By Graeme Peters

Claims of a global decline in the bee population have triggered international concern. With good reason - humans have benefited from honeybees for centuries. In addition to making honey and other useful products, bees help pollinate about a third of our crops.

Scientists around the world have turned their attention to exploring reasons for bee declines in some countries. To date, most agree that there is no single explanation for colony losses but interactions between multiple stressors are likely involved. Pests, such as varroa and nosema ceranae, and pathogens are playing a significant role. Research must now determine why honeybees have become vulnerable to these stressors and how they can be protected.

Given the vital role honeybees play in agriculture, the crop protection industry is naturally concerned about this negative trend and making sure that dispersive use of pesticides does not harm bees. Some scientists hypothesise that pesticides are one of the factors rendering bees more susceptible to disease.

No one disputes that some pesticides and adjuvants are hazardous to bees so it is important that all involved in managing agrichemicals, especially the user, follow safe and responsible practices when applying them. As this article will explain, education and compliance are key factors to reducing off-target application, such as spray drift, affecting bees.

There are also claims that pesticides applied to the seed to protect it during its early growth stage are weakening or wiping out hives. Significant research is underway in this area but the crop protection industry believes that there are strong indications that so-called systemic pesticides are not a significant factor in bee die-offs. That said, interested parties are awaiting the outcome of further research, in particular into the indirect and sub-lethal impacts of neonicotinoids on bees and their link to other stressors.

This article will describe the current situation with bees, both internationally and in New Zealand, look at how pesticides interact with bees, and some of the work underway to manage bee health.

Population Up and Down

Media headlines would suggest that honey bees are in danger of extinction. But is the managed bee population actually under threat?

Well, yes and no. According to United Nations Food and Agriculture Organisation (FAO), the global stock of commercial honey-bee colonies has actually increased by 45 per cent between 1961 and 2007.

The main exceptions to this global increase involve long-term declines in the United States and some European countries, but these are outweighed by rapid growth elsewhere. Thus, despite variation among countries, the overall FAO data reveals that at least domesticated honey bees are not declining globally.

That said, bee numbers are not keeping pace with expansion in agriculture requiring animal pollination and it is indisputable that some areas are suffering from bee declines.

A United Nations Environment Programme (UNEP) report released in March 2011 said that a decrease in managed honey bee colony numbers in Europe has been observed since 1965, but the pattern is diverse. Since 1998, individual beekeepers have been reporting unusual weakening and mortality in some colonies.

In the United States, honey-producing colonies have halved since 1950, when there were 5.5 million hives. Losses of honey bee colonies since 2004 has left North America with fewer managed pollinators than at any time in the last 50 years, the UNEP report said. In this region,

honey bees pollinate nearly 95 kinds of fruits such as almonds, avocados, cranberries and apples, as well as crops like soybeans. In 2000, the value of crops pollinated by bees was estimated at US$14.6 billion ($NZ 18 billion) in the US alone.

In New Zealand, colony numbers were in slight decline from about the turn of the millenium – the year varroa was first detected in New Zealand. By 2005 there were 300,000 managed hives in 2005. But more recently their number has been increasing to about 390,000 hives. That said, the feral bee population has pretty much disappeared, a bleak situation blamed on the devastating parasite varroa.

The evidence is that while the number of hives globally is growing, albeit too slowly, in some parts of the world the bee is facing threats to its survival, which is, quite rightly, flagged as a serious problem.

Reasons for Bee Declines

The UNEP report listed four main reasons for pollinator decline but it placed most blame on a single insect.

“The external parasitic mite, *Varroa destructor*, is the most serious threat to apiculture globally,” the UNEP report said.

About the size of a pinhead, varroa feeds on bees’ circulatory fluid and migrates from one hive to another, spreading viral diseases and bacteria. If left uncontrolled, it will almost certainly lead to the premature death of colonies within three years. Discovered in Southeast Asia in 1904, today it has spread to nearly all countries including New Zealand, except small pockets in the south of the South Island.

Varroa is devastating because it cannot be eradicated, but it can be controlled through monitoring of mite levels, regular treatment with pesticides, and possibly by selecting bees with tolerance to the mite.

Other invasive species include the small hive beetle, which has not been detected in New Zealand. It causes damage to honeycomb, stored honey and pollen, if a beetle infestation is sufficiently heavy, they may cause bees to abandon their hive.

Competition overseas from non-native insects is also having an impact, notably the Africanised bee in the US and the Asian hornet in Europe.

Another parasite causing chaos is *Nosema ceranae,* which was first recognised as a distinct species in 1994, in China. A decade later it was detected in European honey bees in Taiwan and Spain and is now in many countries. During an investigation into hive illness in the Coromandel, the Ministry of Agriculture and Forestry discovered *Nosema ceranae* in New Zealand in September 2010.

The microscopic spore-forming parasite attacks the lining of the middle intestine of worker bees, queens and drones. Severe infections in a hive will cause it to die out, with lesser infections reducing honey yields and population build up.

