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

74pp

February 4, 1999

MEMORANDUM

SUBJECT: Transmittal of EFED's Revised Chapter for the Dimethoate RED

TO: Patrick Dobak, Chemical Review Manager
Special Review & Reregistration Division 7508C

FROM: Daniel Rieder, Chief [signature] 2/4/99
Environmental Risk Branch III
Environmental Fate & Effects Division 7507C

Attached is EFED's revised chapter for the dimethoate RED. As noted in the discussion, we performed some additional PRZM/EXAMS modeling runs using information provided by the registrants in their document of comments. Some of the values provided, however, were from studies not furnished to EFED, but only summarized by the registrants. Nevertheless, the new model runs showed that the output values changed the EEC's very slightly and did not have an effect on the risk conclusions. Therefore, the revised chapter retains the original aquatic risk assessment tables that remain in effect. Please feel free to call me or Mary Frankenberry of my staff if you have any questions.

IFED Chapter A SM

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1. **Use Profile - Dimethoate**
O,O-dimethyl-S-(N-methyl-carbamoylmethyl) phosphorodithioate

A. **Type of use:** Insecticide-Acaricide

B. **Use site:** Applications allowed on the labels include 28 terrestrial food and feed crops, 21 terrestrial food crops, 18 terrestrial non-food crops, nine indoor food uses, two indoor non-food uses, four terrestrial non-food and outdoor residential uses, two outdoor residential, two forestry use and one aquatic non-food industrial use in which it is applied to sewage systems. Directions regarding application intervals, number of applications and total application per year or crop cycle are generally not specified by the label.

C. **Target Pests:** A wide range of insects, including but not limited to scale, thrips, aphids, mites, leaf miners, leaf hoppers, flea hoppers, plant bugs, corn rootworm, lygus bugs, loopers grasshoppers, alfalfa weevil , thrips, planthoppers, fir cone midge, loblolly pine sawfly and whiteflies.

D. **Formulation Type:** As indicated in the LUIS Report dated 5/2/97, dimethoate has 166 approved labels in the United States. These labels include 10 for wettable powder, five of which are state limited (1 AZ, 2 CA and 2 WA), 149 labels for emulsifiable concentrate, of which 68 are state limited (12 AZ, 1 GA, 1 HI, 6 ID, 1 IL, 1 ME, 1 MN, 2 MT, 1 NC, 1 NV, 10 OR, 1 TN, 2 TX, 6 UT and 22 WA), one state registration for a liquid-ready to use products in ID and six identified as 'Form not identified/solid'.

All of the active labels contain one of the following formulations.

Wettable Powders -	25% active ingredient
Emulsifiable Concentrate -	8.0%, 12.0%, 22.7%, 23.4%, 30.5%, 31.0%, 31.4%, 43.5%, 44.8%, and 57.0% active ingredient

E. **Method and Rate of Application:**

Chemical use information for the 1997 Dimethoate RED was obtained from the following sources: the 05\05\97 LUIS Report, a letter summarizing a survey of farmers conducted by Jellinek, Schwartz and Connolly, Inc., and from individual labels currently registered with the EPA.

The application interval, number of applications and total yearly application information on currently registered labels is incomplete. For most uses no information other than the maximum single application rate is given. The survey results provided by Jellinek, Schwartz and Connolly, Inc. gave all the necessary application information for the food uses listed on one label (EPA Reg. No. 4787-7). In instances where the actual label or the LUIS report provides use information which is higher than indicated by the Jellinek report, and vice versa, the higher use information was used. This risk assessment is applicable for those application scenarios which are less than or equal to the evaluated rates. Applications made which are higher than those evaluated are outside the upper bounds of this assessment and this assessment should not be used to evaluate the impacts of such applications. Evaluation of risk quotients was limited to Aerial and Ground spray methods because it is believed they provide the highest risk to fish and wildlife.

Use patterns will be evaluated under the following application scenarios. These scenarios use the highest reported rates and number of applications and intervals from all sources combined. Again, the majority of the frequency information is taken from the Jellinek report.

Major field crops

In 1993, dimethoate applications to the field crops listed in Table 1 accounted for 47% of the total active ingredient used in agricultural applications. Approximately 920,000 pounds of active ingredient were applied to field crops at up to 0.5 lbs. ai/acre. Of the 357 million acres planted to these crops, four million acres (1.1%) were treated with dimethoate.

Table 1 lists the application rates, the number of applications and intervals for field crops which were evaluated in the Reregistration Eligibility Document. These scenarios represent a combination of both the Jellinek document and the LUIS Report.

Table 1. Major field crop applications of dimethoate and their corresponding application information.

Crop	Acres Grown (000)	Acres Treated (000)	Total lbs ai (000)	% of Total lbs ai	App. Method	Max App Rate (lbs ai/A)	Max No Apps /crop	Max No Apps /year	Max App Rate /crop	Max App Rate /year	Interval (Days)
Cotton	13,468	1,347	350	17.31	Aerial	0.50	2	ns	1.0	ns	14
					Ground	0.50	2	ns	1.0	ns	14
Corn	77,000	772	60	3.08	Aerial	0.50	3	ns	1.5	ns	7
					Ground	0.50	3	ns	1.5	ns	7
Alfalfa	24,338	730	300	15.38	Aerial	0.50	1	3	0.5	1.5	30
					Ground	0.50	1	3	0.5	1.5	30
Wheat	71,630	716	150	7.69	Aerial	067	2	ns	1.34	ns	5
					Ground	0.67	2	ns	1.34	ns	5
Soybeans	60,418	604	30	1.54	Aerial	0.50	2	ns	1.0	ns	7
					Ground	0.50	2	ns	1.0	ns	7
Sorghum	10,944	109	30	1.54	Aerial	0.50	3	ns	1.5	ns	7
					Ground	0.50	3	ns	1.5	ns	7

as - As Needed
ns - Not Specified on Label

Orchard Crops

In 1993, dimethoate applications to the orchard crops listed in Table 2 accounted for 35% of the total active ingredient used in agricultural applications, totaling approximately 725,000 pounds of active ingredient. Of the 2.5 million acres planted to these crops, 440,000 acres (18%) were treated with dimethoate.

A use which differs greatly between the Jellinek report and the current LUIS Report is the use on citrus crops (oranges, grapefruit, tangerines, lemons). Jellinek reports farmers are using a maximum foliar application rate of 0.5 lb. ai/acre, twice a year at 15 and 31 day intervals. The LUIS report shows a maximum single application rate of 4.0 lbs ai/acre (EPA Reg. No. 002935-00518 and 009779-00206); however, the number of applications and intervals are not specified. For the purpose of this risk assessment, a maximum single application rate of 4.0 lbs ai/acre was evaluated for acute risk and an application rate of 0.75 lbs ai/acre, twice a year at 15 day intervals was evaluated for chronic risk (see Table 2).

The LUIS and Jellinek reports differ in the application rates on apples, pears, tangelos, pomelos and cherries. Maximum application rates presented in the LUIS report are: apples and pears, 2.0 lbs ai/acre, as needed; tangelo and pomelo, 2.0 lbs ai/acre, twice a year; and cherry, 2.0 lbs ai/acre only one time per year. The Jellinek report suggests that 0.5 lb. ai/acre, three times a year at seven day intervals is typical for apples and pears; and 0.33 lbs ai/acre one time is typical for cherries. For the purpose of this assessment, acute and sublethal hazards were determined for orchard crops at a rate of 0.5 lb. ai/acre, applied three times at seven day intervals.

Table 2. Orchard crop applications of dimethoate and their corresponding application information.

Crop	Acres Grown (000)	Acres Treated (000)	Total lbs ai (000)	% of Total lbs ai	App. Method[2]	Max App Rate (lbs ai/A)	Max No Apps /crop	Max No Apps /year	Max App Rate /crop	Max App Rate /year	Interval (Days)
Citrus[1]	846	101	305	14.82	Aerial						
					(Single)	4.0	1	ns	4.00	ns	15
					(Multiple)	0.75	2	ns	1.5	ns	15
Apple, Pear	620	176	170	7.72	Aerial						
Tangelo,					(Single)	2.00	1	ns	2.00	ns	7
Pomelo,					(Multiple)	0.50	4	ns	2.00	ns	7
Kumquat											
Grape											
Cherry	453	75	150	6.82	(Single)	2.00	1	ns	2.00		
Pecans	453	91	100	5.77	Aerial	0.67	1	ns	0.67	ns	
					Ground	0.67	1	ns	0.67	ns	

[1] Citrus crops include oranges, grapefruits, tangerines and lemons.
[2] Air-blast equipment is also an approved application method.
as - As Needed
ns - Not Specified on Label

Vegetable Crops

In 1993, dimethoate applications to the vegetable crops listed in Table 4 accounted for 17.2% of the total active ingredient used in agricultural applications. Approximately 318,000 pounds of active ingredient were applied to vegetable crops. Of the 387 million acres planted to these crops, 599,000 acres (15%) were treated with dimethoate.

EPA Reg. No. 000070-0011-3 lists the following crops with an application rate of 0.5 lbs ai/acre: Swiss Chard, Collards, Endive, Garbanzo, Kale, Lentils, Lettuce, Mustard, Spinach, Turnips. This application rate is higher than what was reported in the Jellinek Report. All other labels which specify these crops report 0.25 lbs ai/acre as the maximum application rate. However, since it is currently an active registration it was used in the risk assessment. As specified in the LUIS Report, all other vegetable crops have maximum application rates of 0.5 lbs ai/acre.

As indicated by the Jellinek report, Table 3 lists the number applications for select vegetable crops. To reduce the complexity of the assessment, all the vegetable crops, with the exception of peas and Brussels sprouts, were evaluated with the following application scenario, 0.5 lbs ai/acre with three applications spaced seven days apart for a total of 1.5 lbs ai/acre/year. This scenario will slightly underestimate the hazard presented by crops such as broccoli, cauliflower, celery, collards and asparagus, which, according to the label, may be treated with more applications. However it will slightly overestimate crops such as peppers, mustard greens, spinach, melons, tomatoes, beans, lentils, potatoes, kale, and chick peas, which, according to the label, may be treated with 1 and 2 applications. Table 4 lists the application scenarios used in this assessment.

Table 3. Application intervals for select vegetable crops as specified by the dimethoate use survey provided by Jellinek, Schwartz and Connolly, Inc.

Number of Applications	Crop
1	peppers
2	kale, mustard greens, melons, watermelons, tomatoes, beans, lentils, spinach, potatoes
3	cabbage, endive, lettuce, Swiss chard, turnips
4	collards
6	broccoli, cauliflower, celery

Brussels sprouts present one of the highest exposure scenarios. The Jellinek report does not list Brussels sprouts. The LUIS Repots lists the rate at 1.0 lbs ai/acre, six times/year, for a total of 6.0 lbs ai/acre. No application interval is listed, so a period of seven days was used in the analysis.

As presented in the LUIS Report, peas are registered for a maximum rate of 0.25 lbs ai/acre. Jellinek reports the most common application is 0.16 lbs ai/acre and it is applied only once. A rate of 0.25 lb. ai/acre, applied once, was modeled in the risk assessment.

Table 4. Vegetable crops treated with dimethoate. The category grouping is based upon the maximum allowable application rate.

Crop	Acres Grown (000)	Acres Treated (000)	Total lbs ai (000)	% of Total lbs ai	App. Method	Max App Rate (lbs ai/A)	Max No Apps		Max App Rate		Interval
							/crop	/year	/crop	/year	
Vegetables	3551	538	303	16.4	Aerial	0.50	3	ns	1.5	ns	7
					Ground	0.50	3		1.5		7
Peas	306	61	15	0.77	Aerial	0.25	1	ns	0.25	ns	ns
					Ground	0.25	1		0.25		
Brussels Sprouts	na	na	na	na	Aerial	1.0	ns	ns	ns	ns	ns
					Ground	1.0					

[1] Vegetable - Swiss Chard, Collards, Endive, Garbanzo, Kale, Lentils, Lettuce, Mustard, Spinach, Turnips, broccoli, cauliflower, celery, collards and lettuce mustard, spinach, melons, tomatoes, beans, lentils, potatoes, kale, and chick pea
as - As Needed
na - Not Availablel
ns - Not Specified on Label

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Non-Food Uses

The LUIS report provided the maximum single application rates for non-food uses. However, no information was provided concerning the number of applications and intervals. For the purpose of this risk assessment it was assumed that only one application is made; therefore, only acute risk was addressed. Dimethoate has the following registered non-food uses.

	Label Rate	Rate Per 10 gal
Christmas Tree Plantations	0.75 lbs ai/acre	-
Cottonwood (Forest/Shelterbelt)	2.0 lbs ai/acre	-
Nonagricultural uncultivated areas/soils (CA)	2.0 lbs ai/acre	-
Ornamental Shade Trees	1.0 lbs ai/100 gal	0.10 lbs ai/10 gal
Ornamental Woody Shrubs and Vines	0.11 lbs ai/10 gal	0.11 lbs ai/10 gal
Household/Domestic Dwelling (outdoor)	0.25 lbs ai/3.0 gal	0.83 lbs ai/10 gal
Recreational areas	0.25 lbs ai/3.0 gal	0.83 lbs ai/10 gal
Agricultural/Farm Structures/Equipment	0.25 lbs ai/3.0 gal	0.83 lbs ai/10 gal
Commercial/Institutional/Industrial Premises (out)	0.25 lbs ai/3.0 gal	0.83 lbs ai/10 gal
Douglass Fir (Seed Orchard)	8.4 lbs ai/100 gal	0.84 lbs ai/10 gal
Pinyon Pine	8.4 lbs ai/ 100 gal	0.84 lbs ai/10 gal
Refuse/solid waste (outdoor)	0.13 lbs ai/1.25 gal	1.02 lbs ai/10 gal
Ornamental Herbaceous Plants	1.05 lbs ai/10 gal	1.05 lbs ai/10 gal

2. Characterization of Risk to Nontarget Species

A. Historic Use Profile

The Biological and Economic Analysis Division (BEAD) of Office of Pesticide Programs compiled dimethoate 1993 use information on 41 crops throughout the US (Ali 1995). The highlights of this report in relation to wildlife exposure are outlined below. The wide variety of crops and the large number of acres on which dimethoate is used indicate wildlife will encounter dimethoate residues under normal activities.

- In 1993 a total of 1.3 to 2.2 million pounds of active ingredient were applied to 4,701,000 to 6,062,000 acres.

- Applications made to 10 crops accounted for more than 80% of the total dimethoate applied during 1993. These crops include cotton (17.1%), alfalfa (15.4%), oranges (7.7%), wheat (7.0%), apples (6.9%), grapefruit (6.9%), lemons (6.4%), peas/beans (5.68%), lettuce (3.9%) and field corn (3.1%).

- The most common maximum application rate is 0.5 lbs ai/acre. Applications of 0.5 lbs ai/acre are allowed on all registered crops except peas on which 0.25 lbs ai/acre is allowed.

- Field crops alone account for 42-47% of the total dimethoate applied in 1993, totaling approximately 880,000 to 1,034,000 pounds of active ingredient.

- Ten to fifteen percent of the total dimethoate applied during 1993 was to citrus crops, totaling approximately 220,000 to 330,000 pounds active ingredient.

Discussions with agricultural extension agents in citrus and apple growing regions indicate that typical single application rates are significantly lower than the maximum allowable application rates to citrus and other orchard crops of 4.0 and 2.0 lbs ai/acre, respectively.

B. Exposure Characterization

Environmental Fate Assessment

The environmental fate and transport of dimethoate is fairly well understood. Dimethoate is a mobile, yet relatively non-persistent organophosphate insecticide. The primary route of dissipation appears to be microbially-mediated hydrolytic and oxidative degradation in aerobic soil, particularly under moist conditions, with a half-life of 2.4 days. The major degradate was

CO_2, accounting for approximately 62% of the applied after 14 days. Two non-volatile degradates, desmethyl dimethoate and dimethylthiophosphoric acid, were identified but were present at levels less than 2% during the study. Dimethoate does not photodegrade. It hydrolyzes very slowly in sterile buffered solutions at pH's 5 and 7, but under alkaline conditions, it degrades rapidly to desmethyl dimethoate and dimethylthiophosphoric acid with a half-life of 4.4 days at pH 9. Under anaerobic soil conditions, dimethoate does degrade, though not as rapidly as under aerobic conditions. The anaerobic half-life was found to be approximately 22 days, with the major non-volatile degradate being desmethyl dimethoate. Although dimethoate does not photodegrade on soil (the degradation rates and products were essentially the same for the light-exposed and dark control), the study did provide information on the degradation of dimethoate on a thin layer of somewhat dry soil. Under these conditions, the soil degradates (dimethylphosphoric acid and dimethylthiophosphoric acid) accumulated and persisted to a much greater extent than in the aerobic soil metabolism study. Therefore, in the field, these degradates may persist under dry conditions at the soil surface.

Dimethoate is highly mobile in soil. In a soil column leaching study, 72-100% of the applied radioactivity was eluted from the columns (loam, silt loam, sandy loam, and sand). Calculated k_d values based on these column studies ranged from 0.06 for the sand to 0.74 for the loam. Degradate mobility has not been well defined; however based on the aged leaching data as well as the metabolism data, degradates are not expected to persist and move through the soil profile.

A study measuring the volatility of dimethoate from the soil surface showed this not to be a significant route of dissipation. After 30 days, only 2.7% of the applied radioactivity had volatilized; 0.7% of which was CO_2. The majority of the radioactivity (83%) was extracted from the soil and most of this (93.2%) was dimethoate. It should be noted that the rate of degradation in this laboratory volatility study, compared with the aerobic soil metabolism study, was particularly slow. The slower rate in the volatility study may again be explained by comparing soil moisture content in the two studies, as dimethoate metabolism appears to be very sensitive to soil moisture.

Under field conditions, dimethoxon, a toxicologically significant oxygen analogue metabolite of dimethoate, was found though it hadn't been detected in the laboratory studies. The presence of dimethoxon has been established in insects, plants, and mammals (WHO, (1989) Environmental Health Criteria 90- Dimethoate). It is reported that dimethoxon is 75-100 times as potent as dimethoate in inhibiting acetylcholinesterase, suggesting that dimethoxon plays a major role in mammalian toxicity (Hassan, A., 1969). In the dimethoate field dissipation studies discussed below, the only degradate analyzed for was dimethoxon. The other degradates identified in the laboratory studies were not included in the analysis because it was believed that; 1) based on the aerobic soil metabolism study, they would not persist in the field, and 2) they are not toxicologically significant.

DETAILED INFORMATION ON SUPPORTING ENVIRONMENTAL FATE STUDIES

i. Degradation

161-1 Hydrolysis

Dimethoate hydrolyzes very slowly at pH's 5 and 7, but under alkaline conditions, degradation is rapid with a half-life of 4.4 days at pH 9.

^{14}C-Dimethoate at 200 ppm degraded with calculated half-lives of 156, 68, and 4.4 days in sterile buffered aqueous solutions of pH 5, 7, and 9, respectively. Desmethyl dimethoate accounted for 12.2% of the recovered radioactivity in the pH 5 buffered solution at day 30. At 30 days posttreatment, desmethyl dimethoate and dimethylthiophosphoric acid accounted for 62.1 and 36% of the recovered, respectively, at pH 9 and 22.1 and 1.9%, respectively, at pH 7. **MRID 00159761**

161-2 Photodegradation in Water

Dimethoate is not susceptible to photodegradation in water.

^{14}C-Dimethoate at 10 ppm was stable with a calculated half-life of greater than 175 days in a pH 5 buffered aqueous solution irradiated with a xenon arc lamp. After 15 days of continuous irradiation, dimethoate was 9.21 ppm in the solution. Unidentified compounds were ≤0.56 ppm. In the dark control, dimethoate and unidentified compounds were 9.46 and 0.30 ppm, respectively, at 15 days posttreatment. **MRID 00159762**

161-3 Photodegradation on Soil

Dimethoate does not photodegrade on soil.

^{14}C-Dimethoate applied to sandy loam soil degraded rapidly in both the exposed (natural sunlight) and dark control systems during the 30-day study period. The calculated half-life was 10.5 days for light exposed samples and 7.9 days for dark control samples; indicating that photolysis is not required for the degradation of dimethoate on soils. Two major degradates, dimethylphosphoric acid and dimethylthiophosphoric acid, were identified in both the light exposed and dark samples. **MRID 43276401**

ii. Metabolism

162-1 Aerobic Soil Metabolism

Soil metabolism under aerobic conditions is a major route of dissipation for dimethoate.

