

MALATHION (049)

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Malathion was evaluated in 1965 (T), 1966 (T,R), 1967 (R), 1968 (R), 1969 (R), 1970 (R), 1973 (R), 1975 (R), 1977 (R), 1984 (R), 1997 (T), 1999 (R) and 2000 (R). The 1999 JMPR recommended the withdrawal of a number of existing CXLs as most of the trials reported were not based on the highest GAP. The manufacturer reported to the CCPR that a commitment was made with US EPA to support only realistic application rates and asked that the withdrawal of the existing Codex MRLs for apples, broccoli, head cabbages, citrus fruits, grapes, peaches, raspberries and potatoes should be reconsidered. The MRLs for peaches and raspberries were reinstated. No MRL was recommended for potatoes as no trial had been conducted according to maximum GAP. The manufacturer reported the results of trials on mandarins, oranges, apples, peaches, grapes, strawberries, tomatoes, alfalfa to the present Meeting.

Analytical methods

Analytical methods are included in the reports on the individual residue trials. The methods involved extraction with acetone, acetone plus 2-3 drops of dodecane, or acetonitrile, followed by liquid-liquid partition with dichloromethane or acetone/hexane (1:1). In some methods, the extract is further purified by gel permeation chromatography. Malathion and malaoxon are quantified by GC-FID. The LOQ was 0.01 mg/kg and recoveries were within the 70-110% range.

USE PATTERNS

Information on GAP is shown in Table 1. Labels were submitted for all the registered uses shown.

Table 1. Registered uses of malathion (all 440 g/l EW formulation).

Crop	Country	Method	Application		No. or frequency	PHI days
			Rate, kg ai/ha	Spray conc. kg ai/hl		
Alfalfa	Australia	Foliar spray	0.0704-0.55	-	-	1
		Foliar spray + bait	0.1254-0.2508	1.41-2.82		
	Spain	Foliar spray	-	0.11-0.15	-	7
Apple	Australia	Foliar spray	-	0.062	-	3
	Denmark	Foliar spray	1.32-1.76	-	3	7
	Greece	Foliar spray	-	0.044-0.088	-	7
		Foliar spray + bait	0.079-0.132	0.26-0.44	10-15 days interval	
	Italy	Foliar spray	-	0.053-0.16	-	20
	Portugal	Foliar spray	-	0.05 - 0.30	-	7
		Foliar spray + bait	-	0.10 - 0.30		
	Romania	Foliar spray	4.62	0.31	-	-
	Spain	Foliar spray	-	0.11-0.15	-	7
Apricot	USA		4.21	-	4	6
Grapes	Australia	Foliar spray	-	0.062-0.10	-	3
	Greece	Foliar spray	-	0.044-0.088	-	7
					10-15 days interval	
	Italy	Foliar spray	-	0.053-0.16	-	20
	Portugal	Foliar spray	-	0.051-0.12	-	7
	Spain	Foliar spray	-	0.11-0.154	-	7
				10-15 days interval		
Citrus	Australia	Foliar spray	-	0.062-0.10	-	3

Crop	Country	Method	Application		No. or frequency	PHI days
			Rate, kg ai/ha	Spray conc. kg ai/hl		
	Dominican Republic	Foliar spray	0.66-1.32	-	- 10-14 days interval	-
	Greece	Foliar spray	-	0.044-0.088	- 10-15 days interval	7
		Foliar spray + bait	0.079-0.13	0.26-0.44		
	Italy	Foliar spray	-	0.053-0.16	-	20
	Portugal	Foliar spray	0.506-3.036	0.05-0.30	-	7
		Foliar spray + bait	-	0.10-0.30		
	Spain	Foliar spray	-	0.11-0.15	- 10-15 days interval	7
		Foliar spray + Bait	0.0003 kg a.i. / tree	0.31		
Aerial, using bait		0.1496	0.75			
Peach	Australia	Foliar spray	-	0.062	-	3
	Greece	Foliar spray	-	0.044-0.088	- 10-15 days interval	7
		Foliar spray + bait	-	0.26-0.44		
	Italy	Foliar spray	-	0.05-0.16	-	20
	Portugal	Foliar spray	-	0.051-0.30	-	7
		Foliar spray + bait	-	0.10-0.30		
	Spain	Foliar spray	-	0.11-0.154	-	7
		Foliar spray + Bait	-	0.31-0.75		
USA		4.21		-	7	
Strawberry	Denmark	Foliar spray	1.1	-	3	7
	Italy	Foliar spray	-	0.053-0.158	-	20
	Portugal	Foliar spray	-	0.10	-	1
	Spain	Foliar spray	-	0.11-0.15	- 10-15 days interval	7
Tomato	Australia	Foliar spray	-	0.06-0.10	-	3
	Denmark	Foliar spray	-	0.088	3	7
	Dominican Republic	Foliar spray	0.66-1.32	-	- 10-14 days interval	-
	Greece	Foliar spray	-	0.044-0.088	- 10-15 days interval	7
	Portugal	Foliar spray	-	0.051-0.101	-	1
Italy	Foliar spray	-	0.053-0.158	-	20	

RESIDUES RESULTING FROM SUPERVISED TRIALS ON CROPS

Information on residues in crops is shown in Tables 2 to 9.

