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Nosema disease

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Summary

- Nosema disease is the most widespread adult bee disease in the world.
- Although there are a number of symptoms, these often go unnoticed, and the poor performance of a colony is blamed on other factors.
- There are no classic signs of the disease, and hence it frequently goes undetected.
- Heavily infected bees live only half as long as non-infected bees.
- Nosema disease is most likely present in all colonies all the time, and only likely to cause bee losses when conditions favour the micro-organism.

Introduction

Nosema apis, which causes nosema disease, is found worldwide. *Nosema ceranae*, a similar parasite, was found in Asian honey bees (*Apis cerana*) in 1996. In 2005 it was found in *Apis mellifera* in Taiwan, and since in Europe, North America and Australia.

The nosema organism belongs to a unique group of spore-forming organisms known as Microspora, many of which are parasites of insects. *N. apis* is the most common cause of adult bee infection, and is widely regarded as being (in economic terms) the most serious disease of bees in Australia.

N. ceranae and *N. apis* have similar life cycles. Adult bees ingest nosema spores via contaminated water or food, by food exchange with other bees or in their duties of cleaning contaminated combs. The spores then germinate in the epithelial cells of the mid gut. Here they multiply, producing more spores, to the point at which numbers are so great that they burst the epithelial cells and are excreted in the faeces.

Worker bees, queen bees and drones are all susceptible to infection by spores, which can remain viable for considerable periods of time on hive parts.

The visual difference between *Nosema apis* and *Nosema ceranea* spores is only slight. It is not possible to ascertain with any degree of confidence the difference between these two organisms under a normal 400 power microscope. Only DNA tests can differentiate the two species. At this stage, given that both organisms are very closely related, it is very likely that they will respond to the same treatments and management.

Effects of *Nosema apis* on the colony

- Older field bees die off rapidly when heavily infected – the expected life span of individuals can be reduced by more than half.
- Young bees assume field duties in an attempt to maintain the intake of nectar and pollen.
- With fewer bees in the hive, difficulty is experienced in maintaining the brood nest temperature.
- The hypopharyngeal glands of infected nurse bees do not fully develop, resulting in up to 15% of eggs in severely infected colonies not developing to mature larvae.
- Heavily infected queens cease egg laying and die within a few weeks.
- Dysentery is aggravated.
- In serious cases of nosema disease, the colony may eventually die.

Effects of *Nosema ceranae* on the colony

As *N. ceranae* is a newly recognised pathogen of honey bees, the full effects of infection have not been determined. However, the following observations have been made:

- *N. ceranae* can kill bees in eight days, which is faster than bees exposed to *N. apis*

- gradual depopulation, higher autumn/winter colony deaths or low honey production can occur
- none of the dysentery or crawling bee behaviour usually related to *N. apis* infection has been reported.

Symptoms

The disease is far more prevalent during winter and early spring, with its lowest levels over summer. Infected bees often show no symptoms, or, if symptoms are present, they are not specific to nosema disease, but may also be attributed to other diseases or conditions of adult bees. Where present, symptoms include:

- a reduction in the colony population – this may be rapid or subtle, and is often termed ‘spring dwindle’, occurring in August and September
- a serious reduction in honey production in heavily infected colonies, compared with lightly infected colonies
- an accumulation of dead bees at the hive entrance. This is not common, as most field bees die some distance from the hive
- flightlessness in adult bees. They crawl along the ground, and their hind wings may be unhooked from the front wings and held at unusual angles. This is also a symptom of pesticide poisoning or viral infestations
- a sickly look and greasy-looking abdomen in adult bees
- greyish-white, dull intestines
- dysentery, with hives covered in spots of faecal matter. This symptom is often associated with serious cases of the disease
- death of the colony (occasionally).

Diagnosis

The only accurate means of diagnosing nosema disease is microscopic examination of the gut of infected bees. Samples for diagnosis should be collected by gathering 30 live or freshly dead bees from the hive entrance or from the top bars of the frames. Place live specimens in a cage with a small supply of queen candy, or freeze newly dead samples to keep them fresh. Alternatively, place 30 bees in a jar containing methylated spirits. Deliver or send samples to your nearest veterinary laboratory or apiary officer as soon as possible, along with your name, address and a request to test for nosema. If mailing a sample, post early in the week so that it arrives before the weekend.

NB: It will not be possible to mail samples collected in methylated spirits through the post. These will have to be delivered in person or by courier.

