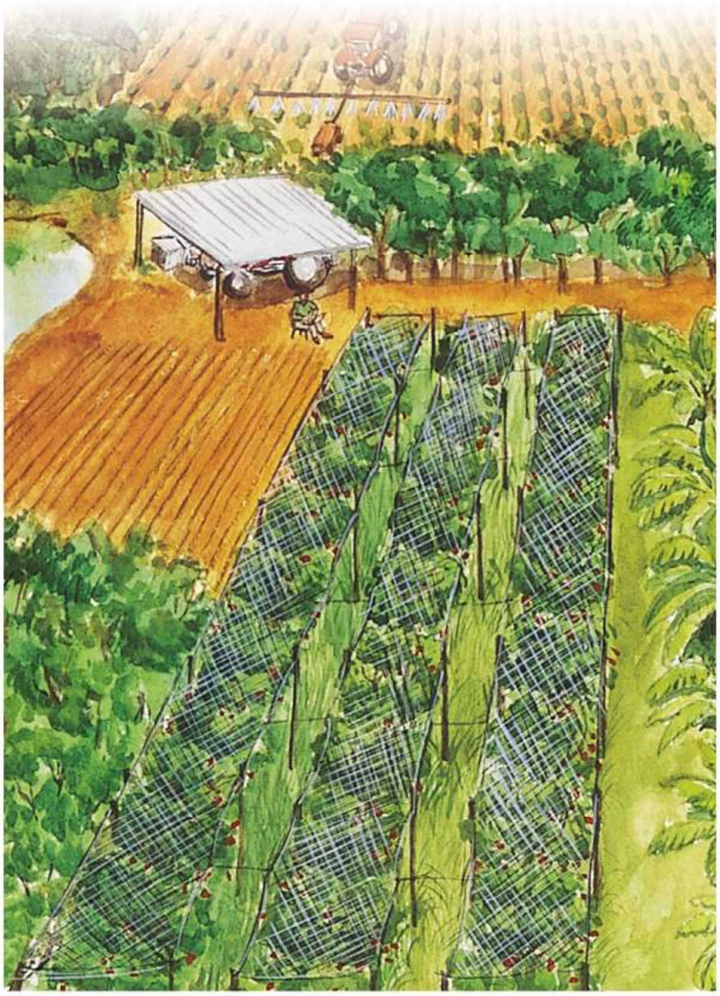
INTEGRATED CROP MANAGEMENT



Section 7: Integrated Crop Management

This section outlines the principles for Integrated Crop Management in the fruit and vegetable industry.

Integrated Crop Management is never static. The emphasis is not on a reproducible recipe for pest control so much as a range of changing but compatible technologies, brought together for current needs.

The more knowledge that is developed about individual problems and their interaction with the biological world, the more integrated the system can become.

Change occurs as growers, crop consultants and researchers transform new knowledge into workable solutions. Choices about how far Integrated Crop Management can be implemented are made at the level that matches the experience and knowledge of individual growers and within current knowledge constraints.

7.1 IMPROVE HYGIENE AND CULTURAL PRACTICES FOR PEST MANAGEMENT

■ *Maintain a healthy plant and destroy alternate hosts for pests*

A biologically healthy crop or tree is more able to ward off insect pests. Crop stress should be avoided by making sure that crops and trees are appropriately fertilised and irrigated, (see Section 1.3 and 2.1 respectively).

Alternate hosts of pests whether weeds, old crops or reject fruit allow populations to persist and re-infest new crops. These need to be destroyed. Examples include,

- weeds like pigweed, blackberry nightshade and carrotweed which can host sucking insects such as jassids, leafhoppers, Rutherglen bugs and green vegetable bugs (Hall 1995)
- reject tomatoes from packing sheds which need to be destroyed within 24 hours (BDGA 1995)
- fallen fruit from trees that can host fruit fly.

