Pesticide's Dangers to Wildlife and Safeguard Dealings in Reducing of the Risks

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Abstract

This paper addresses the effects of various pesticides on nontarget organisms including wildlife, fish and honeybees and safeguard dealings in reducing of risks. Pesticides are the only toxic substances released intentionally into environment to kill pests. This includes substances that kill weeds (herbicides), insects (insecticides), fungus (fungicides), rodents (rodenticides) and others. A side effect of usage of some pesticides results in unfortunate consequences to our nontarget organisms. Wildlife animals usually live in a natural environment including those hunted for food, sport or profit, especially mammals, birds, fishes, amphibians and aquatic insects that are neither human nor domesticated. Directly, wildlife can be exposed to pesticides by eating contaminated food or water, breathing pesticide spray or absorbing pesticides through their skin. Indirectly, predators such as hawks and others can become poisoned by eating other animals that have been exposed to pesticides. For the reason that many insecticides affect the nervous systems of wildlife, exposure to a particular insecticide can affect animals indirectly, by interfering with their ability to survive or reproduce. Before making a pesticide application, it is important to become familiar with the area to be treated and its surroundings. Some pesticides are more environmental friendly than others and may be selected for sites where there are special concerns, and choose a product that is least toxic to nontarget organisms. As with any pesticides application, take precautions with drift, evening or night is the safest time of day for applications, early morning would be fairly safe, and midday has the greatest potential for toxicity concerns. Bees are essential for pollination of many fruit crops that can be harmed by some pesticides used to manage insects, mites and diseases in fruit crops. Growers can reduce pesticide risk to bees through the approaches to develop and implement a pollination contract with beekeepers. Select the least toxic pesticides and formulations when possible, reduce drift onto areas outside crop fields, remove flowering weeds from crops and provide bee-friendly habitat away from crops. Use integrated pest management (IPM) to reduce the need for sprays, avoid pesticide sprays during crop bloom, apply pesticides after sunset or before sunrise, or when air temperature is below 50°F. Integrated pest management practices include using cultural controls, planting pest resistant varieties, scouting fields to monitor pest populations, biological control and using insecticides only when other control measures fail to keep pest numbers or damage below levels which cause economic crop loss.

Keywords: Pesticides and Wildlife, Pesticides Harm, Endangered Species, Application Hazards, User Ethics

1. Introduction

The use of toxic pesticides to manage pest problems has become a common practice around the world. Pesticides are used almost everywhere not only in agricultural fields, but also in homes, parks, schools, buildings, forests and roads. It is difficult to find somewhere where pesticides are not used from the bug spray under the kitchen sink to the airplane crop dusting acres of farmland, thus the world is filled with pesticides. In addition, pesticides can be found in the air where peoples breathe, the food eaten and the water everyone drinks (Sarwar, 2015 a; 2015 b; 2015 c; 2015 d; 2015 e). Wildlife traditionally refers to non-domesticated free-ranging animals and birds species that could be hunted for sport or food, but technically has to take account of all members of the animal kingdom including mammal, bird, fish, amphibian, reptile, mollusk, crustacean, arthropod, or other invertebrates that live wild in an area without being introduced by humans. Wildlife can be found in all ecosystems such as cultivated fields, deserts, forests, plains, grasslands and other areas including the most developed rural or urban sites, wherein all have distinct forms of biota. The chemicals could kill all the wildlife and the key to wildlife management is that all resource management decisions should be based on creating and maintaining sufficient habitat to enhance or improve and support suitable populations of desired wildlife species in a manner consistent with habitat carrying capacity of territory. The eventual outcome in meeting desired management goals is accomplished by manipulating the habitat, manipulating the wildlife population and managing people's activities (Diamond, 1989; Meyer, 1993; Geist et al., 2001; Organ et al., 2012).

