DIMETHOATE (27)

OMETHOATE (55)

FORMOTHION (42)

EXPLANATION

Dimethoate was evaluated for residues by the JMPR in 1965–1967, 1970, 1973, 1977, 1978, 1983, 1984, 1986–1988, and 1990. The 1986 JMPR recommended separate MRLs for dimethoate and its metabolite omethoate to replace the previous limits for the combined residue. The 1988 JMPR reviewed substantial quantities of new field trial data, but most of the trials were in two countries in Europe. The 1990 JMPR reviewed additional data on two commodities.

The toxicology of dimethoate was reviewed by the 1996 JMPR within the CCPR periodic review programme. The Meeting allocated an ADI for the sum of dimethoate and omethoate expressed as dimethoate, although it was noted that omethoate was considerably more toxic. The 1996 Meeting noted that a re-evaluation of the toxicity of dimethoate might be required if the periodic review of its residue chemistry showed omethoate to be a major part of the residue.

Dimethoate was scheduled by the 1992 CCPR (ALINORM 93/24) for a periodic review of its residue chemistry by the 1993 JMPR. The schedule was changed in subsequent years, and the 1996 CCPR scheduled dimethoate, omethoate and formothion for periodic review in 1998 (ALINORM 97/24).

Data and information have been submitted by the Dimethoate Task Force (BASF, Cheminova, and Isagro, via Scientific Consulting Co., Woellstein, Germany), Cheminova, and the governments of Australia, Germany, The Netherlands, Thailand, and the UK.

Omethoate is a metabolite of dimethoate and was a marketed pesticide. Australia submitted product labels for omethoate and The Netherlands also submitted information on GAP as well as summaries of supervised field trials on apples and plums and monitoring data on food in commerce. No additional trial data were submitted for the use of omethoate *per se* on any agricultural commodity. The CCPR agreed that the MRLs for omethoate should reflect residues arising from the use of dimethoate.

Formothion has no extant MRLs. No data or information were submitted.

The following evaluation, within the CCPR Periodic Review Programme, is essentially restricted to dimethoate.

IDENTITY

Chemical name:

IUPAC: *O,O*-dimethyl *S*-methylcarbamoylmethyl phosphorodithioate

CA: *O,O*-dimethyl *S*-[2-(methylamino)-2-oxoethyl] phosphorodithioate

CAS No.: 60-51-5

CIPAC No.:

Synonyms: cygon, cekuthoate, daphene, devigon, dimet, dimethogen, trimetion

Structural formula: $(CH_3O)_2P(=S)SCH_2CONHCH_3$

Molecular formula: $C_5H_{12}NO_3PS_2$

Molecular weight: 229.2 g/mol

Physical and Chemical Properties

Pure active ingredient

Appearance: white crystalline solid

Vapour pressure: 1.85×10^{-6} mm Hg at 25°C
1.18×10^{-6} mm Hg at 35°C (Teeter, 1988)

Melting point: 51–52°C

Octanol/Water Partition coefficient: 5.06 (log K_{ow} = 0.775) (Mangels, 1987)

Solubility:

Water, mg/ml: 39.8 at 25°C (Mangels, 1987)
23.3 at pH 5
23.8 at pH 7
25.0 at pH 9 (20°C) (Robson, *et al.*, 1991)

Other solvents: 140 g/100 ml acetone
140 g/100 ml acetonitrile
120 g/100 ml cyclohexanone
0.043 g/100 ml dodecane
150 g/100 ml ethanol
120 g/100 ml ethyl acetate
0.030 g/100 ml hexane
120 g/100 ml 2-propanol
160 g/100 ml methanol
150 g/100 ml dichloromethane
52 g/100 ml 1-octanol
100 g/100 ml toluene
31 g/100 ml xylenes
120 g/100 ml 1,2-dichloroethane
0.024 g/100 ml n-heptane
(25°C; Madsen, 1994)

Specific gravity: 1.277 g/ml at 65°C

Hydrolysis: Half-lives at 25°C: 68 days at pH 7
: 156 days at pH 5
: 4.4 days at pH 9

The main degradation products are *O*-demethyl-dimethoate and *O,O*-dimethyl hydrogen phosphorothioate acid at pH 9; *O*-demethyl-dimethoate at pH 5 and pH 7 (Hawkins, *et al*, 1986)

Photolysis: Stable under artificial sunlight (15 days continuous exposure) in acetate buffer solution at 25°C (Hawkins, *et al.*, 1986).
Decomposed on sandy loam soil thin-layer plates under artificial sunlight (15 days continuous exposure). Half-lives 7–16 days, control 40 days. Major degradation products were volatiles (9%), dimethyl hydrogen phosphate (15%), and dimethoxon (7%) (Hawkins, *et al.*, 1986)

Thermal stability: Stable up to 35°C. Isomerization to *O,S*-dimethyl *O*-methylcarbamoylmethyl phosphorodithioate occurs at higher temperatures. Rapid decomposition when heated.

Technical material

Minimum purity: 96%

Main impurities: Methyl (dimethoxyphosphinothioyl)thioacetate (CAS 757-86-8), 1.5% w/w, *O,O,S*-trimethyl phosphorodithioate (CAS 2953-29-9) 1.5% w/w

Melting range: 45–47°C

Stability: as pure active ingredient

formulations

The following formulations are available: Cygon, Clean Crop Dimethoate, Perfekthion, BI 58, Danadim 40, Roxion, Rogor. All are emulsifiable concentrates (EC), typically 400 g/l.

METABOLISM AND ENVIRONMENTAL FATE

Animal metabolism

Rats (Dimethoate Task Force, 1995). Dimethoate, labelled with carbon-14 in the two *O*-methyl groups and having a specific activity of 32300 dpm/µg, was administered to Wistar rats, 7–10 weeks of age, at 10 and 100 mg/kg bw in a single dose in three separate experiments (1) orally, in water solution; (2) intravenously, in isotonic saline; and (3) dermally, in 1% aqueous sodium carboxymethylcellulose solution. A separate group of 18 rats was dosed orally at 10 mg/kg bw for seven consecutive days. The radiolabelled material was diluted with natural abundance dimethoate to obtain the desired specific activity.

Urine and faeces samples were collected from each of the single orally dosed animals at intervals for five days after dosing. Expired air was passed through traps of 2-ethoxyethanol/ethanolamine. At slaughter, the stomach and gi tract, adrenal glands, brain, heart, kidneys, liver, lungs, ovaries, testes,

pancreas, spleen, thyroid gland, uterus, muscle, fat, bone, bone marrow, and skin were taken for measurement of the ^{14}C balance. Additional groups of six rats each were killed at 0.5, 2, 6, and 25 hours after dosing, and tissues were taken for quantitative determinations. Rats from the dermal treatment were killed after 120 hours.

The excretion of radioactivity from the various forms of administration is shown in Table 1. After oral and intravenous administration about 80% of radioactivity was excreted within 24 hours, almost all in the urine. Although not indicated in Table 1, no differences were observed between males and females.

Table 1. Elimination of radioactivity from rats after a single dose of [^{14}C]dimethoate.

Dose, mg/kg bw	Route	Sample	Elapsed time (h)	Incremental % of dose
10	Oral	Urine	0–6	71 ± 1.2
			6–12	12 ± 4.7
			12–24	3.0 ± 0.60
			24–120	2.4 ± 1.0
		Expired air	0–72	2.2 ± 0.09
		Faeces	0–72	1.3 ± 0.16
		Carcase (incl. gi, kidney, liver, etc)	-	1.5 ± 0.52
		Total		93
100	Oral	Urine	0–6	56
			6–12	22
			12–24	9.9
			24–120	3.4
		Expired air	0 - 72	2.5
		Faeces	0–120	1.4
		Carcase (incl. gi, kidney, liver, etc)	-	1.7
		Total		97
10	Intravenous	Urine	0–6	81
			6–12	4.4
			12–24	2.1
			24 - 120	1.8
		Expired air	0–72	1.7
		Faeces	0–120	1.2
		Carcase (incl. gi, kidney, liver, etc)	-	0.88
		Total		93
10	Dermal	Urine	0–6	5.0
			6–24	2.5
			24–120	0.52
		Faeces	0–120	0.40
		Carcase (incl gi, kidney, liver, etc)	-	0.76
		Skin wash	6	62
		Treated skin		15
		Total		86
100	Dermal	Urine	0 - 6	0.66
			6 - 24	0.32
			24–120	0.15
		Faeces	0–120	0.09
		Carcase (incl gi, kidney, liver, etc)	-	0.16
		Skin wash	6	84
		Treated skin		2.9
		Total		88

The mean concentrations of triplicate determinations of radioactivity in male and female rat plasma after single oral doses at 10 and 100 mg/kg bw reached maxima in about 0.5 hours in both sexes dosed at 10 mg/kg bw and in females at 100 mg/kg bw. In males at 100 mg/kg bw the time was 0.25 hours. The mean maxima were similar in the two sexes dosed at 10 mg/kg bw, 8.62 mg dimethoate equivalents/l in males and 7.68 mg/l in females. After the 100 mg/kg bw dose the mean maxima were 50.7 and 93.2 mg dimethoate equivalents/l in males and females respectively. The decrease in radioactivity after the peak concentration was biphasic. At 24 hours after administration of the 100 mg/kg bw dose, the plasma concentrations of dimethoate were below detectable levels (0.05 mg/l).

Urine samples collected from animals 48 hours after oral, intravenous, and dermal doses (10 and 100 mg/kg bw) were combined and analysed by HPLC and TLC. Additional aliquots were incubated with ∃-glucuronidase/sulfatase enzymes and analysed by TLC. Other extracts, e.g. kidney and liver, were analysed by HPLC and TLC and co-chromatographed with reference standards. Some urine metabolites were isolated by preparative HPLC and identified by MS or GC-MS.

Four metabolites were identified in the urine: U4, dimethyl hydrogen phosphorothioate; U7, dimethyl hydrogen phosphorodithioate; U9, dimethoate carboxylic acid, and omethoate. U4 (8% of the TRR, 0.14% of the dose), U9 (15% of the TRR, 0.26% of the dose) and U7 (40% of the TRR, 0.68% of the dose) were also found in the kidneys (by TLC and co-chromatography). U4 (12% of the TRR, 0.51% of the dose) and U 7 (22% of the TRR, 0.95% of the dose) were found in the liver. The results are shown in Table 2.

Table 2. Radioactive compounds in rat urine after single doses.

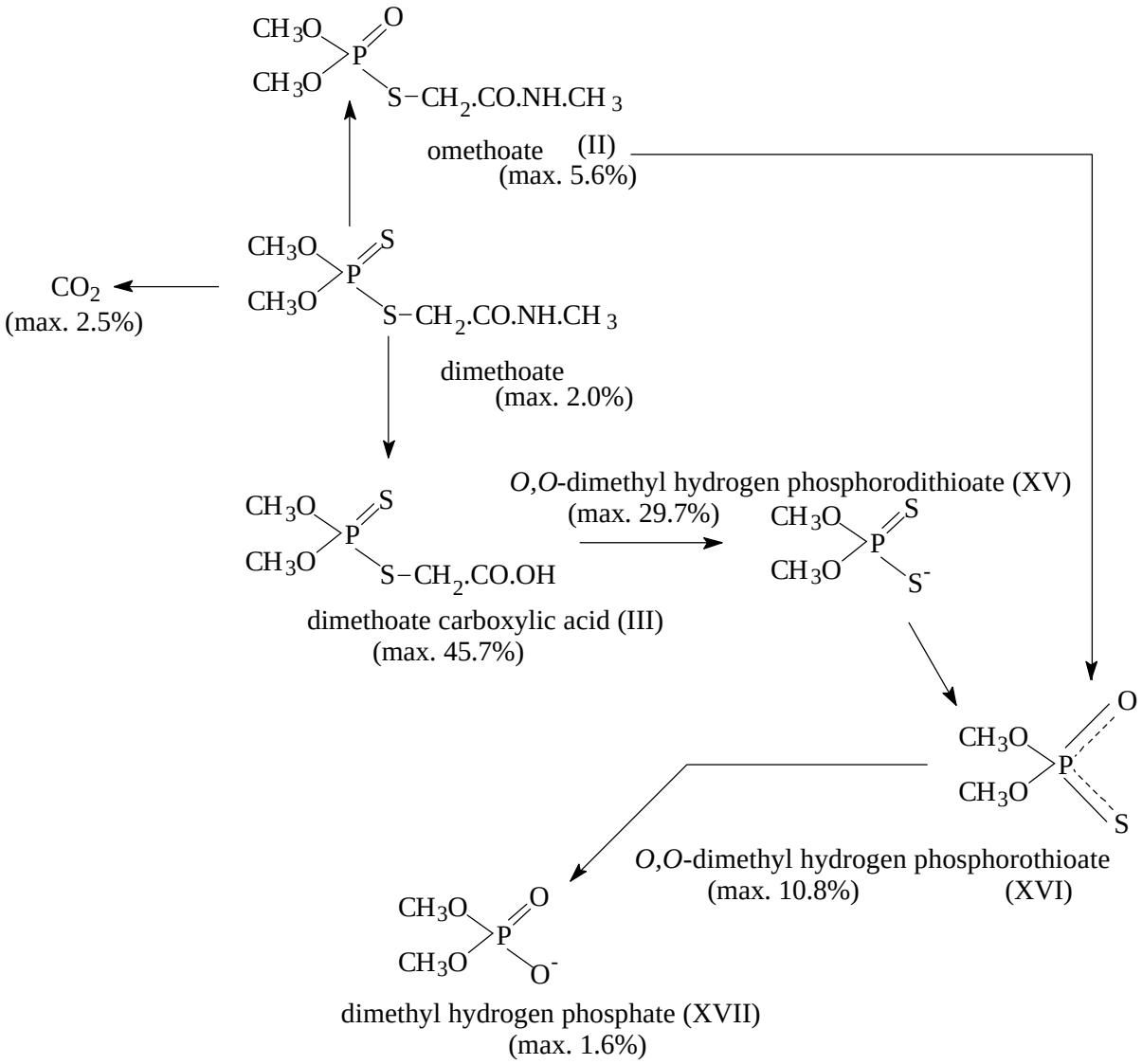
Compound	% of dose							
	Oral: 10 mg/kg bw		Oral: 100 mg/kg bw		Intravenous: 10 mg/kg bw		Dermal: 10 mg/kg bw[1]	
	Male	Female	Male	Female	Male	Female	Male	Female
U1	5.2	5.0	4.8	3.8	4.3	3.9	0.6	0.5
Omethoate	1.5	2.5	3.7	3.7	1.3	1.8	0.2	0.2
U2	0.3	0.2	0.4	0.3	-	-	-	-
U3	4.1	4.0	2.2	2.0	3.7	3.7	0.3	0.3
U4	8.3	5.7	8.7	4.7	6.5	4.0	0.8	0.6
U5	0.9	0.7	1.0	1.3	0.9	0.7	0.2	<0.1
U6	2.5	2.1	2.3	1.9	3.7	1.8		0.1
U7	26.6	25.2	20.3	22.1	22.5	24.1	2.9	3.2
Dimethoate	1.4	0.7	0.7	2.0	0.4	0.5	0.1	0.1
U9	37.8	35.1	43.2	44.4	42.7	45.7	2.5	2.8

[1] Radioactive components from the 100 mg/kg bw treatment were proportionally lower than from 10 mg/kg bw, <0.1–0.3%

The Dimethoate Task Force (DTF) proposed the biotransformation pathway shown in Figure 1.

Figure 1. Metabolism of dimethoate in rats

The values in parentheses are the maximum proportions of the administered dose found in urine. The $^{14}CO_2$ was found in expired air, and XVII was found only in tissues; its identification is tentative.



Poultry (Jalali, *et al.*, 1995). Three groups of 5 White Leghorn laying hens were dosed orally with [*methoxy*-^{14}C]dimethoate by capsule once daily for 7 consecutive days at 0.9 mg/kg bw, equivalent to 10 ppm in the diet. Eggs were collected twice daily, separated into yolks and whites, and pooled within groups. The hens were killed within 24 hours of the last dose, and tissues were composited in each group.

Sub-samples of tissues, eggs, excreta, and blood were homogenized and radio-assayed by combustion and liquid scintillation counting. The results are shown in Table 3.

Table 3. Residues in tissues, eggs, and excreta from the oral administration of [methoxy-^{14}C]dimethoate to laying hens.

Sample	Time	^{14}C, mg/kg as dimethoate			
		Group B[1]	Group C	Group D	Mean
Liver	7 days	0.615	0.621	0.687	0.641
Breast muscle	7 days	0.098	0.087	0.102	0.096
Thigh muscle	7 days	0.079	0.090	0.083	0.084
Fat	7 days	0.028	0.024	0.061	0.038
Skin	7 days	0.042	0.044	0.066	0.051
Blood	7 days	0.234	0.234	0.242	0.237
Egg yolk	0–24 hr	0.018	0.020	0.016	0.018
Egg yolk	24-48 hr	0.040	0.051	0.044	0.045
Egg yolk	4 8-72 hr	0.106	0.099	0.110	0.105
Egg yolk	96–120	0.277	0.246	0.241	0.255
Egg yolk	144 -	0.310	0.351	0.355	0.339
Egg white	0–24	0.080	0.070	0.120	0.090
Egg white	24–48	0.092	0.112	0.141	0.115
Egg white	48–72	0.090	0.120	0.202	0.137
Egg white	96–120	0.183	0.152	0.175	0.170
Egg white	144-	0.144	0.161	0.149	0.151
Excreta	75% dose				

[1] Each group (B,C,D) consisted of 5 hens. Group A was a control group of 5 hens

Homogenized tissue and egg samples were subjected to sequential solvent extraction (hexane and/or acetonitrile/water, methanol/1M ammonium hydroxide, 1:1), protease hydrolysis, 6 N HCl hydrolysis, and 3 N NaOH hydrolysis. These treatments solubilized the following percentages of the TRR: liver 90%, breast 102%, thigh 92%: egg whites 87%, egg yolks 94%, skin 70%, fat 58%, blood 34% and excreta 95%. The acetonitrile/water extracts and the methanol/ammonium hydroxide extracts were analysed by HPLC, as were some protease extracts, e.g. liver. The distribution of the radioactivity is shown in Table 4. Dimethoate was not found in any sample, and omethoate was found at low concentrations only in the liver and egg white.