[14C]Dimethoate applied to sandy loam soil at 2.15 ppm degraded rapidly in the dark under aerobic conditions. The half-life was determined to be 2.4 days and the calculated time to 90% degradation was 7.5 days. The proportion of dimethoate in soil declined rapidly, with apparent first-order kinetics up to about day 14. After 14 days, approximately 2% of the applied compound remained. Thereafter, the proportion declined more slowly up to 181 days when the quantity of dimethoate remaining was 0.2%. The primary degradate was $^{14}CO_2$, which after 181 days, accounted for 75% of the applied radioactivity. Production of volatile radioactivity was most rapid up to 14 days when 61-62% of the applied radioactivity had been found in the volatile traps. The volatile radioactivity was almost exclusively trapped in aqueous NaOH solution. Only 2% of the applied was extractable from the soil after 181 days, while non-extractable radioactivity amounted to 16% of applied. Twelve non-volatile, extractable degradation products of ^{14}C-dimethoate were separated by TLC. Two were identified as desmethyl dimethoate and dimethylthio- phosphoric acid. No unknown component accounted for more than 2% of the applied radioactivity at any time. Desmethyl dimethoate accounted for a maximum of 1.9-2.1% after two days; dimethylthiophosphoric acid accounted for between 0.4-1.0% from days 1 to 4. **MRID 42843201**

162-2 Anaerobic Soil Metabolism

Anaerobic soil metabolism is a route of dissipation for dimethoate, though less important than aerobic soil metabolism.

[14C]Dimethoate applied to sandy loam soil at 2.06 ppm degraded in the dark under anaerobic conditions (flooded/N_2 atm). The half-life was determined to be 22 days after 2 days of aerobic incubation. Dimethoate in soil declined rapidly during the 2 day aerobic incubation to 40% of applied. $^{14}CO_2$ accounted for 27% after 2 days. After conversion to anaerobic conditions, the degradation rate declined. After 7 days, dimethoate declined to approximately 18%, then to 7% at 32 days, and to about 3% after 60 days. Evolution of $^{14}CO_2$ slowed during the anaerobic phase and accounted for about 32% by day 14 of anaerobicity and 39% by the end of the study. Dimethoate was found in approximately equal proportions in the soil extracts and the supernatant water.

During the aerobic phase of the experiment, desmethyl dimethoate and dimethylthiophosphoric acid were identified. No other extractable degradation product represented more than approximately 3% at this point. During anaerobic incubation, desmethyl dimethoate increased to represent approximately 10% of the applied radioactivity after 14 days and declined to 7% after 60 days. Dimethylthiophosphoric acid accounted for 4-5% after 14 - 32 days. Non-extractable radioactivity accounted for approximately 23% of applied radioactivity at the end of the study, though most of the radioactivity could be removed with aqueous NaOH. **MRID 42884402**

iii. Mobility

163-1 Leaching and Adsorption/Desorption

Dimethoate is very mobile in soil. The mobility of its degradates has not been well defined.

^{14}C-Dimethoate was very mobile in columns (30 cm in height) of sand, sandy loam, silt loam, and loam soils leached with 51 cm of water. Radioactivity recovered in the leachate ranged from 71.8 to 100.6% of the applied. Reported k_d values were 0.06 for sand soil, 0.30 for sandy loam soil, 0.57 for silt loam soil, and 0.74 for loam soil.

In soil treated with ^{14}C-dimethoate and aged for 30 days, a total of 36.9% of the applied was recovered from the soil; 4.9% of the applied radioactivity was dimethoate, 3.3% was dimethylphosphoric acid, 0.8% was other extractables, and 27.9% was unextractables. Approximately 30% of the applied was collected as CO_2. Aged dimethoate residues were very mobile in sandy loam soil. The leachate contained 5.1% of the applied radioactivity, which corresponds to 57% of the extractable radioactivity in the aged soil applied to the column. The radioactivity (28.4% of the applied) remaining in the uppermost soil segment of the leached column was approximately equivalent to the unextractable radioactivity (27.9% of the applied) in the aged soil applied to the column. **MRID 00164959**

163-2 Laboratory Volatility

Volatilization from soil is not a major route of dissipation for dimethoate.

^{14}C-Dimethoate (in an EC formulation), applied to loamy sand soil at 2 lb a.i./acre, was only very slightly volatile during the 30 day study. The average radioactivity recovered as volatile organics accounted for only 2% of the applied and $^{14}CO_2$ in traps represented 0.7% of applied ^{14}C. Radioactivity extracted from the soil after 30 days represented 83% of applied, 93.2% of which was dimethoate. Unextracted radioactivity in the soil averaged 10% of applied ^{14}C after 30 days. The mean daily air concentration and volatilization rate of organic volatiles (expressed as dimethoate equivalents) were 1.29 $\mu g/m^3$ and 1.08 x 10^{-4} $\mu g/cm^2/hr$, respectively. **MRID 43276402**

iv. Field Dissipation

164-1 Soil Field Dissipation

The results of the following studies indicate that dimethoate dissipates in the field with half-lives between 5 and 15 days when applied post-emergence to green beans, grapes, and bareground in California, grain sorghum in Texas, and bareground in New York. There appeared to be some downward movement through the soil, particularly in the bareground study, though these residues did not persist.

The degradate dimethoxon, which is of toxicological concern, was detected in all five studies, but degraded fairly rapidly in all but one study. In the California bareground study, dimethoxon was found through day 159. Dimethoxon appeared to be less mobile than parent.

a. Dimethoate (*Clean Crop Dimethoate 25W*), applied at 4.0 lbs ai/acre to a bare ground (sandy loam) site near Waterloo, New York, dissipated rapidly with a half-life of approximately 5 days. Dimethoate was found in the 0-6 inch soil layer only through day 28 and was detected only once (0.023 ppm; one rep on day 10) in the 6-12 inch layer. No residues were found below the 6-12 inch layer.

The metabolite dimethoxon was detected in the 0-6 inch soil layer on days 2 and 3 of the study. Dimethoxon was found in one replicate sample on day 2 at a concentration of 0.010 ppm and in all three replicates on day 3 at a mean concentration of 0.017 ppm. No residues were found below the 0-6 inch layer. **MRID 43388002**

b. Dimethoate (*Clean Crop Dimethoate 400*, emulsifiable concentrate), applied at 1.5 lbs ai/acre to a grain sorghum plot (silt loam) in Burleson County near Snook, Texas, dissipated rapidly with a half-life of approximately 9 days. Dimethoate was found in the 0-6 inch soil layer only through day 28. No residues were found below the 0-6 inch layer.

The metabolite dimethoxon was detected in the 0-6 inch soil layer in one replicate sample on day 6 at a concentration of 0.010 ppm. No residues were found below the 0-6 inch layer. **MRID 43388001**

c. Dimethoate (*Dimethoate 4E*) applied three times (7-day interval) at 0.5 lbs ai/acre to a **green bean** plot (loamy sand) in Fresno County near Fresno, California, dissipated with a half-life of 11 days. Dimethoate was found in the 0-6 inch soil layer through day 113. Residues were as high as 0.212 ppm on day 14 (i.e., immediately after the third application). No residues were found below the 0-6 inch layer. 12 inches of irrigation was applied between days 3 and 17 after the first application with no irrigation or rainfall until almost 4 months later.

The metabolite dimethoxon was detected in the 0-6 inch soil layer through day 28 of the study and in one replicate on day 76. The highest concentration found was 0.059 ppm on day 3. Dimethoxon was found below the 0-6 inch layer in one replicate sample on day 10 (0.01 ppm, 18-24").

Dimethoate (*Dimethoate 25W*) applied two times (14-day interval) at 2.5 lbs ai/acre to a **grape** plot (sandy loam) in Fresno County near Fresno, California, dissipated with a half-life of 9 days. Dimethoate was found in the 0-6 inch soil layer through day 48. Residues were as high as 0.272 ppm on day 18 (i.e., 4 days after the second application). Residues were found below the 0-6 inch soil layer at only one sampling interval (day 7 at 0.014 ppm in the 6-12" layer). 42 inches of irrigation was applied between days 1 and 56 after the first application.

The metabolite dimethoxon was detected in the 0-6 inch soil layer through day 27 of the study. The highest concentration found was 0.093 ppm on day 18. Dimethoxon was not found below the 0-6 inch layer.

Dimethoate (*Dimethoate 4E*) applied 2 times (14-day interval) at 2.5 lbs ai/acre to a **bareground** plot (sandy loam) in Fresno County near Fresno, California, dissipated from the 0-6 inch soil depth with a half-life of 15 days. Dimethoate was found in the 0-6 inch soil layer through day 159. Residues were as high as 1.8 ppm on day 15 (i.e., 1 day after the second application). Residues were found in the 18-24" layer during the first 20 days of the study. Dimethoate was only found once at 24-36 inches (one rep at 0.013 ppm on day 7) and once at 36-48 inches (one rep at 0.025 ppm on day 14). 42 inches of irrigation was applied between days 1 and 56 after the first application.

The metabolite dimethoxon was detected in the 0-6 inch soil layer through day 159 of the study. The highest concentration found was 0.561 ppm on day 18. Dimethoxon was found twice at 18-24 inches (days 3 and 7 at ≤0.015 ppm) and was also detected in the 24-36 inch soil layer at 0.012 ppm on day 3. **MRID 42884403**

Ground Water Contamination Potential

Although dimethoate is similar to many other organophosphate insecticides with respect to its mobility, it is not likely to persist in the environment and therefore should not leach to ground water under most conditions. In non-sterile aerobic soil, dimethoate degraded with a half-life of less than 3 days. Dimethoate may persist longer under anaerobic conditions, where a half-life of 22 days was determined, however it is believed that the majority of dimethoate will have degraded prior to encountering anaerobic conditions. Dimethoate is typically applied foliarly on food/feed crops and according to the World Health Organization (Environmental Health Criteria Document 90- Dimethoate, 1989), when it is applied to plants, it is rapidly absorbed and metabolized (half-life: 2-5 days) both on the surface and within the plant by hydrolytic and oxidative processes. The relatively rapid dissipation of dimethoate has been corroborated in the field, where half-lives have ranged from 5 to 15 days, with little or no downward movement through the soil.

EFED's Screening Concentrations in Ground Water (SCI-GROW) model is a model for estimating concentrations of pesticides in ground water under "high exposure" conditions. SCI-GROW provides a screening concentration; an estimate of likely ground water concentrations if the pesticide is used at the maximum allowed rate in areas with ground water especially vulnerable to contamination. In most cases, a majority of the use area will have ground water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimate. Results from the SCI-GROW model predict that the maximum chronic concentration of dimethoate is not expected to exceed 0.002 µg/L for the majority of use sites.

The State of California keeps a well inventory of wells sampled for pesticide residues (CEPA-DPR, 1992, 1993). From 1986 to 1992, 1693 wells in 36 counties were sampled for dimethoate residues. Residues were detected at 0.38 and 10.0 µg/L, in two wells. Residues were not detected in follow-up samples. In 1993, one sample from 340 wells had a single detection of dimethoate at 0.40 µg/L. The 1992 Pesticide in Ground Water Database (PGWDB) (EPA, 1992) summarizes this same data. The data reported by the PGWDB (EPA, 1992) for Georgia have been retracted by the State of Georgia. These detections of dimethoate are generally greater than the ground water concentrations predicted (0.002 µg/L) by the SCI-GROW model, although they represent only 2 confirmed detections of dimethoate in over 2,700 wells sampled.

The environmental fate of dimethoxon, the toxicologically significant metabolite of dimethoate, is not as well understood as the fate of its parent. Based on field data only, it is believed that dimethoxon also degrades rapidly and thus will not move through the soil and contaminate ground water. However, there are no controlled laboratory data available at this time to support this conclusion. Therefore, the following studies on dimethoxon are required as confirmatory data:

161-1 Hydrolysis
162-1 Aerobic Soil Metabolism
163-1 Adsorption/Desorption

Should these data confirm that dimethoxon is short-lived and/or not mobile in soil, no further information will be required. However, if after reviewing these data the Agency determines that dimethoxon could pose a threat to ground water, a Prospective Ground Water Monitoring Study may be required.

Surface water Assessment

Dimethoate can contaminate surface water at application by spray drift. Substantial fractions of dimethoate penetrating the foliage to the soil should be available for runoff for several days post-application (aerobic soil metabolism half-life of 2.4 days; terrestrial field dissipation half-lives of 5, 9, 9, 11, and 15 days). The low soil/water partitioning of dimethoate (K_d values of 0.06, 0.30, 0.57, and 0.74) indicates that runoff will be primarily by dissolution in runoff water as opposed to adsorption to eroding soil. Despite its relatively low soil/water partitioning, the relatively short persistence of dimethoate on soil indicates that its potential for groundwater contamination is low. Nevertheless, its low soil/water partitioning indicates that leaching may remove a substantial amount of chemical from the top one inch of soil that is normally available for runoff.

Dimethoate will hydrolyze fairly rapidly in highly alkaline waters (abiotic hydrolysis half-life of 4 days at pH 9). Biodegradation will probably also contribute significantly to the dissipation of dimethoate in surface waters with adequate microbiological activities thereby somewhat offsetting large decreases in abiotic hydrolysis rates with decreasing pH (half-life of 68 days at pH 7 and 156 days at pH 5). However, in neutral to acidic waters that also have low microbiological activities and long hydrologic residence times, dimethoate should be somewhat more persistent than in alkaline waters due to substantially lower hydrolysis rates. Dimethoate is stable to direct aqueous photolysis and has an extremely low volatilization from water potential (Henry's Law constant = 8.0×10^{-11} atm*m^3/mol). A longer half-life under anaerobic conditions (anaerobic soil metabolism half-life of 22 days) than under aerobic conditions indicates that dimethoate may persist longer in typically anaerobic sediments and deep water than in more aerobic waters.

The low soil/water partitioning of dimethoate indicates that it will probably readily partition into the water column and that its dissolved concentrations in sediment pore water will be comparable to or greater than its concentrations adsorbed to suspended and bottom sediment. Dissolved concentrations in the water column will of course be less than dissolved concentrations in sediment pore water, but should still be within a somewhat comparable range. The low octanol/water partitioning of dimethoate (K_{ow} = 0.33) indicates that its bioaccumulation potential is probably low.

There were no listings for dimethoate in an August 1996 search of STORET by Siroos Mostaghimi, (Surface Water Section/EFGWB).

The USGS (Goolsby and Battaglin 1993) sampled 7 widely spread locations in 2 Mississippi River sites and 5 tributary sites within the Mississippi Basin at frequent intervals from December 1991 or January 1992 to March-July 1992. A minimum total of 127 samples were collected from the 8 sampling locations. Dimethoate was not detected at dissolved concentrations above a reporting limit of 0.024 µg/L.

The USGS (Kimbrough and Litke 1995) collected samples from each of two Colorado watersheds at least monthly from April 1993 through March 1994. Samples were collected more frequently in late spring and early summer. A total of 25 samples were collected from each watershed. Dimethoate was detected above a "minimum reporting limit" of 0.024 µg/L in only one of the samples (0.05 µg/L in a sample collected from Lonetree Creek draining a primarily agricultural basin.

In 1994, Washington State (Davis 1996) collected surface water samples in April, June, and October from 8 sites (for a total of 24 samples) and analyzed them for multiple pesticides including dimethoate. Dimethoate was not detected in any of the 1994 samples above an approximate quantification limit of 0.06 µg/L. However, dimethoate was detected at concentrations of 0.022 µg/L and 0.033 µg/L in 1993 samples collected from Crab Creek and Moxee Drain, respectively. Neither of these water bodies (located east of the cascades) were resampled in 1994.

The low soil/water partitioning of dimethoate indicates that the primary (sediment removal) treatment processes employed by most surface water source drinking water supply systems will not be effective in removing it. It is not regulated under the Safe Drinking Water Act (SDWA) and the Office of Drinking Water has not established a MCL or any HALs for it.

Implications for Drinking Water

In addition to the monitoring and modeling data presented above, Tier II Surface Water EECs were generated for this analysis. The modeling was done using PRZM3 Version 3.00 (dated 7/15/97) which simulates the erosion and runoff from an agricultural field and EXAMS 2.97.5 (6/13/97) which simulates the fate of a chemical in a surface water body. A Tier II EEC assessment uses a single site which represents a high-end exposure scenario from pesticide use on a particular crop or non-crop use site. The meteorology and agricultural practice are simulated at the site for 36 years so that the probability of an EEC occurring at that site can be estimated. The EECs were determined for dimethoate (Cygon), as this was the formulation registered for use on the specific crops. It was assumed that 5 percent of the applied dimethoate reached the surface water via aerial spray drift at the time of application and that 95% of the applied chemical was deposited on the target site.

The dimethoate scenarios were broccoli in Hidalgo County, Texas, citrus (oranges) in Osceola, Florida, a cotton field in Jefferson County, Mississippi, and a corn in Ashland County, Ohio. Scenarios were chosen that are frequently used by EFED to represent sites expected to produce runoff greater than 90% of the sites where the appropriate crop is grown. Model simulations were made with the maximum application rates, maximum number of yearly applications, and the shortest recommended application interval. Tier II upper tenth percentile EECs are summarized here and presented later in the text. The EECs have been calculated so that in any given year, there is a 10% probability that the maximum average concentration of that duration in that year will equal or exceed the EEC at the site.

The 90%ile of the estimated mean concentrations of dimethoate in a farm pond over the 36-year period ranged from 0.720 µg/L for a single application to oranges at the highest application rate (@4.0 lb. ai/A) to 0.134 µg/L for corn, with three applications at the maximum rate of 0.5 lb. ai/A. Maximum estimated concentrations of 58.35 μg/L occurred for the single 4 lb. ai/A application of dimethoate to citrus. For the other scenarios, the maximum concentrations ranged from 6.40 to 24.37 μg/L. Some additional model runs were made subsequently using new or updated information from the registrants. In general, the minor modifications to some of the input parameters had little or no effect on the risk conclusions.

Considering the modeled concentrations, the rate of microbial degradation, and the available monitoring data, dimethoate parent is not likely to exceed 2.0 μg/L for any appreciable length of time (e.g., 21 to 60 days, from the initial modeling runs). Most modeled scenarios showed estimates of less than 1.0 ug/L at 60-90 days, and long term estimated means for parent dimethoate are well under this level. Values from monitoring studies are lower still. No assessment can be made for degradates due to lack of data.

Limitations of this Analysis

There are several factors which limit the accuracy and precision of this analysis including the selection of the high-end exposure scenarios, the quality of the data, the ability of the model to represent the real world, and the number of years that were modeled. There are additional limitations on the use of these numbers as an estimate of drinking water exposure. Degradation products were not considered due to lack of data.

Scenarios that are selected for use in Tier II assessments are ones that are likely to produce high concentrations in aquatic environments. The scenarios were intended to represent sites that actually exist and are likely to be treated with a pesticide. These sites should be extreme enough to provide a conservative estimate of the EEC, but not so extreme that the model cannot properly simulate the fate and transport processes at the site. Currently, sites are chosen by best professional judgement to represent sites which generally produce EECs larger than 90% of all sites used for that crop. The EECs in this analysis are accurate only to the extent that the sites represent the hypothetical high exposure sites. The most limiting aspect of the site selection is the use of the "standard pond" which has no outlet. It also should be noted that the standard pond scenario used here would be expected to generate higher EECs than most water bodies, although some water bodies would likely have higher concentrations (e.g., shallow water bodies near agriculture fields that receive direct runoff from the treated field.)

The quality of the analysis is also directly related to the quality of the chemical and fate parameters available for dimethoate. Available data are acceptable, but rather limited. Data were not available for degradates and the aquatic aerobic metabolism rate was not known, but estimated. The measured aerobic soil metabolism data lacked sufficient range (sample size) to accurately establish the half-life. However, the use of a range of data (mean times an uncertainty factor of 3) may be sufficient to capture the probable estimated environmental concentration in a manner similar to that when only a single measured value is available.

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The models themselves represent a limitation on the analysis quality. These models were not specifically developed to estimate environmental exposure in drinking water; therefore they may have limitations in their ability to estimate drinking water concentrations. Aerial spray drift reaching the pond is assumed to be 5 percent of the application rate. Another limitation is the lack of field data to validate the predicted pesticide runoff. Although several of the algorithms (volume of runoff water, eroded sediment mass) are validated and understood, the estimates of pesticide transport by PRZM3 have not yet been fully validated. From limited analysis it appears that PRZM3 generates pesticide loadings that are somewhat higher than really occur. This would result in conservative EEC estimates. Other limitations of the models are the inability to handle within site variation (spatial variability), crop growth, and the overly simple soil water balance. Another limitation is that only 36 years of weather data were available for the analysis. If the number of years of weather data were increased, it would increase the level of confidence that the estimated value for the 10% exceedance EEC was close to the true value.

EXAMS is primarily limited because it is a steady-state model and cannot accurately characterize the dynamic nature of water flow. A model with dynamic hydrology would more accurately reflect concentration changes due to pond overflow and evaporation. Thus, the estimates derived from the current model simulate a pond that has no outlets, no flowing water, and no turnover.

