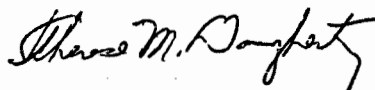


Shaughnessy No.: 128845

Date Out of EAB: JAN 22 1988

To: Robert Taylor
Product Manager #25
Registration Division (TS-767C)

From: Therese M. Dougherty, Chief
Environmental Chemistry Review Section #1
Exposure Assessment Branch/HED (TS-769C)



Thru: Paul F. Schuda, Chief
Exposure Assessment Branch/HED (TS-769C)



Attached, please find the EAB review of:

Reg./File Number: 352-UUA

Chemical Name: DPX-M6316

Type Product: Herbicide

Product Name: Harmony

Company Name: E.I. duPont de Nemours and Company, Inc.

Purpose: Review three studies (confined rotational crop, aerobic soil metabolism and a PRZM run

Date Received: 09/25/87

Action Code: 111

Date Completed: 01/22/88

EAB #(s): 70984

Monitoring Study Requested: _____

Total Reviewing Time: 4.0 days

Monitoring Study Voluntarily: _____

Deferrals To: _____

Ecological Effects Branch

Residue Chemistry Branch

X Toxicology Branch

1. CHEMICAL: Common name:

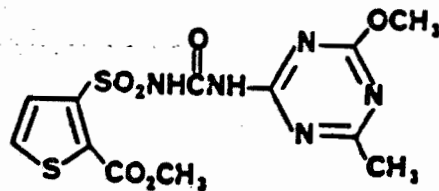
DPX-M6316

Chemical name:

Methyl 3-[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)-amino]carbonyl]amino]sulfonyl]-2-thiophencarboxylate

Trade name(s):

Harmony 75DF

Structure:Formulations:

75% G

Physical/Chemical properties:Molecular formula: $C_{12}H_{13}N_5O_6S_2$

Molecular weight: 387.4

Physical state: White, crystalline solid.

Melting point: 186°C.

Density: 1.49 g/cc.

Vapor pressure: 2.7×10^{-6} mm Hg at 25°C.

Solubility: In water at pH 4.0 (0.024 mg/mL), pH 5.0 (0.26 mg/mL), pH 6.0 (2.4 mg/mL). In acetone (11.9 mg/mL), acetonitrile (7.3 mg/mL), ethanol (0.9 mg/mL), ethyl acetate (2.6 mg/mL), hexane (<0.1 mg/mL), methanol (2.6 mg/mL), methylene chloride (27.5 mg/mL), xylenes (0.2 mg/mL).

2. TEST MATERIAL:

See individual studies.

3. STUDY/ACTION TYPE

This data was submitted in response to the EAB review of 4/10/87 (application for full registration in wheat and barley), which reviewed data for this new chemical.

4. STUDY IDENTIFICATION

a. Aerobic Soil Metabolism Study (of a major degradate, the triazine amine)
Aerobic Soil Metabolism of [2-¹⁴C]4-Methoxy-6-methyl-1,3,5-triazin-2-amine. B. C. Rhodes. September 26, 1986. Submitted by E. I. du Pont de Nemours and Company, Inc. Du Pont Report No. AMR-408-85. Accession No. 403403-17. Reg./File # 352-UUA.

b. Confined Rotational Crop Study (of DPX-M6316)
Greenhouse Accumulation Study of [Triazine-2-¹⁴C]DPX-M6316 on Rotational Crops. A. M. Brown. July 1, 1987. E. I. du Pont de Nemours and Company, Inc., Wilmington, DE. Du Pont Report No. AMR-582-86. Accession # 403403-18.

c. PRZM Run (for a major degradate, the triazine amine)
A PRZM Computer Simulation of Potential Ground Water Concentrations of Triazine Amine (2-Amino-4-Methoxy-6-Methyl-1,3,5-triazine). R. A. Jackson. June 2, 1987. Submitted by E. I. du Pont de Nemours and Company, Inc. Du Pont Report No. 6316-ME-4. Accession No. 403403-19.

5. REVIEWED BY:

Pat Ott
Chemist
EAB/HED/OPP

Signature: Pat Ott
Date: 1/22/88

6. APPROVED BY:

Therese Dougherty
Chief
Environmental Chemistry Review Section #1

Signature: Therese Dougherty
Date: 1/22/88

7. CONCLUSIONS:

a. Confined Rotational Crop Study (triazine-labelled DPX-M6316).

Neither parent nor degradates accumulate to any significant amount in 3 rotated crops: peas, beets and sunflowers.

1. This study is scientifically valid.
2. This study may satisfy Subpart N data requirements if the following points are adequately addressed:

a. What is the recovery for the method for soil and the 3 plant types in the 0.001-0.01 ppm range?

b. Was a storage stability test run to demonstrate little or no degradate deterioration with time, under freezer storage conditions? How long were samples stored before analysis?

c. Was the identity of degradates by HPLC confirmed by another detection method?
3. The data supports the 60 day post application rotational crop interval on the submitted revised label (attached).

b. Aerobic Soil Metabolism Study (for a major degradate, the triazine amine)

This major degradate of DPX-M6316 has a half-life in Keyport silt loam around 5 and 1/2 months (calculated, 8 months), which means it is persistent enough to be available to leach. For an estimate of its leaching potential through soil to ground water, please see PRZM data conclusions.

This study if scientifically valid and satisfies Subpart N guidelines for an aerobic soil metabolism study for the triazine amine.

c. PRZM Data (for a major degradate, the triazine amine)

The triazine amine has a significant potential to leach through soil and contaminate ground water, but because of the low application rate, and single application/crop/growing season, the levels present are very low. The reviewer (W. Martin Williams) estimates that the annual high concentration of the triazine amine at the six foot depth would be around 1.5 ppb in the soil.

