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OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Terbufos (FRSTR) Cover Memo

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Introduction

HED's first review of the data base for Terbufos as part of the registration standard process was completed in 1983. A copy of the cover memo highlighting regulatory issues perceived at that time is attached. Our review identified data gaps according to policies then in place. RD notified registrants of the required studies and the time table for their submittal. HED has now evaluated all new data supporting the registration of Terbufos and reevaluated earlier studies especially in cases where the policy on criteria for acceptability has changed. As indicated below, the results of this process is the identification of areas where, for various reasons, additional studies are required. This memo summarizes the assessments completed by the HED branches and identifies and discusses any concerns that were raised by the review.

Background

Terbufos is an organophosphate soil insecticide/nematicide with the chemical name phosphorodithioic acid, S-(t-butylthio) methyl 0,0 diethyl ester. The structure of terbufos and some of its metabolites is indicated on Table 1. Approximately 10 million pounds of terbufos active ingredient are applied annually in the United States, all as a 15% granular formulation. The major use is on field corn but it is also used on sweet and popcorn, sorghum and sugarbeets.

6 pages

Toxicology

The primary mechanism of toxicity for terbufos is cholinesterase inhibition. Terbufos is acutely toxic to mammals by the oral, dermal, and inhalation routes at very low levels (Toxicity Category I). Primary eye and skin irritation studies with technical material killed all of the rabbits. A nearly complete data base gives no indication that terbufos is likely to cause neurologic, reproductive, oncogenic or other systemic effects. The only outstanding data requirement is a teratogenicity study in the rabbit to replace an unacceptable study.

Residue Chemistry

Relatively few tolerances have been established for terbufos in 40 CFR 180.352. The nature of the residues in plants is adequately understood. RCB recommends and TOX Branch agrees that the tolerance expression specify the cholinesterase-inhibiting metabolites of concern. These are compounds numbered I-VI in Table 1. This specification will make our tolerance expression consistent with Codex. Data previously submitted were considered adequate to support the tolerances for registered uses of terbufos. As detailed in the RCB chapter, however, recent changes in application methods have not been accompanied by adequate data on residues. Hence, additional studies are needed. Earlier studies involving the feeding of exaggerated levels of terbufos to poultry and livestock did not yield detectable residues in milk, meat, and eggs. Thus, no tolerances were required. According to our more recent guidelines, however, metabolism studies should utilize ^{14}C - labeled materials in livestock. Additional studies in ruminants and poultry must be submitted to identify the metabolites and confirm the lack of need for tolerances.

Tolerance Reassessment

The current Provisional Acceptable Daily Intake (PADI) utilizes the plasma ChE LEL from a 1-year dog study (0.015 mg/day) and an uncertainty factor of 100. A new 4-week dog study has now been reviewed and establishes an appropriate NOEL. As approved by the TOX ADI committee, the new ADI (0.00013 mg/kg/day) is virtually identical to the PADI. The current TMRC based on published tolerances utilizes 31% of the PADI and this value will increase to 36% by use of the new ADI.

Exposure Assessment

Generally, exposure to terbufos by farm workers is limited due to use of a granular formulation and soil incorporating ground equipment. Restricted use classification insures the applicator is trained in safe use practices which also aids in minimizing worker exposure. EAB has indicated the need for further protective measures (clothing) and is reexamining the reentry issue, especially since some SLN's utilize a broadcast treatment. An amendment to address this issue is in preparation.

Ecological Effects

The acute toxicity of terbufos requires the addition of label warnings to protect fish and wildlife. Use restrictions to protect endangered species are being implemented and updating may be required depending on results of field studies. Note that bee cautions are not required for granulars and should be removed from future labels. Additional laboratory studies required include those for estuarine and marine organisms, fish early life stage (bluegill) and aquatic organism accumulation. Both terrestrial and aquatic field studies are required.

Environmental Fate

The potential of terbufos to leach to groundwater is uncertain because of gaps in the data base, however, the available data suggest that Terbufos is not likely to cause leaching problems. To date, terbufos has not been detected in groundwater. A decision regarding rotational crops also awaits the availability of storage stability data so that the existing studies can be validated.

cc: Anne Barton
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Table 1. Terbufos and its metabolites occurring in plants.

Number	Structure	Chemical Name	Other Chemical or Common Names and Designations	Substrate and References (MRID)
I	$\begin{array}{c} \text{S} \\ \parallel \\ (\text{C}_2\text{H}_5\text{O})_2\text{-P-S-CH}_2\text{-S-C(CH}_3)_3 \end{array}$	Phosphorodithioic acid, S-(t-butylthio)methyl 0,0-diethyl ester	Terbufos; CL 92,100; S-[[1,1-dimethyl-ethyl]thio]methyl 0,0-diethyl phosphorodithioate	corn plants: 00069512, 00087688; sugar beet roots and shoots: 00087691; sorghum plants: 00079429
II	$\begin{array}{c} \text{O} \\ \parallel \\ (\text{C}_2\text{H}_5\text{O})_2\text{-P-S-CH}_2\text{-S-C(CH}_3)_3 \end{array}$	Phosphorothioic acid, S-(t-butylthio)methyl 0,0-diethyl ester	Terbufosox; Terbufos-0-analog; CL 94,221	corn plants: 00069512, 00087688; corn grain: 00087688; sugar beet roots and shoots: 00087691
III	$\begin{array}{c} \text{O} \\ \parallel \\ (\text{C}_2\text{H}_5\text{O})_2\text{-P-S-CH}_2\text{-S-C(CH}_3)_3 \end{array}$	Phosphorothioic acid, S-(t-butylsulfinyl)methyl 0,0-diethyl ester	Terbufosox sulfoxide; Terbufos-0-analog; sulfoxide CL 94,365	corn plants: 00069512, 00087688; corn grain: 00087688; sugar beet roots and shoots: 00087691; soybean plants: 00088210; sorghum plants: 00079429; cabbage plants: 00062871; rape seed: 00133299

Table 1. Terbufos and its metabolites occurring in plants.