Another important limitation of the Tier II EECs for drinking water exposure estimates is the use of a single 10 hectare drainage basin with a 1 hectare pond. It is unlikely that this small a system accurately represents the dynamics in a watershed large enough to support a drinking water utility. It is unlikely that an entire basin, with an adequate size to support a drinking water utility would be planted completely in a single crop or be represented entirely by the scenario being modeled. The pesticides would more than likely be applied over several days to weeks rather than on a single day. This would reduce the magnitude of the conservative concentration peaks, but also make them broader, reducing the acute exposure, but perhaps increasing the chronic exposure.

Monitoring data are limited by the lack of correlation between sampling data and the use patterns of the pesticide within the study's drainage basin. Additionally, the sample locations were not associated with actual drinking water intakes for surface water nor were the monitored wells associated with known groundwater drinking water sources.

C. Risk to Terrestrial Organisms and Ecosystems

Terrestrial risk can be characterized by examining three aspects of the risk assessment. First, as presented in the previous section, past application history and maximum allowable rates on current labels provide information on which crops receive the highest label recommended rate, which crops receive the greatest quantity of dimethoate in terms of poundage per acre on a nation wide scale, and which individual crops are treated most frequently (ie. the percent of crop planted which is actually treated with dimethoate). Second, examination of the calculated risk quotients gives an indication as to which crops present the greatest hazard to wildlife at maximum application rates. Combined with the historical use pattern this further refines the risk characterization. Third, incorporating wildlife mortality incident data provides insight into the crops and application rates which present a demonstrated risk to wildlife.

Acute Risk

Acute risk was based on maximum application rates. The results indicate that, for the most part, most uses of dimethoate do not represent a significant acute risk to birds. Use at 0.5 to 0.75 lb ai/acre results in few or no acute risk LOC exceedances. However, use on citrus (at 4 lb ai/acre) would result in more extensive acute high risk LOC exceedances.

The restricted use LOC is exceeded for one or more food items at all application rates at or above 0.5 lb ai/acre. The endangered species LOC is exceeded for most food items at or above 0.5 lb ai/acre.

All modeled scenarios result in at least one food item that exceeds the LOC for acute risk to mammals. However, most exceeding risk quotients only marginally exceed the LOC, except for Brussels sprouts and citrus (4 lb ai/acre). These uses would represent a greater potential of acute risk than the other uses. All uses may affect endangered mammals, and the risk level indicates they should be considered for restricted use.

Acute Risk to Birds and Mammals from Other Uses of Dimethoate

Three additional uses of dimethoate include the control of midges, sawflies and scale on Douglas fir, Loblolly pine and Pinon pine, respectively. Application to Douglas fir is via back-pack or hydraulic sprayer at a rate of 3.56 lbs ai/acre. EECs and RQs for use on Douglas fir are slightly less than those in citrus orchards at a rate of 4.0 lbs ai/acre (see the single application acute RQ table). Aerial application is allowed for Loblolly pine at a rate of 0.25 lbs ai/acre. Risk for use on Loblolly pine would be equivalent to what is predicted in peas, below.

Peas (not shown in the table) have the lowest registered single application rate, 0.25 lbs ai/acre. At this application rate the acute risk would be relatively low for both birds and mammals.

Bark drenching treatments to control pinyon pine scale pose a risk to avian species. This application is made in climates where water may be scarce. The recommended application rate for controlling scale on pinon pine is 8 lbs ai/acre. A backpack sprayer is used to drench all of the bark within reach. It is likely that at this application rate, concentrations on food items inadvertently sprayed will represent a risk to birds and mammals. However, this use is not considered extensive, and widespread ecological impacts would therefore be unlikely.

Discussion of acute risk

While most use patterns for dimethoate result in one or more RQs that exceed the high risk LOC, the following factors should influence the overall perception of risk.

It is important to note that **Brussels sprouts** represents a low acreage use site, so any acute effects caused by use of dimethoate would be limited to the acreage (about 4,000 acres) involved. The registrant has proposed to voluntarily discontinue this use pattern.

Orchards are known to be utilized to a greater extent than other agricultural crops by songbirds, small mammals and other wildlife as foraging and brood rearing habitat. Treatment of citrus groves for thrips and aphids can and usually does occur during the spring. Spring applications coincide with the reproductive season of most species. During the nesting season, the distance a bird will travel from an active nest to search for food is greatly shortened. If a bird has nested within a treated orchard it is possible that all of its foraging activity for nestling food will be within the bounds of the treated acreage. The risk for acute mortality in this situation is not only to adult birds but also to nestlings due to the death of the parent, digestion of contaminated food items delivered by the parent, or exposure to the chemical during spray operations. A similar situation exists for small mammals whose home range is limited and whose entire life may be spent within the confines of fruit orchards. Thirty-five percent of all dimethoate applied during 1993 was to citrus, totaling 725,000 lbs active ingredient, on 440,000 acres. Other orchard crops (apples, pears, cherry and grape) allow applications of 2.0 lbs ai/acre. In 1993, applications to these crops totaled approximately 300,000 lbs active ingredient, on 225,000 acres.

One naturally mitigating factor to consider in these uses, however, is that the **citrus** application, at least, involves air blast spraying which is aimed up into the trees. Therefore probably not all of what is applied (currently a maximum of 4 lbs ai/acre) ends up settling on the ground level food items. RQs for the citrus uses are probably higher than would likely occur, therefore, even under maximum exposure conditions. Additionally, the registrant has proposed to voluntarily discontinue this use pattern.

While there are a few reported incidents of bird mortality associated with dimethoate, based on the information provided with those incidents and the toxicity of dimethoate, it is considered unlikely that these suggest a pattern of mortality to birds caused by dimethoate. The risk quotients suggest the possibility of acute effects to birds and mammals, but this is not strongly corroborated by field evidence.

While consideration of acute risk involves using peak maximum exposure levels, it is also important to note that **dimethoate dissipates rapidly** under field conditions. This means that any acute risk associated with maximum residues immediately after each treatment would drop off quickly because the residues dissipate from food items. Therefore, birds moving into fields several days after a treatment would not be exposed to risk at the same levels as birds feeding in the fields a day or two after treatment.

Chronic Risk

Dimethoate, when used at maximum rates for most labels, represents a moderate to high risk of sublethal and/or reproductive effects to birds and mammals. Chronic risk quotients were calculated using the maximum label rates. Most crops allow multiple applications. Typically rates for multiple applications are lower than the maximum single application rate; however, with multiple applications the period of time EECs are elevated is extended by the duration of the application period. In this analysis, mean and upper limit expected environmental concentrations following maximum application rates were used to calculate chronic risk quotients. Even at mean environmental concentrations, chronic risk to avian species is indicated for all modeled uses.

The use sites where most dimethoate is applied include citrus, cotton, alfalfa, wheat, apples, peas/beans, lettuce and field corn. The labels for these uses permit patterns of use (rate and number of treatments) which generally suggest moderate to high sublethal risk to birds, and possibly slightly less risk to mammals because the mammal NOAEL is higher (less sensitive) than the bird NOAEL. However, given the fact that the mammal NOAEL for blood and brain cholinesterase inhibition is 1 ppm, it is not clear that mammals are really less sensitive than birds to sublethal impacts of dimethoate. Therefore, the EFED concludes that dimethoate, when used at maximum rates for most labels, is a moderate to high risk to birds and mammals.

The estimated residues on tree crops assume 100% of the applied settles on the terrestrial food items. Because of how tree crops such as citrus are treated, it is recognized that some of the product will actually reach the target tree, and less than 100% of the applied will settle on these food items. So the risk calculations for citrus may be higher than what might occur in the field.

Evaluation of the 1993 usage data provided by BEAD gives an indication of the extent to which chronic risk is presumed. The following acreages were taken from the 1993 use report and represent the actual numbers of acres treated that year: citrus orchards, 101,000 acres; apples and pear orchards, 167,000 acres; sorghum fields, 109,000 acres; and corn fields 772,000; for a total of 1,149,000 acres in 1993. This number represents less than 2% of the total acreage planted in these crops. Eighty percent of the Brussels sprouts are grown on 4,000 acres in 4 counties south of San Francisco, CA (USDA, 1992). It is not known what percent of the crop was treated with dimethoate.

Mortality Incidents

The above discussion is based upon the theoretical assumption of risk as indicated by risk quotient analysis. As reported in Section E. below, "Reported Field Mortality of Nontarget Species," two separate reports have been filed where dimethoate was thought to be possibly related to the incident. Both of these cases involved cedar waxwings.

Another case where bird mortality was believed to be directly related to the use of dimethoate on alfalfa was a field study (Blus et al.1989). The report was a published peer reviewed article documenting mortality among radio-tagged sage grouse which were exposed to alfalfa treated fields at a rate of 0.5 lbs ai/acre. This study, conducted by the USFWS, affixed radio transmitters on adult and juvenile sage grouse. During the two year study radio tagged juvenile and adult sage grouse were monitored, and their use of treated alfalfa fields was determined. In one instance, 31% mortality was noted among radio tagged birds following treatment of an alfalfa field. Sixty-three birds were found dead in one field alone. The researchers noted juveniles were more sensitive to dimethoate than the adults. The overriding message taken from this study is that when adequate detection methods are used, dead sage grouse could be found in or near fields treated where dimethoate was reported to have been used at 0.5 lbs ai/acre. The majority of agricultural fields where dimethoate can be used receive 0.5 lbs ai/acre. Therefore, these bird kills corroborate the estimates of risk as determined by the quotient analysis.

D. Risk to Aquatic Organisms

Acute toxicity information was submitted for freshwater fish and invertebrates and estuarine/marine fish and invertebrates. The most sensitive organisms were the freshwater invertebrates. Acute risk quotients were exceeded only for freshwater invertebrates. Acute risk to freshwater invertebrates is high in citrus when application rates of 4.0 lbs ai/acre are used. This risk is further increased in Florida orchards, where the ground and surface water are so closely related. Risk quotients for other orchard crops (i.e., apples, cherries, pears and grapes) which are treated at 2.0 lbs ai/acre are not displayed in the table. However, the risk quotient would be approximately one-half of that calculated for the highest citrus use. Therefore, use on these crops may also represent an acute risk. Restricted use is indicated for all other modeled scenarios where 0.5 lb. ai/acre is used at seven day application intervals, and in Brussels sprouts. The chronic level of concern is not exceeded in any modeled scenario.

Due to the short half-life of dimethoate in aquatic environments, decreases in aquatic invertebrates are expected to be short lived. However, repeated application could cause a depletion of invertebrate populations. Invertebrates provide an essential food source for other organisms.

Further results indicate that aquatic acute high risk, restricted use, and endangered species levels of concern are not exceeded for estuarine/marine fish at any of the application scenarios modeled using PRZM3/EXAMS II. Chronic risk could not be determined as no chronic studies are required for estuarine/marine species.

Using normally accepted test species, no LOCs are exceeded for estuarine/marine invertebrate species. The saltmarsh mosquito is nearly 500 times more sensitive than the next most sensitive estuarine/marine species, the brown shrimp. The saltmarsh mosquito is a target species and not a typical test organism. However, data from this test does suggest that other aquatic organisms may be more sensitive than the brown shrimp.

3. Ecological Effects Hazard Assessment and Toxicity Data

A. Toxicity to Terrestrial Animals

i. Birds, Acute and Subacute

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of Dimethoate to birds. The preferred test species is either Mallard (a waterfowl) or Northern Bobwhite (an upland gamebird). Results of this test are tabulated below.

Avian Acute Oral Toxicity

Species	% ai	LD_{50} (mg/kg)	Toxicity Category	MRID No. Author/Year	Study Classification[1]
Red-winged Blackbird *(Aeglaius phoeniceous)*	Tech.	5.4	Very Highly Toxic	00020560/ FEODIM04/ Schafer/ 1972	Supplemental[3]
Ring-necked Pheasant *(Phasianus colchicus)*	97	20	Highly Toxic	00160000/ Hudson et al./ 1984	Supplemental[3]
European Starling *(Strunus vulgaris)*	Tech.	32	Highly Toxic	00020560/ FEODIM04/ Schafer/ 1972	Supplemental[3]
Mallard *(Anas platyrhynchos)*	97	41.7	Highly Toxic	FEODIM03/ Tucker and Crabtree/ 1984	Supplemental[2]
Domestic Chicken *(Gallus domesiticus)*	Tech[4]	50	Highly Toxic	00045817/ 1965	Supplemental[5]
Mallard *(Anas platyrhynchos)*	99.8	63.5	Moderately Toxic	00160000/ Hudson et al./ 1984	Core

[1] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline).
[2] Rated 'Supplemental' because it did not follow the recommended study design (ie. insufficient number of animals).
[3] Rated 'Supplemental' because it did not follow the recommended study design (ie. insufficient number of animals).
[4] Confirmed Technical material by C. Brassard (October 1, 1987 Dimethoate Registration Standard); percent active ingredient unknown.
[5] Data are from an acute oral neurotoxicity study submitted to OPP Health Effects Division.

Since the lowest LD_{50} is less than 10 mg/kg, Dimethoate is considered very highly toxic to avian species on an acute oral basis. The guideline (71-1) is fulfilled (MRID # 00160000).

Two subacute dietary studies using the TGAI are required to establish the toxicity of Dimethoate to birds. The preferred test species are Mallard and Northern Bobwhite. Results of these tests are tabulated below.

Avian Subacute Dietary Toxicity

Species	% ai	5-Day LC_{50} (ppm)[1]	Toxicity Category	MRID No. Author/Year	Study Classification
Ring-necked Pheasant *(Phasianus colchicus)*	99	332	Highly Toxic	00022923/ Hill et al./ 1975	Core
Japanese Quail *(Coturnix coturnix)*	99	346	Highly Toxic	00022923/ Hill et al./ 1975	Core
Mallard *(Anas platyryhnchos)*	99	1011	Slightly Toxic	00022923/ Hill et al./ 1975	Core

Since the lowest LC_{50} falls in the range of 50 - 500 ppm, Dimethoate is considered highly toxic to avian species on a subacute dietary basis. The guideline (71-2) is fulfilled (MRID # 00022923).

ii. Birds, Chronic

Avian reproduction studies using the TGAI are required for Dimethoate. Repeated applications are allowed under current labeling. Depending upon the target insect and crop, early season applications, which coincide with the reproductive season, are recommended. The preferred test species are Mallard and Northern Bobwhite. Results of these tests are tabulated below.

Avian Reproduction

Species/ Study Duration	% ai	NOEC (ppm)	LOEC Endpoints	MRID No. Author/Year	Study Classification
Northern Bobwhite *(Colinus virginianus)* 147 days	99.1	4.0	**35.4 ppm** - reduced egg production, viable embryos, 3-week old embryos, normal hatchlings, 14-day old survivors, 14-day old survivor weight, adult male and female body weight, and egg shell thickness **10.1 ppm** - reduced 14-day old survivor weight	440490-01/ Gallagher et al./1996	Core
Northern Bobwhite *(Colinus virginianus)* 196 days	96.7		**30 ppm** - Reduced number of normal hatchlings, and increased number of cracked eggs	00162777/ Munk/1986	Supplemental[1]
Mallard *(Anas platyrrhinchos)* 154 days	97.3	30 - No significant effects due to low egg production in all treatment groups including the control		00159768/ Munk/1986	Supplemental[2]
Mallard duck *(Anas platyrhynchos)* 154 days	99.1	35.4	**152 ppm** - Reduced egg production, viable embryos, viable 3-week old embryo, normal hatchlings, 14-day old survivors, and adult female body weight.	439671-01/ Gallagher et al./1996	Core

[1] Rated 'Supplemental' because of questionable study design and incomplete data

[2] Rated 'Supplemental' because of low egg production in all treatment and control groups. No eggs were laid in 2 out of 6 control pens.

Two reproduction studies conducted by Munk (1986) were classified supplemental due to questionable results. The studies conducted in 1996 were submitted to clarify the questionable results found in the previous studies. Results of the avian reproduction testing indicate Dimethoate impairs normal reproduction at concentrations >4.0 ppm. The guideline (71-4) is fulfilled (MRID # 44049001, 43967101).

iii. Additional Avian Toxicity Testing

The following two studies were conducted by Hudson, Tucker and Haegele, 1984 (MRID #00160000).

A 30-day daily oral administration test with male and female Mallards (n=6) indicated that the lowest daily oral dosage that produced one or two deaths by the end of the 30-day period (30-day empirical minimum lethal dosage - EMLD) was 6.0 mg/kg/day. The resulting cumulative toxicity index of 7 (acute oral divided by the EMLD 41.6/6) indicates a moderate degree of cumulative action in Mallards.

Another 30-day EMLD study using 20 - 25 week old male and female Ring-necked Pheasants (n=12) indicated an EMLD of 4.0 and 10.0. The cumulative toxicity index is 2.0 to 5.0, indicating a slight degree of cumulative action in pheasants. Acetylcholinesterase measurements were obtained from the brains of the mortalities and the survivors of the pheasant EMLD test. The survivors showed 71.1 percent inhibition and the mortalities showed 88.0 percent inhibition when compared to the controls.

Hoffman and Albers (1984) evaluated the embryotoxic effects of dimethoate to mallard eggs. Eggs were immersed in a solution of dimethoate and water for 30 seconds during the period of organogenesis, day 3 of incubation. Eggs were candled periodically to determine viability and allowed to develop until day 18. At this time surviving embryos were counted and examined for developmental defects. The LC_{50} for mallard eggs exposed in this manner was 30 g/L or 30,000 ppm. Developmental effects observed included defects of the brain, joints and bill, gastroschisis and stunted growth.

iv. Mammals, Acute and Chronic

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. These toxicity values are reported below.

Mammalian Acute Toxicity

Species/ Study Duration	% ai	Test Type	Toxicity Value	Affected Endpoints	MRID No.
Laboratory rat *(Rattus norvegicus)*	43.5%	Acute Oral	LD_{50} F = 415 mg/kg M = 428 mg/kg M&F = 420 mg/kg	Mortality	00163417
Laboratory rat *(Rattus norvegicus)*	Tech	Acute Oral	LD_{50} 250 mg/kg	Mortality	00055371 (Supplemental)
Laboratory mouse *(Mus musculus)*	Lab Grade	Acute Oral	LD_{50} 120 mg/kg	Mortality	00055371
Laboratory rat *(Rattus norvegicus)*	57%	Acute Inhalation	LC_{50} 2.5 mg/L (Both Sexes)	Mortality	406038-02
Rabbit *(Sylvilagus sp.)*	43.5%	Acute Dermal	LD_{50} >2 g/kg	Mortality	00163415

Mammalian Chronic Toxicity

Laboratory rat *(Rattus norvegicus)* 13 weeks	99.1	Sub-chronic Neurotoxicity	NOEL = 1 ppm	Reduction of cholinesterase activity in the 50 ppm dose animals	431282-01
Laboratory rat *(Rattus norvegicus)*	95	Feeding 3-Month	NOEL(ChE)= 32 ppm LEL(Sys) = 400 ppm	ChE - depressed in plasma, RBC and Brain LEL - decreased weight and food consumption, increased kidney and liver weight ratios	00051675 00077532
Domestic dog *(Canis familaris)*	95	Feeding 3-Months	NOEL(ChE) = 2 ppm LEL(Sys) = 50 ppm	NOEL - depressed cholinesterase activity in plasma, RBC and brain LEL - females: tremors and 10% decrease in food consumption	00051676
Laboratory rat *(Rattus norvegicus)*	96.4	2-generation Reproduction	Parental NOEL 1 ppm Reproductive NOEL 15 ppm	Parental NOEL - decreased cholinesterase activity in both sexes and generations Reproductive NOEL - decreased fertility in the F1b, F2a and F2b mating, decreased pup weight during the lactation period for both sexes and generations and decreased number of live births in the F2b litter	422515-01
Domestic dog *(Canis familiaris)*	99.4	1-year Feeding	NOEL(ChE) <5 ppm NOEL(other) <5 ppm	NOEL(other) - decreased liver weights in females and presence of brown granular pigments in the livers	419398-01 421923-01
Laboratory rat *(Rattus norvegicus)*	97.3	Developmental Toxicity	Teratogenic NOEL - >18 mg/kg/day Fetotoxic NOEL - 10 mg/kg/day Maternal NOEL - 6 mg/kg/day	Maternal NOEL - Hypersensitivity, tremors and unsteady gait	00141142 00150130
Wild Mammal Testing					
Wood Mouse (*Apodemus sylvaticus*)	?	Subacute - IP injection	ND	50 mg/kg produced marked but transient behavioral effects	Dell'Omo et al. 1996a
Wood Mouse *(Apodemus sylvaticus)*	?	Subacute - IP injection	ND	50 mg/kg produced marked but transient behavioral effects	Dell'Omo et al. 1996b
Common Shrew (*Sorex aranus*)	?	Subacute - IP injection	ND	50 mg/kg produced significant reductions in rearing, exploring, and sniffing activity and significantly depressed AChE levels	Dell'Omo et al. 1997
Mule Deer (*Odocoileus hemionus*)	97%	Acute Oral	LD_{50} >200 mg/kg (Both Sexes)	Mortality	Worthing, 1979

The results indicate that Dimethoate is moderately toxic to small mammals on an acute oral basis. Significant reductions in cholinesterase activity were observed in a number of studies at concentrations > 1 ppm. Reproductive abnormalities occurred in the rat at concentrations

>15ppm. Developmental toxicity was reported in the rat at concentrations >18 ppm (teratogenic effects) and 10 ppm (fetotoxic effects).

v. Insects

A honey bee acute contact study using the TGAI is required for Dimethoate because use on orchard crops including all citrus crops, apples, pears, cherries, grapes, pecans, >20 vegetable crops, and all major field crops, including peas, will result in honey bee exposure. Current labeling allows application during the flowering stage of development, however, warns against use when bees are observed in the field. Results of this test are tabulated below.

