Pesticide threat to natural aerator

We conclude our in-depth and fascinating look at the earthworm, started in our June Issue.

Earthworm burrows, too, exert both physical and chemical effects on soil. Burrows are of two types. Temporary burrows are made by earthworms moving from one feeding site to another. Permanent burrows are homes to individual worms, are usually more extensive, and are open to the surface, allowing the resident earthworm to select the most favourable microclimate for feeding. Permanent burrows are fastidiously kept clean by earthworms removing casts, organic matter and soil that have washed in.

As they burrow, earthworms excavate networks of passageways throughout the soil, which improves the soil's porosity. Up to two-thirds of all soil pore space is estimated to be the result of earthworm burrows, which can increase a soil's moisture-holding capacity – in some cases by as much as 400 per cent. Because of the large diameter and low surface-tension of most burrows, they also serve as drainage systems during irrigation and heavy rainfall. This may account for better mixing of soluble nutrients throughout the soil profile.

Earthworms also act as effective agents of soil aeration. As they penetrate the topsoil and proceed downward into the subsoil, they may increase the soil-to-air ratio by eight to thirty per cent.

Earthworm Attrition

With so many benefits to the soil accrued from the activity of earthworms, why are they given so little consideration when pesticides are selected, pesticides that ultimately bring them harm?

Pesticide registration guidelines initially placed little importance on the potential impact of pesticides on non-target species. This has changed dramatically in recent years, and the Environmental Protection Agency now gives considerable attention to the impact of pesticides on earthworms and other non-target species during the registration process. Use patterns that negatively process. Use patterns that negatively impact non-target species are unlikely to obtain registration; in fact, at present there are no pesticides registered by the EPA specifically for earthworm control.

Lack of knowledge is another problem – the applicator is often unaware of the detrimental effects that various pesticides have on earthworms. To be sure, the acute effects of various pesticides on earthworm distribution and abundance have been the topic of very little research in this country. Even less is known about pesticides' chronic effects on earthworms.

Another explanation may be linked to the increasing popularity of the game of golf during recent years. To meet the demands of greater use, more sophisticated means of pest control – and more advanced chemicals – are needed to maintain tees, fairways and greens under heavy use.

Finally, early chemicals with broad-spectrum pesticidal activity and long-term residual effects, such as chlordane, resulted in the chronic reduction of earthworm activity. A single treatment could hold earthworm numbers in check for multiple seasons, depending on soil type and climatic conditions. By comparison, pesticides in use today are generally less toxic to earthworms; consequently, earthworm activity is more noticeable.

Pesticides and Earthworms

Toxicity to earthworms varies widely among types of pesticides classified by use – insecticides and related compounds, fungicides, herbicides, fumigants and vermicides. Two groups of pesticides are extremely toxic to earthworms and most other soil organisms – fumigants, such as chloropicrin, dichloropropane, and methyl bromide, and vermicides (designed intentionally to kill worms), such as ammonium sulphate, lead arsenate, and mercuric chloride.

Herbicides, at the other extreme, pose relatively little threat of earthworm toxicity. Their modes of action are directed toward plant regulation, and physiological processes of plants differ significantly from those of animals. This leaves fungicides and insecticides responsible for the most extensive pesticide impact on earthworms.

Insects, like earthworms, may be beneficial inhabitants of the soil in that they decompose organic matter; they may also act as predators or parasites to harmful insects. However, they can also be serious pests and must be maintained below damaging levels. Root-and shoot-feeding insects, which pose the greatest threat to golf course turf, are presently managed with organophosphate and carbamate insecticides to reduce their populations to non-injurious population levels. However, a determination of non-injurious densities is purely arbitrary.

As illustrated in Table 1, many of these compounds present a toxic threat to earthworms.

Insecticide Toxicity

Earthworms are generally susceptible to carbamate compounds, which will significantly reduce their populations. Carbaryl, a carbamate pesticide often used for insect control, acts as a cholinesterase inhibitor, thereby producing long-lasting immobility and rigidity. Bendiocarb (Turcam) and propoxure (Baygon) are two other carbamate insectides that cause paralysis in earthworms at normal dose rates. Carbofuran, another carbamate, is also very toxic to earthworms. Moreover, a sublethal response, characterized by weight loss, delayed clitellum development, and absence of cocoon production, has also been observed at recommended rates of carbofuran application.

Organophosphates are the most widely used class of turf insecticides.

They have been successful in controlling white grubs, mole crickets, chinch bugs, and sod webworms, to name a few. Of the organosophosphates, ethoprop is the most toxic to earthworms. In contrast, chlorpyrifos, isofenphos, and trichlorfon are considered non-toxic to earthworms when applied at normal dose rates.

Understanding how particular classes of biociodes act upon target species may yield insights as to their effects on other living organisms. Organophosphates, as well as carbamates, mimic the structure of the acetylcholine molecule, an important component in the transmission of nerve impulses across synaptic gaps in many animals. Cholinesterase, an important enzyme in the nervous system, is responsible for the destruction of acetylcholine once a nerve impulse has crossed the synapse, thus preparing the synapse for another impulse. The presence of organophosphates or carbamates results in the phosphorylation of cholinesterase, thereby suppressing the destruction of acetylcholine.