Plant Health AUSTRALIA

GRDC Grains Research & Development Corporation

Australian Government
Rural Industries Research and Development Corporation

Australian Government
Australian Pesticides and Veterinary Medicines Authority

Neonicotinoids and other insecticides

Research and stewardship symposium

Federal Golf Club, Red Hill, ACT

Wednesday, 9 April 2014

Plant Health Australia

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Plant Health Australia (PHA) is the national coordinator of the government-industry partnership for plant biosecurity in Australia. As a not-for-profit company, PHA services the needs of Members[1] and independently advocates on behalf of the national plant biosecurity system. PHA's efforts help minimise plant pest impacts, enhance Australia's plant health status, assist trade, safeguard the livelihood of producers, support the sustainability and profitability of plant industries and the communities that rely upon them, and preserve environmental health and amenity.

[1] PHA Members include most major agricultural industries, the Australian government and all state and territory governments. Membership of PHA is unlimited and inclusive, and is available to peak plant industries and government. For more information, see **www.planthealthaustralia.com.au/about-us/our-members/**.

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Acronyms

AEA	Australian Environment Agency Pty Ltd
AHBIC	Australian Honey Bee Industry Council
APVMA	Australian Pesticides and Veterinary Medicines Authority
CCD	Colony Collapse Disorder
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEPI	Victorian Department of Environment and Primary Industries
DPI	NSW Department of Primary Industries
DPIPWE	Tasmanian Department of Primary Industries, Parks, Water and Environment
EFSA	European Food Safety Authority
EPPO	European and Mediterranean Plant Protection Organization
GPA	Grain Producers Australia
GRDC	Grains Research and Development Corporation
HAL	Horticulture Australia Limited
HQ	Hazard Quotient
JKI	Julius Kühn Institute, Germany
NRS	National Registration Scheme for Agricultural and Veterinary Chemicals
OECD	Organisation for Economic Co-operation and Development
PEIP	OECD’s Pesticide Effects on Insect Pollinators Working Group
PHA	Plant Health Australia
PIRSA	Primary Industries and Regions South Australia
NWPPA	National Working Party on Pesticide Applications
R&D	Research and Development
RIRDC	Rural Industries Research and Development Corporation
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency

Background to neonicotinoids and the symposium

Neonicotinoid insecticides are systemic chemicals that are absorbed by the plant and transferred through the vascular system, making the plant itself toxic to sap-sucking and chewing insects. These chemicals were first registered for use in the mid 1990's, and since then, have become widely adopted for use as a seed treatment and spray on farm crops in agricultural and horticultural landscapes. Of the six neonicotinoids commonly used on plants, the most widely used is imidacloprid.

With the large scale use of these chemicals in the farming sector globally, concerns are being raised about the possible direct and indirect effects on honey bees and other pollinators such as solitary bees. On the 16th January 2013, the European Food Safety Authority (EFSA) released their long-awaited risk assessment of three neonicotinoids (clothianidin, imidacloprid and thiamethoxam); the European Commission had asked EFSA to assess the risks associated with the use of these compounds, with particular regard to their acute and chronic effects on honey bee colony survival and developments; their effects on honey bee larvae and honey bee behaviour; and the effects of sub-lethal doses of these compounds.

The EFSA concluded that there were some authorised uses of products containing these compounds that only presented a low risk to bees, while other uses presented a significant risk. However, EFSA was unable to finalise its risk assessments 'due to shortcomings in the available data'; the reports identified the data gaps that would need to be filled. A key point of the EFSA scientific opinion was that 'there is a trade-off between plant protection and protection of bees'.

On the 29th April 2013 the European Commission, in the absence of a majority vote by European member states, moved to suspend for two years (from 1 December 2013) the use of neonicotinoid insecticides on flowering crops such as corn, canola, sunflowers and cotton. The suspension would not apply to crops that are not attractive to bees or to winter cereals.

Shortly after this announcement, the United States Environmental Protection Agency (USEPA) and the United States Department of Agriculture (USDA) advised that they were reviewing neonicotinoids; however, taking into account the information to date, the best management practices that had been initiated in the USA, and the benefits that this class of chemicals affords, they determined that a similar set of restrictions in the USA was not warranted at the time.

These varying announcements raised the concerns of a number of Australian stakeholders about the possible effects that this class of chemicals might be having on the Australian honey bee population. In Australia, these chemicals are used on a wide variety of crops, particularly canola which is widely grown throughout Australia and is a popular plant for beekeepers due to the quantity of nectar and pollen produced.

Because of these concerns and the widespread use of these chemicals in agricultural systems in Australia, the Australian Pesticides and Veterinary Medicines Authority (APVMA) announced in August 2012 that it would be conducting a wide ranging overview of neonicotinoids in Australia to see if they present more of a risk to honey bee health than other pesticides that have been in use for many years. The overview report was released in February 2014 (see **www.apvma.gov.au/news_media/chemicals/neonics.php**) and included a consideration of current data requirements for testing of insecticides and the adequacy of current bee warnings on pesticide product labels.

The APVMA convened a workshop for regulatory stakeholders on 24 July 2013 to address issues relating to bee protection statements on labels and the possible expansion of testing requirements for new insecticides being brought onto the Australian market. Workshop attendance was primarily limited to regulatory staff from relevant federal and state government agencies (as partners in the National Registration Scheme for Agricultural and Veterinary Chemicals, or NRS).

In view of the level of interest from a number of people in the regulatory stakeholder workshop, the APVMA recognised the value in holding a national grower and beekeeper symposium. This proposed symposium would involve a wide range of stakeholders at which issues relating to pesticides and pollination, and the possible risks of pesticides on pollinators could be more broadly outlined and discussed. Open forums such as this have recently been held in the USA and European Union. This would also provide the opportunity for the APVMA to present the report of its overview of neonicotinoid insecticides and pollinator health.

A proposal was subsequently put forward for Plant Health Australia (PHA) to facilitate a one-day symposium to discuss these issues and to enable APVMA to present the findings of their overview report into the review of neonicotinoid insecticides and pollinator health in Australia. The symposium would bring together key representatives from agricultural and horticultural industries, governments, research and development agencies and other affiliated organisations to discuss the broad issues of the possible risks of pesticides, including the neonicotinoids, on insect pollinators.

With sponsorship from the APVMA, the Rural Industries Research and Development Corporation (RIRDC) and the Grains Research and Development Corporation (GRDC), PHA agreed to facilitate this opportunity for wide-ranging discussions between different stakeholders.

Aims of the symposium

The symposium was aimed at providing a forum at which a number of issues related to neonicotinoids and honey bees could be discussed. This included the broad issues surrounding honey bees in pollinator landscapes, implementing pollination best-practice management, research and stewardship of neonicotinoids, the regulation of neonicotinoids, as well as overseas experiences. It also provided a platform for the APVMA to release their overview into neonicotinoid use and pollinator health in Australia.

The symposium brought together several key stakeholders, including representatives from industry bodies such as the Australian Honey Bee Industry Council (AHBIC), Grain Producers Australia (GPA), Horticulture Australia Limited (HAL) and numerous other pollinator-reliant agricultural and horticultural plant industries. It also brought together all levels of government and affiliated organisations, with representatives from PHA, RIRDC, GRDC, Commonwealth Departments of Agriculture, the Environment and Health Departments, the APVMA and state governments. An expert from the USEPA provided a video presentation, and international representatives from Bayer and Syngenta attended the symposium and presented current information on international regulatory approaches and honey bee safety testing.

Overall, the symposium assisted in providing key stakeholders with the most up-to-date knowledge and scientific evidence related to neonicotinoid use in pollinator landscapes in Australia and around the world.

Symposium outcomes

The symposium brought together more than 80 representatives from government agencies, the honey bee industry, pollination-reliant crop industries and researchers, to examine information gathered globally on the effects of neonicotinoids on insect pollinators. Factors affecting the honey bee industry and role of pollinators in the agricultural landscape were explored, in addition to best-practice pollination by growers and apiarists providing pollination services, and product stewardship for the use of neonicotinoids in Australia. Global development of methods to examine pesticide impacts on honey bees were outlined and scientific evidence from global investigations into neonicotinoids presented. The symposium also enabled the findings of the APVMA's report into honey bee health and the use of neonicotinoids to be presented, including various recommendations arising from the review.

Presentations are available from **www.planthealthaustralia.com.au/about-us/events/neonicotinoids-and-other-insecticides/**.