The reviewer's summary and conclusions (page 3 of his report) are:

1. The analysis appears to be appropriately set-up and conservative.
2. Triazine amine is a potent leachate given the half-life (6 to 8 months) and K_d (0.44). The lower concentrations are a result of a relatively small application (12.7 gm/ha) at a low rate (annually). This rate was stated as the maximum rate in the study. If the application amount and rate were to increase, higher concentrations and build-up would occur.
3. If the toxicology impacts on the concentrations reported in the study are determined to be significant, further data is recommended:
 - *Input and output file listings
 - *Concentration histories at shallower depths (e.g., 3 and 6 feet)
 - *Simulations for 10 years
4. If the toxicological effects of the parent chemical are deemed significant, simulation of DPX-M6316 may be warranted, given the higher application rate (35 gm/ha A.I.) and leaching potential of the parent chemical (1-2 week half-life and K_d under 0.01).

d. We defer to Toxicology Branch regarding toxicological concern for DPX-M6316 and its degradates, which, in general, because of (1) the parent's very low application rate, (2) only 1 application/crop/growing season, and (3) degradative mechanisms such as soil metabolism, result in generally low levels (ppb range in field studies).

In laboratory studies, the parent (DPX-M6316), the triazine amine, DPX-M6316 acid, O-Demethyl DPX-M6316, 2-ester-3-sulfonamide, and 2acid-3-sulfonamide all have a significant tendency to leach through soil (including soils containing >1% OM and relatively high CEC (15-21 meq/100 gm). In the EAB review dated 4/10/87, laboratory and field data were considered; the DPX-M6316 acid and the triazine amine were judged to be potential target residues for monitoring, if Toxicology Branch indicated concern.

e. Subpart N Data Requirements Satisfied (4/10/87 review and this review)

Hydrolysis

Leaching and Adsorption/Desorption

4

Photodegradation in Water
Photodegradation on Soil
Aerobic Soil Metabolism
Anaerobic Soil Metabolism

Terrestrial Field Dissipation
Confined Rotational Crop (for thiophene label)
Laboratory Studies of Pesticide Accumulation
in Fish

f. Subpart N Data Requirement that could be satisfied, provided the points of concern listed previously are adequately addressed:

Confined Rotational Crop (for triazine label)

g. Environmental Fate Summary (attached at end of this report, and incorporates the Executive Summary in the 4/10/87 EAB review and summary of studies in this review)

8. RECOMMENDATIONS:

We defer to Toxicology Branch regarding toxicological concern for DPX-M6316 and its degradates, which, in general, because of (1) the parent's very low application rate, (2) only 1 application/crop/growing season, and (3) degradative mechanisms such as soil metabolism, result in generally low levels (ppb range in field studies).

All other environmental fate data requirements will have been satisfied for full registration when the points concerning the confined rotational crop study (triazine label) have been addressed.

9. BACKGROUND:

Introduction

The purpose of this du Pont submission is to answer concerns and fill requirements cited in the 4/10/87 EAB review. Du Pont had previously submitted studies for full registration of DPX-M6316, a broadleaf weed herbicide for use on barley and wheat.

Directions for Use

See attached label. A 60-day rotational crop restriction appears on the label.

10. REVIEW OF INDIVIDUAL STUDIES:

A. Study Identification:

Aerobic Soil Metabolism of [2-¹⁴C]4-Methoxy-6-Methyl-1,3,5-triazin-2-amine. B. C. Rhodes. September 26, 1986. Submitted by E. I. du Pont de Nemours and Company, Inc. Du Pont Report No. AMR-408-85. Accession No. 403403-17. Reg./File # 352-IJUA.

B. Materials and Methods:

Keyport silt loam soil from Newark, DE (pH = 4.3, OM = 4.7%, CEC = 14 meq/100 gm, 11% sand, 78% silt, 11% clay) was fortified with 0.12 ppm of (2-¹⁴C)4-methoxy-6-methyl-1,3,5-triazin-2-amine. The radiochemical purity was 99%. This compound, the triazine amine, is a major degradate of DPX-M6316 (Harmony^R).

The soil was aged aerobically in the dark at 75% moisture retention capacity and sampled for 15 months. The biometer flasks containing the soil were also fitted with CO₂ traps containing 0.1 N NaOH. Soil samples were extracted 5x with a mixture of methylene chloride/methanol/9N NaOH (75:25:0.5, v/v/v). The samples were centrifuged and supernatants from each extraction were pooled and quantitated by LSC. The soil residue was further extracted 3x with 0.1 N NaOH and centrifuged. Again, the supernatants were analyzed by LSC. The soil residue was treated with 1 N NaOH and refluxed for 1 hour. The supernatant was analyzed by LSC and the soil residue was combusted and also analyzed by LSC.

Extracts were analyzed by TLC on silica gel plates and developed using a mixture of methylene chloride/methanol/1M ammonium hydroxide (145/50/5). Nonradiolabeled standards of the triazine amine and possible degradation products (see Figure 1 for structures) were spotted and visualized by fluorescence quenching. Radioactive bands were detected and quantified using a TLC linear analyzer. Some extracts were analyzed by HPLC equipped with a fraction collector and analyzed by LSC. This technique was also used to confirm the identity of the triazine amine and degradates tentatively identified originally by TLC.

¹⁴C-CO₂ in the NaOH traps was converted to Ba¹⁴CO₃ and analyzed by ISC.

C. Reported Results:

Mass balances during the 15 month experiment ranged from 82-100%. Half-life for the triazine amine was about 5 1/2 months (calculated, 8 months) and 28% remained at 15 months; only 2 degradates, dihydroxy methyl triazine and CO₂ were formed in quantities >10%, and these accounted for a maximum of 11% and 38%, respectively, of the applied radioactivity. Round residues accounted for 10% and unresolved polar compounds, 17%.

D. Study Author's Conclusions:

Triazine amine degrades slowly in Keyport silt loam soil and decomposes primarily to CO₂, but first forms hydroxylated intermediates. See Figure 7 for a metabolic pathway scheme.

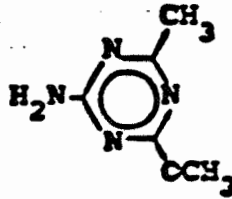
F. Reviewer's Discussion and Interpretation of Study Results:

This study is scientifically valid and satisfies Subpart N guidelines for an aerobic soil metabolism study for the triazine amine.

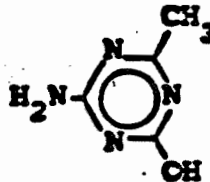
The half-life of the triazine amine degradate of DPX-M6316 in Keyport silt loam is long enough to be available to leach into ground water.