Nontarget Insect (Honey Bee) Acute Contact, Foliar and Oral Toxicity

Species	Study Type	% ai	LD50 (μg/bee)	Toxicity Category	MRID No. Author/Year	Study Classification
Honey bee *(Apis mellifera)*	Contact	Tech	0.17	Highly Toxic	00059971/ /1974	Core
Honey bee *(Apis mellifera)*	Oral	Tech	0.08	n/a	00059971/ /1974	Core
Honey bee *(Apis mellifera)*	Contact	Tech	0.16	Highly Toxic	00026489/ /1972	Core
Honey bee *(Apis mellifera)*	Oral	Tech	0.05	n/a	00026489/ /1972	Core
Honey bee *(Apis mellifera)*	Contact	Tech	0.19	Highly Toxic	00036935/ /1975	Core
Honey bee *(Apis mellifera)*	Foliar	2.67E	0.5	n/a	0004506/ /1975	Core

The results indicate that Dimethoate is highly toxic to bees on an acute contact basis. The guideline (141-1) is fulfilled (MRID 00059971, 00026489 and 00036935).

A honey bee toxicity test of residues on foliage study using the typical end-use product is required for Dimethoate because its use on orchard crops including all citrus crops, apples, pears, cherries, grapes, pecans, >20 vegetable crops, and all major field crops will result in honey bee exposure, and the acute contact honey bee LD50 is less than 0.11 *ug*/bee. Results of this test show that on an acute foliar contact basis Dimethoate is toxic to honey bees at 0.5 lbs ai/acre. The guideline (141-2) is fulfilled (MRID 00045046).

Additional test results of non-target insects have been submitted in support of reregistration. Most of the additional testing was conducted on end-use formulations. Results of this test are tabulated below.

Nontarget Insect Acute Contact Toxicity

Species	Study Type	% ai	LD50 (μg/animal)	Toxicity Category	MRID No. Author/Year	Study Classification
Parasitic wasp *(Bathyplectus curculionus)*	Contact 24 hr	Tech	0.00043	n/a	05012231/ /1975	Core
Ladybird beetle *(Coccinella septempuntata)*	Contact 48 hr	36E	1.6	n/a	42805207/ /1991	Supplemental[1]
Beetle *(Poecilius cupreus)*	Contact 72 hr	36EC	<0.06	n/a	42884501/ /1991	Supplemental[1]
Parasitic wasp *(Trichogramma cacoediae)*	Contact 48 hr	36E	<0.06	n/a	42805202/ /1991	Supplemental[1]

[1] Rated 'Supplemental' because it was not a required study.

The results indicate that Dimethoate is toxic to tested non-target insects on an acute contact basis in the range of 0.00043 to 1.6 ug/animal.

vi. Terrestrial Field Testing

Boudreau (1971) conducted a small pen field study (MRID # 00075585) with the European Starling *(Sturnis vulgaris)* and the Western House Finch *(Carpodacus mexicanus)*. Dimethoate was applied to grapes at a rate of 2.0 lbs ai/acre. Four Western House Finches died during the test, 2 from the control and 2 from the treatment. By the end of the test, all the grapes in the European Starling cages had been eaten and were badly pecked in the Western House Finch cages. Little acute hazard to the test species was shown from exposure to formulated dimethoate as used on grapes at the 2.0 lbs ai/acre. Dimethoate residue levels were not determined in grapes, water, supplemental feed (in appropriate pens), or avian carcasses.

A field study conducted by the US Fish and Wildlife Service (Blus et al. 1989) evaluated Sage Grouse mortality in and around alfalfa fields treated at 0.45 lbs ai/acre. The two year study radio-tracked Sage Grouse which were reported as either healthy or intoxicated in appearance. In 1985, 39 healthy grouse were captured and radio-collared near alfalfa fields. Six radioed grouse occupied alfalfa fields, of which 4 eventually became intoxicated and 2 eventually died. Brain cholinesterase activity in the two dead grouse was depressed by 62 and 73%. In 1986, 31% of the total grouse days recorded through radio tracking were located in alfalfa fields. In one instance, 9 birds were tracked to a treated alfalfa field. Eight of the 9 became intoxicated, 7 out of 9 eventually died. Of the 29 grouse which were initially radio-collared while intoxicated, twenty died in alfalfa fields, ten were confirmed deaths by cholinesterase depression. In 1986, a total of 63 Sage grouse were found dead in alfalfa fields. Signs of dimethoate intoxication included the inability to walk or fly, salivation, emaciation and diarrhea. The researchers stated the evidence from this study supports claims that pesticides are partially responsible for the decline in upland game bird populations, but more data are required.

Cordi et al. (1997) evaluated the effect of dimethoate spray drift on adult and nestling Great tit (*Parus major*) growth and brain, hepatic and serum enzymes. Nest boxes were established in hedgerows adjacent to agricultural fields treated with Dimethoate at an application rate of 0.28 lbs ai/acre. Butylcholinesterase was approximately 50% lower in the adults exposed to dimethoate than the control adults at 24 hours post application and had nearly recovered to control levels by 50 hours post application. No significant inhibition was found in carboxyesterase levels. Weight adjusted brain cholinesterase levels in nestlings exposed to dimethoate were 25% lower than controls at 24 hours and more than 30% lower at 50 hours post application. Weight adusted carboxyesterase levels in nestlings exposed to dimethoate were nearly 20% lower than controls at 24 hours and more than 25% lower at 50 hours post application. Nestling weight was 35% and 10% lower in nestlings exposed to dimethoate than controls at 24 and 50 hours, respectively. However, the authors noted the difficulty in controling for the effect on growth caused by clutch size and habitat effects.

B. Toxicity to Freshwater Aquatic Animals

i. Freshwater Fish, Acute

Two freshwater fish toxicity studies using the TGAI are required to establish the toxicity of Dimethoate to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Results of these tests are tabulated below.

Freshwater Fish Acute Toxicity

Species/ (Flow-through or Static) (Age/Size)	% ai	96-hour LC_{50} (ppm) (measured/nominal)	Toxicity Category	MRID No. Author/Year	Study Classification
Bluegill sunfish *(Lepomis macrochirus)* static - (0.3g)	97.4	6.0	Moderately Toxic	00003503/ Johnson and Finley/1980	Core
Rainbow trout *(Oncorhynchus mykiss)* static - (1.5g)	97.4	6.2	Moderately Toxic	40094602/ Johnson and Finley/1980	Core
Rainbow trout *(Oncorhynchus mykiss)* static - (Juv)	95	7.5	Moderately Toxic	FEODIM02/ USEPA/1977	Core
Goldfish *(Carassius auratus)* Static - (0.6g)	30.5	180 (48 hour)	Practically Non-toxic	00077504/ USEPA/1970	Supplemental[1]

[1] Rates 'Supplemental' because it was not a guideline study; conducted with a formulation, short duration and not an approved species.

32 g

Since the LC_{50} falls in the range of 6.0 to 7.5 ppm, Dimethoate is considered moderately toxic to freshwater fish on an acute basis. The guideline (72-1) is fulfilled (MRID 40094602, FEODIM02 and 0077504).

ii. Freshwater Fish, Chronic

A freshwater fish early life-stage test using the TGAI is required for Dimethoate because the end-use product is expected to be transported to water from the intended use site, and the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity. The preferred test species is rainbow trout or bluegill sunfish.

One freshwater fish chronic test was submitted in support of registration. The result of this test is submitted below.

Freshwater fish early-life stage toxicity under flow through conditions.

Species/ Study Duration	% ai	NOEC/LOEC (ppm)	MATC[1] (ppm)	Endpionts Affected	MRID No. Author/Year	Study Classification
Rainbow Trout (*Oncorhynchus mykiss*) 96 Day	99.1	0.43/0.84	0.60	Growth	431063-03/ Stawn and Muckerman/ 1994	Supplemental

[1] defined as the geometric mean of the NOEC and LOEC

The guideline (72-4) is fulfilled (MRID #43106303).

A freshwater fish life-cycle test using the TGAI would be required for dimethoate if the end-use product is intended to be applied directly to water or is expected to be transported to water from the intended use site, and the following conditions are met: (1) the EEC is equal to or greater than one-tenth of the NOEC in the fish early life stage or invertebrate life-cycle test, or (2) studies of other organisms indicate the reproductive physiology of fish may be effected.

Dimethoate has no registered uses allowing direct application to water bodies. Multiple applications at a rate of 1.0 lbs ai/acre, totaling 6.0 lbs ai/acre, are allowed on Brussels sprouts. At 7 day application intervals, this could result in a 6 week period during which maximum peak EECs would be 0.019 ppm and 60 day mean EECs would be 0.003 ppm in surface water. Using the NOEC from the Rainbow trout early-life stage test, 0.43 ppm, the resulting RQ ranges from 0.04 (max EEC) to 0.007 (60 day mean EEC), one order of magnitude lower than the guideline given in the paragraph above. Consequently, a freshwater fish life-cycle is not required at this time.

iii. Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of Dimethoate to aquatic invertebrates. The preferred test species is *Daphnia magna*. Results of this test are tabulated below.

Freshwater Invertebrate Acute Toxicity

Species/(Static or Flow-through)	% ai	48-hour LC_{50}/ EC_{50} (ppm) (measured/nominal)	Toxicity Category	MRID No. Author/Year	Study Classification
Stonefly *(Pteronarcys californica)* 96 hour - Static	97.4	0.043	Very highly toxic	00003503/ Johnson and Finley/1980	Core
Scud *(Gammarus lacutris)* 96 hour - Static	97.4	0.20	Highly toxic	00003503/ Johnson and Finley/1980	Supplemental[1]
Water flea (Daphnia magna)	>95%	3.32	Moderately toxic	Song et al./ 1997	Supplemental
Yellow fever mosquito (Aedes aegypti)	>95%	5.04	Moderately toxic	Song et al./ 1997	Supplemental[2]

[1] Adults were tested instead of and early instar.
[2] Not an accepted test species

Since the most sensitive LC_{50} is 0.043 to 3.32 ppm, Dimethoate is considered to be very highly toxic to aquatic invertebrates on an acute basis. The guideline (72-2) is fulfilled (MRID #00003503).

iv. Freshwater Invertebrate, Chronic

A freshwater aquatic invertebrate life-cycle test using the TGAI is required for Dimethoate since the end-use product is expected to be transported to water from the intended use site, and the following conditions are met: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity; (2) any aquatic acute LC_{50} or EC_{50} is less than 1 mg/l; and (3) the EEC in water is equal to or greater than 0.01 of any acute EC_{50} or LC_{50} value. The preferred test species is *Daphnia magna*. Results of these tests are tabulated below.

Freshwater Aquatic Invertebrate Life-Cycle Toxicity

Species/Static Renewal or Flow-through)	% ai	21-Day NOEC (ppm)	21-Day LOEC (ppm)	MATC[1] (ppm)	Endpoints Affected	MRID No. Author/Year	Study Classification
Waterflea *(Daphnia magna)* Static	99	0.04	0.1	0.06	Reproduction, Survival and Growth	42864701/ Wuthrich/1990	Core
Waterflea *(Daphnia magna)* NR	94	0.23	0.45 (28 day)	0.32	Reproduction and Survival	FEODIM01/ USEPA/1977	Supplemental[2]

[1] Defined as the geometric mean of the NOEC and LOEC.
[2] Questionable results in the solvent and water control.

The guideline (72-4) is fulfilled (MRID # 42864701).

v. Freshwater Field Studies

No freshwater field studies have been requested or submitted in supported in support of registration.

C. Toxicity to Estuarine and Marine Animals

i. Estuarine and Marine Fish, Acute

Acute toxicity testing with estuarine/marine fish using the TGAI is required for Dimethoate because the end-use product is intended for direct application to the marine/estuarine environment or the active ingredient is expected to reach this environment because of its use in coastal counties. The preferred test species is sheepshead minnow. Results of these tests are tabulated below.

Estuarine/Marine Fish Acute Toxicity

Species/(Static or Flow-through)	% ai	96-hour LC_{50} (ppm) (measured)	Toxicity Category	MRID No. Author/Year	Study Classification
Longnose killifish *(Fundlus similis)* Flow-through	99.3	>1.0 (48 hour)	Moderately toxic	4022840/ 1986	Supplemental[1]
Sheepshead minnow *(Cyprinodon variegatus)*	99.1	>111	Practically Non-toxic	42760001/ Graves/1993	Core

[1] Short test duration.

Since the tested LC_{50} was determined to be > 1 ppm and >111 ppm, Dimethoate is considered no more than moderately toxic to estuarine/marine fish on an acute basis. The guideline (72-3a) is fulfilled (MRID # 42760001).

ii. Estuarine and Marine Fish, Chronic

An estuarine/marine fish early life-stage toxicity test using the TGAI would be required for Dimethoate if the end-use product may be applied directly to the estuarine/marine environment or expected to be transported to this environment from the intended use site, and the following conditions are met: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity, (2) any aquatic acute LC_{50} or EC_{50} is less than 1 mg/l, (3) the EEC in water is equal to or greater than 0.01 of any acute LC_{50} or EC_{50} value, or, (4) the actual or estimated environmental concentration in water resulting from use is less than 0.01 of any acute LC_{50} or EC_{50} value and any of the following conditions exist: studies of other organisms indicate the reproductive physiology of fish and/or invertebrates may be affected, physicochemical properties indicate cumulative effects, or the pesticide is persistent in water (e.g., half-life greater than 4 days).

None of the above condtions are met. Consequently, estuarine/marine fish early life-stage toxicity testing is not required.

iii. Estuarine and Marine Invertebrates, Acute

Acute toxicity testing with estuarine/marine invertebrates using the TGAI is required for Dimethoate because the active ingredient is expected to reach the marine/estuarine environments. The preferred test species are mysid and eastern oyster. Results of these tests are tabulated below.

Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai.	96-hour LC_{50}/EC_{50} (ppm) (measured)	Toxicity Category	MRID No. Author/Year	Study Classification
Eastern oyster (shell deposition or embryo-larvae) *(Crassostrea virginica)* Flow-through/ spat	99.1	113	Practically Non-toxic	42760002/ Graves/1993	Core
Mysid *(Mysidopsis bahia)* 24 hours old	99.1	15	Slightly toxic	42760003/ Graves/1993	Core
Brown Shrimp *(Mysidopsis azteccus)* Juv	99.3	>1.0 (48 hour)	Moderately toxic	40228401/ 1986	Supplemental
Brine shrimp *(Artemia sp.)*	>95	15.73 (48 hour)	Moderately toxic	Song et al./ 1997	Supplemental[1]
Salt marsh mosquito *(Aedes taeniorhychus)*	>95	0.031 (48 hour)	Very highly toxic	Song et al./ 1997	Supplemental

[1] Not an accepted test species

Since the LC_{50}/EC_{50} falls in the range of >1.0 to 113 ppm, Dimethoate is considered moderately toxic to practically non-toxic to many estuarine/marine invertebrates on an acute basis. However, it is noted that the chemical is very highly toxic to the saltmarsh mosquito, that at one time was a target organism. The guideline (72-3b and 72-3c) is fulfilled (MRID #42760002, 42760002 and 40228401).

iv. Estuarine and Marine Invertebrate, Chronic

An estuarine/marine invertebrate life-cycle toxicity test using the TGAI would be required for Dimethoate if the end-use product may be applied directly to the estuarine/marine environment or expected to be transported to this environment from the intended use site, and the following conditions are met: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity, (2) any aquatic acute LC_{50} or EC_{50} is less than 1 mg/l, (3) the EEC in water is equal to or greater than 0.01 of any acute LC_{50} or EC_{50} value, or, (4) the actual or estimated environmental concentration in water resulting from use is less than 0.01 of any acute LC_{50} or EC_{50} value and any of the following conditions exist: studies of other organisms indicate the reproductive physiology of fish and/or invertebrates may be affected, physicochemical properties indicate cumulative effects, or the pesticide is persistent in water (e.g., half-life greater than 4 days). The preferred test species is mysid shrimp.

None of the above conditions are met. Consequently, estuarine/marine invertebrate life-cycle testing is not required.

v. Estuarine and Marine Field Studies

No estuarine or marine field studies have either been requested or submitted in support of registration.

D. Toxicity to Plants

i. Terrestrial

Currently, terrestrial plant testing is not required for pesticides other than herbicides except on a case-by-case basis (e.g., labeling bears phytotoxicity warnings, incident data or literature that demonstrates phytotoxicity). Conditions are not met for dimethoate.

ii. Aquatic Plants

Currently, aquatic plant testing is not required for pesticides other than herbicides and fungicides except on a case-by-case basis (e.g., labeling bears phytotoxicity warnings, incident data or literature that demonstrates phytotoxicity). Conditions are not met for dimethoate.

E. Reported Field Mortality of Non-target Species

Five cases of possible non-target effects have been reported in the EPA 'Ecological Incident Information System' and 'Incident Data System' databases. The reported incidents include those in which Dimethoate is implicated as a highly probable cause of the mortality and those in which Dimethoate is listed as a possible cause.

The Illinois Department of Conservation reported a major fish kill on the Mackinaw River, Tazwell County, in 1988[1]. It was reported that dimethoate was aerially applied to adjacent soybean fields to control spidermites. A total of 9,232 fish and 5 turkeys were found dead. Fish species included bass (54), sunfish (563), white bass (17), minnow (8195), shad (221), carp (78), sucker (55), drum (26), channel catfish (26) and bullhead catfish (2). Stream-flow was at an all-time low at the time. No residue analyses were reported. Beyond the fact that dimethoate was applied, there is no evidence to suggest dimethoate caused the mortality.

Two reports of cedar waxwing mortality were reported in California during 1972. The

[1] Report submitted by Wayne Herndon, August 14, 1988, Illinois Department of Conservation, Division of Fisheries

first incident reported 60 dead and 26 sick birds by the Tulare County Department of Agriculture[2]. The area had been treated with dimethoate (Cygon) as part of the California Department of Food and Agriculture's Comstock mealybug control program. Cedar waxwings in the area were observed feeding on pyracantha berries.

The second reported incident involving cedar waxwings was confined to a residential yard in Lafayette county, California [4]. The garden in this yard had been treated with dieldrin and diazinon on April 10 and dimethoate on April 18, 1972. Autopsy of the birds indicated they were in good body fat condition. Gizzard contents consisted entirely of pyracantha berries. A composite sample of gizzard contents and a composite sample of pyracantha berries were submitted to the State Department of Food and Agriculture for residue analysis. Dimethoate at a level of 5.1 ppm was detected in the gizzard content sample as well a residues of dieldrin at 0.15 ppm and diazinon at 0.76 ppm. Residues at similar levels were present on the pyracantha berries. The occurrence of other pesticides known to be hazardous to birds casts doubt on whether dimethoate was the sole cause of the mortality.

Two sketchy reports were submitted of calves found dead after grazing in wheat fields treated with dimethoate[3 4]. The reports indicated dimethoate had been applied to wheat fields in Oklahoma and Texas, according to label directions. No follow up documentation has been submitted. It is possible these two incidents document the same event. In both reports the company states it has also been reported that calves have died after grazing in untreated fields, so that other causes such as weather related stress, disease, poisonous plants or other natural causes cannot be excluded from consideration. Given the acute toxicity of dimethoate to mammals, it is not likely that it caused the death of these calves.

4. Ecological Risk Assessment

Risk assessment and characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. One means of integrating the results of exposure and ecotoxicity data is the quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic (sublethal or reproductive).

RQ = EXPOSURE/TOXICITY

RQs are then compared to OPP's levels of concern (LOCs). These LOCs are criteria

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[2] Job Progress Report, State and County Departments of Agriculture, California, January 1, 1972 - June 30 1972

[3] Drexal Chemical Corporation, Letter submitted to the USEPA on February 3, 1994. IDS # I000856.

