Risk Assessment for Terrestrial Vertebrates from Soil-Incorporated Pesticides

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Abstract

The USEPA currently uses a revised version of the Hoerger and Kenaga nomogram (Fletcher et al., 1984) as the basis for evaluating exposure and risk to birds and mammals from soil applications of pesticides using its T-REX model. The underlying data for the T-REX model is a portion of the data (Day 0 and Day 1 residue data) from the UTAB database. These data underlying the T-REX model represent Day 0 and 1 downward-direct or airblast foliar applications to a variety of different crops, and some non-crops, such as golf courses. However, these data are not applicable to pesticide products that are applied preplant, at-plant, or as side dress to soil and then are incorporated into the soil or non-leafy plant or soil materials based on soil incorporation. These types of products may be formulated as granular products, wettable powders, or liquid formulations that may be broadcast applied followed by incorporation, may be applied banded with incorporation, or applied in-furrow. While the EPA has a methodology for estimating acute exposures and risks for soil-incorporated products, there is no methodology for estimating chronic exposure and risk, and no methodology for evaluating other soil-applied formulations (e.g., ECs, WP'S, SCs). Residues of these products in plant tissues or invertebrates that may be feed items for birds or small mammals are due to uptake from soil. Some of these products are systemic and some are not; so predictive estimates are highly uncertain and erroneous. Rather than using modeling estimates that are based on an incorrect application scenario, a more appropriate methodology is to rely on residue data for the product. These data can also provide a valuable index to longer-term exposure of birds and mammals. Data are not available for systemic soil fungicides and are contrasted with model estimated residues. Results based on residue data indicate that estimated exposure based on T-REX modeling overestimate actual residues in plant tissues up to five orders of magnitude.

Introduction

The USEPA assesses risks from pesticides to terrestrial vertebrates (mammals, birds, reptiles, and terminal-phase amphibians) by using a nomogram to estimate exposure of these organisms to food items that may contain pesticide residues. EPA uses two similar models: T-REX and T-HERPS, to estimate exposure and risks of terrestrial vertebrates to pesticide residues on various types of possible feed items. These models are based on a compilation of residue data for several different general categories of feed items. The categories of feed items primarily consist of plant-type feed items, and are divided into short grass, tall grass, broadleaf plants, seeds, and arthropods.

The nomogram consists of residue unit doses (RUDs) for each of the feed item categories. RUD values represent the estimated pesticide residue for a 1 lb a.i./A application. Residues in/on feed items following a pesticide application are estimated by multiplying the RUD for applied formulations (e.g., ECs, WPs, SCs). Residues of these products in plant tissues or invertebrates that may be feed items for birds or small mammals are due to uptake from soil. Some of these products are systemic and some are not; so predictive estimates are highly uncertain and erroneous. Rather than using modeling estimates that are based on an incorrect application scenario, a more appropriate methodology is to rely on residue data for the product. These data can also provide a valuable index to longer-term exposure of birds and mammals. Data are not available for systemic soil fungicides and are contrasted with model estimated residues. Results based on residue data indicate that estimated exposure based on T-REX modeling overestimate actual residues in plant tissues up to five orders of magnitude.

Materials and Methods

The pesticide used as a fungicide is applied to directly to soil to control soil-borne fungal diseases that can affect the treated crop. For these uses, the product is formulated as a wettable powder or as an emulsifiable concentrate; both formulations are applied to soil in water at rates of 10 to 50 gallons per acre. Application rates for these uses ranged from 7.5 lb a.i./A to 60 lb a.i./A for different crops. Product was applied either as a broadcast application or a banded application, with the pesticide then being incorporated into the soil to a depth ranging from 2 inches to 10 inches, depending on the crop. For a majority of the crops, a single application was made either preplant or at-plant, but multiple applications were made to some of the crops. These were preplant or at-plant treatments followed by later applications at the base of the plants. Key aspects of these studies were summarized in Table 1. Total rates of pesticide applied in these trials ranged from 7.5 lb a.i./A to 60 lb a.i./A. A majority of the trials involved single applications of the pesticide to soil at rates of either 30 lb a.i./A or 60 lb a.i./A.

Table 1. Summary of MORD study designs for soil-incorporated uses

Table 2. Residues concentrations estimated T-REX:

Table 3. Summary of maximum residues in soil-incorporated uses

Table 4. Avian and mammalian dietary-based risk quotients calculated using T-REX

Table 5. Dietary-based avian and mammalian risk quotients calculated using T-REX

Table 6. Mammalian dietary-based risk quotients calculated using T-REX

Table 7. Dose-based mammalian risk quotients based on soil-applied uses

The USEPA determined residues on feed items or actual measured residues on feed items result in very divergent evaluations of potential risks to birds and small mammals. RQs based on the models suggest chronic risks to both birds and mammals for all categories of feed items except seeds. In contrast, RQs based on measured residues in plant commodities are well below EPA’s level of concern for chronic risks to birds and mammals, indicating that the residues do not pose significant risks to animals that may ingest feed items grown in soils treated with this pesticide. These results indicate that when evaluating risks to birds and mammals for soil-applied/soil-incorporated products, the estimated exposure of non-target birds and mammals should be based on actual measured residues in various plant commodities rather than modeled residues reflecting foliar uses.

Conclusion

Soil incorporation of pesticides significantly alters the exposure scenario for non-target terrestrial vertebrates. The standard nomogram models that are based on residue data for foliar pesticide applications are not applicable to these types of use patterns. Instead, actual residue data for crops grown in treated soils provides the appropriate data for estimating potential exposure of non-target terrestrial vertebrates that may ingest crops, weeds, or parts of crops or seeds (e.g., seeds, leaves) grown in treated soils.

Risks to non-target vertebrates calculated using residue data are much lower than those calculated using the T-REX or T-HERPS models because residues in/on feed items are much lower for soil-incorporated pesticides than for foliar-applied pesticides.