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Bugs by the million for medfly eradication

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As a first step towards nation-wide eradication of Mediterranean fruit fly (Medfly), a pilot project was undertaken in Broome using the Sterile Insect Technique in an attempt to eradicate the local Medfly population. The results have been promising, and further investigation of eradication for Western Australia is underway. Bill Woods reports.

The thought of rearing insects by the million may be shocking to many people. However, the breeding of insects is in fact crucial to the biological control work employed to defend the State’s agricultural industries against unwanted pests. Mediterranean fruit fly, also known as Medfly, is one such pest.

Medfly was introduced to Western Australia over 100 years ago and has spread throughout the State, except for parts of the Kimberley region. It is not established in the rest of Australia but outbreaks are regularly eradicated from South Australia.

Medfly is the key pest of fruit tree crops in Western Australia, costing growers more than any other pest, both in terms of crop damage and insecticide use. Despite regular pesticide applications, crop losses still occur, especially in growing areas close to towns with large numbers of unsprayed trees.

In areas with high Medfly populations, growers must use both baits and cover sprays incorporating organophosphate insecticide to achieve satisfactory control. Area freedom for parts or all of Western Australia would significantly reduce the costs and difficulties of Medfly control, as well as the problems in accessing interstate and overseas markets. As Medfly is not wanted in other growing areas,
Irradiator machine – An irradiator was used to sterilise the male pupae.

In Western Australia, SIT against Medfly was first introduced by the Department of Agriculture in 1978. The aim of the project was to eradicate Medfly from Carnarvon, an isolated area 1,000 kilometres north of Perth. The first releases of seven million sterile flies per week were made in 1980. The number released increased to 12 million flies per week and the program ran until 1985 when successful eradication was declared. However, as there were no quarantine barriers to prevent reinfection, area freedom was lost when infested fruit was brought in from the South West.

In 1989, an outbreak of Queensland fruit fly (Qfly) was detected in Perth. A decision was made to eradicate the pest using a combination of male annihilation, bait spraying and sterile male release. In total, 950 million sterile flies were released in a 16 month period. By 1991, Qfly had been eradicated from Western Australia at a cost of $8 million.

Applying SIT to male only strains

Traditionally, SIT was applied to strains of Medfly where both males and females were reared and released. However, in the 1980s scientists began to investigate ways to release only male flies. It was thought that release of males alone would increase efficacy as males would not have a ready source of sterile females to mate with, and would disperse widely to look for mates.

By using classical genetic techniques, scientists developed the so called ‘male only’ Medfly strains. The first male only strains were those in which the females had white pupae compared to the brown of the male. Male pupae were then optically separated using a commercial rice sorter, as Medfly pupae are similar in size to grains of rice. The disadvantage was that although 99 per cent separation could be achieved, it was still necessary to rear females all the way through the rearing process before they could be removed, resulting in an expensive rearing protocol.

The second generation strains still used the white pupae, but added a temperature sensitive lethal (TSL) gene in females. Females with this gene died when exposed to temperatures above 34 degrees Celsius, and could be removed from the rearing process at the egg stage. This...
Once in Broome, the Medfly pupae were placed in 30 litre bins until they emerged as flies.

enabled significant cost savings in eliminating the production of unnecessary female flies. It was this type of strain that was used in the Broome program, as well as in similar programs in Israel and South Africa.

The Broome pilot program
The program began in 1997 with trapping throughout the Kimberley, which established that breeding populations were only found in Broome. Further trapping in Broome showed that the population was very low during the wet season, providing a window of opportunity for eradication using SIT.

In 1998, Department of Agriculture Senior Technical Officer Roselia Fogliani undertook an intensive four month training course in Austria in the specialist techniques required to rear male only strains.

In August 1999, after approval from AQIS, a flask of TSL Medfly eggs airfreighted from Austria was received at the quarantine facility at South Perth. After being transferred to the fruit fly facility a month later, the colony reached its target of five million flies per week in March 2000.

To maintain the colony, diet trays were spread with untreated eggs. These eggs produced both male and female offspring and became the mother colony. However, it was the heat treated eggs that were used to produce flies for mass release. These eggs were heated in flasks in a water bath for 24 hours at 34 degrees Celsius to kill female embryos, before being spread onto the prepared trays of diet consisting of bran, sugar, yeast, acid, preservative and water.

