

PEST CONTROL HELPLINE
0508 AVOPEST (0508 286 7378)

AVOGREEN® MANUAL

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AvoGreen® Programme

Overview of the AvoGreen® Programme

What is AvoGreen®?

AvoGreen® is an approach to avocado production that aims to increase the profitability and improve the sustainability of avocado growers by ensuring better control decisions and by focusing on the market desire for safe and healthy fruit grown with minimal impact on the environment and the community. Consumers and the wider community often consider pesticides to be very harmful. However pesticides are also potent management tools for Growers and the industry needs to preserve their use. Public concerns need to be addressed and pesticides need to be used carefully and prudently. Demonstrating that as an industry we extract maximum benefit from each and every spray applied would help meet both of these aims.

AvoGreen® uses the principles of Integrated Pest Management (IPM) to ensure pesticides are used only when needed. This approach serves to justify the continued use of pesticides by growers while ensuring use is minimised and justifiable. Monitoring is the key method used worldwide to adapt pest control on an orchard to the actual pest situation found on that orchard. Action thresholds are an integral part of ensuring effective use, keeping pest populations below levels that cause economic loss. The AvoGreen® programme has to be rigorous and auditable to provide the necessary quality and safety assurances to our customers.

The AvoGreen® programme is owned and operated by the AGA for the overall good of the industry. The Board is responsible for the system and how it is managed. AvoGreen® was launched to the industry in 2000 and since then has been tested and proven to be a successful pest management tool, even under high pest pressure. The system is reviewed annually and improved as circumstances change. Comments from growers and other industry players have been and will continue to be sought as part of each review.

Growers become AvoGreen® compliant once they have a monitoring agreement with an accredited AvoGreen® Operator and a Sample Plan (or Plans) for the orchard has been drawn up. Note that growers do not have to be registered or become approved unless they personally are undertaking the monitoring.

Benefits of the AvoGreen® programme

The AvoGreen® programme helps growers by:

- Providing a point of difference that can be used to effectively market our fruit now and in the future as global competition rises in our markets.
- Helping deliver fruit that is acceptable to all markets.
- Saving the use of a spray when none is needed, potentially reducing costs.
- Improved export pack out at an industry wide level leading to less fruit on the local market. For those growers whose rejects are predominantly caused by pest damage, an improved pack out is anticipated.
- Providing an IPM system that is cost effective and controlled by our industry.

Definition of IPM

Integrated Pest Management (IPM) is the management of pests (including diseases) using a combination of methods to reduce the dependence on pesticide sprays and so minimise adverse effects on people and the environment. There is an emphasis on biological control and economic action thresholds.

The basic concepts underlying an IPM programme include:

- Prevention – knowledge of potential problems.
- Observation – monitoring.
- Intervention – when necessary and targeted with minimal side-effects.

The Structure of the AvoGreen® Programme

Using IPM principles, the AIC has developed a Standard to define the requirements of the AvoGreen® Programme for both growers and customers. This **Standard** is met by complying with the **AvoGreen® Monitoring Protocols** and the **AvoGreen® Specifications** which sets the requirements for each of the key roles in the system.

Key Roles

Key roles in the AvoGreen® Programme are:

- AvoGreen® **Operator**: a business that supplies a monitoring service to growers.
- AvoGreen® **Owner-Operator**: a grower who monitors their own orchard.
- AvoGreen® **Monitor**: an individual employed by an Operator (or an Owner-Operator) who monitors orchards under the AvoGreen® requirements.
- AvoGreen® **Trainer**: an individual accredited by the AIC to train people to become AvoGreen® Monitors.

Because these roles are critical, those undertaking them have to be accredited with the AIC.

AvoGreen® Grower

How do I qualify as AvoGreen® compliant?

The critical step that makes you compliant as a grower is to undertake to have your orchard monitored according to a Sample Plan (or Plans) developed for your orchard. You do not have to register unless you intend to become an Owner-Operator or a Monitor.

Each Grower needs to choose whether their orchard will be monitored:

- by contracting an accredited Operator to undertake the monitoring,
- OR by becoming an Owner-Operator and monitoring their own orchard.

Having an accredited Operator monitor your orchard

If you do not want to monitor your orchard yourself, you can contract the services of an AvoGreen® Operator. You and the Operator need a signed agreement covering how the monitoring will be done, including an agreed Sample Plan (or Plans if there is more than one Sample Area), which becomes the basis for determining compliance.

The Sample Plan specifies:

- the orchard(s) (PPIN) concerned, which will be monitored as one or more Sample Areas;
- the number of trees to be monitored, which depends on the size of each Sample Area;
- the type of monitoring, using Marked Trees or Repeated Random selection;
- the Schedule of monitoring, including a defined start date;
- whether scale is to be monitored or not; and
- whether a monitoring round can be terminated once the threshold of the target pest(s) is exceeded.

You should annually review the above details with your Operator to ensure that you are getting the best performance from your monitoring service.

Auditing

The auditing procedure will check for compliance with the Sampling Plan(s) in your contract, which will determine whether the crop is AvoGreen® compliant. If an orchard is covered by more than one Sample Plan, the area covered by each Sample Plan is considered as a separate and independent unit.

Monitoring results

Your Operator will provide monitoring results that note whether or not any action threshold has been exceeded. If a threshold is exceeded, you as the grower decide whether to spray or not, and the choice of spray material. You can delegate this responsibility provided you do so in writing to the person concerned, and as long as that person holds the appropriate qualifications (i.e. GROWSAFE® certificate).

If a threshold is exceeded but you believe the pest is localised, you may choose to spray only part of the relevant Sample Area. You can choose not to spray even if the threshold has been exceeded.

Cost of monitoring

The cost that the Operator charges for their service is part of your individual contractual arrangement with your Operator.

Becoming an Owner-Operator

An AvoGreen® Owner-Operator undertakes monitoring on an orchard that they own or manage. The monitor can be the orchard owner/lessee or an employee.

An Owner-Operator may monitor their own orchard(s) (however many PPINs they may own) plus two other grower's PPINs or one other grower's PPIN plus one Combined Sample Area. A Combined Sample Area is a group of up to 5 small orchards in the one locality that together form a single Sample Area (see AvoGreen® Owner-Operator requirements under the AvoGreen® Specifications). One of the growers involved may also become the Owner-Operator for the group.

If you want to become an Owner-Operator, you need to complete an Expression of Interest form and return it to the AIC. If the role of Monitor is being delegated to a permanent employee, the Owner or Manager registers as the Owner-Operator and specifies who will be the Monitor.

