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Bee pesticide poisoning incidents in the United Kingdom

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Abstract

The present Scheme operates in the United Kingdom to investigate the possible pesticide poisoning of bees. The Scheme enables post-registration surveillance of agricultural and other chemicals to be conducted, allows validation and improvement of the risk assessment processes used in the registration of products and can be used to enforce legislation.

After certain acceptance criteria have been met to accept bee incidents, a field inquiry is carried out. Samples of dead bees are submitted for adult bee disease diagnosis and chemical analyses are performed to detect any potential residues, using modern chromatographic techniques.

Over the years, the number of incidents reported to the Scheme has declined, due to an appreciation that chemicals can cause problems to bees when used in the field.

Reassuringly, only a few incidents recently arise from approved use. In more recent years, where the use is identifiable, the misuse of a product is most prevalent.

The Scheme provides a useful tool in the detection of what has poisoned bees and how this happens. It provides valuable information for regulators, agrochemical companies, farmers, beekeepers and enforcement authorities. It gives confidence to the public that this potential problem is being investigated.

Key words: poisoning, pesticides, surveillance, bees.

Introduction

The Scheme to monitor the possible poisoning of bees by pesticides is part of the Wildlife Incident Investigation Scheme (WIIS) that investigates possible pesticide poisoning of wildlife (Fletcher *et al*. 1994). Bees have been part of WIIS since the early 1980s. At this time a large number of bee deaths were reported and it was found that these had arisen after aerial spraying of oil seed rape with the organophosphorus compound, triazophos. Before this time there had been some monitoring of bee pesticide poisoning (Stevenson *et al*., 1978).

The Scheme enables post-registration surveillance of agricultural and other chemicals to be conducted. It is not possible to test new compounds in the field, under all conditions prior to registration and this Scheme acts as a safety net. Although risk assessments are carried out, certain sets of conditions might occur that cause bee poisoning. The Scheme will highlight these problems if they occur and report them back to the regulators who can change the conditions of use of that compound or even withdraw it.

The Scheme provides real data from the field that can be used to validate and improve any risk assessment processes used in the registration of new or existing products.

The Scheme can also be used to enforce existing legislation. In the UK there are laws that govern the way pesticides can be used and stored and others that aim to protect wildlife and the environment. If, through the Scheme, evidence is gathered that suggests legislation has been breached, then this can be provided to the enforcement authorities for use in legal cases against the perpetrators.

Materials and methods

The Scheme is reactive and relies on beekeepers and other interested organisations or individuals recognising that a poisoning incident has occurred. They must then report it to the Scheme and submit samples for analysis.

As analysis is expensive, it is important to rule out disease or parasites as being the cause of the bee deaths. Bees are examined for the presence of nosema, amoeba, acarine and varroa. In some cases pollen identification of corbicular loads may be made, to identify the crops that the bees have been foraging on.

Once accepted as a possible pesticide, poisoning incident, a field investigation is carried out to ascertain the number and condition of the colonies, find out what symptoms and behaviour the bees were showing and the scope of the incident. Other information, such as what likely crops were in the vicinity, if pesticides were being used locally and the weather conditions at the time of the incident, is also recorded. The views of the beekeeper may also be sought.

Based on the information received chemical analysis is carried out. Using sophisticated modern equipment it is possible to extract, clean up, identify and measure very small residues of pesticides from bees. About 1-2 grams of bees are used for analyses, with a limit of detection down to about 0.002 μg/bee. Analyses and confirmation for residues of organophosphates, organochlorines, carbamates, pyrethroids and some fungicides and herbicides are undertaken (Brown *et al*., 1996).

Interpretation of the results is important. When residues are found these must be examined to determine whether they represent lethal levels or are background residues. Using published LD_{50} values (Stevenson, 1968; Tomlin, 2001) and subsequent residue levels (SRL) (Greig-Smith *et al*., 1994), such determinations can be carried out.

The sources of the pesticide poisonings are sometimes apparent from field information or residue analysis. Pesticide poisoning of bees can be assigned to one of four categories of use.

