, an IPM program cannot be taken for granted. Maintaining such a program will always require a great deal of effort. The biological systems associated with a crop such as citrus are in a constant state of flux. An effective and efficient monitoring system will always be the single most important element in a successful IPM program. An ongoing commitment to practical research, capable of solving day to day problems in an IPM compatible way, will be essential for sustaining IPM systems.

Comments on IPM for Avocados

The fundamental principles discussed in the citrus experience apply to the application of IPM in other crops such as avocados. Our company has only limited experience in avocados having worked with plantings in the Mundubbera area and three blocks on one orchard in the Bundaberg area.

Fruit spotting bug (FSB) is the most challenging insect pest causing problems for avocado growers in Queensland. In the orchards where we have worked we have been able to manage the pest problems with little recourse to pesticides.

The attached graphs (Figures 4-7) illustrate the results of monitoring and treatments applied to three Hass avocado blocks during the 1999/2000 season. In each case for the blocks represented an excellent packout of >95% first grade fruit was achieved with little or no insecticide intervention (Bob Norris, Farm Manager Pers. Comm.). Because of our limited experience in avocados we are reluctant to draw any conclusions from this data.

A survey of avocado growers conducted by Sean Hood in 1999 indicated that most growers considered that fruit spotting bug was a serious pest of avocado and that the average loss to this pest was around 5% (Pers. Comm). This perception was consistent throughout all grower types including those that sprayed regularly for FSB and those that sprayed little or not at all.

Fruit spotting bug is a difficult pest to control chemically especially with conventional spray machinery. I believe efforts to spray for FSB are largely ineffective and lead to disruption of potential natural enemies. This is why growers who spray frequently and those who do not spray experience similar outturns with respect to this important pest.

Suggestions for Further Research

Monitoring methods

Fruit spotting bug is a difficult pest to monitor accurately in avocado orchards. It is extremely cryptic with damage often observed before the bugs are detected. Further research into improved monitoring techniques should be encouraged. Pheromone based monitoring techniques could provide the answer for more accurate assessment of FSB populations and research into this field should continue.

Chemical control

Endosulfan had been the mainstay of FSB control in avocados for many years. It is relatively soft on many beneficial species but its overall impact on biological systems is still poorly understood. Recently there has been a move toward other chemical groups for FSB control. Synthetic Pyrethroids (SP's) are extremely disruptive and invariably lead to secondary pest problems, especially spider mite outbreaks. The SP's should be avoided at all cost.

At present there appear to be few options for non-distruptive chemical control of FSB. In Queensland mature avocado trees represent an enormous challenge to existing spray machinery. Large trees have a massive leaf area and good coverage will always be difficult to achieve. Ineffectual spraying of any horticultural crop has the potential to create more problems rather than solve them.

Biological control

Some pests (eg fruit flies) have naturally poor levels of biological control and fruit spotting bug is probably one of these species. However I believe that some levels of natural control are happening in minimally disturbed orchards and this may explain the anomaly between FSB levels/damage in regularly sprayed vs minimally sprayed orchards. I suspect that some larger predatory species such as salticid spiders may give significant assistance at times and their role should be examined more closely.