Training

The person undertaking the monitoring must have the appropriate accreditation or undergo training with an accredited AvoGreen® Trainer. Monitoring is described in *AvoGreen® Monitoring* on the website: www.nzavocado.co.nz.

For more details on the requirements for an Owner-Operator, see the relevant section under the AvoGreen® Specifications.

AvoGreen® Standard

AvoGreen® is a responsible and auditable production system that assures safe fruit for customers. An operational standard for AvoGreen® has been developed for growers and customers using IPM principles.

I. AvoGreen® Compliance

For an avocado crop to comply as AvoGreen®:

1. Each spray should be supported by pest monitoring results. In certain cases alternative reasons can be used, see section II below, 'Justifying a spray other than by monitoring').
2. Pest monitoring has to be carried out by an **accredited AvoGreen® Monitor**. See **AvoGreen® Specifications** for the relevant requirements.
3. All agrichemicals¹ used must be approved and applied at no more than the maximum rate given in the AIC Avocado Quality Manual and on the product label.
4. All agrichemical applications used in producing an avocado crop must be recorded in the electronic spray diary for that PPIN and the diary verified by the Packhouse before the crop is picked.
5. The appropriate Pre-Harvest Interval given in the AIC Avocado Quality Manual for each agrichemical and market must be met.
6. All persons spraying agrichemicals within an orchard in the AvoGreen® programme must have a current **GROWSAFE certificate**.
7. Spray rigs must be well maintained (a legal requirement under the **HSNO Act**) and should be regularly calibrated and used as set up.

¹ The term "agrichemicals" includes all chemicals used in producing an avocado crop excluding fertilisers and spray adjuvants, unless these are being used as pesticides. Approved agrichemicals are registered pesticides with a label claim for use on avocados.

NON-COMPLIANT CROP

In general, non-compliant crop will not be eligible to be exported. Crops for which AvoGreen® compliance has lapsed may still be accepted for export at the discretion of the AIC and after a review of each case.

II. Justifying a spray other than by monitoring

Monitoring is the most important and most common way in which a spray application can be justified.

Below are specific examples of when a spray is allowed without monitoring. Further situations will be investigated during the implementation phase for universal AvoGreen®.

- a) When the threshold for greenhouse thrips is exceeded, two sprays are allowed without monitoring for the second spray provided the second spray is applied between 14 and 30 days after the first (between 15 – 21 days is ideal).
- b) When armoured scales are found at harvest, growers can use their reject analysis data showing armoured scales were present to ensure that at least one spray with a label claim against armoured scales is applied the following season provided no such spray has already been used against any other pest.
- c) One leafroller spray is allowed after flowering and before the end of January because this is a critical timing.

III. Other AvoGreen® Considerations

Although not an obligatory part of the current AvoGreen® programme, the following aspects are good practice and fit with IPM principles:

- **Coverage** - Ensure all sprays applied result in maximum impact by checking that the coverage achieved matches the target area for the intended pest or disease.
- **Chemical choice** - Where possible use sprays that are selective and have no or little impact on beneficial insects in preference to broad-spectrum pesticides. See selectivity grouping included as **Appendix 1**. However choice is at the grower's discretion. Note that where sprays are needed against more than one pest, market forces and common sense favour the use of a single agrichemical. Market MRLs restrict the choices available.
- **Water blasting** - Where possible, clean fruit at packing with high-pressure water blasting. Use information from the last harvest, from pickers or from a bin inspection at the packhouse to determine the risk of contamination by pests or by other insects and mites. Water blasting not only reduces contamination but also can lower residue levels.
- **Bee Safety** - Protect bees and other pollinators by only spraying during flowering when it is essential, and following "bee-friendly" practices particularly when hives are present in your own orchard or any nearby property. These include mowing the sward before spraying if it contains any flowers. Observe any restrictions given on the label of pesticides that may harm bees.

IV. AvoGreen® Specifications

AvoGreen® Standard consists of the following:

- a) AvoGreen® Operator Requirements;
- b) AvoGreen® Owner–Operator Requirements;
- c) AvoGreen® Monitor Requirements;
- d) AvoGreen® Trainer Requirements;
- e) AvoGreen® Auditing Programme.

a) AvoGreen® Operator Requirements

An AvoGreen® Operator is a business which provides monitoring services to avocado growers in compliance with AvoGreen® specifications. Operators employ or contract accredited AvoGreen® Monitors.

Businesses wanting to become accredited AvoGreen® Operators need to complete an application form and return it to the AIC. Before undertaking monitoring, Monitors employed by the Operator need to be registered with the AIC and appropriately accredited or trained by an accredited AvoGreen® Trainer.

Operators need to:

- Register with the AIC in a contractual agreement;
- Have a documented system;
- Complete an Operator - Grower Agreement with each Grower;
- Agree on the number of Sample Areas per orchard with each Grower;
- Have a Sample Plan for each Sample Area used (see *AvoGreen® Monitoring Protocols* on the website: www.nzavocado.co.nz). The Sample Plan is the basis for determining compliance, and includes:
 - a) An Orchard map;
 - b) Sampling method;
 - c) Sample size;
 - d) Monitoring schedule;
 - e) Whether scale is to be monitored;
 - f) Whether monitoring can stop once the threshold is exceeded.

A template of a Sample Plan is available on www.nzavocado.co.nz

- A register of all Monitors used, including records of their training, eyesight test and accreditation;

- An internal audit program;
- Pay an annual fee of \$200 (+GST) to the AIC plus \$25 (+GST) a year for each Monitor.
- Pay for any audits required by the AIC using the AIC appointed auditor.

There should be a meeting of the Grower with the Operator and/or Monitor before the start of each season to review the Sample Plan with regard to pest levels and damage found at harvest.

b) AvoGreen® Owner-Operator Requirements

An AvoGreen® Owner-Operator undertakes monitoring as in the **AvoGreen® Monitoring Protocols** on an orchard that they own or manage. The monitor can be the orchard owner/lessee or an employee.

An Owner-Operator may monitor their own orchards (however many PPINs they may own) plus two other grower's PPINs or one other grower's PPIN plus one Combined Sample Area. A Combined Sample Area is a group of up to 5 small orchards in the one locality that together form a single Sample Area (see *Combined Sample Area* under the *Sample Area* section of the AvoGreen® Monitoring Protocols). One of the growers involved may also become the Owner-Operator for the group.