The approved use of a chemical is where a pesticide has been used according to its specified condition of use. Misuse of a compound is where there is careless, accidental or wilful failure to adhere to the conditions of use. If there is a deliberate use of a pesticide to poison bees this is defined as abuse. In cases where, despite extensive enquiries, the results have failed to find the use of a pesticide in the poisoning, these are categorised as unspecified use.

A report is produced on the results of all bee incident received into the Scheme. An annual report is published covering all incidents in the UK and includes a section on honeybees, (e.g. Barnett *et. al.*, 2002).

Results and discussion

Previous papers have highlighted the results of incidents (Fletcher *et al.*, 1994; Barnett *et al.*, 1997).

The number of incidents reported to the Scheme has declined over the years from over 100 to about 30 in each year (figure 1). However, the percentage of those found to involve pesticide poisoning has remained at about the same level, 25-30%. The main reason for the decline in reported incidents, is a greater awareness of the problems that chemicals may cause to bees. The registration process of new and existing compounds to new uses has resulted in a rigorous assessment of the risk of compounds to bees. This has resulted in fewer poisoning incidents arising from the approved use of compounds. Steps have been taken by both the regulators and manufacturers to alleviate problems that have been found by incident surveillance. There has also been a better understanding of the potential problems by farmers and contractors and this has led to liaisons between them and beekeepers.

Overall, some 38 different agricultural compounds have been identified in bee poisoning cases in the UK. Insecticides are the most likely compounds to cause deaths. There have been 15 different organophosphates, two organochlorine, five carbamate and seven pyrethroid compounds identified. From time to time other agrochemicals are implicated and these include some herbicides and fungicides. Some of these compounds are found together with others in bee poisoning incidents.

Figure 2 shows the percentages of compounds found in incidents in the UK for 1995-2001. It can be seen that organophosphates and carbamates predominate.

The poisoning of bees involving agricultural chemicals can arise from a number of routes.

Approved use poisoning

In recent years, incidents that arise from the correct use of a pesticide (approved use) are few in number (figure 3), reassuringly providing evidence that the registration process works. However, some approved use incidents do occur.

Poisoning has been found when tank mixes of pyrethroids and fungicides have been applied to crops. This has resulted in an apparent increase in toxicity of the pyrethroid to bees and confirms laboratory experiments where this has been demonstrated (Pilling and Jepson, 1993).

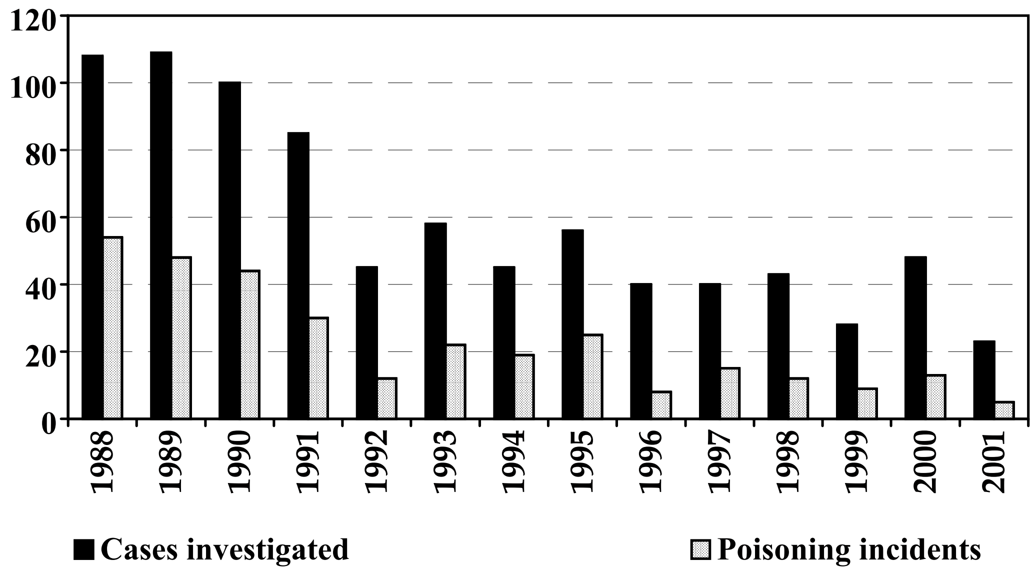

Figure 1. Number of reported and poisoning bee incidents 1988-2001.