■ *Observe a long production break where possible*

Continuous production will encourage a build-up of pest problems. Fallows should be practiced to allow soils to rejuvenate and pest and disease problems to decline.

Example:

Hygiene and cultural methods for leaf miner control in tomato.

Leaf miner is a pest of tomato in the Bowen district. Cultural and hygiene practices have been used to reduce leaf-miner populations.

This involves, rapid post harvest disposal of crop residues infested with leaf miner. Remaining plants are slashed at ground height and the plastic mulch is lifted and rolled. Crop residues are then worked back into the soil to allow as much time as possible for residue breakdown.

This helps reduce populations because there is no regrowth to provide a food source for pupae.

Observing a summer fallow is important to disrupt pest life cycles and reduce numbers. Where the window of summer fallow has been extended, better control of leaf miner occurred. The Bowen District Growers Association recommends non-production from December 25th through to February 15th in their voluntary Code of Practice for IPM (BDGA 1995)

Example:

Cultural and hygiene measures for cabbage moth control in brassicas

Cabbage moth is one of the most difficult pests to manage in brassica vegetable crops of the Lockyer valley. Tips for integrated control follow.

Avoid growing brassicas in summer and early autumn in the Lockyer valley. Rapid life cycles and low yields make the high cost of chemical control prohibitive (Heisswolf et al. 1993). If pests are allowed to build up during this time they become a major problem the following autumn and winter.

Destroy old brassica crop residues to prevent ongoing breeding by pulverising or slashing, then rotary hoeing or ploughing. Crop failures should be quickly destroyed for the same reasons.

Physical barriers (eg. creeks, bushland or windbreaks) should be used where possible to prevent moths moving from older plantings to younger ones.

Information on spray thresholds for cabbage moth, chemicals for control and a chemical rotation strategy are outlined in the QDPI checklist for cabbage moth control (Heisswolf et al. 1993).

7.2 MONITOR PESTS AND SPRAY WHEN NECESSARY

The traditional approach to spray application is to follow a calendar program. This involves scheduling sprays according to the number of days that have elapsed since the last spray or the casual sighting of above average numbers of insect pests.

Program spraying can speed up the potential for insecticide resistance. Constant use of chemicals with the same mode of action will select out a population, which expresses resistance to the chemical.

Resistance can be slowed through,

- targeted insecticide application
- rotation of chemicals with different modes of action against the same pest
- using ‘softer’ insecticides to encourage beneficial insect predators and parasites.

Monitoring provides the foundation for the development of an IPM program. At its simplest, monitoring involves knowing what pests are present, and what numbers of pests warrant spraying.

■ *Identify important pests*

It is important to identify the pests that inflict an economic level of damage. This prevents unnecessary use of pesticides on insects that are not pests or may even be beneficial for pest control.

The Infopest CD ROM sold by the QDPI is an up to date list of registered chemicals for pest control. QDPI pest identification workshops can also help develop skills in pest and beneficial identification and pest management.

■ *Sample for pest numbers and develop a threshold*

It is not sufficient to only know which pests are present. Pest life cycles and location in the crop or trees are important.

Thresholds provide a way of combining all of this information in a form that is useful for the grower. A threshold indicates the numbers of a particular insect pest (counted using a standard sampling method) at which an unacceptably high level of economic damage will occur. Once the threshold is reached, chemical control will normally be needed.

The sampling method should be sensitive to knowledge about the most vulnerable stage of the pest, its location and relate pest pressure to potential damage of crops or trees. Local credible pest consultants can provide expertise in identification of insects and the development of appropriate thresholds.

■ ***Develop a spraying regime based on thresholds instead of program spraying***

A threshold provides the first step away from a program spraying approach. Below the threshold the crop can sustain pest activity without resulting in economic damage. Other non-chemical control measures may be able to assist in keeping pest numbers below spray thresholds.

The decision about what pest threshold to spray at and which chemical products are most effective can be helped by the services of a qualified pest consultant with local knowledge.