[4] Platte Chemical Company, Letter submitted to the USEPA on January 20, 1994. IDS # I000838

used by OPP to indicate potential risk to nontarget organisms and the need to consider regulatory action. The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. LOCs currently address the following risk presumption categories: (1) **acute high** - potential for acute risk is high, regulatory action may be warranted in addition to restricted use classification (2) **acute restricted use** - the potential for acute risk is high, but this may be mitigated through restricted use classification (3) **acute endangered species** - the potential for acute risk to endangered species is high, regulatory action may be warranted, and (4) **chronic risk** - the potential for chronic risk is high regulatory action may be warranted.

In this case, **chronic risk** refers to the risk of sublethal and/or reproductive effects occurring in the field that were observed in the longer-term laboratory studies.

The ecotoxicity test values (i.e., measurement endpoints) used in the acute and chronic risk quotients are derived from the results of laboratory studies. Examples of ecotoxicity values derived from the results of short-term laboratory studies that assess acute effects are: (1) LC50 (fish and birds) (2) LD_{50} (birds and mammals (3) EC_{50} (aquatic plants and aquatic invertebrates) and (4) EC_{25} (terrestrial plants). Examples of toxicity test effect levels derived from the results of long-term laboratory studies that assess chronic effects are: (1) LOEC (birds, fish, and aquatic invertebrates) (2) NOEC (birds, fish and aquatic invertebrates) and (3) MATC (fish and aquatic invertebrates). For birds and mammals, the NOEC value is used as the ecotoxicity test value in assessing chronic effects. Generally, the MATC (defined as the geometric mean of the NOEC and LOEC) is used as the ecotoxicity test value in assessing chronic effects to fish and aquatic invertebrates. However, the NOEC might be used if the measurement end point is production of offspring or survival.

Risk presumptions, along with the corresponding RQs and LOCs are provided below. Risk decisions are made by comparing the RQ with the LOC. If the RQ is equal to or greater than the LOC, a risk presumption is made. A risk presumption means that based on a simple comparison of exposure (estimated or measured) to toxicity thresholds the effect (i.e. mortality, sublethal or reproductive) is considered likely to occur in the field. This risk presumption, by itself, does not provide any indication of the extent or severity of the effect, nor of its ecological significance.

Risk Presumptions for Terrestrial Animals

Risk Presumption	RQ	LOC
Birds		
Acute High Risk	EEC[1]/LC50 or LD50/sqft[2] or LD50/day[3]	0.5
Acute Restricted Use	EEC/LC50 or LD50/sqft or LD50/day (or LD50 < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC50 or LD50/sqft or LD50/day	0.1
Chronic Risk	EEC/NOEC	1
Wild Mammals		
Acute High Risk	EEC/LC50 or LD50/sqft or LD50/day	0.5
Acute Restricted Use	EEC/LC50 or LD50/sqft or LD50/day (or LD50 < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC50 or LD50/sqft or LD50/day	0.1
Chronic Risk	EEC/NOEC	1

[1] abbreviation for Estimated Environmental Concentration (ppm) on avian/mammalian food items

[2] $\frac{\text{mg/ft}^2}{\text{LD50 * wt. of bird}}$ [3] $\frac{\text{mg of toxicant consumed/day}}{\text{LD50 * wt. of bird}}$

Risk Presumptions for Aquatic Animals

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC50 or EC50	0.5
Acute Restricted Use	EEC/LC50 or EC50	0.1
Acute Endangered Species	EEC/LC50 or EC50	0.05
Chronic Risk	EEC/MATC or NOEC	1

[1] EEC = (ppm or ppb) in water

Risk Presumptions for Plants

Risk Presumption	RQ	LOC
	Terrestrial and Semi-Aquatic Plants	
Acute High Risk	EEC[1]/EC25	1
Acute Endangered Species	EEC/EC05 or NOEC	1
	Aquatic Plants	
Acute High Risk	EEC[2]/EC50	1
Acute Endangered Species	EEC/EC05 or NOEC	1

[1] EEC = lbs ai/A

[2] EEC = (ppb/ppm) in water

A. Exposure and Risk to Nontarget Terrestrial Animals

Selection of Use Scenarios to Model

Terrestrial risk estimates are based on several use patterns, see table below.

Use Patterns used to Estimate Acute Risk and Sublethal and/or Reproductive Risk to Birds and Mammals			
Sites that Use Scenario Represents	Use Rate	Number Applications	Between Treatment Interval
SCENARIO 1 **FIELD CROPS** (aerial or ground application) (Corn, Alfalfa, Soybeans, Cotton, Sorghum) **VEGETABLE CROPS** (aerial or ground application) (All registered vegetable uses with the exclusion of Brussels sprouts and peas	0.5 0.5	1 1	
SCENARIO 2 **FIELD CROPS** (Wheat and Soybeans @ 2 applications; Corn and Sorghum @ 3 applications) **ORCHARD CROPS** (Apples, Pears, Tangelos, Pomelo, Kumquats @ 2 applications) **VEGETABLE CROPS** (Kale, Mustard Greens, Melons, Watermelon, Tomato, Bean, Lentil, Spinach, and Potato @ 2 applications) (Cabbage, Endive, Lettuce, Swiss Chard, Turnip @ 3 applications) (Collards @ 4 applications) (Broccoli, Cauliflower, Celery @ 6 applications)	0.5 0.5	3 3	7 7
SCENARIO 3 **COTTON**	0.5 0.5	2 2	14 14
SCENARIO 4 **WHEAT**	0.67 0.67	2 2	5 5
SCENARIO 5 **CITRUS CROPS** (oranges, grapefruit, tangerines, lemons)	0.75 0.75	2 2	15 15
SCENARIO 6 **BRUSSELS SPROUTS** (aerial or ground application)	1 1	6 6	7 7
SCENARIO 7 **CITRUS CROPS** (oranges, grapefruit, tangerines, lemons)	4 4	1 1	

Estimating Exposure to Birds and Mammals

Dimethoate is not formulated as a granular, therefore the estimated environmental concentrations (EECs) on food items following product application are compared to avian and mammalian LC_{50} and sublethal and/or reproductive NOAEL values to assess risk. The predicted 0-day maximum and mean residues of a pesticide that may occur on selected avian or mammalian food items immediately following a direct single application at 1 lb ai/A are provided below.

Estimated Environmental Concentrations on Avian and Mammalian Food Items (ppm) Following a Single Application at 1 lb ai/A)

Food Items	EEC (ppm) Predicted Maximum Residue[1]	EEC (ppm) Predicted Mean Residue[1]
Short grass	240	85
Broadleaf/forage plants, and small insects	135	45
Tall grass	110	36
Fruits, pods, seeds, and large insects	15	7

[1] Predicted maximum and mean residues are for a 1 lb ai/a application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994).

Note that the inclusion of small and large insects in the nomograph with broadleaf and fruit and seeds is based on similarity in surface area to volume ratios. For example, the surface area to volume ratio of small insects is considered similar to the surface area to volume ratio of vegetation included in the "broadleaf" group, etc. Neither Hoerger and Kenega nor Fletcher obtained actual residue data for insects.

Terrestrial residues (EECs) are calculated by multiplying the nomograph values (maximum or mean) by the application rate in lb ai/acre. To estimate the residues on these food items over time, the initial residue is reduced each day by a daily dissipation factor. This dissipation factor is derived from a foliar dissipation halflife. In cases where multiple applications are considered, the residues from each subsequent application are added to the remaining daily residue level on the day of the subsequent treatment. The EFED has a computer program called FATE that automatically generates the daily dissipation factor and calculates daily residue values. In the case of dimethoate, most simulations were run for 30 days since in most cases that encompassed the time period covered by multiple applications.

The tables of values on which both acute and sublethal/reproductive risk assessment are based are found in the EFED Appendix.

Selection of Foliar Dissipation Halflives

A foliar halflife of 2.4 days was based on an aerobic soil metabolism study (MRID 42843201).

According to information submitted by Cheminova in the rebuttal submission dated August 20, 1998, the foliar halflife of dimethoate ranges from <1 day to 5 days. The halflife of 2.4 days is an appropriate "mid-range" dissipation estimate.

i. Acute Risk

Bird Acute Risk

Acute risk quotients are calculated from predicted residues following repeated or multiple applications during a growing season. Application scenarios for multiple applications were taken primarily from the Grower Use Survey provided by Dahl (1997). This information was used due to the nonprescriptive nature of dimethoate labels. The survey provided detailed information on typical use patterns concerning application rate, application interval and number of applications per year. These use patterns are summarized in the table listing use patterns for assessing risk to terrestrial animals. The results of RQ calculations from single and repeated applications are presented in the table with the bird and mammal acute RQ calculations below.

Mammal Acute Risk

The use patterns used to determine potential risk to mammals are the same as those used to assess risk to birds. The mammal acute toxicity value used to assess mammalian risk is the rat acute oral LD50. Of the rat LD50 data available to EFED, the lowest value of 420 mg/kg (male and female combined; test material: 43.5% ai) is from from the study identified as Acc # 247669.

This LD50 is used to calculate a 1-day LC50 as shown in the table below. Food consumption for mammals is often reported as a "percent" of body weight. That is, a 100 g mammal that consumes 10 g of food daily would be considered to consume 10% (or 0.1) of its body weight per day. Different mammals in the field consume different amounts of food relative to their body weight. Generally, the larger the animal, the lower the percentage of it's body weight it consumes per day. Thus, while a larger (2 kg) mammal eats much more food per day than a tiny 20 g mammal, it eats relatively less of it's body weight per day. A 1-day LC50 is determined by calculating what the concentration would have to be in the diet of a mammal for it to receive the equivalent of an LD50 in one day. The full equation is:

$$\text{1-day LC50 (ppm diet)} = \frac{\text{LD50 (mg/kg) X Body weight (kg)}}{\text{Daily food consumption (kg)}}$$

This is shortened to: 1-day LC50 = LD50 (mg/kg) X percent body weight consumed

According to this equation, the lower the percent of body weight consumed in one day, the higher the resulting LC50. Therefore larger mammals and other mammals that eat relatively less of their body weight per day will have relatively higher LC50, suggesting reduced sensitivity to equivalent residue levels in their diet.

There is some uncertainty in calculating a LC50 from a LD50, because it requires assuming a certain level of food consumption. For the acute risk assessment below, only one feeding pattern (percent of body weight consumed per day) is used, a very small mammal that consumes almost its entire body weight (95%) in food (wet weight) per day. Other animals in the field eat proportionately much less food per day, and would have, if calculated, higher LC50 values. The risk quotients from these calculated higher LC50 values would be lower, suggesting these other mammals might be at lower risk of acute effects.

Thus, the risk calculations below, that not only use peak maximum exposure levels, but also assume a mammal that eats an extremely high proportion of its body weight a day, represent the upper bound of risk. Generally, acute risk across the whole spectrum of mammals that do not just feed on items with the maximum residue levels might be lower than these risk quotients suggest.

Avian and Mammal Acute Risk Quotients based on maximum exposure levels. Assuming an avian dietary LC50 of 332 ppm (pheasant, MRID 00022923, Hill et al.,1975), a mammal LC50 of 191 ppm and a 2.4-day halflife

The mammalian LC50 of 191 ppm was calculated from an acute oral LD50 of 182 mg ai/kg body weight which was extrapolated from an LD50 of 420 mg/kg for a 43.5% ai test material. 420 X 43.5% = 182. The formula to calculate a 1-day LC50 from an acute oral LD50 is: 1-day LC50 = LD50 (mg/kg) / percent food consumption (in this assessment, a small mammal is assumed to eat up to 95% of its body weight/day); 182 / 0.95 = 191 ppm

Use Scenarios **Assuming foliar dissipation hafllife of 2.4 days**		Maximum Exposure (EEC in ppm)[1] and RQ							
		BIRDS				MAMMALS			
		Maximum Acute RQs (Maximum EEC / LC50 of 332 ppm)				Maximum Acute RQs (Maximum EEC / LC50 of 191 ppm)			
		short grass	broad leaf	long grass	seeds fruit	short grass	broad leaf	long grass	seeds fruit
Scenario 1 (corresponds to Data Table 1 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.5 lb ai/acre, 1 application per season; represents **FIELD CROPS, VEGETABLE CROPS with single** applications	EEC	120	67	55	7	120	67	55	7
	RQ	0.3	0.2	0.1	<0.1	**0.6**	0.3	0.2	<0.1
Scenario 2 (corresponds to Data Table 2 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.5 lb ai/acre, 3 applications per season, 7-day treatment interval; represents **FIELD CROPS, ORCHARD CROPS, VEGETABLE CROPS with multiple** (3 or more) applications	EEC	138	77	63	8	138	77	63	8
	RQ	0.4	0.2	0.1	<0.1	**0.7**	0.4	0.3	<0.1
Scenario 3 (corresponds to Data Table 3 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.5 lb ai/acre, 2 applications per season, 14-day treatment interval; represents **COTTON** and one of three scenarios for **CITRUS**	EEC	122	68	55	7	122	68	55	7
	RQ	0.3	0.2	0.1	<0.1	**0.6**	0.3	0.2	<0.1
Scenario 4 (corresponds to Data Table 4 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.67 lb ai/acre, 2 applications per season, 5-day treatment interval; represents **WHEAT**	EEC	198	111	91	12	198	111	91	12
	RQ	**0.6**	0.3	0.2	<0.1	**1.0**	**0.6**	0.4	<0.1
Scenario 5 (corresponds to Data Table 5 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.75 lb ai/acre, 2 applications per season, 15-day treatment interval; represents one of three application scenarios for **CITRUS CROPS**	EEC	182	102	83	11	182	102	83	11
	RQ	**0.5**	0.3	0.2	<0.1	**0.9**	**0.5**	0.4	<0.1
Scenario 6 (corresponds to Data Table 6 in the Daily Terrestrial Residue Tables (EFED Appendix) 1 lb ai/acre, 6 applications per season, 7-day treatment interval; represents **BRUSSELS SPROUTS** (registrant proposes to drop this use)	EEC	276	155	126	17	276	155	126	17
	RQ	**0.8**	0.4	03	<0.1	**1.4**	**0.8**	**0.6**	<0.1
Scenario 7 (corresponds to Data Table 7 in the Daily Terrestrial Residue Tables (EFED Appendix) 4 lb ai/acre, 1 applications per season; represents one of three application scenarios for **CITRUS** (the registrant proposes to drop this use)	EEC	960	540	440	60	960	540	440	60
	RQ	**2.8**	**1.6**	**1.3**	0.1	**5.0**	**2.8**	**2.3**	0.3

[1]The maximum exposure level is the highest level estimated based on the Hoerger and Kenega nomograph as modified by Fletcher, 1994. For scenarios with single applications, the maximum level is the concentration immediately after the treatment. For scenarios with multiple applications, the maximum concentration is that which occurs immediately after the final application.
Bolded RQs meet or exceed the high risk LOC
<0.1 indicates no LOCs are exceeded
0.1 or higher suggest effects to endangered or threatened species
0.2 or higher indicates use pattern should be considered for restricted use

The results indicate that, for the most part, most uses of dimethoate do not represent a significant acute risk to birds. Use at 0.5 to 0.75 lb ai/acre results in few or no high acute risk LOC exceedances. However, use on citrus (at 4 lb ai/acre) would result in more extensive acute high risk LOC exceedances.

The restricted use LOC is exceeded for one or more food items at all application rates at or above 0.5 lb ai/acre. The endangered species LOC is exceeded for most food items at or above 0.5 lb ai/acre.

All modeled scenarios result in at least one food item that exceeds the LOC for acute risk to mammals. However, most exceeding risk quotients only marginally exceed the LOC, except for Brussels sprouts and citrus (4 lb ai/acre). These uses would represent a greater potential of acute risk than the other uses. All uses may affect endangered mammals, and the risk level indicates they should be considered for restricted use.

Acute Risk to Birds and Mammals from Other Uses of Dimethoate

Three additional uses of dimethoate include the control of midges, sawflies and scale on Douglas fir, Loblolly pine and Pinon pine, respectively. Application to Douglas fir is via back-pack or hydraulic sprayer at a rate of 3.56 lbs ai/acre. EECs and RQs for use on Douglas fir are slightly less than those in citrus orchards at a rate of 4.0 lbs ai/acre (see the single application acute RQ table). Aerial application is allowed for Loblolly pine at a rate of 0.25 lbs ai/acre. Risk for use on Loblolly pine would be equivalent to what is predicted in peas, below.

Peas (not shown in the table) have the lowest registered single application rate, 0.25 lbs ai/acre. At this application rate the acute risk would be relatively low for both birds and mammals.

The recommended application rate for controlling scale on pinon pine is 8 lbs ai/acre. A backpack sprayer is used to drench all of the bark within reach. It is likely that at this application rate, concentrations on food items inadvertently sprayed will represent a risk to birds and mammals. However, this use is not considered extensive, and widespread ecological impacts would therefore be unlikely.

Discussion of acute risk

While most use patterns for dimethoate result in one or more RQs that exceed the high risk LOC, the following factors should influence the overall perception of risk.

It is important to note that **Brussels sprouts** represents a low acreage use site, so any acute effects caused by use of dimethoate would be limited to the area involved (about 3000 acres). The registrant has proposed to voluntarily discontinue this use pattern.

The **citrus** application involves air blast spraying which is aimed up into the trees. Therefore probably not all of what is applied (4 lbs ai/acre) ends up settling on the ground level food items. So the RQs for the citrus uses are probably higher than would likely occur, even under maximum exposure conditions. The registrant has proposed to voluntarily discontinue this use pattern.

While there are a few reported incidents of bird mortality associated with dimethoate, based on the information provided with those incidents, and the toxicity of dimethoate, it is considered unlikely that these suggest a pattern of widespread and repeated mortality to birds caused by dimethoate.

While consideration of acute risk involves using peak maximum exposure levels, it is also important to note that **dimethoate dissipates rapidly** under field conditions. This means that any acute risk associated with maximum residues immediately after each treatment would drop off quickly because the residues dissipate from food items. Therefore, birds moving into fields several days after a treatment would not be exposed to risk at the same levels as birds feeding in the fields a day or two after treatment.

ii. Risk of Sublethal or Reproductive Effects to Birds and Mammals

Sublethal and reproductive risk to birds and mammals is based on a comparison of the results of longer term testing that is intended to determine effects on growth, reproduction, and/or survival/health of offspring with estimated dietary residue levels.

Avian toxicity threshold

The avian toxicity threshold used to assess sublethal risk to birds is the resulting NOAEL of 4 ppm from a bobwhite quail reproduction study (MRID 44049001). This was based on reduced weight of 14-day old offspring of parent birds fed diet treated at the next higher test level (LOAEL) of 10 ppm. Reduced body weight of young birds is a potentially significant ecological impact, as underweight birds might be less able to compete and survive. This NOAEL is compared to both peak maximum and mean residue levels by calculating risk quotients, as well as being compared graphically to longer-term maximum and mean residue levels.

Mammal toxicity threshold

The mammalian toxicity threshold used to assess sublethal and reproductive risk to mammals is the rat 2-generation reproductive NOAEL of 15 ppm (MRID 42251501. This was based on effects at the next higher test level. The effects were decreased fertility in the F1b, F2a and F2b mating, decreased pup weight during the lactation period for both sexes and generations and decreased number of live births in the F2b litter. Reduced fertility, reduced pup weight and reduced live births are potentially significant ecological effects. This NOAEL is compared to both peak maximum and mean residue levels by calculating risk quotients, as well as being compared graphically to longer-term maximum and mean residue levels.

An **additional mammalian toxicological** endpoint is also used, qualitatively, to characterize sublethal risk to mammals. The brain and blood cholinesterase inhibition NOAEL for short-term exposure is approximately 1 ppm (MRID 43128201). Since this is not a typical endpoint used by EFED to calculate risks, no risk quotients are calculated. However, cholinesterase inhibition is a potentially significant ecological impact, and the possibility of this occurring in the field will not be overlooked in this risk assessment. Relatively short-term exposure to dimethoate is considered capable of causing cholinesterase inhibition.

Duration of Exposure used to Characterize Sublethal and/or Reproductive Risk

The studies from which both the mammalian and avian NOAELs were derived were relatively long-term studies. However, these NOAELs are compared to both longer-term exposure estimates and to peak exposure estimates. The peak estimates are used in addition to the longer term exposure estimates because, while both studies were several months in duration, there does not appear to be a basis for assuming the full duration of exposure was required to trigger the effects that occurred. The longer-term exposure levels are presented to show how long the residue levels remain above the sublethal and/or reproductive thresholds, and to show, graphically, the relatively rapid rate at which dimethoate dissipates on food items.

Methods of Comparing Exposure to Toxicity Thresholds

Two methods are used to characterize the relationship between the avian and mammalian sublethal and reproductive thresholds and exposure. The first method involves calculating risk quotients, the second method involves showing the relationship graphically. Please see the discussion of how residues on various mammal and bird food items were estimated.