Table 4. Distribution of the radiolabelled residues from the administration of dimethoate to hens.

Sample	Fraction	% of TRR	mg/kg as dimethoate	Characterization[1] or identification
Liver (0.822 mg/kg)	Hexane	3.0	0.025	
	Methanol/ammonium hydroxide	22	0.18	Phosphorylated natural products 0.16 mg/kg. No formate.
	Protease	36	0.29	0.081 mg/kg omethoate; 0.131 mg/kg dimethoate carboxylic acid. Not confirmed by 2D-TLC (interference). 0.11 mg/kg phosphorylated natural products.
	6 N HCl	27	0.22	No amino acids
	3 N NaOH	2.4	0.020	
	Total	90	0.74	
Breast muscle (0.098 mg/kg)	Acetonitrile/water (8/2)	46	0.045	Phosphorylated natural products
	Protease	34	0.034	
	Methanol/ammonium hydroxide	14	0.014	
	6 N HCl	8,4	0.008	
	Total	102	0.101	
Thigh muscle (0.079 mg/kg)	Acetonitrile/water (8/2)	36	0.028	Phosphorylated natural products
	Protease	36	0.028	
	Methanol/ammonium hydroxide	6.9	0.005	

Sample	Fraction	% of TRR	mg/kg as dimethoate	Characterization[1] or identification
	6 N HCl	6.2	0.005	
	3 N NaOH	6.2	0.005	
	Total	92	0.071	
Egg white (0.127 mg/kg; 96-120 h)	Acetonitrile/water (8/2)	50	0.064	Phosphorylated natural products. No formate.
	Protease	14	0.018	Omethoate 0.004 mg/kg. Dimethoate carboxylic acid, 0.003 mg/kg
	Methanol/ammonium hydroxide	9.5	0.012	
	6 N HCl	4.5	0.006	
	3 N NaOH	8.6	0.011	
	Total	87	0.110	
Egg yolk (0.192 mg/kg; 96-120 h)	Acetonitrile/water (8/2)	29	0.056	Phospholipids. Co-chromatography
	Protease	35	0.067	Phosphorylated natural product and many other peaks
	Methanol/ammonium hydroxide	11	0.021	
	6 N HCl	1.2	0.002	
	3 N NaOH	18	0.035	
	Total	94	0.18	
Fat (0.028 mg/kg)	Hexane	31	0.008	
	Acetonitrile/water (8/2)	9.8	0.003	
	Protease	10	0.003	
	Methanol/ammonium hydroxide	1.2	0.000	
	6 N HCl	5.4	0.001	
	Total	58	0.016	

[1] Phosphorylated natural products = 4 min HPLC peak + ^{14}C not recovered from HPLC +^{14}C solubilized by HCl and/or NaOH

Goats (Jalali *et al*, 1995; Jalali and Hiler, 1995). Dimethoate radiolabelled on the methoxy carbons was orally administered by capsule once daily for 3 consecutive days to two lactating goats at a level of 1.6 mg/kg bw/day. On the basis of the mean feed consumption for three days before the test, this was equivalent to 30 ppm dimethoate in the diet. During the treatment period, milk was collected twice daily. Urine and faeces were also collected, and the goats were slaughtered within 24 hours of the third dose. Total radioactive levels in the milk were determined by direct radio-assay and in the tissues by combustion and liquid scintillation counting. The results are shown in Table 5.

Table 5. Radioactivity in the tissues, milk, and excreta from goats dosed with 1.6 mg [^{14}C]dimethoate/kg bw/day for three consecutive days.

Sample	Collection time	Total radioactive residue, mg/kg, as dimethoate	
		Goat 1	Goat 2
Liver	Slaughter	1.22	1.01
Kidney	Slaughter	0.15	0.15
Muscle	Slaughter	0.070	0.047
Fat	Slaughter	0.045	0.057
Blood	Slaughter	0.076	0.079
Milk	0–12 h	0.15	0.082
	12–24 h	0.035	0.055
	24–36	0.18	0.13
	36–48	0.081	0.052
	48–60	0.23	0.14
	60 -	0.10	0.070
Urine + cage wash		91% of dose	86% of dose
Faeces		3.2% of dose	3.9% of dose

Homogenized tissue sub-samples were extracted sequentially with hexane, acetonitrile/water (8/2), and methanol/1 M ammonium hydroxide (1/1). The final post-extraction residue from the liver only was hydrolysed sequentially with protease, 6 N HCl, and 3 N NaOH. The extracts were analysed by HPLC (C-18 reverse phase) and/or TLC. Some extracts were benzylated with pentafluorobenzyl bromide (PFBB) before analysis. PFBB would benzylate dimethyl phosphate, methyl phosphate, dimethyl phosphorothioate etc.

Milk (48–60 hours) was sequentially extracted with hexane and acetonitrile/water (8/2). The acetonitrile extract was radio-assayed, concentrated, and chromatographed on an anion-exchange SAX solid-phase extraction column. The aqueous fraction from the column was benzylated and analysed by HPLC. In a separate experiment, the water eluate was lyophilized and analysed on a carbohydrate HPLC column. A sample of [^{14}C]lactose was similarly analysed, both before and after hydrolysis with 1.0 N HCl.

Dimethoate was not found in any of the tissue or milk. A low concentration of omethoate, released by protease treatment, was found in liver.

Urine (from 48 hours to slaughter) was fractionated on a QAE Sephadex A-25 column. Three major peaks were found . A separate urine fraction was fractionated on a C-18 solid phase extraction column. Combined aqueous fractions were analysed by TLC. The three fractions from the SPE column that contained the most radioactivity were prepared on a large scale, benzylated, purified, and analysed by HPLC and GC-MS.

The distribution and characterization of the radioactivity is shown in Table 6.

Table 6. Distribution and characterization of radioactivity from the administration of [^{14}C]dimethoate to lactating goats.

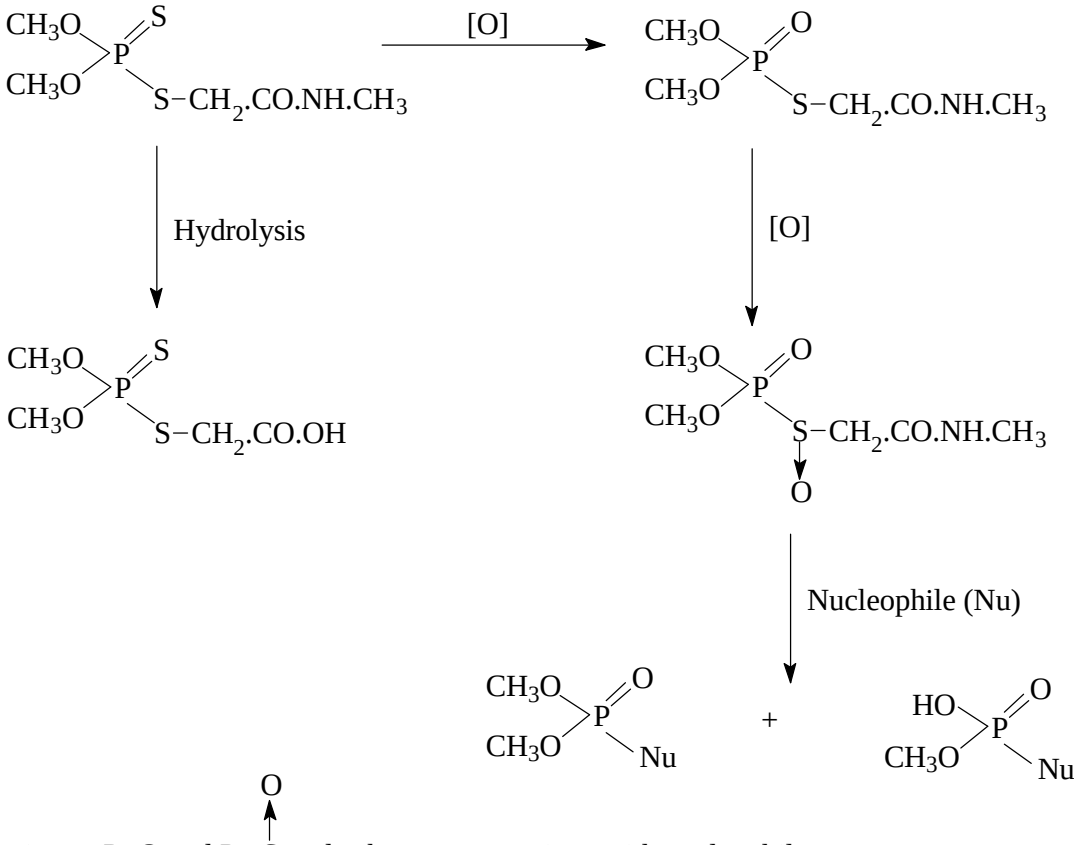
Sample	Fraction	% Total of TRR in sample	mg/kg as dimethoate	Identification or characterization[1, 2]
Liver (1.22 mg/kg)	Hexane	0.3	0.003	
	Acetonitrile/water	41	0.50	Anions 0.076 mg/kg (4 components by HPLC) . Phosphorylated natural products 0.4 mg/kg.
	Methanol/ammonium hydroxide	2.0	0.024	
	Protease	22	0.26	omethoate 0.12 mg/kg, dimethoate carboxylic acid 0.031 mg/kg by HPLC. Confirmation not successful (co-extractives). Phosphorylated natural products 0.03 mg/kg
	6 N HCl	14	0.18	No analysis
	3 N NaOH	1.8	0.022	
	Residue	19	0.23	
Liver (modified extraction)	Hexane	1.0	0.013	
	Acetonitrile/water (8/2)	21	0.26	HPLC peak at 4 min. 84% of injected ^{14}C accounted for. Phosphorylated natural products 0.20 mg/kg, 16% of TRR. No dimethoate carboxylic acid, no dimethyl phosphorothioate, no dimethyl phosphate (A-25 Sephadex). No [^{14}C]formate.
	Protease	22	0.27	Phosphorylated natural products 0.13 mg/kg (HPLC), 11% of TRR. Omethoate and dimethoate carboxylic acid present.
	Residue	11	0.13	

Sample	Fraction	% Total of TRR in sample	mg/kg as dimethoate	Identification or characterization[1, 2]
Kidney (0.149 mg/kg)	Hexane	2.0	0.003	
	Acetonitrile/water (8/2)	66	0.099	HPLC peak at 4 min., 76% of injected ^{14}C accounted for. Phosphorylated natural products 0.048 mg/kg, 32% of TRR. Anions about 0.020 mg/kg, 3 components.
	Methanol/ammonium hydroxide	5.1	0.008	
	Residue	34	0.051	
Muscle (0.070 mg/kg)	Hexane	0.5	<0.001	
	Acetonitrile/water (8/2)	57	0.040	HPLC peak at 4 min., 96% of injected ^{14}C accounted for. Poor benzylation (10%). Phosphorylated natural products 0.037 mg/kg, 53% of TRR. Anions 0.002 mg/kg.
	Residue	17	0.012	
Fat (0.045 mg/kg)	Hexane	11	0.005	
	Acetonitrile/water	12	0.005	
	Acetonitrile	4.2	0.002	
	Acetone	1.8	0.001	
	Residue	82	0.037	
Milk (48 h) (0.228 mg/kg)	Hexane	8.5	0.020	
	Acetonitrile/water (8/2)	82	0.18	HPLC peak at 4 min., 93% of injected ^{14}C accounted for. Poor benzylation, 17%. Phosphorylated natural products 0.12 mg/kg, 53% of TRR. Anions 0.005 mg/kg, 2 components. Lactose not radioactive.
Urine (48 h)	Solid phase extraction (water fractions)			Major metabolites identified by HPLC and TLC: dimethoate carboxylic acid, dimethyl phosphorothioate, dimethyl phosphate (GC-MS). Good benzylation of each metabolite: carboxylic acid 68%; phosphates 95% and 102%.

[1]Phosphorylated natural products = ^{14}C HPLC peak at 4 min minus benzylated peaks plus ^{14}C not recovered from HPLC column plus ^{14}C content of ammonium hydroxide/methanol extract (liver, kidney) plus ^{14}C residue. This represents an estimate of the maximum possible amount.
[2]Anions were assumed to be the ^{14}C peaks at about 50 min retention (C-18 HPLC) from the acetonitrile extract after benzylation

The metabolic pathways shown in Figure 2 are proposed for both poultry and ruminants. Almost all the dimethoate is eliminated in the urine as dimethyl phosphorothioate and dimethyl phosphate, products of the cleavage of the P–S–CH_2 linkage. The residues found in milk and tissues are consistent with the formation of the sulfoxides of omethoate and dimethoate carboxylic acid. The sulfoxides would combine with available nucleophiles, leading to the phosphorylation of proteins and lipids. Incorporation of -O$^{14}CH_3$ into natural products did not occur, as there was no apparent radioactive formate or lactose in milk.

Figure 2: Metabolism of dimethoate in poultry and ruminants.



Conversion to P=O and P– S and subsequent reactions with nucleophiles

NU (nucleophile) is a generic term for any electron-rich endogenous component. For example, the sulfoxide might phosphorylate proteins and lipids.

Plant metabolism

The DTF submitted summary information and literature citations on the metabolism of dimethoate in plants (Heidemann, 1995). No detailed reports were submitted.

The metabolism of [^{32}P]dimethoate in sugar beet was studied by Santi *et al* (1964). The radiolabelled dimethoate was applied to sugar beet plants 5 days after emergence, and the distribution of radioactivity was monitored by autoradiography. The metabolites identified were omethoate, de-*O*-methyl-dimethoate, *O,O*-demethyl hydrogen phosphorothiate ethyl hydrogen phosphate and phosphoric acid. Four metabolites remained unidentified. The concentration of omethoate increased to that of dimethoate after 13 to 30 days. Neither dimethoate nor omethoate could be found in the roots or leaves after day 37. The detailed report was submitted in Italian and could not be evaluated.

The metabolism of [^{32}P]dimethoate was investigated after foliar application by plant dipping to maize, cotton, peas and potatoes (Dauterman *et al.,* 1960). The plants were extracted 2 and 12 days after treatment, and metabolites were identified by paper chromatography and HPLC with co-chromatography. The proportion of the applied radioactivity on the leaf surfaces of maize, potato, and cotton decreased to

≤40% within 12 days of application. The most rapid decrease occurred with cotton, where <20% remained in 4 days, and the slowest with maize, where 40% remained at 12 days. These losses are attributed to volatilization and translocation from the surface. The surface residue on potato foliage after two days consisted of 87% dimethoate, 0.8% omethoate, and 13% water-soluble compounds, and after twelve days 17% dimethoate, 1.3% omethoate and 82% water-soluble compounds. The interval residues consisted of 40% dimethoate, 2.5% omethoate and 57% water-soluble compounds after two days, and 3.8% dimethoate, 1.1% omethoate and 95% water-soluble compounds after 12 days. The water-soluble surface and internal compounds were fractionated into four components by ion-exchange chromatography. The results are shown in Table 7.

Table 7. Composition of the water-soluble extracts of plant leaf surfaces and internal tissues after dipping in [^{32}P]dimethoate.

Interval, days	Surface H_3PO_4	Internal H_3PO	Surface $(MeO)_2P(O)OH$	Internal $(MeO)_2P(O)OH$	Surface Dimetho-ate COOH	Internal Dimetho-ate COOH	Surface De-O-methyl dime-thoate	Internal De-O-methyl dimethoate	Surface $(MeO)_2$ P(S)OH	Internal $(MeO)_2$ P(S)OH
Maize										
2	0.0	-	3.2	-	77	-	10	-	9.0	
12	0.0	0.0	6.3	14	88	4.1	3.5	64	2.7	18
Potato										
2	0.0	-	0.7	-	94	-	2.6	-	2.7	-
12	0.0	0.0	4.4	26	81	10	8.6	45	4.6	18
Cotton										
2	0.0	-	2.4	-	94	-	1.1	-	2.5	-
12	0.0	0.0	6.2	13	71	65.4	18	13	4.6	69
Pea										
12	52	48	7.6	12	81	5.7	8.6	45	6.0	18

The metabolism of [^{32}P] and [^{14}C]dimethoate (carbonyl label) in beans was studied by Lucier and Menzer (1968). Beans (*Phaseolus vulgaris L*) were planted in a greenhouse and treated after 18 days at the two-leaf stage with a foliar application of 5.15 mg/l [^{14}C]dimethoate to each plant. Plant samples (2 plants each) were taken on days 0, 2, 4, 6, 8 and 10 after treatment. For the [^{32}P] study plants were grown in a Percival plant growth chamber and treated 14 days after planting (1.78 mg/l). Samples taken 2 and 4 days were frozen for thirty minutes and rinsed with acetone to remove surface residues, then macerated in acetone and filtered. The filtrate was concentrated and extracted sequentially with hexane and chloroform. The hexane fraction was analysed by celite column chromatography and the chloroform and water fractions by TLC (2-dimensional, with reference compounds). The results are shown in Table 8.

Table 8. Radiolabelled compounds found from the application of [^{32}P]dimethoate or [^{14}C]dimethoate to the foliage of beans.

