CONTENTS

The monographs[1]

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[1] * First evaluation
** Evaluation in CCPR periodic review programme

Location, year	Application			PHI, days	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha		Parent	Met	
1973				7 28	0.52 0.13	----- 0.06	-001
Koldenbuttel 1973	EC	1	4.8	35 56 84	<0.02 <0.02 <0.02a	----- ----- 0.07	CH-726 -001
Geisenheim 1977	EC	1	4.8	40 60 80	0.22 <0.02 <0.02a	<0.02 <0.02 <0.02	CH-726 -002 & CH-726- 003
Frankfurt 1977	EC	1	4.8	30 50 63	0.08 <0.02 <0.02a	<0.02 <0.02 <0.02	CH-726 -002 & CH-726- 003
Bamberg 1977	EC	1	4.8	40 60 80	0.47 0.15 <0.02a	<0.02 <0.02 <0.02	CH-726 -002 & CH-726- 003
Geisenheim 1977	GR	1	0.1 g/plant	40 60 80	1.44 0.37 <0.02b	<0.02 <0.02 <0.02	CH-726 -004 & CH-726- 005
Frankfurt 1977	GR	2	0.1 kg/m^2 and 0.1 g/plant	30 50 63	3.05 0.10 0.07c	<0.02 <0.02 <0.02	CH-726 -004 & CH-726- 005
	GR	1	0.1 g/plant	30 50 63	0.82 0.15 0.09b	<0.02 <0.02 <0.02	
Bamberg 1977	GR	2	0.1 kg/m^2 and 0.1 g/plant	40 60 80	0.40 0.20 0.02c	<0.02 <0.02 <0.02	CH-726 -004 & CH-726 -005
	GR	1	0.1 g/plant	40 60 80	0.71 0.10 <0.02b	<0.02 <0.02 <0.02	

Results underlined once or twice are considered comparable with
a - Dutch GAP where treatment is by spraying at or before planting
b - the German granular single plant treatment
c - the German granular single plant combined with soil treatment according to German GAP
Double underlined residues are from maximum GAP treatments and have been used for estimating the STMR

[1] Duration of sample storage was unspecified in all trials

Met = 1-(2,4-dichlorophenyl)ethanol

Carrots. GAP was reported for Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, The Netherlands, Switzerland and the UK.

Residue trials were available from Canada, France, Germany, The Netherlands, South Africa, Spain, Sweden, Switzerland, Trinidad and the UK (Table 26). In addition the UK government provided data on residues in overwintered commercial carrots whose treatment history had been recorded (Table 27). The highest residues resulted from post-planting EC or WP sprays at *c*.4 kg ai/ha according to GAP in The Netherlands and France. Similar treatments at *c*.2.5 kg ai/ha are GAP in Ireland and the UK. The PHIs reported for these countries ranged between 21 and 60 days which reflects second-generation carrot fly control. French GAP was also reported to include an EC spray at 5 kg ai/ha with a PHI of 15 days, but the Meeting was informed that the use in practice was at the time of sowing. Several trials in France, Germany and The Netherlands complied with the higher rate GAP, with residues of <0.02, 0.05, 0.08, 0.12, 0.14, 0.2(3), 0.22, 0.3, 0.37, 0.45, 0.9, 1.2, 1.8, 2.0, and 3.8 mg/kg. In the overwintered commercial carrots treated in accordance with UK GAP the residues were <0.02-1.6 mg/kg. The Meeting estimated an STMR of 0.22 mg/kg and a maximum residue level of 5 mg/kg.

Table 26. Supervised field trials on carrots.

Location Country, year	Application				PHI, days	Sample	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl			Parent	Met	
Canada 1970[1]	GR	1	2.2	-	14	Root	<0.02	------	CH-724-014
					147	Pulp	0.7	0.04	
					126	Pulp	0.5	0.07	
Canada 1971[1]	GR	1	1.1	-	112	Root	0.1	<0.02	CH-724-0.15
						Pulp	<0.02	<0.02	
						Boiled	0.05	<0.02	
	EC	4	3.5		49	Root	0.09	<0.02	
						Pulp	<0.02	<0.02	
						Boiled	0.04	<0.02	
	EC	5	4.6		49	Root	0.2	<0.02	
						Pulp	<0.02	<0.02	
						Boiled	0.08	<0.02	
Surtainville France 1969[1]	GR	1	5.0	-	210	Root	0.01	<0.05	CH-724-011
							0.02	<0.05	
Avignon France 1969[1]	GR	1	5.0	-	175	Root	<0.02	<0.05	CH-724-011
							<0.02	<0.05	
	GR	1	6.0		175	Root	<0.02	<0.05	
Entraigues	GR	1	5.0	-	294	Root	0.02	<0.05	CH-724

