REDUCED APPLICATION RATES OF MATING DISRUPTION FOR EFFECTIVE CONTROL OF ORIENTAL FRUIT MOTH *GRAPHOLITA MOLESTA* (BUSCK) (LEPIDOPTERA: TORTRICIDAE) ON PEARS

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Summary

Successful control of oriental fruit moth (OFM) *Grapholita molesta* (Busck) has previously been achieved by application of mating disruption in an area-wide basis in Victoria, Australia. To make an area-wide mating disruption less costly, applications using a reduced rate of polyethylene tubing dispensers (Isomate OFM Rosso) on pears bordering disrupted stone fruit orchards were investigated. The results showed that when the initial catches of OFM in pears was low to medium (about 5-10 OFM/trap/week), growers can reduce the cost of mating disruption by applying a half of the registered rate of Isomate OFM Rosso. This treatment was able to reduce the number of OFM caught in all experimental pear blocks, and gave similar results to mating disruption with the full registered rate of Isomate OFM Rosso.

Keywords: mating disruption, oriental fruit moth, pome fruit

INTRODUCTION

Mating disruption (MD) is widely used in Australia as a major part of Integrated Pest Management in orchards. Oriental fruit moth (OFM) *Grapholita molesta* (Busck) has been controlled through the use of MD for many years in Victoria. Recently, some farmers in the Goulburn-Murray Valley reported that shoot tip and fruit damage had occurred mostly on the border of peach MD blocks adjacent to fruit blocks where insecticide treatments were used. Our observations (Il'ichev *et al*. 1999a) indicated that damage at the edge of peach blocks may have been due to migration of mated OFM females, from pear blocks under insecticide treatments, to adjacent peach MD blocks. It is possible that peach shoot tips and fruit may attract mated females away from pears, where they had developed a high population, for oviposition in neighbouring peaches. This explanation of edge damage effects and the occurrence of shoot tip and fruit damage mostly on the borders of peach MD blocks may also indicate a behavioural avoidance of virgin females to MD (Il'ichev *et al*. 1999b). Female moths of some tortricid species have been reported to have the ability to detect their own sex pheromone odour by antennae (Den Otter *et al*. 1996; Palaniswamy and Seabrook 1978). We also suggest that OFM females may have responded to a super-abundance of their own sex pheromone by moving outside of the MD area to seek mates. They may then return for oviposition in response to volatiles from shoot tips or ripening peach fruit (Sexton and Il'ichev 2000).

Vickers *et al.* (1985) demonstrated that MD could provide effective control of OFM in small discrete peach growing districts. They also suggested that MD can be more effective than insecticides if all orchards in a district are treated to prevent immigration of mated OFM females from untreated blocks.

The first large-scale area-wide MD program for OFM control was initiated during the 1991-92 season in 1200 ha of peaches and nectarines in the Tulbagh Valley in South Africa (Barnes and Blomefield 1997). In these experiments the MD treatment in peaches and nectarines was extended to five rows along the borders in all adjacent plum, prune, apricot, almond and pear orchards. By the end of the experiment, shoot tip damage in peach and nectarine was greatly reduced and not a single infested fruit was recorded from the MD treated area. This project was considered an outstanding success after two seasons, but later when MD applications were stopped, OFM quickly started to cause severe damage again. The South African experiment suggested that the success of area-wide MD treatment depended on effective management of borders of MD orchards and nearby blocks. Two factors are relevant: the decrease in the concentration of pheromone at the edges of MD blocks due to wind (Suckling and Karg 1997), and migration of mated OFM females from non-mating disruption blocks into adjacent MD areas (Barnes and Blomefield 1996).