Compound	% of applied radioactivity at interval, days						
	2 (^{14}C)	2 (^{32}P)	4 (^{14}C)	4 (^{32}P)	6 (^{14}C)	8 (^{14}C)	10 (^{14}C)
Dimethoate	29	66	23	44	18	13	12
Omethoate	0.69	2.2	0.81	4.4	0.61	0.53	0.48
De-*N*-methyl-dimethoate	0.72		0.05		0.03	0.05	0.05
Dimethoate carboxylic acid	0.12	1.6	0.14	2.4	0.07	0.06	0.20
De-*O*-methyl carboxylic acid	0.21	0.08	0.17	0.09	0.15	0.05	0.21
De-*O*-methyl-dimethoate		0.39		0.49			
Dimethyl phosphorodithioate		2.5		4.2			
Dimethyl phophorothioate		0.43		0.76			
Dimethyl phosphate		0.38		0.74			
Unknown (2)	11		1.3				

Compound	% of applied radioactivity at interval, days						
	2 (^{14}C)	2 (^{32}P)	4 (^{14}C)	4 (^{32}P)	6 (^{14}C)	8 (^{14}C)	10 (^{14}C)
Unknown (6)		4.0		3.1			
Hexane extract (excluding dimethoate)	2.2	1.9	1.9	1.2	1.6	1.2	1.1
Post-extraction solid	8.7	2.4	8.8	7.0	12	16	16
Total recovery (% of applied dose)	53	82	36	68	32	31	30

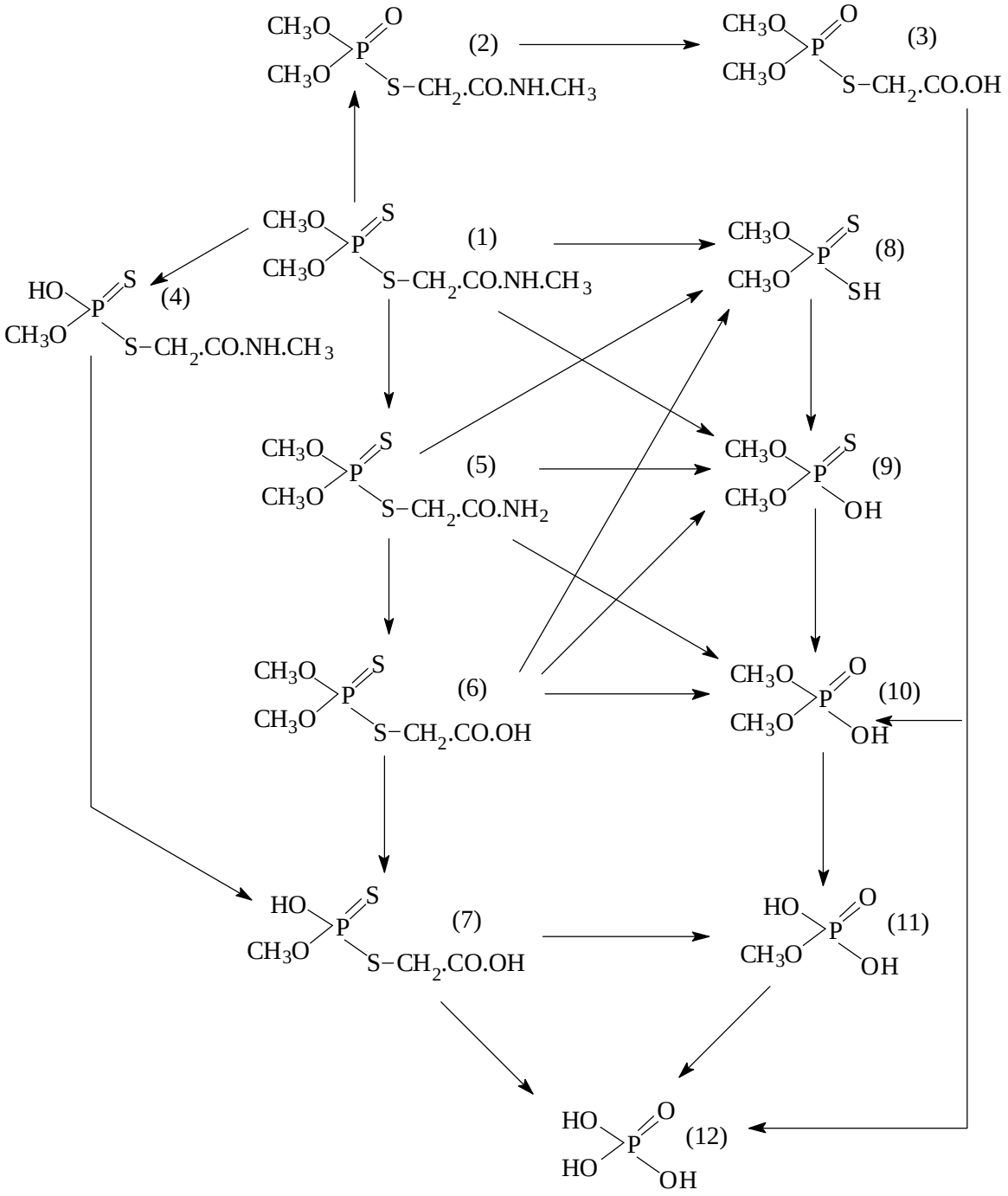
The metabolism of [^{32}P]dimethoate was studied on excised cotton leaves by Hacskaylo and Bull (1963). The third and fourth leaves from the terminal of 8-week old cotton plants removed and the basal ends of the petioles inserted into separate vials containing 100 µg of [^{32}P]dimethoate in 200 ml water. After the solutions were absorbed, the leaves were placed under fluorescent lights for 12 hours. The leaves were macerated with acetone 1, 3, 6 and 14 days after the treatment and the extracts analysed by paper chromatography. The dimethoate fell to 10% of its initial value within 6 days. Omethoate remained at about 6% of the total reactivity in the extract throughout the study. The compounds detected were phosphoric acid, de-*O*-methyl dimethoate carboxylic acid, dimethyl phosphate (2.5–11% of the total radioactivity on the chromatogram), dimethyl phosphorothioate (1.6–12%), dimethyl phosphorodithioate (4–11%), dimethoate carboxylic acid (15–50%) and omethoate. The dimethoate concentration ranged from 70% of the normalized total radioactivity on day 1 to 1.9% on day 14.

The metabolism of [^{32}P]dimethoate on lemons was reported by Santi (1961). The report was in Italian and only an English summary prepared by the Scientific Consulting Co. was available. The radioactive material applied, the method of application and the concentration were not specified. The compounds found were dimethoate, omethoate, dimethyl phosphate, phosphoric acid, *O,O*-dimethyl hydrogen phosphorothioate and de-*O*-methyl dimethoate.

Other studies on tomatoes, olives, wheat grain, sorghum grain, onions and cucumbers were reported in detail or as summaries but they provided information deemed inadequate or supplementary. Some residue dissipation studies, e.g. on spinach, with unlabelled dimethoate were also reported.

Although all the studies were deficient in the conduct of the experiments and/or the reporting of the data, taken together they defined the metabolic pathways shown in Figure 3. The metabolism follows two paths, oxidation to omethoate and hydrolysis with the formation of phosphoric acid, dimethyl phosphate, *O,O*-dimethyl hydrogen phosphorothioate and de-*O*-methyl dimethoate

Figure 3: Proposed metabolic pathways of dimethoate in plants.



1. dimethoate
2. omethoate
3. omethoate carboxylic acid
4. de-*O*-methyl-dimethoate
5. de-*N*-methyl-dimethoate
6. dimethoate carboxylic acid
7. de-*O*-methyl-dimethoate carboxylic acid
8. *O*,*O*-dimethyl hydrogen phosphorodithioate
9. *O*,*O*-dimethyl hydrogen phosphorothioate
10. dimethyl hydrogen phosphate
11. methyl dihydrogen phosphate
12. phosphoric acid

Environmental fate in soil

Residues in rotational crops

In a confined rotational crop study with lettuce, turnips and wheat as the secondary crops (Adair *et al.*, 1995) twelve plots, each consisting of a plastic-lined wooden box 90 x 75 cm x 30 cm deep were filled with Litchfield sandy loam soil in Watsonville, California, USA. Six boxes served as controls. Each of the remaining six was sprayed with an acetone solution of [^{14}C]dimethoate labelled on the methoxy carbons at a rate of 0.56 kg ai/ha which was incorporated into the soil. Before planting the boxes were moved into greenhouses. At 30 days after treatment (DAT), lettuce, wheat and turnips were planted in control and treated boxes. This procedure was repeated at 120 DAT using boxes in which nothing had been planted previously. Some boxes intended for longer planting intervals were not used after measuring the radioactivity levels in the 120 DAT crops.

Samples were collected at normal maturity, weighed and frozen. Wheat hay was dried for three days before freezing. The samples were homogenized with dry ice and returned to frozen storage. The total radioactive residue (of the TRR) in sub-samples was determined by combustion and liquid scintillation counting. Other sub-samples were extracted with solvent, typically acetonitrile or acetonitrile/0.1 N HCl (1:1). Wheat forage extracts (30 DAT) were hydrolysed with hydrochloric acid (6 N, 4 h reflux) to determine conjugates. Other fractions of the wheat forage acetonitrile extracts were acetylated with acetic anhydride in pyridine to determine hydroxy compounds. Wheat forage extracts from the 30 DAT planting were benzylated to determine acidic compounds. The ^{14}C in the post-extraction solids was measured by combustion and LSC.

The final extracts were analysed by HPLC with a C-18 column and UV detector. Fractions were collected at half-minute intervals and analysed by LSC. Extracts were also analysed by TLC on silica gel F254 plates. Compounds were identified by co-chromatography with unlabelled reference standards. All analyses were within 30 days of harvest. The results are shown in Table 9.

Table 9. ^{14}C residues in crops grown in sandy loam soil treated with [^{14}C]dimethoate at 0.56 kg ai/ha.

Crop	Planting DAT	Harvest DAT	TRR, mg/kg as dimethoate	Extracted residue, % of TRR	Unextracted residue, % of TRR	Extract characterization or identification[1]	
						% of TRR, mg/kg	Component
Lettuce	30	78	0.030	74	26	60	Polar
Turnip roots	30	97	0.008	-	-		
Turnip foliage	30	97	0.037	55	45	32	Polar
Wheat forage	30	62	0.036	63	42	50 0 0 25	Polar hydroxy compounds (no acetylation). Conjugates Acidic compounds
Wheat hay	30	97	0.037	35	84	35	Polar
Wheat straw	30	141	0.045	72	29	56	Polar
Wheat grain	30	141	0.021	62	52	57	Polar
Lettuce	120	174	0.003				
Turnip roots	120	208	0.001				
Turnip foliage	120	208	0.005				
Wheat forage	120	168	0.004				
Wheat hay	120	258	0.009				
Wheat straw	120	258	0.020	88	28	55	Polar
Wheat grain	120	258	0.012	27	82		

[1] Co-chromatography with reference standards showed the following compounds to be absent: dimethoate, omethoate, de-*N*-methyl-dimethoate, isodimethoate, de-*O*-methyl-dimethoate, de-*O*-methyl-omethoate, *O,O*-dimethyl hydrogen phosphorothioate, MP-1-acetic acid., demethyl-MPEM, methyl dihydrogen phosphate, de-*O*-methyl-dimethoate carboxylic acid.

Degradation

The DTF reported studies on the degradation of radiolabelled dimethoate in soil under both aerobic and anaerobic conditions (Hawkins *et al.*, 1989, 1990). In the aerobic study (in 1988), [*O-methyl*-^{14}C]dimethoate in water was applied to English sandy loam soil at a rate of 2.15 µg/g soil (dry weight). Some soil samples were fortified at the high level of 3.2 mg dimethoate/sample, the dimethoate being a mixture of radiolabelled and unlabelled material. About 80 g of treated soil was placed in each of a series of dishes which were maintained in glass columns flushed with an upward stream of humidified air which was then passed through trapping solutions for $^{14}CO_2$. The systems were maintained in the dark at 22°C. Duplicate dishes were removed at intervals of 0–181 days for analysis and the trapping solutions were sampled at the same times. The soils were extracted with acetonitrile or 1:1 acetonitrile/water at ambient temperature or under reflux. The extracts were radio-assayed and analysed by both reverse- and normal-phase TLC. Identification was based on co-chromatography with authentic standards in two solvent systems.

The [^{14}C]dimethoate was rapidly degraded under aerobic conditions in the sandy loam soil, with a half-life of 2.4 days. Dimethoate as a proportion of the applied radioactivity decreased from 96% on day 0 to 54% on day 2, 28% on day 4, 2% on day 14, 0.8% on day 30 and 0.4% on day 90. Two degradation products were identified: dimethyl phosphorothioate and de-*O*-methyl dimethoate. Neither exceeded 2% of the applied radioactivity at any time. Numerous unknown compounds were found, but none exceeded 2% of the applied radioactivity. As indicated in Table 10, the major route of degradation was volatilization, with $^{14}CO_2$ accounting for about 75% of the applied radioactivity after 181 days.

Table 10. Recovery of radioactivity from sandy loam soil treated with [^{14}C]dimethoate at 2 mg/kg under aerobic conditions.

Elapsed time, days	% of applied ^{14}C			
	Cumulative CO_2	Extractable	Unextractable	Soil total
0		96.9	0.3	97.2
1	5.2	81.0	4.6	85.6
4	15.2	66.3	9.9	76.2
7	52.2	17.3	15.7	33.0
14	61.4	8.7	19.4	28.1
30	65.1	6.6	20.8	27.4
60	67.8	4.6	19.4	24.0
90	70.2	3.7	16.0	19.7
120	72.8	3.4	15.3	18.7
181	74.6	2.2	16.2	18.4

In the anaerobic study [*O-methyl*-^{14}C]dimethoate in water was applied to English sandy loam soil at a rate of 2.06 µg/g soil (dry weight). 100 g portions of treated soil in Buchner flasks equipped with CO_2 traps were maintained at 25°C in darkness and a stream of air was passed through each system for two days at a rate of 30 ml/minute. After two days of aerobic incubation the soil in each flask was flooded to a depth of 2 cm with distilled, degassed water and the gas purge was changed to nitrogen. Flasks were removed at intervals and the soils extracted as in the aerobic study after removal of the supernatant water. Some soil sub-samples were also extracted with 0.5 M aqueous sodium hydroxide, either at ambient temperature or by reflux, for 24 hours. Supernatants and extracts were radio-assayed and analysed by TLC and HPLC. Autoradiographs of the TLC plates were taken and the HPLC was equipped with both UV and radioactivity detectors. The half-life of dimethoate was calculated to be 4 days from the start of anaerobic conditions with biphasic exponential decay. Two degradation products were identified from the anaerobic period as de-*O*-methyl-dimethoate (10% of the applied radioactivity) and *O,O*-dimethyl phosphorothioate (5%). About 15% of the applied radioactivity was lost as $^{14}CO_2$ during the 60-day anaerobic phase, in addition to a 27% loss during the

initial 2 days of aerobic incubation. The degradation of dimethoate was slower under anaerobic than aerobic conditions. The results are shown in Table 11.

Table 11. Distribution of radioactivity in sandy loam soil after application of [^{14}C]dimethoate at 2 mg/kg under aerobic and anaerobic conditions.

Elapsed time, days	^{14}C, % of applied								
	Cumulative CO_z	Supernatant water	Solvent extract	NaOH Extract	Unextractable	Soil total[1]	Dimethoate	Dimethyl phosphorothionate	De-*O*-methyl-dimethoate
Aerobic phase (days 0–2)									
0		N/A	96		0.3	96	94.7		
2	27		54	9.7	0.8	64	39.8	1.4	3.2
Anaerobic phase (days 2–62)									
9	30	28	18	13	1.0	60	19	3.4	8.6
16	32	28	15	12	0.8	56	13	4.4	9.6
34	35	24	13	14	1.0	52	8.3	4.2	6.2
62	41	16	9.0	21	2.0	48	5.5	3.6	7.1

[1] Supernatant water plus solvent extract plus NaOH extract plus unextractable

Both the DTF and Cheminova reported studies in the UK and USA on the dissipation of dimethoate in or on soil (Burden, 1991; Jacobson and Williams, 1994a,b). In the UK study Riverside clay loam, Middlefield silty clay and Somersham sandy loam were each fortified with dimethoate (60 µg per 50 g dry soil, equivalent to 1.2 kg ai/ha) and incubated aerobically in the dark at 20 $\pm$ 3°C . The soils were contained in conical flasks with cotton wool stoppers. The concentration of dimethoate was monitored from day 0 to day 16. The analysis consisted in overnight Soxhlet extraction of a 50 g sample with acetone/hexane (4/1, 200 ml) and hydrochloric acid (1 ml, 4 M). The extract was concentrated, the solvent changed to toluene and the analysis completed by GLC (25 m x 0.53 mm CP Sil-8 column, NPD). The method was validated by fortification of control samples of each of the three soil types. The overall mean recovery was 92% for a fortification range of 0.05 to 1.2 mg/kg, n = 15, range 79–126%. Concurrent recoveries were also determined.

In the New York studies, bare ground characterized as sandy loam at 0–60 cm and as loam at 60-120 cm was treated with dimethoate formulated as a 25% ai wettable powder (WP) at a rate of 4.5 kg ai/ha, in July 1993. The broadcast application was made with a tractor-mounted applicator. Soil core samples were taken immediately before and after treatment and at selected intervals up to 88 days after application. Total irrigation plus rainfall over the 88-day period totalled 28 cm. Samples (25 g frozen up to 177 days before analysis) were extracted with acetone/water (95/5, 250 ml). The filtrates were stripped of acetone and the residual water solutions partitioned with methylene chloride. The extracts were purified on Celite/charcoal columns and the hexane/acetone (1/1) eluate fractions were fortified with carbowax to 0.1%. The final extracts were analysed by GLC (30 m x 0.53 mm RTX-5 column and FPD). The method was validated with overall recoveries of 91% for dimethoate and 86% for omethoate, n = 12, fortification range 0.01–1.0 mg/kg. The recovery ranges were 82–110% for dimethoate and 80–100% for omethoate. Concurrent recoveries were also determined.

