An economic evaluation of alternative pest management strategies in Northern Victorian peach orchards

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Introduction

Generally, the focus of pest management programs on tree fruit crops is on the control of one or two key pests. For peaches grown in Victoria, the key pest is the oriental fruit moth (Cydia molesta Busk.).

Oriental fruit moth affects the peach crop in a number of ways. The larva tunnel into green and ripening fruit. Affected fruit is generally unsaleable and must be separated from the rest of the crop. Damage to the fruit is not always obvious at grading (Field 1974), therefore the risk of having fruit rejected by the cannery is increased with the amount of crop infestation. In the absence of control measures, up to 80% of the crop could be affected (Field 1974). Larvae also bore into growing tips of the trees. In young trees tip infestations may affect tree shape (Anon 1991). Larval damage has also been identified as a major source of Brown Rot infection (Kable 1969).

There are two methods available for the control of oriental fruit moth. Regular applications of organophosphate insecticides (such as Parathion methyl, azinphos methyl or phosmet) can be used to kill the larva before it enters the fruit or the growing tips. Alternatively, a synthetic pheromone (isomate M or Isomate OFM Plus, marketed By Biocontrol Ltd) can be used to disrupt the mating of oriental fruit moth. The type of program selected will influence what other pest problems are encountered and may affect other orchard management decisions. In this paper the advantages and disadvantages of both methods for oriental fruit moth control are evaluated.

Prior to the commercial introduction of isomate M in the 1984/85 season, control of oriental fruit moth was achieved using regular application of insecticides, applied using airblast sprayers. The aim was to kill the larval stage of the insect after hatching, but before the grub has burrowed into fruit or growing shoots where it is safe from insecticides.

With mating disruption the aim is to release sufficient quantities of pheromone to disrupt the moth's normal sexual communication system (Davidson 1973). Rothschild (1975) found that, provided the pheromone release rate was greater than 6 mg/ha/hr and the treated area large enough

to prevent immigration of adults, then oriental fruit moth numbers could be kept at lower levels compared to areas treated with insecticide.

There are numerous advantages to the grower with the use of the mating disruption technique for oriental fruit moth control (Bell 1993). The pheromone is non-toxic to the operator and has no adverse effects on beneficial organisms within the orchard. Application of the pheromone simply requires tying plastic "twist tie" dispensers onto branches of the trees. With pheromones there is no withholding period so fruit can be harvested at any time, and no orchard re-entry restrictions that are associated with insecticides. The timing of other orchard management practises is therefore unhindered. As orchard spray equipment is used less often, soil compaction is reduced and some operating costs are saved. The technique is also compatible with the Victorian Department of Agriculture's "Clean Agriculture" initiative and with the industry's desire to reduce the use of pesticides in fruit production.

Method of assessing alternative pest control strategies.

In all agricultural production, what is done and achieved in one crop year affects what is done and achieved in ensuing crop years. This raises particular difficulties for evaluating the benefits and costs of alternative management strategies. Ideally all the reasonably probable permutations and combinations of input actions and output events, over time, need to be considered. However, trying to look at the 'whole picture' in this way can result in the problem rapidly becoming intractable, especially once price risk is included with yield risk, as it has to be. The alternative approach, used here, is a partial analytic approach, where a 'snapshot' of a reasonably typical production year is looked at closely and judgements made about what would be involved for alternative pest control measures to achieve the same desired level of control. In effect, the 'desired level of control' is the level of pest control which growers have been aiming at and to a fair extent, have been achieving over recent years. It is a level of control which has enabled them to harvest and market crops which are sufficiently large to meet their obligations and aims for them to continue operating their business.

The focus of the snapshot economic evaluation used then, is on the cheapest ways of achieving the desired level of pest control in a 'typical'

year of a 'typical' operation. The results give some indication of possible gains which might be had on some orchards by changes in methods of control. Whether these possible benefits can be obtained in reality will depend on the precise details of each case. There can be no general prescriptions for farm management actions. However, proposals which look beneficial in a 'typical' set-up may well provide the same sorts of benefits in a reasonable number of operations. Only individual case studies, and time, will tell.

In this study, comparison of the costs of alternative pest control regimes, the methods used have to achieve equivalent results or, if not the gains or losses in output have to be counted as well to get the net cost of the program. In this case the pest control regimes being compared are ones which, in the judgement of growers and other experts, would achieve the level of pest control necessary to minimise pest-induced fruit losses in the current year, and prevent any explosion of pest populations, and control costs or output losses in the next and ensuing years.

To evaluate mating disruption and insecticide based oriental fruit moth control programs, a survey of growers was conducted in the Shepparton and Cobram areas. Using a structured questionnaire, growers were asked to describe how pest control was achieved in their orchard.

Specifically, growers were asked which of the two methods was used for oriental fruit moth control in their orchard, how the method currently used compared to previous programs, and reasons why the current method was used. If an insecticide-based program was used the grower was asked how and when applications were scheduled. Growers were also asked what pesticides were used in the orchard, the rate of application per hectare, the number of times the pesticide is used per season and the pest(s) that they were trying to control. Suppliers of agricultural chemicals in the region were also interviewed, to obtain retail prices for the materials used by the orchardists. From this data, representative pest control programs for each region were prepared and budgets prepared for alternative programs.

