PESTICIDES AFFECTING BEEKEEPING AND CROP POLLINATION

Notes prepared for Crop Pollination Association Inc. conference July 2012, Warren Jones

Thank you for the opportunity to talk on a subject that could well threaten life itself, and particularly as we know it - an environment without our bees and other beneficial insect pollinators.

Our food security is under threat worldwide due to the silent introduction of two new groups of insecticides. They are highly systemic in action and become part of the plant tissues, fruit, seeds, nuts, leaves etc. With long breakdown periods, Neonicotinoids' systemic brain toxins can leave a residue as long as 1600 days in the soil. Phenylpyrazole (includes fipronil) is 7 months in the soil. The companies do say that you need a large MRL if exporting products treated with neonicotinoids. It is 2012 and we still do not know very much about these brain toxins in our food chain – it's a worry. Just about all our annual crops are seed treated without due regard to pest pressure, or the residual still in the fields from previous years.

While working for NSW Agriculture during the 1970s as Livestock Officer Apiculture based at Dubbo, the need for information on field residual toxicities of various chemicals became necessary, due to the number of crop and horticulture advisers, growers and beekeepers that were requesting the information not provided by the various companies and not on the label. So started my first publication in 1978 (Agdex 481/687) of residual toxicity lists to try to address the issue and provide the information requested. The toxicity referred to is the residual toxicity as it affects our bees.

The publication "Pesticides Affecting Beekeeping and Crop Pollination" was last published in 1989 as Agfact A8.9.7 by NSW Agriculture. It used to be updated every two years.

During the early 1980s there were a lot of chemicals removed from use (so called bad chemicals). Each state in Australia had its own Pesticide Act under which chemicals/pesticides/fungicides/herbicides were registered and controlled. There were lots of examples of pesticides registered or banned in one state but still in use in others. Most state Departments of Agriculture/Horticulture had a big say in the Pesticide Acts operation, and carried out independent evaluation of chemicals in the field and toxicity effect on bees.

The various state Pesticides Acts were discontinued so in one Pesticide Act covered all pesticide legislation issues, administered by Australian Pesticide Veterinary Medicine Authority (APVMA) from 1995. We all hoped that the management of chemicals would improve, under one Pesticide Act, but not so.

At about the same time period other changes were occurring. The Gatton Agriculture College, a valued research institute and very important asset to our Australian beekeeping industry horticulture and agriculture. We all know the amount of research and support that our industry received from Gatton and the late Graham Kleinschmidt.

Probably not as well known was that Gatton College had a very active Entomology department that recognised that the honey bee and other beneficial insects were being wiped out in agriculture/horticulture. This resulted in extensive field and lab research efforts.

So, the Gatton Entomology Department started "Pestchem" which I assisted, with the information on pesticides, toxicity to honey bees by using the generally accepted use class system from the U.S.A..

Use Classes as used for toxicity to honey bees from a pesticide if known

0 - No information available
1 – Cannot be applied safely to flowering crops
2 – Can be applied late evening after foraging
3 – Can be applied whenever bees are not foraging
4 – Can be applied safely at any time

So the first Australia wide chemical register was available to all Australian users. It gave information on a chemical's status or registration (where registered, which state); also on what crops it could be used, and the group of chemicals it belonged to. But, most important, its toxicity and residual toxicity rating for bees. Every State Department of Agriculture/Horticulture used "Pestchem".

My Agfacts publications were used by most states incorporating the information into their own publications, i.e. Canberra, N.T., S.A., Queensland Bee Book, etc. But like all good things they seem to have to come to an end. Gatton Agriculture College became part of the University of Queensland, Hawkesbury Agricultural College became part of the new University of Western Sydney.

NSW Dept Agriculture was also under restructure and sold off another very successful institution known as the Biological and Chemical Research Institute at Rydalmere, the main headquarters for NSW entomology. Lost from all these changes was the scientific expertise and knowledge. Even as I write, Departments are under restructure and there is a big chance that some of the remaining research institutes will be lost.