Following the presentations, a question-and-answer session took place with an expert panel consisting of representatives from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Bayer, Syngenta, APVMA and CropLife Australia. This provided the audience with the opportunity to ask questions, clarify information presented, air their concerns, and suggest recommendations moving forward.

In summary, the overall message conveyed at the symposium was that neonicotinoids are unlikely to be presenting any greater threat to honey bees and crop pollination than other pesticides which have been in use for many years. Neonicotinoids can adversely impact bee populations if used incorrectly, as can many other pesticides; however these impacts can be minimised with proper use and effective communication between the farmer and the beekeeper. Improved labelling of pesticides would assist this process, including the addition of bee warning statements and more user guidance. Overall, it is likely that the introduction of neonicotinoids has reduced the risks to the environment from the application of insecticides. However, further research in an Australian context would be useful, in particular given the opportunity to study honey bee health in an environment free of the Varroa mite.

While the use of neonicotinoids has caused a number of significant bee poisoning incidents in various countries (particularly from dusts arising during sowing of certain crops such as corn and soybeans), declines in honey bee populations that have been observed in some parts of the world cannot be attributed to the introduction of the neonicotinoid insecticides. Current scientific opinion is that these pollinator declines are likely to be caused by multiple interacting pressures which may include habitat loss and disappearance of floral resources, honeybee nutrition, climate change, bee pests and pathogens, miticides and other chemicals intentionally used in hives, bee husbandry practices, as well as insecticides and other agricultural pesticides e.g. fungicides. To reduce the risks from pesticide use we need to ensure that a range of regulatory, industry stewardship and educational measures are in place.

Symposium attendees

Name	Organisation
Acharee Pheloung	Commonwealth Department of Agriculture
Alastair James	CropLife Australia
Amadou Traore	Commonwealth Department of Health
Ami Ward	Commonwealth Department of the Environment
Andrew Hawkins	NSW Office of Environment and Heritage
Andrew Weidemann	Grain Producers Australia (GPA) [Chair]
Barry Large	GPA
Ben Brown	Almond Board of Australia and RIRDC
Ben Hooper	RIRDC Honey bee and Pollination Advisory Committee
Ben McKee	AHBIC Committee on Food Safety and Prevention of Residues
Bryn Jones	National Council of Pollination Associations
Casey Cooper	NSW Apiarists' Association
Chris Lee-Steere	Australian Environment Agency Pty Ltd (AEA)
Christian Maus	Bayer CropScience
Colin Sharpe	Dow Agrosciences
Craig Scott	Crop Pollination Association Inc
Danny Le Feuvre	Australian Bee Services
Dave Alden	RIRDC and Honey bee and Pollination Advisory Committee
David Gregor	Bayer CropScience
Dean Schrieke	AUSVEG
Don McCaffery	Australian Oilseeds Federation
Donald Ward	Commonwealth Department of Agriculture
Doug Paton	Sumitomo
Doug Sommerville	NSW Department of Primary Industries (DPI)
Felicity Andriunas	PHA
Gavan Cattanach	National Working Party on Pesticide Applications (NWPPA) [Chair]
Gavin Jamieson	Victorian Farmers Federation
Gaye Weller	APVMA
Gerald Martin	RIRDC Honey bee and Pollination Advisory Committee

Name	Organisation
Greg Kauter	Cotton Australia
Hagen Ganahl	Commonwealth Department of the Environment
Helen Thompson	Syngenta
Ian Zadow	AHBIC [Chair]
Jack Holland	Commonwealth Department of the Environment
James Kershaw	RIRDC Honey bee and Pollination Advisory Committee
Janine Glaser	APVMA
Jessica Burrows	PHA
Joan Ashton	APVMA
Jodie Pedrana	HAL
John Kassebaum	Primary Industries and Regions South Australia (PIRSA)
John Roberts	CSIRO
Jon Bell	Department of the Senate, Parliament of Australia
Karl Adamson	APVMA
Ken Gell	AHBIC
Kevin Bodnaruk	GRDC
Kevin Clayton-Greene	AUSVEG
Kevin MacGibbon	Victorian Apiarists Association
Kim Garsia	APVMA
Kimberley Balaga	Department of the Senate
Kyeelee Driver	APVMA
Leigh Nelson	APVMA
Les Davies	APVMA
Linden Moffatt	APVMA
Lindsay Bourke	Tasmanian Beekeepers Association [President]
Lionel Hill	Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE)
Luc Streit	Sumitomo
Margaret Heath	RIRDC and Honey bee and Pollination Advisory Committee
Marianne Peso	RIRDC Honey bee and Pollination Advisory Committee

Name	Organisation
Michael Hornitzky	RIRDC Honey bee and Pollination Advisory Committee
Michael Stedman	PIRSA
Nicholas Woods	PHA
Peter Arkle	Syngenta
Ralph Wilson	Wilgro Orchards
Richard Dickmann	Bayer CropScience
Rod Pavy	AHBIC
Rod Turner	PHA
Rodney Edmundson	BASF
Rohan Rainbow	Crop Protection Australia/GRDC
Róisin Mortimer	Commonwealth Department of Agriculture
Russell Goodman	Department of Environment and Primary Industries (DEPI) Victoria
Sam Malfroy	PHA
Saul Cunningham	CSIRO
Shona Blair	Wheen Bee Foundation
Steven Field	DEPI Victoria
Subbu Putcha	APVMA
Susan Cross	Bayer CropScience
Thomas Steeger	USEPA (provided video presentation and appeared via Skype)
Tim Shue	AUSVEG
Tom Langley	GRDC
Trevor Klein	Syngenta
Trevor Monson	RIRDC Honey bee and Pollination Advisory Committee
Trevor Weatherhead	AHBIC [Executive Director]
Virginie Grégoire	Apple and Pear Australia
Zuzanna Rajczyk	APVMA

Symposium agenda

Item	Time	Topic	Presenter
1	8.20 – 8.30	Welcome and introduction	Chair, Rod Turner, PHA
		Honey bees and pollination	
2	8.30 – 9.00	The honey bee industry in Australia • Overview and structure of the honey bee industry • Issues facing the honey bee industry	Trevor Weatherhead, Executive Director, AHBIC
3	9.00 – 9.30	Pollination of crops and the role of honey bees • The current state of crop pollination in Australia • Bee and crop interactions • The global debate • Other pollinators/invertebrates	Dr Saul Cunningham, Group Leader, Ecology Program, Sustainable Agriculture Flagship, CSIRO
4	9.30 – 9.45	Best practice pollination of canola – a growers perspective	Andrew Weidemann, Chairman, GPA
5	9.45 – 10.15	Best practice pollination – a beekeepers perspective	Mr Ben Hooper, SA Beekeeper and Danny Le Feuvre, Director, Australian Bee Services
6	10.15 – 10.30	Best practice pollination of apples – a growers perspective	Ralph Wilson, Owner, Wilgro Orchards
	10.30 – 11.00	Morning tea	
		Neonicotinoids: a global context	
7	11.00 – 11.45	Bee health in the USA and the debate about neonicotinoids (via video presentation)	Dr Thomas Steeger, Senior Science Advisor, USEPA
8	11.45 – 12.00	Global development of tests to assess the impact of pesticides on bees	Chris Lee-Steere, Director, AEA
	12.00 – 1.00	Lunch	

Item	Time	Topic	Presenter
		Research and stewardship of neonicotinoids	
9	1.00 – 1.30	International regulatory approaches and bee safety testing • Honeybee risk assessments and lab to field extrapolations	Dr Helen Thompson, Principal Technical Expert, Syngenta
10	1.30 – 2.00	International regulatory approaches and bee safety testing • Evidence beyond the regulatory data base and novel exposure pathways	Dr Christian Maus, Global Pollinator Safety Manager, Bayer CropScience
11	2.00 – 2.30	Product stewardship for neonicotinoids and other insecticides • Manufacture of seed treatment products • Professional (mobile) seed treaters using products • Growers treating their own seed on-farm • Growers sowing treated seed	Alastair James, Policy Manager, Agchem Regulation and Stewardship, CropLife Australia
	2.30 – 3.00	Afternoon tea	
		Regulation of chemicals and neonicotinoids	
12	3.00 – 4.00	APVMA bee health and neonicotinoid review • Honeybee health in Australia and overseas • What the neonicotinoids are and how they are used • Their likely risks to insect pollinators in Australia • Their risks in relation to other pesticides • Additional risk management strategies • Next steps for the APVMA	Dr Les Davies, Chief Regulatory Scientist, Pesticides, APVMA
13	4.00 – 5.00	Q&A from the floor with expert panel	Chair, All
	5.00	Summary and close of symposium	Chair

Workshop presentations

The honeybee industry in Australia

(*Trevor Weatherhead, Executive Director, AHBIC*)

The landscape of the honey bee industry in Australia was described, including the history of the introduction of European honey bees, the latest beekeeper statistics, production values, opportunities for the industry and threats. The key points are summarised below.