Results and Discussion

The cost comparisons in Table 1 and 2 relate to situations in which it is expected that the risk of output losses from pests in the current and near

future seasons is maintained at least at the levels currently achieved. Benefits come, from cost savings from either more strategic and thus less chemical use, or from marked reductions in chemical use with chemical control replaced by isomate control.

Mating disruption has no direct effect on other arthropod pests in the orchard. Compared to conventional spray programs, populations of mites and aphids usually decline in orchards where mating disruption of oriental fruit moth is practised, due to an increase in biological control by predators or parasitoids. This increased biological control results in less pesticide applications for these pests. Other pests such as San Jose scale, light brown apple moth and Fullers rose weevil that were inadvertently controlled under spray programs tend to increase in number to a level where control measures become necessary specifically for these pests. Occasionally the oriental fruit moth population reaches levels where mating disruption will fail to protect the crop from economic damage. In these cases use of an insecticide is also required, usually methyl parathion.

In Tables 1 and 2 the costs of pest control in mating disruption orchards is compared to insecticide programs for orchards in Cobram and Shepparton respectively.

Table 1 Pest control program for Orchard in Cobram area

	Pest						
pest program	oriental fruit moth	light brown apple moth	San Jose scale	mites	aphids	Total Cost	Comments
(a) isomate OFM plus methyl parathion	$366 0-3 sprays $0-$108	1-2 sprays Bacillus t $50-$100	0 or 1winter oil $0 or $50		1 spray Pirimicarb $96	$586-$714	requires more stringent monitoring of ofm compared to other programs additional measures may be required around borders if ofm immigrations from nearby crops occur
(b) methyl parathion	8-10 sprays $296-$360			0-1 spray Propargite $0-$100	2 sprays Pirimicarb $180	$476-$652	ofm monitored using pheromone traps
(c) azinphos methyl	5-7 sprays $450-$630	-	-	1-2 sprays Propargite $150	2 sprays Pirimicarb $180	$780-$960	ofm monitored using pheromone traps

Table 2 Pest control program for Orchard in Shepparton area

	Pest						
pest program	oriental fruit moth	light brown apple moth	San Jose scale	mites	aphids	Total Cost	Comments
(a) isomate OFM plus methyl parathion	$366 0-3 sprays $0-$108	1-2 sprays Bacillus t $50-$100	0 or 1winter oil $0 or $50	-	0-1 spray Pirimicarb $0-$90	$416-$714	requires more stringent monitoring of ofm compared to other programs additional measures may be required around borders if ofm immigrations from nearby crops occur
(b) methyl parathion	5-7 sprays $180-$252	-	-	0-1 spray Propargite $0 or $100	2 sprays Pirimicarb $180	$360-$532	ofm monitored using pheromone traps
(c) azinphos methyl	4-5 sprays $360-$450	-	-	1-2 sprays Propargite $100-$200	2 sprays Pirimicarb $180	$640-$830	ofm monitored using pheromone traps

Here, two important points can be noted. Firstly Isomates compare more favourably to insecticidal control in regions where orchardists have to spray more often to control oriental fruit moth. Secondly the economic advantage of mating disruption using isomates over chemical pest control depends on which insecticide is used in the spray program. Ebert (1988) has noted that the use of mating disruption in the MIA region of N.S.W (where it replaced an azinphos methyl based program) is higher than in the Shepparton region where methyl parathion is more widely used.

Mating disruption has some other disadvantages as noted by Ebert (1988); insect populations need to be monitored and the treated area is susceptible to infestations from outside sources. Also, the technique is relatively unfamiliar to most growers at this stage, and may require assistance from pest control advisers to monitor and interpret pest populations.

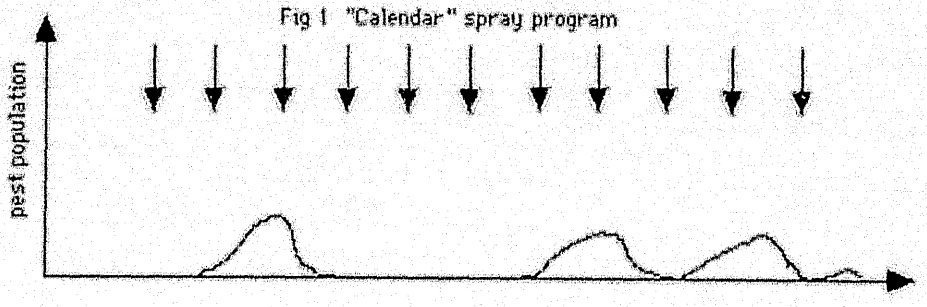
Orchardists who grow large areas of peaches (and other types of fruit) are more likely to use mating disruption compared to smaller growers. Large growers are more likely to employ pest control advisers, are able to reduce the amount of spray equipment required, and because they have larger blocks of trees, infestations from other sources and edge effects are less important. Mating disruption is not recommended on fruit blocks of less than two hectares (Biocontrol).

