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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF PREVENTION,
PESTICIDES AND TOXIC SUBSTANCES

MEMORANDUM

RE: Drinking Water Assessment for Chlorethoxyfos

TO: Steve Knisner
Health Effects Division (7509C)

FROM: Robert Matzner, Hydrologist
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Environmental Fate and Effects Division (7507C)

THRU: Elizabeth Behl, Chief
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DATE: November 23, 1998

CONCLUSIONS

Chlorethoxyfos (phosphorothioic acid, O,O diethyl O-(1,2,2-tetrachloroethyl) ester) is the active ingredient in the granular soil insecticide Fortress, which is used for pest control on field corn, sweet corn and popcorn. Groundwater and surface water monitoring data were not available to the Environmental Fate and Effects Division (EFED) for chlorethoxyfos at this time (EPA, 1998). Therefore, screening models were used to determine estimated concentrations for chlorethoxyfos in groundwater and surface water. Although these estimates are only for chlorethoxyfos, there are several chlorethoxyfos degradates that have been identified including trichloroacetaldehyde (chloral), dichloroacetic acid (DCA), trichloroacetic acid (TCA), diethylthiophosphate (DETP) and diethylphosphate (DEP). We will be following up with you on this issue in approximately on week (11/30/98).

Results from the SCI-GROW screening model indicates that chlorethoxyfos will not be found in high concentrations in groundwater using the recommended maximum annual

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application rate (0.163 lbs. a.i. acre^{-1}). This is due to chlorethoxyfos's aerobic soil metabolism half-life (20-23 days) and adsorption Freundlich coefficients (40-200). Since the groundwater concentrations were developed through a screening model and no monitoring data were used, we are only moderately confident of this estimate.

The PRZM/EXAMS model was used to estimate surface water concentrations for chlorethoxyfos. Corn (Ohio) was used as the crop of interest. The application methods for chlorethoxyfos include In-furrow and T-band. The modeling results indicate that chlorethoxyfos has a low potential to reach surface water as an aqueous species in runoff. However, chlorethoxyfos does have the potential to reach surface water through erosion of soil particles to which the compound is adsorbed. Chlorethoxyfos is moderately persistent in water with abiotic hydrolysis half-lives of 72 and 59 days at pH 5 and 7, respectively. The modeling results indicate that the In-furrow application method will significantly reduce the amount of chlorethoxyfos which enters into aquatic environments.

SUMMARY

Groundwater	Surface Water
acute and chronic: 1.82 ng L^{-1}	**In-furrow** **acute: 63.6 ng L^{-1}** **chronic: 11.9 ng L^{-1}** **T-band** **acute: 427 ng L^{-1}** **chronic: 79.9 ng L^{-1}**

ENVIRONMENTAL FATE

The major route of dissipation for chlorethoxyfos is through aerobic soil metabolism. The compound was moderately persistent in the soils tested in the aerobic soil metabolism studies with half-lives ranging from 20-23 days. The compound has a relatively low aqueous solubility (2.1 mg L^{-1}) and does not partition to soils (adsorption Freundlich coefficients 40-200) to a significant degree. Chlorethoxyfos has a relatively high vapor pressure although soil incorporation of the granular will minimize this route of dissipation. Therefore, under most conditions chlorethoxyfos will have a low potential for movement into groundwater. There is a moderate risk of chlorethoxyfos contaminating surface water through erosion of soil particles to which chlorethoxyfos is adsorbed. If the compound were to reach surface water it may persist for a significant period of time due to the long abiotic hydrolysis half-lives (72 days/pH 5, 59 days/pH 7) as well as the low inclination to photodegrade. Chlorethoxyfos does have a high potential to bioaccumulate in fish (BCF's of 1000-4000). Volatilization would decrease the persistence (Henry's law constant: 1.5×10^{-2}, 3.5×10^{-4} atm m^3 mole^{-1}) in surface water.

The degradates of chlorethoxyfos vary according to soil pH and include DCA, generated under neutral and alkaline pH's and chloral generated under acidic to neutral pH's. Chloral is sometimes oxidized to TCA depending upon soil microbial populations and/or soil physical/chemical characteristics as was noted in the soil photolysis, adsorption/desorption, confined rotational crop study and the terrestrial field dissipation studies.

The phosphoryl portion of the molecule was not labeled and therefore its fate was not addressed in laboratory studies. The registrant has provided a literature review (summary, not actual studies) on the environmental fate and toxicity of DETP and DEP in lieu of conducting studies using chlorethoxyfos labeled in the phosphoryl moiety. Based upon the literature data DETP and DEP are the primary phosphoryl degradates of chlorethoxyfos. DETP is the primary hydrolysis product of DETP and diethyldithiophosphate and is stable to further hydrolysis in the environmentally significant pH ranges. DETP and DEP are polar anions in the environment which are mobile in soil and could contaminate groundwater and surface water under some conditions. Both DETP and DEP are expected to degrade to CO_2 with the possibility of monoethyl compounds being formed. DETP has reported degradative half-lives of less than two weeks to less than eight weeks in various soils under aerobic conditions.