Citrus fruits	Table 2	Mandarins
	Table 3	Oranges
Pome fruits	Table 4	Apples
Stone fruits	Table 5	Peaches
Berries and other small fruits	Table 6	Grapes
	Table 7	Strawberries
Fruiting vegetables, other than Cucurbits	Table 8	Tomatoes
Legume animal feeds	Table 9	Alfalfa hay and forage (green)

Undetected residues are shown as below the LOQ (e.g. <0.01 mg/kg). Control plots were included in all trials and residues in control samples are shown in parentheses when they exceeded the LOQ. Values within maximum GAP ($\pm 30\%$) are double-underlined and were used for the estimation of maximum residue levels, STMRs and HRs.

Mandarins and oranges. Malathion EW (440 g/l) was applied 4 or 6 times by a mistblower sprayer. Residues in the whole fruit were calculated from the residues found in the peel and pulp. Samples

were stored at -18° C for 9-29 months and there was a maximum interval of one month between extraction and analysis. The results are shown in Tables 2 and 3.

Table 2. Residues of malathion in mandarins (Gillis, 2003, AF/5223).

Country, year (variety)	Application					Sample	PHI days	Residues mg/kg		Reference
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.			Malathion	Malaoxon	
Greece, 2001 (Clementine)	EW	1.8-2.0	0.18	990- 1090	6	Fruit	11	0.75	<0.01	CN/11
							14	<u>0.76</u>	<0.01	
						Peel	11	2.4	0.02	
							14	2.4	0.02	
						Pulp	11	<u>0.02</u>	<0.01	
							14	<u>0.02</u>	<0.01	
Italy, 2002 (Tardivo di Ciaculli)	EW	4.0	0.18	2200	6	Fruit	10	1.8	0.03	CN/12
							14	<u>2.4</u>	0.03	
						Peel	10	6.8	0.10	
							14	<u>9.0</u>	0.13	
						Pulp	10	<u><0.01</u>	<0.01	
							14	<0.01	<0.01	
Spain, 2000 (Clemenvilla)	EW	5.0-5.5	0.27- 0.31	1750- 1970	4	Fruit	0	2.6	0.04	CN/2
							3	2.3	<0.01	
							7	1.8	<0.01	
							10	1.5	<0.01	
							14	<u>2.4</u>	0.09	
							21	0.88	<0.01	
						Peel	3	8.2 (c0.02)	0.02	
							7	6.4	0.02	
							10	6.0	0.01	
						Pulp	3	0.07	<0.01	
							7	0.14	<0.01	
							10	<u>0.15</u>	<0.01	
Spain, 2001 (Marisol)	EW	2.9-4.4	0.18	1640- 2430	6	Fruit	10	<u>1.8</u>	<0.01	CN/9
							14	3.0	<0.01	
						Peel	10	7.0	0.03	
							14	13	0.05	
						Pulp	10	<u>0.12</u>	<0.01	
							14	0.01	<0.01	
Spain, 2001 (Fortuna)	EW	5.0-5.3	0.32- 0.39	1290- 1670	4	Fruit	0	7.5	0.06	CN/17
							3	4.4	<0.01	
							7	<u>4.7</u>	<0.01	
							10	2.7	<0.01	
							14	3.0	0.04	
							21	3.8	0.01	
						Peel	3	18 (c0.01)	0.03	
							7	18	0.02	
							10	12	0.02	
						Pulp	3	0.30	<0.01	
							7	<u>0.21</u>	<0.01	
							10	0.01	<0.01	
Spain, 2001 (Fortune)	EW	5.0-5.3	0.26- 0.29	1780- 1890	4	Fruit	0	9.4	0.09	CN/18
							3	3.7	<0.01	
							7	2.8	<0.01	
							10	2.1	<0.01	
							14	<u>2.9</u>	0.06	
							21	1.1	<0.01	
						Peel	3	12	0.01	
							7	9.5	0.01	
							10	7.5	0.01	
						Pulp	3	0.14	<0.01	
							7	<u>0.22</u>	<0.01	
							10	0.02	<0.01	
Spain, 2001 (Fortune)	EW	3.9-4.4	0.18	2170- 2460	6	Fruit	0	6.9	0.06	CN/21
							3	3.2	0.01	

Country, year (variety)	Application					Sample	PHI days	Residues mg/kg		Reference
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.			Malathion	Malaoxon	
							7	<u>2.4</u>	<0.01	
							10	1.3	<0.01	
							14	2.2	0.06	
							21	1.9	<0.01	
						Peel	3	11	0.03	
							7	9.1	0.03	
						10	5.2	0.02		
						Pulp	3	0.10	<0.01	
							7	<u>0.03</u>	<0.01	
10	0.01	<0.01								
Spain, 2002 (Mermandina)	EW	1.7-2.2	0.18	930- 1220	6	Fruit	10	<u>3.1</u>	0.02	CN/10
							14	3.1	0.02	
						Peel	10	10 (c0.02)	0.06	
							14	10 (c0.02)	0.06	
						Pulp	10	<u>0.01</u>	<0.01	
							14	<0.01	<0.01	

Table 3. Residues of malathion in oranges (Gillis, 2003, AF/5223).