7

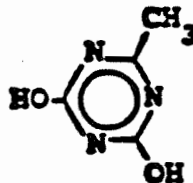
Du Pont Report No. AMR-408-85

FIGURE 1CHEMICAL STRUCTURE AND NAMES OF TEST COMPOUND AND
POSSIBLE SOIL METABOLITESTriazine Amine

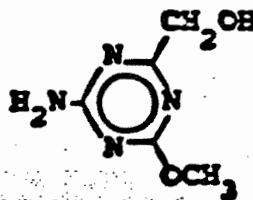
4-Methoxy-6-methyl-1,3,5-triazin-2-amine

O-Demethyl Triazine Amine

4-Hydroxy-6-methyl-1,3,5-triazin-2-amine

Dihydroxy Methyl Triazine

2,4-Dihydroxy-6-methyl-1,3,5-triazine

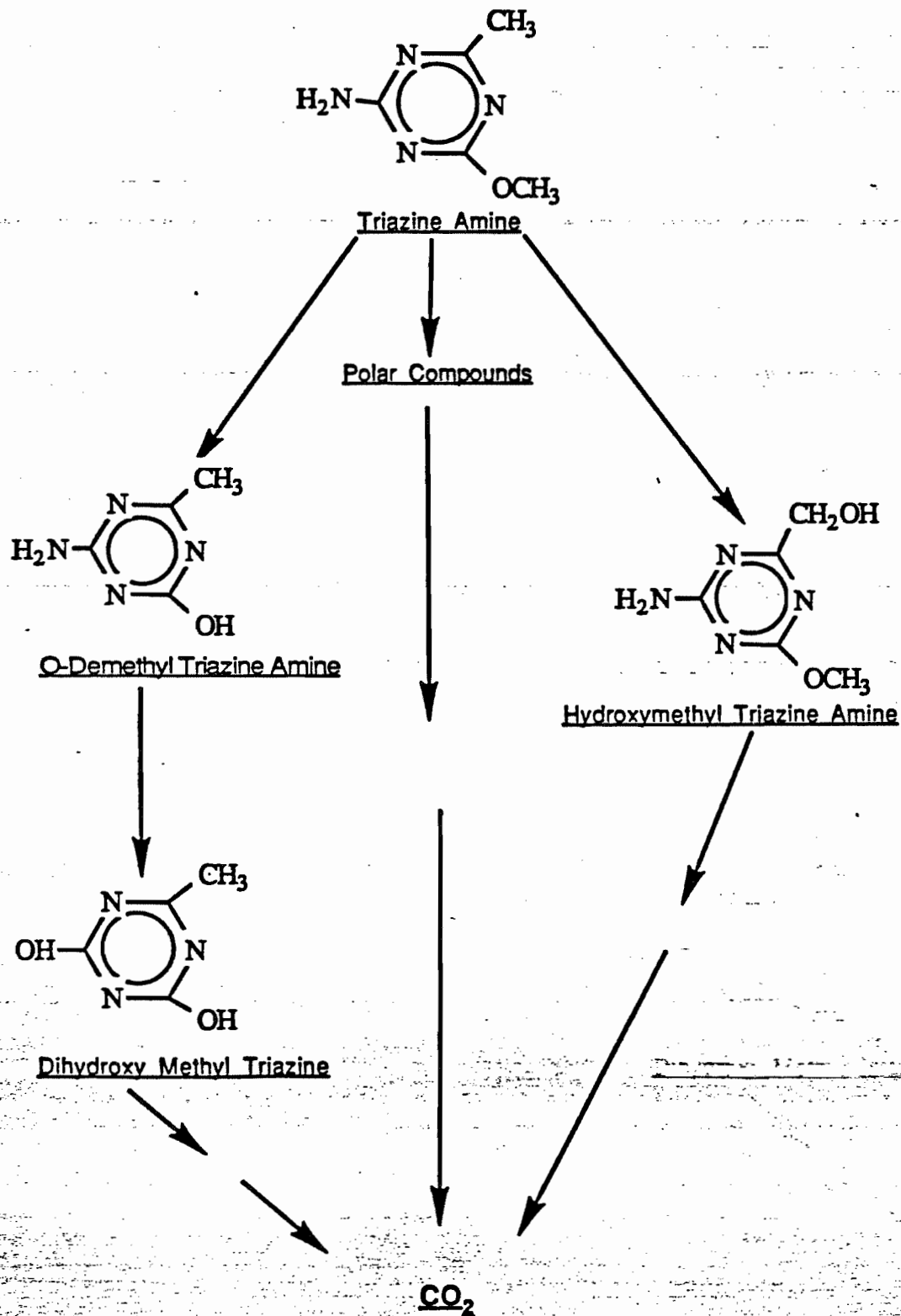
Hydroxymethyl Triazine Amine

4-Methoxy-6-methanol-1,3,5-triazin-2-amine

October 4

FIGURE 7

Proposed Metabolic Pathway of Triazine Amine on Aerobically Aged Keyport Silt Loam Soil



9

10. REVIEW OF INDIVIDUAL STUDIES:

A. Study Identification:

Greenhouse Accumulation Study of [Triazine-2-¹⁴C]DPX-M6316 On Rotational Crops.
A. M. Brown. July 1, 1987. F. I. du Pont de Nemours and Company, Inc., Wilmington,
DE. Du Pont Report No. AMR-582-86. Accession # 403403-18.

B. Materials and Methods:

1. Crop Culture

The primary crop, wheat, was treated with [triazine-2-¹⁴C]DPX-M6316 (Harmony^R)¹ at the 2-leaf stage at 36 gm a.i./ha (40 gal/A spray volume), which is equivalent to the maximum recommended rate of 2/3 oz/A of a 75% formulation. The radiochemical purity was >98%.

The wheat was grown in Sassafras sandy loam soil² in fifteen 14-inch plastic pots in a greenhouse and treated 45, 74, and 75 days prior to planting 3 rotational crops: beets, peas and sunflowers, which were planted, grown to maturity, and harvested. The wheat was reincorporated into the soil before the rotational crops were planted. Three pots of beet, three of peas, and 2 of sunflowers were planted for the 45 day study; 2 pots of peas, 2 of sunflowers and 3 of beets were planted for the 75 day study.

Because of poor yields of peas and sunflowers in the 75 day post-treatment study, 3 fresh pots of wheat were planted, treated and grown for 74 days prior to planting peas (1 pot) and sunflowers (2 pots).