■ ***Use good information on pesticides for control***

For many pests of fruit and vegetables integrated pest management is still in it's infancy. The previous steps represent the first steps, but there are still knowledge gaps in some of the information needed for IPM, such as pest life cycles, thresholds for economic control and useful parasites and predators.

In the absence of using a personal, qualified, local pest consultant, see the relevant Information Kit from the Agrilink Series for more detail (QDPI 1998). Each kit has 2 useful foldouts. The *Problem Solver Handy Guide* (with chemical application rates) and the *Pest and Disease Management Handy Guide* (QDPI 1998).

Other helpful resources include,

Citrus pests and their natural enemies (Smith et al. 1997)

The Good Bug Book (Broadley and Thomas 1995)

The Banana Insect and Mite Management Manual (Pinese and Piper 1994)

Protect Your Cucurbits (Lovatt et al. 1994)

Pineapple pests and disorders (Swete-Kelly et al. 1993)

Protect Your Pineapples (Sinclair et al. 1993)

Protect Your Avocados (Broadley et al. 1992)

Protect Your Strawberries (Broadley et al. 1992)

Avocado pests and disorders (Broadley et al. 1990)

Strawberry Pests (Broadley et al. 1988)

Protect Your Citrus (Broadley et al. 1987)

7.3 ENCOURAGE BENEFICIALS BY USING 'SOFT' OPTIONS

Beneficial insects such as predators and parasites can help with pest management. These beneficials may be adversely affected by the heavy use of broad-spectrum insecticides such as synthetic pyrethroids. Where it is possible, 'softer' products should be substituted for broad-spectrum products.

This requires special attention on compatibility of beneficial insects with insecticides. A list of chemical options for IPM is found in the document, 'A Practical Guide to Integrated Pest Management for Horticultural Cropping Systems of Queensland' (Hall 1995).

Healthy, well foliaged trees on the farm can also help shelter beneficial insects from extremes of heat and low humidity.

Example:

Beneficial insects and vegetable crops

Several insects act as biological control agents in vegetable crops. These include spiders, natural parasitic wasps and predators such as lacewings and ladybirds.

These beneficials are normally most helpful early in the life of the crop. For example, with mite pest problems delaying the use of synthetic pyrethroids and organo phosphates for as long as possible can prevent the 'flaring' of mite numbers because beneficial insects are retained for longer (Hall 1995). Wettable sulfur is also softer on beneficial insects and may be used for mite control in some situations.

Example:

Using a softer insecticide in tomatoes

The bacterial toxin ***Bacillus thuringiensis*** *(Bt) provides a 'softer' insecticide option because it is not harmful to beneficials. The place for Bt sprays is early in the life of a tomato crop to try and control leaf miner, loopers and cluster caterpillars (Hall 1995). However, the usefulness of Bt sprays in tomatoes is more limited where insect pressure from heliothis is heavy (White et al. 1996).*

Example:

Beneficial insects in citrus

An IPM system that uses parasites and predators is now well established in citrus. In many situations pests such as red scale, mealybug and mites can be well controlled without chemicals (Vock et al. 1997).

IPM works better in dry inland areas and requires a high level of management and/or pest consultant support. The recent publication, ***Citrus pests and their natural enemies - Integrated Pest Management in Australia****, has more detail on IPM in citrus (Smith et al. 1997).*

Example:

Bell injection of banana means spray application is more targeted.

Bell injection is used to control banana scab moth, flower thrips and rust thrips. This involves injecting the bell with insecticide as it starts to emerge from the throat of the plant.

Pesticide is confined to the target area (Pinese and Piper 1994) compared with the previous alternatives of large scale aerial or cover spraying.

Bell injecting has fostered increased populations of the lady bird beetle, ***Stethorus****, which is a predator of banana spider mite. Previous aerial or cover sprays of insecticides were detrimental to* ***Stethorus****, whose decline led to severe outbreaks of banana spider mite and two-spotted mite.*

Other predators that assist with mite control include predatory mites, lacewings, thrips and some beetles.