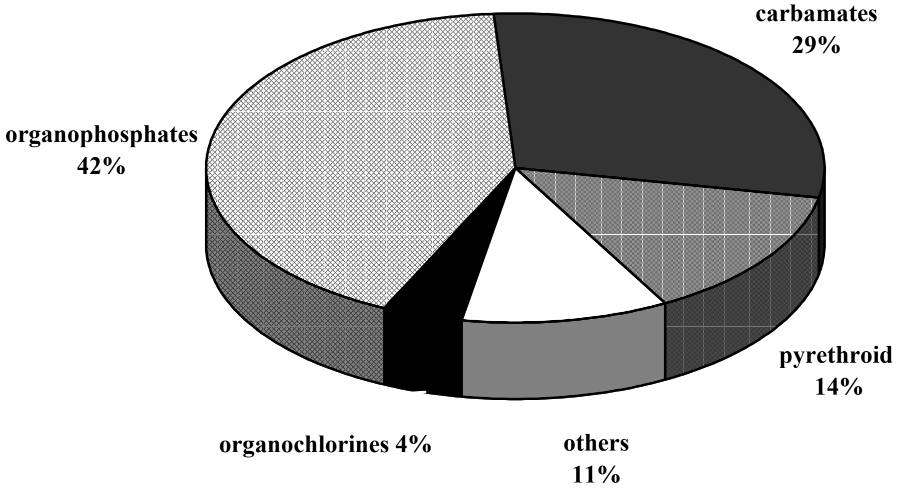

Figure 2. Types of compounds found in bee poisoning incidents 1995-2001 (n=95).

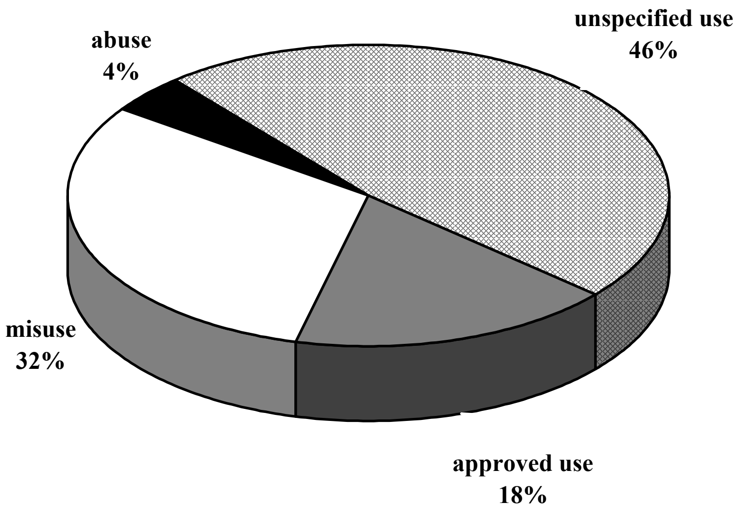

Figure 3. Categories of bee pesticide poisoning incidents 1995-2001 (n=95).

Incidents where bees have been collecting honeydew have also been detected. Heavy aphid infestations on cereals result in the farmer spraying the crop. The bees, attracted to the honeydew, are therefore likely to be poisoned.

Sometimes a crop is sprayed and the field is on a flight path for foraging bees. These foraging bees may pick up the insecticide as they pass over the sprayed crop and be poisoned.

Ant control at an apiary has resulted in bee deaths. Insecticidal ant treatments have been placed by the beekeeper near to the colony and bees have been found poisoned by the chemicals. In one incident, resulting in bee poisoning, an insecticidal lacquer, containing diazinon, was put on crown boards to deter ants.

During a dry spell, a paraquat treatment to a field formed small puddles. Bees were attracted to this source of water and were subsequently poisoned.

