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Management of Pesticides to Avoid Exposure to Bees and other Pollinators

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Abstract:

The spread of disease and pests in bee colonies, habitat loss, reduced access to or quality of food resources, climate change, queen bee deterioration, changing trade practices, and exposure to apicultural and agricultural pesticides both in and out of beehives are all factors contributing to bee population decline. Pesticide exposure is a significant factor in this. Better awareness of the problems with bee pesticides should motivate all parties involved to take the necessary efforts to limit chemical impacts on bees and apiarist productivity. Pollinator species other than honey bees may be damaged if farmers contaminate the surrounding landscapes, particularly water bodies, with pesticides.

Keywords: Pesticides, Pollinators, Beekeeping, Pesticide exposure

The overall number of honeybees (*Apis mellifera)* is more than 90% of the total pollination. As bees can fly around the world and pollinate variety of flowers but there are some poisonous species of flowering plant that kills these bees, as they come in contact with a variety of species such as parasites, predators, diseases and highly toxic pesticides, chemicals present in the environment [1]**.** There are many factors that have a negative impact on the health and well-being of honey bees, including the spread of pathogen and parasite, loss of habitat, reduced access or quality of food resources, climate change, low queen bee status, changing trade practices, and exposure to apicultural and agricultural pesticides both in beehives and in the field. These factors are often closely linked, and it is agreed that a single stressed bee can cause a colony loss. There is a growing consensus, though, that increasing the share of pathogens and parasites is among the most threatening effects of bee control. Unfortunately, beekeepers' poor colony management may increase parasite numbers and disease spread; also, research is still gathering data on the harmful and complex relationships that exist between bee protection and pesticide exposure. In both developed and developing countries, a considerable amount of the land is used for agricultural activities, and pesticides of various kinds are administered on a regular basis to enhance crop productivity [2]**.** In order to reduce the risk to bees and other pollinators, an understanding of need-based and judicious pesticide use must be explored. This review paper is all about the effect of pesticide on bees and other pollinators and interaction between pesticides and pollinators and management of pesticide to avoid bee poisoning

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EXPOSURE ROUTE FOR DIFFERENT PESTICIDES

Different types of pesticides are applied to the plant in so many ways to save the plant from various substances such as insects, weeds, rodents etc. According to pesticides nature the three main uses for herbicides are as follows: Direct spraying, often used in gardens and houses. Soil loading and seeding methods are often used in large-scale treatment programs. These different methods of fertilizer play a role in the chemical exposure of pollinating insects to plants [3].

During pesticide application, specifically dust formulations, they gets stuck with the foragers. Sometimes, the systemic pesticides will translocate from root and will get stored in pollen and nectar. The visiting forager bees which collecting pollen and nectar will be affected by contaminated plant materials. The bees which are exposed to these could die immediately near to their hive or they may encounter the behavioural changes (learning, memory, mobility, egg lay, sperm count). Apart from that, carrying and storing of sub-lethal dose of pesticides in the beehive will contaminate the entire colony [2].

