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Bee Poisoning - A Potential Threat to Biodiversity

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Abstract

Honeybees are valuable insects that are critical for pollinating many crops, contributing significantly to the global economy. Apart from producing wax and honey, their primary role is to pollinate crops, which is essential for the growth and survival of many plant species. However, honeybees face numerous challenges, including biotic and abiotic factors that threaten their existence. The most significant and pressing threat to their survival is the use of pesticides in agriculture, especially neonicotinoids. The widespread use of these pesticides is putting honeybees at risk by poisoning them and compromising their health. As a result, it is crucial to take action to reduce the use of pesticides and other harmful chemicals to ensure that honeybees can continue to thrive and play their vital role in the ecosystem.

1. Introduction

In addition to producing honey, wax, propolis, royal jelly and venom, bees play an important role in pollinating entomophilous crops. It was discovered that pollinating bees are responsible for an increase in agricultural production that is 10–15 times more than the production of honey, wax, etc. According to National Bee Board, an array of crops has benefited with an exponential increase in yield for example Mustard (128.1 to 159.8%), Safflower (42 to 114.3%), Niger (260.7%), Sunflower (20 to 3,400%), Guava (70-140%), Carrot (9.1 to 135.4%), Onion (353.5 to 9.878%), Cucumber (21.1 to 411%) and Coffee (16.7 to 39.8%). Further, it has been estimated that 737 honey bee colonies are required to substantiate crop pollination in these crops based on 2–3 colonies/ha depending upon the acreage under these crops in India. This would be reflected in the economy worth 3000 crore rupees annually. These figures and facts are exemplary of the importance of honey bees in sustaining livelihood across the planet. Van-Engelsdorp et al. (2009) explained a phenomenon called Colony Collapse Disorder (CCD) where in many factors are responsible viz, destruction of habitat, widespread use of pesticides, intensive agriculture and specific parasites such as bacteria and viruses. To date no single factor can explain colony loss

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in bees, however, most common factor to blame around the globe is an insecticide and its wide application. Bee poisoning from pesticides is a serious concern. Given that pollination, particularly that of honey bees is essential to one-third of worldwide agricultural production, the bee crisis poses a threat to global food security. Honeybees are extremely important to humans, yet their mortality rate is frighteningly high. The rate at which honey bees are disappearing in Europe and America has increased dramatically in recent years as a result of pollution, pesticide use, and neglect. It appears more likely than ever that Einstein's theory, which states that humanity has four years to extinction if bees go extinct is accurate. The bee catastrophe has the potential to destroy global food security, which is already compromised by the economic crisis, so the issue has taken on a level of extreme urgency. It can occasionally happen that the beekeeper employs improper products that should safeguard the honey bees, leading to the poisoning of his bees. Thus, it is feasible to overlook the crucial role that pesticides play in the issues that honey bees face and to envision a multifactorial explanation. In light of these, it should be necessary to study how pesticides affect honey bees. The vast array of agrochemicals employed in crop cultivation makes it unsurprising that 173 distinct substance residues have been discovered in apiaries thus far. It should be understood that, because of the varying rates of pesticide exposure in the environment, bees are threatened by a cocktail of numerous agricultural compounds rather than by a single poison.

2. Routes of Exposure

While the most typical way to apply pesticides to crops is by spraying them on top, some fungicides and herbicides are sprayed directly onto the soil. Bees that fly over the treated fields are exposed to the dust and droplets from the applications in each case. Granular pesticides are applied indirectly to avoid direct exposure to bees, making them comparatively safer.

When systemic pesticides are sprayed as seed coatings, the pesticides move through the plants and eventually find their way to the flowers, pollen and nectar. This also affects non-target plants since pesticides may get to them through lateral water flow. The forager bees carry these substances back to their colonies, where they remain for a while and can be detected in beebread and honey. In addition to all of these methods, tainted water is another way that bees are exposed to pesticides since they need water to regulate their body temperature. The use of acaricides to control *varroa* mites and other parasites is another prevalent way of exposure.

