NATIONAL BEE UNIT

Control of Small Hive Beetle Using Nematodes

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As outlined by Cuthbertson et al (2010), small hive beetle (SHB), *Aethina tumida*, is a significant threat to UK honey bees. This beetle, a major bee pest in many areas of the world, has the potential to cause serious disruption to UK beekeeping, should it come to the UK.

Cuthbertson et al (*Bee Craft,* May 2013, pp 30–31) outlined the lifecycle of the beetle. This includes a soil dwelling stage, where 'wandering larvae' leave the beehive in search of a suitable pupation site, most usually just simply the soil surrounding the hive. Understandably, treating beetle infestations within the hive is both difficult and extremely sensitive, especially in regards to the use of chemical control measures. Therefore, alternative control methods are required. It is deemed plausible that the life stage of the beetle leaving the hive to enter the surrounding soil to pupate could be a 'weak' link in the pest's lifecycle. Therefore, the opportunity to treat the soil surrounding the hive with a satisfactory control agent affords a practical control measure that beekeepers could employ.

National Bee Unit research offers a practical solution to the contol of small hive beetle

Figure 1. Entomopathogenic nematodes

Much work has been undertaken at the Food and Environment Research Agency (Fera) in York into the development of Integrated Pest Management (IPM) strategies against a range of non-indigenous invertebrate pests including whitefly (*Bemisia tabaci*) and thrips (*Thrips palmi*). These non-indigenous insects, including small hive beetle, are held securely within quarantine laboratories for research purposes (Marris et al, 2010). The control strategies developed against these invading insects, many of which have been rapidly taken on board by their respective industries, include the use of biocontrol agents such as entomopathogenic nematodes (Figure 1). These are minute, transparent and worm-like organisms that occur widely within the soil environment. Several species of nematodes are commercially available within the UK for control of various soil dwelling pests such as larvae of the vine weevil (*Otiorhynchus sulcatus*).

Investigating the Potential of Nematodes

Three species of nematodes were investigated for their ability to infect and kill pupating small hive beetle larvae in the soil: *Steinernema feltiae*, *S. kraussei* and *S. carpocapsae* (Cuthbertson et al, 2012).

For direct exposure trials, individual wandering larvae were dipped in the recommended dose rates of nematode products (10,000 infective juveniles/ml) for three seconds. They were then placed on moist filter paper within 9 cm diameter Petri dishes and maintained at 20 °C, 65% RH and 16:8 hr light:dark regime.

For indirect exposure, 7 cm diameter by 15 cm tall plastic containers were filled with sand (8% moisture content). 50 ml of control product (500,000 nematode infective juveniles) was added over the surface of the sand at the same dose rates as in the direct trials. Once the solution had soaked down into the sand, ten wandering larvae were added to the surface. The containers were then sealed and maintained at the conditions described above. There were ten containers per treatment. Controls consisted of wandering larvae added to containers in which the sand had been treated with 50 ml of water. Treatments were maintained for six weeks in order to allow adult beetles to emerge. Mortality was calculated as the number of beetles that failed to emerge. In order to confirm the fate of those individuals that did not emerge as adult beetles, at the end of each trial the sand substrate was sieved and searched for insect debris.

For delayed application trials using the two most efficient nematode species (*S. carpocapsae* and *S. kraussei*), containers as described above were prepared. Batches of ten wandering SHB larvae were added to each container. Following 24 hours, the first batch of nematode solution was added to ten containers. Then, at weekly intervals, nematode treatments were added (at the same dose rate as before: 50 ml of product (500,000 infective juveniles)) to separate batches of the original larvae-infested containers. Control containers received an equal volume (50 ml) of water. After treatment all containers were maintained in a controlled environment room (23 °C, 65% RH) for six weeks to allow beetles ample opportunity to emerge.

Results

The nematodes proved extremely effective at infesting beetle larvae. Best control was obtained following indirect exposure using the nematodes *S. kraussei* and *S. carpocapsae* (Figure 2). Here, 100% mortality of the beetle was obtained under laboratory conditions. Upon dissecting the larvae in the treatments, nematodes flowed freely from within, providing proof that they had infected the larval host (Figure 3).

Delayed application of the nematodes demonstrated that *S. carpocapsae* could offer a good level of control of the pupating small hive beetle larvae up to three weeks following the larvae entering the sand. Assessment of the pupation medium following the trials in which nematodes had been applied three weeks after the larvae had entered the sand produced semi-formed adult beetles that had been infected and killed by the nematodes (Figure 4).

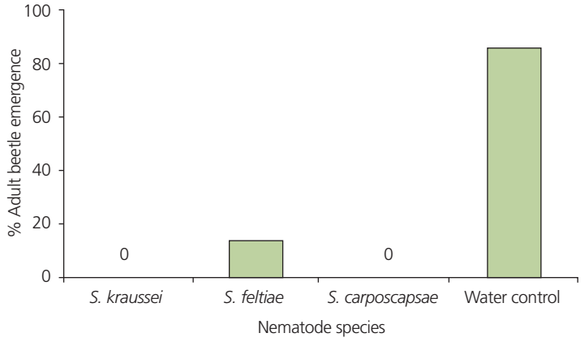

Figure 2. Impact of indirect exposure of nematodes on Aethina tumida ***wandering larvae***

Figure 3. Dissected Aethina tumida ***larvae releasing the entomopathogenic nematode*** Steinernema carpocapsae

Figure 4. Developing small hive beetle killed by nematodes applied to sand three weeks after the larvae had entered the sand to pupate

Conclusion

In conclusion, our trials demonstrate that commercially available entomopathogenic nematodes in the UK can infest and kill *A. tumida* wandering larvae. Furthermore, these products are available across Europe and so have the potential to be used as control agents should the small hive beetle expand its range to this continent (Cuthbertson et al, 2013b). Ongoing work at the National Bee Unit is seeking to determine economic dose rates of the nematodes and the timespans required between applications to ensure full control of *A. tumida.* The information gathered all supports the development of contingency plans to deal with *A. tumida* should it ever be located within the UK

Further Information

Dr Andrew GS Cuthbertson, along with James Mathers and Lisa Blackburn, coordinates the small hive beetle research at Fera. Dr Gay Marris is Science Coordinator for the NBU.

Please send any enquires about honey bees to nbu@fera.gsi.gov.uk For enquiries regarding Bee Health Policy and Regulatory issues, contact Bee Health Policy at beehealthinfo@fera.gsi.gov.uk

Suggested Further Reading

Cuthbertson, AGS, Mathers, JJ, Blackburn, LF, Brown, MA & Marris, G (2010). Small hive beetle: the next threat to British honey bees? *The Biologist*, **57**(1), 35–39.

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Cuthbertson, AGS, Mathers, JJ, Blackburn, LF & Marris, G (2013a). Lifecycle of the Small Hive Beetle, *Aethina tumida*. *Bee Craft*, **95**(5), 30–31.

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