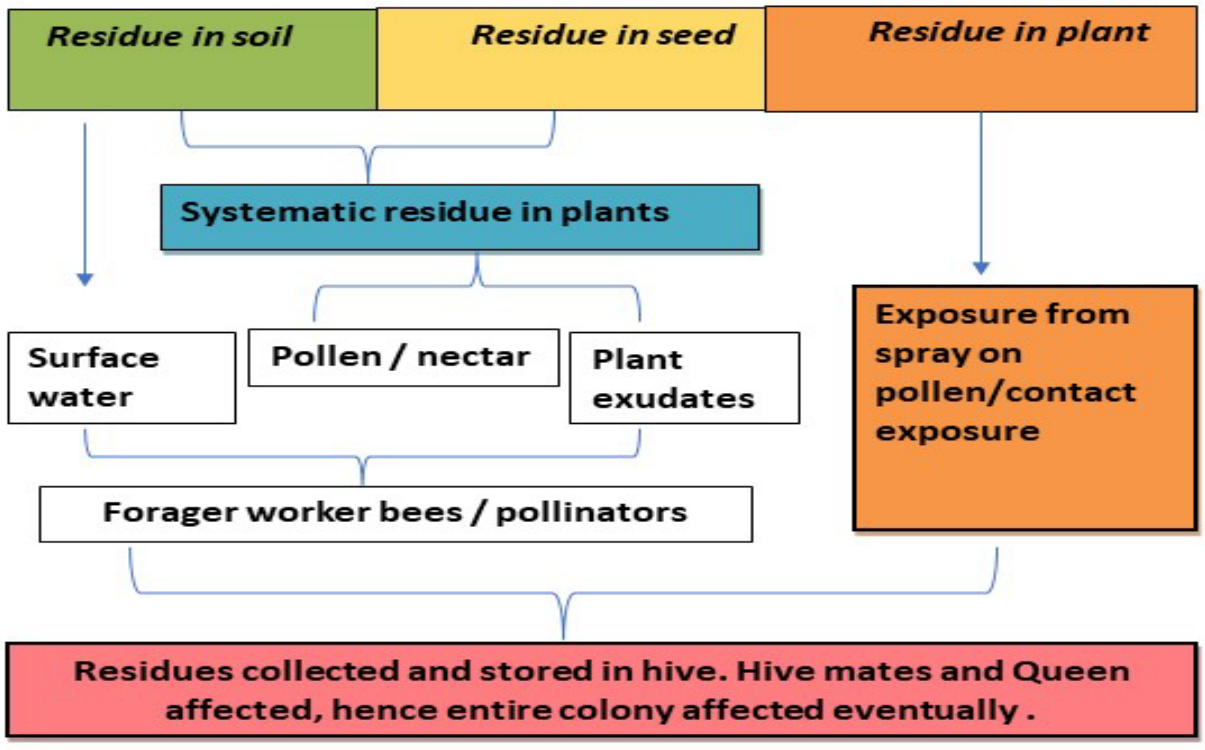

Figure 1: Representation of exposure route for different pesticides to bees.

Therefore, on the basis of different application methods and the perseverance of different pesticides in nature, honey bees get exposed to different pesticides through these

major routes: Direct application with chemical at the time of foraging on a treated plant, wind drifting through the pesticide particles of dust formulations sticking to the bees colony, Runoff of pesticides from the treated fields to nearby reservoirs, pesticidal drift to non-treated foraging plants growing close to the treated crop, residues of pesticides in pollen through treated material etc. Most of the time, exposure of pesticides to bees is due to the absorption of contaminants found inside the pollen and nectar of visiting flowers [4]. Chemical residues in the pollen and nectar carried by bees to their colonies and would sustain in the hive cells for a long time as brood food and diets for queen bee [5, 6]. Another way to exposure is direct exposure with many pesticides when used as sprays on crop plants, however the herbicides and fungicides are sometimes sprayed directly into the soil before planting. In these cases, due to drifting of pesticides contaminants and droplets from the application will fall directly on the flying bees [7]. One drop of pesticide can kill seventy-eighty bees because spray solutions contain concentrated doses of those chemicals, this is a common cause of bees decline [8]. Insecticide-treated pesticides in the soil unit (e.g., herbicides) have no direct exposure to honey bees. Bees are exposed to pesticides when they come into contact with infected water Bees consume water in addition to food to regulate their body temperature [9]. Honey bees and other bees like to drink from fresh water sources such as irrigation canals, lakes, and streams, and become poisoned when this water is contaminated with chemical residues [10]. Chemical residues in the soil eventually reach the water and mingle with agricultural streams and lakes, as well as water sources utilized for irrigation in agriculture, becoming contaminated with a mixture of agrochemicals **[11, 12, 13].**

Table1. List of pesticide affecting bees [14]