In the Texas trial, a sorghum plot was sprayed with dimethoate formulated as a 43.5% ai EC (Dimethoate 400) in July 1993. The application was broadcast, post-emergence, at 1/7 kg ai/ha top two- to four-leaf plants. The soil was characterized as silt loam at 0–120 cm. Soil core samples were taken immediately before and after treatment and at selected intervals for 90 days. The total rainfall plus irrigation over the 90-day period was 22 cm. Soil cores were stored frozen and analysed within 123 days of collection by the method used for the New York work.

The results of the three dissipation studies are shown in Table 12. The half-life of dimethoate in the UK and New York soils was 2–4 days. In Texas, where a crop was sprayed, the half-life was about 11 days. The US trials showed that the dimethoate did not migrate below the top soil layer.

Table 12. Dissipation of dimethoate in soil.

Trial/Year	Application rate, kg ai/ha	Post - treatment interval, days	Soil type/depth, cm, in US trials	Dimethoate, mg/kg	Omethoate, mg/kg	Concurrent analytical recoveries
DTF-UK/1991	1.2	0	Riverside clay loam/NA	1.0		88% at 1.2 mg/kg
		1		0.94		93% at 1.0 mg/kg
		2		0.62		97% at 0.8 mg/kg
		4		0.42		73% at 0.5 mg/kg
		5		0.13		105% at 0.8 mg/kg
		7		0.11		93% at 0.1 mg/kg
		8		0.077		87% at 0.1 mg/kg
		10		0.065		72% at 0.1 mg/kg
		12		0.041		57% at 0.1 mg/kg
	1.2	0	Middlefield silty clay	1.5		115% at 1.2 mg/kg
		1		1.0		93% at 1.0 mg/kg
		2		0.74		95% at 0.8 mg/kg
		4		0.79		57% at 0.5 mg/kg
		5		0.25		57% at 0.8 mg/kg
		7		0.070		100% at 0.1 mg/kg
		8		0.081		90% at o.1 mg/kg
		10		0.063		98% at 0.1 mg/kg
		12		0.037		56% at 0.1 mg/kg
		0	Somersham sandy loam	0.95		82% at 1.2 mg/kg
		1		0.77		82% at 1.0 mg/kg
		2		0.75		84% at 0.8 mg/kg
		4		0.52		72% at 0.5 mg/kg
		5		0.42		74% at 0.8 mg/kg
		7		0.43		87% at 0.1 mg/kg
		8		0.32		
		10		0.065		
		12		0.096		75% at 0.5 mg/kg
		16		0.10		93% at 0.1 mg/kg
Cheminova New York/ 1993	4.5	0	0–5.2	1.38	<0.01	D: 80-110%, n = 15, at 0.01 mg/kg, mean 92% O: 50-100%, n = 15, at 0.01 mg/kg, mean 81% D: 83-95%, n = 10, at 0.02-0.10 mg/kg, mean 87% O: 65-80%, n=10, at 0.02-0.10 mg/kg, mean 69% D: 91-111%, n =5, at 0.25-2.0 mg/kg, mean 92% O: 71-89%, n=5, at 0.25–2.0 mg/kg, mean 78%
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
			45.7-61	<0.01	<0.01	
		1	0-15.2	1.44	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
			45.7-61	<0.01	<0.01	
		2	0-15.2	1.52	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		3	0-15.2	1.39	0.017	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		6	0-15.2	0.59	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		10	0-15.2	0.23	<0.01	
			15.2-30.5	0.011	<0.01	
			30.5-45.7	<0.01	<0.01	
			45.7-61	<0.01	<0.01	
		14	0-15.2	0.090	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
			45.7-61	<0.01	<0.01	

Trial/Year	Application rate, kg ai/ha	Post - treatment interval, days	Soil type/depth, cm, in US trials	Dimethoate, mg/kg	Omethoate, mg/kg	Concurrent analytical recoveries
		28	0-15.2	0.012	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		60	0-15.2	<0.01	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		88	0-15.2	<0.01	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
Cheminova Texas/1993	1.7	0	0-15.2	0.48	<0.01	D: 60–100%, n = 14, at 0.01 mg/kg, mean 89% O: 70–110%, n = 14, at 0.01 mg/kg, mean 86% D: 70-106%, n = 11 at 0.05–0.25, mean 92 O: 26–80%. n = 11, at 0.05–0.25 mg/kg, mean 69 (sd 18) D: 89- 96%, n = 4 at 0.50–1.00 mg/kg, mean 93% O: 67–86%, n = 5 at 0.50–2.0 mg/kg, mean 77%
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		1	0-15.2	0.37	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		2	0-15.2	0.40	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		3	0-15.2	0.37	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		6	0-15.2	0.32	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-35.7	<0.01	<0.01	
		11	0-15.2	0.21	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		14	0-15.2	0.17	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		28	0-15.2	0.088	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		60	<0.01	<0.01	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.01	<0.01	
		90	0-15.2	<0.01	<0.01	
			15.2-30.5	<0.01	<0.01	
			30.5-45.7	<0.1	<0.01	

The DTF reported a soil dissipation study with bean, grape and bare ground plots in California (Becker, 1991). A dimethoate EC formulation was applied three times with a 7-day re-treatment interval at 0.56 kg ai/ha to green beans planted in Atwater Sandy Loam and twice at 2.8 kg ai/ha to bare ground with a 14-day re-treatment interval. The applications were at the early bloom, bloom to 5.1 cm pod and 5.1 to 7.6 cm pod stages. A WP formulation (Dimethogon 25WP, 25% ai; for apples, pears, grapes) was applied twice to the bare ground was with an overhead spray boom at 2.8 kg ai/ha with a 14-day interval The application to grape vines was by airblast spray to the foliage at the 0.75-1.5 and 1.5-2.0 cm diameter berry stages. The crops were maintained according to normal agricultural practice, including furrow irrigation. The half-lives were 9.8 days in bean soil, 6.0 days in grape soil and 7.8 days in bare soil.

Soil cores stored frozen pending analysis were segmented and analysed after acetone extraction by GLC with flame photometric detection. The method was validated with control soil samples fortified at 0.01–0.10 mg/kg with dimethoate and omethoate.

In the bean trial dimethoate and omethoate were not detected below the top core segment (0–15 cm) at any time up to 227 days after the first application. The highest dimethoate concentration was 0.19 mg/kg on the day of the third treatment and the highest omethoate concentration was 0.038 mg/kg 3 days after the third treatment.

In the grape vine plots the maximum dimethoate and omethoate concentrations in the top soil layers (0–15 cm) were 0.27 and 0.093 mg/kg respectively, both 4 days after the second application. Dimethoate only was found in the second core layer (15–30 cm) seven days after the first application at 0.014 mg/kg. Monitoring was continued for 112 days after the first application, with a nominal limit of quantification of 0.01 mg/kg.

After treating bare ground the maximum dimethoate concentration was 1.8 mg/kg in the 0–15 cm layer on the day after the second treatment, and the maximum omethoate concentration 0.56 mg/kg in the same layer three days after the second treatment. Dimethoate was found in lower soil layers up to two weeks after each treatment. The deepest apparent residue was 0.025 mg/kg in the 91–120 cm layer immediately after the second application, but this may have been spurious as no dimethoate was found in the four higher layers (15–91 cm) nor in the 91-120 cm layer in two replicate plots. Generally, dimethoate in the lower layers was highest 2–7 days after an application, with a maximum concentration of 0.022 mg/kg in the 46–61 cm segment. The maximum omethoate migration appeared to occur 3–7 days after the first application with maximum concentrations of 0.015 mg/kg in the 46–61 cm and 0.012 mg/kg in the 61–91 cm layers. No migration was observed after the second application. The bare ground was irrigated one and nine days after the first application and seven days after the second application, 15.2 cm each time.

The DTF reported a study of the mobility of [*O-methyl*-^{14}C]dimethoate in columns of four English soils: sand, sandy loam, silt loam and clay loam (Hawkins *et al.*, 1986). All four were leached after adding unaged dimethoate, and the sandy loam also after ageing. In the experiment with aged residues the sandy loam was treated with a mixture of labelled and unlabelled dimethoate equivalent to 0.15 mg dimethoate per 100 g soil (sifted and brought to 40% of maximum water holding capacity). The samples were placed in conical flasks and stored in the dark at 22ºC. After thirty days storage one sample was taken for radio-assay and a duplicate sample was subjected to column leaching. The sample for assay was extracted with 1:1 acetonitrile/water and the radioactivity in both the extract and the extracted soil was determined. For the leaching trial a column of the sandy loam soil (25 cm height) was topped with the remainder of the stored dimethoate-treated soil mixed with ^{36}Cl-sodium chloride. The radiolabelled sodium chloride was used to ascertain the void volume, defined as the volume of eluant needed to leach 50% of the recovered ^{36}Cl through the column. The column was eluted with distilled water (1 l) and fractions of 16–21 ml each were radio-assayed for ^{14}C and ^{36}Cl. The column was divided into six sections of 5 cm each and the soil from each section was air-dried and radio-assayed.

This procedure was repeated with freshly fortified samples of each of the four soils. A weighed 30 cm column of each sifted soil was covered with distilled water and 1 ml of an aqueous solution of [^{14}C]dimethoate and sodium [^{36}Cl]chloride. The application rate was 0.15 mg dimethoate per column, approximately equal to 0.75 kg ai/ha.

The eluates and soil extracts from both aged and unaged soil columns were analysed by TLC and HPLC.

The [^{14}C]dimethoate was extensively leached on columns of all four soils, both unaged and aged. The rate of leaching was inversely proportional to the loam content, being most rapid with sand. The results are shown in Table 13.

Table 13. Elution of [^{14}C]dimethoate from soil columns.

Column section	% of applied radioactivity				
	Somersham sandy loam	Gleadthorpe sand	Goole silt loam	Sandiacre clay loam	30-day aged Somersham sandy loam
1 (top)	2.9	0.3	1.6	2.0	28.4
2	1.7	0.3	2.7	2.7	6.2
3	1.4	0.3	2.7	2.5	0.1
4	1.2	0.2	3.2	2.5	0.1
5	2.1	0.3	3.6	2.5	0.2
6 (bottom)	1.9	0.3	4.0	3.4	0.1
Total retained	11.2	1.6	17.8	15.6	35.1
Total eluted	86.7	100.6	72.8	71.8	5.1
Total recovered	97.9	102.2	90.5	87.4	40.2
% Dimethoate eluted (TLC)	79	93	60	55	-
Distribution coefficient, K_d[1]	0.30	0.06	0.57	0.74	-
% organic carbon in soil	1.5	0.9	3.5	7.4	1.5

[1] K_d (ml/g) = [(vp-1)vv]/[vv/w] where vp is volume of eluant to leach 50% of applied ^{14}C through column, vv is void volume of column, and w is the weight of soil in the column

The DTF also reported a lysimeter trial (Wyss-Benz *et al.*, 1993). [*Carbonyl*-^{14}C]dimethoate was applied as a foliar spray to cabbages planted in two lysimeters embedded in the ground to soil level in 1992 in Itingen, Germany. The depth was 120 cm and the cultivated area was 1 m^2 (115 cm diameter). The amount of dimethoate applied to each lysimeter was 120 mg, corresponding to 1.2 kg ai/ha. Various crops were planted around the lysimeters. The actual applications were 112.02 mg to lysimeter 1 and 113.08 mg to lysimeter 2. Each lysimeter had a steel sieve bottom and was surrounded by a cylindrical sleeve with a vessel to collect water that had percolated through the lysimeter soil. The total precipitation and irrigation over the two-year study was 190 cm. After harvesting the cabbage, winter salad, garden salad, endive salad and winter wheat were planted sequentially. The total study period was 744 days. Some results are shown in Table 14.

The leachates were analysed by TLC after lyophilization. Dimethoate was never detected. Layers 12 and 11 from the lysimeters were extracted and 30–38% of the extractable radioactivity (<4%) was attributable to dimethoate. The unextracted radioactivity was characterized as bound to fulvic acids (20%), bound to humic acids (45%) and bound to humin (30%).

Table 14: Percolation of [^{14}C]dimethoate applied to cabbage at 1.2 kg ai/ha in lysimeters.

Sample	% of applied radioactivity	
	Lysimeter 1	Lysimeter 2
Leachate year 1	0.31	0.28
Leachate year 2	0.12	0.075
Cabbage	1.4	2.5
Winter salad	0.009	0.006
Garden salad	0.019	0.017
Endive salad	0.015	0.015
Winter wheat	0.002	0.002
Layer 12 (0-12 cm)–744 d	18	16
Layer 11 (12-21 cm)	1.3	0.85
Layer 10 (21-30 cm)	0.30	0.30
Layer 9 (30-40 cm)	0.20	0.14
Layer 8 (40-50 cm)	0.12	0.07
Layer 7 (50-60 cm)	0.05	0.04
Layer 6 (60-70 cm)	0.03	0.03
Layer 5 (70-80 cm)	0.02	0.02
Layer 4 (80-90 cm)	0.01	0.03
Layer 3 (90-100 cm)	0.01	0.01
Layer 2 (100-110 cm)	0.01	0.02
Layer 1 (110-120 cm)	0.02	0.01

[1]Unaccounted radioactivity (78–80% of that applied) was assumed to be in volatile substances

The DTF reported a study on the adsorption and desorption of dimethoate on soil (Schanne, 1981). Dimethoate, labelled on the carbonyl carbon, in 0.01 M $CaCl_2$ aqueous solution was equilibrated with various soils (5 g) by shaking at 150-200 oscillations/min for 4.5 hours. The dimethoate concentration range studied was about 0.04 to 5.2 mg/l. The mixtures were centrifuged and decanted. For desorption, the residual soils were equilibrated with $CaCl_2$ solution for 16 hours.

It was found that the amounts adsorbed increased with increasing silt content of the soils. On the basis of the linear relationship between the dimethoate solution concentration and the amount adsorbed, the sorption behaviour was described by a distribution coefficient. The results are shown in Table 15.

Table 15. Freundlich adsorption and desorption constants for dimethoate in various soils.

Soil	% silt	Adsorption k (dm^3/kg)	Desorption k (first step)
Sand/loamy sand	4.8	0.25	0.56
Sandy loam	25	0.33	1.34
Silt loam	52.2	0.42	2.38
Loam/silt loam	50.7	0.42	0.77
Sand	24.5	0.34	0.97
Loam	42.6	0.37	0.34

Environmental fate in water/sediment systems

The DTF reported a study on the degradation of dimethoate in aqueous systems (Volkl, 1993). The systems studied were Rhine river water (550 ml) + sediment (275 g) (system I) and pond water (550 ml) + sediment (190 g) (system II). The apparatus included an all-glass series of traps with an open air-flow system (60-80 ml/min) maintained in the dark at 20°C. Exactly 0.211 mg of [^{14}C]dimethoate, corresponding to a field application rate of 1.194 kg ai/ha, was added in acetone/water solution to each test system. The systems were incubated for 105 days with samples taken 0, 6, 24 and 48 hours and 7, 14, 30, 61 and 105 days. The water and sediment in each sample were separated and radioanalysed. The water phases were analysed by TLC and sediments extracted with acetonitrile or by Soxhlet with methanol. Some extracts were analysed by HPLC.

The half-lives of dimethoate were 17.2 days in system I and 13.2 days in system II estimated by non-linear regression analysis. The half-life values for the transfer of dimethoate to the sediments were 14.8 days for system I and 12.5 days for system II. The major degradation product was demethyl-dimethoate, which reached a maximum value of 22% of the applied radioactivity in the river system on day 30 and 17% in the pond system on day 7. The distribution of the dimethoate residues is shown in Table 16. Most of the ^{14}C was bound to sediment or converted to carbon dioxide.

Table 16. Distribution of ^{14}C from [^{14}C]dimethoate in water/sediment systems after 105 days.

Component	% of applied radioactivity	
	Rhine river system	Pond system
Demethyl-dimethoate	0.9	1.8
Polar metabolites	<5	<2
$^{14}CO_2$	28	24
Humin bound	16	28
Humic acid bound	4.8	11
Fulvic acid bound	21	13
Total accounted for	76	80

Cheminova reported a study of the photodegradation of dimethoate in contact with soil (Skinner and Shepler, 1994). [^{14}C]dimethoate labelled at the *O*-methyl groups was applied to sandy

loam soil at a nominal rate of 2.24 kg ai/ha. The treated soil was exposed to natural sunlight for 30 days at a controlled temperature of 25°C. A control soil in an identical apparatus was maintained in the dark. A continuous humidified air flow was maintained and volatile compounds were trapped. The soils were sampled at 0, 2, 5, 10, 20 and 30 days and extracted with acetonitrile/water (1:1, 3 x 10 ml). The extracts were radio-assayed and analysed by TLC, with radioanalytical imaging and HPLC. Residual solids were radio-assayed. Three main degradation products were indicated and two were isolated and identified by GC-MS. The third was lost during isolation and derivatization, apparently as a result of the extreme volatility of the derivative.