Growers wishing to become an Owner-Operator need to complete an Expression of Interest form and return it to the AIC (form available on www.nzavocado.co.nz). If the role of Monitor is being delegated to a permanent employee, the Owner or Manager registers as the Owner-Operator and specifies who the Monitor will be.

All Owner-Operators need to:

- Register with the AIC using an AvoGreen® licensing agreement;
- Have a documented system as detailed below;
- Verify ongoing compliance, and;
- Pay an initial fee of \$100 (+GST) every five years.

The documented system is made up of:

- A Sample Plan for each Sample Area, including:
 - a) An orchard map;
 - b) Sampling method;
 - c) Sample size;
 - d) Monitoring schedule;
 - e) Whether scale is to be monitored;
 - f) Whether monitoring can stop once the threshold is exceeded.

For more details on the Sample Plan, see the **AvoGreen® Monitoring Protocols**. These protocols and a template of a Sample Plan are available on www.nzavocado.co.nz.

- A register of all Monitors used, including records of their training and eyesight test.
- If an Owner-Operator monitors a Combined Sample Area or an adjacent orchard not under their direct management, a written agreement including the above details is necessary.

Training

The Owner-Operator or person nominated as Monitor must be accredited or undergo training from an accredited AvoGreen® Trainer. Monitoring requirements are detailed in the **AvoGreen® Monitoring Protocols**, which is found on the website: www.nzavocado.co.nz

The initial fee for becoming an Owner-Operator includes the accreditation of one monitor, either the employee nominated as Monitor or the Owner-Operator. The AIC will provide this training at no extra cost (excluding travel costs etc), provided attendance is at a specified AIC training course – training outside of these specified sessions through a commercial provider will not be funded.

c) AvoGreen® Monitor Requirements

An AvoGreen® Monitor is a suitably trained and accredited person who undertakes monitoring using the **AvoGreen® Monitoring Protocols**.

Monitors must:

- Either be an Owner-Operator or be employed by either an Owner-Operator or an Operator.
- Have acceptable eyesight – this is ascertained by taking an AvoGreen® eyesight form to an Optometrist and having an eyesight test (form available on: www.nzavocado.co.nz)
- Complete an application form and return it to the AIC with a \$25 (+GST) payment (form available on: www.nzavocado.co.nz).
- Following a successful eyesight test and application, the monitor will need to undergo the appropriate training and pass the test from an AIC accredited AvoGreen® Trainer.
- Have at least one year's experience of pest monitoring or be undergoing the AIC in field training course.

Although the basic monitoring protocols have remained the same through the current revision of AvoGreen®, there have been a number of small changes. Currently accredited Monitors should familiarise themselves with these by studying the *AvoGreen® Monitoring Protocols* on www.nzavocado.co.nz.

d) AvoGreen® Trainer Requirements

An AvoGreen® Trainer must have a sound knowledge of the pests of avocados and their identification as well as previous experience in AvoGreen® Monitoring.

Consistency and standard of Monitor training will be maintained by:

- Using a set basic course (AIC Basic Training Module);
- Comparing test results from different Trainers;
- Having assessors attending some courses.

Trainers need to:

- Attend and pass one of the AIC courses for Trainers;
- Be assessed in the delivery of 2 free training sessions to monitors as specified by the AIC;
- Have access to a data projector, **or** devise an alternative way to show the powerpoint training module for the basic course (e.g. networked computers), as well as access to a suitable venue;
- Be able to locate suitable sites with pests present in order to run practical field training sessions;
- Limit training attendance to a maximum of 20 people per session;
- Test monitors using an AIC test and notify individual test results to the AIC.

e) AvoGreen® Auditing Programme

The AIC will appoint an independent verification agency to audit compliance of Operators, Monitors and Growers with the AvoGreen® specification and protocols. The costs of these audits will be borne by the AIC except for the Operator audits which will be at the expense of the Operator.

By registering with the AIC each entity (Operator, Owner-Operator, Monitors and Growers) agree to submit to and co-operate with any audits as required.

All Operators will be audited on an annual basis. Owner-Operators, Monitors and Growers will be audited on a random basis with a fixed proportion being audited each year.

V. AvoGreen® Monitoring Protocols

1. Sample Area

An orchard can be monitored as a single unit or subdivided into several Sample Areas. The number of Sample Areas has to be specified for each orchard when monitoring is first established, and reviewed at the start of monitoring each season.

Subdivision is recommended if there are big differences between different parts of an orchard (varying tree size, variety or tree management) that are considered likely to affect the pest risk in that area, or how the grower responds to a pest find. Most orchards are likely to use a single Sample Area.

The aim is for all trees in the Sample Area to be as similar as is practical in order to target the response to where it is most effective, and to ensure that sampling can be minimised. Large orchards may group blocks under different management practices, such as time of intended harvest. If the differences are significant, each such group is better treated as a separate Sample Area.

Factors to consider in determining the number of Sample Areas to use are:

- Historical pest levels and how these are spread across the orchard,
- Sources of pest invasion e.g., adjacent vegetation including unsprayed or neglected areas,
- Type, and location of shelter belts,
- The need to obtain a representative sample for each Sample Area,
- Cost.

It is important that the sample trees do truly represent the Sample Area.

- Avoid selecting corner trees as these can be atypical,
- If a selected tree is obviously atypical, e.g. a sick or replacement tree, substitute it,
- Don't select pollinisers to be sample trees.
- As far as is possible ensure representation reflects likely sources of pest invasion, e.g. from adjacent vegetation.
- If necessary subdivide the area to ensure representation.

The appropriate number of sample trees for that size Sample Area is selected at random across the area.

Combined Sample Area

A group of up to five small orchards in the one locality may join together to become a single Sample Area provided they are sufficiently similar in tree size and management and have a combined total productive area of less than five hectares. This provision is to allow small, potentially uneconomic units to combine for monitoring. They can then contract for monitoring with an Operator or a local Owner-Operator, who may be one of them. As a guide, orchards within 1 km of a central point could be considered for combining. At least one tree must be sampled on each orchard in each round.

2. Sample Plan

Once the Sample Area (s) for an orchard has been defined, a Sample Plan for each is developed. In the majority of orchards a single Sample Area will suffice and have only one Sample Plan.

A Sample Plan is a written plan that includes the following:

- Orchard map;
- Sampling method;
- Sample size;
- Monitoring schedule;
- Whether scale is to be monitored;
- Whether monitoring can stop once the threshold is exceeded.