Risk quotients are calculated from peak residue levels. Both the peak maximum residue level, and the peak mean residue level were used. The table below shows the risk quotients and the approximate number of days the toxic threshold is exceeded.

Avian and Mammalian Sublethal and Reproductive Risk Quotients Based on Peak Maximum and Peak Mean Exposure Levels.

Use Scenarios		Avian NOAEL=4 ppm		Mammal NOAEL=15ppm	
		peak maximum[1]	peak mean[2]	peak maximum[1]	peak mean[2]
Scenario 1 (corresponds to **Data Table** 1 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.5 lb ai/acre, 1 application per season represents **FIELD CROPS, VEGETABLE CROPS with single** applications	EEC	120	21	120	21
	RQ (days)[3]	30 (12 days)	5 (6 days)	8 (8 days)	1.4 (1 day)
Scenario 2 (corresponds to **Data Table** 2 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.5 lb ai/acre, 3 applications per season, 7-day treatment interval represents **FIELD CROPS, ORCHARD CROPS, VEGETABLE CROPS with multiple** (3 or more) applications	EEC	138	24	138	24
	RQ (days)[3]	34 (26 days)	6 (21 days)	9 (22 days)	1.6 (~1 day after each appl)
Scenario 3 (corresponds to **Data Table** 3 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.5 lb ai/acre, 2 applications per season, 14-day treatment interval represents **COTTON** and one of 3 application scenarios for **CITRUS**	EEC	122	22	122	22
	RQ (days)[3]	30 (24 days)	5 (11 days)	8 (12 days)	1.4 (~1 day after each appl)
Scenario 4 (corresponds to **Data Table** 4 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.67 lb ai/acre, 2 applications per season, 5-day treatment interval represents **WHEAT**	EEC	198	35	198	35
	RQ (days)[3]	49 (18 days)	8 (13 days)	13 (14 days)	2 (~2 days after each appl)
Scenario 5 (corresponds to **Data Table** 5 in the Daily Terrestrial Residue Tables (EFED Appendix) 0.75 lb ai/acre, 2 applications per season, 15-dzay treatment interval represents one of three application scenarios for **CITRUS CROPS**	EEC	182	32	182	32
	RQ (days)[3]	45 (~29 days)	8 (~7 days after each appl)	12 (~9 days after each appl)	2 (~2 days after each appl)
Scenario 6 (corresponds to **Data Table** 6 in the Daily Terrestrial Residue Tables (EFED Appendix) 1 lb ai/acre, 6 applications per season, 7-day treatment interval represents **BRUSSELS SPROUTS** (registrant proposes to drop this use)	EEC	276	49	276	49
	RQ (days)[3]	69 (>42 days)	12 (>42 days)	18 (>42 days)	3 (~4 days after each appl)
Scenario 7 (corresponds to **Data Table** 7 in the Daily Terrestrial Residue Tables (EFED Appendix) 4 lb ai/acre, 1 applications per season represents one of three application scenarios for **CITRUS** (the registrant proposes to drop this use)	EEC	960	173	960	173
	RQ (days)[3]	240 (~17 days)	43 (~12 days)	54 (~14 days)	11 (~8 days)

[1]The maximum exposure level is for short grass, which is the highest level estimated based on the Hoerger and Kenega nomograph as modified by Fletcher, 1994. For scenarios with single applications, the maximum level is the concentration immediately after the treatment. For scenarios with multiple applications, the maximum concentration is that which occurs immediately after the final application.
[2] The peak mean EECs are based on an average of the highest daily means across all food items (short grass, broadleaf, long grass and seeds) based on the mean residue levels for each food item (Fletcher, 1994). For further explanation, please see **Discussion of Methods Used to Estimate Exposure for Graphs** in this chapter.
[3] The number of days in parenthesis indicates the time the residues exceed the NOAEL.
All RQs greater than 1 exceed the chronic risk LOC.

Discussion of Methods Used to Estimate Exposure for Graphs

The "**maximum residue**" curve is based on the maximum daily residues estimated for short grass. The initial residue level is calculated by multiplying the application rate in lb ai/acre times 240 ppm based on Kenega/Fletcher nomograph. This residue level is recalculated each day assuming a dissipation rate based on a foliar halflife. Where crops might receive multiple treatments, each subsequent treatment is added to the residue level estimated to be remaining on short grass on the day of the subsequent treatment.

The "**mean of means**"curve is based on a daily average of the means across the four food item groups (short grass, broadleaf, long grass and seeds). The initial residue level for each food item group is estimated by multiplying the application rate in lb ai/acre times the following residues levels:

Short grass	Broadleaf	Long grass	Seeds
85 ppm	45 ppm	36 ppm	7 ppm

The following example table shows how the "Mean of means" column (J) was calculated. For each Day, the residue in each of the 4 "mean" columns (C, E, G and I) were added across and the sum divided by 4 to get the residue value in column J. The table below contains part of the residue values used in Figure 5. The use scenario was: 0.5 Lb ai/A, 2 treatments at a 14 day intervals assuming a 2.4-day halflife.

Example table showing columns of daily residue levels for food item groups and the "mean of means" column. This table used to show how the mean of means column was calculated, but it is also an actual table developed to construct one of the graphs for the dimethoate avian and mammalian sublethal and/or reproductive risk assessment.

A	B	C	D	E	F	G	H	I	J
Day	Maximum (short grass)	Mean (short grass)	Maximum (broad leaf)	Mean (broad leaf)	Maximum (long grass)	Mean (long grass)	Maximum (seeds)	Mean (seeds)	Mean of means
1	120.00	42.50	67.50	22.50	55.00	18.00	7.50	3.50	21.625
2	89.90	31.84	50.57	16.86	41.20	13.48	5.62	2.62	16.2
3	67.35	23.85	37.88	12.63	30.87	10.10	4.21	1.96	12.135
4	50.45	17.87	28.38	9.46	23.12	7.57	3.15	1.47	9.0925
5	37.80	13.39	21.26	7.09	17.32	5.67	2.36	1.10	6.8125
6	28.32	10.03	15.93	5.31	12.98	4.25	1.77	0.83	5.105
7	21.21	7.51	11.93	3.98	9.72	3.18	1.33	0.62	3.8225
8	15.89	5.63	8.94	2.98	7.28	2.38	0.99	0.46	2.8625
9	11.91	4.22	6.70	2.23	5.46	1.79	0.74	0.35	2.1475
10	8.92	3.16	5.02	1.67	4.09	1.34	0.56	0.26	1.6075
11	6.68	2.37	3.76	1.25	3.06	1.00	0.42	0.19	1.2025
12	5.01	1.77	2.82	0.94	2.29	0.75	0.31	0.15	0.9025
13	3.75	1.33	2.11	0.70	1.72	0.56	0.23	0.11	0.675
14	2.81	0.99	1.58	0.53	1.29	0.42	0.18	0.08	0.505
15	122.10	43.25	68.68	22.89	55.96	18.32	7.63	3.56	22.005
16	91.48	32.40	51.45	17.15	41.93	13.72	5.72	2.67	16.485
17	68.53	24.27	38.55	12.85	31.41	10.28	4.28	2.00	12.35
18	51.34	18.18	28.88	9.63	23.53	7.70	3.21	1.50	9.2525
19	38.46	13.62	21.63	7.21	17.63	5.77	2.40	1.12	6.93
20	28.81	10.20	16.21	5.40	13.21	4.32	1.80	0.84	5.19
21	21.59	7.64	12.14	4.05	9.89	3.24	1.35	0.63	3.89

Charts showing foliar residues compared to the avian and mammal sublethal and reproductive NOAELs.

The charts showing the residues on avian and mammalian food items are presented below. They show the maximum potential residues (short grass) and mean residues on food items for many dimethoate use scenarios. For each use pattern, one chart was constructed showing the residue curves assuming a foliar dissipation halflife of 2.4 days. Generally, these charts show that the initial maximum and mean residues exceed the avian and mammalian sublethal and reproductive toxicity NOAELs and that, except for use on Brussels sprouts, maximum and mean residues would not be expected to exceed the mammal or avian NOAELs for more than 29 days and 21 days respectively.

The duration of exceedance is shown, as well as the magnitude of exceedance, as both are indicative of the probability of the risk occurring. The longer the residues exceed the NOAELs, the greater the probability that mammals or birds will be exposed to hazardous levels, and the greater the probability that they might be exposed during a critical stage of development or reproduction.

See the discussion beside each chart below.

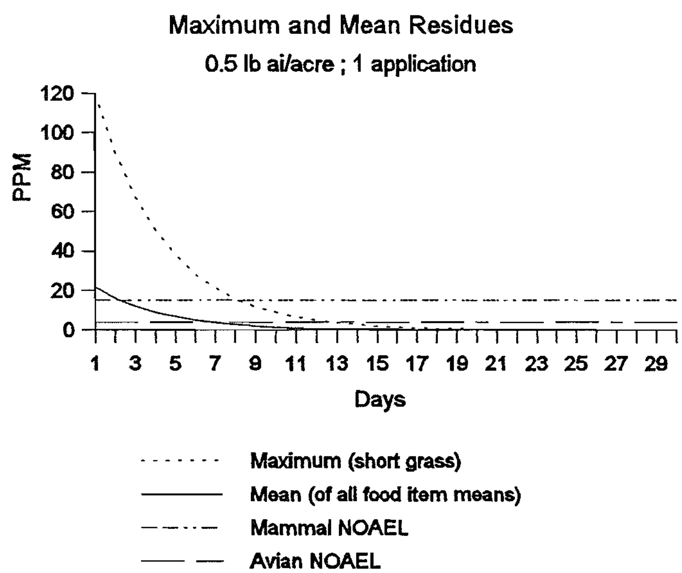


Chart showing decline of maximum and mean residues over time assuming a halflife of 2.4 days. The risk suggested by this would apply to any single application at 0.5 lb ai/acre. Some crops that are treated at up to 0.5 lb ai/acre include FIELD CROPS (Corn, Alfalfa, Soybeans, Cotton, Sorghum) and VEGETABLE CROPS (All registered vegetable uses with the exclusion of Brussels sprouts and peas). The LOC for chronic risk is exceeded. Maximum residues suggest high risk, however, mean residues might exceed the mammalian NOAEL for only a day or so, and the avian NOAEL for up to 8 days. A single application at 0.5 lb ai/acre does not suggest a high probability for sublethal or reproductive risk.

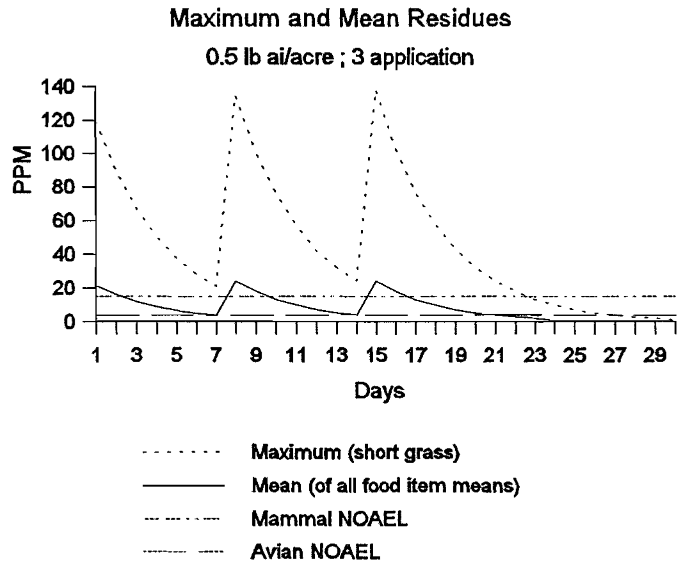


Chart showing decline of maximum and mean residues over time assuming a halflife of 2.4 days. The risk suggested by this would apply to most multiple applications at up to 0.5 lb ai/acre at 7 day intervals. Some crops that are treated with multiple applications at up to 0.5 lb ai/acre are FIELD CROPS (Wheat and Soybeans @ 2 applications; Corn and Sorghum @ 3 applications) ORCHARD CROPS (Apples, Pears, Tangelos, Pomelo, Kumquats @ 2 applications (7-day interval) VEGETABLE CROPS (Kale, Mustard Greens, Melons, Watermelon, Tomato, Bean, Lentil, Spinach, and Potato @ 2 applications) (Cabbage, Endive, Lettuce, Swiss Chard, Turnip @ 3 applications) (Collards @ 4 applications) (Broccoli, Cauliflower, Celery @ 6 applications). Treatments beyond the third application would not result in appreciably higher residues levels, but could extend the duration of exposure. The LOC for chronic risk is exceeded. Mean residues might exceed the avian NOAEL for about 7 days after each treatment, such that as long as applications of 0.5 lb ai/acre are repeated at 7-day intervals, the avian NOAEL is likely to be exceeded throughout the treatment season. The mammal NOAEL is only exceeded a couple of days after each treatment. However, each subsequent application provides another opportunity for mammals to be exposed at or above their NOAEL. The risk of sublethal or reproductive effects in mammals is moderate, however, the probability of risk to birds is high.

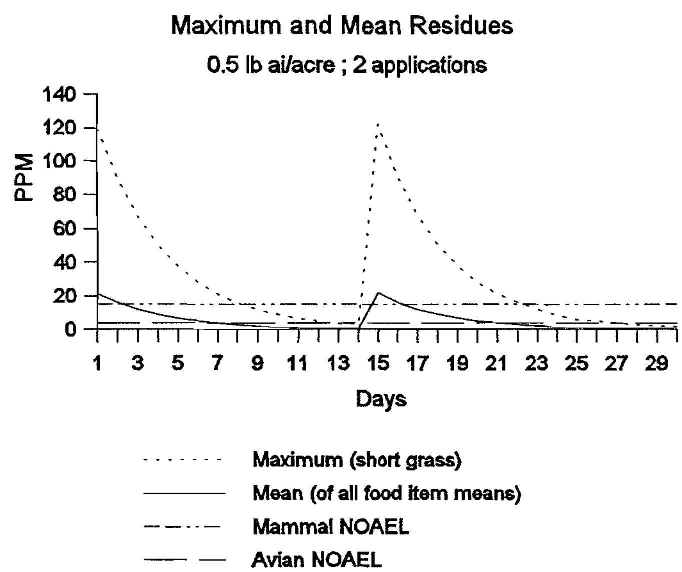


Chart showing decline of maximum and mean residues over time assuming a halflife of 2.4 days. The risk suggested by this would apply to COTTON, and some CITRUS use, which includes two applications at up to 0.5 lb ai/acre at a 14-day (15-day for citrus) interval. The LOC for chronic risk is exceeded. The probability of sublethal or reproductive risk to mammals is relatively low because the mean residues exceed the NOAEL for a short time. The avian NOAEL is exceeded for longer time periods, but the probability of risk is still moderate.

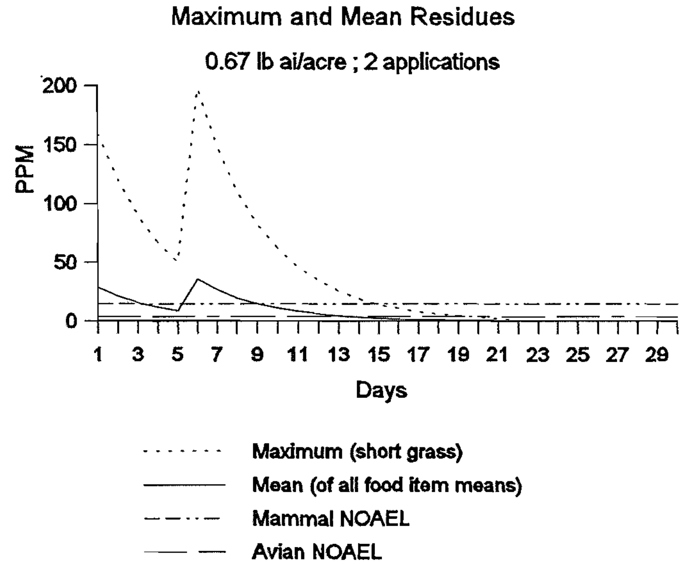


Chart showing the decline of maximum and mean residues over time assuming a halflife of 2.4 days relative to the mammal and avian NOAELs. The risk suggested by this would apply to WHEAT which is treated with two applications at up to 0.67 lb ai/acre at a 5-day interval. The LOC for chronic risk is exceeded. Maximum residues exceed both NOAELs for up to 2 weeks or more. The mean residues exceed the mammal NOAEL for only a few days after each treatment. Mean residues exceed the avian NOAEL for over 11 days suggesting high sublethal or reproductive risk to birds.

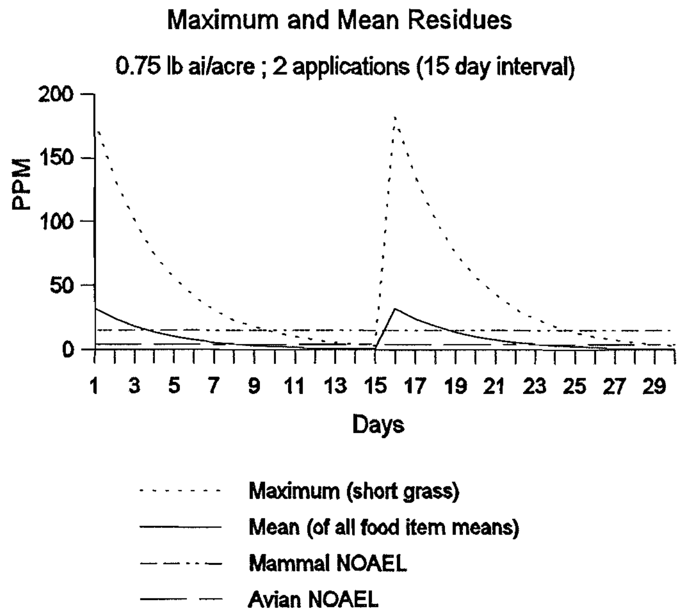


Chart showing residues calculated from one of three use scenarios representing CITRUS. Chart shows decline of maximum and mean residues over time assuming a halflife of 2.4 days. The risk suggested by this would apply to CITRUS CROPS (oranges, grapefruit, tangerines, lemons) treated with two applications at up to 0.75 lb ai/acre at a 15-day interval. The LOC for chronic risk is exceeded. Maximum residues exceed both NOAELs for several days (9 to 13 for mammals and birds respectively, after each application. Mean residues exceed the avian NOAEL for about 8 days after each treatment for a total of 16 days per season. Mean residues exceed the mammalian NOAEL for only a few days after each treatment. This exposure pattern suggest high sublethal or reproductive risk to birds, but only moderate risk to mammals.

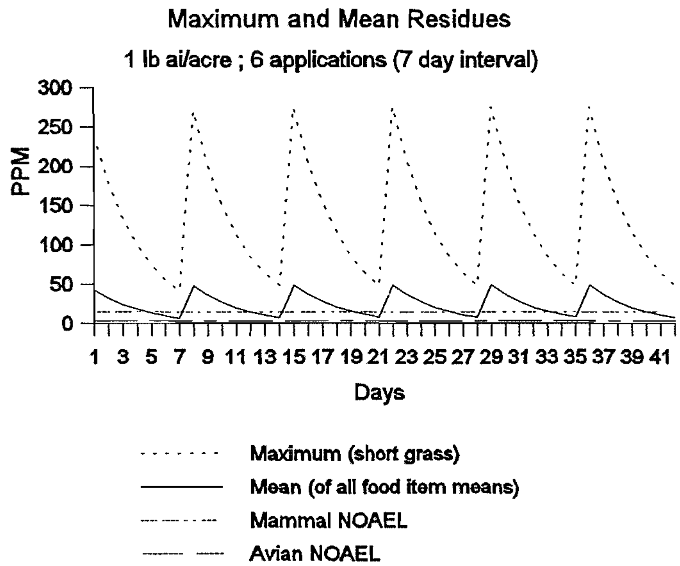


Chart showing decline of maximum and mean residues over time assuming a halflife of 2.4 days. The risk suggested by this would apply to BRUSSELS SPROUTS which, according to the current label may be treated with multiple applications at up to 1 lb ai/acre at 7-day intervals. The LOC for chronic risk is exceeded. The mean residues exceed the avian NOAEL throughout the application season, and the mammal NOAEL exceeded repeatedly for several days after each treatment. This suggests a very high probability of risk to terrestrial organisms. Brussels sprouts is grown on relatively few acres nationwide (~3,000).

