DATA EVALUATION RECORD

STUDY 8

CHEM 030703 Naptalam sodium salt §165-1

FORMULATION--00--ACTIVE INGREDIENT

STUDY ID 40069102
McManus, J.P. 1987a. Alanap confined rotational crop study (interim report). Project No. 8644. Unpublished study performed by Uniroyal Chemical Company, Inc., Naugatuck, CT, and submitted by Uniroyal Chemical Company, Inc., Middlebury, CT.

STUDY ID 40274501
McManus, J.P. 1987b. Alanap confined rotational crop study - supplemental report. Project No. 8644A. Unpublished study performed by Uniroyal Chemical Company, Inc., Naugatuck, CT, and submitted by Uniroyal Chemical Company, Inc., Middlebury, CT.

DIRECT REVIEW TIME = 6

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CONCLUSIONS:

Confined Accumulation - Rotational Crops

1. This study cannot be used to fulfill data requirements.

2. [^{14}C]Naptalam residues accumulated in wheat planted 36 days after sandy clay loam soil was treated with 1-naphthyl-labeled [^{14}C]-naptalam at approximately 4.0 lb ai/A, but did not appear to

accumulate in lettuce and turnips planted at 36 and 260 days post-treatment. At harvest, [^{14}C]residues were present in the wheat seed at 0.068 ppm and in the wheat straw at 0.16 ppm.

3. This study is scientifically sound, but does not meet Subdivision N guidelines for the following reasons:

   crop and soil residue data were incomplete;

   the experimental methodology was not adequately described;

   residues in the crops and soil were not identified;

   residues in the soil were not analyzed at the time of treatment;

   storage stability data were not provided for the plant and soil substrates; and

   immature plants were not analyzed.

4. In order for this study to fulfill the accumulation in confined rotational crops data requirement, the registrant must submit acceptable data for the following: identity and quantity of degradates in all crops and soil from both rotations; storage stability data for the plant and soil substrates; details of the experimental methodology (refer to Comment 3); and crop and soil data from the 260-day rotational wheat.

METHODOLOGY:

1-Naphthyl-labeled [^{14}C]naptalam (radiochemical purity >99%, specific activity 1.81 mCi/mmol, Pathfinder Labs, Inc.), dissolved in distilled water, was added to six portions (50 g) of air-dried sandy clay loam soil (67.2% sand, 11.6% silt, 21.2% clay, 5.66% organic matter, pH 6.3, CEC 26.97 meq/100 g) and thoroughly mixed. An additional 500 g of untreated soil was added to each treated sample and mixed by tumbling; the final [^{14}C]naptalam concentration in the treated soil as determined by LSC following combustion was 41 ppm. Six pails (5-gallon volume, surface area 641 cm^2) were filled with untreated sandy clay loam soil (amount of soil per pail was not specified), and the samples (550 g) of treated soil were layered on top of the untreated soil in each pail. The depth of the treated soil layer was not specified, but the study author stated that the treatment rate per bucket was 4.0 lb ai/A. The soil was aged for 36 days in a greenhouse (temperature unspecified) in Bethany, CT; during the aging period, the soil was kept moist with periodic watering and was hand cultivated.

At 36 days posttreatment, the 0- to 6-inch soil layer in an unspecified number of pails was removed and portions were analyzed

for total radioactivity; the 6- to 12-inch soil layer was also sampled (method of sampling not described). The 0- to 6-inch soil layer was then returned to each pail and planted to lettuce, turnips, or wheat; it was not specified how many pails were planted to each crop. The crops were grown "under normal greenhouse conditions" (conditions not specified) and harvested only at maturity; 71 days postplanting for lettuce, 171 days for turnips, and 199 days for wheat.

At 260 days posttreatment, treated soil was planted to lettuce, turnips, and wheat; treatment rate, aging conditions before planting, and number of pots planted were not described. Lettuce and turnips were harvested only at maturity (112 and 115 days postplanting, respectively); the wheat had not yet been harvested when the study was submitted. Crops were stored frozen (-30 C) until analysis. Soil samples (0- to 6- and 6- to 12-inch depths) were taken at each planting interval and at harvest; storage conditions for the soil samples were not described.

Plant samples were thawed, chopped, homogenized with dry ice, and air-dried prior to analysis; plant and soil samples were analyzed for total radioactivity by LSC following combustion. The statistical limit of detection was 0.035 ppm.