As these flies are sensitive to temperature, the trays were designed to provide sufficient space when stacked to enable good air circulation, and hence cooling of the maggots. A tray full of maggots can produce a lot of metabolic heat (up to 40 degrees Celsius), and therefore the diet trays were well watered and kept in refrigerated rooms to prevent the temperature reaching critical levels.

As opposed to standard Medfly strains that are quite robust under mass rearing, TSL strains tend to be unstable and prone to genetic recombination, which may mean loss of temperature sensitivity. Therefore, when rearing these strains, a small filter colony is usually kept under low stress conditions to maintain a low level of recombination, and flies from this small filter colony are introduced into the main colony when the level of recombination (genetic breakdown) is too high. During the course of the program, the percentage of females from heat treated eggs rose to 16 per cent (see Figure 1). However, once low recombinant flies from the filter colony were used to replace the main colony, the percentage of females was once more
brought down to below one per cent. This was a significant achievement as other rearing facilities had experienced this problem, but were unable to reduce recombination to a low level.

The pupae were sterilised by irradiation, with nitrogen gas used during the process to improve the competitiveness of irradiated flies. After irradiation, the sterile pupae were dyed (orange, pink or yellow) and packed in plastic 'sausages' in polystyrene containers to be airfreighted to Broome.

In Broome they were placed in 30 litre bins to emerge. Flies were fed with an agar-sugar jelly block on the mesh top of the lid. After four days the flies were ready to be released. Refrigerated sea containers maintained at 27 degrees Celsius were used as emergence rooms.

During the wet season, most releases began at 5.30 am to prevent mortality from overheating. Bins of flies were released on a 400 metre grid twice a week. Releases were made over approximately 20 square kilometres, comprising the Broome townsite and two horticultural areas - 12 Mile and Coconut Wells.

Overall production was very consistent (see Figure 2). However, some gaps in production occurred when the old colony was being replaced by the filter colony. The number of male flies released was also reduced when the percentage of females reached 16 per cent. In

Results

Trapping is the best method of judging the effectiveness of SIT programs. Accordingly, the team set up a trapping grid to international standards, as verified by an independent audit. Over 120 Lynfield/Capilure traps were used on a 400 metre grid in Broome. Traps were checked fortnightly and the lure replaced monthly.

Trapping data over the three years of the trial showed that the eight month period of releases had suppressed but not eradicated the flies (see Figure 3). This was not an unexpected result given the short period of releases, the learning curve required to deal with a new technology, and the difficulties of working in a cyclone prone tropical environment.

Long term eradication would not be possible without quarantine measures to prevent reinfection. A full checkpoint was considered too expensive for a trial program and therefore innovative techniques had to be developed. Radio and television advertisements were used to promote awareness, with signs, random checkpoints and 'on the spot fines' used as further deterrents.
April 2000, Cyclone Rosita also put a stop to releases by disrupting power in Broome for two weeks, as well as destroying the trapping grid.

In June 2000, an aerial release trial commenced in the horticultural area. It was found that aerial release was quicker, gave better distribution of flies, and removed problems with property access.

**Eradication for the future?**

While Medfly has not yet been eradicated from the Kimberley, the Broome pilot provided the information required to develop a robust eradication strategy for Australia. Integration of insecticide baiting into the equation may be necessary to achieve eradication. Once the population of wild flies exceeds the ability of sterile flies to suppress it, there is no going back unless insecticides are employed.

Factors such as competitiveness of flies, rates of release, percentage of females, distribution of flies, and efficiency of quarantine measures also interact to determine overall effectiveness of SIT.

Using results from the Broome trial and overseas data, consultants from Imperial College in London and the University of Western Australia have completed a benefit cost analysis for statewide eradication of Medfly. To achieve eradication, it is estimated that a facility capable of rearing up to 300 million Medfly per week would be required. While this seems like a daunting task, there are already factories overseas that can produce one billion flies per week. With construction of a suitable mass rearing factory, mass production on this scale could be possible for Australia.

Results of the benefit cost analysis suggest that eradication of Medfly from Australia would cost around $70 million over a six year period. If the area of horticulture expands over a 20-year period, then the benefits of eradication could equal or exceed the cost.

The main beneficiary would be the local horticultural industry. Other beneficiaries would be the broader community, and in particular the South Australian Government, which spends millions each year in eradicating Medfly outbreaks originating in Western Australia.

*The Medfly pupae were packed in polystyrene containers before being airfreighted to Broome.*

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**Figure 3. Medfly trapping data - Broome (all traps).**

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