Example:

Research into pesticide impregnated ribbon for use in bananas.

Chlorpyrifos (Lorsban®) is usually dusted over the bunch for control of sugar cane bud moth and rust thrips.

New treatments are being researched. This includes spraying the outside of the bag with Lorsban® so that it is absorbed by the plastic bag polymer and released more slowly.

Eventually, a slow release pesticide impregnated ribbon strip will be registered which can be attached to the upper bunch stalk (Pinese 1996). The article, 'Some more facts on Bunch Dusting' in volume 22 of Bananatopics has more information (Lindsay 1996).

7.4 INTRODUCE BIOLOGICAL CONTROL AGENTS

Introducing biological control agents adds a new level of complexity to managing pests. These introduced agents will cause changes to the range of insect pests and natural predators and parasites. Most of the work with introduced biological control agents is still exploratory in nature.

Example:

Using predatory mites for spider mite control in strawberries

Predatory mites (Phytoseiulus persimilis) can be used for biological control of spider mites in strawberries. Details of predatory mite release after a mite build-up are outlined in the Strawberry Agrilink Information Kit (Vock and Greer 1997). This involves using a miticide; irrigating with overhead sprinklers and then post release care to foster predator numbers.

The pest-in-first (PIF) strategy is a modified approach to using predatory mites in strawberries (Waite 1997). The main principle is to introduce spider mites early in the life of the crop followed by predators 2 weeks later (Waite 1997). This allows predator mites to rapidly increase population numbers due to higher levels of humidity and closer proximity to an established source of spider mite. PIF as a step by step strategy is outlined in the Strawberry Agrilink Information Kit Vock and Greer 1997).

Example:

Trialing biological control of heliothis in sweetcorn and lettuce

Heliothis is a major insect pest of most vegetable crops. It burrows into sweet corn cobs or the heart of lettuce plants, making it difficult to contact with sprays.

The development of resistance in Heliothis is making the use of preventative sprays less and less viable for the long term.

Trials were carried out in sweet corn and lettuce with Trichogramma, the tiny wasp parasitoid that attacks the egg stage of heliothis, killing them before they hatch and cause damage (Scholz 1997). Another tactic involved using a viral disease that affects only Heliothis caterpillars (Scholz 1997).

Damage to corncobs using the wasps or virus was less than using Bts or conventional treatment. In lettuce the Trichogramma wasps did not perform as well due to lack of shelter in the lettuce plants from the summer sun. The virus killed 90% of Heliothis caterpillars and didn't affect the beneficial ladybirds, lacewings and wasps (Scholz 1997).

7.5 COMBINE CHEMICAL DISEASE CONTROL WITH NON-CHEMICAL OPTIONS WHERE POSSIBLE

■ ***Use good information on pesticides and disease control***

For many diseases of fruit and vegetables, IDM or integrated disease management is still in its infancy.

Disease organisms are microscopic and cannot be seen. Unlike insects, their arrival and buildup in the crop cannot be easily monitored. With many fruit and vegetable diseases (like fungal diseases) the approach requires routine preventative spraying to protect the crop from possible infection. If infection occurs a curative product may be needed also.

The relevant Information Kit from the Agrilink Series has more detail in the *Problem Solver Handy Guide* (with chemical application rates) and the *Pest and Disease Management Handy Guide* (QDPI 1998).

Other possibilities for combining non-chemical control with chemical control are outlined below.

■ ***Consider previous cropping history.***

Where there have been other crops of the same family grown previously in the same field, a longer production break may be needed. For example, at least a two-year rotation between tomatoes and other solanaceous crops (capsicums, eggplants and potatoes) is advisable. Rockmelon and honeydew crops should not be planted back to back or rotated with other members of the cucurbit family.

