Chapter 4

Pesticides and Honeybees

Pesticide Poisoning of Honeybees

Beekeeping and the use of pesticides are both essential inputs for modern techniques of vegetable seed production. Vegetable seed production will be seriously impaired if either of these two is ignored. Since the advent of synthetic pesticides several decades ago, the beekeeping industry, both in developed and developing countries, has been incurring heavy losses. In developed countries, large-scale monocultural cultivation of crops and a high degree of mechanisation has greatly amplified the problem of honeybee poisoning by pesticides. On the other hand, in developing countries, the basic problem is the lack of information about the harmful effects of pesticides on honeybees. Conflicts often arise when pesticides are applied to a crop at the inappropriate time, or by inappropriate means, or when unsafe pesticides are used.

In recent years, pest control problems are becoming more serious and difficult to manage. This is because large areas of land are being used to cultivate exotic cultivars of vegetable crops which, under the new environmental conditions, are more susceptible to pests and diseases. In some cases, pests and diseases affecting exotic cultivars/varieties are also introduced either accidently through human error, or lack of proper quarantine facilities. Such pests and diseases multiply and

spread more rapidly in their new environment, because of the absence of their natural enemies such as predators or parasites. Chemical pest control measures are absolutely essential under such circumstances.

The increasing reliance on chemical methods for the control of pests and diseases is also creating serious environmental pollution problems, including health hazards to human beings and decline in other non-target, beneficial insect populations. Amongst the latter, natural insect predators, parasites, and insect pollinators, especially honeybees, are the primary victims. These beneficial insects are facing extinction in their natural habitat where they greatly contribute to the conservation of biological diversity and render essential ecological services, i.e., pollination and maintaining the population levels of different insects-pests below economic thresholds.

In developing countries, the basic problem is lack of information and lack of awareness about the harmful effects of biocides to honeybees along with the indiscriminate prescription of pesticides by agricultural scientists and extension workers and blanket and erratic application of pesticides by farmers due to lack of knowledge regarding what, how much to use, and when.

The practice of using honeybees to enhance the productivity levels of different agricultural and horticultural crops has not become very popular among farmers because indiscriminate use of biocides kills large numbers of bees. However, now other methods are available and these ensure the selective use of biocides at some right time and in the appropriate formulation and concentration. As a result of this, the hazards of bee poisoning by pesticides can be reduced to a minimum.

Effects of Pesticides

Pesticides may be absorbed by bees in one or more of the following ways - oral, respiratory, and dermal. Oral intake is likely to occur when nectar and/or pollen are contaminated. For a pesticide to be toxic

via this route, it must be absorbed and the efficiency of absorption depends upon the characteristics of the pesticide. For example, bees could carry lethal doses of organophosphate dimethoate in their honey stomachs without showing signs of intoxication.

Contamination of nectar occurs in a number of plants treated with systemic insecticides. However, there is a little danger of contamination through nectar. But, on the other hand, several scientists have reported that dimethoate applied at the rate of 11kg/ha killed the bees as a result of nectar contamination.

The major cause of bee poisoning is the contamination of pollen by microencapsulated insecticides. For example, when Penncap-M^{R} capsules are applied to agricultural crops, the capsules are carried by foraging bees to their hives and stored in the brood frames together with pollen; hive bees feed the contaminated pollen to the developing brood which results in loss of the total colony. Foraging bees are killed while collecting and transporting this pollen, young hive bees are killed while storing and feeding the contaminated pollen, and the brood is killed by the poisoned food.

Insecticides such as DDVP, some organochlorine pesticides such as chlordane, and compounds such as nicotine can be present in sufficient concentration in the air to be toxic to bees by way of their tracheal system. Another possible problem in this regard is the absorption and subsequent release of volatile pesticides with fumigant properties. Beeswax has excellent absorptive properties. Combs exposed to DDVP for 48 hours absorb sufficient pesticide to kill bees that are exposed to these combs within two to six minutes.

Direct contact is probably the major way in which pesticides are absorbed by bees. Interception of pesticide droplets in the air during spraying operations and contact with sprayed surfaces are the most likely sources of contamination. The toxicity of the airborne droplets varies according to the method of application, and the amount of pesticide available to bees decreases with increasing absorption of pesticide by the surface.

Bees lose their sense of time when exposed to sub-lethal doses of pesticides like parathion. However, it is not clear whether this phenomenon is the result of changes in the "internal clock" of the poisoned bees or in the manner in which they communicate this "time" to other bees. Disruption in the communication of distance also occurs due to pesticide poisoning.

Outbreaks of European Foulbrood and Sacbrood Virus infections were observed to follow applications of Carbaryl insecticide in the foraging area of the affected colonies. The first records of the occurrence of Chalkbrood disease came from colonies that were exposed to fenetrothion spray.

Symptoms of Bee Poisoning

One of the obvious signs of poisoning is the presence of a large number of dead or dying bees at the hive entrance. These adult bees are foragers who have been exposed to pesticides sprayed on flowering plants. The mortality figures in Table 4.1 are used as guidelines to assess the extent of bee poisoning by pesticides.