The procedure for measuring the nosema infection of the samples requires a compound microscope with a x400 objective. The most common method used is that published by Cantwell (1970). This method does not differentiate between *Nosema apis* and *Nosema ceranae*; to distinguish between these organisms, molecular tests, including a polymerase chain reaction (PCR) test, are necessary, to identify the specific DNA sequences of each organism.

Test results

The results received after submitting samples to the laboratory for analysis or doing your own counts will provide you with an estimated number of spores per bee, ranging from zero to many millions. There is no definite research to indicate what the safe level of infection is, but the rule of thumb is that anything less than one million spores is acceptable, and any reading greater than one million is cause for concern.

This, however, will largely depend on the time of year, as a low level of nosema spores at the beginning of winter may need to be taken more seriously than a similar level at the end of winter. If high readings (many millions) are obtained, it can be expected that the infected bees will be very short-lived, and that the colony will struggle to increase in population. This is typical of the ‘spring dwindle’ phenomenon. In extreme cases, the colony dies.

In most cases, once the nosema levels have reached very high levels, the colonies will take a number of generations to recover.

Methods of control

Management practices

- Climatic conditions play a major role. Protect colonies from cold, wet winds and locate apiaries on the northern side of a hill. Ensure hives have maximum exposure to sunlight during autumn, winter and early spring.
- Keep the hive dry – elevate it if possible. In northern New South Wales and Queensland, cane toad stands have been found to reduce nosema levels.
- In autumn, compact the colony in preparation for winter. Do not leave excess boxes on each hive; reduce the colony to one or two boxes for the winter period.
- Placing beehives on the cooler tablelands will cause the colony to become broodless. This reduces the stress and demands on the colony, and will assist in keeping nosema levels low.
- Ensure the hive is headed by a young queen with a strong population – this will greatly reduce any adverse effects from nosema.
- From early autumn, avoid moving brood combs around a hive or between hives.

- Avoid moving hives during winter. Multiple shifting of hives and opening of colonies during the winter months have been associated with increased nosema levels.
- At the end of autumn, leave more than half a box of honey on each hive for winter.
- Old brood combs are a constant source of disease pathogens. Replace old brood combs with new in late spring and summer, so that old combs do not remain for years in the brood nest.
- Protein deficiency is probably a major cause of increased nosema levels. Many autumn and early winter flows have protein-deficient pollens, causing low breeding levels and resulting in shorter lived bees prone to nosema infections. Putting bees on flora that provide high-protein pollens, before and directly after working a honey flow with low-protein pollens, will help overcome protein deficiencies.
- High-protein pollens, available at the end of autumn and over winter, can ensure that bees breed and replace population lost to nosema.

Fumigation

Fumigating combs with a commercial grade 80% acetic acid can be an effective method of killing nosema spores on contaminated equipment (it is also effective in killing European foulbrood, *Melissococcus pluton,* organisms). The 80% acetic acid is produced by adding one part by volume of water to four parts of glacial acetic acid.

Stack supers of empty combs outdoors in a sheltered area or open shed. Pour 150mL of the solution onto an absorbent material placed on the top bars of the frames in each super. Seal the stack with masking tape and leave for a week to fumigate. Air combs for a week before reusing.

Acetic acid is not widely used, because it is highly corrosive to metals.

Warning: Acetic acid fumes will corrode the frame wire and nails in hive components. About five fumigations are possible before frame wires are completely corroded. Acetic acid is highly corrosive, and contact with the skin should be avoided. If acid is spilt onto your person or any area where it is not required, such as concrete floors, wash the area thoroughly.

Heat

Heat will decontaminate equipment affected by nosema. Dry equipment should be heated to 49°C and held for 24 hours at this temperature to destroy nosema spores. Combs must not contain honey or pollen, and heat must not exceed this temperature, as damage to combs may result.

Antibiotics

Only one antibiotic, fumagillin (trade name – ‘Fumidil B’), is successful in controlling nosema. However, it is only available for use under permit in queen rearing operations, because its residual activity period can last many years in honey. The risk of honey contamination is far too great to use fumagillin in honey-producing hives.

Irradiation

Gamma irradiation of hive equipment will kill all nosema spores present, as well as killing all other microbial disease pathogens.

Conclusion

Sound management practices will help reduce losses caused by nosema. Good management practices – such as appropriate nutrition, young queens with populous hives, new comb rotation and placing hives in a warm sunny position over the autumn, winter and early spring – all contribute to minimising nosema losses. Avoid stimulating colonies during cool weather.

References

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