- The first recorded surviving introduction of honey bees into Australia occurred in 1822 and was the English black bee *Apis mellifera mellifera*.
- Races of bees kept in Australia include the Italian, Caucasian and Carniolan bees. The Italian bee was first introduced in the 1860's and 1870's, and the Caucasian and Carniolan bees were both introduced in the 1880's. Other races that were introduced but did not establish, include the Cyprian, Punic, Spanish, Cartpathian and Russian bees.
- The latest statistics on beekeeper and hive numbers in each state and territory were provided, with Victoria having the greatest number of beekeepers and NSW the greatest number of hives.
- The average annual production of honey in Australia is between 25,000 and 30,000 tonnes. Farm gate prices are currently between $3.70 and $4.00 per kilogram, providing an annual value of honey production between $90 and $100 million (for 25,000 tonnes).
- The majority of beekeepers in Australia make their income from honey, with none relying purely on pollination services alone. However income is also made from the sale of other apiary products such as live bee exports, beeswax and pollen.
- There are several beekeeping associations in Australia, with the peak body, AHBIC, having several members and associate members. There are also many amateur associations within the country.
- Industries reliant on honey bees were described, with the value of honey bee pollination to agricultural and horticultural crops estimated to be between $4 to $6 billion annually. The honey packing industry is an integral part of beekeeping as well as the manufacture of beekeeping equipment.
- Opportunities for the honey bee industry include pollination services, honey export and live bee exports.
- Threats to the industry include pests and diseases, loss of access to public lands, Myrtle rust (a pathogen of Myrtaceae, a major foraging species of honey bees), Asian honey bees, mislabelled products and pesticides.
- In relation to effects of insecticides and fungicides on honey bees, there are many unanswered questions and further research on specific issues relating to chemical use is required. Overall, in crops for which beekeepers provide pollination services, there are good relationships with growers, however there are some rogue operators and adherence to label directions is an area that requires attention.

Pollination of crops and the role of honey bees

(*Dr Saul Cunningham, Group Leader, Ecology Program, Sustainable Agriculture Flagship, CSIRO*)

The importance of insect pollination in agriculture was described, and the story of pollinator decline summarised. Overall, there are growing views that multiple interacting pressures are responsible for pollinator decline.

- Both managed and wild bee systems play important roles in crop pollination. The degree of reliance on pollination depends on the crop and this is called the 'estimated reliance on pollination'. It is reported that 75% of crops obtain some benefit from pollination; however 60% of the volume of traded Australian crop products get no benefit because cereals (wild pollinated) are the largest traded commodity.
- The majority of crops have a medium estimated reliance on pollination. These crops will still produce seed and fruit without pollinators, however most will benefit from pollination in some way. Pollination is rarely managed in these crops, both globally and in Australia, and one of the biggest problems is the uneven grower knowledge regarding the benefits of pollination.
- The biggest users of managed pollination, both in Australia, and globally, are orchards (e.g. almonds, cherries, apples, summerfruit, berries, melons) and seed producers (e.g. vegetables, lucerne). Broadacre crops such as canola, faba bean and cotton also benefit from pollination, however the majority do not use managed honey bees.
- Pollination can occur through managed or wild European honey bees (*Apis mellifera*) or other wild insects, which includes a diverse range of native species about which little is known.
- A recent global review of pollination across 41 crop systems demonstrated that the majority of crops do not use managed bees (*Garibaldi et al. 2013; Science*). Most pollination occurs through wild insects which are strongly associated with improved fruit set. Honey bees were only associated with better fruit set in 14% of the systems surveyed. The best outcome is obtained through the use of both wild insects and managed honey bees.
- Food production trends show that crops that require pollination are the most rapidly expanding worldwide and therefore the global demand for pollination services is increasing. Pollination-dependent crops frequently show under-yielding, supporting the claim that the under supply of pollination limits food production (*Garibaldi et al. 2011; PNAS*).
- A meta-analysis of field studies demonstrated that isolation of cropping areas from diverse natural and semi-natural habitat reduces both the stability and the mean levels of flower-visitor richness, visitation rate and fruit set (*Garibaldi et al. 2011; Ecology Letters*). This occurs because the cropping environment creates challenges for insects as food is only present for a short season, there is a limited range of pollen and nectar sources, the habitat does not provide the right

resources for nesting, and some agricultural inputs (e.g. insecticides) can be harmful.

- There are several documented cases of population and diversity decline in wild bee species, especially in the US and Europe. There have also been studies that show a decline in the number of managed honey bee hives in some countries. There are many reasons for this; however it has been difficult to show clear trends. For wild bees, habitat loss and land use change are two of the biggest issues, whereas for managed honey bees, pests/diseases (e.g. Varroa) and insecticides are the biggest threats. Other threats include social and economic change, land use change, habitat loss and climate change.
- The decline in managed honey bees is not universal, with some countries showing an increase in the number of managed hives. The reasons for differing trends include that humans manage honey bee populations within economic constraints. For example, the decline in managed hives in some countries is due to people moving out of honey production.
- There has been strong community interest in honey bees worldwide and concern regarding their decline. There are many complex drivers for this, and although the spotlight is currently on neonicotinoids, there was community concern before neonicotinoids came into play. The question many are asking is whether systemic insecticides lead to chronic effects from sub-lethal exposure.
- Overall, there is no single, global reason for decline in honey bees, with many factors involved, including human, economic and environmental. In an agricultural context, pollen and nectar sources, the landscape context and insecticides all contribute to compromised immunity. In a hive context, pests/diseases, and poor hive management practices lead to compromised immunity. In turn, compromised immunity leads to a decline in honey bee populations.

Following the presentation, a question was asked as to whether the data showing variation in yield and pollination dependency took into account biannual variation in crops. The answer indicated that this was taken into account, and all we can currently say is that there is an association between yield variation and pollination.

Best practice pollination of canola – a grower's perspective

(*Andrew Weidemann, Chairman, GPA*)

The role of honey bees in pollination of canola and faba beans was described, as well as the benefits and limitations on bringing in honey bees to provide pollination services in these crops, and issues that need resolving. Key points are summarised below.

- In general, honey bees are not on the radar of grain farmers. However, the industry recognises their importance in pollination of canola and faba bean and the final yields obtained. A bee-tagging project will assist the understanding of honey bee behaviour and help the industry to maximise the benefit received from pollination services (**www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-109-Mar-Apr-2014/Tagged-bees-in-crop-pollination-study**). More studies like these are required to demonstrate the benefits of pollinators to broadacre farming.

- In canola it is difficult to demonstrate the increase in yield, however, in bean crops, yield increases of up to 20% have been observed. There is limited impact on yield for most other grain crops.
- Farmers typically have limited access to beekeepers and rely on wild bee populations for pollination. Where honey bees are used for pollination services, the importance of communication between growers and apiarists was stressed, to prevent any impact of pesticides on bees. This applies also to neighbours, who should be informed when honey bees are present on neighbouring properties.
- For canola, insecticides are often used late in the season for aphids and heliothis, as these reduce yield and price per tonnage considerably if left untreated. Producers are driven by profitability and therefore their decision to spray may not take into account the presence of bees in the paddock.
- Human factors such as allergies to honey bees also weigh into the decision on whether to bring honey bees in for pollination services.
- Issues that need to be resolved include the need for further research into the value of bees in broadacre cropping systems, the importance of communication at a local level for coexistence between apiarists and growers, and further research into insect management systems for modern farming practices.

Following the presentation it was asked whether preventative measures against heliothis can be used in beans. The answer provided was there aren't currently any preventative products available. It was added that there is a need to ensure product labels are correct so that other industries are protected and the grains industry are keen to push the issue of correct use of insecticides with growers.