Country, year (variety)	Application					Sample	PHI days	Residues, mg/kg		Referen ce
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.			Malathion	Malaoxon	
Greece, 2001 (Merlin)	EW	1.8	0.18	990- 1040	6	Fruit	11	<u>0.58</u>	<0.01	CN/15
							14	0.30	<0.01	
						Peel	11	1.8	<0.01	
							14	1.2	<0.01	
						Pulp	11	<u><0.01</u>	<0.01	
							14	<0.01	<0.01	
Italy, 2002 (Sanguinello)	EW	3.9-4.0	0.18	2170- 2210	6	Fruit	10	<u>1.6</u>	<0.01	CN/16
							14	1.1	<0.01	
						Peel	10	4.2	0.01	
							14	2.8	0.01	
						Pulp	10	<u><0.01</u>	<0.01	
							14	<0.01	<0.01	
Spain, 2000 (Navelina)	EW	5.1-5.3	0.40-0.49	1080- 1270	4	Fruit	0	8.0	0.05	CN/8
							3	1.7	<0.01	
							7	2.1	<0.01	
							10	1.7	<0.01	
							14	1.4	0.03	
							21	(c0.02) 0.95	<0.01	
						Peel	3	5.3	<0.01	
							7	6.3	<0.01	
							10	4.9	<0.01	
						Pulp	3	0.02	<0.01	
							7	0.03	<0.01	
							10	0.06	<0.01	
Spain, 2001 (Navelina)	EW	2.6-2.9	0.18	1430-1620	6	Fruit	10	<u>1.1</u>	<0.01	CN/13
							14	1.2	<0.01	
						Peel	10	4.3	0.02	
							14	4.9	0.02	
						Pulp	10	<0.01	<0.01	
							14	0.01	<0.01	
Spain, 2001 (Lane Late)	EW	4.9-5.3	0.27-0.29	1660-1980	4	Fruit	0	6.7	0.04	CN/19
							3	2.0	0.01	
							7	<u>1.4</u>	<0.01	
							10	1.4	<0.01	
							14	1.2	0.03	
							21	0.32	<0.01	
						Peel	3	7.1	0.04	

Country, year (variety)	Application					Sample	PHI days	Residues, mg/kg		Referen ce
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.			Malathion	Malaoxon	
							7 10	5.4 4.8	0.02 0.02	
						Pulp	3 7 10	0.05 <u>0.07</u> 0.04	<0.01 <0.01 <0.01	
Spain, 2001 (Lane Late)	EW	5.1	0.27-0.30	1680- 1930	4	Fruit	0	2.9	0.02	CN/20
							3	1.3	<0.01	
							7	<u>0.89</u>	<0.01	
							10	0.66	<0.01	
							14	0.49	0.02	
						21	0.47	<0.01		
						Peel	3	5.5	0.02	
							7	3.5	0.02	
							10	(c0.01) 2.6	0.02	
Pulp	3	0.08	<0.01							
	7	<u>0.01</u>	<0.01							
	10	0.01	<0.01							
Spain, 2001 (Valencia Late)	EW	2.0-2.7	0.18	1120- 1500	6	Fruit	0	3.3	0.04	CN/22
							3	1.2	<0.01	
							7	<u>0.75</u>	<0.01	
							10	0.45	<0.01	
							14	0.48	0.02	
						21	0.26	<0.01		
						Peel	3	3.5	0.01	
							7	2.6	0.01	
							10	1.5	0.01	
						Pulp	3	0.01	<0.01	
							7	<u>0.01</u>	<0.01	
							10	<0.01	<0.01	
10	<0.01	<0.01								
Spain, 2002 (Lane Late)	EW	1.8-2.2	0.18	1020-1240	6	Fruit	10	<u>1.7</u>	<0.01	CN/14
							14	1.4	<0.01	
						Peel	10	6.9	0.02	
							14	5.5	0.02	
						Pulp	10	<u>0.07</u>	<0.01	
							14	0.02	<0.01	

Apples. Malathion EW (440 g/l) was applied to the trees as a directed spray three times at approximately 14 day-intervals at growth stages 74-78, 77-81 and 81-85 respectively. Samples were stored frozen for a maximum of 6 months and kept for up to 2 weeks before analysis. The results are shown in Table 4.

Table 4. Residues of malathion in apples after 3 applications of an EW formulation in trials in France.

Year (variety)	Application			PHI days	Residues mg/kg		Reference
	kg ai/ha	kg ai/hl	Water, l/ha		Malathion	Malaoxon	
2000 (Melrose)	1.7-1.8	0.18	980- 1040	0	0.68	<0.01	Goodband, 2002a AF/5230/CN/1
				3	0.13	<0.01	
				7	<u>0.09</u>	<0.01	
				10	0.08	<0.01	
				14	0.03	<0.01	
				21	0.02	<0.01	
2000 (Braeburn)	1.7-1.9	0.18	990- 1070	0	1.2	<0.01	Goodband, 2002a AF/5230/CN/2
				3	0.42	<0.01	
				7	<u>0.19</u>	<0.01	
				10	0.02	<0.01	
				14	0.01	<0.01	
				21	<0.01	<0.01	
2000 (Kid's Orange)	1.7-1.9	0.18	970- 1090	0	1.3	0.01	Goodband, 2002a
				3	0.37	<0.01	