Using the South African experience a larger area-wide MD program for control of OFM edge damage and outbreaks was established in northern Victoria initiated in September 1997, in over 800 ha on 18 orchards to the south of the Cobram district. The area-wide MD program was achieved by treating every tree in the entire experimental area with OFM pheromone at the full registered rate of four dispensers of Isomate OFM Plus (Shin-Etsu Chemical Co. Ltd., Japan for Biocontrol Ltd., Australia) per tree or 1000 dispensers per ha. The area-wide MD program was continued in the 1998-99 season with 40 orchards in an expanded area over 1100 ha in the same region by treating every tree with the full registered rate of two dispensers of Isomate OFM Rosso (Shin-Etsu Chemical Co. Ltd., Japan for Biocontrol Ltd., Australia) per tree or 500 dispensers per ha (Sexton and Il'ichev 2001). There was a significant reduction in both the OFM population level and damage to stone fruit in the treated area. The area-wide MD experiment also demonstrated control of OFM outbreaks and reduction of edge damage effects attributed to migration of OFM. These results indicated that the area-wide MD approach was able to control medium level 'hot spots' after the first year and high level 'hot spots' after two years (Il'ichev *et al.* 1999a).

Fruit growers were enthusiastic about the area-wide MD approach but raised the question of whether costs could be reduced in pome fruit not normally treated with MD for OFM, by use of lower pheromone application rates. This paper reports on work to investigate if reduced rates of Isomate OFM Rosso dispensers in pears adjacent to MD treated stone fruit would provide effective control of OFM.

MATERIALS AND METHODS

Experimental sites

The experiments to compare the effectiveness of the full registered rate (two dispensers per tree or 500 dispensers per ha) of Isomate OFM Rosso and half the registered rate (one dispenser per tree or 250 dispensers per ha) were conducted on pears during two consecutive seasons (1998-2000). Isomate OFM Rosso is a controlled release formulation of polyethylene tubing dispensers with OFM sex pheromone that contains Z-8-dodecenyl acetate (223 mg/dispenser), E-8-dodecenyl acetate (14.5 mg/ dispenser) and Z-8-dodecenol (2.5 mg/dispenser). The field trials were laid out in two different commercial orchards in Cobram, and one orchard in Ardmona. All experimental plots were established in pear [varieties William Bon Chretien (W.B.C.) and Packham] blocks of approximately 2 ha each. The area of an experimental plot was about 34 × 30 pear trees planted 6 × 6 m. All experimental pear blocks were adjacent to peach MD blocks with different varieties.

Isomate OFM Rosso dispensers were applied in the pear experimental blocks during the last week of August of each season. Peach blocks adjacent to pear experimental blocks were always treated with the full registered rate of Isomate OFM Rosso in the last week of August as well. Each treatment was replicated four times in the first season (1998-1999) and six times in the second season (1999-2000). Two replications were placed in one property at Cobram and a single replication in each of the other properties at Cobram and Ardmona in the first season. In the second season two more replications were added to properties at Cobram and Ardmona. In the Goulburn-Murray Valley, it was not possible to find an abandoned pear block without any treatments against OFM for an appropriate 'no treatment' control. Most commercial pear blocks in this district were treated with parathion-methyl and/or azinphos-methyl applied about seven to fourteen times for control of both codling moth *Cydia pomonella* (L.) and OFM. Such intensively treated pear blocks would not serve as an appropriate 'no treatment' control. Therefore, there was no 'no treatment' control in our experiments. The experiments compared the effectiveness of the two rates of dispensers, full registered rate (two dispensers per tree or 500 dispensers per ha) of Isomate OFM Rosso and half the registered rate (one dispenser per tree or 250 dispensers per ha).