The half-life of dimethoate in sunlight was 10.5 days, but its half-life of the control (dark) soils was 7.9 days, showing that dimethoate on soil is not prone to photolytic degradation. On day 30 the extract of the irradiated soil contained 79% of the applied radioactivity, and that of the unexposed soil 84%. The bound soil residues accounted for 12% and 7.9% respectively. Dimethoate represented 11% of the applied radioactivity in the exposed soil and 4.9% in the unexposed (HPLC). The major degradation products identified in the 30-day extracts were dimethyl hydrogen phosphate, 28% and 13% of the applied radioactivity in the exposed and unexposed soils respectively, and dimethyl hydrogen phosphorothioate, 25% and 56% respectively (TLC). A third unidentified product accounted for about 6% of the applied radioactivity, and volatiles for about 5%.

METHODS OF RESIDUE ANALYSIS

Analytical methods

A series of related methods and validation data for them were presented for the determination of dimethoate and omethoate in or on various raw and processed agricultural commodities (ABC Laboratories, 1998). The methods are on the basis of those of Leoni (1992) and Aoki (1975). A homogenized sample, typically 50 g, is blended with acetone (100 ml). If the water content is <47%, 50 ml water is added. The slurry is filtered and the filtrate extracted with methylene chloride (3 x 100 ml). The combined methylene chloride extracts are evaporated to dryness, dissolved in hexane/acetone (1/1), and cleaned up on a column of Celite topped with Celite/charcoal (4:1). The column is eluted with hexane/acetone (200 ml, 1/1) under sufficient vacuum to obtain a 3-5 ml/min flow. Carbowax 200 is added to the eluate to give a 0.1% solution, which is concentrated in a rotary evaporator under nitrogen.

The extraction procedure is modified for oily substrates, such as corn oil and orange oil. A 10 g sample is brought to 50 ml with a methylene chloride/cyclohexane mixture (15/85), mixed thoroughly and chromatographed on a 50 g GPC column. The eluates are adjusted with Carbowax 200 solution to 0.1% and concentrated to 0–2 ml by rotary evaporation. The residue is taken up in acetone for GLC analysis.

This method, with the GPC clean-up, was used in a 1994 market basket survey in Australia (Marro, 1996).

Cotton seed (50 g) is extracted for 24 h with ethyl acetate in a Soxhlet extractor. After extraction the ethyl acetate is stripped and the residual oil is cleaned up by GPC as above. Soapstock (10 g) is mixed with galcial acetic acid (1.5 ml) and cleaned up by GPC. Potato chips (50 g) are mixed with ethyl acetate (3 x 200 ml) and sodium sulfate (~50 g). The mixture is filtered and again cleaned up by GPC.

The concentrated purified extracts are all analysed by GLC on a 30 m x 0.53 mm RTX-5 or 15 m x 0.53 mm DB-17 capillary column with an initial column temperature of 140°C, injection by flash vaporization (splitless) and flame photometric detection in the phosphorus mode. Calibration is with external standards of 0.05–1.0 µg/ml (0.01 to 0.08 mg/kg). The standards are prepared in acetone

containing 0.1% Carbowax 200. The Carbowax is needed to maintain constant sensitivity over the course of the GLC run. The limit of quantification is $\leq$ 0.01 mg/kg for each analyte.

The recoveries from a wide range of samples are shown in Table 17.

Table 17. Validation of the ABC/Leoni/Aoki methods for dimethoate and omethoate.

Sample	Fortification range, mg/kg	No. of analyses	Mean Recovery, %		Standard Deviation, %		Recovery Range, %	
			Dimethoate	Omethoate	Dimethoate	Omethoate	Dimethoate	Omethoate
Sorghum grain	0.01–0.50	7	83	85	4	4	80–90	80–90
Sorghum forage	0.01–0.50	7	86	91	3	5	80–90	87–100
Sorghum hay	0.01–0.50	7	85	93	8	7	75–100	83–100
Wheat grain	0.01–0.50	7	92	110	3	7	90–96	104–120
Wheat bran	0.01–0.50	7	93	103	3	5	90–98	96–109
Wheat middlings	0.01–0.50	7	93	97	6	3	80–99	91–100
Wheat shorts	0.01–0.50	7	95	106	5	11	90–102	92–120
Wheat flour	0.01–0.50	7	92	93	23	17	70–140	73 - 124
Maize grain	0.01–0.50	7	87	86	5	10	80–92	71–100
Maize grits	0.01–0.50	7	90	92	2	9	87–92	83–110
Maize meal	0.01–0.50	7	88	88	8	8	76–100	74–100
Maize flour	0.01–0.50	7	96	101	4	15	91–100	82–120
Maize starch	0.01–0.50	7	86	86	4	6	80–90	80–100
Maize oil	0.01–0.50	7	87	78	5	13	78–91	66–100
Cotton seed	0.01–0.50	5	98	65	8	14	90–110	49–80
Cotton seed meal	0.01–0.50	7	83	82	4	8	78–90	66–90
Cotton seed hulls	0.01–0.50	7	87	90	3	8	83–90	81–100
Cotton seed oil (crude)	0.01–0.50	7	105	116	13	17	90–120	99–140
Cotton seed soapstock	0.01–0.05	4	76	31	6	7	70–82	28–40
Oranges (whole)	0.01–0.50	8	101	100	5	12	95–110	82–120
Orange juice	0.01–0.50	7	107	99	4	5	102 –110	90–107
Orange pulp (dry)	0.01–0.50	7	79	72	5	6	69–84	63 - 80
Orange molasses	0.01–0.50	7	87	90	12	12	70–100	66–101
Orange oil	0.01–0.50	7	93	79	7	21	80–100	65–120
Potato	0.01–0.50	7	93	114	3	10	90–98	100–130
Potato granules	0.01–1.0	9	98	112	6	9	90–106	101–130
Potato chips	0.01–0.50	7	100	96	11	21	91–120	77–130
Potato peel (wet)	0.01–1.0	9	89	101	5	13	80–97	80 –120
Potato peel (dry)	0.01–0.50	7	83	87	5	8	80–93	76–100
Tomatoes (whole)	0.01–0.50	7	89	110	7	5	80–96	100–116
Tomato pomace (dry)	0.01–0.50	7	87	97	11	17	70–104	70–114
Tomato paste	0.01–0.50	7	98	88	7	18	90–110	60–107
Beans (succulent)	0.01–0.50	7	92	111	3	6	90–98	105–120
Bean forage	0.01–0.50	7	89	100	5	4	80–95	94–108
Bean straw	0.01–0.50	7	92	96	4	11	86–100	80 - 110
Peas (peas + pods)	0.01–0.50	7	99	104	8	12	90–110	91–120
Pea vines	0.01–0.50	7	88	98	9	16	79–100	83–120
Pea hay	0.01–0.50	7	75	83	5	9	70–82	74–100

The DTF reported a series of validations of Deutsche Forshungsgemeinschaft (DFG) method 236 (Lieferung, 1989). The method involves macerating a homogenized sample (typically 20-25 g) with acetone (2 x 100 ml) and water (2 x 50 ml), filtering, purifying by partition with methylene chloride (100 ml + 3 x 50 ml) followed by activated charcoal (2 g) after drying with sodium sulfate or by gel permeation or Florisil chromatography. The initial extraction solvent mixture may also contain ethyl acetate (e.g. for peas) or may be methanol/water rather than acetone, e.g. for barley. Residues in the concentrated extract are determined by GLC with a flame photometric detector and a 10 m x 530 µm HP-17 or 30 m x 530 µm HP-5 capillary column in the splitless mode, or equivalent. The limit of determination was 0.01 mg/kg, with recoveries of 70–110% and a relative standard deviation of $\leq$20%. Calibration was by external standards with a typical linear calibration range of 0.02 to 1.0 µg/ml. Recoveries are shown in Table 18.

Table 18. Recoveries from various samples fortified with dimethoate and omethoate and analysed by DFG method 236.

Sample	Omethoate		Dimethoate		Reference
	Fortifications, mg/kg/number	Recovery, %, range/mean [! SD]	Fortifications, mg/kg/number	Recovery, %, range/mean [! SD]	
Potato	0.010 n = 6	79–103 92 ± 8.8	0.010 n = 6	87–107 95 ± 8.3	Flatt, 1996
	0.20 n = 6	80–107 94 ± 11	0.20 n = 6	96–112 104 ± 7.0	
Sugar beet, leaf	0.010 n = 6	79–108 94 ± 10	0.010 n = 6	94–116 106 ± 8.2	Flatt, 1995
	0.20 n = 6	81–107 97 ± 11	0.20 n = 6	96–116 107 ± 7.2	
	5.0 n = 6	86–99 94 ± 5.2	5.0 n = 6	98–106 102 ± 2.7	
Sugar beet, root	0.010 n = 6	79–104 91 ± 8.7	0.010 n = 6	69 – 108 94 ± 16	
	0.20 n = 6	77–104 90 ± 11	0.20 n = 6	88–113 102 ± 9.6	
Peas (with pod)	0.01 n = 3	70 – 100 83	0.01 n = 3	71 – 90 80	Heyer and Schreitmuller, 1996
	0.5 n = 3	67–72 69	0.5 n = 3	74–77 75	
	3.0 n = 3	72 – 78 73 76	20. n = 3	55–72 64	
Peas (seeds)	0.01 n = 3	78–90 86	0.01 n = 3	90–100 93	
	0.5 n = 3	96–100 98	0.5 n = 3	65–75 69	
			1.0 n = 3	69–87 78	
Peas (straw)	0.01 n = 3	60–80 73	0.01 n = 3	90–130 113	
	0.20 n = 4	43–56 47	0.20 n = 4	70–73 72	
	5.0 n = 3	42–66 52	0.20 n = 3	75–79 78	
Barley (grain)	0.01 n = 3	60–80 70	0.01 n = 3	89–109 96	Melkebeke, 1996
	0.2 n = 3	77–86 82	0.2 n = 3	91–97 95	
Barley (straw)	0.01 n = 3	61-66 63	0.01 n = 3	93–115 103	
	0.5 n = 3	59–76 66	2. n = 3	79–88 84	
Maize (grain)	0.01 n = 6	90 90	0.01 n = 6	100–110 102 ± 4.0	Heyer, 1995
	0.2 n = 6	69 – 110 88 ± 16	0.2	81–108 95 ± 11	
Maize (cob)	0.01 n = 6	70 – 120 87 ± 18	0.01 n = 6	80–100 88 ± 7.5	
	0.2 n = 6	66–96 83 ± 12	0.2 n = 6	87–95 91 ± 4.0	
Maize (plant, green)	0.01 n = 6	50–70 62 ±7.5	0.01 n = 6	90–130 105 ± 14	
	0.2 n = 6	50–66 59 ± 7.2	0.2 n = 6	91–100 95 ± 3.7	
			5.0 n = 6	66–96 84 ± 10	
Wheat (whole plant)	0.01 n = 6	85–102 94 ± 6.3	0.01 n = 6	96–115 107 ± 7.7	Flatt, 1995
	0.20 n = 6	73-83 78 ± 4.5	0.20 n = 6	84–95 91 ± 4.2	

Sample	Omethoate		Dimethoate		Reference
	Fortifications, mg/kg/number	Recovery, %, range/mean [! SD]	Fortifications, mg/kg/number	Recovery, %, range/mean [! SD]	
			5.2 n = 6	81–89 85 ± 2.9	
Wheat (grain)	0.01 n = 6	70-94 84 ± 9.9	0.01 n = 6	81–95 89 ± 5.4	
	0.20 n = 6	70–81 75 ± 3.9	0.21 n = 6	87–96 93 ± 3.4	
Wheat (straw)	0.01 n = 6	53–72 61 ± 6.4	0.01 n = 6	64–84 76 ± 7.7	
	0.50 n = 6	58–74 66 ± 7.1	0.52 n = 6	88–94 91 ± 2.3	

The Netherlands submitted their official method for the determination of dimethoate (Ministry of Health, Welfare and Sport, 1996). It is a multi-residue method for compounds amenable to determination by GLC. Information was also supplied on methods used for field trials, but it was in Dutch. The official method contains extraction schemes for oily and non-fatty samples, meat, eggs and milk. Extracts are purified by gel permeation chromatography or liquid-liquid partitioning (milk, meat). For organophosphorus pesticides, the recovery is >80% for non-fatty foods, with a limit of determination of 0.01–0.05 mg/kg, and 65–105% for fatty foods, with a limit of determination of 0.01–0.04 mg/kg.

Australia provided information on several methods used with market basket surveys and field trials. method M16.01 (Melksham and Hargreaves, 1981) specifies extraction of the sample (50 g) with acetone (200 ml), evaporation, filtration and washing with water, extraction of the aqueous solution with chloroform, evaporation to dryness and sweep co-distillation (200°C) with ethyl acetate. The distillation step destroys omethoate. The distillate is analysed by GLC with a flame photometric detector. The recommended column is 1800 x 6 mm 3% OV101, operated isothermally at 196°C. The detector response is linear over a range of 20–120 ng dimethoate. The recoveries are shown in Table 19.

Table 19. Recoveries of dimethoate by method M16.01.

Commodity	Dimethoate fortification, mg/kg	Recovery, %	Reference
Avocado peel	2.2	86.5; 78.3; 72.3; 78.3; 78.9	Hargreaves *et al.*, 1982
Avocado pulp	0.48	118.9; 109.1	
	0.39	94.1	
Tomatoes	1	117; 92.4	Hamilton *et al.*, 1980
	0.5	95	
	0.4	95	Hargreaves and Jackson, 1988
Zucchini	0.4	94	

A method was described for the extraction and analysis, without clean-up, of rockmelons and cucumbers (Hargreaves and Heather, 1989). A sample (50 g) is macerated with acetone (3 x 150 ml) and filtered. The final volume is adjusted to 500 ml with acetone. An aliquot (20 ml) is mixed with water (30 ml), stripped of acetone and extracted with chloroform (1 x 100 ml, 2 x 50 ml). The combined organic extracts are concentrated to dryness and dissolved in ethyl acetate (1 ml). This extract is analysed by GLC with a 10 m HP-5 column and a flame photometric detector. The nominal limit of detection is 0.01 mg/kg. The method was validated for rockmelons at 1.5 and 0.5 mg/kg with recoveries of 92% and 97% respectively, and for cucumbers at 0.5 mg/kg, with recoveries of 100% and 101%.

Method PPQ-02 (Simpson, 1993) specifies blending the sample (50 g) with acetone (100 ml), filtration and transfer of a 50 ml aliquot to hexane/methylene chloride (100 ml, 1/1). The residual

aqueous layer is saturated with sodium chloride and extracted with methylene chloride (2 x 50 ml). The combined organic fractions are dried with sodium sulfate and concentrated to 1–2 ml. The concentrated extract is analysed by GLC with a 10 m x 0.53 mm HP-5 column and flame photometric detector. The detector displayed linear response from 0.26–52 µg/ml. Confirmation is by GC-MS. The method has been validated for dimethoate only, with strawberries and sweet potatoes. Duplicate samples fortified at 0.52 and 2.1 mg/kg were analysed. The recoveries are shown in Table 20. The method has been used on cabbage, asparagus, pasture grass, strawberries and sweet potatoes, and was used for the determination of residues on litchis in the supervised trials (Table 36).

A variation of method PPQ-02 was developed by Heather, *et al.* (1987). Chopped tomato (200 g) was macerated with acetone (2 x 200 ml) and filtered. The acetone was stripped under vacuum and the residual aqueous fraction extracted with hexane (2 x 100 ml). The aqueous solution was extracted with chloroform (1 x 200 ml, 5 x 100 ml) and the combined chloroform extracts were dried and stirred with decolourising charcoal. The solution was filtered and the solvent changed to acetone. The concentrated acetone extract was analysed by GLC on a 1 m x 2 mm column packed with OV-225.

Table 20. Recoveries of dimethoate by method PPQ-02.

Sample	Fortification, mg dimethoate/kg	Recovery, %		
		First analysis	Second analysis	Mean
Strawberries	0.52	111	111	111
	2.1	111	103	107
Sweet Potatoes	0.52	107	104	106
	2.1	103	102	102
Tomato (Heather variation)	0.02	70		
Tomato (Heather variation)	0.1	73		

A method for the extraction and determination of dimethoate and omethoate in or on strawberries has been published (Goodwin, *et al.*, 1985). A chopped sample (25 g) is blended with acetonitrile and filtered. Water is added to the filtrate and the acetonitrile stripped on a rotary evaporator. The aqueous solution is extracted with chloroform (3 x 25 ml) and the chloroform replaced by hexane. The final extract is analysed by GLC on a 2 m x 0.32 mm column of OV-225 on Chromosorb W with a specific thermionic detector. The mean recovery of dimethoate and omethoate was 93 $\pm$ 2% from 0.5, 1, 1.5 and 2 mg/kg fortifications.

Stability of pesticide residues in stored analytical samples

Cheminova submitted a detailed report of a study in the USA in 1993-4 on the storage stability of dimethoate and omethoate in potato tubers, orange fruit, sorghum grain, sorghum forage and cotton seed (Williams, 1994). The commodities were stored at –20°C until homogenized, when 50 g sub-samples of each homogenate, fortified separately with either 1.0 mg/kg dimethoate or 0.5 mg/kg omethoate were stored at -20°C. Duplicate samples were analysed at intervals, together with control samples and freshly fortified samples.

Analyses were by the ABC methods detailed above. All essential details and copies of supporting chromatograms were supplied. The results are shown in Table 21.

Table 21. Storage stability of dimethoate and omethoate in frozen samples fortified at 1.0 mg/kg and 0.5 mg/kg respectively.