So, while all the above has been happening, in 1993 the first of a new group of chemicals, known as Neonicotinoids, was registered in Australia. *Imidacloprid* was first registered in U.S.A. 1992 there have been several more neonicotinoids added since then and are available in Australia for use without independent evaluation. This group are brain toxins, have been shown to affect the olfactory section of the bee brain, stopping their ability to return to their hive, and this is not reflected with the current lab LD50 test.

Neonicotinoids' Toxicity to honey bees:

Chemical	Brand name	Acute contact	Acute Oral
thiamethoxam	Actara, Platinum, Helix, Cruiser, Adage, Meridian, Centric, Flagship	Highly toxic	Highly toxic
clothianidian	Poncho, Titan, Clutch, Belay, Arena	Highly toxic	Highly toxic
imidacloprid	Confidor, Merit, Admire, Ledgend, Pravado, Encore, Goucho, Premise	Highly toxic	Highly toxic
acetamiprid	Assail, Intruder, Adjust	Toxic	Toxic
thiacloprid	Calypso	Toxic	Toxic
dinotefuran	Venom	Highly Toxic	Highly Toxic

Looking at the above table, you notice the neonicotinoid "thiamethoxam"; look at the brand name "Helix". It was used by the cotton industry, but banned and removed from Australia some time in the late 1980's. This is another question unanswered. This raises another question – that of Cruiser, now available as a seed treatment in Australia.

Maryann Frazier – Senior Extension Associate at Penn State University, found that some neonicotinoids in combination with certain fungicides synergized to increase the toxicity over 1000 fold in lab studies in 2004. Both the neonicotinoids and fungicides (Terraguard and Procure) are widely used and need to be investigated. This point of Maryann Frazier's needs immediate research. The practice is a common practice in Australian agriculture and does increase our problems being faced in bee kills.

The following list of bee kill numbers will enable you to assess the size of the spray problem you may be facing.

Bee Kill Estimations (per hive)

0 - 100	dead bees per day	Normal Die-off
200-400	dead bees per day	Low Kill
500-900	dead bees per day	Moderate Kill
1000 or more	dead bees per day	High Kill

Also, beekeepers should start a list of insecticides that your bees may come into contact with. Before doing a pollination job, list the chemicals that may be used on the crop – ask are they registered for use on the crop. Do you have to move your bees out before spraying due to residue? Ask for 48 hrs notice. Always have your pesticides listed by active ingredient, then list trade names and manufacturer so that you can access more information from the MSD of the pesticide. Ask if the seed of a crop has been treated, and what with.

Don't lose your chemical list – carry it with you in car, ute and truck, it's that important. Just keep adding to your list as new chemicals come up. All beekeepers should start their own lists as they work in different areas and crops and use different chemicals, so do your homework, no one else is.

If you have a problem, Collect both dead bees and live bees and freeze as soon as possible. Do the same with sprayed plant material. These samples can be dispatched as soon as you have an address or lab to forward to. Results can take a week to ten days. Have your DPI number, also preferred laboratory number handy. Have a dry run, just to get the numbers so you don't lose time if a problem does arise.

Main Groups of Insecticides

These include organochlorines, organophosphates, carbamates and pyrethroids.

Organochlorines – most organochlorines are very persistent, with half lives of several years in the environment. They also accumulate in animal fat. Consequently the majority are banned from use in agriculture, e.g. DDT, Dieldrin, Endrin, Chlordane. However, endosulfan is still in use. Its relatively low toxicity to bees and wide spectrum of pests affected makes it an important tool during pollination by bees. This chemical has been reduced to permit use only.