Year (variety)	Application			PHI days	Residues mg/kg		Reference
	kg ai/ha	kg ai/hl	Water, l/ha		Malathion	Malaaxon	
Red)				7	<u>0.24</u>	<0.01	AF/5230/CN/3
				10	0.16	0.01	
				14	0.11	<0.01	
				21	0.08	0.01	
2000 (Ozark Gold)	1.7-1.8	0.18	990- 1050	0	1.1	<0.01	Goodband, 2002a AF/5230/CN/4
				3	0.05	<0.01	
				7	<u>0.02</u>	<0.01	
				10	0.01	<0.01	
				14	0.02	<0.01	
21	<0.0	<0.01					
2001 (Golden)	1.7-1.8	0.18	980- 1030	3	0.07	<0.01	Goodband, 2002a AF/5230/CN/5
				7	<u>0.05</u>	<0.01	
2001 (Golden)	1.7-1.9	0.18	980- 1060	3	0.46	0.02 (c0.06)	Goodband, 2002a AF/5230/CN/6
				7	<u>0.25</u>	0.01 (c0.03)	
2001 (Golden)	1.6-1.8	0.18	910- 1010	3	0.30	<0.01	Goodband, 2002a AF/5230/CN/7
				7	<u>0.13</u>	<0.01	
2001 (Melrose)	1.7-2.0	0.18	960- 1120	3	0.15	<0.01	Goodband, 2002a AF/5230/CN/8
				7	<u>0.05</u>	<0.01	
2001 (Granny Smith)	1.8	0.18	1000	0	1.1	0.01	Goodband, 2002b AF/6079/CN/1
				3	0.18	<0.01	
				7	<u>0.07</u>	<0.01	
				10	0.05	<0.01	
				14	0.02	<0.01	
21	0.01	<0.01					
2001 (Granny Smith)	1.7-1.8	0.18	990- 1020	3	0.13	<0.01	Goodband, 2002b AF/6079/CN/3
				7	<u>0.08</u>	<0.01 (c0.01)	
2001 (Granny Smith)	1.7-1.8	0.18	970- 1010	3	0.23	<0.01 (c0.03)	Goodband, 2002b (392 FYF) AF/6079/CN/4
				7	<u>0.14</u>	<0.01 (c0.02)	
				10	0.05	0.01 (c0.02)	
				14	0.01	0.01	
21	0.02	0.01 (c0.01)					
2001 (Lady)	1.8	0.18	1000	3	0.70	<0.01	Goodband, 2002b AF/6079/CN/5
				7	<u>0.37</u>	<0.01	

Peaches. Malathion EC (516 g/l) or EW (440 g/l) was applied three times to peaches using a directed mistblower sprayer, the first 48 days before commercial harvest, followed by two at 13-15 day-intervals. Whole peaches without stones were analysed and residues for whole fruit are shown in Table 5. Samples were stored at a minimum -18°C for up to 3 months.

Table 5. Residues of malathion in peaches in trials in Italy in 1977 (Cowley, 1998b, AF/3832).

Variety	Application					PHI days	Residues mg/kg		Reference
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.		Malathion	Malaaxon	
Padana	EW	2.4	0.16	1500	3	0	0.92	<0.01	CN/3
						3	0.28	-	
						7	0.10	<0.01	
						14	<0.01	<0.01	
						20	<u><0.01</u>	-	
Padana	EC	2.4	0.16	1500	3	0	0.68	<0.01	
						3	0.12	-	
						7	0.03	<0.01	
						14	<0.01	<0.01	
						20	<u><0.01</u>	-	

Variety	Application					PHI days	Residues mg/kg		Reference
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.		Malathion	Malaaxon	
Vega	EW	2.4	0.16	1500	3	0	1.0	<0.01	CN/2
						3	0.59	-	
						7	0.18	<0.01	
						14	0.07	<0.01	
						20	<u>0.01</u>	-	
Vega	EC	2.4	0.16	1500	3	0	1.2	0.01	
						3	0.44	-	
						7	0.12	<0.01	
						14	0.07	<0.01	
						20	<u>≤0.01</u>	-	

Grapes. Malathion EW (440 g/l) or EC (516 g/l) was applied as a directed spray three times with approximately 14 days intervals (Table 6). Samples were stored frozen for up to one year before extraction with an interval of up to 6 months before analysis. Recoveries were 84 and 91% for malathion and malaaxon respectively.

Table 6. Residues of malathion in grapes.

Country, year (variety)	Application					PHI days	Residues mg/kg		Reference
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.		Malathion	Malaaxon	
France, 2000 (Tanat)	EW	1.8-1.9	0.27	670-680	3	0	3.56	0.02	Goodband, 2002c AF/5224/CN/1
						3	1.25	0.04	
						7	0.42	0.02	
						10	0.37	<0.01	
						14	0.18	<0.01	
						21	0.23	<0.01	
France, 2001 (Gamay)	EW	1.9-2.0	0.27	690-720	3	7	0.26	0.01	Goodband, 2002c, AF/5224/CN/8
						10	0.27	0.01	
France, 2001 (Chardonnay)	EW	1.8-1.9	0.27	670-700	3	0	2.58	0.03	Goodband, 2002d AF/6133/CN/1
						3	0.51	0.02	
						7	1.30	0.02	
						10	0.64	0.01	
						14	0.32	<0.01	
21	0.40	<0.01							
France, 2001 (Sauvignon)	EW	1.8-1.9	0.27	660-710	3	0	1.17	0.02	Goodband, 2002d AF/6133/CN/2
						3	0.78	0.02	
						7	0.26	<0.01	
						10	0.14	<0.01	
						14	0.12	<0.01	
21	0.10	<0.01*							
France, 2001 (Cabernet)	EW	1.7-2.0	0.27	640-720	3	7	0.59	0.01	Goodband, 2002d AF/6133/CN/3
France, 2001 (Aligote)	EW	1.9-2.0	0.27	680-740	3	7	0.27	0.01	Goodband, 2002d AF/6133/CN/4
Italy, 1997 (Trebbiano)	EW	1.9	0.16	1200	3	0	0.98	0.01	Cowley, 1998b AF/3831/CN/1
						3	0.31	0.01	
						7	<u>0.03</u>	0.01	
						14	0.01	-	
						20	<0.01	-	
Italy, 1997 (Trebbiano)	EC	1.93	0.16	1200	3	0	0.85	0.01	Cowley, 1998b AF/3831/CN/1
						3	0.19	0.01	
						7	<u>0.01</u>	0.01	
						14	0.03	-	
						20	<0.01	-	
Italy, 1997 (Barbera)	EW	1.9	0.16	1200	3	0	1.9 (c0.06)	0.02	Cowley, 1998b AF/3831/CN/2
						3	0.41	0.02	
						7	<u>0.21</u>	0.01	
						14	0.05	-	
						20	0.08	-	
Italy, 1997	EC	1.9	0.16	1200	3	0	1.2 (c0.02)	0.02	Cowley, 1998b

