Bee Keeping in Intensive Agriculture: Impact of Agrochemicals

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Abstract

Application of agrochemicals for the management of pests, diseases and weeds are inevitable in the intensive agriculture. These agrochemicals applied on the crop land cause adverse effect to the bees and bee keeping practices. Since honey bees considered as ecological indicator, complete eradication of honey bees intern leads to miserable failure of agriculture and pose threaten to food security. Review on impact of agrochemicals is necessary to know the status of beekeeping in intensive agriculture area and to derive the concrete decision or policy decision on use of agrochemicals in the intensive cropping area.

Introduction

One-third of the total human food supply depended on animals and insects, including honey bees pollination. Farmers use different external inputs, including pesticides, to grow subsistence and commercial crops of different varieties for agricultural crop maximization. Honeybees are economically essential insect pollinators in all over the world. Production of agriculture crops is increasing up to 50 through pollination processes by the honeybees. In addition, the unpredictable vagaries of weather parameters that could affect flower production. Further, another threat is agrochemicals which are regularly used over large areas of crops, fruit groves, forests and other environments for the management of weeds, insect pests and plant diseases. Broad spectrum fungicides and neonicotinoids are commonly used in agriculture and have been found in bee bread, beeswax and foraged environment. There was no doubt, the chemical insecticides could represent a serious threat to bees for the simple reason that bees are insects and, therefore, susceptible to any poison designed to kill insect pests. The decline of beneficial insects includes honeybees is a side effect of the practice of protecting crops against undesirable insects through pesticide use.

Flowers and foraging

The expansion of cultivation areas, especially fields planted with a single plant species, promotes the emergence of pests and diseases which make agriculture even more dependent on agrochemicals. These products enter the soil-water-plant chain and represent a direct and indirect dangerous source of contamination to bees, which, in their turn, contaminate their products. Bees are the most prolific pollinators in nature. They spend the majority of their time searching for pollen and nectar as they are the main sources of food for themselves and their young. Foraging honey bees may fly 2–5 miles (3.2–8 km) from their colony in any direction in search of resources. Flowers that have evolved to attract bees as their main pollinators often are full of nectar and colored bright white, yellow, or blue. Temporal and spatial variation of flower resources affects foraging decisions of wild and honey bees. Field bees are the individuals most likely to be exposed to pesticides because they forage outside the hive. While foraging, honey bees collect pollen from flower anthers and nectar from plant blossoms and extra-floral nectarines. Honey bees typically forage during daylight hours when temperatures are above 55°F (12.8°C), and they reduce their activity at dawn and dusk and during inclement weather.

Influence of agrochemicals

Honey bees play a vital role in crops, wildflowers pollination. Pesticide refers to a wide range of compounds including insecticides, herbicides, fungicides, rodenticides, molluscicides and plant growth regulators. In recent years, honey bee populations have been declining worldwide due to regular exposer to various agrochemicals such as herbicides, fungicides, acaricides and most importantly insecticides. A single droplet of insecticide may be sufficient to kill a bee because the spray solutions contain concentrated doses of these chemicals. The more attractive yellow flowers are

canola (rape seed oil), sunflowers and many weeds that grow in and around the crops compared to flowers of potato. Pesticide sprayed on the above-mentioned crops have residues in pollen and nectar are taken by the forager bees to their colonies and remain in the beebread and honey for quite some time. These residues are then fed to the larvae and the queen, which are affected in similar ways as the forager bees. Honey bees, bumblebees and wild bees like to drink from puddles, irrigation ditches, ponds and streams, and if these waters are contaminated with pesticide residues, the forager bees ingest them as well. In this case, bees come in contact with the high residue levels present on the waxy cells of the comb, affecting mainly the developing larvae and presumably the adult honey bees and the queen. Despite, many studies have revealed that honey bee (*Apis mellifera* L.) larvae are posting a high risk on exposure to pesticides. As a fungicide, chlorothalonil may affect the fungal community in the honey bee gut. Bees are very vulnerable to agrochemical stress because they have a limited number of detoxifying enzymes compared to other insects. Even if agrochemicals do not cause the immediate death of bees, they may have sub-lethal effects on them, such as disrupting their forging ability and making it more difficult for them to return to the colony, or they may bring agrochemicals back with them, weakening or even causing territorial mortality. Different classes of insecticides namely neonicotinoids, pyrethroids, chlorantraniliprole, spinosad, flupyradifurone and sulfoxaflor not only negatively affect the growth and development of honey bee but also decrease their foraging activity and pollination services by influencing their olfactory sensation, memory, navigation back to the nest, flight ability, and dance circuits etc