Groundwater Modeling

The annual application rate used for chlorethoxyfos (0.163 lbs. a.i. acre^{-1}) is the maximum label recommended value. Table 1 shows the input parameter values used in SCI-GROW (Screening Concentrations in Ground Water) (Barrett, 1997) for chlorethoxyfos. The K_{oc} value (4083 L kg^{-1}) was the median value for four soil types This value was chosen because there was a less than a three-fold variation in the K_{oc} values for the four soils, indicating that adsorption is related to the organic carbon content of the soil. The K_{oc} was calculated using the K_d values determined from the linear portion of the adsorption isotherm (MRID #41290618) and the organic matter content of each soil type. The aqueous phase concentrations over the linear portion of the isotherm covered the groundwater concentration resulting from the SCI-GROW modeling. This strengthens the validity of using the linear portion of the isotherm to determine the K_d used in the modeling. The aerobic soil metabolic half-life (21.5 days) was the average of two values (20 and 23 days). The groundwater concentration resulting from the SCI-GROW modeling is shown in Table 1.

Table 1. Input parameters for chlorethoxyfos used in the SCI-GROW model and result.

K_{oc} (L kg^{-1})	4083
Annual Application Rate (lbs. a.i. acre^{-1})	0.163
Number of Applications	1

Table 1. Input parameters for chlorethoxyfos used in the SCI-GROW model and result.

Aerobic Soil Metabolism half-life (days)	21.5
Groundwater Concentration (ng L^{-1})	1.82

There may be circumstances under which groundwater concentrations could exceed the SCI-GROW estimates. However, such exceptions should be infrequent since the SCI-GROW model is based on maximum groundwater concentrations from studies conducted at sites and under conditions which are most likely to result in groundwater contamination. The groundwater concentrations generated by SCI-GROW are based on the largest 90-day average recorded during the sampling period. Since there is relatively little temporal variation in groundwater compared to surface water, the concentrations can be considered as acute and chronic values.

Surface Water Modeling

This report describes the Tier II estimated environmental concentration (EEC) computer modeling for chlorethoxyfos use on corn. The analysis uses a single site which represents a typical exposure scenario for the use of chlorethoxyfos. In-furrow and T-band application methods were simulated. The weather and agricultural practices are simulated over 36 years so that the ten year excedence probability at the site can be estimated. The EEC's generated in this analysis were calculated using PRZM 3.1 (Pesticide Root Zone Model) (Carsel et al, 1997) for simulating runoff and erosion from the agricultural field and EXAMS 2.97.5 (Exposure Analysis Modeling System) (Burns, 1997) for estimating environmental fate and transport in surface water. A partial list of input parameters for PRZM-EXAMS are presented in Table 2.

Table 2. PRZM-EXAMS input parameters.

Crop	Corn
Aqueous Solubility (mg L^{-1})	2.1
Hydrolysis half-life (days) pH 5 pH 7 pH 9	 72 59 4.3
Aqueous Photolysis half-life (days)	stable
Aerobic Soil Metabolism half-life (days)	23.5
Aerobic Aquatic Metabolism half-life (days)	stable
Soil/Water Partition Coefficient (K_d) (L kg^{-1})	89 (silt loam)

Table 2. PRZM-EXAMS input parameters.

Annual Application Rate (lbs. a.i. acre^{-1})	0.163
Application Method	In-furrow, T-band
Source	EFED DER
Date	8/30/95

The scenario chosen was in Ohio. The site represents a typical to high runoff field for chlorethoxyfos applied to corn. The modeled site is a field in MLRA (Major Land Resource Area) 111. The soil is a Cardington silt loam (a C hydrologic group soil) which would be expected to produce moderate runoff and limited erosion. A ten hectare corn field draining into a one hectare static pond, two meters deep with no outlet was modeled. It is assumed that evaporation losses and inflow from rainfall and runoff are in balance. The percentage of chlorethoxyfos in the upper two centimeters of soil was assumed to be 10 and 67 percent for the In-furrow and T-band methods, respectively. The modeling results are shown in Table 3.

Table 3. Upper tenth percentile (ng L^{-1}) from PRZM-EXAMS modeling.

APPLICATION METHOD	PEAK (ACUTE)	YEARLY AVERAGE (CHRONIC)
IN-FURROW	63.6	11.9
T-BAND	427	79.9

There are several factors which may limit the accuracy and precision of the PRZM-EXAMS modeling. These include the selection of the typical exposure scenarios, the quality of the input data, the ability of the models to represent the real world and the number of years that were modeled. The scenarios that are selected for use in Tier II EEC calculations are the ones that are likely to produce large concentrations in the aquatic environment. Each scenario should represent a real site to which the pesticide of concern is likely to be applied. The EEC's in this analysis are accurate only to the extent that the site represents the hypothetical high exposure site. The most limiting part of the site selection is the use of the standard pond with no outlet. A standard pond is used because it provides a basis for comparing pesticides in different regions of the country on equal terms. The models also have limitations in their ability to represent some processes. The greatest limitation is the handling of spray drift. A second major limitation is the lack of validation at the field level for pesticide runoff.

REFERENCES

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