Honey bee crop dusters plug a gap in Bt cotton defences

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Ingard cottons are providing an effective tool for managing *Helicoverpa armigera* but there is a chance that some young larvae could take advantage of one area of the Bt cotton plant that is relatively safe for them. The Bt toxin is expressed less in the flowers than in other parts of the plant, and these are common places for the moths to lay their eggs.

It is possible that newly emerged larvae, by first feeding on the Bt-free flowers, could reach a size which is more tolerant of the Bt toxin in the rest of the plant. This could allow them to damage fruiting structures and other parts of the cotton plant before succumbing to the Bt.

In a CRDC funded project, CSIRO Entomology scientists looked at the possibility of using honey bees to deposit the plain infective stages of the pathogen, Heliothis Nuclear Polyhedrosis Virus (HNPV), (see box) in the flowers. This would eliminate the safe haven that new larvae may otherwise have been able to exploit.

A honey bee coated with pink fluorescent Bt dust about to approach a cotton flower.

ADDED BONUS

If successful, the use of honey bee disseminated HNPVs would give growers a bio-control option that would fit in with their IPM programs for *Helicoverpa*. An added bonus would be the potential of honey bees to increase cotton lint yield. Work by John Rhodes (NSW Agriculture, Tamworth) suggests placing honey bee hives close to cotton crops can improve yield by up to 15 per cent.

By making simple modifications to the hive, bees can be forced to pick up a load of HNPV dust and carry it with them when they visit the cotton flowers. Being portable, the hives can be moved to areas where they are required.

Honey bees can be used to dust cotton flowers with Bt toxin.

This way of moving bio-pesticides to where they are needed has been used successfully in other crops such as crimson clover and sunflowers in the US. But no work had been done on cotton under Australian conditions where the climate can be severe — such as extremes of temperature and UV radiation. It is possible that, on Australian cotton farms, HNPV would be degraded before it achieved its purpose.

Five grams of a HNPV powder formulation containing pink or orange fluorescent dust were applied to each hive. This dose was equivalent to the amount of the commercial biopesticide, Gemstar or ViVus, required to treat 400 square metres. On average, the bees moved this amount of dust out within three hours, though the rate of its removal did depend on the number of bees and how active they were.

The 'pathogen applicator device' forces bees leaving the hive to crawl through a removable tray containing the HNPV dust, thus covering their bodies in it. (Bees entering the hive can do so directly and are not exposed to the dust.

All bees leaving treated hives were covered with the dust. The presence of the dust didn't affect the bees' flight or ability to forage (and the coloured bees were easy to spot). The colour is also visible where bees deposit it inside the white cotton flowers.

Bee foraging activity was highest in the morning — between 7am and 11am — when cotton flowers are open, and dust coated bees effectively transferred visible traces of HNPV powder to the petals and anthers of flowers they visited. The addition

NUCLEAR POLYHEDROSIS VIRUSES

NPVs are naturally occurring viruses which are specific to insects. Heliothis Nuclear Polyhedrosis Virus attacks only the heliothis group which includes Helicoverpa. Because NPVs are highly pathogenic, highly specific to certain types of insects and do not infect vertebrates (including humans), several have been developed as biopesticides such as Gemstar and ViVus.

of HNPV dust to the hive made no difference to bee activity.

Observations on the bees showed they tended to forage close to the edge of the field — mostly within the first 10 metres. Although the numbers of bees dropped rapidly further into the field, some were found foraging up to 250 metres into cotton fields.

If bees carrying visible traces of HNPV powder were captured while, or immediately after, visiting a cotton flower, they were highly infective, as were the flowers collected immediately after an infected bee visit. When homogenised and tested against *Helicoverpa armigera* larvae, the infected bees killed 78 per cent of *Helicoverpa armigera* larvae and the flowers, 65 per cent.

Honey bees at work on a cotton flower.

Sentinel *Helicoverpa armigera* larvae (3rd instar) were placed in marked cotton flowers at a range of distances (up to 100 metres) from hives treated with HNPV dust. These larvae were retrieved 24 hours later and over 57 per cent of them developed lethal infections of the virus. There was no evidence of any differences in the incidence of HNPV at different distances from the hive.

When the flowers whose sentinel larvae had become infected were tested later on additional larvae, they killed 37 per cent of them. This relatively low result for flowers known to have carried the virus suggests that the HNPV dust may be degraded over time, perhaps by UV radiation.

This is supported by the fact that flowers collected randomly four hours after HNPV was put in the hives did not have a higher incidence of HNPV than flowers collected prior to each release. It is also possible that sample processing and testing procedures for flowers were underestimating the efficacy of bee disseminated HNPV.

Although the incidence of HNPV infection in free living *Helicoverpa armigera* larvae in all crop fields sampled increased substantially during the course of the project, it wasn't clear how much of this was due to the bees.

EFFECT ON HONEY

Observations had shown that bee behaviour wasn't affected by the dust, but it wasn't known if the bees could transfer the virus to their honey. Of the larvae tested on honey from treated hives, only one out of 277 developed HNPV, an indication that only a trace of HNPV was present. This was actually lower than the result for the control treatment.

In an attempt to see if other insects could pick up the virus from flowers visited by dusty bees, pollen beetles (*Carpophilus spp)* were collected from flowers close to treated hives. A few larvae became infected with HNPV when tested against these beetles, an indication that pollen beetles could possibly carry HNPV particles.

The research demonstrated that honey bees can be successfully used to disseminate powdered *Heliothis* NPV onto cotton flowers at levels that will infect a large number of *Helicoverpa armigera* larvae. And they can do this for up to 100 metres from the hive.

Growers who are thinking of using honey bees on their cotton farms could consider using the bees to transport HNPV and so potentially reduce the need for supplementary sprays. This would result in cost savings and help preserve beneficial insects.

Sincere thanks are extended to Ken and Lou Platt for their generosity in allowing this research to be done on their property, 'Lowana' near Pilliga, New South Wales, and to Ken for the original idea. Gary Wooldridge, the apiarist who designed and built the successful 'pathogen applicator device', made the project possible. He also lent his commercial beehives and assisted in their care and transport. The work was done in collaboration with Andy Richards, formerly of CSIRO Entomology and the excellent support of the technical staff involved — Trudy Staines, Louise Mundey and Janelle Scown.

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