Monitoring of OFM population trends

Standard Efecto-fly traps (Avond Pty. Ltd., Western Australia) were used as food traps for OFM monitoring. Three food traps in a row with five trees (about 36 m) between traps were placed near the middle of each pear block and in the middle of the adjacent peach block in each experimental plot. These food traps are not specific to OFM, but are capable of indicating the level of OFM population under mating disruption. Each trap was filled with 1 litre of 100 g/L brown sugar solution and 12 drops of terpinyl acetate solution (48.5 mL of terpinyl acetate with 1.5 mL of non-ionic wetting agent and 50 mL of warm water). Food traps were placed in the tree canopy at a height of 1.5-2.0 m and monitored weekly in all plots. The moths caught in the traps were identified and counted in the field. The monitoring of the experiments in both seasons usually started in late August or early September, before the start of the first spring flight, and stopped in the middle of April, when the last OFM flight had finished. The weekly monitoring data in which OFM were trapped (except for weeks of nil catches) was used for statistical analyses. A generalised linear mixed model with Poisson errors using GENSTAT 5. Release 4.2 Lawes Agricultural Trust, Rothamsted Experimental Station (Genstat 2000) was fitted to the counts at each time and orchard to analyse differences in the total number of OFM trapped under the two treatments.

Shoot tip and fruit damage assessments

OFM larvae tunnel 8-10 cm into young shoot tips of peach trees and this causes the shoot tip to wilt or die. Damage caused by OFM larvae to stone fruit shoot tips is easy to see and assess. Damage to pear shoot tips is difficult to find, because of the longer time required for pear shoot tips to wilt and die compared with tender stone fruit shoot tips. Larvae can also damage developing peach fruit, causing them to exude gum. Larvae enter the fruit and burrow to the stone, filling the tunnel with brown particles of excrement. Unlike the damage caused by codling moth on apples and pears, this excrement is not usually conspicuous on the outside of the peach. OFM damage to pome fruit looks like codling moth damage but when the fruit is cut open, the damage does not usually include the pips. Therefore, OFM fruit damage assessment on pears requires all fruit to be cut open for larval identification.

The damage assessments of shoot tips and fruit were carried out on experimental pear blocks and on peaches adjacent to pear blocks under treatments with full and half of the registered rate of Isomate OFM Rosso. Fifty shoot tips (25 at random on both sides of the canopy) were counted on each of the 20 trees in the rows where food traps had been placed on the experimental pears and on the peach blocks adjacent to pears. A random sample of 100 fruit was taken from the same trees that were assessed for shoot tip damage. Shoot tip damage assessments were carried out in January-February after the second OFM flight. The assessments of damaged fruit were made at the time of harvest, after the third OFM flight in February-March. The numbers of damaged shoot tips and fruit were recorded and used for analyses. Zeros were excluded.

RESULTS AND DISCUSSION

The average numbers of OFM caught per trap per week (OFM/trap/week) from all 12 food traps for each treatment in both locations Cobram and Ardmona during the 1998-99 season under the full and half the registered rates of Isomate OFM Rosso are shown in Figure 1. The monitoring data from Cobram and Ardmona are not presented separately in the figures, but it is important to mention the initial data from these locations. The initial level of OFM in Cobram was low with the peak of the first flight reaching 3 OFM/trap/week under half rate and 1 OFM/trap/week under full rate respectively. In Ardmona it was higher and the peak reached 11 OFM/trap/week under half rate and 23 OFM/trap/week under full rate for the first flight. This variability in the initial levels of OFM populations made direct comparison of results difficult. In both treatments the highest peak of OFM catches was recorded during the first flight (Figure 1). The number of OFM caught during the season gradually decreased under both treatments. For almost the entire season, the catches in pears with the half rate were lower compared to that in pears with the full rate of Isomate OFM Rosso. During the 1998-99 season the highest average number of OFM recorded in the peak of the first flight was 3.3 and 6.3 OFM/trap/week in the half and full the registered rate respectively (Figure 1). OFM catches under both treatments at the end of the season were reduced to about 50% compared with those at the beginning of the season. Total catches in all traps under full and half rate treatments were 376 and 370 respectively. There were no significant differences between two treatments in pears ($P=0.93$).

The initial level of OFM catches on adjacent peaches treated with full rate of Isomate OFM Rosso was higher than on pears and reached 27 OFM/trap/week in the peak of the first flight in Ardmona and 9 OFM/trap/week in Cobram. There was a significant decline in OFM numbers ($P<0.001$) during the season in all adjacent peach blocks. But in this decline, there was no significant difference in the effects of full and half rates of MD treatment on pears on OFM numbers on adjacent peaches ($P=0.72$).