■ ***Ensure plant residues are broken down.***

Any organic matter from cover crops or green manure crops should be well incorporated into the soil before planting to allow it to break down completely and avoid serious losses from 'damping off' diseases.

For example, tomatoes, crops like sorghum, beans or cane can host sclerotium rolfsii; hence the importance of ensuring that all plant material is broken down before tomatoes are planted (Fullelove 1991).

If nematodes are a particular concern, the rate of organic matter breakdown may need to be balanced with requirements for nematode control (see the further section on 'Combine chemical Nematode control with non-chemical options where possible').

■ ***Choose disease free planting material***

For most crops, the choice of variety can play a part in disease management. Selecting disease free seed or varieties with resistance or tolerance to prevalent diseases can help to remove more susceptible varieties out of production.

Example:

Disease free planting material

Strawberries

Choose runners that are part of a certified runner scheme. Certified runners have a low risk of virus and fungal infection because inspections are carried out regularly (Greer 1996).

In the Queensland scheme, plants are indexed for virus freedom as nucleus plants (Hutton 1997). Any plants brought onto a runner grower's property are tissue-cultured plants, which have been tested free of Colletotrichum gloeosporiodes. The accreditation of special runners means there is a minimum set of standards for acceptable levels of disease, pest and weeds (Hutton 1997).

Tree crops

When deciding what varieties to plant, consider varietal suitability for the area and potential disease susceptibility as tabled in the relevant Information Kit from the Agrilink Series (QDPI 1998). All new trees should be purchased from a specialist tree crop nursery.

For instance, with avocados choose a nursery accredited under the Avocado Nursery Voluntary Accreditation Scheme (ANVAS). These nurseries follow strict hygiene procedures to ensure planting material is free of root rot and other soil diseases.

■ ***Consider hygiene throughout the life of the crop or tree***

Some hygiene measures to prevent disease include removing old crops that are close, cleaning headlands and controlling volunteer weeds.

Layout can often inhibit or encourage disease. Row orientation which allows maximum leaf drying and air movement will help manage some diseases.

Viral diseases are usually transferred via insect vectors such as aphids or thrips. Reducing volunteer plants, cleaning headlands, and not planting near infected crops will help control viral infections.

Examples:

Hygiene measures to reduce disease incidence

Tomatoes

Trellis and wire materials for tomatoes can be dipped in formalin to prevent reinfection of new blocks (Fullelove 1991).

To provide conditions that minimise disease infection, reduce plant populations and use windbreaks to prevent spore dispersion, protect branches and fruit. Orient rows for maximum leaf drying and plant new blocks upwind of older blocks where possible (Fullelove 1991).

Do not transplant too deeply and try to avoid root damage at transplanting (Fullelove 1991). Avoid throwing soil up onto the plant and try to minimise the introduction of 'dirty' machinery into the paddock (Fullelove 1991).

When harvesting tomatoes, keep bush damage to a minimum to prevent infections of target spot and grey mould (Fullelove 1991). Clean down picking equipment and avoid carrying off mud or infected soil on the machine.

Melons

In melons, there are two mosaic viruses, Papaya ringspot virus, cucurbit strain (PRSV-W) and zucchini yellows mosaic virus (ZYMV). Infection can be reduced by ploughing in old cucurbit crops once harvesting is completed and avoiding new plantings of cucurbits that overlap with old infected crops (Lovatt et al. 1997).

Strawberries

Plant spacing can help to manage black spot and grey mould. Wider plant spacing promotes airflow between plants, reduces the density of foliage and improves spray penetration (Hutton 1997).

Three weeks after planting runners, old runners or old leaves should be cut off with a sharp knife to improve plant vigour and prevent disease build-up (Hutton 1997).

Leaves that are dead or infected with Gnomonia should be removed, while fruit affected by grey mould or black spot should be removed from the patch and destroyed (Hutton 1997).