Table 4.1: Extent of Bee Poisoning by Pesticides

Number of dead bees per day at entrance	Level of poisoning
100	Normal death rate
200-400	Low
500-1000	Medium
Over 1000	High

Source: FAO Bulletin 68/3 1988.

As a result of organophosphorous poisoning, dying bees extend their tongues through which nectar is regurgitated and a moist and sticky

mass of dead bees is often found at the hive entrance. Fast-acting insecticides kill foraging bees in the field itself, and only a small number of such bees manage to return to the hive. Sometimes, the whole bee colony may die instantly. Strong bee colonies suffer greater losses due to pesticide poisoning than weaker ones because the former have a larger number of foraging bees.

Foraging bees often carry residual pesticides in their pollen loads while returning to the hive. The behaviour of bees in the hive changes abruptly as a result. Honeybees in such colonies become more agitated or aggressive. As and when the hive with pesticide-affected forager bees is opened, they often fly off the top bars of the hive and sometimes straight into the face of the beekeeper handling them. Other symptoms of pesticide poisoning include stupefaction; paralysis; and abnormal, jerky, or spinning movements. Carbaryl poisoning causes bees to crawl around at the hive entrance, they lose their ability to fly and ultimately die in two to three days after poisoning.

Nurse bees in pesticide-affected colonies lose their ability to clean dead bees from the hive, as a result of which the hive entrance is completely blocked.

Pesticide poisoning also affects the colony strength because there is a break in the brood-rearing cycle and often dead or deserted colonies cease foraging, as a result of which there is a sharp decline in food storage, and incoming foragers are attacked at the hive entrance by other bees.

Protective Measures

i) As far as possible, biocides should not be applied during the blooming period.

ii) Pesticides that have short residual effects and those that are less hazardous to honeybees should be selected.

iii) Ignorance and the absence of extension programmes to educate farmers about the harmful effects of pesticides are the biggest problems in developing countries. Both vegetable growers and beekeepers should be properly informed regarding pesticide application schedules and how to reduce poisoning in a particular area.

iv) Broad-spectrum pesticides should be avoided as they are much more hazardous than selective pesticides which are safer for bees and other beneficial insects.

v) Night or early morning application of pesticides is always desirable because foraging honeybees are in the hive at that time and thus out of danger. Night application of pesticides allows adequate time for the pesticide to dissipate or break down into substances that are non-toxic to bees.

vi) It has been recognised that spray or liquid formulations are safer than dust or wettable powder formulations. The death rate is six times higher if powder formulations are used in comparison to liquid formulations. The addition of solvents or oily substances to sprays significantly reduces bee losses.

Insecticide formulations can be classified in order of their toxicity:

dust>wettable powder>flowable> emulsifiable concentrate or soluble powder or liquid solution>granular formulation.

vii) It is always advisable to keep bee colonies as far away as possible from the pesticide-treated fields. Even a distance of one kilometre from the sprayed site will reduce honeybee mortality ninefold.

ix) Remove all the flowering weeds from the fields by either mowing or beating so that they do not become a source of poison to the bees. This practice will force the bees to forage

over longer distances, free from the adverse effect of pesticides.

x) In the temperate regions of the Hindu Kush-Himalayas, residues will remain toxic for a longer time due to lower temperatures. But, at the same time, low temperatures delay the initiation of the foraging activities of honeybees in the morning. Keeping this in mind, the time of pesticide application should be shifted accordingly.

xi) Primary emphasis should be placed on an integrated pest management programme which mainly relies on biological or cultural methods of insect-pest control and minimises the use of poisonous chemicals.

Relative Toxicity of Some Pesticides to the Asian Hive Bee, *Apis cerana*

In several developing countries of southeast Asia, beekeeping with *Apis cerana* has been sustaining heavy losses since the advent of synthetic pesticides several decades ago. Such widespread and careless use of toxic pesticides during the blooming periods of agricultural and horticultural crops not only kills bees but also contaminates hive products.

Several research workers have compared the relative toxicities of commonly used pesticides on *Apis cerana* and these have been classified as highly toxic, moderately toxic, and non-toxic. Application of highly toxic pesticides on blooming crops or weeds may cause severe damage to bees. Beekeepers should be warned in advance by the growers when these insecticides are to be used so that they can temporarily move the colonies to safer locations. Even 10 hours after spraying, these pesticides are still highly toxic to bees. Moderately toxic pesticides should be applied during the late evening when bees are not foraging actively. Bee hives should not be directly exposed to these pesticides. For minimal hazards to honeybees, the dose, the timings, and the methods of application of these moderately toxic

pesticides are very important. Relatively non-toxic pesticides cause minimum damage to the bees. These should be applied during late evening, night, or early morning. The list of pesticides is given in Appendix I and Appendix II gives instructions regarding their safe usage.