2. Background

Pesticides are widely used in agricultural production to prevent or control pests, diseases, weeds, and other plant pathogens in an effort to reduce or eliminate yield losses and maintain high product quality. Although pesticides are developed through very strict regulation processes to function with reasonable certainty and minimal impact on human health and the environment, serious concerns have been raised about health risks resulting from occupational exposure and from residues in food and drinking water. Regarding the adverse effects on the environment (water, soil and air contamination from leaching, runoff and spray drift, as well as the detrimental effects on wildlife, fish, plants and other non-target organisms), many of these effects depend on the toxicity of the pesticide, the measures taken during its application, the dosage applied, the adsorption on soil colloids, the weather conditions prevailing after application, and how long the pesticide persists in the environment (Damalas and Eleftherohorinos, 2011). The organochlorine applications have received special attention due to their toxic effects in vitro, lab animals, and wildlife (Dickerson et al., 1998).
The most obvious effects of pesticides on these organisms are direct effects of acute poisoning. At times, pesticides are solely blamed for fish kills, in many cases, however, the indirect effects of pesticides, such as causing dissolved oxygen depletion, are the reason for the kill. Pesticides can enter water sources through drift, runoff, soil erosion, leaching and occasionally by accidental or deliberate release. Pesticides can be classified as very highly or highly toxic to fish and pesticides that range in concentrations of less than 0.1 to 1.0 ppm can kill fish. Pesticides can also kill birds in several ways, including direct ingestion of granules, baits, treated seeds and direct exposure to sprays. Indirect bird kills may result from consumption of treated crops, contaminated water, or feeding on contaminated prey. Birds and other wildlife can be poisoned when baits, such as those targeting rodents, are improperly placed or not recovered in a timely fashion. Pellet and granular-formulated pesticides may be mistaken for food and consumed by birds and other wildlife. Pesticides are also classified as very highly to highly toxic to birds and these pesticides have bird acute oral LD_{50} values ranging from less than 10 to 50 mg/ kg of body

weight. Some pesticides have been implicated in negatively affecting the reproductive potential of certain birds and wildlife, and have been banned (Fishel, 2005; 2014).

Obviously, exposure to pesticides poses a continuous health hazard, especially in the agricultural working environment. By their very intense nature most pesticides show a high degree of toxicity because they are designed to kill certain organisms and thus create some risk of harm. Within this context, pesticide use has raised serious concerns not only of potential effects on human health, but also about impacts on wildlife and sensitive ecosystems. Often, pesticide applications prove counterproductive because they kill beneficial species such as natural enemies of pests and increase the chances of development of pest's resistance to pesticides. Therefore, before any pesticide can be used commercially, several tests are conducted that determine whether a pesticide has any potential to cause adverse effects on humans and wildlife, including endangered species and other non-target organisms, or potential to contaminate surface waters and groundwater from leaching, runoff and spray drift. Effects in any non-target species may translate into ecosystem unbalance and food-web disruption that ultimately may affect human health and edible species (Stoate et al., 2001; Berny, 2007).

Exacting standards are necessary for consistency in the evaluations of pesticide safety and also for the comparisons among chemicals. Ecological risk assessments to determine what risks are posed by a pesticide and whether changes to the proposed uses of the product are necessary to protect human health, wildlife and the environment. To evaluate the environmental risks of a pesticide product, scientists of the registration authority look at all the data together. If the risk assessment indicates a high likelihood of hazard to wildlife or any phytotoxicity to non-target plants, the registration authority may require additional testing and extra data or require that the pesticide be applied only by certified individuals (i.e., restricted use). Alternatively, the registration authority may decide not to allow its use (Power, 2010).

3. Pesticides Harm to Wildlife

Most insecticides kill insects by damaging their central nervous systems and can harm wildlife in the same way. Wildlife may be exposed to insecticides by breathing the chemical, swallowing contaminated food or water, absorbing the chemical through the skin or feathers, or by swallowing the chemical when grooming. Some birds may eat granular insecticides, mistaking them for seeds or grit. Some animals may become sick or die when exposed to pesticides. This is a lethal effect and it is measured as the particular chemical's toxicity. The toxicity of a pesticide to animals is commonly expressed as either its LD_{50} (lethal dose) or LC_{50} (lethal concentration). The LD_{50} of a particular chemical is the dose that kills 50 percent of the animals exposed to it. The LC_{50} is the concentration of the chemical in the diet, air or water required to kill 50 percent of the animals exposed. Both LD_{50} and LC_{50} are different for every animal species and are determined by laboratory research, and for any species, the lower the LD_{50} or LC_{50} the higher the toxicity. Wildlife also may suffer sublethal effects from pesticides and in such cases they do not die, but their behavior may be altered or their survival or reproductive abilities are affected. For example, in one study, bobwhites that received sublethal doses of the insecticide terbufos (Counter) suffered higher mortality from predators. This kind of sublethal effect of pesticides is difficult to measure and may be underestimated (European Commission, 2004; Pereira et al., 2009).