Best practice pollination – a beekeeper's perspective

(*Mr Ben Hooper, SA Beekeeper and Danny Le Feuvre, Director, Australian Bee Services*)

The structure and working function of a beehive was described, together with an example of a year in the life of a hive used for crop pollination in South Australia.

- The basic structure of a bee hive was described and the reasons it is structured the way it is – for functionality, storage of honey and enabling transport of hives to areas with floral resources. The queen is vital to maintaining high numbers of honey bees in hives and in order to have successful hives, it is important to regulate the genetics of queens through queen breeding. Honey bee numbers in hives fluctuate depending on the season, with numbers ranging from 20,000 in winter to over 60,000 in spring and summer.

- Nutrient demand is primarily driven by the presence of brood pheromone and an inventory of available store in the hive. Forager bees collect nectar for carbohydrates and pollen for protein and both processes result in plant pollination. Distinct groups of significant nutrient consumers in the hive include the queen, nurses, foragers and drones. Therefore the more bees there are, the more demand for nutrients and hence the more pollination occurs. Healthy colonies can collect between 50 and 100 kg of pollen and up to 800 kg of nectar annually per hive. Crude protein levels in pollen vary from plant to plant and the amount of nectar collected depends on the moisture content.
- In describing a year in the life of a hive used for pollination, the example used begins its journey in August when the hive is moved to almond orchards for paid pollination. Here, it is exposed to various chemicals used to control almond pests and diseases, including copper hydroxide, fluvalinate and pirimicarb. Between August and September the hive is moved to bean crops and is again exposed to various chemicals. It then moves to apple and cherry orchards in the Adelaide Hills in September where an important issue is the use of hail netting; this can negatively impact bees as they cannot easily escape exposure if/when pesticides are being applied. In November the hive is moved to pollinate dryland lucerne and then in January to irrigated lucerne. In both cases bees are exposed to residues of chemicals such as fipronil, copper, manganese and synthetic pyrethroids. In March the hive returns home.
- A variety of other crops are also pollinated by managed hives, with the demand varying by crop and time of year. Some of the crops with the greatest demand include sunflower (March, April), canola (August, September), macadamia and almond (August), mango (September), cotton (September, October) and soybean (December, January).
- The overall message presented was that individual hives used for pollination are exposed to multiple chemical events over a year, and the interactions between these chemicals and bees are complex. There is a need to further understand if and how chemicals are stored in the hive and the chemical use patterns and interactions of residual chemicals in the hive.

Following the presentation, a question was asked about whether honey is left in the hives while they are overwintering. The answer was that it depends on the season and how the hives are going. They try to leave as much honey as possible on the hives over winter, or they don't have strong enough bees to undertake almond pollination early in spring. There is often a fine line between earning money from the honey produced and leaving the honey on the hive over winter to obtain a greater number of strong hives for paid almond pollination.

Best practice pollination of apples – a grower's perspective

(*Ralph Wilson, Owner, Wilgro Orchards*)

Pollination of apples in a Batlow orchard was described, including the advantages of the use of managed hives. Typical spray regimes used in the orchard were also described.

- The majority of apple varieties are not self-fertile and therefore pollination is vital. Successful pollination contributes to the size and quality of the apple and is therefore critical in achieving a saleable and profitable crop. This can be shown through a trial in which 33 foraging bees per 1000 flowers lead to 32% set and 57 kg of apples, compared to 15 foraging bees per 1000 flowers leading to 15% set and 30 kg of apples.
- In order to enhance pollination in their orchard, trees are planted closely (2,800 trees/ha). There is also good spread of cross pollinator trees which include Crab apples and Granny Smith varieties. Other pollen sources are also planted that flower at the same time and have the same coloured flower, as the bees prefer this. Cross pollinators are planted in the row as bees prefer to work up and down rows.
- There is economic value in placing bee hives in their orchards even though they do get native pollinators. Wilgro Orchards is currently using 2 – 3 hives per hectare depending on tree age. Hives are placed in the orchard at about 10% flower and are positioned in sunny, wind protected areas. Apple growers prefer active, preconditioned hives with well-fed bees. This leads to more pollen-rather than nectar gatherers, because, in apples, the flowers are large and gathering nectar results in little pollination.
- Spraying in the orchard is a necessity, with fungicides used over the flowering period. Wilgro Orchards rarely uses insecticides (once every 5 years) as many pests are controlled naturally with predators or pheromones. If they are used, it is not at flowering time and spraying is targeted. The use of fungicides is kept to a minimum and is weather dependent. The orchard is very conscious of the presence of bees, with spraying occurring very early in the morning or late at night, with equipment that ensures low drift and without surfactants added.

Bee health in the USA and the debate about neonicotinoids (via video presentation)

(*Dr Thomas Steeger, Senior Science Advisor, USEPA*)

Via video presentation, Thomas Steeger outlined bee health in the USA, including pollinator decline and reasons for this. Neonicotinoid insecticides were described and the risks they presented to the environment and honey bees as well as incident reports, USEPA registration reviews, and actions being taken in the USA to reduce risks from exposure to seed-treatment dusts.

- Multiple federal reports in the USA have identified a decline in pollinators, concluding that a number of factors are responsible. In addition, demand for managed pollinators over the past decade has increased and this has been observed across multiple crops requiring pollination services.

- National Agricultural Statistics Survey data show a decline in managed honey bee colonies; however this data needs to be interpreted carefully because of a number of factors such as changing demographics, different survey methodologies as well as issues such as Varroa and Colony Collapse Disorder (CCD). Over the past 15 years, colony numbers have stabilised in the USA. Reports of pollinator decline have been documented in areas other than the USA, for example, in Europe; however the number of beekeepers has also declined in Europe over the past 20 years.
- Opinions regarding the causes of managed pollinator declines differ, with the media reporting CCD as the predominant cause and beekeepers believing mites are the predominant cause. However the reality appears to be that CCD is multi-factorial, with pests and diseases, bee management and agricultural practices, urbanisation, poor nutrition and pesticides all playing a role.
- Varroa mite is an important factor in colony decline, since when left untreated, it can reduce adult longevity by 50%. Furthermore, the Varroa mite is a vector for multiple viruses including deformed wing virus, black queen cell virus, Israeli acute paralysis virus and chronic paralysis virus. A fungal disease, Nosema (*Nosema ceranae, N. apis*) is also increasing and contributing to reduced longevity of adult bees.
- Neonicotinoids are a class of chemicals modelled on nicotine, and act as agonists on nicotinic acetylcholine receptors. There are two subclasses, including cyano-substituted (thiacloprid, acetamiprid) and nitroguanidine-substituted (imidacloprid, thiamethoxam, clothianidin, dinotefuran) neonicotinoids. The cyano-substituted neonicotinoids are not as toxic to bees as the nitroguanidine-substituted compounds.
- The majority of research and public interest has focussed on the nitroguanidine-substituted chemicals and these are among the top ten compounds applied to agricultural acreages. Use of these chemicals as seed treatments dominate the market and have increased in use over the past ten years. Several of them form toxic degradation products and are persistent in soil and mobile in the environment. In some cases they may pose a risk to mammals and birds; in general, they do not pose a risk to fish or plants.
- Data on the effects of neonicotinoids on honey bees include field data submitted by registrants (residue studies on a variety of crops and semi-field and field studies) and scientific literature studies in which sub-lethal effects have been investigated (e.g. behavioural, olfactory, immunosuppression, queen performance and nutrition).
- Although some beekeepers believe strongly that neonicotinoids are associated with bee kills and reduced overwintering success, there have been relatively few incident reports in the USA. However this may be due to beekeeper reluctance or limited state resources, and furthermore the absence of incident reports cannot

be construed as the absence of incidents. Compared to other insecticides, the number of incident reports for neonicotinoids is low; however, other insecticides have been around for longer. In Canada, most incidents have been associated with sowing of treated seed (primarily clothianidin) and over 95% occurred in southern Ontario.