Example:

Plastic mulch helps minimise disease effects where used

Plastic mulch also helps minimise disease incidence on tomatoes by reducing raindrop splash on soils that can transfer diseases from soil to the bush.

Other benefits for tomatoes include reduced risks of fruit drop and blossom end rot disorder because of more even water availability and distribution. Fruit losses from soil borne diseases are reduced, particularly with ground grown crops. Soil temperatures are increased and provide a better growing environment in cool weather.

Reflective silver mulch can deter aphids from landing on melon plants until the vine has covered the mulch (Lovatt et al. 1997). These aphids are vectors for the melon mosaic viruses, Papaya ringspot virus - cucurbit strain (PRSV-W) and zucchini yellows mosaic virus (ZYMV). Deterring aphids early in the crop's life helps prevent infection.

Example:

Some of the non-chemical measures available to manage phytophthora in papayas

Phytophthora root rot on papayas is favoured by poorly drained heavy soil and is a particular problem in replant situations (Peterson 1996). Phytophthora fruit rot is favoured by very wet windy conditions. For fruit infection, spores need to be splashed from soil or diseased tissue onto the fruit (Peterson 1996).

Trial work in north Queensland suggests that old papaya land should not be replanted immediately but should be fallowed before replanting (Peterson et al. 1997).

Mounding (0.75 metres high) helps improve internal soil drainage and reduces plant losses while increasing plant growth (Peterson et al. 1997).

Plastic mulch can help reduce root rot because it reduces moisture levels in the soils but organic mulch can increase root rot, as it retains moisture (Peterson et al. 1997).

(Pictured right)

Example:

Minimising root rot in beans

The effect of bean root rot is to slow the development of roots. It's most common during winter with noticeable losses in cold and wet conditions.

Bean root rot occurs in Gympie, the Burdekin and the Lockyer valley. Research into alternative means of control was prompted by the failure of chemical treatments (Wright 1996).

Shallow planting was found to reduce disease severity and is now being adopted by farmers in the Gympie area (Wright 1996). It's particularly important during the winter months. Mulching also helped improve tolerance to the disease, increasing yields even though roots were infected with root rot (Wright 1996).

Example:

Early disease forecasting for beetroot and pea crops

Damping off and root rot can cause significant losses in vegetable crops. A glasshouse bioassay test recently developed will help to predict the severity of soil-borne diseases in beetroot and pea paddocks (O'Brien 1997).

Growers can get the test done on a soil sample to predict potential disease severity before planting or analyse the potential level of disease for a new crop after a crop failure.

A rating for potential field severity is made after raising seedlings in the test soil in the glasshouse. The rating can only be made on the potential for disease and other factors will influence actual losses in the field such as seasonal weather.

Beetroot can be tested (over 4 weeks) for pre and post emergent damping off diseases (O'Brien 1997). Peas are not only at risk in the establishment stage but also during vegetative growth (O'Brien 1997). The pea bioassay takes 2 weeks.

■ *Use chemicals as part of a strategy*

Managing diseases for fruit and vegetable crops still relies heavily on a chemical approach.

Fungicides in particular should be used as part of a disease management strategy, to slow the development of resistance.

Consider using fungicides with different modes of action. Often the preventative fungicides, which rely on good coverage of foliage, can be managed in conjunction with curative fungicides where rapid action is needed if the crop or tree becomes infected.

Disease forecasting (where it has been developed) can anticipate when the highest incidence of infection is most likely. This allows fungicides to be targeted, rather than a simple program spray approach.

A strategy for management of diseases in grapes seeks to combine several measures for overall control (QDPI 1995).

Example:

Disease management in grapes

1. Apply recommended protective fungicides according to seasonal conditions supplemented with eradicant fungicides following wet weather, especially during blossoming and pre-harvest for control of Grey mould.

2. Remove prunings and crop residues from vineyards during winter to reduce carryover of disease.

3. Use training systems to promote air movement through the canopy to reduce relative humidity favourable to disease.

4. Handle bunches carefully to prevent damage and possible entry of disease organisms, during training early in the season and later during harvest.