Location Country, year	Application				PHI, days	Sample	Residues, mg/kg Parent	Met	Ref.
	Form	No.	kg ai/ha	kg ai/hl					
France 1970[1]							0.01	<0.05	-012
Surtainville France 1970[1]	GR	1	5.0	-	98	Root	0.3	<0.05	CH-724 -012
							0.2	<0.05	
				-					
	GR	1	6.0		98	Root	0.4	<0.05	
Le Thor France 1971[1]	GR	1	4.0	-	133	Root	0.1	0.2	CH-790 -029
						Canned	<0.02	0.03	
						Tops and peel	0.09	0.05	
	GR	1	8.0	-	133		0.2	0.25	
						Root	<0.02	0.03	
						Canned	0.1	0.1	
						Tops and			
	GR		4.0	-	133	peel	0.1	0.2	
							<0.02	0.02	
						Root	0.1	0.2	
						Canned			
				-	133	Tops and	0.2	0.3	
	GR		8.0			peel	<0.02	0.01	
							0.20	0.3	
						Root			
						Canned			
						Tops and peel			
Le Thor France 1972[1]	GR	1	4.0	-	504	Root	<0.02	<0.02	CH-790 -031
	GR	1	8.0	-	504	Root	<0.02	<0.02	
	GR	2	4.0	-	175	Root	0.03	0.03	
	GR	2	4.0	-	175	Juice Pulp	<0.02 <0.02	<0.02 <0.02	
	GR	2	8.0	-	175	Root	0.07	0.10	
	GR	2	8.0	-	175	Juice Pulp	<0.02 <0.02	<0.02 <0.02	
	GR	1	4.0	-	504	Root	<0.02	<0.02	
	GR	1	8.0	-	504	Root	<0.02	<0.02	
	GR	2	4.0	-	175	Root	0.06	0.1	
	GR	2	4.0	-	175	Juice Pulp	<0.02 <0.02	<0.02 <0.02	
	GR	2	8.0	-	175	Root	0.1	0.2	
	GR	2	8.0	-	175	Juice Pulp	<0.02 <0.02	<0.02 <0.02	
Le Thor France 1973[1]	GR	3	4.0	-	175	Root	0.02	<0.02	CH-790 -033
	GR	3	8.0	-	175	Root	0.03	0.04	
	GR	3	8.0	-	175	Root	0.02	0.07	

Location Country, year	Application				PHI, days	Sample	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl			Parent	Met	
Frankfurt	EC	1	5.0	-	49	Root	3.1	-----	CH-724
Germany					77	Root	1.5	-----	-017
1973[1,2]					168	Root	0.1	<0.02	
	EC	1	5.0	-	42	Root	1.2	-----	
					63	Root	0.3	-----	
					112	Root	<0.02	<0.02	
Frankfurt	GR	1	5.0	-	42	Root	0.4	-----	CH-724
Germany					56	Root	0.1	-----	-018
1973[1]					112	Root	<0.02	<0.02	
	GR	1	5.0	-	49	Root	8.8	-----	
					77	Root	1.4	-----	
					168	Root	<0.02	<0.02	
Lübeck	GR	1	55.0	-	42	Root	2.4	-----	CH-724
Germany					63	Root	0.7	-----	-018
1973[1]					112	Root	<0.02	<0.02	
Geisenheim	EC	1	4.8	--	53	Root	1.8	-----	CH-724
Germany					67	Root	0.5	-----	-022
1980					81	Root	0.2	-----	
Bamberg	EC	1	4.8	-	42	Root	0.9	-----	CH-724
Germany					56	Root	0.3	-----	-022
1980					70	Root	0.1	-----	
Frankfurt	EC	1	4.8	-	60	Root	1.2	-----	CH-724
Germany					74	Root	0.6	-----	-022
1980					88	Root	0.3	-----	
Geisenheim	GR	1	5.0	-	49	Root	1.9	-----	CH-724
Germany					63	Root	0.4	-----	-023
1980					77	Root	0.2	-----	
Bamberg	GR	1	5.0	-	42	Root	0.7	-----	CH-724
Germany					56	Root	0.3	-----	-023
1980					70	Root	0.1	-----	
Frankfurt	GR	1	5.0	-	56	Root	<0.02	-----	CH-724
Germany					70	Root	<0.02	-----	-023
1980					84	Root	<0.02	-----	
Frankfurt	EC	1	4.8	1.2	70	Root	0.05	-----	CH-724
Germany					77	Root	0.03	-----	-024
1989					84	Root	<0.02	-----	
Bonn	EC	1	4.8	1.2	42	Root	0.2	-----	CH-724
Germany					49	Root	0.2	-----	-024
1989					63	Root	0.2	-----	
München	EC	1	4.8	1.2	84	Root	<0.02	-----	CH-724
Germany					91	Root	<0.02	-----	-024
1989					105	Root	<0.02	-----	
Hannover	EC	1	4.8	1.2	63	Root	0.3	-----	CH-724
Germany					70	Root	0.1	-----	-024
1989					84	Root	0.04	-----	
Buttelborn	EC	1	4.8	0.48	11	whole plant	21	----	Anon 1995
Germany					44	root	0.1	----	
1990[3]					60	root	0.06	----	
					89	root	<0.04	----	
					110	root	<0.04	----	
	EC	1	4.8	0.48	9	whole plant	5.5	----	