COMMON NAME OF INSECTICIDE	PESTICIDE CLASS	EXPOSURE TIME	BEE TOXICITY
6	CHLORINATED	2 HOURS	HIGHLY TOXIC
CARBOFURAN	CARBAMATE	7-14 DAYS	HIGHLY TOXIC
ACEPHATE	ORGANOPHOSPHATE	3DAYS	MODERATELY TOXIC
FIPRONIL	PHENYLPYRAZOLE	4 HOURS	HIGHLY TOXIC
CYPERMETHRIN	PYRETHROID	LESS THAN 2 HOURS	HIGHLY TOXIC
THIAMETH-OXAM	NEONICOTINOID	13 WEEKS	HIGHLY TOXIC
METHOMYL	CARBAMATE	2 HOURS	HIGHLY TOXIC
ENDOSULFAN	CYCLODIENE	8 HOURS	MODERA-TELY TOXIC
PROPOXUR	CARBAMATE	14-50 DAYS	HIGHLY TOXIC

AZINPHOS-METHYL	ORGANOPHOSPHATE	2.5DAYS	HIGHLY TOXIC
ENDOSULFAN	CHLORINATED	8 HOURS	MODERATELY TOXIC

MANAGEMENT PRACTICES TO PROTECT BEES FROM PESTICIDE

Insect pests, diseases, or any other environmental factor attack crops at different stages of their growth. Pesticides should only be applied after assessing the fields for the presence of weeds, insect populations, or disease frequency at threshold levels. This helps to keep beneficial insects and insect pollinators alive and well. Insecticides should only be used on crops that are severely damaged. Additionally, utilise pesticides that are less hazardous or poisonous to honey bees. For the protection of pollinators and other beneficial non-target creatures, we should observe pesticide application principals discussed as following.

Never put pesticide on a crop that is about to blossom. Pesticides should not be used on blooming crops; instead, they should be sprayed only when absolutely essential. The use of the safest insecticide formulation is as follows: Granular formulations are always the safest for bees. Dusts pose a greater threat to bees than sprays, although emulsifiable and water-soluble concentrations do not. Granular formulations are safer for bees because they transport pesticides to the lowest parts of the plant canopy, limiting direct pollinator contact with flowers.

Select the most appropriate application method: The most common way for foragers to be exposed to pesticides is through spary drift. Pesticides applied on the ground are safer than those applied from the air. If at all possible, soil treatment is preferable to direct application on plants for pest and disease management. Fine sprays are always thought to be safer than coarse ones. Pesticides with a biorational or botanical origin are thought to be less dangerous to bees.

Bees can also be deterred from foraging on the treated crop by using repellents.

Because bees and other foragers are most active between sunrise and an hour or two before sunset, pesticides should not be applied while the crop or nearby crop is flowering or bees are visiting. Most honey bees forage within a 2–4 km radius of their hive, but when local pollen and nectar sources are short, they may go as far as 7 km or more in search of pollen and nectar. To minimise pollinators coming into direct touch with insecticides, treatment should take place largely in the early evening hours. The late application of pesticides permits these chemicals to degrade completely or partially during the night.

Don't pollute water around the hive: Bees need water to keep the hive cool and feed the brood. Insecticides should never be used in standing water, nor should the contents of a spray tank be poured onto the ground, resulting in puddles (Sanford 1993). Bees and other pollinators are poisoned when they come into direct contact with a contaminated puddle to drink the water.

Pesticide dust and small particles must be safely disposed of. Bees may have the opportunity to capture randomly scattered dust during times of extreme scarcity. Bumble bees are substantially more vulnerable to

microencapsulated pesticides than any other formulation that has been created thus far. These poisons are easily carried to the hive by bees and can remain harmful for long periods of time due to their small size. Dusts are more harmful than liquid formulations because they can travel via the air current and reach and penetrate honey bee nests. ULV formulations, likewise, rove with the airflow and are even more harmful than traditional liquid formulations.

Provide advance notification of chemical treatment to beekeepers; colonies can be evacuated or wrapped loosely in burlap or coarse cloth to keep bees contained while allowing them to cluster outside the hive under the cloth. Sprinkle water every hour to avoid overheating [15]. Moving hives takes more than 24 hours on average, so farmers must give their neighbouring beekeepers plenty of notice. Only in this way can hive damage from drift be avoided. Plastic sheets should never be used to seal or cover colonies. In a bee hive, overheating can result in suffocation and death.