2. Sampling (see Table 4)

a. Soil

Soil samples were removed to the full depth of the pot (12") using a Hoffer tube (2 cm diameter) on treatment days, planting and harvesting of mature crops. On the day of planting, separate soil samples were taken prior to and after incorporation of the treated wheat into the soil.

b. Crops

1. Beets

1. Methyl 3-[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amine]-sulfonyl]-2-thiophene-carboxylate

2. Soil characteristics: pH = 6.2; OM = 0.9%; CEC = 3.5 meq/100 gm; clay = 10%; silt = 29%; sand = 61%

Tubers were removed and sliced; leaves were chopped.

2. Peas

Peas were shelled. The pod and the foliage were cut up.

3. Sunflowers

Seeds were removed from the seed heads. Foliage and seed heads were cut into small sections.

3. Analytical Methodology

a. Soil

Soil samples were air dried, homogenized, weighed, then stored in freezer (-25°C) until analysis. Total radioactivity was determined by soil combustion (3 replicates). Evolved $^{14}\text{CO}_2$ was trapped and quantified by LSC.

Soil samples were extracted twice with a 9:1 acetone:0.1 M ammonium carbonate solution. The soil residue was extracted 2x with 0.1 M ammonium carbonate, then acetone. Finally, the soil residue was extracted 2x with 0.1 M NaOH, then acetone. Immediately prior to HPLC analysis, the NaOH extract was adjusted to pH 3 with HCl.

The remaining soil residue was combusted to determine the level of unextracted radioactivity.

b. Crops

After sampling, plants were immediately weighed, frozen, lyophilized, and powders frozen (-25°C) prior to analysis. Plant tissue was extracted 2x with 0.02 M NaHCO_3 . Then the plant residue was washed 2x with 9:1 MeOH:EtOAc. After concentrating the extracts, the sample was analyzed with LSC and HPLC.

Foliage samples were further extracted with refluxing with 1N HCl for one hour. Solids were rinsed with water and added to the acid extract. The resulting solution was concentrated and analyzed by LSC. Before HPLC analysis the extract was adjusted to pH 3.

c. Both Substrates

HPLC analysis was performed with a UV detector. The limit of detection appears to be 0.001 ppm. No recovery data was presented in this study.

C. Reported Results

1. Plant Tissue

a. 45 Day Post-Treatment Study

The principal degradate was the triazine amine. At maturity, <0.01 ppm total radioactive residues were in beet roots, beet foliage, peas, pea pods, sunflower seeds and sunflower seed heads. Pea foliage and sunflower foliage contained 0.053 and 0.015 ppm, respectively, at maturity. Of this, the triazine amine accounted for 0.032 ppm in the pea foliage. In the sunflower and beet foliage, none of the

individual metabolites exceeded 0.01 ppm.

b. 74/75 Day Post-Treatment Study

Peas, beet tubers, beet foliage, sunflower seeds and sunflower seed heads contained <0.01 ppm radioactivity (based on the triazine amine). Pea foliage contained 0.04 ppm and sunflower foliage contained 0.01 total ¹⁴C radioactivity, calculated as the triazine amine.

2. Soil

The major degradate found was the triazine urea, present at <0.01 ppm during the entire study.

D. Study Author's Conclusions

The major radiolabelled degradate in the soil was the triazine urea; in plants, the major metabolite was the triazine amine. In both the 45- and 75-day post-treatment studies, no accumulation of radioactivity (>0.01 ppm) was detected in mature beet tubers, beet foliage, peas, pea pods, sunflower seeds and sunflower seed heads. Some accumulation of radioactivity was observed in the pea foliage and beet foliage, due to concentration of residues because of plant dehydration.

F. Reviewer's Discussion and Interpretation of Study Results

1. This study is scientifically valid.

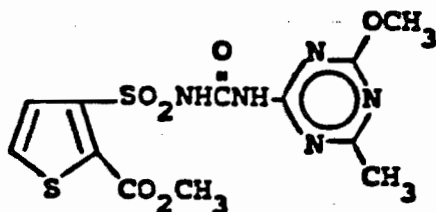
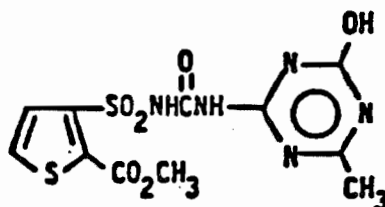
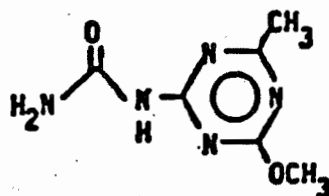
2. Neither parent nor degradates accumulate to any appreciable amount in 3 rotated crops: beets, peas, and sunflowers, due, mainly, to the extremely low application rate.

3. This study may satisfy Subpart N data requirements if the following points are adequately addressed:

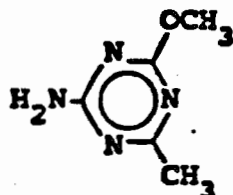
- a. What is the recovery for the method for soil and the 3 plant types in the 0.001-0.01 ppm range?
- b. Why was a root crop chosen and not a leafy vegetable (spinach, lettuce)?
- c. Was a storage stability test run to demonstrate little or no degradate deterioration with time, under freezer storage conditions? How long were samples stored before analysis?
- d. Was the identity of degradates by HPLC confirmed by another detection method?

4. It is assumed that the purpose of incorporating the wheat crop into the soil before planting the rotational crops was to simulate a "worst case" scenario, as in crop failure.