A template of a Sample Plan is given in **Appendix 2** and on the website. If an orchard has several Sampling Areas, each would have a separate Sample Plan, but with some common features, such as a single orchard map.

2.1- Orchard Map

An Orchard Map is a key part of the Sampling Plan for each orchard showing all orchard blocks, other significant landmarks and the AvoGreen® Sample Areas. The Grower, the Monitor and the Operator should each have a copy of the orchard map, which should be available for audit.

Each map must show:

- Name of orchard owner or manager;
- Contact phone/fax number;
- Orchard address, including number, road, and P-PIN;
- Orchard boundaries;
- Boundaries of avocado blocks, and block name or number;
- Access routes;
- Buildings and other physical landmarks;
- The number of avocado trees per block;
- Plantings in other blocks, e.g. kiwifruit, citrus;
- Boundary and a unique identifier of each Sampling Area;
- If sampling is from Marked Trees, the approximate position of each should be shown;
- Any hazards.

2.2- Sampling Method

Sampling can be done by:

- EITHER repeatedly visiting marked trees selected initially at random - the **marked trees method**,
- OR by repeatedly taking a random sample of trees - the **repeated random method**.

The marked trees method is considered simpler to operate, while the repeated random fits better with statistical theory on sampling. Some growers believe that the marked trees method gives a better measure of how effective a spray applied between two consecutive samplings has been. Although this may apply with the more numerous pest populations such as six-spotted mite and greenhouse thrips, the method may overstate the effectiveness with more individual pests such as leafrollers.

a) Marked Trees

Within each Sample Area identify and mark the randomly selected trees using a readily identifiable and durable marker e.g. coloured tape or paint. Monitoring can be carried out on these trees for up to three seasons before a new set of marked trees is selected. Changing more frequently is better. When selecting trees to be marked, the grower or orchard manager should accompany the monitor. Marked trees should be indicated on the orchard map

b) Repeated Random Sampling

True random sampling each round is time consuming. Selecting trees using a 'zig-zag' or 'W' path through the Sample Area is an acceptable compromise. Start the zig-zag on each visit at a different part of the Sample Area and vary the distance between trees sampled in a random manner. On each visit trees are sampled without regard as to whether or not they have been sampled on previous visits.

c) Sites to Monitor

Sites to monitor should be taken from around the circumference of each tree and at a range of heights within reach from the ground:

- **A fruit site** is a pair of touching fruit: use five sites per tree. Fruit monitoring is preferred for leafrollers (LRs) and is the only way to sample greenhouse thrips (GHT). If fruit are not in contact with one another, fruit that are touching leaves or branches may be used as substitutes. If all fruit are hanging freely, sample a nearby tree with touching fruit instead. If there is no near tree with fruit hanging individually, for LR's use shoot samples while for GHT use three individual fruit as a fruit site.
- **A shoot site** for leafrollers is all the leaves and the tip of the terminal 15cm of an actively growing shoot: use ten sites per tree. When only some fruit sites are available, use two shoot sites for each fruit site that has to be replaced.
- **A leaf site** for six-spotted mite is a freshly mature (i.e. newly full sized) leaf: use ten sites per tree.

Sampling from the upper canopy can be done instead of ground sampling, but needs the written mutual agreement of the Grower and their Operator or Monitor. In the case of Owner-Operators sampling from the upper canopy needs to be included in the sampling plan. The OSH implications mean that this practice is more suited to Owner-Operators. All other aspects of tree selection and sampling remain the same when monitoring sites in the upper canopy.

2.3- Sample Size

AvoGreen[®] monitors 5 fruit sites (and 10 leaf sites) on each tree sampled on each occasion in the Sampling Schedule.

The number of trees monitored is based on the size of the Sample Area.

Sample Areas larger than 5 ha are not recommended. If a grower chooses to use very large Sample Areas they must be extremely careful that these are sufficiently uniform, and that it is not being done simply to reduce the amount of sampling.

| Sample Area | Number of trees monitored |
|--------------------|---------------------------|
| less than 50 trees | 5 |
| less than 3.5 ha | 10 |
| 3.5 – 10 ha | 30 |
| greater than 10 ha | 50 |

The areas above are for blocks less headland space.

Sample trees are selected randomly from throughout the entire Sample Area that they represent. A **stratified sample plan** could also be used.

The numbers of trees in the table above gives the basic or minimum number of samples. If any pest is of particular concern, then taking more samples will more accurately determine its abundance. It is far better to do this by selecting more trees for sampling rather than by examining more sites per tree. The action threshold remains the same even if the sample size is increased.

2.4- Monitoring Schedule

A Monitoring Schedule outlines the plan of monitoring rounds to be undertaken throughout the season.

How often monitoring is done depends on the risk of damage which in turn depends on pest pressure and how quickly this can change. As pest pressure varies from orchard to orchard, the best schedule for any particular orchard should be developed specifically for that orchard.

Populations of greenhouse thrips (GHT) change more rapidly than other avocado pest, especially when conditions favour the thrips. This is why during the high risk period for thrips, monitoring should be no more than 2 weeks apart, while it can remain at 3-week intervals for leafrollers (LRs), even at times of high risk for LR.

Flowering and harvest periods also affect what can be done about pests and hence whether a grower monitors or not at such times. However a Quarantine Monitoring for LR should be carried out shortly before each harvest.

Note. A Monitoring Schedule is a flexible planning tool and not a rigid timetable – things will change as the season progresses and the Schedule altered accordingly.

The main three approaches on how to define a Monitoring Schedule are indicated below. Full details on how to use these approaches are given in Appendix 3: *“Determining the Best Monitoring Schedule”*.

1. The “Pest up” approach

In this approach anticipated critical periods (flowering and harvesting) are noted on a calendar and monitoring planned around these targeted at GHT, LR and 6SM in that order and taking into account pest biology and past experience with each pest on that particular orchard.

This method has the advantage of clearly showing the planned monitoring rounds and whether there are gaps (see example in Appendix 3).

2. The “Periods of Risk” approach

This is the method previously used in AvoGreen. Key periods of risk and a suggested sampling frequency are defined for each individual pest without actually drawing up a proposed schedule. The risk periods for each pest will vary from one orchard to the next depending on location and pest pressure. To use this approach properly would require adjusting the periods to reflect what actually happens on the particular orchard for which the Monitoring Schedule is being devised.

3. From a spray programme

It is possible to derive a Monitoring Schedule based on a past spray programme, however this approach risks missing the ideal timing for sprays, and is most unlikely to increase packouts. Be very cautious if considering this method, and plan a monitoring round at least one interval before a spray was applied to increase the possibility of improving timing.