5. Prevent insect and bird damage.

6. Use disease free or virus tested grape propagating material.

Example:
Managing Yellow Sigatoka (Leaf Spot) in bananas

The constant use of the same systemic fungicide for control of yellow sigatoka (leaf spot) will select out more resistant strains of leaf spot. This is exacerbated where systemic fungicide is broadly applied to large populations of the fungus because there is a greater chance that resistant individuals will be present (Peterson et al. 1996).

The following measures of the 'Banana Leaf Spot Anti-Resistance Strategy' aim to reduce selection pressure by lowering the level of disease exposed to fungicides and limiting the use of systemic fungicides to critical periods. (Peterson et al. 1996). Practices include,

- *using de-leafing to reduce fungal populations before applying fungicides*
- *having well drained and well aerated blocks to reduce high relative humidity*
- *good spray coverage by using optimum sized droplets.*

More detail can be found in the strategy, including recommended numbers of sprays in a year, spray free periods and recommended number of consecutive sprays of the same fungicide type (Peterson et al. 1996).

7.6 COMBINE CHEMICAL NEMATODE CONTROL WITH NON-CHEMICAL OPTIONS WHERE POSSIBLE

Nematicides are currently used in a preventative way to avoid nematode damage. This is because it is difficult to control nematodes once crop or tree damage has already occurred.

Many of the nematicides used in Australia are likely to be removed from the market due to environmental concerns.

EDB is being removed from the pineapple industry because it leads to groundwater contamination and methyl bromide because it contributes to ozone depletion. Non-chemical options are needed because chemical control becomes more expensive. Decisions regarding nematode control will require greater management skill than in the past (Stirling 1996).

Deleafing in bananas is an important practice for minimising Banana Leaf Spot resistance.

■ *Identification and counts will give some indication of activity*

It is important to know what level of nematode activity is present in the crop. Some indication can be gained by using the disease index system developed by the QDPI.

Example:
Using a Disease Index for burrowing nematode in bananas

Burrowing nematode damage in bananas can be quantified to generate a Disease Index. Thresholds for a level of physiological damage and economically important damage can be set using the Disease Index. The article, "Sustainable Management of Burrowing Nematode in Bananas" has more detail (Pattison and Stanton 1996).

■ *Consider non-chemical options for reducing nematode activity.*

Nematode pressure can be reduced through a production break. This may be achieved by fallowing or rotating with non-susceptible crops.

Example: ***Pineapples***

Having a production fallow can reduce nematode pressure. Longer fallow periods between pineapple crops (4-6 months) can help reduce nematode numbers. Green manure crops also provide some control. Forage sorghum or velvet bean are more promising non-hosts of nematodes (Stirling 1996).

Example:

Rotations in bananas for burrowing nematode control

Most banana paddocks are fallowed between ploughing out the old stand and planting the new stand. The number of burrowing nematodes can be reduced by growing an appropriate green fallow crop for long enough to be effective.

QDPI trial work indicated that Jarra grass was resistant to burrowing nematodes but still allowed some reproduction to occur. Cane varieties Q117, Q135, Q124 and Q96 were highly resistant to burrowing nematode and would be suitable rotation crops (Pattison and Stanton 1996).

Example:

Rotations in vegetable crops for root-knot nematode control

Root-knot nematode is a major pest of horticultural crops, particularly vegetables.

Nematodes will multiply on crops that are a good host (such as maize, sweetcorn and capsicum) and decline on crops that are a poor host (such as forage sorghum, pinto peanut and watermelon) (Stirling et al. 1996).

Trials have shown that where zucchini, a susceptible crop, was planted after a poor host, yields were high and there was no sign of nematode damage. Good hosts resulted in damage to the following zucchini crop (Stirling et al. 1996).

Other rotation options found to suppress nematodes in the glasshouse include peanuts, oats, Rhodes grass, and green panic and forage sorghum (Stirling et al. 1996).