Country, year (variety)	Application					PHI days	Residues mg/kg		Reference
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.		Malathion	Malaoxon	
(Barbera)						3	0.25	0.01	AF/3831/CN/2
						7	<u>0.21</u>	0.01	
						14	0.08	-	
						20	0.08	-	
Spain, 2000 (Tempranillo)	EW	2.0-2.2	0.16	1220- 1370	3	0	7.5	0.05	Goodband, 2002c AF/5224/CN/3
						7	<u>1.5</u>	0.05	
Spain, 2000 (Garnacha)	EW	1.9-2.0	0.16	1190- 1240	3	0	6.1	0.05	Goodband, 2002c AF/5224/CN/7
						3	3.3	0.13	
						7	<u>1.5</u>	0.11	
						10	1.5	0.06	
						14	0.62	0.04	
21	0.72	0.02							
Spain, 2001 (Garnacha)	EW	1.9- 2.0	0.16	1170 1270	3	7	<u>1.1</u> (c0.12)	0.05 (c0.01)	Goodband, 2002c AF/5224/CN/5
						10	1.4 (c0.18)	0.08	
Spain, 2001 (Garnacha)	EW	1.8-1.9	0.16	1180- 1200	3	7	<u>2.6</u>	0.06	Goodband, 2002c AF/5224/CN/6
						10	1.8	0.07	

Strawberries. Malathion EW (440 g/l) was applied as a directed spray and/or overall spray (Table 7). Samples were stored at minimum -18° C for up to 10 months. Recoveries of malathion and malaoxon were 76 and 96% respectively.

Table 7. Residues of malathion in strawberries (Oxspring, 2002, AF/5226).

Country, year (variety)	Application					PHI days	Residues mg/kg		Reference
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.		Malathion	Malaoxon	
France 2000 (Mara Des Bois)	EW	1.2-1.5	0.15	930- 1030	4	0	0.90 [±]	0.01 [±]	CN/1
						3	0.08	<0.01	
						7	<u>0.03</u>	<0.01	
						10	0.02	<0.01	
						14	0.01	<0.01	
21	<0.01	<0.01							
France, 2000 (Seascape)	EW	1.5-1.6	0.15	990- 1060	4	0	0.40	0.01	CN/2
						3	0.01	<0.01	
						7	<u>0.01</u>	<0.01	
						10	<0.01	<0.01	
						14	<0.01	<0.01	
21	<0.01	<0.01							
France, 2001 (El Santa)	EW	0.7-1.5	0.18	400- 860	6	0	0.39	0.02	CN/5
						3	0.09	<0.01	
						7	<u>0.06</u>	<0.01	
Italy, 2000 (Selva)	EW	1.5	0.15	1000	4	0	3.2 [±]	0.04 [±]	CN/3
						3	0.07	<0.01	
						7	<0.01	<0.01	
						10	0.03	<0.01	
						14	<0.01	<0.01	
21	<0.01	<0.01 [*]							
Italy, 2000 (Don)	EW	1.4-1.7	0.15	950- 1000	4	0	2.7	0.02 [±]	CN/4
						3	0.02	<0.01	
						7	<u>≤0.01</u>	<0.01	
						10	<0.01	<0.01	
						14	<0.01	<0.01	
21	<0.01	<0.01							
Spain, 2001 (Camarrosa)	EW	1.2-1.8	0.18	700- 1000	6	0	0.60	0.02	CN/6
						3	0.07	<0.01	
						7	<u>0.10</u>	<0.01	
Spain, 2001 (Camarrosa)	EW	1.0-1.8	0.18	620- 1000	6	0	1.87	0.06	CN/7
						3	0.20	0.03	

Country, year (variety)	Application					PHI days	Residues mg/kg		Reference
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.		Malathion	Malaoxon	
						7	0.12	0.02	
Spain, 2001	EW	1.1-1.2	0.18	590- 660	6	0	2.40	0.03	CN/8
						3	0.24	0.01	
						7	<u>0.14</u>	0.01	

Tomatoes. A formulation of malathion EC (516 g/l) or EW (440 g/l) was applied as an overall spray to plants four or six times (Table 8). Samples were stored at -18 ° C for up to six and a half months. Recoveries were 73 and 100% for malathion and malaoxon respectively.

Table 8. Residues of malathion in tomatoes.