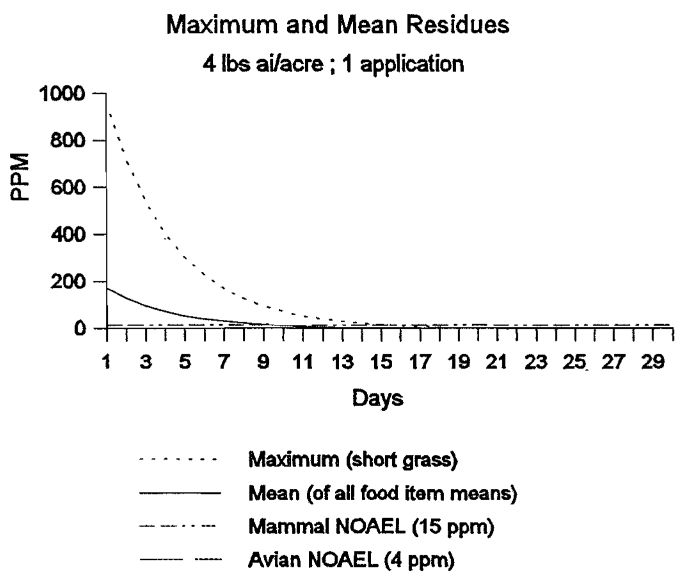
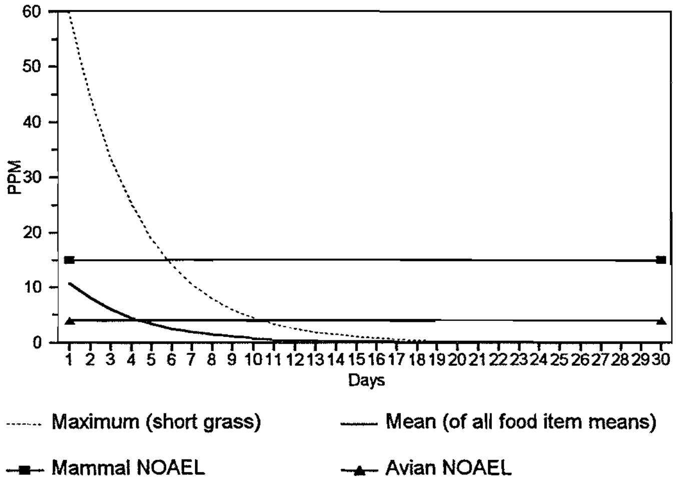


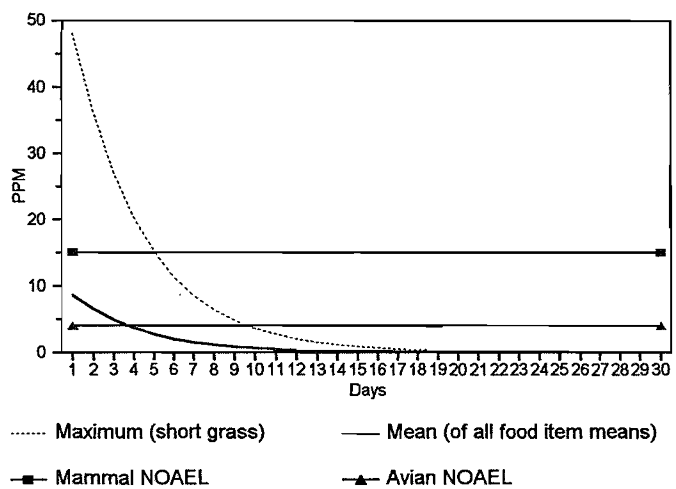
Chart showing decline of maximum and mean residues over time assuming a halflife of 2.4 days. The risk suggested would apply to one of the label uses for CITRUS CROPS (oranges, grapefruit, tangerines, lemons). According to the current label may be treated with a single application at up to 4 lbs ai/acre. The LOC for chronic risk is exceeded. Maximum and mean residues exceed both NOAELs initially by a substantial margin and remain above for~15 to ~8 days, respectively. This combination of initial high level of exceedance and duration of exceedance increases the likelihood of sublethal or reproductive risk to terrestrial animals.

Maximum and Mean Residues
0.25 lb ai/A; 1 appl; halflife 2.4 day

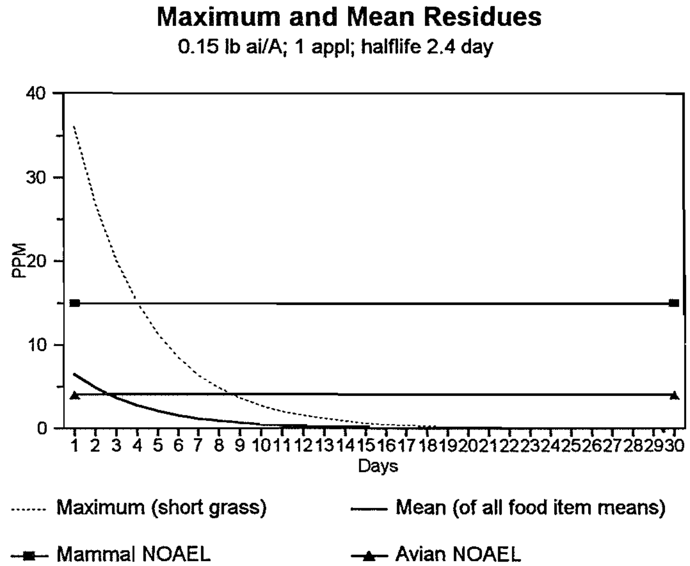


This chart represents the use of dimethoate on PEAs at 0.25 lb ai/acre as well as times when application to other crops is at a lower than maximum label rate (1 time at 0.25 lb ai/acre). The LOC for chronic risk is exceeded. Maximum residues exceed both NOAELs for several days. The mammal NOAEL is not exceeded by the mean residue levels, and the duration of exceedance for birds suggests a relatively low probability that sublethal reproductive risk will be extensive.

Maximum and Mean Residues
0.2 lb ai/A; 1 appl; halflife 2.4 days



This chart represents the use of dimethoate when application to other crops is at a lower than maximum label rate (1 time at 0.20 lb ai/acre). The LOC for chronic risk is exceeded. Maximum residues exceed both NOAELs for several days. The mammal NOAEL is not exceeded by the mean residue levels, and the duration of exceedance for birds suggests a relatively low probability that sublethal or reproductive risk will be extensive.



This chart represents the use of dimethoate when application to other crops is at a lower than maximum label rate (1 time at 0.15 lb ai/acre). The LOC for chronic risk is exceeded. The maximum residues exceed both NOAELs for several days. The mammal NOAEL is not exceeded by the mean residue levels, and the duration of exceedance for birds suggests a relatively low probability that sublethal or reproductive risk will be extensive.

Discussion of Sublethal and Reproductive Risk to Birds and Mammals

The use sites where most dimethoate is applied include citrus, cotton, alfalfa, wheat, apples, peas/beans, lettuce and field corn. The labels for these uses permit patterns of use (rate and number of treatments) which generally suggest moderate to high sublethal risk to birds, and possibly slightly less risk to mammals because the mammal NOAEL is higher (less sensitive) than the bird NOAEL. However, given the fact that the mammal NOAEL for blood and brain cholinesterase inhibition is 1 ppm, it is not clear that mammals are really less sensitive than birds to sublethal impacts of dimethoate. Therefore, the EFED concludes that dimethoate, when used at maximum label rates for most labels, is a moderate to high risk to birds and mammals.

The estimated residues on tree crops assume 100% of the applied settles on the terrestrial food items. Because of how tree crops such as citrus are treated, it is recognized that some of the product will actually reach the target tree, and less than 100% of the applied will settle on these food items. So the risk calculations for citrus may be higher than what might occur in the field.

iii. Insects

Currently, EFED does not assess risk to nontarget insects. Results of acceptable studies are used for recommending label precautions. Please see Section **6. Labeling Requirements**

B. Exposure and Risk to Nontarget Freshwater Aquatic Animals

EFED uses environmental fate and transport computer models to calculate refined EECs. As noted earlier, the Pesticide Root Zone Model (PRZM3) simulates pesticides in field runoff. The Exposure Analysis Modeling System (EXAMS II) simulates pesticide fate and transport in an aquatic environment (one hectare body of water, two meters deep), taking into account the following: (1) adsorption to soil or sediment (2) soil incorporation (3) degradation in soil before washoff to a water body and (4) degradation within the water body. The model also accounts for direct deposition of spray drift into the water body (assumed to be 1% and 5% of the application rate for ground and aerial applications, respectively). When multiple applications are permitted the interval between applications is included in the calculations. The environmental fate parameters used in the model for this pesticide are listed in the following table.

Environmental Fate Parameter		Input Parameters
Molecular weight (amu)		229.25
Water solubility (mg/l @ 21°C)		32000
Henry's Law coefficient (atm-m^3/mol)		8.0E-11
Partition coefficient (K_{oc})		13.2
Vapor pressure (mmHg)		8.5E-06
hydrolysis half-life at	pH5	156 days
	pH7	68 days
	pH9	4.4 days
Aerobic soil half-life		9 days
Aerobic aquatic half-life		18 days

The EECs generated by the PRZM3/EXAMS II model are used for assessing acute and chronic risks to aquatic organisms. Acute risk assessments are performed using peak EEC values for single and multiple applications. Chronic risk assessments are performed using the 21-day average EEC for invertebrates and the 56-day average EEC for fish. Because of the wide variety of crops and the high variability in recommended application rates, the following use scenarios were modeled for determination of aquatic EECS: Citrus crops grown in Osceola County, Florida; cotton grown in Jefferson County, Mississippi; corn grown in Ashland County, Ohio; and Brussels sprouts grown in San Mateo county, California. It is recognized that numerous applications have been excluded, however it is felt that the majority of uses and rates are covered by these models. EECs generated by these models are presented in the following table.

Estimated Environmental Concentrations (EECs) For Aquatic Exposure

Site	Application Method	Application Rate (lbs ai/A)	# of Apps./ Interval Between Apps.	Initial (PEAK) EEC (ppb)	21-day average EEC (ppb)	60-day average EEC (ppb)
PRZM3/EXAMS II						
Citrus	aerial/ground application of liquid formulation	0.5	6 / 7	9.6	1.9	0.8
Citrus	aerial/ground application of liquid formulation	4.0	1 / 0	58.3	9.6	3.4
Cotton	aerial/ground application of liquid formulation	0.5	2 / 14	24.4	5.4	2.0
Corn	aerial/ground application of liquid formulation	0.5	3 / 7	6.4	1.7	0.6
Brussels sprouts	aerial/ground application of liquid formulation	1.0	6 / 7	19.0	5.1	3.0

i. Freshwater Fish

Acute and Chronic risk quotients for freshwater fish are tabulated below.

Risk Quotients following **multiple** applications of dimethoate for freshwater fish based on a Bluegill sunfish LC50 of 6.0 ppm and a Rainbow trout MATC of 0.6 ppm.

Crop Application Rate No. and Interval	LC50 (ppm)	MATC (ppm)	EEC Initial/Peak (ppm)	EEC 60-Day Ave. (ppm)	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/MATC)
Citrus 0.5 lbs ai/acre 2 / 15	6.0	0.6	0.0096	0.0008	< 0.01	<0.01
Citrus 4.0 lbs ai/ acre 1 / 0	6.0	0.6	0.0583	0.0034	<0.01	<0.01
Cotton 0.5 lbs ai/acre 2 / 4	6.0	0.6	0.0244	0.002	<0.01	<0.01
Corn 0.5 lbs ai/acre 3 / 7	6.0	0.6	0.0064	0.0006	<0.01	<0.01
Brussels sprouts 1.0 lbs ai/acre 6 / 7	6.0	0.6	0.019	0.003	<0.01	<0.01

*** exceeds acute high, acute restricted and acute endangered species LOCs.
** exceeds acute restricted and acute endangered species LOCs.
* exceeds the endangered species LOC
@ exceeds the Chronic LOC

The results indicate that aquatic acute high risk, restricted use, endangered species or chronic levels of concern are not exceeded for freshwater fish at any of the application scenarios modeled using PRZM3/EXAMS II.

ii. Freshwater Invertebrates

The acute and chronic risk quotients for freshwater invertebrates are tabulated below.

Risk Quotients following **multiple** applications of dimethoate for freshwater invertebrates based on a stonefly LC_{50} of 0.043 ppm and a *D. magna* MATC of 0.06 ppm.

Crop Application Rate No. and Interval	LC50 (ppm)	MATC (ppb)	EEC Initial/Peak (ppm)	EEC 21-Day Ave. (ppm)	Acute RQ (EEC/LC_{50})	chronic RQ (EEC/MATC)
Citrus 0.5 lbs ai/acre 2 / 15	0.043	0.06	0.0096	0.0019	0.22**	0.03
Citrus 4.0 lbs ai/ acre 1 / 0	0.043	0.06	0.0583	0.0096	1.36***	0.160
Cotton 0.5 lbs ai/acre 2 / 14	0.043	0.06	0.0244	0.0054	0.57***	0.090
Corn 0.5 lbs ai/acre 3 / 7	0.043	0.06	0.0064	0.0017	0.15**	0.03
Brussels sprouts 1.0 lbs ai/acre 6 / 7	0.043	0.06	0.019	0.0051	0.44**	0.09

*** exceeds acute high, acute restricted and acute endangered species LOCs.
** exceeds acute restricted and acute endangered species LOCs.
* exceeds the endangered species LOC
@ exceeds the chronic LOC

The results of this analysis indicate the acute high risk LOC is exceeded in citrus when treated one time at 4.0 lbs ai/acre and cotton. Risk quotients for other orchard crops (i.e., apples, cherries, pears and grapes) which are treated at 2.0 lbs ai/acre are not displayed in the table. However, the risk quotient would be approximately one-half of that calculated for the highest citrus use so use on these crops may also represent an acute risk. Restricted use is indicated for all other modeled scenarios where 0.5 lbs ai/acre is used at seven day application intervals and in Brussels sprouts. The chronic level of concern is not exceeded in any modeled scenario.

iii. Estuarine and Marine Fish

Acute and chronic risk quotients for estuarine/marine fish are tabulated below.

Acute Risk Quotients following multiple applications of dimethoate for estuarine/marine fish based on a sheepshead minnow LC_{50} of > 111 ppm. chronic risk quotients could not be calculated because of the lack of chronic toxicity information.

Crop Application Rate No. and Interval	LC50 (ppm)	MATC (ppm)	EEC Initial/Peak (ppm)	EEC 60-Day Ave. (ppm)	Acute RQ (EEC/LC_{50})	chronic RQ (EEC/MATC)
Citrus 0.5 lbs ai/acre 2 / 15	> 111	-	0.0096	0.0008	< 0.01	-
Citrus 4.0 lbs ai/ acre 1 / 0	> 111	-	0.0583	0.0034	< 0.01	-
Cotton 0.5 lbs ai/acre 2 / 4	> 111	-	0.0244	0.002	< 0.01	-
Corn 0.5 lbs ai/acre 3 / 7	> 111	-	0.0064	0.0006	< 0.01	-
Brussels sprouts 1.0 lbs ai/acre 6 / 7	> 111	-	0.019	0.003	< 0.01	-

*** exceeds acute high, acute restricted and acute endangered species LOCs.
** exceeds acute restricted and acute endangered species LOCs.
* exceeds the endangered species LOC
@ exceeds the chronic LOC

The results indicate that aquatic acute high risk, restricted use, and endangered species levels of concern are not exceeded for estuarine/marine fish at any of the application scenarios modeled using PRZM3/EXAMS II. Chronic risk could not be determined as no chronic studies are required for estuarine/marine species.

iv. Estuarine and Marine Invertebrates

Acute and chronic risk quotients for estuarine and marine invertebrates are listed below.

Acute Risk Quotients following multiple applications of dimethoate for estuarine/marine invertebrates based on a mysid LC_{50} of 15 ppm. chronic risk quotients could not be calculated because of the lack of chronic toxicity information.

Crop Application Rate No. and Interval	LC50 (ppm)	MATC (ppm)	EEC Initial/Peak (ppm)	EEC 21-Day Ave. (ppm)	Acute RQ (EEC/LC_{50})	chronic RQ (EEC/MATC)
Citrus 0.5 lbs ai/acre 2 / 15	15	-	0.0096	0.0019	<0.01	-
Citrus 4.0 lbs ai/ acre 1 / 0	15	-	0.0583	0.0096	<0.01	-
Cotton 0.5 lbs ai/acre 2 / 4	15	-	0.0224	0.0054	<0.01	-
Corn 0.5 lbs ai/acre 3 / 7	15	-	0.0064	0.0017	<0.01	-
Brussels sprouts	15	-	0.019	0.0051	<0.01	

*** exceeds acute high, acute restricted and acute endangered species LOCs.
** exceeds acute restricted and acute endangered species LOCs.
* exceeds the endangered species LOC
@ exceeds the chronic LOC

The results indicate that no aquatic acute levels of concern are exceeded for estuarine/marine invertebrates at any registered application rate. Chronic risks were not determined as no chronic studies were available.

Results of acute toxicity testing indicate there are more sensitive species than the brown shrimp (see table in Section C.1). The saltmarsh mosquito, at one time a target species, is nearly 500 times more sensitive than the next most sensitive species, the brown shrimp. The saltmarsh mosquito is not a normally accepted test organism. However, this data does suggest other aquatic organisms may be more sensitive than the brown shrimp.

5. Endangered Species

Endangered species acute LOCs are exceeded for both birds and mammals in many of the modeled agricultural systems. The main exceptions are in birds which eat seeds and large insects and granivorous mammals. No endangered species LOCs are exceeded for freshwater fish, however all modeled applications exceed LOCs for endangered aquatic invertebrates.

When the Endangered Species Protection Program becomes final, limitations in the use of Dimethoate will be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. EPA anticipates that a consultation with the Fish and Wildlife Service will be conducted in accordance with the species-based priority approach described in the Program. After completion of consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.

6. Labeling Requirements

A. Manufacturing-Use Products

This pesticide is extremely toxic to birds, mammals and aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or public waters unless this product is specifically identified and addressed in an NPDES permit. do not discharge effluent containing this product to sewer systems without previously notifying the sewage treatment plant authority. For guidance, contact your State Water Board or Regional Office of the EPA.

B. End-use Products

This pesticide is extremely toxic to birds, mammals and aquatic invertebrates. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high-water mark. Drift and runoff may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water when disposing of equipment washwater or rinsate.

This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply the product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.

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EFED Appendix Tables of daily residue values for each of the scenarios that were modeled. These tables formed the basis for both acute and sublethal/reproductive risk assessment for birds and mammals.