- Registration reviews for neonicotinoids are underway with imidacloprid due for completion in 2016-2017, and thiamethoxam, clothianidin and dinotefuran due in 2017-2018. In-house data includes acute studies and field studies. Data on pollinators required from industry includes residues in pollen and nectar, larval toxicity tests, chronic toxicity tests and pollinator field studies.
- The federal advisory committee is exploring and developing mitigation and management options that go beyond the label. Pollinator protection language has been applied to neonicotinoids and labels will continue to retain more restrictive language.
- Actions are being taken to reduce potential exposure via dust drift. This includes ensuring appropriate sticking agents are used to reduce abraded seed coat dust and working with equipment manufacturers, registrants and seed treaters to develop standards aimed at reducing dust. In addition, this route of exposure has been identified in the registration review and will be further characterised during this process.
- Overall, there are multiple factors associated with declines in pollinator health, and while pesticides are a factor, they are not the single cause. Residues of neonicotinoids have been associated with some bee kill incidents. However, in general, these incidents have been regionally specific and have resulted in knock-back of colony strength. The USEPA is collaborating with other regulatory authorities to evaluate the potential risks from neonicotinoids. They are also collaborating with a broad range of stakeholders to develop and implement tools to help reduce the exposure of bees to pesticides. This includes alternative forage areas, equipment modification, fluency agents, increased communication/ education and improved label language.

Due to a technical error with the Skype connection, the audience was invited to send questions/comments to Thomas Steeger via email. In relation to the restriction of colony losses in Canada to southern Ontario, a member of the audience (who is from Southern Ontario) provided some information which might help explain this. Southern Ontario has a microclimate heavily influenced by the proximity of the Great Lakes. As a result, the warmer humid environment means that southern Ontario is the only place in Canada where a lot of the fruit trees that are reliant on bee pollination are grown, thus restricting impacts to this region. [**Editor’s Note**: Canadian data (from 2011; **www.statcan.gc.ca/pub/96-325-x/2014001/article/11913-eng.htm**) indicates that approximately 92% of Canada’s corn crop was grown in Eastern Canada (southern Ontario - 62%; southern Quebec - 30%. Corn is Canada's third largest grain crop after wheat and barley and is the most important one in eastern Canada. Data from 2011 indicate that 83% of Canada's soybean crop was grown in southern Ontario and Quebec. These two crops are commonly sown using vacuum seeders which have the potential to generate neonictoinoid-containing dusts arising from abrasion of the seed coating. By contrast, canola crops, which are mostly grown in the western provinces of Alberta, Saskatchewan and Manitoba (where problems with neonicotinoids and bees have not been reported), are sown by low pressure air seeders which do not generate seed-coating dusts during sowing operations.]

Global development of tests to assess the impact of pesticides on bees

(*Chris Lee-Steere, Director, Australian Environmental Agency*)

This presentation focussed on the activities occurring in the Organisation for Economic Co-operation and Development (OECD) Pesticide Effects on Insect Pollinators (PEIP) group. A number of guidelines for risk assessment are being developed or reviewed, with the use of US and European guidelines to inform the process.

- The OECD PEIP group of experts was established in 2010 within the OECD Pesticides Programme. They have been working in four areas, with Theme 2 – Testing requirements and risk assessment being summarised in this presentation. Activities occurring under Theme 2 are prioritised based on an analysis of needs and feasibility, with a number of honey bee-related activities currently underway.
- For tests that assess effects of pesticides/chemicals on honey bees, there are OECD test guidelines already available. These include OECD Test Guideline 213 (Honey bees, acute oral toxicity tests for adults), OECD Test Guideline 214 (Honey bees, acute contact toxicity test for adults) and OECD Test Guideline 237 (Honey bee larval toxicity test, single exposure). Proposed activities for toxicity testing that are high need and high feasibility include Activity 3 – 10 day laboratory toxicity test on adult honey bees and Activity 8 – Honey bee tunnel test under semi-field conditions (revision of OECD Guidance Document No. 75).
- High need and high feasibility activities for tests that assess exposure of honey bees to pesticides/chemicals include Activity 12 – Estimation of level of residues in pollen and nectar by calculation based on the application rate. One aim here is to develop more consistent methodology and this should be available in 2014.
- High need and high feasibility activities for risk assessment methods assessing the risk to honey bees from pesticides/chemicals include Activities 17, 18 and 20.
    - Activity 17 relates to risk assessment schemes for adult and larval honey bees, bumble bees and solitary bees for sprayed products, soil and seed treatments. However development of a risk assessment scheme for this is not a priority as risk assessment schemes have been made available by the USEPA and EFSA (and are under consideration for use in Australia).
    - Activity 18 relates to risks from exposure to dusts. The European Commission is developing guidance on dusts and the Julius Kühn Institute

(JKI) Germany is developing a paper that will review methodologies for measuring exposure and effects from dusts. These will be used by the OECD PEIP group to develop guidelines.
  - Activity 20 will address uncertainties in risk assessment.
- High need and medium feasibility activities that assess effects of pesticides/chemicals on honey bees include Activities 5b, 6, 9, 10, 11 and 14.
  - Activity 5b is the Honey bee larval toxicity test – repeated exposure. Current guidelines for acute and repeated exposure do not address the period from pupation up to emergence and therefore the repeat exposure test currently under development will address this.
  - Activity 6 relates to semi-field tests on larval development of honey bee microcolonies. This will address the entire life cycle, however will not address all potential effects on honey bees. A draft will be available in October and when completed, a repeat exposure test will no longer be necessary.
  - Activity 9 is the honey bee field toxicity test and is covered by the European and Mediterranean Plant Protection Organization (EPPO) 170 guideline. This will be adapted through capturing effects on pollination in the field through, for example, observations on behaviour, pollen characterisation and honey production. A protocol may be available in October.
  - Activities 10 and 11 relate to estimation of residues in pollen and nectar resulting from sprayed treatment and soil/seed treatment respectively. Exposure estimates for pollen and nectar will be refined on the basis of an expanded database and used as default values in the risk Quotient calculation. The review should be available in 2014.
  - Activity 14 relates to evaluation of residues in pollen and nectar resulting from sprayed treatment, soil or seed treatment. Exposure levels may need to be measured for a specific product and there are currently no guidelines. Discussions are still needed on how to best generate residue data and the related guidelines.
- Testing methods for non-*Apis* bee species are addressed under Activities 22, 23 and 32.
  - Activity 22 relates to laboratory tests on solitary adult bees and is considered high feasibility.
  - Activity 23 will develop a laboratory acute toxicity test on adults of social non-*Apis* bee species and is considered medium feasibility. Discussions are required on whether the priority should be given to a species with a life cycle different to that of the honey bee or to a *Bombus* (bumble bee) species for which testing protocols are more advanced.
  - Activity 32 relates to safety factors and is of medium feasibility. It aims to understand the sensitivity of the honey bee relative to other species and develop extrapolation factors to reflect observed differences.

Following the presentation, a question was asked about whether the testing will be for the original pesticide product or the metabolites. The response was that they usually test for the active constituent, however higher-tier (laboratory) studies cover the metabolite.

International regulatory approaches and bee safety testing - honeybee risk assessments and laboratory to field extrapolations

(*Dr Helen Thompson, Principal Technical Expert, Syngenta*)

The tiered risk assessment process for chemicals, from the laboratory to the field was explained, including effects, exposure and use in risk assessment. Laboratory to field extrapolation of findings was described as well as multi-year field studies.

- Tier I studies occur in the laboratory under controlled conditions. They use modelled exposure values and generate acute and chronic toxicity data for adults and larvae. Tier II studies are semi-field and measure residues in nectar and pollen. These semi-field (tunnel) effects studies occur on small hives and use surrogate crops. Tier III are field studies and use multiple hives and target crops. These studies incorporate environmental realism as bees are studied under 'real' conditions, for example, Varroa.
- Tier I (laboratory) studies have been conducted for over 20 years in Europe, with acute contact and oral toxicity data for honey bees required for both active ingredients and formulations. For sprays, if the hazard quotient (HQ) is above 50 then studies progress to semi-field and field. For systemics, a comparison of toxicity (adult and larval LC50) is conducted with exposure based on residues in nectar with trigger values. If concerns are raised, more detailed studies are undertaken at a higher tier and with more realistic exposure.
- For adult honey bees, standard laboratory studies utilise OECD guidelines 213 and 214 for acute contact and oral toxicity. A 10 day chronic study is also undertaken and there are currently no guidelines for this. Acute larval testing occurs under OECD guideline 237. The guideline for chronic/repeated exposure is under development. Systemic pesticide residues in nectar are estimated by the residue per unit dose approach (EFSA).
- In the UK, risk assessments are validated through the UK bee incident scheme. Data shows that early on (1981 – 1991) there were many pesticide incidents reported. Improved education and labelling has since reduced the number of reported incidents.
- Sub-lethal effects measured in the laboratory include measurement of hypopharyngeal gland development, proboscis extension reflex, locomotor activity, food consumption, longevity, immunity, visual and morphological/histochemical parameters. The question was raised as to why these effects are measured in the laboratory when it is known that field studies are a lot more realistic. Laboratory sub-lethal effects data is very sensitive

compared to in the field, e.g. colony level effects are observed for imidacloprid at above individual LD 50. There were no observable adverse effects at the colony level for controlled chronic exposure to 10 times the 90 percentile of the field residue level (systemic exposure via pollen and nectar).