A similar trend was demonstrated in the second season (1999-2000) (Figure 2). OFM catches were low during the whole season compared with the previous season. Individual trap counts did not exceed 2 OFM/trap/week and 46% of trap counts were zero. The peak of the first flight was 1.45 and 1.21 OFM/trap/week in the half and full rate treatments respectively (Figure 2). Over the entire sampling period, 85 OFM were trapped in the full rate treatment and 107 were trapped in the half rate treatment. Once again the difference in total trap catch in two treatments was not significant ($P=0.32$).

During both 1998-1999 and 1999-2000 seasons, the numbers of OFM caught in pears under both MD treatments declined over time ($P<0.03$). The difference between treatments with full and half the

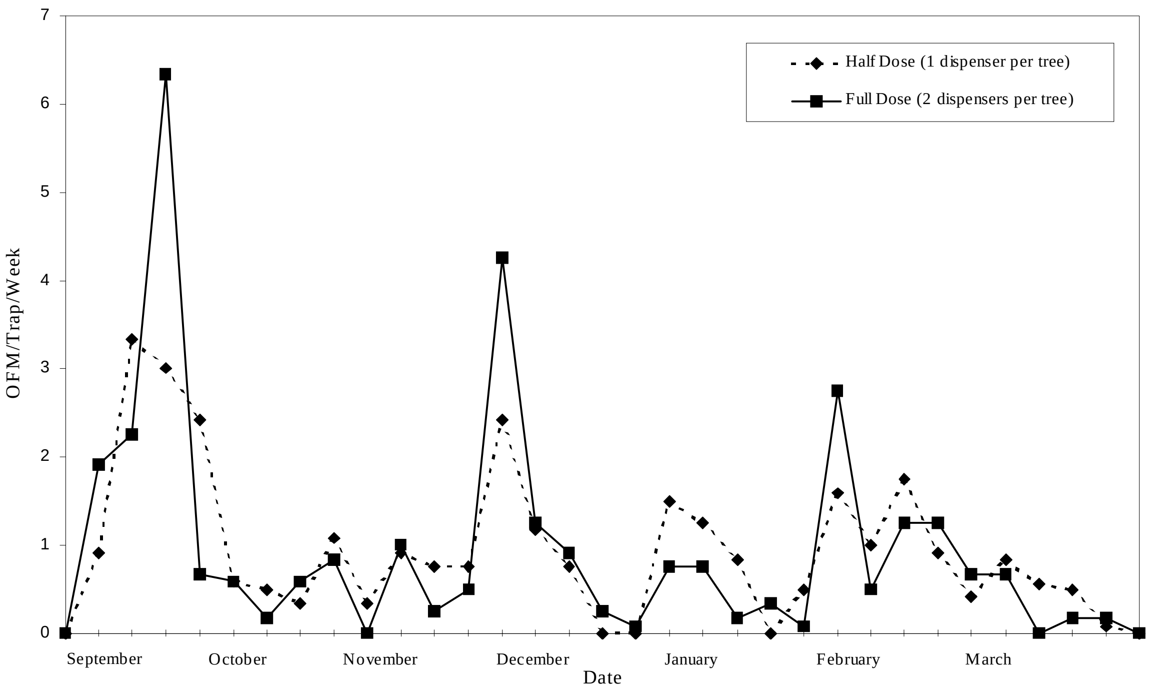

Figure 1. Catches of OFM pooled from four replications (average of 12 traps) under MD treatments with half and full registered rate of Isomate OFM Rosso on pears (1998-99).