Table 1
0.5 lb ai/acre, 1 application per season represents FIELD CROPS, VEGETABLE CROPS with single applications

Scenario 1 (2.4 day halflife)

Day	Maximum (short grass)	Mean (short grass)	Maximum (broad leaf)	Mean (broad leaf)	Maximum (long grass)	Mean (long grass)	Maximum (seeds)	Mean (seeds)	Mean of means
1	120.00	42.50	67.50	22.50	55.00	18.00	7.50	3.50	21.625
2	89.90	31.84	50.57	16.86	41.20	13.48	5.62	2.62	16.2
3	67.35	23.85	37.88	12.63	30.87	10.10	4.21	1.96	12.135
4	50.45	17.87	28.38	9.46	23.12	7.57	3.15	1.47	9.0925
5	37.80	13.39	21.26	7.09	17.32	5.67	2.36	1.10	6.8125
6	28.32	10.03	15.93	5.31	12.98	4.25	1.77	0.83	5.105
7	21.21	7.51	11.93	3.98	9.72	3.18	1.33	0.62	3.8225
8	15.89	5.63	8.94	2.98	7.28	2.38	0.99	0.46	2.8625
9	11.91	4.22	6.70	2.23	5.46	1.79	0.74	0.35	2.1475
10	8.92	3.16	5.02	1.67	4.09	1.34	0.56	0.26	1.6075
11	6.68	2.37	3.76	1.25	3.06	1.00	0.42	0.19	1.2025
12	5.01	1.77	2.82	0.94	2.29	0.75	0.31	0.15	0.9025
13	3.75	1.33	2.11	0.70	1.72	0.56	0.23	0.11	0.675
14	2.81	0.99	1.58	0.53	1.29	0.42	0.18	0.08	0.505
15	2.10	0.75	1.18	0.39	0.96	0.32	0.13	0.06	0.38
16	1.58	0.56	0.89	0.30	0.72	0.24	0.10	0.05	0.2875
17	1.18	0.42	0.66	0.22	0.54	0.18	0.07	0.03	0.2125
18	0.88	0.31	0.50	0.17	0.41	0.13	0.06	0.03	0.16
19	0.66	0.23	0.37	0.12	0.30	0.10	0.04	0.02	0.1175
20	0.50	0.18	0.28	0.09	0.23	0.07	0.03	0.01	0.0875
21	0.37	0.13	0.21	0.07	0.17	0.06	0.02	0.01	0.0675
22	0.28	0.10	0.16	0.05	0.13	0.04	0.02	0.01	0.05
23	0.21	0.07	0.12	0.04	0.10	0.03	0.01	0.01	0.0375
24	0.16	0.06	0.09	0.03	0.07	0.02	0.01	0.00	0.0275
25	0.12	0.04	0.07	0.02	0.05	0.02	0.01	0.00	0.02
26	0.09	0.03	0.05	0.02	0.04	0.01	0.01	0.00	0.015
27	0.07	0.02	0.04	0.01	0.03	0.01	0.00	0.00	0.01
28	0.05	0.02	0.03	0.01	0.02	0.01	0.00	0.00	0.01
29	0.04	0.01	0.02	0.01	0.02	0.01	0.00	0.00	0.0075
30	0.03	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.005

Table 2

0.5 lb ai/acre, 3 applications per season, 7-day treatment interval
represents FIELD CROPS, ORCHARD CROPS, VEGETABLE CROPS with multiple (3 or more) applications

Scenario 2 (2.4 day halflife)

Day	Maximum (short grass)	Mean (short grass)	Maximum (broad leaf)	Mean (broad leaf)	Maximum (long grass)	Mean (long grass)	Maximum (seeds)	Mean (seeds)	Mean of means
1	120.00	42.50	67.50	22.50	55.00	18.00	7.50	3.50	21.625
2	89.90	31.84	50.57	16.86	41.20	13.48	5.62	2.62	16.2
3	67.35	23.85	37.88	12.63	30.87	10.10	4.21	1.96	12.135
4	50.45	17.87	28.38	9.46	23.12	7.57	3.15	1.47	9.0925
5	37.80	13.39	21.26	7.09	17.32	5.67	2.36	1.10	6.8125
6	28.32	10.03	15.93	5.31	12.98	4.25	1.77	0.83	5.105
7	21.21	7.51	11.93	3.98	9.72	3.18	1.33	0.62	3.8225
8	135.89	48.13	76.44	25.48	62.28	20.38	8.49	3.96	24.4875
9	101.80	36.06	57.26	19.09	46.66	15.27	6.36	2.97	18.3475
10	76.27	27.01	42.90	14.30	34.96	11.44	4.77	2.22	13.7425
11	57.14	20.24	32.14	10.71	26.19	8.57	3.57	1.67	10.2975
12	42.80	15.16	24.08	8.03	19.62	6.42	2.68	1.25	7.715
13	32.07	11.36	18.04	6.01	14.70	4.81	2.00	0.94	5.78
14	24.02	8.51	13.51	4.50	11.01	3.60	1.50	0.70	4.3275
15	138.00	48.87	77.62	25.87	63.25	20.70	8.62	4.02	24.865
16	103.38	36.61	58.15	19.38	47.38	15.51	6.46	3.02	18.63
17	77.45	27.43	43.56	14.52	35.50	11.62	4.84	2.26	13.9575
18	58.02	20.55	32.64	10.88	26.59	8.70	3.63	1.69	10.455
19	43.47	15.39	24.45	8.15	19.92	6.52	2.72	1.27	7.8325
20	32.56	11.53	18.32	6.11	14.92	4.88	2.04	0.95	5.8675
21	24.39	8.64	13.72	4.57	11.18	3.66	1.52	0.71	4.395
22	18.28	6.47	10.28	3.43	8.38	2.74	1.14	0.53	3.2925
23	13.69	4.85	7.70	2.57	6.28	2.05	0.86	0.40	2.4675
24	10.26	3.63	5.77	1.92	4.70	1.54	0.64	0.30	1.8475
25	7.68	2.72	4.32	1.44	3.52	1.15	0.48	0.22	1.3825
26	5.76	2.04	3.24	1.08	2.64	0.86	0.36	0.17	1.0375
27	4.31	1.53	2.43	0.81	1.98	0.65	0.27	0.13	0.78
28	3.23	1.14	1.82	0.61	1.48	0.48	0.20	0.09	0.58
29	2.42	0.86	1.36	0.45	1.11	0.36	0.15	0.07	0.435
30	1.81	0.64	1.02	0.34	0.83	0.27	0.11	0.05	0.325

Table 3

0.5 lb ai/acre, 2 applications per season, 14-day treatment interval represents COTTON and one of three scenarios for CITRUS

Scenario 3 (2.4 day halflife)

Day	Maximum (short grass)	Mean (short grass)	Maximum (broad leaf)	Mean (broad leaf)	Maximum (long grass)	Mean (long grass)	Maximum (seeds)	Mean (seeds)	Mean of means
1	120.00	42.50	67.50	22.50	55.00	18.00	7.50	3.50	21.625
2	89.90	31.84	50.57	16.86	41.20	13.48	5.62	2.62	16.2
3	67.35	23.85	37.88	12.63	30.87	10.10	4.21	1.96	12.135
4	50.45	17.87	28.38	9.46	23.12	7.57	3.15	1.47	9.0925
5	37.80	13.39	21.26	7.09	17.32	5.67	2.36	1.10	6.8125
6	28.32	10.03	15.93	5.31	12.98	4.25	1.77	0.83	5.105
7	21.21	7.51	11.93	3.98	9.72	3.18	1.33	0.62	3.8225
8	15.89	5.63	8.94	2.98	7.28	2.38	0.99	0.46	2.8625
9	11.91	4.22	6.70	2.23	5.46	1.79	0.74	0.35	2.1475
10	8.92	3.16	5.02	1.67	4.09	1.34	0.56	0.26	1.6075
11	6.68	2.37	3.76	1.25	3.06	1.00	0.42	0.19	1.2025
12	5.01	1.77	2.82	0.94	2.29	0.75	0.31	0.15	0.9025
13	3.75	1.33	2.11	0.70	1.72	0.56	0.23	0.11	0.675
14	2.81	0.99	1.58	0.53	1.29	0.42	0.18	0.08	0.505
15	122.10	43.25	68.68	22.89	55.96	18.32	7.63	3.56	22.005
16	91.48	32.40	51.45	17.15	41.93	13.72	5.72	2.67	16.485
17	68.53	24.27	38.55	12.85	31.41	10.28	4.28	2.00	12.35
18	51.34	18.18	28.88	9.63	23.53	7.70	3.21	1.50	9.2525
19	38.46	13.62	21.63	7.21	17.63	5.77	2.40	1.12	6.93
20	28.81	10.20	16.21	5.40	13.21	4.32	1.80	0.84	5.19
21	21.59	7.64	12.14	4.05	9.89	3.24	1.35	0.63	3.89
22	16.17	5.73	9.10	3.03	7.41	2.43	1.01	0.47	2.915
23	12.11	4.29	6.81	2.27	5.55	1.82	0.76	0.35	2.1825
24	9.08	3.21	5.10	1.70	4.16	1.36	0.57	0.26	1.6325
25	6.80	2.41	3.82	1.27	3.12	1.02	0.42	0.20	1.225
26	5.09	1.80	2.87	0.96	2.33	0.76	0.32	0.15	0.9175
27	3.82	1.35	2.15	0.72	1.75	0.57	0.24	0.11	0.6875
28	2.86	1.01	1.61	0.54	1.31	0.43	0.18	0.08	0.515
29	2.14	0.76	1.20	0.40	0.98	0.32	0.13	0.06	0.385
30	1.60	0.57	0.90	0.30	0.74	0.24	0.10	0.05	0.29

Table 4
0.67 lb ai/acre, 2 applications per season, 5-day treatment interval represents WHEAT
Scenario 4 (2.4 day halflife)

Day	Maximum (short grass)	Mean (short grass)	Maximum (broad leaf)	Mean (broad leaf)	Maximum (long grass)	Mean (long grass)	Maximum (seeds)	Mean (seeds)	Mean of means
1	160.80	56.95	90.45	30.15	73.70	24.12	10.05	4.69	28.9775
2	120.46	42.66	67.76	22.59	55.21	18.07	7.53	3.51	21.7075
3	90.25	31.96	50.76	16.92	41.36	13.54	5.64	2.63	16.2625
4	67.61	23.94	38.03	12.68	30.99	10.14	4.23	1.97	12.1825
5	50.65	17.94	28.49	9.50	23.21	7.60	3.17	1.48	9.13
6	198.74	70.39	111.79	37.26	91.09	29.81	12.42	5.80	35.815
7	148.89	52.73	83.75	27.92	68.24	22.33	9.31	4.34	26.83
8	111.54	39.50	62.74	20.91	51.12	16.73	6.97	3.25	20.0975
9	83.56	29.59	47.00	15.67	38.30	12.53	5.22	2.44	15.0575
10	62.60	22.17	35.21	11.74	28.69	9.39	3.91	1.83	11.2825
11	46.90	16.61	26.38	8.79	21.49	7.03	2.93	1.37	8.45
12	35.13	12.44	19.76	6.59	16.10	5.27	2.20	1.02	6.33
13	26.32	9.32	14.81	4.94	12.06	3.95	1.65	0.77	4.745
14	19.72	6.98	11.09	3.70	9.04	2.96	1.23	0.58	3.555
15	14.77	5.23	8.31	2.77	6.77	2.22	0.92	0.43	2.6625
16	11.07	3.92	6.22	2.07	5.07	1.66	0.69	0.32	1.9925
17	8.29	2.94	4.66	1.55	3.80	1.24	0.52	0.24	1.4925
18	6.21	2.20	3.49	1.16	2.85	0.93	0.39	0.18	1.1175
19	4.65	1.65	2.62	0.87	2.13	0.70	0.29	0.14	0.84
20	3.49	1.23	1.96	0.65	1.60	0.52	0.22	0.10	0.625
21	2.61	0.92	1.47	0.49	1.20	0.39	0.16	0.08	0.47
22	1.96	0.69	1.10	0.37	0.90	0.29	0.12	0.06	0.3525
23	1.47	0.52	0.82	0.27	0.67	0.22	0.09	0.04	0.2625
24	1.10	0.39	0.62	0.21	0.50	0.16	0.07	0.03	0.1975
25	0.82	0.29	0.46	0.15	0.38	0.12	0.05	0.02	0.145
26	0.62	0.22	0.35	0.12	0.28	0.09	0.04	0.02	0.1125
27	0.46	0.16	0.26	0.09	0.21	0.07	0.03	0.01	0.0825
28	0.35	0.12	0.19	0.06	0.16	0.05	0.02	0.01	0.06
29	0.26	0.09	0.15	0.05	0.12	0.04	0.02	0.01	0.0475
30	0.19	0.07	0.11	0.04	0.09	0.03	0.01	0.01	0.0375

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Table 5

0.75 lb ai/acre, 2 applications per season, 15-day treatment interval represents one of three application scenarios for CITRUS CROPS

Scenario 5 (2.4 day halflife)

Day	Maximum (short grass)	Mean (short grass)	Maximum (broad leaf)	Mean (broad leaf)	Maximum (long grass)	Mean (long grass)	Maximum (seeds)	Mean (seeds)	Mean of means
1	180.00	63.75	101.25	33.75	82.50	27.00	11.25	5.25	32.4375
2	134.85	47.76	75.85	25.28	61.81	20.23	8.43	3.93	24.3
3	101.02	35.78	56.82	18.94	46.30	15.15	6.31	2.95	18.205
4	75.68	26.80	42.57	14.19	34.69	11.35	4.73	2.21	13.6375
5	56.70	20.08	31.89	10.63	25.99	8.50	3.54	1.65	10.215
6	42.47	15.04	23.89	7.96	19.47	6.37	2.65	1.24	7.6525
7	31.82	11.27	17.90	5.97	14.58	4.77	1.99	0.93	5.735
8	23.84	8.44	13.41	4.47	10.93	3.58	1.49	0.70	4.2975
9	17.86	6.32	10.05	3.35	8.19	2.68	1.12	0.52	3.2175
10	13.38	4.74	7.53	2.51	6.13	2.01	0.84	0.39	2.4125
11	10.02	3.55	5.64	1.88	4.59	1.50	0.63	0.29	1.805
12	7.51	2.66	4.22	1.41	3.44	1.13	0.47	0.22	1.355
13	5.62	1.99	3.16	1.05	2.58	0.84	0.35	0.16	1.01
14	4.21	1.49	2.37	0.79	1.93	0.63	0.26	0.12	0.7575
15	3.16	1.12	1.78	0.59	1.45	0.47	0.20	0.09	0.5675
16	182.37	64.59	102.58	34.19	83.58	27.35	11.40	5.32	32.8625
17	136.62	48.39	76.85	25.62	62.62	20.49	8.54	3.98	24.62
18	102.35	36.25	57.57	19.19	46.91	15.35	6.40	2.99	18.445
19	76.68	27.16	43.13	14.38	35.14	11.50	4.79	2.24	13.82
20	57.44	20.34	32.31	10.77	26.33	8.62	3.59	1.68	10.3525
21	43.03	15.24	24.21	8.07	19.72	6.45	2.69	1.26	7.755
22	32.24	11.42	18.13	6.04	14.78	4.84	2.01	0.94	5.81
23	24.15	8.55	13.59	4.53	11.07	3.62	1.51	0.70	4.35
24	18.09	6.41	10.18	3.39	8.29	2.71	1.13	0.53	3.26
25	13.55	4.80	7.62	2.54	6.21	2.03	0.85	0.40	2.4425
26	10.15	3.60	5.71	1.90	4.65	1.52	0.63	0.30	1.83
27	7.61	2.69	4.28	1.43	3.49	1.14	0.48	0.22	1.37
28	5.70	2.02	3.21	1.07	2.61	0.85	0.36	0.17	1.0275
29	4.27	1.51	2.40	0.80	1.96	0.64	0.27	0.12	0.7675
30	3.20	1.13	1.80	0.60	1.47	0.48	0.20	0.09	0.575

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Table 6
1 lb ai/acre, 6 applications per season, 7-day treatment interval represents BRUSSELS SPROUTS
Scenario 6 (2.4 day halflife)

Day	Maximum (short grass)	Mean (short grass)	Maximum (broad leaf)	Mean (broad leaf)	Maximum (long grass)	Mean (long grass)	Maximum (seeds)	Mean (seeds)	Mean of means
1	240.00	85.00	135.00	45.00	110.00	36.00	15.00	7.00	43.25
2	179.80	63.68	101.14	33.71	82.41	26.97	11.24	5.24	32.4
3	134.70	47.70	75.77	25.26	61.74	20.20	8.42	3.93	24.2725
4	100.91	35.74	56.76	18.92	46.25	15.14	6.31	2.94	18.185
5	75.60	26.77	42.52	14.17	34.65	11.34	4.72	2.20	13.62
6	56.63	20.06	31.86	10.62	25.96	8.49	3.54	1.65	10.205
7	42.43	15.03	23.86	7.95	19.45	6.36	2.65	1.24	7.645
8	271.78	96.26	152.88	50.96	124.57	40.77	16.99	7.93	48.98
9	203.61	72.11	114.53	38.18	93.32	30.54	12.73	5.94	36.6925
10	152.53	54.02	85.80	28.60	69.91	22.88	9.53	4.45	27.4875
11	114.27	40.47	64.28	21.43	52.37	17.14	7.14	3.33	20.5925
12	85.61	30.32	48.15	16.05	39.24	12.84	5.35	2.50	15.4275
13	64.13	22.71	36.07	12.02	29.39	9.62	4.01	1.87	11.555
14	48.05	17.02	27.03	9.01	22.02	7.21	3.00	1.40	8.66
15	275.99	97.75	155.25	51.75	126.50	41.40	17.25	8.05	49.7375
16	206.76	73.23	116.30	38.77	94.77	31.01	12.92	6.03	37.26
17	154.90	54.86	87.13	29.04	70.99	23.23	9.68	4.52	27.9125
18	116.04	41.10	65.27	21.76	53.19	17.41	7.25	3.38	20.9125
19	86.93	30.79	48.90	16.30	39.84	13.04	5.43	2.54	15.6675
20	65.13	23.07	36.63	12.21	29.85	9.77	4.07	1.90	11.7375
21	48.79	17.28	27.44	9.15	22.36	7.32	3.05	1.42	8.7925
22	276.55	97.94	155.56	51.85	126.75	41.48	17.28	8.07	49.835
23	207.18	73.38	116.54	38.85	94.96	31.08	12.95	6.04	37.3375
24	155.21	54.97	87.30	29.10	71.14	23.28	9.70	4.53	27.97
25	116.28	41.18	65.40	21.80	53.29	17.44	7.27	3.39	20.9525
26	87.11	30.85	49.00	16.33	39.92	13.07	5.44	2.54	15.6975
27	65.26	23.11	36.71	12.24	29.91	9.79	4.08	1.90	11.76
28	48.89	17.31	27.50	9.17	22.41	7.33	3.06	1.43	8.81
29	276.62	97.97	155.60	51.87	126.79	41.49	17.29	8.07	49.85
30	207.23	73.40	116.57	38.86	94.98	31.09	12.95	6.04	37.3475
31	155.25	54.98	87.33	29.11	71.16	23.29	9.70	4.53	27.9775
32	116.31	41.19	65.42	21.81	53.31	17.45	7.27	3.39	20.96
33	87.13	30.86	49.01	16.34	39.94	13.07	5.45	2.54	15.7025
34	65.27	23.12	36.72	12.24	29.92	9.79	4.08	1.90	11.7625
35	48.90	17.32	27.51	9.17	22.41	7.34	3.06	1.43	8.815
36	276.63	97.97	155.61	51.87	126.79	41.50	17.29	8.07	49.8525
37	207.24	73.40	116.57	38.86	94.99	31.09	12.95	6.04	37.3475
38	155.26	54.99	87.33	29.11	71.16	23.29	9.70	4.53	27.98
39	116.31	41.19	65.42	21.81	53.31	17.45	7.27	3.39	20.96
40	87.13	30.86	49.01	16.34	39.94	13.07	5.45	2.54	15.7025
41	65.28	23.12	36.72	12.24	29.92	9.79	4.08	1.90	11.7625
42	48.90	17.32	27.51	9.17	22.41	7.34	3.06	1.43	8.815

Table 7

4 lb ai/acre, 1 applications per season represents one of three application scenarios for CITRUS

Scenario 7 (2.4 day halflife)

Day	Maximum (short grass)	Mean (short grass)	Maximum (broad leaf)	Mean (broad leaf)	Maximum (long grass)	Mean (long grass)	Maximum (seeds)	Mean (seeds)	Mean of means
1	960.00	340.00	540.00	180.00	440.00	144.00	60.00	28.00	173
2	719.19	254.71	404.54	134.85	329.63	107.88	44.95	20.98	129.605
3	538.78	190.82	303.06	101.02	246.94	80.82	33.67	15.71	97.0925
4	403.63	142.95	227.04	75.68	185.00	60.54	25.23	11.77	72.735
5	302.38	107.09	170.09	56.70	138.59	45.36	18.90	8.82	54.4925
6	226.53	80.23	127.42	42.47	103.83	33.98	14.16	6.61	40.8225
7	169.71	60.10	95.46	31.82	77.78	25.46	10.61	4.95	30.5825
8	127.14	45.03	71.51	23.84	58.27	19.07	7.95	3.71	22.9125
9	95.24	33.73	53.57	17.86	43.65	14.29	5.95	2.78	17.165
10	71.35	25.27	40.14	13.38	32.70	10.70	4.46	2.08	12.8575
11	53.45	18.93	30.07	10.02	24.50	8.02	3.34	1.56	9.6325
12	40.05	14.18	22.53	7.51	18.35	6.01	2.50	1.17	7.2175
13	30.00	10.62	16.87	5.62	13.75	4.50	1.87	0.87	5.4025
14	22.47	7.96	12.64	4.21	10.30	3.37	1.40	0.66	4.05
15	16.84	5.96	9.47	3.16	7.72	2.53	1.05	0.49	3.035
16	12.61	4.47	7.10	2.37	5.78	1.89	0.79	0.37	2.275
17	9.45	3.35	5.32	1.77	4.33	1.42	0.59	0.28	1.705
18	7.08	2.51	3.98	1.33	3.24	1.06	0.44	0.21	1.2775
19	5.30	1.88	2.98	0.99	2.43	0.80	0.33	0.15	0.955
20	3.97	1.41	2.23	0.74	1.82	0.60	0.25	0.12	0.7175
21	2.98	1.05	1.67	0.56	1.36	0.45	0.19	0.09	0.5375
22	2.23	0.79	1.25	0.42	1.02	0.33	0.14	0.07	0.4025
23	1.67	0.59	0.94	0.31	0.77	0.25	0.10	0.05	0.3
24	1.25	0.44	0.70	0.23	0.57	0.19	0.08	0.04	0.225
25	0.94	0.33	0.53	0.18	0.43	0.14	0.06	0.03	0.17
26	0.70	0.25	0.40	0.13	0.32	0.11	0.04	0.02	0.1275
27	0.53	0.19	0.30	0.10	0.24	0.08	0.03	0.02	0.0975
28	0.39	0.14	0.22	0.07	0.18	0.06	0.02	0.01	0.07
29	0.30	0.10	0.17	0.06	0.14	0.04	0.02	0.01	0.0525
30	0.22	0.08	0.12	0.04	0.10	0.03	0.01	0.01	0.04