Number	Structure	Chemical Name	Other Chemical or Common Names and Designations	Substrate and References (MRID)
I	$(C_2H_5O)_2\overset{\overset{S}{ }}{P}-S-CH_2-S-C(CH_3)_3$	Phosphorodithioic acid, S-(t-butylthio)methyl 0,0-diethyl ester	Terbufos; CL 92,100; S-[[[(1,1-dimethyl-ethyl)thio]methyl]0,0-diethyl]phosphorodithioate	corn plants: 00069512, 00087688; sugar beet roots and shoots: 00087691; sorghum plants: 00079429
II	$(C_2H_5O)_2\overset{\overset{O}{ }}{P}-S-CH_2-S-C(CH_3)_3$	Phosphorothioic acid, S-(t-butylthio)methyl 0,0-diethyl ester	Terbufosox; Terbufos-0-analog; CL 94,221	corn plants: 00069512, 00087688; corn grain: 00087688; sugar beet roots and shoots: 00087691
III	$(C_2H_5O)_2\overset{\overset{O}{ }}{P}-S-CH_2-\overset{\overset{O}{ }}{S}-C(CH_3)_3$	Phosphorothioic acid, S-(t-butylsulfinyl)methyl 0,0-diethyl ester	Terbufosox sulfoxide CL 94,365	corn plants: 00069512, 00087688; corn grain: 00087688; sugar beet roots and shoots: 00087691; soybean plants: 00088210; sorghum plants: 00079429; cabbage plants: 00062871; rape seed: 00133299

(continued).

Table 1. Terbufos and its metabolites occurring in plants (Continued).

Number	Structure	Chemical Name	Other Chemical or Common Names and Designations	Substrate and References (MRID)
IV	$ \begin{array}{c} \text{O} \\ \parallel \\ (\text{C}_2\text{H}_5\text{O})_2\text{-P-S-CH}_2\text{-S-C(CH}_3)_3 \\ \parallel \\ \text{O} \end{array} $	Phosphorothioic acid, S-(t-butyl-sulfonyl) methyl 0,0-difethyl ester	Terbufos sulfone; Terbufos-0-analog sulfone; CL 94,302	corn plants: 00069512, 00087688; sugar beet roots and shoots: 00087691; soybean plants: 00088210; sorghum plants: 00079429; cabbage plants: 00062871; rape seed: 00133299
V	$ \begin{array}{c} \text{O} \\ \parallel \\ (\text{C}_2\text{H}_5\text{O})_2\text{-P-S-CH}_2\text{-S-C(CH}_3)_3 \\ \parallel \\ \text{S} \end{array} $	Phosphorodithioic acid, S-(t-butylsulfinyl)methyl 0,0-difethyl ester	Terbufos sulfoxide; CL 94,301	corn plants: 00069512, 00087688; corn grain: 00087688; sugar beet roots and shoots: 00087691; soybean plants: 00088216; sorghum plants: 00079429; cabbage plants: 00062871; rape seed: 00133299

(Continued).

Table 1. Terbufos and its metabolites occurring in plants (Continued).

Number	Structure	Chemical Name	Other Chemical or Common Names and Designations	Substrate and References (MRID)
VI	$ \begin{array}{c} \text{S} \\ \parallel \\ (\text{C}_2\text{H}_5\text{O})_2\text{P}-\text{S}-\text{CH}_2-\text{S}-\text{C}(\text{CH}_3)_3 \\ \parallel \quad \parallel \\ \text{O} \quad \text{O} \end{array} $	Phosphorodithioic acid, S-(t-butylsulfonyl) methyl 0,0-diethyl ester	Terbufoson sulfone; CL 94,320	corn plants: 00069512, 00087688; corn grain: 00087688; sugar beet roots and shoots: 00087691; soybean plants: 00088210; sorghum plants: 00079429; cabbage plants: 00062871; rape seed: 00133299
VII	$ \begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{S}-\text{CH}_2-\text{S}-\text{C}(\text{CH}_3)_3 \\ \parallel \quad \parallel \\ \text{O} \quad \text{O} \end{array} $	Methane, (t-butylsulfonyl) (methylsulfonyl)	CL 99,844	corn plants: 00087688; corn grain: 00087688; sugar beet roots and shoots: 00087691
VIII	$ \begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{S}-\text{CH}_2-\text{S}-\text{C}(\text{CH}_3)_3 \\ \parallel \quad \parallel \\ \text{O} \quad \text{O} \end{array} $	Methane, (t-butylsulfonyl) (methylsulfonyl)	nonphosphorylated terbufoson sulfoxide; CL 99,843	corn plants: 00087688; corn grain: 00087688; sugar beet roots and shoots: 00087691; soybean plants: 00088210; sorghum plants: 00079429; rape seed: 00133299

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