Seek for extra blossoming plants and weeds that can attract honeybees before spraying pesticides on a field: Before spraying pesticides on a field, look for additional blossoming plants and weeds that can attract honeybees. Despite the fact that the pesticide-treated crop was not in blossom, bees have been killed on several instances. These lovely blooms can often be mowed or otherwise removed, but this may result in the loss of other important insect habitat or the introduction of destructive insects into the crop [16].

To limit pesticide hazard, use integrated pest management (IPM) strategies: Using cultural, natural/biological/non-chemical methods of insect pest control will limit the need of poisonous/hazardous pesticides. IPM stands for Integrated Pest Management, and it refers to tactics that have been created to increase pest management while minimising hazards to beneficial species like pollinators. Pest control is combined with an understanding of a species' underlying ecology and the environment in which it flourishes in IPM. One suggestion is to avoid using pesticides, such as insecticides and fungicides, when ornamental plants that attract bees are in flower (e.g., heather, lavender, linden, rhododendron, and rose). Pesticides should also be applied "just after flower petals have fallen, when ornamental plants are less appealing to bees," and all pesticide label requirements for bee protection should be adhered to [17].

Here are a few key techniques for preserving bees and avoiding bee poisoning. Recognize the various types of honey bees that live in the area and learn how to protect them. Many honey bees, alkali bees, honey bees, bumble bees, and other honey bees go through scientific modifications. During pre-sprout, avoid using insecticides or miticides with a long residual time or precise movement [18, 19, 20]. Pesticides, especially insecticides and miticides, should not be used on flowering plants. Keep pesticides away from developing plants, including weeds, in the area. Also keep away from pesticide float to local sprouting plants including weeds. If a herbicide or fungicide application is justified during blossom and permitted by the name and guideline make the application among dusk and 12 PM when honey bees are not active. Be aware that, unlike bumble bees, honey bees are not active. Know that, unlike bumble bees who return to their colony at night, a few honey bees spend the night on plants or in the soil at the site.

Any pesticide should not be sprayed directly on honey bees, bee colonies, or settling areas [21]. Make sure the tool's spouts are turned down when it's close to bee colonies or settling areas, and that any hives or honey bee boxes are removed from the area before using it. Remove or cover water sources before spraying pesticides, or offer fresh, clean water afterward. Use appropriate chemigation management practices to avoid honey bee exposure to pesticide-contaminated water dribbles or puddles, which may attract water-gathering honey bees. Prevent pesticide-tainted residue from forming when sowing pesticide-treated seed or spraying pesticide granules or pellets. Ascertain that all stakeholders are informed about rural splashes, so that beekeepers are always aware of upcoming application and implements are fully educated about the parameters required area, materials, technique, and application timing. Pesticides were used to take care of the yields' quality and to restrict the use of pesticides. For applications where plants, especially weeds, are blooming, avoid mixing herbicides with other pesticides, in the same tank. Examine labels carefully before deciding which insecticide to use, and make sure you understand and agree to any relevant state and local regulations. The residual characteristic of pesticides after spraying should be examined because it can remain anywhere from hours to more than seven days, causing serious harm to honey bees.

Finally, an improved comprehension of bee pesticide issues should encourage all stakeholders to take the necessary steps to prevent chemical impacts on bees and apiarist productivity. First and foremost, such initiatives must attempt to manage the use of agrochemicals in a way that does not negatively influence other land users. Farmers should also limit chemical contamination of the surrounding landscapes, especially water bodies, because pollinator species other than honey bees (such as butterflies, bumblebees, hoverflies, and others) could be damaged.

References

[1] Ollerton J, Winfree R and Tarrant S 2011. How many flowering plants are pollinated by animals? *Oikos* **120**(3):321-326. DOI: 10.1111/j.1600-0706.2010.18644.x

[2] O'Neal ST, Anderson TD and Wu-Smart JY 2018. Interactions between pesticides and pathogen susceptibility in honey bees. *Curr Opin Insect Sci*. **26**: 57-62. doi: 10.1016/j.cois.2018.01.006. Epub 2018 Feb 2. PMID: 29764661.