Wood treated with dieldrin as a preservative has also resulted in the poisoning of bees. This has resulted not only from treated hives, but also with boxes used to transfer bees.

The transportation of queens from one country to another, by airline, has also led to poisoning. The area in which the bees have been transported has been treated with insecticides to prevent exotic or harmful insects being inadvertently imported from one country to another.

Some oil seed rape seed had been contaminated with GM seed. This mistake was not found out until the oil seed rape was in flower. The farmers were fearful that their crop would be compromised and so destroyed the whole crop using paraquat. Unfortunately, bees were working the crop and were poisoned. This problem led to several incidents in one year.

Misuse poisoning

These are incidents that have arisen from the product being used in a careless, accidental or by wilful failure to adhere to the approved practice. Barnett and Fletcher (1998) have highlighted some bee incidents in this category. About a third of incidents where poisoning of bees was identified can be attributed to misuse (figure 3).

The most obvious cases of misuse of pesticides causing bee poisoning are where crops are sprayed when in full flower. Uneven flowering in a field can cause a dilemma for a farmer as spraying may be required for the non-flowering part of the field but not allowed as there is a high proportion still in flower.

The presence of flowering weeds in a crop, where spraying is required, can also lead to poisoning. The bees may be foraging on the flowering weeds and may pick up the pesticide as it has been applied to the crop.

Over-spraying of a crop can also lead to poisoning of bees that may be foraging in neighbouring fields. This can also apply to some unusual situations. Honeybees were poisoned after saplings in a forest were sprayed for weevil control and the over-spraying went onto flowering heather in the surrounding area.

The control of feral bee colonies by insecticides presents a problem. After treatment, the comb should be removed or the space blocked off. However, this is sometimes not carried out and bees will come and rob the comb, picking up the poison. In some cases the removal of comb or blocking of the space is difficult, for example if the comb is down a chimney.

Incidents have occurred after wax moth control has been applied to stored comb over winter. In one incident dichlorvos strips were used and in another dichlorobenzene (DCB) was applied but the comb was not fully aired prior to use and the bees were later found poisoned.

There have been incidents where spray tanks have not been cleaned out properly prior to reuse. Insecticide compounds had been used and on a subsequent occasion a benign compound to bees had been placed in the tank. However, on spraying the crop the bees had been poisoned by the insecticide still remaining in the tank.

In one incident, bees died from chlorpyrifos poisoning. It was found that sacking material, used in the smoker, was contaminated by this compound and the bees were poisoned from the chlorpyrifos in the smoke.

Abuse poisoning

Abuse results from the deliberate use of pesticides to kill bees. Only a few incidents are reported where this is found to have occurred (figure 3). These usually arise as a result of neighbourly disputes or maliciousness. Many compounds have been used containing organophosphates, carbamates or pyrethroids. There was even one incident where a treatment for mites in racing pigeons, containing malathion, was used.

Unspecified use poisoning

There are always a number of incidents where there is no evidence available from the field information or the residue analysis to ascertain how the bees have been poisoned, although a lethal residue was detected from the bees. These unspecified use poisonings are always the largest category found by the Scheme for bees (figure 3). Bees can forage over a long distance and it is often not possible to investigate over such a large area to identify the situation with pesticide use. The bees from these incidents, are found to have been poisoned by the same compounds found in other categorised incidents.

Conclusions

The Scheme acts as a barometer, detecting what has poisoned bees and how this poisoning has come about. It provides valuable information for regulators, agrochemical companies, farmers, beekeepers and the enforcement authorities. It is important that we identify the circumstances in which poisoning can occur, so that they may be remedied or reduced in the future.

Various initiatives have resulted from incident findings. Apart from the obvious reassessment of compounds by regulators that may result in changes in the way that a pesticide may be used, or even withdrawal, agrochemical chemical companies have used stewardship schemes to give out advice or instructions with their products to alleviate problems with bees. Beekeepers and farmers have got together to set up spray liaison schemes so that there is a single point of contact for a farmer to warn nearby beekeepers prior to spraying.

Importantly, the Scheme provides public confidence that something is being done to monitor pesticides, and this cannot be underestimated.

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