Caution

Reducing the number of monitoring rounds increases the risk that a pest will cause damage before it is detected. Careful use of past and current information from your orchard minimises the risk but does not eliminate it. Also note that damage at harvest may indicate a critical timing was missed, but only if all sprays against that pest achieved a successful kill.

2.4.1- AvoGreen® Lite

In seasons with little or no fruit, there is little incentive to monitor or to spray. Returns per unit area are lower, while the cost of a spray remains constant. This raises the level of percentage damage at which a spray is worthwhile, i.e. the economic threshold. As well a lighter crop gives proportionally more fruit that hang singly, which reduces the potential for damage by leafrollers or greenhouse thrips as these pests prefer to occupy where fruit touch.

In such circumstances AvoGreen® compliance is maintained provided every spray applied is justified by a monitoring result or other recognised justification. This approach leaves the decision process of balancing the actual crop load against the pest risk in the hands of the grower, who is in the best position to quantify the relevant factors.

Any reduction in monitoring increases the risk that sprays will not be optimally timed, and that damage will occur that could have been prevented. Reducing monitoring should only be done after carefully considering the periods of maximum risk of damage on your orchard, as the tactic of only monitoring when you intend to spray is a very high risk approach that is likely to fail to deliver any benefit.

3. Monitoring by Pest

3.1- Leafrollers

Leafroller caterpillars are the most common and damaging pests of avocado crops in New Zealand. A number of species are involved, with the main ones being the brown-headed leafroller *Ctenopseustis obliquana*, the black-lyre leafroller *Cnephasia jactatana* and light brown apple moth *Epiphyas postvittana*.

When to sample for leafroller caterpillars:

Fruit damage can occur at any time of year, but is more common soon after fruit set once fruit grow large enough to contact other fruit and so provide the sites where caterpillars prefer to feed. In some areas caterpillars will be found around the stem on young, marble-sized fruit before this, and for early fruit monitoring you can use three nearby individual fruit of this size as a single fruit site.

Leafrollers are also important quarantine pests so that a Quarantine Monitoring of fruit close to harvest is highly recommended.

The Monitoring Schedules given as examples indicate what is best practice for orchards with low to moderate pest pressure, but more monitoring should be undertaken where there is a higher risk of leafroller damage. Monitoring within 2 weeks of applying a leafroller spray is not recommended except to check the effectiveness of the spray application.

How to sample for leafroller caterpillars:

Leafroller caterpillars feed on both fruit and leaves, but fruit sampling better reflects the damage potential for the crop, and shoot sampling should only be used when touching fruit are not available.

Fruit sampling:

- A fruit site is a pair of touching fruit;
- If touching pairs are not present, one option is to use 3 individual fruit as a fruit site;
- Check 5 fruit sites per sample tree;

- Inspect for the presence of live caterpillars. Even if more than one caterpillar is found in a site, record it as one live infestation.
- Record clearly fresh damage as if you had found a live caterpillar because the caterpillar can be lost during the inspection.

Shoot sampling:

- A shoot sample is all the leaves and the tip on the terminal 15 cm of an actively growing shoot.
- Check 10 shoot samples per sample tree;
- Examine all the leaves on the terminal 15 cm, including the shoot tip, the leaves of which should be prised apart to find any young caterpillars sheltering inside.
- If a live leafroller is found, record the shoot as infested and move on to the next site on the same tree. Do **not** record leaf damage where no caterpillar is seen. If more than one caterpillar is found on one shoot, record it only as one infested site.

Shoot samples and 3 individual fruit are options particularly for early in the season when the previous crop has been harvested and before the new crop has grown and provided fruit to fruit contacts.

When examining both fruit and shoot sites in the one monitoring round, record the results separately. Use 2 shoot samples for every 1 fruit site that has to be replaced. The combined percentage infestation is calculated using:

$$\frac{(2 \times (\text{total infested fruit sites})) + (\text{total infested shoot sites})}{10 \times \text{number of trees monitored}} \times 100$$

Action Threshold Level

A spray application is recommended when more than 2% of sites are infested.

Quarantine Monitoring

A pre-harvest monitoring round within 7 days of intended harvest should be completed for Leafroller.

Sample fruit as above for caterpillars but also record any leafroller egg rafts found on the fruit.

Action Threshold level for Quarantine sampling

If **any** caterpillars or eggs are found discuss what options are available with your packhouse.

NB: One leafroller spray may be applied without monitoring between the end of flowering and the end of January due to this being a critical timing. Consider the export market MRLs when choosing what pesticide to use at this time of the year.

3.2- Greenhouse Thrips (*Heliothrips haemorrhoidalis*)

Greenhouse thrips (GHT) are most common from February into autumn, particularly when conditions are both warm and moist. A few may be found over most of the season in warmer districts. Thrips are first found between touching fruit or where a fruit touches a branch or leaf, and if left uncontrolled can damage much of the surface of a fruit. The feeding of both adults and larvae causes a russetty scarring. Eggs are inserted into the plant tissue where they are protected from sprays.

How and when to sample for greenhouse thrips

From January until April monitor about fortnightly. Sample five fruit sites per tree on the specified number of trees. As a fruit site, use two fruit in contact as first choice; if not enough fruit pairs are available use fruit in contact with a branch or a leaf: and if all fruit are small and hanging free use three individual fruit as one fruit site.

Carefully examine each fruit around the point of contact, stopping for that site as soon as GHT are found.

Record whether each site was infested or not.

Action Threshold Level

A spray is recommended if more than 2 % of sites are infested

- Two sprays two-three weeks apart are recommended.
- The second spray does not require separate monitoring as justification provided it is applied between 14 and 30 days after the first (between 15 – 21 days is ideal).
- A grower may always choose not to spray once a threshold is exceeded (for example if conditions for the pest are not favourable), but in such circumstances and with GHT in particular they should then monitor more frequently, even weekly, in case numbers increase rapidly.

3.3- Six-Spotted Mite (*Eotetranychus sexmaculatus*)

Six-spotted mite (6SM) causes leaf drop. The mites are on the lower leaf surfaces, where they cause a characteristic purplish discolouration. Damage starts next to the main veins where side veins branch. However the presence of damage is not sufficient by itself to determine whether a spray is needed because frequently there is only old damage with no live mites present. 6SM are more of a problem in the Far North and Whangarei than in the Bay of Plenty, although induced leaf drop has been reported from all regions.