DATA SUMMARY:

[^{14}C]Naptalam residues accumulated in wheat planted 36 days after 1-naphthyl-labeled [^{14}C]naptalam (radiochemical purity >99%) was applied, at 41 ppm (4.0 lb ai/A), to sandy clay loam soil. [^{14}C]-Residues detected in lettuce and turnips planted at 36 and 260 days posttreatment did not exceed the limits of detection of total radioactivity in the various plant matrices (0.035 ppm).

In crops planted at 36 days posttreatment, [^{14}C]residues at harvest were 0.016 ppm in lettuce, 0.032 and 0.031 ppm in turnip tops and roots, respectively, and 0.068 and 0.16 ppm in wheat seed and straw, respectively (Table III, MRID 40069102). Immature plants were not analyzed.

In crops planted at 260 days posttreatment, [^{14}C]residues at harvest were 0.0016 ppm in lettuce, and 0.026 and 0.007 ppm in turnip tops and roots, respectively (Table II, MRID 40274501); wheat samples had not been harvested at the time this study was submitted. Immature plants were not analyzed.

Total [^{14}C]residues in the treated soil applied to the pots were 41 ppm immediately posttreatment; residues were not determined for the 0- to 6- and 6- to 12-inch depths at time of application. In the 0- to 6-inch soil layer, [^{14}C]residues were 1.5-3.3 ppm at 36 days posttreatment, 0.94-4.0 ppm at harvest of the 36-day rotational crops (107-225 days posttreatment), 3.5-4.4 ppm at 260 days posttreatment,

and 1.0-2.0 ppm at harvest of the 260-day rotational crops (372-375 days posttreatment) (Table II, MRID 40069102 and Table I, MRID 40274501). In the 6- to 12-inch soil layer, [^{14}C]residues were 0.40-0.89 ppm at 36 days posttreatment, 0.29-2.5 ppm at harvest of the 36-day rotational crops, 2.1 ppm at 260 days posttreatment, and 1.1-1.5 ppm at harvest of the 260-day rotational crops.

COMMENTS:

1. Data for wheat plant tissue and soil from the 260-day posttreatment interval were not provided; the registrant reported that the wheat had not been harvested at the time this study was submitted. In addition, the air temperature and relative humidity in the greenhouse were not reported, and counting (dpm) data were not provided for the soil and plant samples taken during the 260-day rotation.

   In addition, the experimental methodology was not described in sufficient detail to allow an adequate review of the study. Some examples of unclear descriptions are: it was not specified what depth the treated soil layer was when applied to the untreated soil in the pails; it was not specified how many of the six pails were planted to each rotational crop; it is unclear why the 0- to 6-inch soil layer was removed and then replaced prior to planting the 36-day rotational crops, and it was not specified if this procedure was performed for the 260-day rotation; other than at 36 days posttreatment, it was not specified how the soil samples were obtained; and, it was reported that control rotational crops were planted in soil treated with unlabeled naptalam, but the treatment rate and number of pails planted were not reported.

2. Residues in the crops and soil were not identified; samples were analyzed for total radioactivity only.

3. Residues in the soil were not analyzed at the time of treatment. The treated soil applied to the pails (550 g per pail) was analyzed immediately posttreatment; the value as determined by direct analysis of the soil by LSC following combustion was 41 ppm. However, residues were not quantified in the 0- to 6- and 6- to 12-inch depths at time of application; the application rate, as stated by the study author, was 4.0 lb/A. If so, the maximum concentration present in the 0- to 6-inch depth should have been approximately 2 ppm; [^{14}C]naptalam residues were found at up to 3.3 and 4.4 ppm 36 and 260 days posttreatment, respectively.

4. Freezer storage stability data were not provided for the plant substrates; it was also not specified how long samples were stored frozen prior to analysis. Storage conditions for the soil samples were not described. The freezer storage data for soil as provided for Study 6 (MRID 41385403) and Study 7 (MRID 40488901 and 40069101) were inconclusive because the data were conflicting.

5. Immature plants were not analyzed.

6. The study author reported that the crops were planted at 33 days posttreatment; however, the treatment date was May 19, 1986 and the planting date was June 24, 1986 which results in a 36-day planting interval. It was reported in this review as 36 days.