A shortage of good quality food is also cited as one of the factors affecting bees. Good food is essential for pollinators’ successful larva development and also to optimise their activity cycle during the winter season. The UNEP report says it is increasingly difficult for pollinators to obtain sufficient pollen sources for all their essential amino acids.

“Consequently, this can weaken the insects’ immune system, making them more vulnerable to various pathogens. Some researchers have observed that where crops with low-protein pollens such as blueberries and sunflowers are grown, there is a correspondingly increased likelihood of colony collapse disorder.”

Federated Farmers has taken a positive initiative to improve food variety through establishing a ‘Trees for Bees' programme to help give bees a greater opportunity to gather pollen and nectar, providing the vitamins and minerals required to maintain optimum hive strength and a viable pollinated bee force.

Stating that the bee industry contributes at least $4.5 billion a year to the New Zealand economy, the Federation has produced brochures which make suggestions about what can be planted on a farm and along the riparian margins in order to support bee health.

Another factor affecting bee health is transport. Commercial beekeeping involves trucking bees to where they are needed at particular times of the year for pollination. In some countries, where large areas of land are planted in single crops, beekeepers must transport their hives long distances. Scientists say that prolonged confinement and temperature fluctuation is stressful to bees and can bolster bee disease in a colony.

The UNEP report also cites air pollution, climate change, loss of habitat, and electromagnetic fields as threats to bees. Pesticides are also mentioned.

Pesticides and Bees

Pesticides are designed to treat particular pests and diseases on a target plant or organism. Alongside new plant biotechnologies, crop protection helps farmers grow more food on less land by protecting crops from pests and disease and raising yields per hectare. This ensures the availability of a year-round, affordable supply of a wide variety of nutritious, fresh produce.

In an ideal world, all pesticides would land on its intended target, usually plant foliage, unripe produce, or soil, and stay on this target until it breaks down, without impacting other beneficial organisms like bees.

In practice it’s impossible to achieve perfect application but modern methods of applying treatments can be extremely accurate. There is a whole science dedicated to perfecting on-target application through techniques such as varying the droplet size, nozzle design and pump pressure. New types of spray applicators which recapture chemicals which miss the leaf and recycle are also starting to emerge.

If a small quantity of pesticide strays from its intended target, this is called off-target application, and can occur through spraying in unfavourable conditions such as high winds or no wind. It may also occur if, say, an aerial operator sprays the wrong field, or pesticide dust particles which coat seeds are blown onto fields nearby. Due to new technologies such as GPS and polymer-based ‘stickers’ which bind neonicotinoids to seeds, these failures are rare.

Everyone’s goal is to minimise off-target application, and not just to help bees, It’s also important to farmers and growers, neighbours (especially organic growers), and the general public.

There are two main ways of minimising off-target application. The first is through education of users.

All regular users of spray equipment should complete a GROWSAFE training course – which is the leading training provider and which bases its programme on a New Zealand Standard (NZS8409:2004) on the management of agrichemicals. GROWSAFE offers introductory and other courses, including advanced courses for aerial sprayers.

GROWSAFE is the recommended course for sprayers because it encompasses the requirements of the two key laws on spraying, the HSNO Act and HSE Act, and regional air plans overseen by regional authorities. GROWSAFE certification is required by orchardists and growers under the global Good Agricultural Practice (GAP) quality assurance programmes.

Another, albeit lesser, option for users is ‘approved handler’ training, which is a requirement under the HSNO Act when purchasing certain agrichemicals.

Another way of minimising off-target application is effective compliance activity – meaning that reckless use of chemicals should be followed up in the same way that other dangerous activities are policed. Education and compliance would be the carrot and stick to reducing off target application.

Compliance is the responsibility of the Department of Labour and regional authorities, none of which is adequately resourced or motivated to monitor and enforce spray activities in remote places like the back of farms and in hill country.

Spray drift incidents are reported from time to time but it is often very difficult to track the source of spray drift, and thereby prosecute the user who may be at fault. Effective compliance would create more of an incentive for the small minority of ignorant or reckless users to improve their practices.

Agcarm will lobby for greater compliance activity from the government’s review of the HSNO Act expected in the current term of the new government.

Meanwhile Agcarm has, in partnership with the National Beekeepers’ Association, Federated Farmers, and Rural Contractors New Zealand, circulated 30,000 ‘Bee Safe Spray Safe’ stickers in recent months.

Agcarm also provides information on bee-safe spray practice in all GROWSAFE manuals and on its website. It is a founding trustee of the New Zealand Agrichemical Education Trust, which oversees GROWSAFE.

A key part of responsible use is reading the label to look for bee-safety warnings. Some sprays are harmful to bees so they must be used carefully. For example, insecticides should not be sprayed on flowering plants but, if application during flowering is absolutely necessary, spraying must take place after sunset when bees have stopped working.

Another important aspect is the correct use of adjuvants, which help a pesticide work more effectively in some situations. Some adjuvants are harmful to bees so should not be applied to flowers when bees are working.