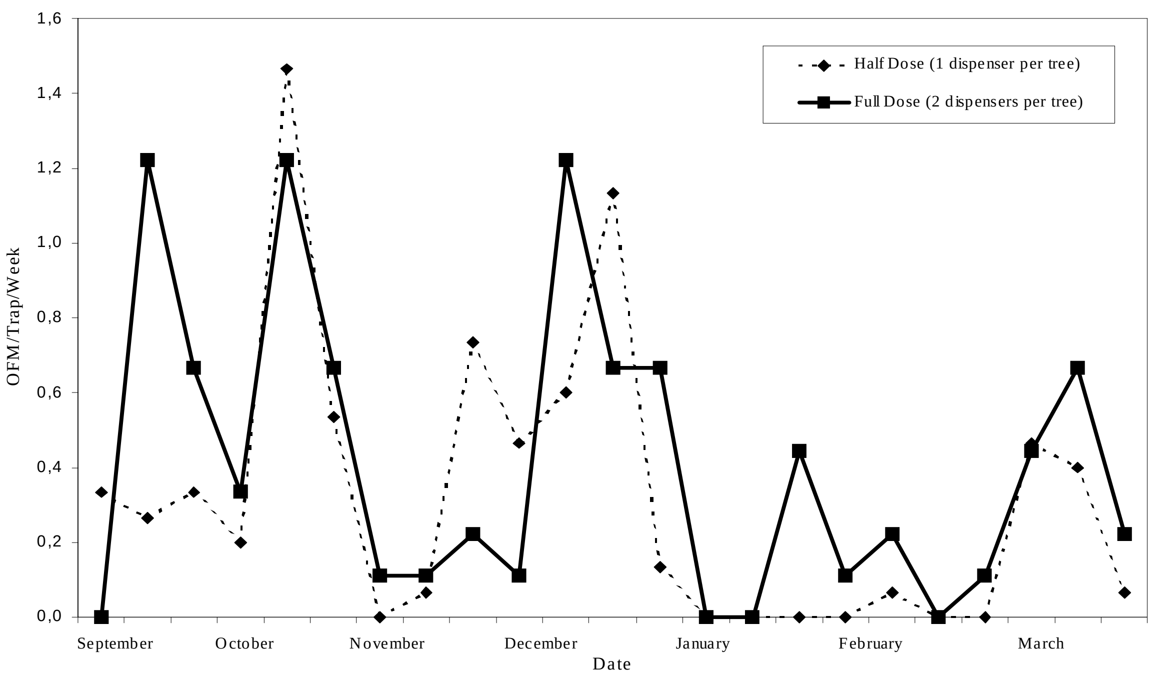

Figure 2. Catches of OFM pooled from six replications (average 18 traps) under MD treatment with half and full registered rate of Isomate OFM Rosso on pears (1999-2000).

registered rates was not significant (P>0.50) in this decline during both seasons. The weather conditions recorded during these two seasons were similar and are unlikely to have influenced the level of OFM population.

No damaged shoot tips and fruit were detected on experimental pear blocks during both 1998-1999 and 1999-2000 seasons. Extremely low levels of OFM infestation were detected in shoot tips on peaches adjacent to experimental pears under full rate MD treatment (mean 0.20% of damaged shoots per tree) and half rate MD treatment (mean 0.17% of damaged shoots per tree) in 1998-1999. There were only six and five trees each with 4% damaged shoots found on 80 peach trees adjacent to experimental pears under full and half rate MD treatments respectively in 1998-1999.

Similarly, fruit damage was extremely low on peaches adjacent to pears under both full rate (mean 0.033% damaged fruit per tree) and half rate MD treatment (mean 0.067% damaged fruit per tree). Only one in 100 fruit was damaged in four of 80 peach trees adjacent to pears under full rate and two in 100 fruit were damaged in four of 80 trees adjacent to pears under half rate MD treatment. There was no OFM infestation on peach shoot tips and fruit observed during the 1999-2000 season.

It is reasonable to equate reduction in moth numbers in food traps to control of the OFM. During the two seasons of the trial, both treatments reduced moth catches to a similar degree. Therefore, in pears adjacent to MD peaches, when the initial catches of OFM is low to medium (about 5-10 OFM/trap/week), growers can reduce the cost of mating disruption on pears by applying a half the registered rate (one dispenser per tree or 250 dispensers per ha) of Isomate OFM Rosso.

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