Country, year (variety)	Application					PHI days	Residues mg/kg		Reference
	Form	kg ai/ha	kg ai/hl	Water, l/ha	No.		Malathion	Malaoxon	
Italy, 1997 (PS1296)	EW	0.64	0.11	600	4	0	0.33	<0.01	Cowley, 1998c AF/3830/CN/1
						3	0.04	0.01	
						7	<u>0.02</u>	<0.01	
						14	<0.01	-	
						20	<0.01	-	
Italy, 1997 (PS1296)	EC	0.64	0.11	600	4	0	0.32	<0.01	Cowley, 1998c AF/3830/CN/1
						3	0.03	0.01	
						7	<u>0.01</u>	<0.01	
						14	<0.01	-	
						20	<0.01	-	
Italy, 1997 (PS1296)	EW	0.64	0.11	600	4	0	0.21	<0.01	Cowley, 1998c AF/3830/CN/2
						3	0.02	<0.01	
						7	<u><0.01</u>	<0.01	
						14	<0.01	-	
						20	<0.01	-	
Italy, 1997 (PS1296)	EC	0.64	0.11	600	4	0	0.20	<0.01	Cowley, 1998c AF/3830/CN/2
						3	0.04	<0.01	
						7	<u><0.01</u>	<0.01	
						14	<0.01	-	
						20	<0.01	-	
Italy, 2000 (VC 82)	EW	0.94	0.12	750	4	0	0.26	<0.01	Harrison, 2002 AF/5225/CN/2
						3	0.02	0.01	
						7	<u><0.01</u>	<0.01	
						10	<0.01	<0.01	
						14	<0.01	<0.01	
						21	<0.01	<0.01	
Italy, 2001 (1296)	EW	1.1 - 1.2	0.18	636 - 673	6	0	0.56	<0.01	Harrison, 2002 AF/5225/CN/6
						3	0.02	<0.01	
						7	<0.01	<0.01	
Spain, 2000 (Perfectil)	EW	0.9 - 0.9	0.12	745- 757	4	0	0.03 (c0.02)	<0.01	Harrison, 2002 AF/5225/CN/1
						3	0.04	<0.01	
						7	<u>0.01</u>	<0.01	
						10	<0.01	<0.01	
						14	<0.01	<0.01	
						21	<0.01	<0.01	
Spain, 2000 (H9491)	EW	0.9	0.12	720- 760	4	0	0.45	<0.01	Harrison, 2002 AF/5225/CN/3
						3	0.12	<0.01	
Spain, 2001 (H9036)	EW	1.8-	0.18	1000	6	0	0.64	<0.01	Harrison, 2002 AF/5225/CN/4
						3	0.22	<0.01	
						7	0.04	<0.01	
Spain, 2002 (H3044)	EW	1.8	0.18	1000	6	0	0.46	<0.01	Harrison, 2003 AF/6022/CN/1
						3	0.06	<0.01	
						7	0.06	<0.01	

Alfalfa. Malathion EW (440 g/l) was applied once as an overall spray to alfalfa (Table 9) and forage samples were handpicked approximately 5 cm above the ground immediately after the spray had dried up to 7 days later. Seven days after treatment the crop was cut, left on the ground to dry and sampled after 10-21 days. The forage samples were stored at -18°C for 4-10 months. Recoveries from forage were 84% and 75% and from hay 89% and 82% for malathion and malaaxon respectively.

Table 9. Residues of malathion, dry weight basis, in alfalfa after a single application of EW formulation.

Country, year (location)	Application			Sample	PHI days	Residues mg/kg		Reference	
	kg ai/ha	kg ai/hl	Water, l/ha			Malathion	Malaaxon		
Italy, 2000 (Romagnola)	1.5	0.15	1000	Forage	0	93	0.60	Anthony, 2002 AF/5228	
					3	2.0	0.04		
					7	<u>0.67</u>	0.01		
				Hay	10	<u>0.12</u>	<0.01		CN/2
					14	0.02	0.03		
					21	0.06	<0.01		
Italy, 2001 (Garisenda)	1.5	0.15	1000	Forage	0	11	1.89	CN/4	
					7	<u>0.41</u>	0.02		
Spain, 2000 (Aragon)	1.5	0.15	1000	Forage	0	110 (c0.20)	1.14	CN/1	
					3	11 (c0.16)	0.09		
					7	<u>3.5</u> (c0.18)	0.04		
				Hay	10	<u>3.3</u> (c0.10)	0.04		
					14	1.8 (c0.11)	0.02		
					21	0.61 (c0.03)	0.01		
Spain, 2001 (Aragon)	1.5	0.15	1000	Forage	0	137	1.50	CN/3	
					7	<u>1.2</u>	0.05		

RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

In a market basket study in 2001 samples were collected from 500 different randomly-selected grocery stores throughout the continental USA over a one-year period. Samples were prepared as consumers would typically prepare their food (i.e. washing, peeling, rubbing, coring, de-hulling, pitting and de-stemming). A multi-residue screen method was used with a limit of quantification (LOQ) of 0.001 mg/kg. The average limit of detection (LOD) of malathion and malaaxon was 0.00001 and 0.0007 mg/kg respectively (Polakoff and Daniels, 2003).

Table 10. Residues of malathion found in a market basket study in the USA.

Crop	No. of samples	Non-quantifiable		Average residue (mg/kg)		Maximum residue	
		Malathion	Malaaxon.	Malathion	Malaaxon.	Malathion	Malaaxon.
Apple	500	100%	100%	0.00001	<0.000005	NQ	NQ
Broccoli	493	99%	100%	0.00003	0.00001	0.00253	NQ
Cherry	144	84%	100%	0.00064	0.00001	0.00865	NQ
Cucumber	498	100%	100%	0.00001	<0.000005	NQ	NQ
Grape	491	100%	100%	0.00001	0.00002	NQ	0.00168
Green beans	465	100%	100%	0.00001	<0.000005	NQ	NQ
Head lettuce	496	100%	100%	0.00001	0.00001	NQ	NQ
Orange	499	99%	100%	0.00005	<0.000005	0.00167	NQ
Peach	352	100%	100%	0.00009	0.00002	0.01408	NQ
Potato	500	99%	100%	0.00001	<0.000005	0.00386	NQ
Strawberry	451	79%	90%	0.00676	0.00027	1.48832	0.00534
Sweet corn	452	100%	100%	0	0	NQ	NQ
Tomato	498	100%	100%	<0.000005	0	0.00107	NQ

NQ: non-quantifiable

NATIONAL MAXIMUM RESIDUE LIMITS

The current MRLs in Australia, the European Union and the USA for the commodities considered in this evaluation are shown below. The MRLs for Australia are downloaded from <http://www.apvma.gov.au>, February 02, 2004, and for the European Union from Directive 88/298 ECC downloaded from http://europa.eu.int/comm/food/plant/protection/resources/publications_en.htm, February 02, 2004. The website was updated Jan. 20, 2003. The US MRLs are downloaded from <http://npirs.ceris.purdue.edu/htbin/tolchem.com>, February 02, 2004.