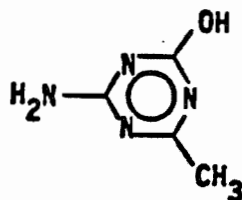
Du Pont Report No. AMR-582-86

Figure 1STRUCTURES AND CHEMICAL ABSTRACT NAMES OF DPX-M6316
AND RELATED COMPOUNDSDPX-M6316Methyl-3-[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]-
carbonyl]amino]sulfonyl]-2-thiophenecarboxylateO-Demethyl-DPX-M6316Methyl-3-[[[(4-hydroxy-6-methyl-1,3,5-triazin-2-yl)amino]-
carbonyl]amino]sulfonyl]-2-thiophenecarboxylateTriazine Urea

(4-Methoxy-6-methyl-1,3,5-triazin-2-yl)urea

Figure 1 (Cont'd.)STRUCTURES AND CHEMICAL ABSTRACT NAMES OF DPX-M6316
AND RELATED COMPOUNDSTriazine Amine

4-Methoxy-6-methyl-1,3,5-triazin-2-amine

O-Demethyl Triazine Amine

4-Amino-6-methyl-1,3,5-triazin-2-ol

TABLE 4

SUMMARY OF SOIL SAMPLING DATES AND ¹⁴C-RADIOCHEMICAL LEVELS IN SOILS

<u>Date Sampled</u>	<u>Days After Treatment</u>	<u>Event</u>	<u>Total ¹⁴C-Conc.^a ppm DPX-M6316</u>	<u>Calculated as: ppm Triazine Urea</u>
<u>45-Day, Post-Treatment Study</u>				
7/28/86	0	Cover crop treated	0.008	
9/11/86	45	Rotational crops ^b planted	0.005 ^c (0.010) ^d	0.002 ^c (0.005) ^d
10/23/86	87	Harvest peas	0.007	0.003
12/8/86	133	Harvest sunflowers	0.006	0.003
12/29/86	154	Harvest beets	0.007	0.003
<u>75-Day, Post-Treatment Study</u>				
10/11/86	75	Rotation crops ^b planted	0.010 ^c (0.016) ^d	0.005 (0.008)
11/21/86	116	Peas harvested	0.007	0.003
1/29/87	185	Beets harvested	0.007	0.003
<u>74-Day, Post-Treatment Study</u>				
12/1/86	0	Cover crop treated	0.011	
2/13/87	74	Peas & sunflowers planted	0.009 ^d	0.004 ^d
3/27/87	116	Peas harvested	0.009	0.004
5/13/87	153	Sunflowers harvested	0.006	0.003

^a Calculated as parts per million on a dry soil weight basis

^b Average for all soils taken that day

^c Prior to wheat incorporation

^d After wheat incorporation

TABLE 5
DISTRIBUTION OF ¹⁴C-RESIDUES
PRESENT IN SOILS TREATED WITH [TRIAZINE-2-¹⁴C]DPX-M6316

Days After Treatment	¹⁴ C Total Residues (ppm)	Concentration of Total Radioactivity in Each Fraction (ppm as triazine urea equivalents)		
		(NH ₄) ₂ CO ₃ Extracts	NaOH Extracts	Bound
<u>45-Day, Post-Treatment Study</u>				
0	0.008 ^a	0.007 ^a	0.001 ^a	<0.001 ^a
45	0.002 ^b	0.001	0.001	<0.001
45	0.005 ^c	0.003	0.001	0.001
87	0.003	0.001	0.001	0.001
133	0.003	0.002	0.001	0.001
154	0.003	0.001	0.001	0.001
<u>75-Day, Post-Treatment Study</u>				
75	0.005 ^b	0.002	0.001	0.001
75	0.008 ^c	0.004	0.002	0.002
116	0.003	0.001	0.001	0.001
185	0.003	0.001	0.001	0.001
<u>75-Day, Post-Treatment Recrop Study</u>				
0	0.011 ^a	0.010 ^a	0.001 ^a	<0.001 ^a
74	0.004 ^c	0.002	0.001	0.001
116	0.004	0.002	0.001	0.001
153	0.003	0.001	0.001	0.001

^aValue expressed as ppm DPX-M6316
^bPrior to wheat incorporation
^cAfter wheat incorporation

TABLE 6

¹⁴C-COMPOSITION OF EXTRACTED SOILS^a TREATED WITH [TRIAZINE-2-¹⁴C]M6316

Days After Treatment	Total Residues (ppm) ^b	Parts Per Million					Unextracted
		DPX- M6316	O-Demethyl DPX-M6316	Triazine Amine	Triazine Urea	O-Demethyl Triazine Amine	
<u>45-Day, Post-Treatment Study</u>							
0	0.008 ^c	0.005	0.002	--	--	0.001	<0.001
45 ^d	0.002 ^d	--	--	<0.001	0.001	<0.001	<0.001
45 ^e	0.005 ^e	--	--	<0.001	0.003	0.001	0.001
87	0.003	--	--	<0.001	0.002	<0.001	0.001
133	0.003	--	--	--	0.002	<0.001	0.001
154	0.003	--	--	<0.001	<0.001	0.001	0.00
<u>75-Day, Post-Treatment Study</u>							
75	0.005 ^d	--	--	<0.001	0.002	<0.001	0.001
75	0.008 ^e	--	--	<0.001	0.004	0.001	0.002
116	0.003	--	--	<0.001	0.001	<0.001	0.001
185	0.003	--	--	<0.001	0.001	<0.001	0.001
<u>74-Day, Post-Treatment Recrop Study</u>							
0	0.011 ^c	0.008	0.001	--	--	<0.001	0.001
74	0.004 ^e	--	--	<0.001	0.002	<0.001	0.001
116	0.004	--	--	<0.001	0.002	<0.001	0.001
153	0.003	--	--	<0.001	0.001	<0.001	0.00

^aRepresents data from (NH₄)₂CO₃ and NaOH extracts

^bValue expressed as ppm triazine urea

^cValue expressed as ppm DPX-M6316

^dPrior to wheat incorporation

^eAfter wheat incorporation

"--" denotes none detected <0.001 denotes trace amount detected

TABLE 8a

TOTAL ^{14}C -RESIDUES IN CROPS PLANTED 45 DAYS POST-TREATMENT OF
COVER CROP WITH [TRIAZINE-2- ^{14}C]DPX-M6316

<u>Mature Plant Tissue</u>	<u>Days After Treatment</u>	<u>^{14}C Conc. (ppm) of Total C-Residues at Harvest</u> ppm Calculated as Triazine Amine
Beet Foliage	109	0.008
Beet Tubers	109	0.001
Sunflower Foliage	89	0.015
Sunflower Seed Head	89	0.004
Sunflower Seeds	89	0.002
Pea Foliage	42	0.053
Pea Pods	42	0.002
Peas	42	0.002

