

## **AVO-GREEN AN OPTION FOR REDUCING PESTICIDE USE**

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### **Abstract**

Comparisons of pest control achieved under "green" and "conventional" spray programmes were carried out on adjacent blocks of avocado over two seasons. The green spray programme relied on applications of the organically-acceptable insecticide *Bacillus thuringiensis* (Bt) (Delfin) while the conventional programme included broad-spectrum organophosphates (Lorsban and Attack). Fruit from blocks which received Bt sprays had slightly higher levels of leafroller and thrips damage, however the levels of damaged fruit from blocks receiving either spray programme were economically acceptable. After two seasons of comparisons, the grower decided to convert the entire orchard to a Bt based spray programme. Using information about the most important leafroller damage period, and the likely persistence of Bt, an experimental organic spray programme was developed. The effectiveness of this experimental spray programme was tested on two orchards in Te Puke. The organic programme relied on Bt applications concentrated over the critical time for leafroller control (flowering to March). Excellent leafroller control was achieved on blocks managed using the organic spray programme and it was concluded that a Bt-based programme provided effective control of leafrollers in avocado orchards. The nil withholding period of this product confers significant advantages over the picking period, however the short persistence of Bt means that an increased number of spray applications would be required compared to conventional materials. Any decisions on the most appropriate material must consider the balance between the harvesting timetable and leafroller pressure. In the future it is hoped that a reliable leafroller monitoring system can be developed so that growers can assess the need to apply sprays.

### **Introduction**

Leafrollers, thrips and armoured scale insects are the main pests of avocado in New Zealand. In the regions growing most of the export crop, leafrollers are the dominant pest for which insecticides are applied.

Several species of leafrollers can be found feeding on avocado trees, but the main pest species is the native brownheaded leafroller, *Ctenopseuslis obliquana* (Stevens *et al*,

1995). Caterpillars of this species feed on the fruit, and the severe scarring which can result, causes the fruit to be rejected from export. In addition, the caterpillar feeding during early fruit development can increase the incidence of fruit drop. Leafroller moths also cause export rejection by laying egg batches on fruit.

Previous research (Stevens and McKenna, 1996) has shown that the majority of leafroller damage occurs in the first few months after fruit set. The incidence of damage increases rapidly from December until late April after which time only low levels of new damage occur. Caterpillars show a preference for young fruitlets, and one of the difficulties growers can face is to provide adequate protection of these fruitlets against leafrollers, at the time when mature fruit are being harvested. The long withholding periods for some insecticides precludes their use over the harvest season.

While most broad-spectrum insecticides are applied against leafrollers, the minor pests are generally incidentally controlled. All life stages of the greenhouse thrips, *Heliothrips haemorrhoidalis* feed on avocado fruit, causing a dark scarring usually at the base of fruit. Most damage occurs in the autumn and specific sprays targeting thrips can be applied. Armoured scale insects, usually latania scale, *Hemiberlesia lataniae*, are the major pest problem in the far north and Gisborne growing regions. Although the presence of armoured scale insects is no longer a quarantine problem for fruit exported to Australia, the presence of large numbers is recorded as a cosmetic defect (Blank, 1995).

The pests of avocado are currently controlled by a calendar spray programme of broad-spectrum insecticides. Increasing customer demand for safe and environmentally friendly food and production techniques mean that it is desirable to develop effective pest control systems which use a minimum number of insecticide applications, and which incorporate "softer" spray materials. This paper describes trials which aimed to assess the practicality of a "green" approach to pest control. As a first step, the effectiveness of a spray programme based on the "soft" insecticide *Bacillus thuringiensis* (Bt) products was compared with a programme based on conventional broad-spectrum insecticides. Bt sprays specifically target caterpillars so beneficial insects are not harmed, although neither are greenhouse thrips or armoured scale insects. The second step was to assess the effectiveness of a recommended organic spray programme. This organic spray programme was developed using information about the most important leafroller damage period, and knowledge about the likely persistence of Bt. The timing of sprays was very targeted with reduced spray intervals.

## **Materials and methods**

### Part 1: Comparison between conventional and organic pest control programmes

Adjacent blocks in a mature Te Puke avocado orchard (Orchard A) were managed with different spray programmes in the 1994-95 and 1995-96 seasons. All sprays were applied using a hand lance. In 1994-95, each block received the same number of sprays, but in one block conventional broad-spectrum insecticides were selected, while in the other block, sprays based on Bt (Delfin) were used. Sprays were applied at approximately monthly intervals over summer (Table 1). The levels of leafroller and

thrips damage and armoured scale infestation were recorded in November 1995.