Organophosphates – there are a wide variety of these used in agriculture. Unlike organochlorines they persist only for a few days and do not accumulate in body fat. Organophosphates usually kill insects on contact but some are absorbed into the plant and travel through the sap-stream to give systemic action against sap feeding insects. Their toxicity to bees ranges from very high to low. Examples: dimethoate (Rogor®), chlorpyrifos (Lorsban®), methamidophos (Nitofo®), methadithion (Supracide®), monocrotophos (Azodrin®).

Carbamates – like organophosphates these are short lived (a few days) and do not accumulate in body fat. Their toxicity to bees ranges from very high to very low. Examples: methomyl (Lannate®), carbaryl (Carbaryl®), pirimicarb (Pirimor®).

Pyrethroids – these are synthetic insecticides with chemical structures related to the plant pyrethrin. Most household insect sprays contain pyrethroids of types with low mammalian toxicity. Generally pyrethroids are very toxic to bees but they repel bees so that the effective toxicity in the field is low. Examples: cypermethrin (Ripcord®), permethrin (Ambush®), deltamethrin (Decis®).

Formulations

The formulation of a pesticide greatly influences its toxicity to bees.

Most toxic:
- dust and microencapsulated insecticide
- wettable powder
- ultra low volume (ULV) = undiluted pesticide
- emulsifiable and water soluble concentrates
- granules

The new chemicals in agriculture/horticulture - they are Neonicotinoids (brain toxins and highly systemic) and Phenylpyrazole which includes fipronil is also highly systemic with a 28 day knockdown by contact.
We do not know a lot about them but they do differ from the above chemical groups because they become systemic in the plant and can be detected in pollen and nectar throughout the flowering period. The residual period is very long, some 1600 days, with sub lethal levels extending for years in soil.

The current LD50 lab test is not a suitable test for adult bees, as not many adults die during the lab test. But large losses occur in the field; also young larvae are killed at 5 - 6 days old in large numbers when fed. More bees and larvae die as a result of sublethal effects from the residue of neonicotinoids . This is not covered by our current registration systems. Due to the effect on the olfactory sector of adult bee brain, the bees affected fail to navigate home to their hives.

We need a new test to replace the LD50 test as now used, the new test to be based on in-hive testing of adults and larvae in the field, before it is too late for the bees and our environment. This will happen if a new LD50 test is not found.

Also needed - an independent survey to find out the status of pests populations and our main beneficial insects populations in areas of high neonicotinoid use, with the results to be published. Check for MRLs in our food chain for neonicotinoids. Look for sickness clusters in our human population for any mental abnormalities that could be out there as a result of consumption of high neonicotinoids MRLs in food. Especially large animals that consume treated fodder.

Our food security is at risk until we solve these problems. We cannot afford to just ignore the problem, as this problem will not go away. Australia has to face the problem and do the research if we can find the expertise to do so. If not, use the current overseas work that is becoming available, it is that important.

The LD50 test for bees will need to be arrived at quickly to be able to co pe with sub lethal level measurements at one in two trillionths of the applied rate. Our remaining facilities will have to be upgraded urgently to be able to carry out the research, or there will not be much left for carbon or climate change to finish off.

We have lost Gatton (Qld) and Biological Chemical Institute at Rydalmere. Yes, we have other centres but not biological or chemical institutes. We need urgently to have a new biological and chemical institute, not only for the wellbeing of our "beneficial pollinators", or the environment, it is essential to get the chemical balance right or food security will suffer, either by prices or simply not available, or contaminated by unacceptable MRL levels.

Invoke the precautionary principle and put in place a dedicated watch dog, such as a Biological Institute.

Overseas research is becoming available as these overseas countries have as much to lose as we do. Some countries have banned the chemicals concerned. They may be silver bullets for agriculture, but not for mankind or the environment. We have removed a lot of bad chemicals in the past, but maybe we have to remove more.

WARREN JONES

References:

Dr James E. Tew, The Ohio State University, *Protecting Honey Bees from Pesticides*

Maryann Frazier, Penn State University, *Protecting Honey Bees from Chemical Pesticides*