Location Country, year	Application				PHI, days	Sample	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl			Parent	Met	
					42	root	0.8	----	
					59	root	0.9	----	
					92	root	0.7	----	
					101	root	0.5	----	
Wulfsdorf Germany 1990[3]	EC	1	4.8	0.48	42	root	1.1	----	Anon 1995
					60	root	0.2	----	
					91	root	0.05	----	
					117	root	0.04	----	
Braunschweig Germany 1990[3]	EC	1	4.8	0.48	20	whole plant	15	----	Anon 1995
					42	root	0.3	----	
					61	root	0.2	----	
					89	root	0.09	----	
					170	root	0.07	----	
Saarlouis Germany 1990[3]	EC	1	4.8	0.48	28	whole plant	3	----	Anon 1995
					42	root	0.6	----	
					61	root	0.09	----	
					90	root	<0.04	----	
München Germany 1990[3]	EC	1	4.8	0.48	25	whole plant	3.5	----	Anon 1995
					42	root	0.7	----	
					60	root	0.3	----	
					90	root	<0.2	----	
Rastede Germany 1990[3]	EC	1	4.8	0.48	26	whole plant	2	----	Anon 1995
					41	root	0.4	----	
					60	root	0.1	----	
					90	root	0.09	----	
					102	root	0.08	----	
Moos Germany 1990[3]	EC	1	4.8	0.48	28	whole plant	0.6	----	Anon 1995
					42	root	0.2	----	
					61	root	0.05	----	
					90	root	0.04	----	
					110	root	0.05	----	
Lubeck Germany 1990[3]	EC	1	4.8	0.48	25	whole plant	3.3	----	Anon 1995
					41	root	0.8	----	
					60	root	0.1	----	
					90	root	0.05	----	
					94	root	0.08	----	
Bonn Germany 1990[3]	EC	1	4.8	0.48	42	root	0.04	----	Anon 1995
					60	root	0.05	----	
					90	root	0.04	----	
Germany 1964[4]	GR	1	2	-	119	Root	0.02	----	CH-601-001
			4	-	119	Root	0.02	----	
			8	-	119	Root	0.12	----	
	EC	1	2	-	119	Root	<0.02	----	
			4	-	119	Root	0.03	----	
			8	-	119	Root	<0.02	----	
Netherlands 1964[1]	WP	1	3	-	91	Root	<0.05	-----	CH-724-001
	WP	1	4	-	91	Root	0.1	-----	
	WP	1	5	-	91	Root	0.07	-----	
Noordwijk Netherlands 1966[1]	GR	1	3	-	343	Root	0.2	-----	CH-724-002
	GR	2	3	-	252	Root	0.9	-----	