7. It is not sufficiently clear if the 260-day rotational crops were planted in the same soil used for the 36-day rotation, or if the crops were planted into aged, unused soil. It appears that the soils were treated at the same time (5/19/86), but a comparison of the concentrations of [^{14}C]residues between soils analyzed at harvest in the 36-day rotational crop (Table II, MRID 40069102) and soils analyzed at time of planting for the 260-day rotational crop (Table I, MRID 40274501) provides ambiguous information. The concentrations in the lettuce and turnip soils are similar and, therefore, those soils could have been sequentially cropped; however, the concentrations in the two depths of the wheat soil at time of harvest for the 36-day rotational crop (0.94 and 0.29 ppm) and 260-day planting (3.5 and 2.1 ppm) would suggest that these were not the same soils used sequentially.

8. It appears that total [^{14}C]residues in the 0- to 6-inch soil layer increased between the 36- and 260-day planting intervals; however, because the depth of the treated soil layer was not specified, this trend could not be evaluated. In addition, it is unclear if the removal and replacement of the 0- to 6-inch soil layer prior to planting of the 36-day rotation had any effect on the results.

9. Naptalam was applied as a fortified soil. Naptalam (28.8 mg) was mixed with 550 g of soil, and the soil was applied evenly to each pail. The surface area of the soil in each pail was 641 cm^2, so the nominal application rate was 4.01 lb/A. However, 28.8 mg naptalam/550 g of soil would result in a concentration of 52.4 ppm; the value as determined by direct analysis of the soil by LSC following combustion was 41 ppm.

STUDY AUTHOR(S)'S RESULTS AND/OR CONCLUSIONS

(INCLUDING PERTINENT TABLES AND FIGURES)

Project No. 8644

MRID 40069102

RESULTS AND DISCUSSION

Soils were treated with ^{14}C-naptalam at a rate of 4.0 lbs/A and placed on top of 5 gallon pails containing sandy loam. Properties of the sandy loam are shown in Table I. The soil was aged in the greenhouse for approximately one month. During this fallow period, the soil was kept moist and cultivated by hand. For control analysis, soils were also treated with non-radioactive naptalam under the same conditions.

Thirty-three days after treatment, soil samples from the 0-6" and 6-12" regions were taken and analyzed for total radiocarbon by combustion to $^{14}CO_2$. Results are shown in Table II for the soil analysis at this planting time. The soil regions of 0-6" contained approximately 2.5 ppm of radioactivity whereas the 6-12" regions showed less than 0.65 ppm. These results suggest that naptalam and/or its degradation products show some leaching from the applied top region to the underlying soil zone.

Representative crops (turnips, lettuce and wheat) were then planted in the aged treated soil. The same control crops were also planted in soil treated with nonradioactive naptalam. The crops were grown to maturity under normal greenhouse conditions which included one application of a liquid fertilizer and watering as needed. Lettuce was harvested at 71 days after planting, turnips 171 days and wheat 199 days. Both the control and treated crops were similar in appearance and yield.

At harvest time, soil samples were taken and analyzed for total radiocarbon. Lettuce 0-6" soil region contained only 3.6 ppm, turnip 4.0 ppm and wheat 0.94 ppm. These results are shown in Table II.

RESULTS AND DISCUSSION (Continued)

There was some ^{14}C-activity detected in the 6-12" soil zones. This indicated that some of the applied naptalam and breakdown products dis. pated from the 0-6" soil regions and leached to the 6-12" regions.

The crops were immediately frozen after harvesting. They were later thawed, chopped, air dried and ground with dry ice in a blender. The solids were then combusted and analyzed as $^{14}CO_2$. Results are shown in Table III for the total radiocarbon content of the plants at harvest time. Radiocarbon residue levels ranged from a high of 0.21 ppm in turnip greens to a low of less than 0.022 ppm in lettuce. The limit of detection can be calculated using the standard method (Curie, 1968), which determines the limits of quantitation for liquid scintillation counting calculated as follows:

$$\sigma = \sqrt{\frac{BKg + BKg}{t \times n}} = \sqrt{\frac{37 + 37}{10 \times 2}} = 1.9$$

where:

σ = standard error of counting
BKg = background counts
t = time each vial is counted
n = number of times the vial is counted

$$L_Q (dpm) = \frac{\sigma \times K_Q}{effic.} = \frac{1.9 \times 14.1}{0.6} = 45 \text{ dpm}$$

where:

L_Q = limits of quantitation (radiation not significantly different from background)

K_Q = quantification constant (14.1)

effic. = liquid scintillation counter efficiency

RESULTS AND DISCUSSION (Continued)

From the above calculations, a crop sample that contains less than 45 dpm/aliquot is below the limits of quantitation as defined.