**Table 1 Spray programmes (1994-1996) applied to two adjacent blocks of avocado in Te Puke**

Conventional spray programme	Organic spray programme
5.11.94 (Attack)	5.11.94 (Delfin)
5.12.94 (Delfin)	5.12.94 (Delfin)
24.12.94 (Lorsban)	24.12.94 (Delfin)
29.1.95 (Delfin)	29.1.95 (Delfin)
4.2.95 (Lorsban)	4.2.95 (Delfin)
26.3.93 (Attack)	26.3.93 (Delfin)
30.4.95 (Attack)	30.4.95 (Delfin)
18.9.95 (Attack)	18.9.95 (Delfin)
10.11.95 (Delfin)	10.11.95 (Delfin)
5.12.95 (Delfin)	5.12.95 (Delfin)
22.12.95 (Lorsban)	22.12.95(Delfin)
12.1.96 (Lorsban)	16.1.96(Delfin)
	30.1.96(Delfin)
21.2.96 (Lorsban)	16.2.96(Delfin)
28.3.96 (Lorsban)	21.3.96 (Delfin)
30.9.96 (Lorsban)	30.9.96 (Delfin)
29.10.96 (Delfin)	29.10.96 (Delfin)
5.12.96 (Delfin)	5.12.96 (Delfin)
6.1.96 (Delfin)	6.1.96 (Delfin)

Orchard A continued to be managed using a calendar spray programme of either conventional or organic materials in 1995-96 but the frequency of spray applications was adjusted depending on the material being applied. An interim assessment of leafroller damage was carried out on 25.4.96, and the packhouse reject analysis at harvest was recorded.

#### Part 2: Assessment of an organic pest control programme

The experimental organic spray programme was applied to blocks on two avocado orchards in Te Puke (Orchard A, 1996-97 and Orchard B; 1995-96, 1996-97). An interim assessment of leafroller damage was carried out on 10.6.96, and 17.4.97 (Orchard B) and 16.4.97 (Orchard A). Reject information for fruit harvested at the end of 1996 was recorded.

The recommended organic spray programme included a pre-flowering Bt, a Bt during flowering, followed by fortnightly applications of Bt from the end of flowering until March. From March to June it was recommended that a sample of fruit be checked every 3-4 weeks for the presence of caterpillars and/or fresh damage, and apply Bt if needed.

From June until September, it was recommended that fruit be checked for caterpillars or

fresh damage every 5-6 weeks, and to apply Bt if needed.

## Results

### Part 1: Comparison between conventional and organic pest control programmes

Fruit from the avocado block managed using the organic materials had a slightly higher percentage of fruit with pests or pest damage. This was mainly due to an increased number of fruit with leafroller damage, and a higher incidence of thrips damage (Table 2).

**Table 2** Pest control achieved after a conventional or organic spray programme in 1994-95

Defect (% fruit infested)	Conventional	Organic
Clean	78.0	65.6
Leafroller damage <sup>1</sup>	4.4	7.9
Leafroller eggs	0	1.0
Thrips damage	7.0	12.5
Psocid eggs	0	1.0
Armoured scale insects	0.2	0.4

<sup>1</sup>Only economically important damage with an area of more than 2cm<sup>2</sup> was recorded.

In 1995-96 fruit from blocks which received a conventional spray programme had significantly less total and heavy leafroller damage than fruit from blocks which received a Bt-only spray programme (Table 3). However, overall leafroller damage levels were low.

**Table 3** Mean percent of avocado fruit with leafroller damage sampled from blocks receiving either an organic or conventional spray programme. Assessed on 25.4.96. (mean ± standard error)

Type of spray programme	Mean percent fruit with leafroller damage	Mean percent fruit with heavy leafroller damage <sup>1</sup>
Organic	7.3 ± 0.9 a	0.9 ± 0.3a
Conventional	3.4 ± 0.6 b	0.2 ± 0.1b

<sup>1</sup> Damage was classed as heavy if it covered an area of more than 2cm<sup>2</sup>

<sup>2</sup>Numbers within a column followed by the same letter are not significantly different at the 5% level

Reject analysis of fruit from the conventional and Bt blocks showed very similar levels of leafroller damage. The percentage of reject fruit with leafroller damage ranged between

18 -24% for both the conventional and Bt blocks. Based on these figures the manager of Orchard A decided to only use Bt sprays over the whole orchard in the future.

## Part 2: Assessment of an organic pest control programme

When the incidence of leafroller damage was assessed at the end of the main damage period very low levels of caterpillar chewings were found (Table 4).