TABLE 8b

TOTAL ^{14}C -RESIDUES IN CROPS PLANTED 75 DAYS POST-TREATMENT OF
COVER CROP WITH [TRIAZINE-2- ^{14}C]DPX-M6316

<u>Mature Plant Tissue</u>	<u>Days After Treatment</u>	<u>^{14}C Conc. (ppm) of Total C-Residues at Harvest</u> ppm Calculated as Triazine Amine
Beet Foliage	110	0.006
Beet Tubers	110	0.001
Pea Foliage	41	0.040
Pea Pods	41	0.004
Peas	41	0.001

TABLE 8c

TOTAL ^{14}C -RESIDUES IN CROPS PLANTED 74 DAYS POST-TREATMENT OF
COVER CROP WITH [TRIAZINE-2- ^{14}C]DPX-M6316

<u>Mature Plant Tissue</u>	<u>Days After Treatment</u>	<u>^{14}C Conc. (ppm) of Total C-Residues at Harvest</u> ppm Calculated as Triazine Amine
Pea Foliage ^a	42	0.014
Peas	42	0.004
Pea Pods ^b	42	0.030
Sunflower Foliage	89	0.014
Sunflower Seed Heads	89	0.003
Sunflower Seeds	89	0.001

^aSample contained considerable dry tissue, data presented is for a representative succulent tissue. Combustion of a sample containing all dry tissue gave ^{14}C -residues of 0.092 ppm (based upon triazine amine).

^bSample contained considerable dry tissue.

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TABLE 9
DISTRIBUTION OF ^{14}C -RESIDUES IN MATURE CROP FRACTIONS

Plant Tissue	^{14}C Total Residue (ppm)	Radioactivity (ppm Based upon Triazine Amine Equivalents) in Each Fraction		
		$\text{NaHCO}_3^{\text{a}}$ Extract	HCl Extract	Bound
45-Day, Post-Treatment Study				
Pea Foliage	0.053	0.047	0.002	0.004
Beet Foliage	0.008	0.004	<0.001	0.001
Sunflower Foliage	0.043	0.012	0.001	0.002
75-Day, Post-Treatment Study				
Pea Foliage	0.040	0.037	0.001	0.002
Beet Foliage	0.006	0.005	<0.001	0.001
74-Day, Post-Treatment Recrop Study				
Pea Foliage ^b	0.092	0.072	0.009	0.010
Sunflower Foliage	0.008	0.006	0.001	0.001

^aCombined NaHCO_3 extracts and MeOH/EtOAc rinses

^bRepresents dry foliage, insufficient sample of succulent foliage for extraction

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TABLE 10
CHARACTERIZATION OF ¹⁴C-RESIDUES^a MATURE CROP FRACTION

Plant Tissue	¹⁴ C-Residue (ppm) ^b	Composition (ppm)				
		Triazine Amine	Triazine Urea	O-Demethyl Triazine Amine	Polar Metabolites	Unextracted
<u>45-Day, Post-Treatment Study</u>						
Pea Foliage	0.053	0.032	0.006	0.002	0.001	0.004
Beet Foliage	0.008	0.005	0.001	<0.001	<0.001	0.001
Sunflower Foliage	0.015	0.008	0.001	<0.001	<0.001	0.002
<u>75-Day, Post-Treatment Study</u>						
Pea Foliage	0.040	0.024	0.004	0.001	<0.001	0.002
Beet Foliage	0.006	0.003	<0.001	<0.001	<0.001	0.001
<u>74-Day, Post-Treatment Study</u>						
Pea Foliage ^c	0.090	0.025	0.015	0.005	0.008	0.011
Sunflower Foliage	0.008	0.004	<0.001	0.001	<0.001	0.001

^aRepresents data from NaHCO₃ and HCl Extracts

^bRepresents total ppm based on equivalent weight of triazine amine

^cRepresents dry foliage, insufficient sample of succulent foliage for extraction

NOTE:

SUBJECT: Review of "A PRZM Computer Simulation of Potential Groundwater Concentrations of Triazine Amine (2-Amino-4-Methoxy-6-Methyl-1,3,5-Triazine)"

FROM: W. Martin Williams, Hydrologist
Ground Water Team

*W.M. Williams
C.E.D. for P. Halder*

TO: Pat Ott, Chemist
Section 1

DATE: January 12, 1988

I have reviewed the report referenced above and would like to provide the following comments.

Overall Comments:

The analysis appears to be based on reasonable and/or conservative assumptions regarding model parameters (i.e., application rates, soil characteristics, herbicide parameters, and hydrologic characteristics). There is, however, an omission of important input data (i.e., runoff curve numbers, crop characteristics, soil transmissivity or velocity, and diffusion-dispersion coefficients). This omission appears to be due more to a lack of documentation than a failure to represent important processes in the model. It would have been very helpful to have obtained a listing of the input and perhaps output file from a typical simulation to give this study the level of review it deserves.

The results focus on a 16 foot depth. This depth was selected as being the regionalized depth of the water table in the Florida shallow aquifer represented in the study. In general, PRZM is not considered valid to depths much greater than the root zone of crops. EAB simulations have typically focused on a 2-meter (approximately 6.5 foot) depth for model output. Required assumptions in PRZM regarding soil homogeneity tend to introduce uncertainties in results as depths increase. With the exception of March, June and September of 1976, the report only presents results at a 16 foot depth. Higher concentrations can be found at shallower depths, but the range of these concentrations cannot be assessed in detail from the information in the report. With the given information, I would predict that annual high concentrations of the triazine amine is on the order of 1.5 ppb at a six foot depth. The health significance of this concentration needs to be determined. If it is evaluated as significant, then the PRZM simulation must be judged as inconclusive, with further simulation work at the discretion of the registrant. If 1.5 ppb is judged as toxicologically of no concern, then the GW Team concurs with the registrant in the general conclusion that the use of DPX-M6316 will not result in ground water residues of the triazine amine of concern.

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The study focused on triazine amine as opposed to DPX-M6316. For triazine amine, the simulated half-life of eight months and K_{oc} of 58 ($K_d = 0.44$) appear reasonable and conservative based on the laboratory data discussed in the report. Your data on DPX-M6316 indicates a critical leachate potential ($K_d < 0.01$ and half-lives of one to two weeks) in sandy soils. Because of the significant difference in half-lives (eight months vs two weeks), it may not be necessary to request additional simulations of DPX-M6316 as well as triazine amine, unless there is a concern because of different health advisory limits between the herbicide and metabolite. If this is a concern, a simulation of the DPX-M6316 would also be appropriate.