The naptalam used in this study had a specific activity of 1.81 mCi/mmol which can be calculated as 12,800 dpm/µg by the equation:

$$1.81 \frac{\mu Ci}{\mu mole} \times 2.2 \times 10^6 \frac{dpm}{\mu Ci} \times 1 \frac{\mu mole}{313\ \mu g} = 12{,}700 \frac{dpm}{\mu g}$$

Typical sample analysis using 100 mg of sample which shows 45 dpm would be equivalent to 450 dpm/g. Hence, the limit of detection is 35 ppb calculated by:

$$ppm = \frac{\mu g\ (naptalam)}{g\ (crop)} = \frac{450\ dpm}{g} \times \frac{1\ \mu g}{12{,}700\ dpm} = 0.0[illegible]\ ppm$$

Other soil metabolism studies using ^{14}C-naptalam have indicated a rapid degradation to 1-naphthylamine and phthalic acid with a half-life of 2 to 4 weeks. The ring cleavage of phthalic acid by soil bacteria has been reported (Engelhardt, 1978) as well as its biodegradation by mixtured bacterial cultures in anaerobic environments (Af[illegible]ring, 1981). Extensive studies in our laboratory have shown that 1-napthylamine has a half-life in soil of about three weeks. The ultimate products of naptalam in soils should be natural components formed after cleavage of the aromatic rings.

Project No. 8644

Table II. Radiocarbon Levels Detected in Soils Treated with Naptalam

Sample	Time**	Zone	ppm*
lettuce soil	planting	0-6"	3.1
lettuce soil	planting	6-12"	0.40
turnip soil	planting	0-6"	3.3
turnip soil	planting	6-12"	0.89
wheat soil	planting	0-6"	1.5
wheat soil	planting	6-12"	0.67
lettuce soil	harvest	0-6"	3.6
lettuce soil	harvest	6-12"	2.1
turnip soil	harvest	0-6"	4.0
turnip soil	harvest	6-12"	2.5
wheat soil	harvest	0-6"	0.94
wheat soil	harvest	6-12"	0.29

* These values assume that all the radioactivity is attributed to ^{14}C-naptalam.

** Treatment date 5/19/86, planting date 6/24/86, lettuce harvested 9/3/86, turnips harvested 12/2/86, wheat harvested 12/30/86.

Project No. 8644

Table III. Radiocarbon Levels Detected in Plants Grown in Soil Treated with ^{14}C-Naptalam 33 Days Prior Planting

Sample	ppm*
lettuce	0.016
turnip green	0.032
turnip roots	0.031
wheat seed	0.068
wheat straw	0.16

* These values assume that all the radiocarbon is attributed to ^{14}C-naptalam. Plant parts were dried prior to analysis.

Project No. 8644A

MRID 40274501

RESULTS AND DISCUSSION

The design and procedures used in this study have been described in the earlier ALANAP rotational crop study report (McManus 1987). Soils were analyzed for total radiocarbon at planting and harvest time. These results are shown in Table I.

Table I. Radiocarbon Levels Detected in Soils Treated with Naptalam

Sample	Time**	Zone	ppm*
lettuce soil	planting	0-6"	3.8
lettuce soil	planting	6-12"	2.1
turnip soil	planting	0-6"	4.4
turnip soil	planting	6-12"	2.1
wheat soil	planting	0-6"	3.5
wheat soil	planting	6-12"	2.1
lettuce soil	harvest	0-6"	2.0
lettuce soil	harvest	6-12"	1.1
turnip soil	harvest	0-6"	1.9
turnip soil	harvest	6-12"	1.5
wheat soil***	harvest	0-6"	
wheat soil***	harvest	6-12"	

* These values assume that all the radioactivity is attributed to ^{14}C-naptalam.