3.1. Past Pesticides and Wildlife

Public should study the past, and apply it to the present, so that these may affect the future. The most common pesticides widely used in the past appeared the organochlorine compounds (DDT, aldrin, dieldrin and others) and eventually, environmental problems associated with their use became apparent. One problem is that organochlorine compounds, sometimes referred to as chlorinated hydrocarbons, are very persistent in the environment and may take years to dissipate. Most organochlorines are relatively insoluble in water and can be carried from fields into streams by heavy rainfall. Also, these chemicals bioaccumulate that is they accumulate at successively higher concentrations in animals higher up in the food chain. For example, concentrations of the insecticide DDT might be as low as 0.02 parts per million (ppm) in plankton, but 900 ppm in small fish, 2,000 ppm in larger fish, and even greater in fish-eating birds such as gulls or bald eagles. Such accumulations caused egg shell thinning in many birds of prey such as bald eagles, brown pelicans and peregrine falcons, so that when contaminated birds attempted to incubate their eggs, the eggs often broke under the bird's weight. The widespread use of organochlorine insecticides contributed to the decline of these birds. Fortunately, most organochlorine compounds have not been used in certain states and consequently, populations of eagles, falcons and brown pelicans are improving. Exposure to pesticides may pose particular problems for certain endangered species. In fact, the presence of threatened or endangered plants or animals may restrict the use of pesticides in certain areas of the state (Rattner, 2009; Kohler and Triebskorn, 2013).

3.2. Present Pesticides and Wildlife

Herbicides account for 70 to 80 percent of all pesticides used, but only a few herbicides are acutely toxic to wildlife and they can have a major effect on wildlife habitats. Insecticides are more acutely toxic to wildlife and most of the insecticides in use today are organophosphates (malathion, parathion, dimethoate) or carbamates (aldicarb and carbofuran). While these chemicals do not tend to bioaccumulate or persist in the environment, so most are more acutely toxic than the organochlorine compounds. Pesticides from these two groups are most often associated with wildlife kills. The newest group of insecticides, the synthetic pyrethroid compounds, includes such products as esfenvalerate, cyfluthrin and cyhalothrin. Synthetic pyrethroids usually are only slightly toxic to birds and mammals, but are extremely toxic to fish and other aquatic animals (Vyas, 1999; Maxwell and Hokit, 1999; Vyas et al., 2003).

3.3. Future Pesticides and Wildlife

Pesticides might continue to be an integral part of agriculture, at least for the near future. However, broad-spectrum pesticides likely can be replaced by compounds that are more selective and environmental friendly. The use of microbial insecticides can be increased and these contain bacteria, fungi or viruses which attack insects, for example, the most common biological insecticide is *Bacillus thuringiensis,* which is practically non-toxic, non-pathogenic, and little to no direct toxicity to non-target organisms, no evidence of a disease outbreak among wild animals and have minimal toxicity to honeybees. Biological insecticides usually are highly selective in the organisms and nonhazardous to birds, mammals and fishes. Other biological controls being developed involve the use of parasites, predators and pathogens to control insect pests. Common examples include parasitic wasps and beneficial predators such as lady beetles, green lace wings and predatory mites (Sarwar, 2015 f; 2015 g; 2015 h).

Herbicides and Wildlife

Most herbicides are only slightly toxic to wildlife with a notable few exception, thus, while herbicides rarely have lethal effects, they can affect wildlife populations indirectly by altering the structure of the habitat. Many species of weeds and brush provide important food or shelter for wildlife; thus, care should be taken to protect wildlife habitats when applying herbicides. Risks can be minimized by following user ethics wherein every pesticide user has a legal duty to use chemicals according to label directions. Failure to use pesticides according to label directions not only jeopardizes wildlife, but also exposes the pesticide user to criminal liability and may ultimately result in further restrictions on pesticide use. Peoples should do their parts to see that pesticides are used responsibly according to label directions (Surgan et al., 2010). The needs for wildlife should always be considered when planning control programs before using chemicals such as, is herbicide use the most appropriate control method considering the site, wildlife species present and the land manager's goals; what amount of land, density, composition and arrangement is necessary to provide the most desired land for wildlife; and what management actions are needed to improve vegetation for the sake of livestock or wildlife (Jackson, 2006).

5. Pesticide Toxicity to Bees

The potency of a toxic chemical to wilflife is usually gauged by its lethal median dose (LD_{50}), median lethal concentration (LC_{50}) or median effective concentration (EC_{50}) to surrogate species belonging to common taxa i.e. , fish, mammals, birds, crustaceans, worms and bees. With the exception of insect pests, which are the target of the insecticides, all other species and taxa are considered non-target organisms. It is a fact that different species within the same taxonomic class can vary considerably e.g., one or two orders of magnitude, in susceptibility to a given toxicant, so for selection of representative test species standard testing protocols is important (Wu et al., 2007).