Commodity	Period, days	Dimethoate			Omethoate		
		Apparent recovery, %	Freshly fortified control recovery, %	Corrected storage recovery, %	Apparent recovery, %	Corrected fortified control recovery, %	Corrected storage recovery, %
Potato	0	92	92	100	93	93	100
	39	77; 81	87	91	78; 76	83	93

Commodity	Period, days	Dimethoate			Omethoate		
		Apparent recovery, %	Freshly fortified control recovery, %	Corrected storage recovery, %	Apparent recovery, %	Corrected fortified control recovery, %	Corrected storage recovery, %
	70	91; 92	96	96	91; 92	95	97
	137	85; 86	95	90	84; 89	95	91
	188	88; 89	94	95	88; 89	93	96
	620	80; 76	88	89	87; 87	93	94
Orange fruit	0	84	84	100	81	81	100
	39	87; 87	93	94	88; 80	89	95
	70	95; 110	97	106	99; 97	94	104
	137	91; 86	99	90	102; 98	101	99
	188	95; 95	97	98	102; 103	102	101
	620	92; 88	89	101	107; 112	100	110
Sorghum Grain	0	91	91	100	91	91	100
	34	88; 86	85	103	84; 33	75	78
	67	74; 72	91	80	86; 90	97	91
	137	89; 90	94	96	84; 88	94	92
	185	92; 98	97	98	92; 93	97	96
	620	71; 68	106	70	77; 79	100	78
Sorghum Forage	0	76	76	100	85	85	100
	36	79; 73	85	90	74; 73	71	104
	69	98; 94	101	95	98; 97	104	94
	139	81; 78	86	93	80; 81	91	89
	187	82; 84	86	97	86; 86	86	100
	622	65; 72	94	73	84; 96	103	90
Cotton seed	82	93; 97	97	96	44; 50	53	87
	126	88; 91	95	95	52; 46	62	79
	189	87; 87	98	89	48; 53	67	76
	623	91; 92	103	92	78; 82	101	80

Cheminova referenced, but did not supply, storage stability data on lettuce and apples.

Definition of the residue

On the basis of the metabolism of dimethoate in plants and animals, the conclusions of the 1996 JMPR on the toxicology, the available analytical methods and the lack of significant data on omethoate *per se*, the Meeting concluded that the residue for compliance with MRLs should be defined as dimethoate. For the estimation of dietary intake the residue is based on the sum of dimethoate and omethoate, each considered separately.

USE PATTERN

The DTF provided numerous labels with translations. Extensive information on GAP was supplied by Australia and some additional information by the governments of the UK, Germany, The Netherlands and Thailand. The information is summarized in Tables 22 and 23.

Table 22. Registered uses of dimethoate.

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Abius	Australia	EC 400 g/l		0.00030		Foliar	7	
Alfalfa	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.24			Ground, aerial (min 20 l water/ha)	7	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Alfalfa	Hungary	Danadim 40 EC. 400 g/l	0.40			Foliar	14	
Alfalfa	Mexico	Perfekthion EC. 400 g/l	0.40	0.0013		Foliar	10	
Alfalfa	USA	Dimethoate 400 EC. 4 lbs/gal	0.56	0.012	1 per cutting	Foliar aerial, ground	10	
Amsoi	Netherlands	Perfekthion EC. 400 g/l	0.20		Repeat as needed	Foliar	21	Outdoor cultivation
Apples	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.075 kg/100 l water		>1	Foliar	7	
Apples	Australia	EC 400 g/l		0.00060		Foliar	7	
Apples	Belgium	Hermootrox EC. 400 g/l	0.04 kg/100 l water			Foliar	21	
Apples	Italy	Danadim EC. 400 g/l	0.048 kg/100 l water			Foliar, no aerial	20	
Apples	Mexico	Perfekthion EC. 400 g/l	0.50 (125 cc/100 l)	0.00050		Foliar	28	Assumed high volume = 1000 l/ha
Apples	Netherlands	400 g/l EC	0.30	0.0002	3	Foliar	21	Perfekthion label: 50 ml/100 l water, NOT for use in glasshouse
Apples	Sweden	Danadim 40 EC. 400 g/l	0.30	0.00075	1 (after blossom)	Foliar	28	Apply at bud formation, before blossoming, or one week after blossoming
Apples	UK	40 EC. 400 g/l	0.68	0.0025 low vol.; 0.00027 high vol.	4	Foliar	35	
Apples	USA	Dimethoate 400 EC. 4 lbs/gal		0.0006 (1 pt/100 gal water)	Not specified	Foliar aerial, ground	28	
Apricots	Australia (Qld)	Saboteur EC 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Artichoke	Italy	Danadim EC. 400 g/l	0.06 kg/100 l water			Foliar, not aerial	20	
Asparagus	Belgium	Hermootrox EC. 400 g/l	0.20			Foliar	21	Wetter recommended
Asparagus	Denmark	Perfekthion 500 S EC. 500 g/l. Danadim 40 EC. 400 g/l	0.30; 0.32	0.00030; 0.00032		Foliar	14 (Perf)	
Asparagus	Italy	Danadim EC. 400 g/l	0.06 kg/100 l water			Foliar, not aerial	20	
Asparagus	Morocco	Rogor L 40 EC. 400 g/l	0.038 kg/ 100 l water			Foliar	20	
Asparagus	Netherlands	400 g/l EC	0.30	0.0006	4	At stem emergence	21	
Asparagus	USA	Dimethoate 400 EC. 4 lbs./gal.	0.56	0.012	5	Foliar aerial, ground, chemigation	180	
Avocado	Columbia	Perfekthion EC. 400 g/l	0.48	0.00048			14	Assumed high volume = 1000 l/ha
Avocado	Australia (Qld)	400 EC. 400 g/l	0.3	0.00030	Not specified	Foliar, high volume @ 1000 l/ha	7	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Avocado	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Babacos	Australia	EC 400 g/l		0.00030		Foliar	7	
Bananas	Australia (Qld, NT, NSW)	EC. 400 g/l	0.30	0.00030	Not specified	Foliar, in at least 1000 l water/ha	7	
Bananas	Australia (NSW)	Rogor Diostop EC. 400 g/l		0.0060		Dip 20–60 sec.	Post-harvest	
Bananas	Australia (Qld, NSW)	Roxion 400 EC. 400 g/l		0.00060	1	Dip 10–60 sec.	Post-harvest	
Bananas	Australia (Qld)	EC. 400 g/l	150 ml/100 l water (600 ppm)		1	Post-harvest dip		
Bananas	New Zealand	EC. 500 g/l	?	?				120 ml/100 l water
Bananas	Reunion	Perfekthion EC. 400 g/l	150 ml/100 l water			Foliar	15	
Barley	Columbia	Perfekthion EC 400 g/l	0.30			Foliar	14; 7 (fodder)	
Barley	Netherlands	400 g/l EC	0.20	0.001	1	Foliar	14	
Beans	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.22; 0.50 high vol.	0.00050 high vol.	>1	Foliar, ground and aerial (min 20 l water/ha)	20	
Beans	Australia	EC. 400 g/l	0.30	0.00030 high vol.; 0.0064 low vol.	Repeat as needed	Foliar	7	
Beans	Belgium	Hermootrox EC. 400 g/l	0.20			Foliar	21	Field beans
Beans	Columbia	Perfekthion EC. 400 g/l	0.30			Foliar	14	
Beans, broad	Denmark	Perfekthion 500 S EC. 500 g/l	0.30	0.00030		Foliar	14	
Beans, horse	Denmark	Danadim 40 EC. 400 g/l	0.32	0.0021		Foliar		
Beans, long	Indonesia	Perfekthion 400 EC. 400 g/l	0.20	0.00020		Foliar		Assumed high volume = 1000 l/ha
Beans	Italy	Danadim EC. 400 g/l	0.06 kg/100 l water			Foliar, not aerial	20	
Beans, French, broad, runner	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	0	
Beans (pulses)	Netherlands	400 g/L EC	0.20	0.001	3	Foliar	21	With and without pods
Beans, broad, French, runner	UK	40 EC. 400 g/ha	0.34	0.0016	2	Foliar	14	
Beans, green, lima, snap, dry	USA	Dimethoate 400 EC. 4 lbs/gal	0.56	0.012	Not specified	Foliar aerial, ground, chemigation	0	
Beetroot	Australia (NSW)	Roxion 400 EC. 400 g/l	0.32	0.0064 (low vol.); 0.00030 high vol. @ 1000 l/ha	Repeat as needed	Foliar	7	
Beetroot	Denmark	Perfekthion 500 S EC. 500 g/l.	0.30; 0.32	0.00030; 0.00032		Foliar	14 (Perf)	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
		Danadim 40 EC. 400 g/l						
Beetroot	Netherlands	400 g/l EC	0.20	0.001	3	Foliar	21	Also applies to scorzonera root, witloof root, chicory root
Berries	Australia	400 g/l EC	0.32	0.00030 high vol.; 0.0064 low vol.	Repeat as needed	Foliar	7	
Berries	Denmark	Danadim 40 EC. 400 g/l	0.60	0.00030		Foliar		
Blackcurrant	UK	Dimethoate 40 EC. 400 g/l	0.34 low volume; 0.22 high volume	0.00062 low vol.; 0.00022 high vol.	3	Foliar	28	
Blackberries	Netherlands	400 g/l EC	0.24	0.00020	3	Foliar	21	Also raspberries
Brassica vegetables	Australia	Roxion 400 EC. 400 g/l	0.3	0.00030 high vol. @ 1000 l/ha	Not specified	Foliar	7	
Brassica vegetables	Netherlands	400 g/l EC	0.2	0.0005	3	Foliar	21	Specifies broccoli, cauliflower, head, Savoy, pointed and Chinese cabbage, kale, kohlrabi
Brassica vegetables	Thailand	400 g/l EC	0.4	0.00040	4	Foliar	14	
Brassica vegetables	UK	3.6% G (with 3.6% chlorpyrifos)	5.54 g ai/100 meters row; 1.84 kg/ha for 30 cm row spacing; at planting, transplanting; 2nd as a surface band		2	Soil incorporated; banded	28	Specifies broccoli, Brussels sprouts, cabbage, cauliflower, kale, collards, mustard, rape.
Brassica vegetables	UK	40 EC. 400 g/l	0.40	0.00040–0.00067	6	Foliar	7	
Broccoli	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	7	
Broccoli	USA	Dimethoate 400 EC. 4 lbs/gal	0.56	0.012	Not specified	Foliar ground, aerial, chemigation	7	
Brussels sprouts	Germany	400 g/l EC	0.24 0.36	0.0012 (200 l water/ha) 0.00040	2	Foliar	14	Higher rate if >50 cm
Brussels sprouts	USA (CA)	Dimethoate 400 EC. 4 lbs/gal	1.12	0.0012	6	Foliar ground, aerial	10	
Bush fruit	Denmark	Perfekthion 500 S EC. 500 g/l	0.6	0.00030		Foliar	14	
Cabbage	Columbia	Perfekthion EC. 400 g/l	0.20			Foliar	24	
Cabbage	Germany	400 g/l EC	0.24	0.00020–0.00040	2	Foliar	14	Specifies red, white, Savoy. See next entry.
Cabbage	Germany	400 g/l EC	0.4	0.002 (200 l water/ha)	1	Foliar	42	Specifies red, white, Savoy