The addition of organic amendments does seem to suppress nematode activity by stimulating microbial activity (Stirling et al. 1996). There is more work needed to understand why this happens.

7.7 COMBINE CHEMICAL WEED CONTROL WITH NON-CHEMICAL OPTIONS WHERE POSSIBLE

Most weed control in fruit and vegetable crops relies heavily on herbicides. In some small crops, plastic mulch is used for weed control as well as herbicide.

The 'quick-fix' approach that sees herbicides as the only solution is beginning to have consequences for Queensland horticulture. Even where herbicides are registered for specific weeds they are costly and can select out resistant weed ecotypes, or encourage non-susceptible weed species, by applying a selection pressure to weed populations.

Their use can sometimes pose a risk of damage to the crop and restrict future rotation possibilities. They don't always replace the need for some hand weeding.

There is a need to develop weed control that integrates non-chemical methods with current chemical practice to reduce the overall reliance on herbicides. One of the key strategies for implementing an integrated weed management program is selection of crop rotations that enable a diverse range of weed control practices to be used.

Specific weed management strategies are included in the Agrilink Information Kits as part of the crop management program.

Example:

Plastic mulch can help minimise the effects of weeds

Trial work in tomatoes during the 1980's found that under trickle irrigation, tomato yields could be increased by 20%-50% when combined with plastic mulch for weed control rather than using herbicides or cultivation (Wright and Bally 1987).

Plastic mulch helps prevent weeds germinating in the plant line preventing the need for a post establishment tillage operation. This is especially so where some form of soil fumigation is used.

Additionally, when inter-row herbicides are used with plastic mulch, there is no need to cultivate down the row during the life of the crop.

Example:

Developing an integrated approach to management of potato weed in vegetables

Potato weed has a major impact on production cost and risk for vegetable enterprises in the Granite Belt, Toowoomba, Lockyer / Fassifern valleys and the Redland's / Brisbane area (Henderson 1996).

Several measures can be used as part of an integrated approach to the control of yellow weed in lettuce, celery, brassicas and onions (Henderson 1996).

Potato weed found near wetter soils and where cultivation is poorer (such as irrigation and fence-lines, roadways, headlands, and drainage lines) can be earlier maturing and therefore shed seed continuously through the cropping cycle.

The emphasis for control is focused on preventing early germination. This prevents weed seed production in sequential crops and allows the seed bank to eventually be depleted (Henderson 1996).

Choosing crop rotations that include a phase where potato weed is more easily controlled is a key component of managing weed seed populations. For example, rotation of brassica vegetables (particularly short-term, competitive crops such as broccoli) or celery, where potato weed is more readily killed, can be very important in managing this weed in following lettuce crops.

Example:

Weed control in tree crops

Weed control normally involves maintaining a permanent sod culture of a suitable grass / legume in the interrow area and mulching along the tree rows. Introduced mulches include coarse hay or straw such as sorghum stubble.

As an alternative, the interrow can provide a valuable source of mulch if the slashings are directed under the trees. However, it should not be slashed until the grass is 15 to 20 cm high to provide a large volume of mulch (Dwyer et al. 1994c). Too frequent slashing will lead to compaction, cost money and time, and favour the growth of unproductive grasses and weeds (Dwyer et al. 1994c).

As well as providing mulch, the grass sward inter-row helps eliminate dust. If grasses are allowed to flower before slashing (like Rhodes grass) they can also provide pollen as a food source for predatory mites (Smith et al. 1997).

The herbicides tabled in the relevant Information Kit from the Agrilink Series can be used where weeds grow through the mulch (QDPI 1998). Spot spraying allows weeds to be tackled as individuals or in small groups and minimises the chance of herbicide damage on the trees. This can also be minimised by using a shielded, low-pressure fan or flood nozzle or a rope wick applicator if applicable (QDPI 1998).