When to sample for 6SM

6SM acts as an extra stress that may trigger premature defoliation rather than always and automatically causing leaf drop. The most critical time to detect and control 6SM is just before flowering, because during flowering trees are under great stress, mites can be numerous and control options are limited by the presence of bees for pollination. Mite numbers often crash naturally to low levels in mid-summer without intervention.

Mites are most common from September to early December, but have been found at other times.

How to sample for 6SM

Choose leaves that have recently matured, i.e. are just fully expanded. This focuses on current infestations and avoids some leaves that have only old damage. Pick ten such leaves per sample tree, one leaf from each of ten sites around the tree, or two from each of five sites.

6SM can be patchily distributed across an orchard block.

Examine the underside of each leaf carefully to determine whether or not live 6SM are present. Leaves can be littered with bodies of mites, infertile eggs and other debris. Note that tydeid mites are also common, and can be mistaken for 6SM although tydeids are actually harmless. Some magnification is essential when monitoring for 6SM, and a microscope is better than a hand lens to minimise the risk of missing infestations or misidentifying what is present.

Score each leaf for live mites (ignoring eggs) to give an abundance index:

| | |
|------------------------------------|--------|
| Low abundance = less than 5 | <5 |
| Moderate abundance = 5 to 10 | 5 - 10 |
| Higher abundance = greater than 10 | >10 |

Action Threshold levels

Thresholds for 6SM have not been established by trials in New Zealand. The following are suggested because low numbers do not warrant spraying:

- More than 25 % of leaves with Low abundance, OR
- More than 10 % of leaves with Higher abundance.

However a spray is at the grower's discretion once 6SM are detected. A higher threshold should be used at times other than just before or during flowering.

3.4- Armoured Scale Insects

The main armoured scale pest on avocados is latania scale, *Hemiberlesia lataniae*, but the closely related greedy scale, *H. rapax*, may also be found.

Changes in the quarantine status of latania scale in 2005 reduced armoured scales to a minor pest for almost all markets. Monitoring for armoured scales is now optional.

Using harvest data

Instead of monitoring, growers can use reject analyses from their packhouse showing that armoured scales were found to ensure that at least one spray with a label claim against armoured scales is applied during the following season. If no such spray has already been used against any other pest before this time, the harvest detection of scales serves to justify one application.

How and when to monitor for armoured scales:

Monitoring is best done in January and/or April, with a sample in October if the pest is abundant.

- EITHER Sample fruit:
 - Examine the five pairs of touching fruit per tree used as a leafroller sample for scale.
 - Carefully lift the scale cap and determine whether it is live or not using a hand-lens.
 - Live - the body under the cap is yellow or pale and plump with fluid.
 - Dead - the body will be brown, either bloated with liquid or dried out and dark.
 - Score each fruit of the pair separately as being infested with live scales or not.
- OR Sample leaves:
 - Sample ten mature leaves per tree from inside the canopy at a height of 1.5 - 2.0m.
 - Place in a bag labelled with the grower's name, Sample Area, tree number, and date picked.
 - Keep the bag in the shade until sampling is completed. At base, store in a cool place until examined, but do not refrigerate.
 - Using a microscope or mag-lamp, examine both top and lower surface of each leaf for settled scales.
 - Determine whether each scale is alive or dead as above.
 - Record the numbers of leaves infested with live scale.

Action Threshold Levels

A spray application is recommended if:

- EITHER more than 4% of leaves are infested with live scale;
- OR more than 6% of fruit are infested with live scale.

Appendix 1: Agrichemical Selectivity grouping

Grouping Avocado Pesticides by health and environmental impact

Note that the rate at which a pesticide is used can affect the selectivity, e.g. Calypso is more selective at the rate used in avocados than the heavier rate used in pipfruit.

The way a product is used also has an effect, e.g. a post-harvest treatment has less general impact than a field spray.

| IMPACT | ACTIVE INGREDIENT | TRADE NAME (e.g.) |
|-----------------|--------------------------------------|---|
| HIGH | permethrin, pirimiphos methyl | Attack |
| | carbaryl | Carbaryl, Sevin Flo |
| | chlorpyrifos | Lorsban, Chlorfos, Chlorpyrifos, Pychlorex, Pyrinex |
| | acephate | Orthene, Lancer |
| MODERATE | diazinon | Dew, Diazinon |
| | maldison | Malathion |
| | tauflualinate | Mavrik |
| | pyrethrum, field spray | Pyrethrum |
| LOW | abamectin | Avid, Verdex, Abamax |
| | thiacloprid | Calypso, Topstar |
| | tebufenozide | Mimic, Comic, Islandzide |
| | milbemectin | Mit-E-Mec |
| | oil | D-C Tron, Excel |
| | phosphorous acid | Foli-R-Fos, Foschek, Phosgard |
| | emamectin benzoate | Proclaim |
| | spinosad | Success, Entrust Naturalyte |
| | pyrethrum, post-harvest | Key Pyrethrum |
| | prochloraz, post-harvest | Sportak, Mirage, Zelum |
| copper | Blue Shield, Kocide, Champ, Liquicop | |

Within the leafroller sprays in the Low Impact Group:

Bt < Mimic < Proclaim < Success

Where Bt has the least impact.

Appendix 2: AvoGreen® Sample Plan

AvoGreen® Sample Plan

Before filling in this form, read **AvoGreen® Monitoring** on the NZ Avocado website: www.nzavocado.co.nz. Once completed, this form with an Orchard Map and a Monitoring Schedule attached will form a Sample Plan. Either print this form off and fill it in, or complete it in Microsoft Word before printing a copy for your records.

Name of Grower or Manager:

Name of orchard: **PPIN:**

Contact details (If different from those given on the attached map):

Orchard address (road & number):

Phone: Email:

Number of Sample Areas that orchard is divided into:

Please note: The following information is required for each Sample Area. For more than 3 Sample Areas, use more than one form.

| Where boxes are shown, fill in or circle as appropriate. | Sample Areas | | | | | |
|--|--------------|-----------------|--------------|-----------------|--------------|-----------------|
| | 1 | | 2 | | 3 | |
| Sample Area name (if used) | | | | | | |
| Area in hectares. | | | | | | |
| Blocks included under each sample area | | | | | | |
| Number of trees to be monitored (As in the table in AvoGreen® Monitoring) | | | | | | |
| Type of sampling (circle or delete accordingly) | Marked trees | Repeated random | Marked trees | Repeated random | Marked trees | Repeated random |
| Date for first planned monitoring? | | | | | | |
| Is scale to be monitored? | Yes | No | Yes | No | Yes | No |
| Can monitoring stop once threshold is exceeded? | Yes | No | Yes | No | Yes | No |

Monitoring Schedule.