Most fruit plantings are visited by a community of wild bees that live in and around the farms and gardens where fruit crops are grown. Many types of bees contribute to the pollination of fruit crops. Some of these are wild and unmanaged, providing a natural source of pollination and others can be managed using nesting structures that enable growers to have a high abundance of bees in the local area. A variety of wild bee species are active throughout the growing season, and some of them are well-suited to provide pollination of crop flowers. Most of these species cannot be commercially managed because they nest in the ground. Some have been found nesting in the grass-free strips under the fruit crop or in adjacent habitat and these bees can fly to blooming crop plants within their flight range. Bee body size, nest location (above or below ground), flight season (what time of year the bee is active) and sociality (whether a bee is solitary or social) can all affect how bees are exposed to and affected by pesticides. Large-bodied bees, such as honey bees and bumble bees, can generally fly to greater distances than smaller bees in search of pollen and nectar resources. Honey bees have been found to fly more than a mile in search of rewarding flower patches, but many smaller wild bees fly no farther than the length of a football field in search of food. Larger bees may also be able to tolerate higher levels of certain pesticides than smaller bees, but their broader flight range means that they cover more ground and have the potential to be exposed to a wider variety of pesticides. The social structure of bees is another important aspect that determines how they respond to pesticides. Honey bees are the classic example of social bees that have a single queen laying eggs for the colony and many adult female offspring (workers) taking care of other tasks such as caring for brood and foraging for nectar and pollen. In contrast, many wild bee species are solitary, meaning that a single adult female lays eggs, cares for offspring and makes foraging trips. Social bees have the advantage of having many foraging bees across the landscape, if some bees die while foraging, the colony is likely to have other bees available to take their place. If a solitary bee is killed while foraging, there are no other adult females that can take its place. Symptoms of bee poisoning, shared by honey bees and wild bees, can include increased defensiveness, disorientation or confusion, lethargy, paralysis and abnormally jerky or wobbly movements. They may also include loss of navigational capacity, further reducing the number of foraging bees returning to their nest or colony. Bees may exhibit different suites of symptoms depending on the chemical to which they are exposed (Theiling and Croft, 1988; May et al., 2015).

6. Solution to Pesticides

It is needed to make our food, our air, our water, and our soil free from toxic chemicals. The real solution to our pest and weed problems lies in non-toxic and cultural methods of agriculture by not in pulling the pesticide trigger. Organically grown foods and sustainable methods of pest control are key factors to our families' health and the health of the environment (Matthews, 2006; Magkos et al., 2006; Dale et al., 2013).

6.1. Better Pesticide Testing

State and federal agencies should require stricter independent testing, including testing of synergistic effects of pesticides. Pesticides known or suspected of causing human health problems should be phased out.

6.2. Pesticide Usage Reduction

Provide technical assistance to farmers, local governments, businesses, and homeowners on non-toxic alternatives to pesticide use. This includes alternatives to nuisance spraying for mosquitoes and controlling West Nile virus and other pest problems.

6.3. Prohibit of Pollution

Ensure that aerial pesticide use does not pollute our waterways, and provision of our communities through strict rules governing spraying and buffer zones that prevent the harmful effects of drift. Prohibit the use of pesticides for purely aesthetic reasons; prevent pesticide applications to water bodies, and instead encourage using non-chemical methods of managing aquatic invasive weeds.

6.4. Reduction of Toxicity

Toxicity is an intrinsic quality of the insecticide and strictly speaking, it cannot be changed. In order to reduce the insecticide risk, is to choose and use lower-toxicity insecticides. To reduce the impact of pesticides use, it is important to calibrate and maintain the spraying equipment on a regular basis, control the quality of spraying, use lower (but still effective and allowed by label) dose rates, avoid repeated treatments of the same areas, observe the buffer zones around water bodies and human settlements and ensure the use of appropriate regulations. If a barrier or strip treatment is possible, this reduction of the insecticide coverage can also reduce the magnitude of exposure. To reduce the duration of exposure, one should apply the best practices, respect of spraying parameters, buffer zones, use of less persistent insecticides and again, avoid replicated treatments of the same area. Each of the chosen application strategies and techniques has its own advantages and disadvantages from human safety and environmental risk standpoint. For example, during aerial treatments environmental concerns are usually higher than during ground treatments because of larger areas sprayed, higher probability of uncontrollable drift and contamination of ecologically sensitive areas such as wetlands, national parks, fisheries, bee-keeping areas, nature reserves. During ground treatments, human health concerns are usually higher because they involve more (and often inexperienced) staff and more opportunities for exposure. In all cases, using good pesticide application practices is a very important factor in contributing to risk reduction and ensuring the follow up and control of this good application practice in the field is the key success to reduce the pesticide use concerns on the human health and environment.