3. Effects of Pesticide Exposure to Bees

One of the obvious signs of pesticide poisoning is the presence of a large number of dead or dying bees at the hive entrance. These bees are foragers who have been exposed to pesticides sprayed in the fields. In addition to having a detrimental effect on honey bee growth and development, various insecticide classes, including pyrethroids, neonicotinoids, spinosad, flupyradifurone and sulfoxaflor harm the bee's ability to navigate back to their nest, remember where they are, smell, fly and use their dance circuits (Zhao et al., 2022). Exposure to pesticides can significantly affect the nutritional makeup of royal jelly that honey bees generate, which in turn can affect queen development. Moreover, the presence of pesticide residues in royal jelly suggests a potential indirect route via which pesticides could adversely affect the environment necessary for honey bee growth (Milone et al., 2021). The health and survival of young honey bees may be impacted by pesticide exposure during larval development, which could lead to overall colony stress or loss.

Furthermore, exposure to pesticides changed the detoxification enzyme's gene expression (Tome et al., 2020). Both imidacloprid and glyphosate pesticides reduced sucrose responsiveness and had a negative effect on olfactory learning. Glyphosate also reduced food uptake during rearing. The results indicate differential susceptibility according to honey bee age. The two agrochemicals had adverse effects on different aspects of honey bee appetitive behaviour, which could have repercussions for food distribution, propagation of olfactory information and task coordination within the nest (Mengoni and Farina., 2018).

4. Ways to Mitigate Bee Poisoning

4.1. Reducing the use of pesticides

Using pesticides should only be done after thoroughly inspecting the crop fields for the presence of weeds, pest populations or disease incidence for threshold levels. This contributes to the preservation of important insect pollinators. Do not apply pesticides while crops are in the blooming stage.

4.2. Apply pesticide when bees are not active

Since the majority of pollinators are active from 8 a.m.

to 5 P.M. it is best to avoid using pesticides during these hours to prevent forager bees from getting into close contact with the substance. The majority of the treatment might take place in the early evening to prevent this situation of pollinators from coming into direct contact with insecticides. The insecticides are applied later, giving the toxins time to break down completely or partially during the night.

4.3. Avoid water contamination

Because the bees gather water from these sources to lower the colony's temperature during the summer, it is best to prevent pesticide runoff from contaminating surrounding standing water.

4.4. Use of less toxic compounds

When circumstances permit, substances that are less harmful to bees should take precedence over those that are extremely harmful. The potential risks to honey bees should be noted on pesticide labels. The different dosages can be used if there isn't any other viable choice. In comparison to other formulations, microencapsulated pesticides have been demonstrated to be more hazardous to honey bees. These capsules' size is comparable to that of pollen, which makes it easier for them to be transported straight into the colony, where they remain deadly for an extended period and can also be given to the developing brood. If there is a possibility that a foraging bee will gather pollen from the treated crop, then using this formulation should be forbidden. Dusts are riskier than liquid formulations because they can enter a honey bee colony by drifting with the air current. Ultra-low-volume (ULV) formulations are especially riskier since they can enter or reach a colony in the same manner as other liquid formulations. Concentrations that can be emulsified are less hazardous than wettable powders. Because these pesticides are applied to the lower portions of the plant canopy, which reduces their direct contact with any pollinators visiting the flowers, the granular formulation is also safer for the bees.

4.5. Identify attractive blooms

Before treating a field, it is advisable to inspect the flowers of beautiful weed flora nearby since these blooms typically attract foraging bees and pesticide drift to them may jeopardize visiting pollinators. The blossoms of weed plants may be removed prior to treatment to avoid reoccurring problems.

4.6. Notify beekeepers

Since this window of opportunity will allow them to move their colonies to an area with low pesticidal drift, beekeepers should be notified well in advance of the application. Colonies can also be covered with cloth to keep bees inside the box and stop them from foraging for a day or two.

5. Conclusion

The relationship between pesticide use and bee health is a complex, interesting and ongoing area of research. The evidence suggests that certain pesticides, especially neonicotinoids, can have detrimental effects on bees, but the extent of these effects can depend on various factors. Sustainable agricultural practices, integrated pest management and continued research are crucial to mitigate the impact of pesticides on bee populations and overall pollinator health.

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