- Most sub-lethal studies for residues in nectar from systemic seed treatment are conducted at unrealistic exposure levels and show no effects at the field nectar maximum. The field nectar maximum residue is the worst case scenario. Hence, laboratory studies provide information on the potential mode of action rather than the real risk.
- In tier-II semi-field studies, the honey bee colony is confined to the treated crop. Replicated treated and control tunnels are used, and both adults and brood are assessed (OECD 75). Foraging activity and mortality are assessed. There is a limited confinement period and a toxic reference and control are used.
- In tier-III field studies, isolated plots are utilised, with 4-6 colonies per plot, and both control and treated plots. Assessment occurs from pre-application through a minimum 10 day post application period (including throughout the flowering period). Overwintering success is examined in addition to mortality, bee foraging behaviour and colony assessment. Assessment is based on experience and expert judgement. Field studies are conducted on multiple crops.
- An example of a tier-III field study is examination of effects of clothianidin seed treatment in canola in Canada in 2012. Honey bees were exposed to up to 1.9 ppb clothianidin in pollen, with results showing no effect on any parameter including colony development, adult mortality, colony weight, honey yield and overwintering survival. A multi-year field study of thiamethoxam-treated canola and corn seed examined effects on bee mortality, flight intensity, parasites and disease, behaviour, brood, colony weight and strength. Overall, residues of thiamethoxam in nectar and pollen were low, and no differences in colony development, adult mortality, flight intensity, behaviour or colony health were observed between treated and control colonies foraging on canola or corn. Similar multi-year studies have been conducted for clothiandin and imidacloprid.
- In conclusion, laboratory studies provide hazard data and an indication of potential risk, whereas laboratory sub-lethal studies provide information on modes of action. Well conducted higher-tiered studies can be useful in determining, under actual use conditions and typical foraging activity of bees, whether a compound represents a significant risk to bees. Field studies provide real-world exposure scenarios and allow “bees to be bees”.

A question was asked following the presentation about the understanding of how neonicotinoids act on honey bees, in terms of causing their death or effects on memory/behaviour. The answer was provided that it depends on the pattern and level of exposure. For example, if neonicotinoids are sprayed directly onto bees, then this obviously leads to death. Behavioural effects are measured through impacts on colony strength. If honey bees are exposed in one single hit, to the amount of neonicotinoid applied across a full day, effects on behaviour are observed, such as difficulty locating their hive. However, it should be noted that this was not a realistic exposure scenario.

It was also asked how the combined effects of two systemics are measured. The answered provided was that there has been a lot of work conducted on systemics, for example, some of the field studies conducted used seeds treated with two systemics, and effects were additive.

Another question asked was whether the 4-year studies looked at residues in hive wax, with the answer provided that neonicotinoids are hydrophilic so they won't enter or accumulate in wax. They are only found in wax when there is contamination with pollen.

International regulatory approaches and bee safety testing – evidence beyond the regulatory data base and novel exposure pathways

(*Dr Christian Maus, Global Pollinator Safety Manager, Bayer CropScience*)

Issues with both spray and systemic applications of neonicotinoids were described, and measures that can be taken to prevent these. Investigations into guttation fluid and insecticide residues as a pathway of exposure were also explained, along with several examples of field monitoring studies undertaken in Europe. Overall there have been thorough investigations of neonicotinoids and effects on honey bee health over 20 years, with no demonstration of adverse effects under realistic exposure scenarios in the field.

- Issues with spray application of neonicotinoids are easily addressed through risk mitigation measures, for example, not applying during flowering, using safety intervals before flowering and buffer zones.
- Systemic applications (e.g. seed treatment, granular applications, drenching) are more complex. Although these treatments overall minimise the exposure of bees to neonicotinoids, there are exceptions, for example, systemic residues contained in nectar and pollen, dust from the seed coating released during sowing and potentially guttation.
- Exposure to seed dust occurs when seeds are treated poorly. Certain coating techniques lead to a low abrasion resistance, which has been found to be a key driver of dust dispersion during sowing. In particular, bees can be exposed when dust is deposited on flowering forage plants and when small fields are located in a patchwork array together with other crops flowering during sowing season. When the use of poorly treated seeds is combined with the use of poor sowing machinery (in particular vacuum-pneumatic planters), honey bees can be severely impacted. As a result, approaches to minimise dust emission have been developed and tested.
- The first key factor in minimising dust exposure is the use of polymer stickers in the recipe to minimise abrasion, along with thorough cleaning of the seeds prior to treatment. The second key factor is the use of appropriate deflector technology

on vacuum-pneumatic drilling machines, which directs the outlet air to the ground. This reduces dust emission and thereby off-crop ground-deposition of dust by more than 90%. The use of both high quality seed coating and machinery modification has been verified to minimise dust emission and thus adverse effects to honey bee colonies through a large scale field study.

- Guttation is the active extraction of liquid water by some vascular plants in the form of droplets on the tips of leaves or leaf edges. It occurs especially in maize in which the guttation fluid can also contain high concentrations of neonicotinoid residues, especially in young seedlings. Studies into guttation fluid have shown it is not a regular pathway for exposure of honey bees to systemic neonicotinoids. Guttation fluid is not a regular source of water for honey bees, except in certain exceptional cases, and even in these cases there has been no significant effect observed on honey bee health. Although under certain circumstances, individual bees may be intoxicated by guttation droplets, damage to bee colonies has not been observed. It has therefore been concluded that guttation of neonicotinoid seed-treated crops does not constitute a risk to honey bee colonies.
- In terms of monitoring of honey bees, field studies provide the best data source. This type of data is suitable for the detection of correlations between different factors and can therefore be a powerful tool to support causal analysis. Another strength of field studies is that these monitoring approaches reflect what happens under realistic conditions in the field. A number of bee-health monitoring projects have been conducted or are ongoing in many European countries.
- An example of a monitoring study is a large-scale multi-stakeholder, multifactorial bee monitoring project being undertaken in Germany (and ongoing) since 2004. It aims to analyse parameters affecting bee health and investigate factors contributing to honey bee colony losses. No correlation has been identified between colony mortality and pesticide residues in hives, or between colony mortality and exposure to neonicotinoid-treated crops. A similar monitoring project in France showed no correlation between in-hive residues of pesticides and bee colony mortality. A Belgium study monitoring the effects of imidacloprid seed-treated maize on exposed bee colonies showed no adverse effects related to seed treatment.
- Investigations into sub-lethal effects have also shown no adverse effects at the colony level in realistic exposure scenarios.
- Incident report monitoring (in UK, Germany and Netherlands) shows pesticide-related bee incidents have been continuously decreasing over the past few decades, with most countries recording no, or very few neonicotinoid-related incidents. Exceptions include incidents related to inappropriate seed treatment quality.

Following the presentation a question was asked regarding whether neonicotinoids act like nerve toxins on honey bees and also whether any impact on mammals has been assessed. The answer provided was that they act on the neural system of insects, which is common for insecticides. They have been tested on mammals with no effects shown. Furthermore, no substances are allowed registration if they impact on mammals. The fact there is no impact on mammals is an advantage of this class of insecticides, as they are specific to insect receptors.

Product stewardship for neonicotinoids and other insecticides

(*Alastair James, Policy Manager, Agchem Regulation and Stewardship, CropLife Australia*)

Background was provided on CropLife Australia and its role in crop protection and industry stewardship. Modern seed treatments were described and the stewardship program being undertaken by CropLife, including the development of several best practice guides.