The over-riding message is that pesticides, especially those which are toxic to bees, such as broad-spectrum insecticides, must be used according to the label and in the right conditions. We can’t save every bee, but good spray practice should not lead to unacceptable bee deaths.

Systemic Pesticides and Bees

Systemic pesticides are coated on a seed, where they are absorbed and remain effective as an insecticide when the plant is in its early growth stage.

One treatment option is a group of products called neonicotinoids, which have been hugely helpful in protecting young crops and improving yields. Despite being hard to say and even harder to spell, neonicotinoids have whipped up media debate over claims that tiny trace quantities may be picked up by bees, weakening colonies and causing premature bee deaths.

Representatives of the National Beekeepers’ Association and the Green Party stood together at Parliament last year launching a petition asking the government to suspend the sale of neonicotinoids, and for regulators to hold a special inquiry, called a ‘reassessment’, into the seed protector.

It's convenient to point the finger of blame for bee maladies at neonicotinoids. But this condemnation ignores the fact that international research doesn't support claims that tiny residues of neonicotinoids cause bee deaths.

Neonicotinoids are similar to the natural insecticide nicotine. They are available as seed treatments and foliar sprays. First introduced to New Zealand in 1992, neonicotinoids are in about two dozen products containing one of four active ingredients (imidacloprid, thiacloprid, thiamethoxam, and clothianidin). Sold by half a dozen companies, neonicotinoids are registered for use on cereals, forage brassicas, pasture, maize and sweetcorn, potatoes, pumpkins, and winter squash.

Systemic pesticides, neonicotinoids are absorbed by the seed and remain effective as an insecticide when the plant is in its early growth stage. But as time passes and the plant grows, the presence of neonicotinoid falls to extremely low levels. Pollen from a mature plant may have traces of neonicotinoid measured in parts per billion, the equivalent of half a teaspoon of water (2.5 millilitres) in an Olympic-sized swimming pool (2.5 million litres). There's no dispute that neonicotinoids are toxic to bees, but not when used correctly and not at levels which are barely detectable.

It's important to know that the majority of neonicotinoids sold in New Zealand are used to treat seeds for crops which are wind pollinated – which means bees are unlikely to be in contact with their pollen. These are cereals, forage brassicas, maize, sweetcorn and pasture, New Zealand's biggest crop.

The USEP report cited laboratory research linking neonicotinoids to loss of sense of direction and memory impairment, and said that use of neonicotinoids with certain fungicides increased the toxicity of the systemic insecticide.

But it also put a caveat on its commentary about neonicotinoids, saying "results obtained in laboratory conditions are hard to compare to field conditions". Crucially, the conclusion in the USEP report did not include recommendations about curbing or banning neonicotinoids.

A very large study by food safety authority in France, one of a handful of European countries which temporarily suspended use of neonicotinoids on some crops, made it clear that a multitude of factors are responsible for persistent bee mortality. The authority expressly stated that there is no statistical correlation between bee deaths and neonicotinoid residues in pollen or applications of plant protection products.

Denouncing seed treatments is a case of barking up the wrong tree, diverting the bee industry from tackling other, more serious threats to bees which are looming large.

Looking Forward

New Zealand beekeepers are right to be concerned about their bees, and they're right to be alarmed about reports overseas that entire hives are mysteriously dying due to the unexplained "colony collapse disorder".

In total the EU budget already dedicated to research related to honeybee and other pollinators amounts to approximately 10 million euros. Current projects deal with the decline of both wild and domesticated pollinators, including honeybee colonies, and its potential causes, as well as the development of appropriate diagnostic tools.

Thankfully there have been no reports of colony collapse disorder in New Zealand.

In most countries, New Zealand included, the varroa mite poses the biggest danger to the survival of bees. Varroa suck the blood of adult honey bees for sustenance, leaving open wounds. The compromised adult bees are more prone to infections which the mites unwittingly spread.

In a position paper, the German Bee Research Institutes outlined that most of the colony collapses which have occurred in recent years were due directly or indirectly to severe varroa mite infestation. And a study group set up by the institutes considers the varroa situation to be extremely critical and sees an urgent need for action.

After campaigning against neonicotinoids for much of 2011, the National Beekeepers Association's adopted the view that it should wait for more research into the various stressors on bees. This is sensible. Given the international attention on bee health, there is little point in lobbying New Zealand lawmakers and regulators to review neonicotinoids when bigger countries have research projects underway and will make better-informed decisions.

In the meantime, urgent attention must focus on finding new ways to combat varroa. At present there are three animal health products available to treat varroa but resistance to the mites, which reproduce on a 10-day cycle and therefore build up resistance quickly, has already been observed near Auckland.

Agcarm has been working with its member companies to bring forward new treatments for varroa. Work on introducing these miticides must begin now before beekeepers are left to struggle with infested bees and no way to treat them.

Though varroa is the most significant influence, bee ill-health is a multi-factorial problem. Pointing the finger of blame and calling for quick fix solutions will not help beekeepers deal with their serious challenges ahead.

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