** Treatment date 5/19/86, planting date 2/3/87, lettuce harvested 5/26/87, turnips harvested 5/29/87, wheat harvested .

*** Wheat samples have not been harvested to date.

RESULTS AND DISCUSSION (Continued)

The representative crops (turnips, lettuce and wheat) were grown to maturity in the treated soils. These harvested plants were analyzed for total radiocarbon content. Results are shown in Table II. They range from a high of 26 ppb in turnip greens to a low of 1.6 ppb in lettuce. These values are all below the limit of detection calculated by the standard method (Curie, 1968) outlined as follows:

$$\sigma = \frac{\sqrt{BKg + BKg}}{t \times n} = \frac{\sqrt{37 + 37}}{10 \times 2} = 1.9$$

where:

σ = standard error of counting
BKg = background counts
t = time each vial is counted
n = number of times the vial is counted

$$L_Q(dpm) = \frac{\sigma \times K_Q}{effic.} = \frac{1.9 \times 14.1}{0.6} = 45 \text{ dpm}$$

where:

L_Q = limits of quantitation (radiation not significantly different from background)

K_Q = quantification constant (14.1)

effic. = liquid scintillation counter efficiency

From the above calculations, a crop sample that contains less than 45 dpm/aliquot is below the limits of quantitation as defined.

The raptalam used in this study had a specific activity of 1.81 mCi/mmol which can be calculated as 12,700 dpm/µg by the equation:

$$1.81 \frac{\mu Ci}{\mu \text{ mole}} \times 2.2 \times 10^6 \frac{dpm}{\mu Ci} \times \frac{\mu \text{ mole}}{313 \ \mu g} = 12{,}700 \frac{dpm}{\mu g}$$

RESULTS AND DISCUSSION (Continued)

Typical sample analysis using 100 mg of sample which shows 45 dpm would be equivalent to 450 dpm/g. Hence, the limit of detection is 35 ppb calculated by:

$$ppm = \frac{\mu g \text{ (naptalam}}{g \text{ (crop)}} = \frac{450 \text{ dpm}}{g} \times \frac{1 \text{ ug}}{12{,}700 \text{ dpm}} = 0.035 \text{ ppm}$$

Since all the levels of radiocarbon in the crops are below the 35 ppb limit of detection, they are considered statistically insignificant and additional analyses would be unwarranted.

Table II. Radiocarbon Levels Detected in Plants Grown in Soil Treated with ^{14}C-Naptalam 9 Months Prior Planting

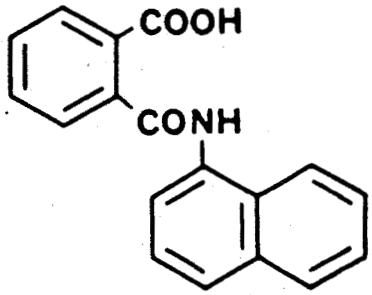
Sample	ppb*
lettuce	1.6
turnip green	26
turnip roots	7.0
wheat seed**	
wheat straw**	

* These values assume that all the radiocarbon is attributed to ^{14}C-naptalam. Plant parts were dried prior to analysis.

** Wheat samples have not been harvested to date.

APPENDIX

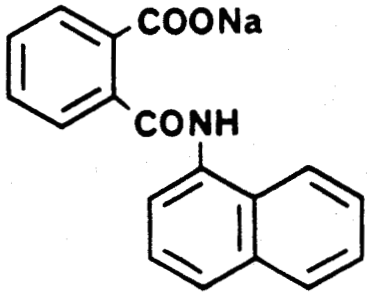
NAPTALAM AND ITS DEGRADATES



2-[(1-naphthalenylamino)carbonyl]benzoic acid

N-1-naphthylphthalamic acid

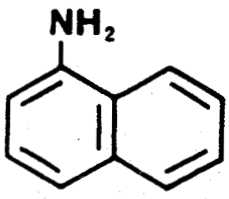
Naptalam



Sodium 2-[(1-naphthalenylamino)carbonyl]benzoate

N-1-napthylphthalamic acid, sodium salt

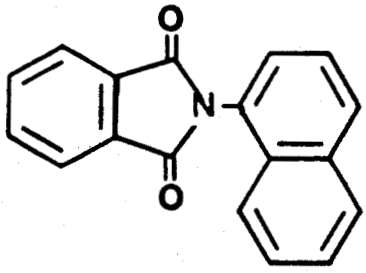
Naptalam, sodium salt



Aminonaphthalene

N-1-Naphthylamine

1-Naphthylamine



N-1-Naphthylphthalimide