EITHER mark the intended Sample Dates on the attached calendar, or otherwise describe when each monitoring round is planned. Record the actual dates sampling was done; this can be on the calendar using a different colour.

Orchard Map.

As part of the Sample Plan in your records attach an orchard map showing:

- Name of orchard owner or manager,
- Contact phone number,
- Orchard boundary,
- Boundaries of blocks, and block name or number,
- Buildings and other major physical landmarks,
- The number of avocado trees per block,
- Type of crop in other blocks, e.g. kiwifruit, citrus
- Boundaries of each Sampling Area if more than 1.
- If sampling is from Marked Trees, the approximate position of each marked tree

Monitoring Schedule

| September '10 | | | | | | |
|---------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| | | | 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | | |

| October '10 | | | | | | |
|-------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
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| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

| November '10 | | | | | | |
|--------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | | | | |

| December '10 | | | | | | |
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| Su | Mo | Tu | We | Th | Fr | Sa |
| | | | 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | | |

| January '11 | | | | | | |
|-------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| | | | | | | 1 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | | | | | |

| February '11 | | | | | | |
|--------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
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| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | | | | | |

| March '11 | | | | | | |
|-----------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
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| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | | |

| April '11 | | | | | | |
|-----------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
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| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

| May '11 | | | | | | |
|---------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | | | | |

| June '11 | | | | | | |
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| Su | Mo | Tu | We | Th | Fr | Sa |
| | | | 1 | 2 | 3 | 4 |
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| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | | |

| July '11 | | | | | | |
|----------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
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| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | | | | | | |

| August '11 | | | | | | |
|------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | 31 | | | |

Key:

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Monitoring Schedule

| September '11 | | | | | | |
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| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | |

| October '11 | | | | | | |
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| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | | | | | |

| November '11 | | | | | | |
|--------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| | | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | | | |

| December '11 | | | | | | |
|--------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| | | | | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |

| January '12 | | | | | | |
|-------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | | | | |

| February '12 | | | | | | |
|--------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| | | | 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | | | |

| March '12 | | | | | | |
|-----------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
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| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
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| April '12 | | | | | | |
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| Su | Mo | Tu | We | Th | Fr | Sa |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | | | | |

| May '12 | | | | | | |
|---------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
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| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | | |

| June '12 | | | | | | |
|----------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
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| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

| July '12 | | | | | | |
|----------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | | | | |

| August '12 | | | | | | |
|------------|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
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| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | 31 | |

Key:

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Appendix 3: Determining the best Monitoring Schedule for your Orchard

Determining the best Monitoring Schedule for your orchard

Monitoring is the key to achieving more effective pest control and to adjusting the controls to fit the pest situation on your orchard. A Monitoring Schedule outlines the plan of monitoring rounds to be undertaken throughout the season and below we describe how this is put together.

Monitoring and Risk

How often you should monitor depends on the risk of damage on your orchard which in turn depends on pest pressure. This varies with a number of factors, but firstly with the time of year. The frequency of monitoring is also affected by how quickly pest populations change. On avocado trees, populations of greenhouse thrips (GHT) change more rapidly than do those of other pests, especially when conditions favour the thrips. This is why during the high risk period for thrips, monitoring should be no more than two weeks apart, while it can remain at three week intervals for leafrollers—even at times of high risk for these pests.

The extent and periods of risk for each pest vary from region to region, within regions and also from season to season. Growers need to use their experience including any information from past seasons to judge when a risk occurs on their orchard for each pest. Remember that pest damage may have occurred because a critical timing was missed, or because an applied spray did not achieve the desired kill of the pest targeted. Avocados are not an easy crop to spray well and although there has been much recent progress, there is still often room for improvement.

Flowering and Harvest

Flowering and harvest periods also affect what can be done about pests and hence whether a grower monitors or not at such times. However a quarantine monitoring for LRs should be carried out shortly before each harvest.

During harvest, only products with a short **Pre-harvest Interval (PHI)** can be used, while during flowering great care must be taken to avoid any impact on pollination. Only bee-safe products can be applied over flowering, and as water droplets can impact on flying bees; even these products are best applied when bees are not actively foraging. Where possible avoid spraying at all while bees are present. Growers use two basic strategies at such time. One approach is not to monitor because you are not going to spray, while the other is to continue to monitor to find out what is going on and, should spray be needed, then determine what is possible.

How do you combine all these considerations into a Monitoring Schedule?

Three ways that can be used to derive a Monitoring Schedule are described below; others are possible.

Note that a Monitoring Schedule is a flexible planning tool – things change as the season progresses and the actual schedule will need to be altered accordingly. Record the reasons when major changes are necessary.

1. Pest Up approach:

- a. Take a year calendar and mark on it the flowering period and anticipated harvest periods for your orchard based on past experience (see Figure 1.)
- b. Green House Thrips (GHT) – now consider the pest with the shortest interval between monitoring rounds; GHT at two weeks. GHT are abundant in the warm moist conditions of late summer into autumn. In the example the risk period is estimated as mid-February to mid-March, but your experience may indicate an earlier or later start or finish for your orchard. Note that if a spray is required against GHT, two sprays should be applied 14-21 days apart without monitoring between them.
- c. Leafroller (LR) – Next consider leafrollers (LR). These occur all year round but are worst for a couple of months from fruit set. The monitoring interval for LR is three weeks stretching to four or even more in winter. So as GHT pressure falls, LR becomes the main reason for monitoring, although both pests are sampled each time. Add LR-focussed rounds onto the calendar after the risk period for GHT, through winter to spring the approach of both first pick and flowering. Once again local knowledge will indicate whether more or fewer rounds are

needed.

- d. Six-Spotted Mite (6SM) – before flowering it is important to monitor for 6SM, doing it early enough before flowering starts so that a spray can be applied if one is needed, as the mite controls are all bee toxic. 6SM is the pest that varies most throughout the country, and the number of monitoring rounds specifically focussed on this mite also varies considerably. In the example, rounds targeting 6SM were only needed at the beginning and end of flowering. The latter timing allows for spray as soon as bees are removed, if one is needed.
- e. Harvest – The time of harvest determines what happens from flowering until GHT–focussed monitoring begins again in mid to late February. Before each picking round, a quarantine monitoring for LR (including egg rafts) is recommended. If all fruit is picked early there is little point in monitoring before late January unless 6SM is a real concern, or even later if a ‘risk period’ LR spray is applied by mid January.
- f. After spraying – whenever a spray is applied in response to monitoring, there is no need to monitor until three weeks after the application. If you are concerned with coverage, or the effectiveness of the application, a two week interval is better, but effectiveness can also be addressed in other ways such as direct observations.