MRLs for Australia, the EU and the USA.

Country	Commodity	MRL (mg/kg)
Australia	Citrus, fruit	4.0
	Fruit, dried	8.0
	Grape	8.0
	Pear	0.5
	Strawberry	1.0
	Tomato	3.0
EU	Almond	0.5
	Apple	0.5
	Citrus fruit (others)	2.0
	Grapefruit	2.0
	Lemon	2.0
	Lime	8.0
	Mandarin	2.0
	Peach	0.5
	Orange	2.0
	Pear	0.5
	Plum	0.5
	Pome fruit (others)	0.5
	Small fruit and berry (others)	0.5
	Stone fruit (others)	0.5
	Strawberry	0.5
	Table grape	0.5
Tomato	3.0	
Wine grape	0.5	
USA	Alfalfa	135
	Apple	8.0
	Apricot	8.0
	Citrus, pulp, dehydrated (cattle feed)	50.0
	Grape	8.0
	Grapefruit	8.0
	Lemon	8.0
	Lime	8.0
	Nectarine	8.0
	Orange	8.0
	Peach	8.0
	Pear	8.0
	Plum (pre- and post- harvest application)	8.0
	Plum, prune	8.0
Strawberry	8.0	

Country	Commodity	MRL (mg/kg)
	Tangerine	8.0
	Tomato	8.0

APPRAISAL

Malathion has been evaluated many times since 1965. The company asked the CCPR at its Thirty-third Session in 2001 to reconsider withdrawal of the existing Codex MRLs recommended during the periodic review of the compound by the 1999 JMPR. The CCPR at its Thirty-sixth Session decided to retain the current CXL for apple, broccoli, cabbage (head), cereal grains, citrus fruit and grape, awaiting the review of the new residue data by the 2004 JMPR. The company submitted data on mandarin, orange, apple, peach, grape, strawberry, tomato, alfalfa fodder and forage (green) to the present Meeting.

Results of supervised trials on crops

Citrus fruit

Sixteen trials were conducted with mandarin and orange in Greece (GAP for citrus, 0.044–0.088 kg ai/hl, 7-day PHI), Italy (GAP, 0.053 kg ai/hl, 20-day PHI) and Spain (GAP for foliar application, 0.11–0.15 kg ai/hl, 7-day PHI) between 2000 and 2002. Malaoxon was analysed in all trials and the maximum residue level found in fruit was 0.09 mg/kg on the day of the last application.

Ten trials conducted at 0.18 kg ai/hl and five trials performed at 0.30 kg ai/hl were evaluated against Spanish and Portuguese GAP for citrus (0.05–0.30 kg ai/hl, 7-day PHI), respectively. Decline studies conducted in both crops indicated that residue levels decreased slowly within 3 days of the last application and samples harvested from 7 up to 10–11 days could be considered at GAP.

The residue levels in *mandarin* fruit were, in ranked order: 0.75, 1.8 (three), 2.4 (two), 2.9, 3.1 and 4.7 mg/kg. In mandarin pulp, the levels were: < 0.01, 0.01, 0.02, 0.03, 0.12, 0.15, 0.21 and 0.22 mg/kg.

The residue levels in *orange* fruit were, in ranked order: 0.58, 0.75, 0.89, 1.1, 1.4, 1.6, 1.7 and 2.1 mg/kg. The levels in orange pulp were: < 0.01 (three), 0.01 (two), 0.03 and 0.07 (two) mg/kg. One trial conducted at 0.4 kg ai/hl gave residue levels within the same range.

The Meeting agreed that the levels of residues of malathion in mandarin and orange from trials conducted at GAP could be combined to represent a residue population for citrus. In fruit, the levels were, in ranked order: 0.58, 0.75 (two), 0.89, 1.1, 1.4, 1.6, 1.7, 1.8 (three), 2.1, 2.4 (two), 2.9, 3.1 and 4.7 mg/kg. In citrus pulp, the levels were: < 0.01 (four), 0.01 (three), 0.02, 0.03, 0.07 (two), 0.12, 0.15, 0.21 and 0.22 mg/kg.

The Meeting recommended a maximum residue level of 7 mg/kg, a STMR of 0.02 mg/kg and a highest residue level of 0.22 mg/kg for malathion in citrus.

Apple

Twelve trials were conducted on apples in northern France in 2000 and 2001, with three applications at 0.18 kg ai/hl. There is no GAP for malathion in France; however, the results can be evaluated against Spanish or Italian GAP (up to 0.16 kg ai/hl). The PHI is 7 days in Spain and 20 days in Italy. The residue levels in apple fruit at the most critical PHI (7 days) were, in ranked order: 0.02, 0.05 (two), 0.07, 0.08, 0.09, 0.13, 0.14, 0.19, 0.24, 0.25 and 0.37 mg/kg. The levels of malaoxon were < 0.01–0.02 mg/kg.

The Meeting recommended a maximum residue level of 0.5 mg/kg, an STMR of 0.11 mg/kg and an HR of 0.37 mg/kg for malathion in apple.