**Table 4** Interim assessment of incidence of leafroller damage to avocado fruit on trees managed with an organic spray programme

	% clean fruit	% damage	% heavy damage <sup>1</sup>
Orchard A 1997	84.9	15.1	3.6
Orchard B 1996	96.3	3.7	1.6
Orchard B 1997	96.9	3.1	1.8

<sup>1</sup> Damage was classed as heavy if it covered an area of more than 2cm<sup>2</sup>

Very few fruit from Orchard B were found to have economically significant leafroller damage at harvest 1996 (B. Stowell pers. comm.). The fruit from the 1997 season have yet to be harvested.

## **Discussion**

This paper reports on trials to assess the practicality of using a spray programme based on a soft insecticide for the control of leafrollers in avocado orchards. In all trials, blocks managed with an organic spray programme had a higher incidence of leafroller damage compared to blocks managed with a more conventional spray programme. However, the levels of leafroller damage in the organic blocks were still relatively low and similar to levels on conventionally sprayed avocados (unpublished data). Reject analysis at harvest found economically acceptable levels of damage irrespective of the type of spray programme applied.

In the first year of trials comparing conventional and organic spray programmes, the sprays were applied at approximately monthly intervals, regardless of the type of insecticide being used. Bt products have a very short persistence and are known to rapidly break down in sunlight and should therefore be applied more frequently than conventional broad-spectrum insecticides. Recent research on the persistence of Bt on grapevine leaves found that leaves exposed to direct sun lost more than 50% activity against the leafroller, lightbrown apple moth, after one day (Bailey *et al.*, 1996). In comparison, grape leaves from shaded areas were found to retain 60% activity after two days of sunlight, which is thought to be sufficient time for caterpillars to consume a lethal dose of Bt. In avocados, caterpillars are often found feeding on the soft green leaf shoots or young fruitlets which are generally located on the sunniest parts of the canopy. It is not known how persistent Bt is on avocado leaves or fruit but the location of fruit and preferred leafroller feeding sites suggests that persistence would be low. In the second season of trials to compare conventional and organic pest control, the short

persistence of Bt was taken into consideration and an extra Bt spray was applied over the critical leafroller damage period. However, the incidence of leafroller damage in the conventional and organic blocks was similar to that found in the previous season. The efficacy of Bt could potentially be improved by the addition of wetting/sunproofing etc. agents. In Israel, where Bt sprays are used to control caterpillar pests, an additive is mixed with Bt, which significantly improves control (Y. Izhar, pers. comm.).

The disadvantages of more frequent spray applications needs to be weighed up against the advantages of the nil withholding period applying to Bt. The use of Bt results in no interruption to picking schedules. Applying Bt sprays over the critical damage period will protect the young fruitlets from leafroller damage without interrupting the harvest of mature fruit for export. Decisions on the most appropriate spray material can be made, taking the picking schedule into account. Once the mature fruit are harvested, or a sufficient interval before commencement of picking is planned, the more effective conventional materials could be used.

All sprays in these trials were applied using a hand lance so the effectiveness of Bt when sprayed at low volume from a helicopter is unknown. Helicopter-application of pesticides is common practice in avocado orchards but no research has been carried out to compare the efficacy of insecticides applied using a helicopter versus hand application. Trials have been carried out with fungicides (Hartill and Sale, 1996) where it was found that Kocide applications using a hand lance resulted in greater visible spray deposits and a slightly reduced incidence of rots. However, the practical benefits of applying sprays from helicopters, particularly in large trees, means that some research is justified.

The highly specific Bt sprays have no activity against other pests, and an increase in the incidence of thrips damage was noted in the first year of trials in Orchard A. Thrips damage tends to occur in autumn and it is possible to monitor for thrips populations. Checking samples of fruit at regular intervals towards the end of summer and autumn should be used to warn of potential thrips problems.

The experimental organic pest control programme included a recommendation to monitor caterpillar populations using a search technique before applying sprays. This is a critical aspect of developing an avo-green type production system for avocados. Whatever spray materials are selected, the justification for application needs to come from a known risk of economic damage if no steps are taken. Initial research suggests that the incidence of leafroller caterpillars is similar at different heights in the canopy (unpublished data), which means that an inspection of fruit from the ground can provide useful information about leafroller pressure over the whole tree (assuming even spray coverage). In the future, a reliable leafroller monitoring system should be available which, in combination with the use of Bt sprays, should provide the basis for an avo-green pest management programme for avocado.

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