- CropLife is the peak industry organisation for Australia's plant science sector and represent 19 member companies, including innovators, developers, manufacturers and registrants of crop protection and agricultural biotechnology products. The importance of crop protection products to food security was emphasised.
- CropLife is committed to industry stewardship and members adopt and promote ethical and responsible practices from product discovery and development through to its use and disposal. Members spend more than $13 million per year on stewardship activities that ensure the safe use of products on the environment and human health. Examples of successful industry programs include Agsafe Accreditation and Training, *drum*MUSTER and ChemClear. To oversee the Industry Waste Reduction Scheme, CropLife has established AgStewardship Australia in partnership with the National Farmers Federation, the Australian Local Government Association, the Veterinary Manufacturers and Distributors Association and the Animal Health Alliance (Australia).
- Multiple stressors affect bee health, including poor bee nutrition, bacteria, viruses and parasites, genetic weakness, poor beekeeping practices, pesticides and weather.
- Modern seed treatments consist of a layer of fungicide, insecticide, a coating layer, colourant and a finishing layer. They are advantageous as they reduce the use of pesticides, thereby reducing the potential chance of exposure to bees. In addition, the area treated is significantly reduced relative to whole area sprays or in-furrow treatments and there is less impact on non-target organisms. The disadvantage is the potential for neonicotinoid dusts to be generated and for honey bees to be exposed to this.
- CropLife is undertaking a stewardship program that includes the development of several stewardship guides that cover seed treatment product manufacture, application of seed treatment products and sowing insecticide treated seed.

- The Seed Treatment Product Manufacture Stewardship Guide includes information regarding general safety requirements, formulation, labelling and transport.
  - The Application of Seed Treatment Product Stewardship Guide covers general safety, application, environment, safe use, training, labelling, storage and transport.
  - The Planting Treated Seed Stewardship Guide covers general safety, transport, environment, safety, seeding, equipment washing and waste disposal.
  - The Best Management Practice Guide for Planting Insecticide Treated Seed includes information about pollinator protection and responsible use of treated seed, knowing where bee hives are located, weather conditions and the influence on pollinator exposure, avoiding generating dust when handling treated seed, ensuring seed sowing equipment best practice, proper clean up and disposal, exercising pollinator friendly practices throughout the growing season and reporting suspected pollinator pesticide poisonings.
- Next steps for CropLife include further consultation with industry groups involved in seed treatment production and use, finalising stewardship guides which will be available at the end of financial year through member bodies and research and development corporations, expanding stewardship to pollinators in general, application timing, spray drift communication and spray drift control.

Following the presentation, it was asked whether the draft stewardship guides would be released for public comment. The answer provided was that they wouldn't be released for public comment, however, broader stakeholder engagement would take place prior to publication.

The comment was made that the design of seed sowing machinery in Europe is very different to that used in Australia. The typical planters used here have a low risk of dust emission during sowing and therefore bee kills as a result of this should be a rare event in Australia. It is important to recognise those differences between Australian and European machinery. CropLife will be targeting areas that use poor seed sowing machinery when launching the stewardship guides.

Another comment was made that it is important to ensure there is adequate information in the stewardship guides relating to the chemical risks to honey bees.

APVMA bee health and neonicotinoid review

(*Dr Les Davies, Chief Regulatory Scientist, Pesticides, APVMA*)

The APVMA's overview report into neonicotinoid use and pollinator health in Australia was outlined, including recommendations and research suggestions arising from the review. Honey bee health in Australia and overseas was explored as well as some of the advantages and disadvantages of neonicotinoid insecticides, exposure pathways for pollinators, reasons for the focus on this class of insecticides, the risks in relation to other pesticides, the multitude of threats to honey bees and the next steps for the APVMA.

- The APVMA's overview report was published in February 2014 and is available from their website (**www.apvma.gov.au/news_media/chemicals/bee_and_neonicotinoids.php**). Some of the key recommendations included:
    - Managing the release of neonicotinoid seed-treatment dusts at sowing – CropLife Australia could consider working together with relevant member companies to develop a best management practice guide.
    - Surveillance and bee poisoning incidents - AHBIC and its member associations could consider the feasibility of trialling an annual survey of apiarists on the health of their hives.
    - Residue monitoring for pesticide residues in bee media – It is suggested a research project be established and funded to analyse pesticide residues in in various plant (nectar, pollen, guttation fluid) and bee (collected pollen, comb and foundation wax, bee bread, honey) media.
    - Residue monitoring in honey – A separate recommendation to the preceding one was that the National Residue Survey extend the range of residues measured in honey to include neonicotinoids. However such monitoring has already commenced, with the 2012-13 sampling program testing 23 random samples of honey for acetamiprid (and N-demethyl metabolite), imidacloprid (and 5-hydroxy and olefin metabolites), thiacloprid and clothianidin (thiamethoxam not assayed as its primary active metabolite is clothianidin), with none of these residues being detected.
    - National symposium – Relevant agencies should consider holding a one-day symposium for a wide range of stakeholders to hear about issues relating to bee health from Australian and international experts. [This symposium on 9th April 2014 arose as a result of this recommendation]
- Research suggestions included:
    - Canola – Assess if there are differences in the output and quality of nectar and pollen from the current range of commercially-grown varieties/cultivars.
    - Neonicotinoid persistence in the environment – Due to their long half-lives, more information is required on their potential to accumulate in the soil and in plants grown in fields that are used to grow crops treated with neonicotinoids (as a seed or soil treatment) in previous seasons.
    - Honey bee research in an environment free of Varroa – As Australia is free from Varroa, it would be an ideal location to study the health of honey bee colonies without the confounding effects of Varroa and the chemicals used to treat it.

- It appears that globally, there is not a decline in honey bee stocks with the trend continuing upward. However bee hive number variations differ between countries. Data provided in the report supports this and shows no evidence of bee decline as a result of the introduction and increased use of neonicotinoids (report downloadable from **www.perc.org/articles/colony-collapse-disorder-market-response-bee-disease**).
- Neonicotinoids act as neurotoxins on nicotinic receptors in insects. These nicotinic receptors are very different in insects and humans and therefore neonicotinoids have quite low toxicity to humans. In contrast, organophosphorus insecticides ('organophosphates') inhibit both insect and human acetylcholinesterase in the nerve synapse and therefore are poisonous to humans. Other benefits of neonicotinoids include that they can be applied as a seed coating treatment and this has resulted in a significant reduction in the overall volume of chemicals applied in the environment (as there is less need for regular chemical sprays). Disadvantages of neonicotinoids include that selection pressure on pests from ongoing exposure to systemic insecticides may lead to the development of resistance. In addition, their effectiveness as a seed treatment requires a reasonable level of soil and plant stability. The greater their persistence in the soil, the greater the environmental concerns compared to other less persistent and less mobile insecticides.
- Pollinators may be exposed to neonicotinoids through contact with dusts arising during sowing of coated seeds, via intake of systemic residues in nectar, pollen and guttation fluid (arising from seed or spray/granule application to soil) or from contact with foliar sprays applied to the flowering plant (e.g. canola).
- Honey bee colony poisonings by dusts generated during sowing of treated seeds have resulted when a number of conditions occurred concurrently. For example, the 2008 Rhine Valley Incident in Germany in which 12,000 colonies were poisoned occurred due to adverse weather delaying seed sowing across a huge acreage, coincidental flowering of oil seed rape, fruit trees and weeds, and sowing accompanied by dry weather and constant winds which blew neonicotinoid dusts into adjacent areas. This event raised awareness of these issues and the need for best management practice. In Australia, air seeders are widely used for broad-acre crops and hence the chance of dust drift from these machines (which vent into the furrows) is negligible. However some crops are sown using vacuum seeders and this issue is being addressed through the development of best practice guidelines for handling and using insecticide-treated seed by CropLife Australia.
- Overall, there are many pesticides that are acutely toxic to honey bees, not just neonicotinoids. This includes insecticides, fungicides, herbicides and interactions between combinations of these. In addition, other product excipients, especially surfactants, can be hazardous to bees. Analysis of poisoning incidents from the UK, the Netherlands and Germany suggests that the number of incidents ascribed

to pesticides has steadily declined since the mid-1970s and since about 1992 has remained relatively constant.

- There are a number of different stress factors impacting honey bee health, including food supply, climate/weather (e.g. drought), pathogens, acaricides, bee keeper and farmer practices (e.g. monocultures providing less variety of pollen and nectar) and pesticides (direct toxicity or weakened resistance/immunity to pathogens).
- Next steps for the APVMA include working through the recommendations arising from the overview report, investigating the adoption of more extensive tests before new pesticides are approved, improved labelling including bee warning statements and more user guidance as well as review of the adequacy of risk assessment procedures (including new toxicity test protocols being developed internationally) and current bee protection statements on Australian pesticide products.
- The Adverse Experience Reporting Program needs to be promoted for use in bee poisoning incidents in which agvet chemicals are suspected to be involved.
- The importance of communication between all stakeholders was reiterated, especially between farmers/horticulturalists and beekeepers.