6.5. Public Awareness and Information

It is important to keep the public informed about possible environmental and health effects of insecticides, before, during and after pest control operations. This is to ensure that precautionary measures are taken whenever needed but also to reduce any misunderstandings that may exist about the risks to wildlife.

6.6. Application Hazards and Drift

One of the greatest risks associated with pesticides is the movement of the chemical, through drift or runoff, from the target crop to adjacent wetlands or other sensitive habitats. Most pesticides are applied either as liquids (sprays) or granules. Spray should be applied under conditions that will minimize drift into sensitive habitats. Drift can be minimized by making ground rather than aerial applications, especially near sensitive habitats; using nozzles and spray pressures that produce large spray droplets; spraying when the wind will carry the chemical droplets away from sensitive habitats; not spraying when wind speed is more than 8 mph; and using a drift control agent. Use integrated practices to decrease pesticide use; use the pesticide least toxic to fish and wildlife and completely cover pesticide granules with soil, especially spilled granules at the ends of rows. Minimize drift when applying chemicals near fish and wildlife habitats; avoid spraying over ponds, drainage ditches or other wetlands; and use filter strips along drainages to decrease pesticide runoff into streams. Never wash spray equipment or containers where rinse water could enter ponds or streams. Granular pesticides are much less susceptible to drift, but they pose a special threat to some species of wildlife, especially seed-eating birds. Birds may mistake pesticide granules for grit or seed and it takes only a few granules of some insecticides to kill a sparrow-sized bird. When granules are applied, take special care to cover them with soil and completely disk under any spills.

6.7. Rotation of Chemicals

Rotate chemicals with a different mode-of-action, and do not use products with the same mode of action more than twice per season to help in preventing the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a number other than 1B. For mode-of-action, broad selectivity means it affects most groups of insects and mites; narrow means it affects only a few specific groups. Generally, toxicities are averages of reported effects and should be used only as a general guide. Actual toxicity of a specific chemical depends on the species of predator or parasite, environmental conditions and application rate. Scores include do not apply to blooming plants; apply only during late evening, night or early morning; and apply at any time with reasonable safety to bees.

7. Use of Integrated Pest Management

Many farmers and ranchers are seeking new ways to curb pesticide usage in order to address the many concerns. Leading farmers and ranchers are seeking new approaches to pest problems by employing integrated pest management (IPM). Thus, a growing culture of innovation addressing environmental and human health concerns is taking root. Integrated pest management is based on the coordination of scouting for pest and disease development and a combination of biological, cultural, mechanical and other tactics to minimize the amount of chemical inputs needed. Using IPM to inform pest management decisions can help to reduce the cost and frequency of treating pests and the need for spraying crops. This should help to lower the chance that wildlife and bees can be exposed to pesticide residues (Frangenberg, 2000; Baker et al., 2002; Chandler et al., 2008; Sarwar et al., 2012; 2013 a; 2013 b; Sarwar et al., 2015).

8. Conclusion

Wildlife is exposed to pesticides through many routes, including spray drift, skin contact even for non-users, and in food and drinking water. There is sufficient evidence that many pesticides, including some of those found in the waters around water bodies may be causing a range of adverse wildlife health effects, Action needs to be taken at a regulatory level to recognize the problems of ongoing high dose exposure of wildlife to the mixtures of pesticides, the effects of which are not adequately addressed by the standard risk assessment of individual pesticides. For this reason there is a move internationally to restrain wildlife from risk of pesticides and towards following of regulation on the basis of hazards. Integrated pest management and sustainable agriculture can benefit wildlife by reducing pesticide uses and increasing diversity. Always use the least toxic and least persistent products, do not spray during the breeding season for wildlife, do not wash pesticide application equipment in any body of water, and report any incident of wildlife mortality to the Department. Very strict laws have been enacted to protect wildlife and other nontarget organisms, so, pesticide users might be aware of these. In many instances, following the directions on the pesticide label can prevent injury to nontarget organisms. When these directions are not followed, benefits from pesticides can be outweighed by the risks and harm associated with them.

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