Peach

Four trials were conducted in Italy in 1997 on peaches, with three applications of 0.16 kg ai/hl, corresponding to GAP. The residue levels of malathion in the fruit at 20 days' PHI were < 0.01 (three) and 0.01 mg/kg. No malaoxon was found in the fruit after the last application (0–20 days).

The Meeting agreed that four trials is not enough to recommend a maximum residue level for malathion in peaches. The Meeting confirmed the previous recommendation of 1999 JMPR to withdraw the CXs for malathion in peaches

Grape

Six trials were conducted in grapes in southern and northern France (no GAP) in 2000–01, with three applications at 0.27 kg ai/hl. The residue levels of malathion 7 days after the last application were 0.26–1.3 mg/kg.

In four trials conducted in northern Spain in 2000–01 within maximum GAP (0.11–0.15 kg ai/hl, 7-day PHI), the residue levels of malathion at 7 days' PHI were: 1.1, 1.5 (two) and 2.6 mg/kg. The levels of malaoxon were 0.02–0.13 mg/kg. Four trials conducted in Italy at GAP (0.05–0.16 kg ai/hl, 20-day PHI), evaluated against Spanish GAP, showed levels of 0.01, 0.03 and 0.21 (two) mg/kg.

The residue levels in trials conducted in Italy and Spain according to GAP were 0.01, 0.03, 0.21 (two), 1.1, 1.5 (two) and 2.6 mg/kg.

The Meeting recommended a maximum residue level of 5 mg/kg, a STMR of 0.16 mg/kg and a highest residue level of 2.6 mg/kg for malathion grapes.

Strawberry

GAPs for malathion on strawberry in Europe are: Denmark, three times 1.1 kg ai/ha, 7-day PHI; Italy, up to 0.16 kg ai/hl, 20-day PHI; Portugal, 0.10 kg ai/hl, 1-day PHI; and Spain, up to 0.15 kg ai/hl, 7-day PHI. In three trials conducted in France, two in Italy and three in Spain with four or six applications at 0.15–0.18 kg ai/hl, the residue levels at 7 days' PHI were < 0.01–0.14 mg/kg.

The Meeting confirmed the currently recommended maximum residue level of 1 mg/kg of malathion in strawberry, which was set by the 1999 JMPR on the basis of trials conducted in the USA according to GAP with a 1-day PHI.

Tomato

GAP for malathion in tomato is up to 0.088 kg ai/hl with a 7-day PHI in Greece, up to 0.16 kg ai/hl with a 20-day PHI in Italy and up to 0.10 kg ai/hl with a 1-day PHI in Portugal. In five trials conducted in Italy and one in Spain in 1997–2001 according to Greek GAP, the residue levels were < 0.01 (three), 0.01 and 0.02 (two) mg/kg. Four other trials were conducted in these countries at higher or lower rates than GAP.

The Meeting confirmed the currently recommended maximum residue level of 0.5 mg/kg for malathion in tomato, which was set by the 1999 JMPR on the basis of trials conducted in the USA according to GAP with a 1-day PHI.

Alfalfa

Two trials were conducted in Italy in 2000–01 (no GAP) and two in Spain (GAP, 0.12–0.25 kg ai/hl or 1.5–2.8 kg ai/ha) with one application at 0.15 kg ai/hl (1.5 kg ai/ha). The Italian trials, evaluated against Spanish GAP, gave residue levels of malathion of 0.67 and 0.41 mg/kg on a dry weight basis in alfalfa forage (green) at 7 days' PHI and 0.12 mg/kg in hay harvested at 7 days' PHI and allowed to dry on the field for 3 days. In the Spanish trials, the residue levels were 1.2 and 3.5 mg/kg in forage and 3.3 mg/kg in hay.

The Meeting confirmed the currently recommended maximum residue levels for malathion on alfalfa forage (green) and alfalfa hay of 500 and 200 mg/kg, respectively, which were set by the 1999 JMPR on the basis of trials conducted in USA according to GAP at 1 day PHI.

RECOMMENDATIONS

On the basis of the data derived from supervised trials, the Meeting concluded that the residue levels listed below are suitable for establishing maximum residue limits and for dietary intake assessment.

Summary of recommendations for MRLs , STMRs and HRs.

Commodity		MRL, mg/kg		STMR or STMR-P mg/kg	HR or HR-P, mg/kg
CCN	Name	New	Previous		
FP 00226	Apple	0.5	W	0.11	0.37
FC 0001	Citrus fruits	7	W	0.02	0.22
FB 0269	Grape	5	W	0.16	2.6
FS 0247	Peach	W	W		

DIETARY RISK ASSESSMENT

Long-term intake

The current ADI for malathion is 0.3 mg/kg bw. IEDIs were calculated for commodities for human consumption for which STMRs were estimated by the 1999 JMPR and by the present Meeting (Annex 3 of the Report). The IEDI for the five GEMS/Food regional diets was 0% of the maximum ADI. The Meeting concluded that long-term intake of residues of malathion resulting from uses considered by the JMPR is unlikely to present a public health concern.

Short-term intake

An ARfD for malathion of 2 mg/kg bw was established by the 2003 JMPR. The IESTIs of malathion by the general population and by children were calculated for commodities for which STMR and highest residue values were estimated by the current Meeting (Annex 4 of the Report). The IESTI was 0–4% of the ARfD for the general population and 0–10% of the ARfD for children. The Meeting concluded that short-term intake of residues of malathion from its use in citrus, apples and grapes is unlikely to present a public health concern.

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