Q&A from the floor with expert panel

(*Dr Christian Maus, Dr Helen Thompson, Dr Saul Cunningham, Mr Alastair James and Dr Les Davies*)

Question: Is it possible for a beekeeper to report an incident to the APVMA if they believe their bees have been affected, but not killed? If so, who would investigate the incident?

Response: The APVMA Adverse Experience Reporting Program is for issues related to the on-label use of a chemical. Adverse experience reports will normally be referred to the relevant state/territory for investigation, as they are responsible for control-of-use under the National Registration Scheme for Agricultural and Veterinary Chemicals (NRS) and enforcing the adherence to labels. The relevant state/territory will then report back to the APVMA which will then classify the incident as to the likelihood of an association between the pesticide application and the adverse incident. Not uncommonly, investigations will determine that a use was off-label or the use not carried out according to label instructions.

Question: At what level is bee navigation, foraging activity and ability to learn (sub-lethal effects) impacted by neonicotinoids?

Responses: The thought that neonicotinoids affect foraging and learning behaviour arose mainly due to the findings published by Henry (*Henry et al. 2012*; *Science*). However the dose used in this laboratory study was so high that the bees should have died. The exposure occurred in one single large dose at a rate that the bees may be exposed to over a whole day in the field. The results from single large dose studies need to be interpreted carefully as there is no cumulative effect because the neonicotinoids are metabolised quickly. Therefore this study did not represent realistic exposure rates. Furthermore, none of the realistic field studies conducted have shown that neonicotinoids affect bee foraging behaviour or their ability to learn.

Another laboratory study conducted before the study published in the Henry paper examined this exact issue (neonicotinoid effects on bee orientation) and used approximate rates honey bees would be exposed to in the field. No significant effects on honey bees were found.

It is important to note that if other pesticides were examined in such studies then they would likely to be shown to have effects on honey bee behaviour.

Question: There has been a major switch from the use of open pollinated canola varieties to hybrids. There are also many varieties on the market, for instance, 53 on the market in NSW, 34% of which are open pollinated and 66% of which are hybrid. Is there any information available relating to the impact of varietal differences on bee health?

Responses: Although there have been a suite of studies undertaken on canola and bee health, there does not appear to be any studies specifically looking at the difference between open pollinated and hybrid varieties of canola or the potential impact on pollinator reliance. If such studies are to be conducted, it would be important to consider environmental aspects as well as differences in agricultural practices.

Studies comparing spring and winter oilseed varieties have shown there is a huge variation in nectar production. However not many studies have analysed nectar or pollen quality. There is also not a lot of information around assessing the difference between open pollinated and hybrid varieties, however, this would be quite useful.

One observation is that it appears less honey is obtained from honey bees that feed on open pollinated varieties of canola compared to hybrid varieties.

Question: There has been a recent massive bee kill incident which has taken place in an almond orchard in California. From reports it is estimated that 80,000 colony deaths have occurred. It appears an illegal tank mix was applied late to almonds. Do you have any comments related to this?

Responses: The tank mix consisted of a fungicide and an insect growth regulator - neonicotinoids were not involved. This was clearly off-label use and involved the release of the bees at the wrong time. Therefore it comes down to better communication between growers and beekeepers.

This is a good example of why the focus should not be solely on neonicotinoids. When any insecticides are used in this manner, or are mixed, they can have disastrous effects on honey bees. This emphasises why education and communication are critical to avoiding these instances in Australia.

Question: Neonicotinoid-treated canola appears to be causing major rates of supersedure of queens in hives (>75%) compared to colonies on untreated seed. Has there been any research into exposure effects of neonicotinoids on the queen bee which could show or explain these higher rates of queen supersedure?

Responses: There have been numerous long term field studies around the world comparing effects of neonicotinoid treated canola seed on honey bee colonies to untreated seed and these studies included examination of behaviour, mortality, foraging and potential supersedure. In all of these studies there was no increase in queen supersedure rates observed.

It appears that some beekeepers in Australia are avoiding canola and therefore further research is required to address this.

Question: Are the realistic doses changed after you see how the chemicals are acting on honey bees in the field, or is there a standard rate used for testing?

Response: Colony feeding studies undertaken over the past 20 years have tested a range of concentrations and have also examined a variety of entry mechanisms. Testing combinations of chemicals can be difficult. Some combinations can be thoroughly tested in the field, however erratic combinations are usually tested through in situ field monitoring.

Question: Where do beekeepers go to find out information on seed protection products that use multiple chemicals?

Response: The modern day seed coating can include a variety of insecticides and/or fungicides. In order to find out further information on these products, contact the local re-seller.

Question: For crops such as canola, there is a difference in the growth period in the southern versus northern hemisphere. Are there also differences in the rate at which the systemic insecticides degrade over time as well as chemical rates applied? For example, seed treated canola provides greater protection from aphids at the start of the growing season, but doesn't appear to control aphids at the end of the growing season.

Responses: Seed coatings do not provide protection for the entire life of the plant, they mainly provide protection during the early growth stages. In relation to the rate of chemicals applied, this is based on extensive crop- and season-specific studies. For instance, comprehensive studies conducted on spring oilseeds do not apply to winter oilseeds which require their own separate study. In addition, it is commercially unviable to completely drench seeds in chemicals, therefore from a profitability point of view, only as much chemical is applied to the seeds as is required to be effective.

A recommendation to spray in the evening when bees are not around or when temperatures are low is one way to address spray toxicity. Where there are differences in cropping between different countries, this is examined during assessment of the chemical. Sulfoxaflor, a compound related to the neonicotinoids, is used as a foliar spray. Foliar residues can affect honey bees when wet, but not after they have dried. Therefore it should also be recommended on the label to ensure it is dry by the time bees will become exposed to it.

Best management practice guidelines need to be developed for pollinator reliant crops, not only for neonicotinoids, but other pesticides. There needs to be better communication between the beekeepers and growers and it is important this is two-way communication is encouraged. There also needs to be better guidance on the data sets required as well as consistent and effective label advice for chemicals that bees may come into contact with.

The biggest risk to beekeepers is off-label use of pesticides and, because of this, improved education and communication is required amongst growers and beekeepers. Another critical issue is related to the supply chain and the fact that agribusinesses do not keep stocks of chemicals. Therefore growers may be familiar with the use of a particular chemical and then, when stocks of this run out, they have to use a different chemical they are not as familiar with.

Question: If new information becomes available from international studies, will a formal review of neonicotinoids be undertaken?

Response: The APVMA has a formal chemical review program in which chemicals are reviewed based on concerns which arise in relation to human health, the environment, international trade or efficacy. The previous government introduced a re-registration program in which all products were to be reviewed on a regular basis (for periods between 7 to 15 years) prior to being granted re-registration. With the new government coming into power, these re-registration provisions of agvet chemical legislation are to be removed and thus chemical reviews will only be driven by issues of concern which arise rather than on a calendar basis. There are opportunities for anyone to nominate a chemical for review. A full review of the neonicotinoids has not been ruled out; however this would take a significant amount of time and therefore a review into a specific issue such as labelling would be a more appropriate path. There is currently an application in the system for a combination neonicotinoid seed-treatment product and due to the current global concerns about this class of chemical the company has supplied a lot of data relating to bees. This is currently being evaluated and will be completed this year, providing us with further guidance on the risks to bees presented by these chemicals.

Question: Is there any evidence that other colony forming insects such as ants are impacted by neonicotinoids?

Responses: Off target impacts such as those on birds, ants etc. are all considered in chemical applications; however no one on the panel or in the audience were aware of any studies into other colony forming insects such as ants. Ants don't collect pollen, however they feed on nectar and would also be exposed to chemicals in the soil and if they eat chemically-treated seed. Exposure rates however would be different.

The Department of the Environment considers non-target insects such as ants; however, this is usually in relation to IPM statements that go on labels. Professor Ben Oldroyd, University of Sydney, is organising an international congress on social insects and this research conference may provide more information on the effects of neonicotinoids on other colony forming insects. [**Editor's Note:** International Union for the Study of Social Insects. International Congress. 13 - 18 July 2014, Cairns Convention Centre, Queensland, Australia. **www.iussi2014.com**]

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