[3] Krupke CH, Hunt GJ, Eitzer BD, Andino G and Given K 2012. Multiple routes of pesticide exposure for honey bees living near agricultural fields. *PLoS One*. **7**(1):e29268. DOI: 10.1371/journal.pone.0029268

[4] Sánchez-Bayo F and Goka K. 2014. Pesticide residues and bees – A risk assessment. *PLoS One* **9**(4): e94482.

[5] Kubik M, Nowacki J, Pidek A, Warakomska Z, Michalczuk L and Goszczynski W 1999. Pesticide residues in bee products collected from cherry trees protected during blooming period with contact and systemic fungicides. *Apidologie*.**30**: 521–32.

[6] Orantes-Bermejo FJ, Pajuelo AG, Megías MM and Fernández-Píñar CT 2010. Pesticide residuesin beeswax and beebread samples collected from honey bee colonies (*Apis*

mellifera L.) in Spain. Possible implications for bee losses. *J Apicult Res*; 48(1): 243–50

[7] Craig I, Woods N, Dorr G 1998. A simple guide to predicting aircraft spray drift. *Crop Protection* **17**(6): 475–82

[8] Marinelli E, De Pace FM, Belligoli P and Oddo LP 2004. Biomonitoring by bees. Tests in Latium region. Redia **87**: 207–10

[9] Schmaranzer S 2000. Thermoregulation of water collecting honey bees (*Apis mellifera*) *J Ins. Physiol*. **46**(8): 1187–94.

[10] Samson-Robert O, Labrie G, Chagnon M and Fournier V. 2014. Neonicotinoid-contaminated puddles of water represent a risk of intoxication for honey bees. *PLoS One*; **9**(12):e108443.

[11] Woods N, Craig IP, Dorr G and Young B 2001. Spray drift of pesticides arising from aerial application in cotton. *J Environ Qual* **30**(3): 697–701.

[12] Belden JB, Gilliom RJ, Martin JD and Lydy MJ 2007. Relative toxicity and occurrence patterns ofpesticide mixtures in streams draining agricultural watersheds dominated by corn andsoybean production. *Integr. Environ. Assess. Manag*. **3**(1): 90–100.

[13] Siebers J, Binner R and Wittich KP 2003. Investigation on downwind short-range transport of pesticides after application in agricultural crops. *Chemosphere*. **51**(5): 397–407.

[14] **http://extoxnet.orst.edu/tics/ghindex.html** Accessed 24 May 2021.

[15] Sanford MT 1993. Protecting honey bees from pesticides. Cooperative Extension Service, University of Florida, https://pesticidestewardship.org/wp-content/uploads/sites/4/2016/07/PROTECTING-HONEY-BEES-Florida.pdf

[16] Casella, MI 2016. Beekeeper Notification for Pesticide Applications. https://plant-pest-advisory.rutgers.edu/beekeeper-notification-for-pesticide-applications/ Accessed 15 July 2021

[17] WSDA 2013.Washington State Department of Agriculture, 10 Ways to Protect Bees from Pesticides, AGR PUB 701-388, https://agr.wa.gov/getmedia/6144c435-c1ad-4092-afe3-436bdd627e41/388-tenwaystoprotectbeesfrompesticides.pdf

[18] Abrol DP and Sharma D 2007. Morphogenic and toxic effects of pesticides on honeybee brood. *J. Research, SKUAST*-J, **6** (2): 133-148.

[19] Abrol DP and Kumar A 2009. Foraging activities of *Apis* species on strawberry blossoms as influenced by pesticides. *Pak. Entomol*., **31**: 36-41.

[20] Christian HK, Gregory H and Rick EF 2012. Protecting honey bees from pesticides. *J. Apiculture Sci. **24**: 156-16*

[21] Goulson D 2013. An Overview of the Environmental Risks Posed by Neonicotinoid Insecticides, *Journal of Applied Ecology*, **50**: 4 (4): 977–987.