Toxicity of pesticide

The term biocide is reserved for broad-spectrum poisons that kill any organism, mainly microbes, but also large animals. Beekeepers should be wary of any insecticide application in the vicinity of their hives because spray drift could certainly inflict a heavy toll on the bees because by their nature, insecticides are the most toxic compounds to honey bees. Like other animals, bees are endowed with detoxification mechanisms that transform, eliminate most toxic chemicals. The majority of organic pesticides are degradable either in the organisms themselves or in the environment some exceptions are organochlorine pesticides (DDT and lindane), which are very persistent and recalcitrant. Due to their application in large quantities during past decades, their residues are still present although at low levels in the soils. Systemic insecticides, such as neonicotinoids (e.g. imidacloprid) and fipronil, are more toxic and persistent than the majority of organophosphorus (e.g. malathion), carbamates (e.g. carbofuran) and pyrethroids (e.g. cypermethrin). The toxicity of certain insecticides can be enhanced in the presence of ergosterol-inhibiting fungicides (e.g. propiconazole, myclobutanil), which act as synergists.

Given the enormous variety of agrochemicals used in crop production, it is not surprising that, to date, residues of 173 different compounds have been found in apiaries. It should be realized that through the various routes of exposure to pesticides in the environment, bees are not threatening by one or two chemicals alone but by cocktails of many agricultural compounds. The activity of some pyrethroids is enhanced by fungicides classified as ergosterol biosynthesis inhibitors while the fungicide propiconazole increases the toxicity of the pyrethroid insecticide, lambda-cyhalothrin, when the two are mixed. Chronic exposure to acetamiprid was found to have an effect on the expression of genes related to immune, detoxification, and memory in larvae and adults of bees.

Chronic pesticide exposure may include lethal and sublethal effects on the brood, workers, drones, and queens, who may be killed or rendered infertile. Sublethal effects of pesticides include physiological effects that impact enzyme activity and brain activity that led to impairment of olfaction, learning, and memory. Fipronil´s high toxicity is due to the mechanism which interferes with the functioning of the neurotransmitter GABA (amino-butyric acid) and which breaks the normal neuronal influx (chloride ions passage), causing excessive excitation, severe paralysis and death. Commercially known as Regent,

the insecticide fipronil belongs to the pyrazole class used to control agricultural pests. Nevertheless, the agrochemical affects non-target insects and causes the mortality of important pollinators such as *Apis mellifera* L.

Decline of pollinators

Over the past few decades, we have seen a measurable loss in the number of both managed and native bee populations, along with a decline in butterfly populations. We depend on pollination for many of our staple foods, as do many other organisms. Approximately one-third of the food produced globally is dependent on pollinating insects. It is estimated that pollinators contribute $24 billion to the agricultural economy. The decline in pollinators can be attributed to many different factors. Land development often greatly reduces or eliminates habitats needed by pollinators. Insecticides are highly toxic to bees and butterflies. Herbicides used by farmers and homeowners kill many of the flowering plants bees and butterflies depend on. Inadequate diets, loss of genetic diversity, and parasitic mites in managed honey bee colonies may also play a role in their decline.

Bees poisoning may occur by contact or ingestion during flower visiting. During forage, bees get in touch with different groups of agrochemicals, such as insecticides, fungicides, acaricides and herbicides. However, the effect of insecticides on the pollinator fauna of agroecology systems has been well shown and is directly responsible for the decline of bee populations and indirectly for economic losses owing to the population decline of pollinators. Agrochemical group of insecticides acts directly upon the nervous system and causes over activity of neurons, or rather, those connected to learning and memory, and, as a consequence, may change brain structures with paralysis of leg, wings and digestive tract. Insects stop consuming water and food and, consequently, die from starvation or dehydration. The effect of insecticides on the agro-ecosystems pollinator wildlife has been well evidenced, being directly responsible for the reduction of bee populations and indirectly for economic losses as a result of the insects´ population decline.

Conclusion

Farmers should minimize the contamination of insecticide, fungicide and herbicide (higher doses, repeated use, combined application) to the surrounding landscapes, including water bodies, because not only affect the honey bees but also a large array of pollinator species (e.g. butterflies, bumblebees, hoverflies, etc.).

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