Location Country, year	Application				PHI, days	Sample	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl			Parent	Met	
	GR	1	4	-	343	Root	0.3	-----	
	GR	2	4	-	252	Root	1.0	-----	
	WP	1	3	-	343	Root	0.2	-----	
	WP	2	3	-	252	Root	3.8	-----	
	WP	1	4	-	343	Root	0.2	-----	
	WP	2	4	-	252	Root	1.6	-----	
	GR	1	3	-	343	Root	0.2	<0.05	
	GR	2	3	-	252	Root	1.1	<0.05	
	GR	1	4	-	343	Root	0.3	<0.05	
	GR	2	4	-	252	Root	1.1	<0.05	
	WP	1	3	-	343	Root	0.2	<0.05	
	WP	2	3	-	252	Root	3.8	<0.05	
	WP	1	4	-	343	Root	0.1	<0.05	
	WP	2	4	-	252	Root	2.0	<0.05	
Alkmaar Netherlands 1974[5]	WP	1	4	0.2	103	Root	0.08 0.07 0.04 0.06	----- ----- ----- -----	Anon 1996c
Alkmaar Netherlands 1974[5]	WP	1	4	0.2	60	Root	0.13 0.14 0.13 0.13	----- ----- ----- -----	Anon 1996c
Wageningen Netherlands 1977[5]	EC	1	5.3	1.06	93	Root	0.03 0.12 0.09 0.05	----- ----- ----- -----	Dorlijn, 1977
Twello Netherlands 1977[5]	EC	1	5.3	1.06	89	Root	0.28 0.25 0.33 0.37	----- ----- ----- -----	Dorlijn, 1977
Wieringerwerf Netherlands 1978[5]	GR	1	1.6	-	184	Root	<0.02	-----	Ten Broeke, 1979
Wieringerwerf Netherlands 1978[5]	GR	1+ 1	0.32+ 0.5	-	184	Root	<0.02	-----	Ten Broeke, 1979
Wieringerwerf Netherlands 1978[5]	GR	1+ 1	1.26+ 1.0	-	184	Root	<0.02 <0.02 <0.02 0.03	----- ----- ----- -----	Ten Broeke, 1979
Wieringerwerf Netherlands 1978[5]	GR	1+ 1	2.0+ 2.0	-	184	Root	0.05 <0.02	----- -----	Ten Broeke, 1979

Location Country, year	Application				PHI, days	Sample	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl			Parent	Met	
							0.03	-----	
							0.04	-----	
Zwaagdizk Netherlands 1986[5]	EC	2	4	0.4	103	Root	0.17	-----	Greve, 1987
							0.25	-----	
							0.17	-----	
							0.45	-----	
							0.18	-----	
							0.33	-----	
							0.25	-----	
							0.17	-----	
Zwaagdizk Netherlands 1986[5]	EC	2	4	0.4	72	Root	0.15	-----	Greve, 1987
							0.2	-----	
							0.15	-----	
							0.22	-----	
Zwaagdizk Netherlands 1986[5]	EC	1+ 1	4+ 2	0.4+ 0.2	103	Root	0.15	-----	Greve, 1987
							0.19	-----	
							0.07	-----	
							0.08	-----	
							0.07	-----	
							0.1	-----	
							0.1	-----	
							0.14	-----	
Zwaagdizk Netherlands 1986[5]	EC	1+ 1	4+ 2	0.4+ 0.2	72	Root	0.16	-----	Greve, 1987
							0.11	-----	
							0.04	-----	
							0.06	-----	
Philippolis South Africa 1972[1,6]	EC	2	1.0	-	42	Root	0.1	-----	CH-724 -008
						Pulp	0.07	-----	
	EC	7	1.0	-	0	Root	1.0	-----	
						Pulp	0.5	-----	
	EC	2	2.0	-	42	Root	0.3	-----	
						Pulp	0.1	-----	
	EC	7	2.0	-	0	Root	2.3	-----	
						Pulp	1.0	-----	
Seville Spain 1970[1]	GR	1	2	-	119	Root	<0.02	0.09	CH-724 -013
						Pulp	<0.02	<0.02	
	GR	1	3	-	119	Root	<0.02	0.1	
						Pulp	<0.02	0.07	
	GR	1	4	-	119	Root	<0.02	0.40	
						Pulp	<0.02	0.2	
Seville Spain 1972[1]	GR	1	4	-	140	Root	0.4	0.2	CH-724 -016
	GR	1	8	-	140	Root	2.9	0.6	
Seville Spain 1973[1]	GR	1	4	-	511	Root	<0.02	<0.02	CH-724 -019
	GR	2	4	-	140	Root	0.1	0.05	
	GR	1	8	-	511	Root	<0.02	<0.02	