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Cabbage	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	7	
Cabbage	Sweden	Danadim 40 EC. 400 g/l	0.0001 kg/linear m	0.0002		Directed to soil about root of plant		Use in early July
Cabbage	USA	Dimethoate 400 EC. 4 lbs/gal	0.56	0.012	Not specified	Foliar ground, aerial, chemigation	7	
Cacao	Reunion	Perfekthion EC. 400 g/l	150 ml/100 l water			Foliar	15	
Cacao	New Zealand	EC 500 g/l	?	?				120 ml/100 l
Cactus fruit	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l (400 ppm)		1	Post-harvest dip		
Canola	Australia	400 g/l EC	0.30	0.00030 @ 1000 l/ha	Repeat as needed	Foliar	14	
Canola	Australia	Roxion 400 EC. 400 g/l	165 ml/600 ml water/50 kg seed		1	Seed treatment	N/A	
Caraway seed	Netherlands	400 g/l EC	0.20	0.001	2	Foliar	21	
Carrot	Australia	EC 400 g/l	0.32	0.00030		Foliar	7	
Carrot	Germany	400 g/l EC	0.24	0.00040–0.0012	2	Foliar	14	
Carrot	Netherlands	400 g/l EC	0.20	0.001	3	Foliar	21	
Carrot	Sweden	Danadim 40 EC. 400 g/l	0.0001 kg/linear m	0.0002		Irrigation preparation, directed to plant roots		
Carrot	UK	40 EC. 400 g/l	0.34 low volume	0.0016	4	Foliar	14	
Casimiroas	Australia	EC 400 g/l		0.00030		Foliar	7	
Cauliflower	Columbia	Perfekthion EC. 400 g/l	0.20			Foliar	14	
Cauliflower	Germany	400 g/l EC	0.4	0.00067; 0.002 (Danadim label; 200 l water/ha)	1	Foliar	42	
Cauliflower	Mexico	Perfekthion EC. 400 g/l	0.4			Foliar	7	
Cauliflower	USA	Dimethoate 400 EC. 4 lbs/gal	0.56		Not specified	Foliar, ground, aerial, chemigation	7	
Celeriac	Belgium	Hermootrox EC. 400 g/l	0.20			Foliar	21	
Celeriac	Netherlands	400 g/l EC	0.40	0.002	2	Foliar	21	
Celery	Australia	Roxion 400 EC. 400 g/l	0.32	0.00030 (high vol. @ 1000 l/ha)	Repeat as needed	Foliar	7	
Celery	Italy	Danadim EC. 400 g/l	0.06 kg/100 l water			Foliar, no aerial	20	
Celery	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	7	
Celery	Netherlands	400 g/l EC	0.20	0.001	3	Foliar	21	
Celery	USA (FL)	Dimethoate 400 EC. 4 lbs/gal	0.56	0.012	Not specified	Foliar ground, aerial, chemigation	7	
Cereals	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.40			Foliar ground, aerial (min 20 l water/ha)	20	
Cereals	Australia	EC. 400 g/l	0.30 high volume; 0.036 low	0.00030 high vol.; 0.00072	Reapply as needed	Foliar	28	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
			volume	low vol. (ground boom); 0.0018 low vol. (aerial or misting machine)				
Cereals	Australia	400 EC. 400 g/l	0.30; 0.034 low volume	0.00030 high vol. @ 1000 l/ha; 0.0017 low vol. (mister)	Not specified	Foliar, boom, aerial, mister	28	
Cereals	Denmark	Danadim 40 EC. 400 g/l	0.80	0.0053		Foliar		
Cereals	Sweden	Danadim 40 EC. 400 g/l	0.32			Foliar	28	
Cereals	UK	40 EC. 400 g/l	0.34	0.0005; 0.00034	4	Foliar, ground or aerial	14 (ground) Mar. 31 (aerial)	Aerial: at least 20 l water/ha
Cherry	Australia	EC 400 g/l		0.00030		Foliar	7	
Cherry	Australia	400 g/l EC	50 ml/100L (200 ppm)		1	Post-harvest dip		
Cherry	Belgium	Hermootrox EC. 400 g/l	0.030 kg/100 l water			Foliar	14	
Cherry	Germany	400 g/l EC	0.6	0.00040	3	Foliar	21	
Cherry	Italy	Danadim EC. 400 g/l	0.048 kg/100 l water			Foliar, no aerial	20	
Cherry	Netherlands	400 g/l EC	0.3	0.0002	3	Foliar	14	Perfekthion label: 50 ml/100 l water. NOT for use in glasshouses.
Cherry	UK	40 EC. 400 g/l	0.68	0.0023 low vol.; 0.00027 high vol.	4	Foliar	21	
Cherry	USA (ID, OR)	Dimethoate 400 EC. 4 lbs/gal	1.12	0.0024	1	Foliar ground	21	
			0.28	0.0003	1			
Cherry	USA (ID, WA, OR)	Dimethoate 400 EC. 4 lbs/gal		0.0006	1	Foliar ground	≥7 days post-harvest	
Chickpeas	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	21	
Chicory – see Witloof								
Chilli peppers	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Chilli peppers	Indonesia	Perfekthion 400 EC. 400 g/l	0.20	0.00020		Foliar		Assumed high volume = 1000 l/ha
Chilli peppers	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	21	
Chokos	Australia	EC. 400 g/l	0.30	0.00030				
Citrus	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.75	0.00075	>1		20	
Citrus (except Meyer Lemons, Seville Oranges and Kumquats)	Australia	EC. 400 g/l	0.30	0.015 low vol. (misting machine or aerial); 0.00060 high vol.	Repeat as needed	Foliar	7	
Citrus	Columbia	Perfekthion EC. 400 g/l	1.2	0.0012			14	Assumed high volume = 1000 l/ha
Citrus	Italy	Danadim EC. 400 g/l	0.06 kg/100 l water			Foliar, not aerial	20	
Citrus	Morocco	Perfekthion EC. Rogor L 30 EC. 400 g/l	0.048-0.10 kg/100 l water			Foliar	21; 20	
Citrus	Reunion	Perfekthion EC. 400 g/l	100 ml/100 l water			Foliar	15	Do NOT apply to rough lemon or Seville oranges
Citrus	Thailand	400 g/l EC	0.85	0.0004			14	
Citrus	USA	Dimethoate 400 EC. 4 lbs/gal		0.00060	2 (for mature fruit)	Foliar ground		
			2.24	0.048	2 (for mature fruit)	Foliar aerial		
Citrus	USA	Dimethoate 400 EC. 4 lbs./gal		0.00090	2 (for mature fruit)	Foliar ground	45	
Citrus	USA (CA, AZ)	Dimethoate 400 EC. 4 lbs/gal		0.0060	Not specified	Foliar ground, in year trees first bear fruit	Not specified	
Citrus	USA (CA, AZ)	Dimethoate 400 EC. 4 lbs/gal	2.24		Not specified	Soil drench in furrow about trees		Do not apply to trees that bear fruit within one year
Citrus	New Zealand	EC 500 g/l	?	?				80 ml/100 l
Clover	Australia	EC 400 g/l	0.30	0.00030		Foliar	1 (pregraze)	
Clover	Australia	Saboteur EC. 400 g/l	600 ml in 2 L of water/100 kg seed		1	Seed treatment	Not applicable	Do not use for animal feed.
Coffee	Argentina	Perfekthion EC. 400 g/l	1.0	0.0010		Foliar		Assumed high volume = 1000 l/ha
Coffee	Reunion	Perfekthion EC. 400 g/l	150 ml/100 l water			Foliar	15	
Coffee	New Zealand	EC 500 g/l	?	?				120 ml/100 l
Collards	USA	Dimethoate	0.28		Not	Foliar ground,	14	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
		400 EC. 4 lbs/gal			specified	aerial, chemigation		
Cotton	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.16			Ground, aerial (min 20 l water/ha)	14	
Cotton	Australia (NSW, WA, Qld)	400 EC. 400 g/l	0.30	0.004-0.0003 ground boom; 0.01 mister or aerial	Repeat as needed	Foliar	14	
Cotton	Mexico	Perfekthion EC. 400 g/l	0.60			Foliar	14	
Cotton	Morocco	Rogor L 40 EC. 400 g/l	0.038 kg/100 l water			Foliar	20	
Cotton	Reunion	Perfekthion EC. 400 g/l	0.40			Foliar	15	
Cotton	USA (CA, AZ)	Dimethoate 400 EC. 4 lbs/gal	0.56		2	Foliar ground, aerial, chemigation	14	
Cotton	USA	Dimethoate 400 EC. 4 lbs/gal	0.28		Multiple at 14 day intervals	Foliar	14	
Courgettes	Netherlands	Perfekthion EC. 400 g/l	0.20		Repeat as needed	Foliar	21	
Cowpea	Australia (NSW)	Roxion 400 EC. 400 g/l	0.32	0.0064 for ground boom; 0.016 for ground mister	2 (pre--bloom to full flowering)	Foliar	7	
Crucifers	Denmark	Perfekthion 500 S EC. 500 g/l. Danadim 40 EC. 400 g/l	0.30; 0.32	0.00030; 0.0021		Foliar	14 (Perf)	Such as cabbage, mustard, cauliflower (Perfekthion)
Cucumbers	Hungary	Danadim 40 EC. 400 g/l	0.48			Foliar	14	
Cucumber	Thailand	400 g/l EC	0.4	0.0008	`	Foliar	14	
Cucurbits	Australia	EC. 400 g/l	0.30	0.00030 high vol. @ 1000 l/ha	Repeat as needed	Foliar	1; 7 (NSW)	
Currants	Australia	EC 400 g/l		0.00030		Foliar	7	
Currants	Hungary	Danadim 40 EC. 400 g/l	0.32			Foliar	14	
Currants	Netherlands	400 g/l EC	0.24	0.0002 0.002 (1/3-1/11)	3	Foliar	21	Specifies black, red, white and gooseberries. Perfekthion label: 50 ml/100 l water. NOT for use in glasshouse.
Currants	Sweden	Danadim 40 EC. 400 g/l	0.2	0.0002		Foliar	28	Apply before blossoming or within one week after blossoming stops
Custard apples	Australia (Qld, NT)	Roxion 400 EC. Saboteur EC. 400 g/l	0.30	0.00030 high vol. @ 1000	Repeat as needed, usually	Foliar, high volume	7	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
				l/ha	late season			
Custard apples	Australia (Qld)	Saboteur EC. 400 g/l	100 ml /. 100 l (400 ppm)		1	Post-harvest dip.	7	Not for food/feed in NSW
Duboisa	Australia (Qld)	Saboteur EC. 400 g/l	0.30	0.003 high vol. @ 1000 l/ha	Repeat as needed, 7–10 day interval	Foliar	None specifi ed	
Egg plant	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l (400 ppm)		1	Post-harvest dip		
Endive	Netherlands	Perfekthion EC. 400 g/l	0.20			Foliar	21	Outdoor cultivation only.
Endive (escarole)	USA	Dimethoate 400 EC. 4 lbs/gal	0.28		Not specified	Foliar, ground, aerial, chemigation	14	
Feijoas	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l (400 ppm)		1	Post-harvest dip		
Fennel	Netherlands	400 g/l EC	0.20	0.001	3	Foliar	21	
Figs	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l (400 ppm)		1	Post-harvest dip		
Fruit	Switzerland	400 g/l EC	0.0004 kg/l (0.1%)			Foliar	21	
Fodder beet	Germany	400 g/l EC	0.16	0.00027	1	Foliar	35	
Fodder beet	Netherlands	400 g/l EC	0.40	0.002	3	Foliar		
Fodder beet	Switzerland	400 g/l EC.		0.0004 kg/l (0.1%)		Foliar	42	Last application before flowering
Forage crops	Australia	EC 400 g/l	0.30	0.00030				
Fruit trees	Morocco	Rogor L 40 EC. 400 g/l Perfekthion EC	0.048–0.06kg/100 l water			Foliar	20	Apricots, peaches
Fruits with seeds	Reunion	Perfekthion EC. 400 g/l	150 ml/100 l water			Foliar	15	Pome fruit ?
Garbanzo beans	USA	Dimethoate 400 EC. 4 lbs/gal	0.56		Not specified	Foliar, ground, aerial, chemigation	0	
Gherkins	Australia	EC. 400 g/l	0.30	0.00030		Foliar	1	
Gooseberries	Sweden	Danadim 40 EC. 400 g/l	0.20	0.0002		Foliar	28	Apply before blossoming or within one week after blossoming stops
Grain	Denmark	Perfekthion 500 S EC. 500 g/l	0.75	0.00075		Foliar	14	
Granadillas	Australia	EC. 400 g/l		0.00030		Foliar	7	
Grapefruit	Mexico	Perfekthion EC. 400 g/l	0.80 (200 cc/100 l water)	0.00080		Foliar	15	Assumed high volume = 1000 l/ha
Grapes	Australia (Queens-land)	Roxion 400 EC. Saboteur EC. 400 g /L	0.30	0.00030 high vol. @ 1000 l/ha	Not specified	Foliar, high volume	7	
Grapes	Hungary	Danadim 40 EC. 400 g/l	0.32			Foliar	14	
Grapes	Hungary	Rogor L40 EC. 400 g/l		0.0004		Foliar	14 (7?)	
Grapes	Mexico	Perfekthion EC. 400 g/l	0.60			Foliar	27	
Grapes	Morocco	Rogor L 40 EC. 400 g/l		0.00048		Foliar	21	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Grapes	Netherlands	400 g/l EC	0.30 (1/3–1/11) 0.24	0.0002	3	Foliar	28 (1/3-1/11) 21	
Grapes	USA (CA)	Dimethoate 400 EC. 4 lbs/gal	2.24	0.00067	Repeat as needed	Foliar	28	
Grass	Denmark	Danadim 40 EC. 400 g/l	0.80	0.0053				
Grass	Netherlands	Perfekthion EC. 400 g/l	0.20	0.0013		Foliar		Grass grown for seed.
Grass	USA (ID, OR, WA)	Dimethoate 400 EC. 4 lbs/gal			Not specified	Foliar	Not specifi ed.	Grass grown for seed only
Green-leafed vegetables	Denmark	Perfekthion 500 S EC. 500 g/l	0.30	0.00030		Foliar	21	Such as lettuce, spinach, Chinese cabbage, kale.
Guavas	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water. (400 ppm)		1	Post-harvest dip		
Hops	Hungary	Rogor 40L EC. 400 g/l	0.0002 kg per plant (0.5 L of a 0.1% solution)			Foliar	14	
Hops	UK	Dimethoate 40 EC. 400 g/l	0.34 high volume	0.00034	8	Foliar	14	Fuggles variety only
Kale	USA	Dimethoate 400 EC. 4 lbs/gal	0.28		Not specified	Foliar, ground, aerial, chemigation	14	
Kiwifruit	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Kohlrabi	Denmark	Danadim 40 EC. 400 g/l	0.32	0.0021				
Leafy vegetables	Australia	400 g/l EC	0.32	0.00030 high vol. @ 1000 l/ha; 0.0064–0.016 low vol.	Repeat as needed	Foliar	7	Specifies cole crops, lettuce, silverbeet, beet, celery.
Leafy vegetables	Denmark	Danadim 40 EC. 400 g/l	0.32	0.00032		Foliar		
Leek	Netherlands	400 g/l EC	0.40 (0.20)	0.001	2 (3)	Foliar	21	
Legumes - pasture and fodder	Australia	EC 400 g/l	0.30	0.00030		Foliar	1 (pregra ze)	
Legumes – seed	Australia	EC 400 g/l	0.32	0.00030		Foliar	1 (pregra ze)	
Legume vegetables	Thailand	400 g/l EC	0.30	0.00040	8		14	
Lemons	Mexico	Perfekthion EC. 400 g/l	0.80 (200 cc/100 l water)	0.0080		Foliar	15	Assumed high volume = 1000 l/ha
Lentils	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.30				20	
Lentils	Australia	EC. 400 g/l	0.04			Foliar	7	
Lentils	USA	Dimethoate 400 EC. 4 lbs. gal	0.56		2	Foliar, ground, aerial, chemigation	14	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Lettuce	Australia	Roxion 400 EC. 400 g/l	0.32 low volume; 0.30 high volume	0.00030 high vol.; 0.0064 low vol.	Repeat as needed.	Foliar	7	
Lettuce	Columbia	Perfekthion EC. 400 g/l	0.20			Foliar	14	
Lettuce, Head	Germany	400 g/l EC	0.24	0.00020–0.00040	2	Foliar	21	
Lettuce	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	21	
Lettuce, Head	Netherlands	400 g/l EC	0.20	0.001	3	Foliar	21	Also crisphead lettuce
Lettuce	UK	40 EC. 400 g/l	0.34	0.0016 low vol.; 0.00034 high vol. @ 1000 l/ha	1	Foliar	28	
Lettuce, Head	USA	Dimethoate 400 EC. 4 lbs/gal	0.28		Not specified	Foliar, ground, aerial, chemigation	7	
Lettuce, Leaf	USA	Dimethoate 400 EC. 4 lbs/gal	0.28		Not specified	Foliar, ground, aerial, chemigation	14	
Leucaena	Australia	EC. 400 g/l	0.14			Foliar	1 (pre-graze)	
Linseed	Australia	EC. 400 g/l	0.30	0.00030		Foliar	14	
Litchi (lychees)	Australia	EC. 400 g/l	0.1 l/100 l	-		Post-harvest dip	0	
Litchi (lychees)	Australia (Qld, NSW)	EC. 400 g/l	75 ml/100 l water (300 ppm)		1	At-plant dip	N/A	Plants immersed in mixture for one min before planting. Some labels also specify persimmons and Chinese gooseberries
Loquats	Australia (Qld)	Saboteur EC. 400 g./L	100 ml/100 l water. (400 ppm)		1	Post-harvest treatment		
Lucerne	Australia	EC. 400 g/l	600 ml in 1.8 l of water/100 kg seed		1	Seed treatment	Not appli-cable	
Lucerne	Australia	Roxion 400. 400 g/l EC	0.30 high volume; 0.15 low volume	0.003 low vol. (ground boom); 0.008 low vol. (aerial or misting machine); 0.00030 high vol.	Repeat as needed	Foliar	1	
Lucerne	Netherlands	400 g/l EC	0.20	0.001	2	Foliar		
Lupins	Australia	400 g/l EC	0.32	0.016 low vol. (ground misting); 0.0064 low vol.		Foliar	14	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
				(ground boom)				
Lupins	USA	Dimethoate 400 EC. 4 lbs/gal	0.56		2	Foliar, ground, aerial, chemigation	0	
Maize	Australia	EC. 400 g/l	0.20			Foliar	28	
Maize	Columbia	Perfekthion EC. 400 g/l	0.24			Foliar	14	
Maize	Denmark	Perfekthion 500 S EC. 500 g/l. Danadim 40 EC. 400 g/l	0.30; 0.32	0.00030; 0.0021		Foliar	14 (Perfek-thion)	
Maize	Hungary	Rogor 40L EC. 400 g/l	0.80			Foliar	14	
Maize	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	14	
Maize	Netherlands	400 g/l EC	0.20	0.001	1	Foliar		
Maize	Reunion	Perfekthion EC. 400 g/l	0.32			Foliar	15	
Maize	USA	Dimethoate 400 EC. 4 lbs/gal	0.56		3	Foliar, ground, aerial, chemigation	14	
Mango	Australia	Roxion 400 EC. Saboteur EC. 400 g/l	0.30	0.00030	Not specified	Foliar	7	
Mango	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip	7	
Marrows	Australia	EC. 400 g/l	0.30	0.00030		Foliar	1	
Mate	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.30			Foliar, ground, aerial (min 20 l water/ha)	7	
Medics	Australia	EC. 400 g/l	0.30	0.00030		Foliar	1 (pre-graze)	
Melons	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	3	
Melons	USA	Dimethoate 400 EC. 4 lbs/gal	0.56		Not specified	Foliar, ground, aerial, chemigation	3	
Mulberries	Australia	EC. 400 g/l		0.00030		Foliar	7	
Mustard	Australia	EC. 400 g/l	0.30	0.00030		Foliar	14	
Mustard greens	USA	Dimethoate 400 EC. 4 lbs/gal	0.28		Not specified	Foliar, ground, aerial, chemigation	14	
Nectarine	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Oats	Columbia	Perfekthion EC. 400 g/l	0.30			Foliar	14; 7 (fod-der)	
Oats	Netherlands	400 g/l EC	0.2	0.001	1	Foliar	14	
Oil seeds	Australia	EC. 400 g/l.	0.30 high vol.; 0.14 low vol.	0.00030 high vol.; 0.003 low vol. (ground boom): 0.007 low vol. (aerial or misting machine)	Not specified	Foliar	14	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Olives	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.075 kg/100 l water			Foliar ground, aerial (min 20 l water/ha)	20	
Olives	Italy	Danadim EC. 400 g/l	0.060 kg/100 l water			Foliar, no aerial	20	
Olives	Morocco	Rogor L 40 EC. 400 g/l. Perfekthion EC	0.056 kg/100 l water			Foliar	20	
Olives	Reunion	Perfekthion EC. 400 g/l	150 ml/100 l water			Foliar	15	
Onions	Australia	EC. 400 g/l	0.30	0.00030		Foliar	7	
Onions	Denmark	Perfekthion 500 S EC. 500 g/l	0.32	0.00030		Foliar	14	
Onions	Germany	400 g/l EC	0.24	0.00020–0.00040	2	Foliar	14	
Onions	Denmark	Danadim 40 EC. 400 g/l	0.32	0.00032		Foliar		
Onions	Netherlands	Perfekthion EC. 400 g/l	0.40				21	Spring; 1st year sets; 2nd year sets; picklers; silver-skin; shallots; leeks
Onions	Sweden	Danadim 40 EC. 400 g/l	0.0001 kg per linear m	0.0002		Irrigation preparation		
Onions	Sweden	Danadim 40 EC. 400 g/l	0.1% (400 ppm)			Dip		Dip sets for 15 minutes before planting
Oranges	Australia	EC	400 mg /L		1	Dip	0	Queensland only
Oranges	Mexico	Perfekthion EC. 400 g/l	0.80	0.00080		Foliar	15	Assumed high volume = 1000 l/ha
Pak Choi	Netherlands	Perfekthion EC. 400 g/l	0.20		Repeat as needed	Foliar	21	Outdoor cultivation only.
Passion fruit	Australia	Roxion 400 EC. Saboteur EC. 400 g/l	0.30	0.00030	Not specified	Foliar	7	
Oranges	Indonesia	Perfekthion 400 EC. 400 g/l	0.80	0.00080		Foliar		Assumed high volume = 1000 l/ha
Oranges	Mexico	Perfekthion 400 EC. 400 g/l	0.80 (200 cc/100 l water)			Foliar		Assumed high volume = 1000 l/ha
Parsnips	Australia	EC. 400 g/l	0.32	0.00030		Foliar	7	
Passion fruit	Australia	EC. 400 g/l		0.00030		Foliar	7	
Passion fruit	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Pasture	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.40		>1		7	Apply early morning or late evening.