Specific Comments

While PRZM may not be as valid for depths below the root zone, simulating to depths of 16 feet is not necessarily erroneous. However, the 16 foot saturation assumption may be excessively deep for a Florida shallow aquifer in which the water table often resides only a few feet below the surface. This also supports the need to quantify concentrations at shallower depths.

The scenario was simulated for a five year period. The concentrations have an annual cyclic pattern governed by the time of herbicide application. At the 16 foot depth, soil-water concentrations vary from 0.08 to 0.15 ppb during the year. The time histories reported at a 16 foot depth do not indicate a build-up of herbicide concentrations. While the concentrations appear to increase near the end of the fifth year, those levels are following the cyclic trends predicted for earlier years. Therefore, the duration simulated appears to be sufficient. If the herbicide was applied more frequently than annually, or higher amounts were applied in the single application, higher concentrations and herbicide build-up could occur.

The report is very vague on hydrologic parameters. It appears that the only transportation mechanisms simulated are: application, plant uptake, runoff, and advection. Although the herbicide is applied post-emergent, foliar processes were neglected and all herbicide was assumed to become incorporated into the soil. This assumption is valid for prediction purposes because it provides a more conservative estimate of soil water concentrations. It is unclear whether other processes were simulated: dispersion-diffusion and erosion. In addition to not documenting runoff curve numbers, crop properties are not specified (i.e., planting and harvesting data, root zone depths, etc.). Even the crop on which the herbicide is applied was not specified.

Summary and Conclusions:

- 1) The analysis appears to be appropriately set-up and conservative.
- 2) Triazine amine is a potent leachate given the half-life (6 to 8 months) and Kd (0.44). The low concentrations are a result of a relatively small application (12.7 gm/ha) at a low rate (annually). This rate was stated as the maximum rate in the study. If the application amount and rate were to increase, higher concentrations and build-up would occur.
- 3) If the toxicology impacts on the concentrations reported in the study are determined to be significant, further data is recommended:
 - Input and output file listings,
 - Concentration histories at shallower depths (say 3 and 6 ft), and
 - Simulations to 10 years.
- 4) If the toxicological effects of the parent chemical are deemed significant, simulation of DPX-M6316 may be warranted given the higher application rate (35 gm/ha A.I.) and leaching potential of the parent chemical (1-2 week half-life and Kd under 0.01).

cc Patrick Holden
Matt Lorber

ENVIRONMENTAL FATE SUMMARY

The information presented below is a combination of the Executive Summary in the 4/10/87 EAB review and a summary of the studies submitted in this review.

The data summarized here are scientifically valid data that have been reviewed in this report but do not fulfill data requirements unless noted in the Recommendations section of this report.

Thiophene-labeled [^{14}C]DPX-M6316 (radiochemical purity >99%), at 0.5 and 5.0 ppm, degraded with half-lives of 3-6 days in sterile aqueous buffered solutions of pH 5, but was relatively stable to hydrolysis at pH 7 and 9, with ~10% degradation of parent occurring within thirty days. (Rhodes et al., Account #263760). 2-Ester-3-sulfonamide was the major degradate at pH 5 (62-64% of the applied at day 30) and the only degradate at pH 7 (9-10% of the applied) and pH 9 (4-8% of the applied). 2-Ester-3-triuret and O-demethyl DPX-M6313 were detected in pH 5 solutions at maximum concentrations of 8-32% and 4-7% of the applied, respectively. In a related study, triazine amine was the major degradate of triazine-labeled [^{14}C]DPX-M6316 at pH 5, representing 36% of the applied radioactivity at 31 days.

Radiolabeled [^{14}C]triazine amine (radiochemical purity 99%), at 0.5 and 5 ppm, was stable to hydrolysis at pH 5, 7, and 9 for 30 days (Friedman, Acc. No. 252492).

Thiophene- and triazine-labeled [^{14}C]DPX-M6316 (radiochemical purities >98%), at 10 ppm, degraded with a half-life of 30-72 hours in a pH 5 aqueous buffered solution irradiated with natural sunlight, and a half-life of 72-144 hours in pH 7 and 9 solutions (Ryan, Acc. No. 263760). DPX-M6316 in the dark control degraded with a half-life of >336 hours. In the irradiated pH 7 solution treated with triazine-labeled [^{14}C]DPX-M6316, methyl-2-(4-methoxy-6-methyl-1,3,5-triazine-2-yl-amino)-3-thiophene-carboxylate (tentative), triazine amine, and triazine urea were the major degradates (0.78, 1.24, and 1.55 ppm, respectively, at 336 hours). In the pH 7 solution treated with thiophene-labeled [^{14}C]DPX-M6316, methyl-2-(4-methoxy-6-methyl-1,3,5-triazine-2-yl-amino)-3-thiophene-carboxylate was the only major degradate (0.84 ppm at 336 hours).

Thiophene- and triazine-labeled [^{14}C]DPX-M6316 (radiochemical purities >98%), at 0.83 g/cm², degraded with a half-life of 7-14 days in sunlight-irradiated silt loam soil; the half-life was 14-21 days in the dark controls (Ferguson, Acc. No. 263760). The major degradate of the thiophene-labeled [^{14}C]DPX-M6316 was 2-ester-3-sulfonamide (20.4% of the applied at 30 days). The major degradate of the triazine-labeled [^{14}C]DPX-M6316 was triazine amine (32.3% of the applied at 30 days). Other degradates included O-demethyl DPX-M6316, DPX-M6316 acid, 2-acid-3-sulfonamide, thiophene-sulfonamide, and triazine urea.

Under aerobic conditions in soil, thiophene-labeled [^{14}C]DPX-M6316 degraded to $^{14}\text{CO}_2$ via several intermediates with a half-life of 2-6 days; 31-44% of the applied radioactivity was mineralized after 20 weeks of incubation (Rapisarda, Acc. No. 263760). DPX-M6316 acid, 2-acid-3-sulfonamide, 2-ester-3-sulfonamide, O-demethyl DPX-M6316, and thiophene sulfonimide each comprised up to 30% of the recovered radioactivity. Unextractable residues comprised up to 46% of the recovered radioactivity.