Advantages of mating disruption that growers mention are: less exposure of the grower and employees to pesticides; more time available to carry out other orchard operations; the beneficial effects on orchard fauna and the ability to harvest fruit for the fresh market at any time. Mating disruption is also seen to be the preferred pest control option for the future, due to concerns regarding possible future pest resistance to pesticides, operator health, and society's increased awareness of the environment and chemical residues in foods with the concomitant pressures to reduce chemical usage. The value of these benefits is difficult to measure, but nevertheless, all are benefits valued to various extents by growers and need to be considered.

Growers using a spray program for oriental fruit moth control use one of three different spray programs: calendar, window or threshold based

schedules. Calender based programs involve the spraying of an insecticide at a given interval (usually 14-21 days). With this method sprays are applied whether the pest is present or not and is used by growers who do not monitor oriental fruit moth numbers on their crop. The idea is to maintain a constant cover of toxic residue on the crop to kill any emerging larva. The first spray is usually timed to a particular growth stage of the tree.

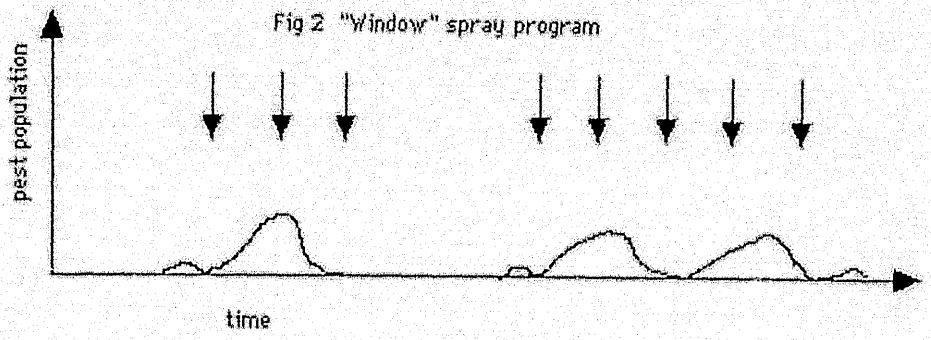
Fig 1 "Calendar" spray program



arrows represent insecticide application

The next spray regime that is used is the 'window' program. Window spray programs have been developed for leaf roller pests in NZ apple orchards (Suckling etal 1988). With this program insecticide applications are timed to coincide with the presence of a particular stage of the pest. in this case the oriental fruit moth larva. This method requires monitoring of the adult population with pheromone traps. Trap catches indicate that moths are flying within the orchard and presumably mating. The trap catches are entered into a predictive model which then forecasts when eggs laid from the moth flights will hatch. Sprays are therefore only applied when the moth larva is present.

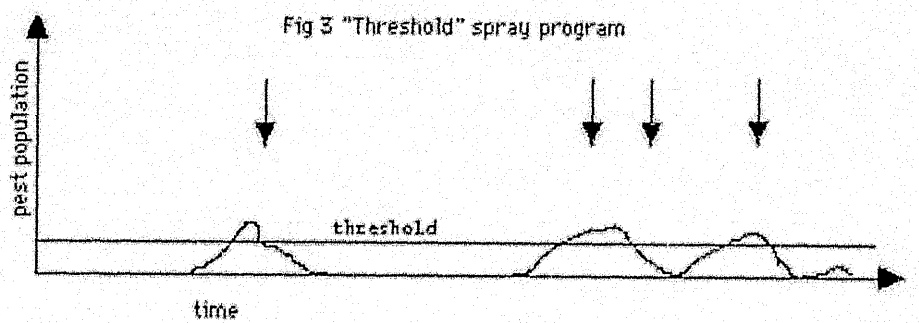
Fig 2 "Window" spray program



arrows represent insecticide application.

The final spray program is similar to a window program except that a spray is applied only when the pest exceeds a certain number or "threshold."

Fig 3 "Threshold" spray program



arrows represent insecticide application.

Growers not monitoring for oriental fruit moth use calendar scheduling, while growers that do use chemical control and who monitor generally use window schedules. Spray schedules based on threshold aren't commonly used, probably because the relationship between pheromone trap catches and fruit damage is not really known. Growers who change from a calender program to a window program can reduce the number of sprays applied with no increase in risk costs; in fact the improved scheduling of insecticides provides better control and so decreases the costs of risk.

Conclusion

In comparing the measurable costs of mating disruption and spray programs for oriental fruit moth control, it was found that mating disruption is cheaper than an azinphos methyl spray program, but usually

more expensive than a program using methyl parathion. In areas where growers spray less frequently to control oriental fruit moth, the cost differential between mating disruption and a methyl parathion program is even greater. Mating disruption does deliver a number of benefits to growers that are difficult to evaluate. Growers using mating disruption are well aware of these benefits, and consider these benefits when comparing the two methods.

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