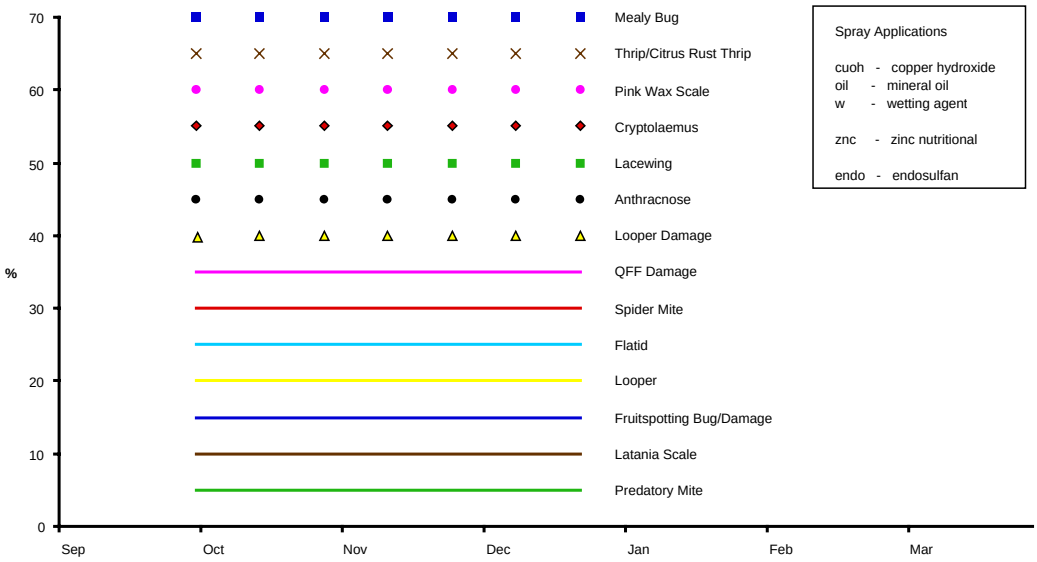

Figure 4. Key to avocado monitoring charts

Yandilla Park Farm #10 - 45 Avocado 99/00

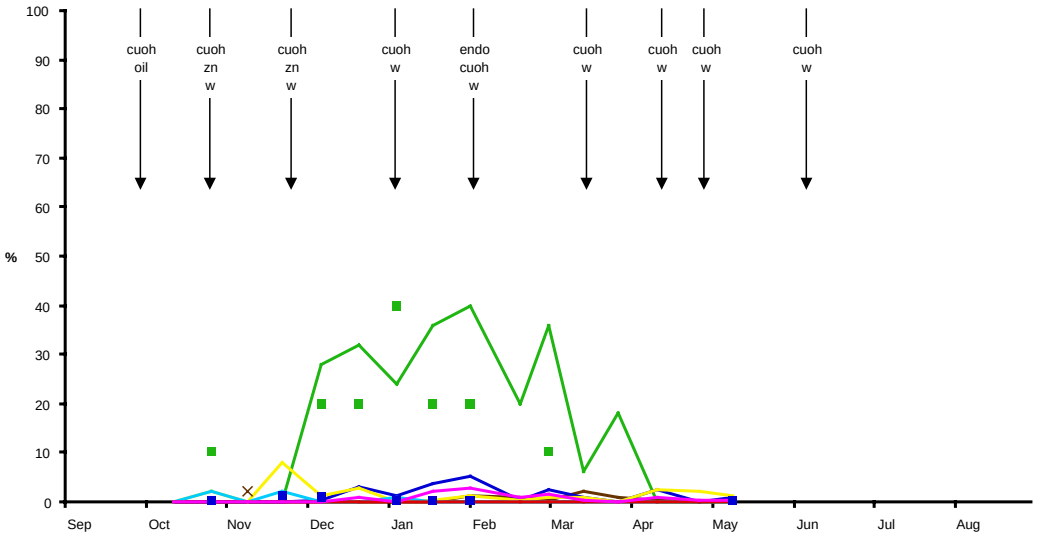

Figure 5. Results of monitoring and treatments applied to Hass avocado block #45 YPL Bundaberg

Yandilla Park Farm #10 - 46 Avocado 99/00

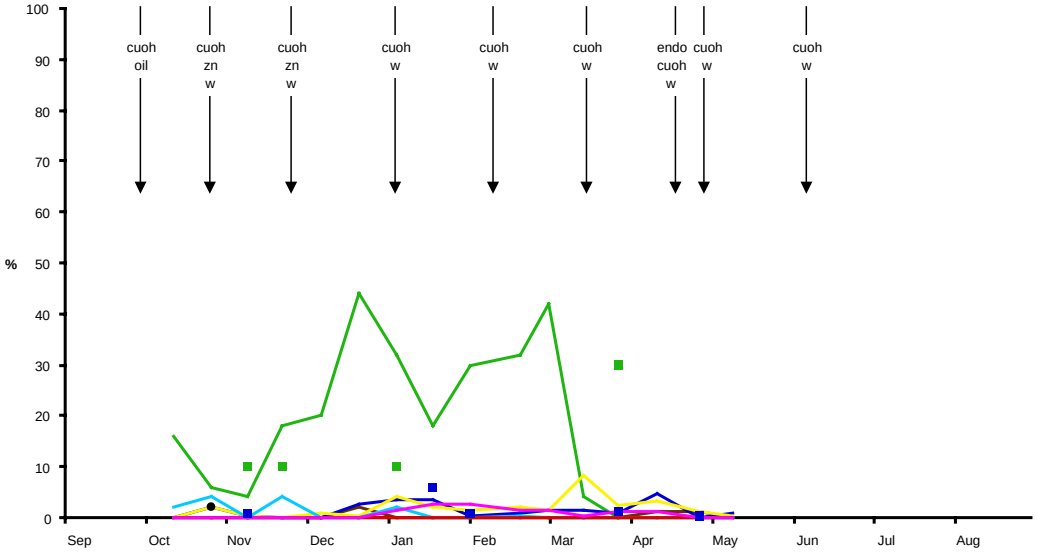

Figure 6. Results of monitoirng and treatments applied to Hass avocado block 46 YPL Bundaberg

Yandilla Park Farm #10 - 47 Avocado 99/00

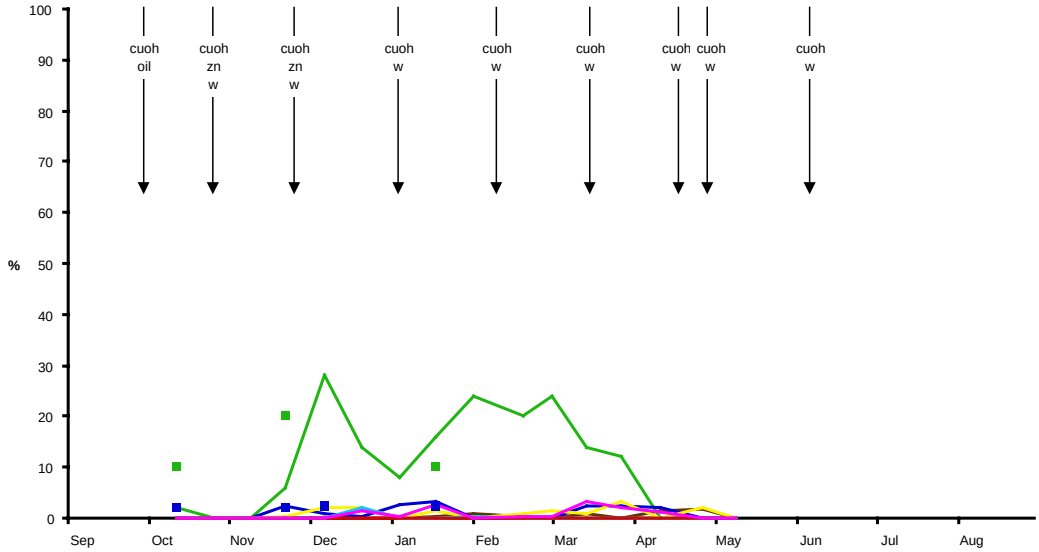

Figure 7. Results of monitoring and treatments applied to Hass avocado block 47 YPL Bundaberg

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