Figure 1.

EXAMPLE ONLY

Monitoring Schedule 2010 - 2011



Key:

| | |
|--|--------------------------------------|
| | Flowering |
| | Thrips focussed monitoring |
| | Leafroller focussed monitoring |
| | Six-spotted Mite focussed monitoring |
| | picking |

Note: All pests would be sampled on each occasion, the focus shows the key pest(s) for each time.

2. The “Periods of Risk” approach

This was the approach used previously in AvoGreen. It uses a generalised diagram showing the period of risk plus a recommended frequency of monitoring for each pest. The periods of risk, called the periods for monitoring, can be adjusted to reflect variability in pest pressure by including the optional periods indicated. Users need to specify a start date as a fix point as the approach itself does not require a finalised or overall schedule.

This is a useful and flexible technique which remains valid, and when used well is very similar to the “pest up” approach. There has been a tendency to see the generalised example provided as being optimal for all situations, which it isn't. The range which recent diagrams represent has been identified, for example the one below is for moderate to low pest pressure.

The “Pest up” approach has been introduced to overcome some of the perceived shortcomings in the “Periods of Risk”. It focuses on the situation of an orchard, and on combining the information for each pest into an actual proposed schedule.

Figure 2.

The Periods for Monitoring giving Best Practice with Low to Moderate Pest Pressure

| Pests | Monitoring interval | Sample type | Periods for Monitoring | | | | | | | | | | | |
|-------------------|---------------------|-----------------|------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|----------|----------|
| | | | Month | | | | | | | | | | | |
| | | | July | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Leafrollers | Every 3-4 weeks | Fruit | | Optional | Optional | Recommended | Recommended | Recommended | Recommended | Recommended | Recommended | Recommended | Optional | Optional |
| | | Shoots | | | | Recommended | Recommended | Recommended | Recommended | | | | | |
| Greenhouse thrips | Every 2 weeks | Fruit | | | | | | Optional | Recommended | Recommended | Recommended | Optional | | |
| 6-spotted mite | Every 2-3 weeks | Leaves | | Recommended | Recommended | Recommended | Recommended | Recommended | Rare | Rare | | | | |
| Armoured scales | If needed | Leaves or fruit | | | | Optional | | | Recommended | | | Recommended | | |

KEY:

| | | | |
|---|-------------|---|-------------|
|  | Recommended |  | Recommended |
|  | Optional |  | Optional |
| | |  | Rare |

Notes:

- The recommended monitoring periods above are for when pest pressure is low to moderate for each pest. More or fewer rounds may be needed on your orchard.
- Undertake more monitoring if the orchard has a past history of problems with a particular pest, the weather favours a pest outbreak, or if a pest is still present at the end of recommended monitoring.
- Monitoring in mid-flowering is optional.
- Additional monitoring can be done at any time by mutual agreement between the Operator and Grower.
- Decrease the time to the next monitoring round if a pest is present at levels below the threshold.
- Once a threshold has been exceeded and it is decided to spray, another monitoring round is not required until after the spray has been applied. Sprays should be applied as soon as possible once recommended.
- For leafrollers, fruit monitoring is the preferred method; shoot monitoring is only an alternative when no fruit sites are available. Ensure that a monitoring is done just before the first pick.

3. From a spray programme

Another possible way to derive a Monitoring Schedule is to use your spray programme from the last year as a base. **However this approach runs a real risk of missing ideal timing, and is unlikely to increase packouts.**

Looking at every spray applied and what the target pest was, go back at least one and preferable two pest monitoring intervals and plan a monitoring round. Two steps back is to help avoid missing the best time for application. Improved timing is indicated when at least one round occurs before the threshold is exceeded.

Mark these planned dates for monitoring on a calendar together with your anticipated flowering and harvesting periods and make sure that there is no obvious and extended gap for any pest.

Caution

Reducing the number of monitoring rounds will increase the risk that a pest may cause damage before it is detected. Careful use of past and current information from your orchard lowers the risk but does not eliminate it.

Once your Monitoring Schedule is drawn up...

Attach a copy of your Monitoring Schedule to your Sample Plan.

The Schedule can be varied during the season as results come in and things happen. Record the reason for any major change.

Evaluate and revise the Schedule at the start of each season using reject analyses from harvest

Appendix 4: AvoGreen Recording sheet

AVOGREEN RECORDING SHEET

NOTE: read the AvoGreen Manual before using this recording sheet

Orchard : _____ P-PIN: _____ SAMPLE AREA _____ Monitor : _____

Date : _____
 Start time : _____
 End time : _____

* Use Leafroller shoot monitoring only when touching fruit is NOT available
 ** Leafroller egg rafts are only counted in Quarantine Monitoring just before harvesting.
 *** Monitor Scale only if agreed with the Grower on the Sample Plan

| Tree No. | LR - fruit / * shoots (circle what used) | | ** Egg rafts | GHT | 6SM | | | ***SCALE (10 per tree) Fruit or Leaf (circle one) | OBSERVATIONS |
|----------|--|--------------|--------------|-----|--------------------|----------|--------------|---|--------------|
| | Fruit = 5 sites / Shoots = 10 sites per tree | | | | 10 leaves per tree | | | | |
| | Sm (<6mm) | Med (6-10mm) | | | L (>10mm) | <5 (Low) | 5 - 10 (Med) | | |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |

Totals : _____

| | | | | | | | |
|----|---|---|-----|----------|--------------|------------|---|
| Sm | M | L | GHT | <5 (Low) | 5 - 10 (Med) | >10 (High) | |
| a | b | c | d | e | f | g | h |

% Infested (5 sites sampled)

| |
|----------------------------|
| LR = (a+b+c) x 2 = _____ % |
| GHT = (d x 2) = _____ % |

6SM Abundance (%)

| |
|--------------------|
| Low (e) = _____ % |
| Med (f) = _____ % |
| High (g) = _____ % |

Scale = (h) = _____ %

IMPORTANT: If leafrollers are sampled only using shoots, the summed total (a+b+c) is the percentage. If a mixture of fruit and shoot samples are used, see the calculation on the web.