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Pasture	Australia	400 EC.	0.30	0.0060 low vol. (ground boom); 0.015 low vol. (aerial or misting machine) 0.00030 high vol.	Repeat as needed	Foliar	1 (pre-gra-zing)	
Pasture	Denmark	Perfekthion 500 S EC. 500 g/l	0.75	0.00075		Foliar	14	
Paw paw	Australia	Roxion 400 EC. Saboteur EC. 400 g/l	0.30	0.00030 high vol.	Not specified	Foliar	7	
Paw paw	Australia (Qld)	Saboteur EC. 400 g/l.	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Peanuts	Australia (Qld, NSW)	Roxion 400 EC. Saboteur EC. 400 g/l	0.14	0.0027 low vol.	Not specified	Foliar	7 or 14	
Peanuts	Australia	EC. 400 g/l	0.30	0.00030		Foliar	14	
Peanuts	Reunion	Perfekthion EC. 400 g/l	0.40			Foliar	15	
Peanuts	New Zealand	EC 500 g/l	0.40	?				
Peach	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.050 kg/100 l water			Foliar ground, aerial (min 20 l water/ha)	20	
Peach	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Peach	Hungary	Rogor 40 L EC. 400 g/l	0.004 kg/10 L water			Foliar	7	
Peach	Italy	Danadim EC. 400 g/l	0.048 kg/100 l water			Foliar, no aerial	20	
Pear	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.075 kg/100 l water		>1	Foliar ground, aerial (min 20 l water/ha)	7	
Pear	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Pears	Italy	Danadim EC. 400 g/l	0.048 kg/100 l water			Foliar, no aerial	20	
Pears	Mexico	Perfekthion EC. 400 g/l	0.50	0.00050		Foliar	28	
Pears	Netherlands	400 g/l EC	0.3	0.0002	3	Foliar	21	Perfekthion label: 50 ml/100 l water. Not for use in glasshouses
Pears	UK	Dimethoate 40 EC. 400 g/l	0.68 low volume; 0.34 high volume	0.0025 low vol.; 0.00034 high vol.	4	Foliar	35	
Pears	USA	Dimethoate 400 EC. 4 lbs/gal		0.00060	Not specified	Foliar, ground, aerial	28	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Peas	Australia	Saboteur EC. 400 g/l	0.32	0.00030 high vol.; 0.0064 low vol.	Repeat as needed	Foliar	7	
Peas	Australia	Roxion 400. Saboteur EC. 400 g/l	300 ml/900-1000 ml water/50 kg seed		1	Seed treatment	N/A	
Peas	Australia	Roxion 400. 400 g/l	0.32	0.00030	Not specified	Foliar	7	
Peas	Belgium	Hermootrox EC. 400 g/l	0.20			Foliar	21	
Peas	Denmark	Perfekthion 500 S EC. 500 g/l. Danadim 40 EC. 400 g/l	0.30; 0.32	0.00030; 0.0021		Foliar	14 (Perf)	
Peas	Hungary	Danadim 40 EC. 400 g/l	0.40			Foliar	14	
Peas	Italy	Danadim EC. 400 g/l	0.06 kg/100 l water			Foliar, not aerial	20	
Peas	Netherlands	400 g/l EC	0.20	0.001	3	Foliar	21	Dry peas and dry dwarf beans. Field beans for silage.
Peas	UK	40 EC. 400 g/l	0.34	0.00076-0.00034	6	Foliar	14	Aerial application: 25-60 l water/ha
Peas	USA	Dimethoate 400 EC. 4 lbs/gal	0.19		1	Foliar, ground, aerial, chemigation	0 (21 day grazing /hay restric-tion)	
Pecans	USA	Dimethoate 400 EC. 4 lbs/gal	0.37		Not specified	Foliar, ground, aerial	21	
Pepinos	Australia (Qld)	Saboteur EC. 400 g/l	100 ml /100 l water (400 ppm)		1	Post-harvest dip		
Peppers	Australia	Saboteur EC. 400 g/l	0.30	0.00030 high vol.; 0.0060 low vol.	Not specified	Foliar	7	
Peppers	Australia	Roxion 400 EC. 400 g/l	0.30	0.00030 high vol.; 0.0060 low vol.	Repeat as needed	Foliar	7	
Peppers	Australia	. 400 g/l	400 ppm			Dip		Queensland
Peppers	Hungary	Danadim 40 EC. 400 g/l	0.40			Foliar	14	
Peppers	USA	Dimethoate 400 EC. 4 lbs/gal	0.37		Not specified	Foliar, ground, aerial, chemigation	0	
Persimmons	Australia (Qld)	Saboteur EC. 400 g/l	100 ml /100 l water. (400 ppm)		1	Post-harvest dip		
Pigeon peas	Australia	EC. 400 g/l	0.32			Foliar	7 or 14	
Pineapple	Reunion	Perfekthion EC. 400 g/l	150 ml/100 l water			Foliar	15	
Pineapple	Australia	EC. 400 g/l		0.044		Foliar	14	
Pineapple	New Zealand	EC 500 g/l	?	?				120 ml/100 l

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Plum	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Plum	Belgium	Hermootrox EC. 400 g/l	0.020 kg/100 l water			Foliar	21	
Plum	Germany	400 g/l EC	0.6	0.00040	3	Foliar	14	
Plum	Hungary	Rogor 40L EC. 400 g/l	0.004 kg/10 l water			Foliar	7	
Plum	Netherlands	400 g/l EC	0.3	0.0002 (0.002 for 1/3-1/11)	3	Foliar	21 (28 for 1/3–1/11)	Perfekthion label: 50 ml/100 l water. NOT for use in glasshouses
Plum	UK	Dimethoate 40 EC. 400 g/l	0.68 low volume; 0.34 high volume	0.0025 low vol.; 0.00034 high vol.	4	Foliar	21	
Pome fruit	Australia (NSW)	400 EC. 400 g/l	0.60	0.00060 high vol.	Not specified	Foliar	7	
Pome fruit	Australia	400 EC. 400g/l	0.30	0.00030 high vol.	Repeat at 3 week intervals as needed	Foliar	7	
Pome fruit	Denmark	Perfekthion 500 S EC. 500 g/l. Dandim 40 EC. 400 g/l	1.0	0.00050		Foliar	14 (Perf)	
Pome fruit	Germany	400 g/l EC	0.6	0.00040	3 (5 Danadim label; 0.1% per app)	Foliar	21	
Pome fruit	Hungary	Danadim 40 EC. 400 g/l	0.32			Foliar	14	
Pome fruit	Hungary	Rogor L40 EC. 400 g/l	0.004 kg/10 L water			Foliar	14	
Pomegranate	Australia (Qld)	Saboteur EC. 400 g/l	100 ml/100 l water (400 ppm)		1	Post-harvest dip		
Poppy seed	Netherlands	400 g/l EC	0.20	0.001	2	Foliar	21	
Potatoes	Australia	Roxion 400 EC. Saboteur EC. 400 g/l	0.30	0.00030 high vol.; 0.0060 low vol.	Repeat as needed	Foliar	7	
Potatoes	Belgium	Hermootrox EC. 400 g/l	0.20			Foliar	21	
Potatoes	Columbia	Perfekthion EC . 400 g/l	0.30			Foliar	14	
Potatoes	Denmark	Perfekthion 500 S EC. 500 g/l. Danadim 40 EC. 400 g/l	0.30; 0.32	0.00030; 0.0021		Foliar	14 (Perf)	
Potatoes	Germany	EC. 400 g/l	0.24	0.00040	1	Foliar	14	
Potatoes	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar		
Potatoes	Netherlands	400 g/l EC	0.20	0.001	4 (10 day interval)	Foliar	21	
Potatoes	UK	40 EC. 400 g/l	0.34	0.0016 low vol.; 0.00034 high vol.	2 (7 for seed potatoes only)	Foliar	June 30	Aerial application: 25-60 l water/ha
Potatoes	USA	Dimethoate 400 EC. 4 lbs/gal	0.56		Not specified	Foliar, ground, aerial, chemigation	0	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Quince	Australia	400 g/l EC	0.6	0.0006 @ 1000 l/ha	3	Foliar	7	
Rape	Australia	Roxion 400 EC. 400 g/l	165 ml/600 ml water/50 kg seed		1	Seed treatment	N/A	
Rape	Australia	Saboteur EC. 400 g/l	600 ml in 2 L of water/100 kg seed		1	Seed treatment	Not applica ble	See oilseed
Raspberries	Hungary	Danadim 40 EC. 400 g/l	0.32			Foliar	14	
Raspberries	UK	Dimethoate 40 EC. 400 g/l	0.68 low vol.; 0.22 high vol.	0.0013 low vol.; 0.00022 high vol.	4	Foliar	21	
Red beet	Australia	EC. 400 g/l	0.32	0.00030		Foliar	7	
Red beet/	Belgium	Hermootrox EC. 400 g/l	0.20			Foliar	21	Specified as “beet”
Red beet	Denmark	Perfekthion 500 S EC. 500 g/l. Danadim 40 EC. 400 g/l	0.75–0.80	0.0053		Foliar	14 (Perf.)	
Red beet/	Morocco	Rogor L 40 EC. 400 g/l Perfekthion EC	0.028 kg/100 l water 0.20 (Perfekthion)			Foliar	20	
Red beet	Reunion	Perfekthion EC. 400 g/l	0.32			Foliar	15	
Red beet/	UK	Dimethoate 40 EC. 400 g/l	0.40	0.00089 low vol.	2	Foliar	30	Aerial appli-cation: 25-60 l water/ha
Rhubarb	Netherlands	400 g/l EC	0.20	0.001	3	Foliar	21	
Rice	Reunion	Perfekthion EC. 400 g/l	0.32			Foliar	15	
Rice	New Zealand	EC 500 g/l	0.32	?				
Root vegetables	Australia	EC. 400 g/l	0.30	0.015-0.006 low vol.; 0.00030 high vol.	Repeat as needed	Foliar	7	
Rye	Germany	400 g/l EC	0.24	0.00040	1	Foliar, up to stage 55 (mid-head shooting)	21	
Rye	Netherlands	400 g/l EC	0.20	0.001	1	Foliar	14	
Safflower	Australia	EC. 400 g/l	0.30	0.00030		Foliar	14	
Safflower	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	14	
Safflower	USA (CA, AZ)	Dimethoate 400 EC. 4 lbs/gal	0.73		2	Foliar, ground, aerial, chemigation	14	
Salsify	Netherlands	Perfekthion EC. 400 g/l	0.20		Repeat if needed	Foliar	21	Pen cultivation
Santols	Australia	EC. 400 g/l		0.00030		Foliar	7	
Sapodillas	Australia	EC. 400 g/l		0.00030		Foliar	7	
Scarole	Netherlands	400 g/l EC	0.20	0.001	3	Foliar	21	
Silverbeet	Australia	Roxion 400 EC. 400 g/l	0.30 high volume; 0.32 low volume	0.0064 low vol.; 0.00030 high vol.	Repeat as needed	Foliar	7	
Sorghum	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.40			Foliar, ground, aerial (min 20 l water/ha)	20; 7 (fod-der)	
Sorghum	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	28	

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Sorghum	Reunion	Perfekthion EC. 400 g/l	0.32			Foliar	15	
Sorghum (milo)	USA	Dimethoate 400 EC. 4 lbs/gal	0.56		3	Foliar, ground, aerial, chemigation	28	
Soya beans	Argentina	Perfekthion S EC. 50 g/cm^3	0.60			Foliar, ground and aerial (min 20 l water/ha)	14	Use after flowering
Soya beans	Australia	Roxion 400 EC. 400 g/l	0.30	0.00030 high vol.; 0.0060 low vol.	Repeat as needed	Foliar	7	
Soya beans	Columbia	Perfekthion EC. 400 g/l	1.2	0.0012		Foliar	14	Assumed high volume = 1000 l/ha
Soya beans	Mexico	Perfekthion EC. 400 g/l	0.40			Foliar	21	
Soya beans	USA	Dimethoate 400 EC. 4 lbs/gal	0.56		Not specified	Foliar, ground, air, chemigation	21 (5 days for gra-zing)	
Spinach	Italy	Danadim EC. 400 g/l	0.06 kg/100 l water			Foliar, not aerial	20	
Spinach	Morocco	Rogor L 40 EC. 400 g/l	0.028 kg/100 l water			Foliar	20	
Spinach	Netherlands	400 g/L EC	0.20	0.001	3	Foliar	21	
Spinach	UK	Dimethoate 40 EC. 400 g/l	0.40	0.00089 low vol.	2	Foliar	June 30	Aerial application 25-60 L water /ha
Squash, Summer (courgettes)	Netherlands	400 g/l EC	0.20	0.0005	3	Foliar	2	
Stone fruit (except apricots and early peach)	Australia	400 EC. 400 g/l	0.30	0.00030 high vol.	Not specified	Foliar (typically 3)	7	
Stone fruit	Denmark	Perfekthion 500 S EC. 500 g/l. Danadim 40 EC. 400 g/l	1.0	0.00050		Foliar	14 (Perf)	
Stone fruit	Hungary	Danadim 40 EC. 400 g/l	0.32			Foliar	14	
Stone fruit	Reunion	Perfekthion EC. 400 g/l	150 ml/100 l water			Foliar	15	
Strawberries	Australia	Roxion 400 EC. Saboteur EC. 400 g/l	0.30	0.00030 high vol.	Repeat as needed (3 week intervals)	Foliar	1	
Strawberries	Denmark	Perfekthion 500 S EC. 500 g/l. Danadim 40 EC. 400 g/l	0.60	0.00030		Foliar	14 (Perf)	
Strawberries	Germany	400 g/l EC	0.4	0.00040	2	Foliar	Pre-flowe-ring; post-harvest	
Strawberries	Hungary	Danadim 40 EC. 400 g/l	0.32			Foliar	14	
Strawberries	Netherlands	400 g/l EC	0.24 (1/3-1/11) 0.20	0.0004	3		28 (1/3-1/11) 21	Perfekthion label: 50 ml/100 l water. NOT

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
								for use in glasshouses
Strawberries	UK	Dimethoate 40 EC. 400 g/l	0.34 low volume	0.00062	6	Foliar	21	
Sugar beet	Belgium	Hermootrox EC. 400 g/l	0.20			Foliar	21	Specified as "beet."
Sugar beet	Germany	400 g/l EC	0.16	0.00027	1	Foliar	35	
Sugar beet	Hungary	Danadim 40 EC. 400 g/l	0.40			Foliar	14	
Sugar beet	Netherlands	400 g/l EC	0.40	0.002	3	Foliar		
Sugar beet	Reunion	Perfekthion EC. 400 g/l	0.32			Foliar	15	
Sugar beet	Sweden	Danadim 40 EC. 400 g/l	0.32			Foliar	28	
Sugar beet	Switzerland	400 g/l EC		0.0004 kg/l (0.1%)		Foliar	42	Last application before flowering
Sugar beet	UK	40 EC. 400 g/l	0.40	0.00089 low vol.; 0.00040 high vol.	2	Foliar	June 30	Aerial application 25-60 L water/ha
Sugar cane	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.16			Foliar, ground aerial (20 l water min/ha)		
Sugar cane	Indonesia	Perfekthion 400 EC. 400 g/l	0.80	0.00080		Foliar		Assumed high volume = 1000 l/ha
Sunflower	Australia	Roxion 400 EC. 400 g/l	0.30	0.00030 high vol.; 0.0060 low vol.	Repeat as needed	Foliar	14	
Sunflower	Australia	EC. 400 g/l	0.30	0.00030		Foliar	14	
Swede	Denmark	Perfekthion 500 S EC. 500 g/l	0.30	0.00030		Foliar	14	
Swede	UK	3.6% G, with 3.6% chlorpyrifos	5.54 g ai/100 m row; 1.84 kg ai/ha for 30 cm row spacing. 1st at planting or transplanting; 2nd as a surface band.		2	Soil incorporated; banded	2	
Sweet corn	Australia	EC. 400 g/l	0.20			Foliar	7	
Swiss chard	USA	Dimethoate 400 EC. 4 lbs/gal	0.28		Not specified	Foliar, ground, aerial, chemigation	14	
Tobacco	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.90		>1	Foliar, ground, aerial (min 20 l water/ha)	14	
Tobacco	Columbia	Perfekthion EC. 400 g/l	0.20			Foliar	14	
Tobacco	Morocco	Rogor L 40 EC. 400 g/l	0.038 kg/100 l water			Foliar	20	
Tobacco	Reuniion	Perfekthion EC. 400 g/l	0.48			Foliar	15	Also, 50 ml/20 l water for seedbeds and 100 ml/20 l water for transplants
Tobacco	New Zealand	500 g/l EC	0.50			Foliar		

Commodity	Country	formulation	Application				PHI, days	Note
			kg ai/ha	Spray concen-tration, kg ai/l	No.	Method		
Tomatoes	Australia	EC. 400 g/l	0.30; 0.34 (low volume)	0.00030 high vol.; 0.006 low vol. (misting machine)	2–3	Foliar	7	
Tomatoes	Australia	EC. 400 g/l	400 ppm			Dip	7*	Queensland
Tomatoes	Columbia	Perfekthion EC. 400 g/l	0.30			Foliar	14	
Tomatoes	Germany	400 g/l EC	0.24 0.36 0.48	0.0012 (200 l water/ha) 0.00040 0.00040	3	Foliar, under glass	3	<50 cm 50-125 cm >125 cm
Tomatoes	Italy	Danadim EC. 400 g/l	0.06 kg/100 l water			Foliar, not aerial	20	
Tomatoes	Mexico	Perfekthion EC. 400 g/l	0.60			Foliar	-	
Tomatoes	Morocco	Rogor L 40 EC. 400 g/l	0.038 kg/100 l water			Foliar	20–21	
Tomatoes	Thailand	400 g/l EC	0.25	0.00040	5	Foliar	14	
Tomatoes	UK	Dimethoate 40 EC. 400 g/l	0.34 high volume	0.00034 high vol.	8	7		
Tomatoes	USA	Dimethoate 400 EC. 4 lbs/gal	0.56		Not specified	Foliar, ground, aerial, chemigation	7	
Turnips	UK	3.6% G with 3.6% chlorpyrifos	5.54 g ai/100 meters of row; 1.84 kg ai/ha for 30 cm row spacing. 1st at planting or transplanting; 2nd as a surface band		2	Ground incorporated; banded	28	
Turnip, roots	USA	Dimethoate 400 EC. 4 lbs/gal	0.28		Not specified	Foliar, ground, aerial, chemigation	14	
Turnip, tops	USA	Dimethoate 400 EC. 4 lbs/gal	0.28		Not specified	Foliar, ground, aerial, chemigation	14	
Vegetables	Argentina	Perfekthion S EC. 50 g/100 cm^3	0.15; 0.50 high volume	0.00050 high vol.		Foliar	20; 7 (potato radish beet chicory yams kohl-rabi); 14 (onions garlic leeks)	Garden vegetables such as artichoke, broad bean, cabbage, potato, onion, tomato
Vegetables	Australia	Saboteur EC. 400 g/l	0.30	0.00030 high vol.; 0.0060 low vol.	Reapply as needed	Foliar	7	
Vegetables	Belgium	Hermotrox EC. 400 g/l	0.20			Foliar	21	Do not use on leafy vegetables. Do not use of

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*Post-treatment interval