An aerobic soil metabolism study (Rhodes, 1986, Accession # 403403-17) of a major degradate, the triazine amine, gave a half-life of about 5 and 1/2 months (calculated, 8 months), indicating this compound is persistent enough to be available for leaching, accumulation in rotational crops, etc. The triazine amine degraded to dihydroxy methyl triazine (11% of the applied) and CO₂ (38% of the applied).

Surrogate data for the triazine moiety was obtained from studies on DPX-4189. Under aerobic conditions in soil, DPX-4189, at 0.1 and 1 ppm, degraded with a half-life of 4-10 days (Rapisarda, Acc. No. 072846). Triazine amine was isolated at up to 25% of the recovered at one month, then plateaued at about 15% of the recovered during the 4-7 months remaining incubation period.

Thiophene-labeled [¹⁴C]DPX-M6316 (radiochemical purity >99%), at 52-60 ppb, degraded with half-lives of 7-14 days in anaerobic (flooded) loamy sand sediment and 14-28 days in anaerobic (flooded) sandy loam and silt loam sediments (Lewis and Carter, Acc. No. 263760). The major degradates were 2-ester-3-sulfonamide (maximum concentration 13-40% of recovered), 2-acid-3-sulfonamide (maximum concentration 25-43%), and 2-acid-3-sulfonic acid (maximum concentration 16-24%). 2-Ester-3-triuret, O-demethyl DPX-M6316, and DPX-M6316 acid were also detected. In sterile anaerobic sediments, DPX-M6316 degraded with a half-life of 56-112 days.

Triazine-labeled [¹⁴C]chlorsulfuron (radiochemical purity >99%), at 1 ppm, degraded with a half-life of >52 weeks in silt loam soil incubated under anaerobic conditions (Chrzanowski, Acc. No. 260973). Chlorsulfuron and DPX-M6316 have the same triazine moiety. The major degradate, triazine amine, increased over time with a maximum concentration of 21% at 52 weeks.

Unaged thiophene- and triazine-labeled [¹⁴C]DPX-M6316 (radiochemical purities >98%) was very mobile in columns of sandy loam, loamy sand, silt, and silt loam soils; 72-97% of the recovered radioactivity was leached from the columns (Ferguson, Acc. No. 263760). K_d values were 0, 0.01, 0.86, and 0.15-0.16 for sandy loam, loamy sand, silt, and silt loam soils, respectively. DPX-M6316 was the major [¹⁴C]compound in the leachate from the unaged soil. Aged (6 days) thiophene- and triazine-labeled [¹⁴C]DPX-M6316 residues were very mobile in columns of silt loam soil; 69-72% of the thiophene and triazine-labeled [¹⁴C]-residues were recovered in the leachate. DPX-M6316 acid comprised 35-44% of the residues in the leachate from the aged soil.

Thiophene-labeled [¹⁴C]DPX-M6316 was very mobile in two sandy loam soils, a silt loam soil, and a silt soil (K_{ads} 0.19-1.38, K_{des} 0.27-1.67) based on batch equilibrium studies (Priester, Acc. No. 263760). Based on soil TLC studies, DPX-M6316 was very mobile in two sandy loam soils (R_f 0.73-0.92) and was mobile in silt loam and silt soils (R_f 0.44-0.49).

Thiophene-labeled DPX-M6316 (radiochemical purity >98%), at 80 g ai/ha, degraded with a half-life of 3-20 days in field plots of silt loam soil near Moscow, Idaho, loam soil near Akron, Colorado, silty clay loam soil near Fargo, North Dakota, and silty clay loam soil near Manitoba, Canada (Rapisarda and Scott, Acc. No. 263760). The degradates O-demethyl DPX-M6316 and 2-ester-3-sulfonamide were recovered in the soil at all four test sites. Most [¹⁴C]-residues remained in the upper 5 inches of soil throughout the 60- to 80-week study at all four test sites; however, some leaching of residues was evident.

In soil field studies, triazine-labeled [¹⁴C]chlorsulfuron (radiochemical purity >99%), applied at 100 g ai/A, degraded with a half-life of 2-4 weeks (Han,

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Acc. No. 260974). The metabolite, triazine amine, reached maximum levels of 48% of the applied at 4-8 weeks, then declined to 13% at 16 weeks, and plateaued at that level for the 77-week study period. Some leaching of the triazine amine at the lowest depth sampled (20-38 cm) was evident.

Thiophene-labeled [^{14}C]DPX-M6316, at 4-5 ppm, did not bioaccumulate in bluegill sunfish during 28 days exposure (Larkin, Acc. No. 072646). Also, since the octanol/water partition coefficient for DPX-M6316 is 0.027, residues would not be expected to accumulate in fish.

For 30-day crop (beets, peas, sunflowers) rotation intervals following soil application of thiophene-labeled [^{14}C]DPX-M6316 (radiochemical purity >98%) at 34.8 g ai/A (1.8 x maximum proposed use rate), residues at maturity were detected in beet and sunflower foliage at up to 22 ppb and 17 ppb, respectively (Hardesty, Acc. No. 254641).

Soil was treated with triazine-labeled [^{14}C]chlorsulfuron at 28.3 g ai/A and then planted to soybeans, rape, and sugar beets 1 year posttreatment (Han, Acc. No. 260975). Sugar beets died after one month. Residues were detected at 1-7 ppb in seeds and foliage of both rape and soybeans.

triazine-labeled

A confined rotational crop study of DPX-M6316 (Brown, 1987, Accession # 403403-18) indicated the major soil degradate was the triazine urea (present <0.01 ppm throughout study) and the major plant metabolite, in 3 rotated crops (peas, beets and sunflowers) was the triazine amine. Only the pea and sunflower foliage contained radioactive residues at or above 0.01 ppm (up to 0.05 ppm), while the peas, pea pods, beet tubers, beet foliage, sunflower seeds, and sunflower seed heads contained <0.01 ppm. The rotational crops were planted 45, 74 or 75 days post-treatment of the primary crop (wheat); the wheat was incorporated into the soil just before planting the rotational crops.

A PRZM (Pesticide Root Zone Model) run for a major degradate, the triazine amine, was run, to estimate concentrations which could leach through soil and be available to contaminate ground water. The reviewer (W. Martin Williams) concluded that the triazine amine has a significant leaching capability, but, because of the low application rate and single application/growing season, the amount leached is low (estimated annual high concentration at the 6 foot depth is 1.5 ppb),

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