Location Country, year	Application				PHI, days	Sample	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl			Parent	Met	
	GR	2	8	-	140	Root	0.2	0.2	
Seville Spain 1974[1]	GR	1	4	-	882	Root	<0.02	-----	CH-724 -021
	GR	3	4	-	182	Root	0.3	-----	
						Pulp	0.1	-----	
	GR	1	8	-	882	Root	<0.02	-----	
	GR	3	8	-	182	Root	0.5	-----	
						Pulp	0.4	-----	
Sweden 1966[1]	GR	1	1.5 kg per 20,000 m	-	98	Peel	1.5	-----	CH-724 -004
						Peel	0.9	-----	
						Peel	0.9	-----	
						Pulp	0.06	-----	
						Root	0.3	-----	
	GR	1	1.5 kg per 20,000 m	-	98	Peel	0.9	-----	
						Peel	1.2	-----	
						Pulp	0.04	-----	
						Root	0.3	-----	
	GR	1	1.5 kg per 20,000 m	-	175	Root	0.2	-----	
						Root	0.2	-----	
						Root	0.3	-----	
						Root	0.2	-----	
	GR	1+ 1	1.5+ 2 both kg per 20,000 m	-	84	Root	0.9	-----	
						Root	1.0	-----	
						Root	1.4	-----	
						Root	1.3	-----	
						Root	1.5	-----	
						Root	1.5	-----	
						Root	1.7	-----	
Eggensil Switzerland 1974[1]	GR	1	2	-	84	Root	0.01	-----	CH-724 -020
	GR	1	4	-	84	Root	0.02	-----	
Reichenberg Switzerland 1974[1]	GR	2	1.5	-	140	Root	0.01	-----	CH-724 -020
	GR	2	2	-	140	Root	0.01	-----	
	GR	2	3	-	105	Root	0.04	-----	
	GR	2	4	-	105	Root	0.1	-----	
Switzerland undated[4]	EC	1	1.5	-	49	Root	<0.02	----	CH-601-001
Shell Station Trinidad 1971[1]	EC	1	4	-	140	Root	<0.02	<0.05	CH-790 -027
	EC	1	8	-	140	Root	<0.02	<0.05	
Shell Station Trinidad 1972[1]	EC	1	4	-	448	Root	<0.02	<0.02	CH-790 -030
	EC	2	4	-	112	Root	<0.02	<0.02	
	EC	1	8	-	448	Root	<0.02	<0.02	
	EC	2	8	-	112	Root	<0.02	<0.02	

Location Country, year	Application				PHI, days	Sample	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl			Parent	Met	
Shell Station Trinidad 1973[1]	EC	3	4	-	112	Root	<0.02 <0.02	<0.02 <0.02	CH-790 -032
	EC	3	8	-	112	Root	<0.02 <0.02	<0.02 <0.02	
Kent UK 1963[4]	EC	1	4.48	-	203	Root	0.02	----	CH-601-001
UK undated[4]	GR	1	4	-	98	Root	0.1	----	CH-601-001
Suffolk UK undated[4]	GR	1	4.48	-	183	Root	0.04	----	CH-601-001
			8.96	-	183	Root	0.09	----	
	EC	1	4.48	-	183	Root	<0.02	----	
			8.96	-	183	Root	0.04	----	
Peterborough UK undated[4]	GR	1	4.48	-	161	Root	0.03	----	CH-601-001
			8.96	-	161	Root	0.06	----	
	EC	1	4.48	-	161	Root	0.01	----	
			8.96	-	161	Root	0.04	----	
UK 1967[1,7]	EC	1	4.4	-	273	Root	<0.02	-----	CH-724-003
Faversham UK 1969[1]	GR	1	4	-	1274	Root	<0.02	-----	CH-790 -026
	GR	4	4	-	182	Root	<0.02	-----	
East Anglia UK 1971[1]	EC	5	1.1	-	98	Root Pulp Pre-boiled Boiled	1.5 0.8 0.8 0.1	<0.05 ----- ----- -----	CH-724 -007
	EC	5	1.1	-	98	Root Pulp Pre-boiled Boiled	1.00 0.5 0.5 0.06	<0.05 ----- ----- -----	
						Root	2.6	<0.05	
	EC	10	1.1	-	98	Pulp Pre-boiled Boiled	1.0 1.0 0.1	----- ----- -----	
Feltwell UK 1992/3[6]	EC	1	4.7	-	90	Root	<0.02	<0.1	CH-724 -077
	EC	2	4.7	-	19	Root	0.03	0.1	
	EC	2	4.7 + 2.4	-	41	Root	0.05	0.1	
	EC	3	4.7+2x2.4	-	20	Root	0.05	<0.1	
	EC	3	4.7+2x2.4	-	42	Root	0.05	<0.1	
	EC	7	4.7+6x0.78	-	20	Root	<0.02	<0.1	
	EC	7	4.7+6x0.78	-	41	Root	<0.02	<0.1	
	GR	1	4.5	-	90	Root	<0.02	<0.1	
	Gr/Ec	2	4.5+1.2	-	19	Root	0.02	<0.1	
	Gr/Ec	3	4.5+2x1.2	-	23	Root	<0.02	<0.1	
	Gr/Ec	4	4.5+3x1.2	-	20	Root	0.01	<0.1	
	Gr/Ec	4	4.5+3x1.2	-	42	Root	0.01	<0.1	
Friday Bridge UK 1992/3[8]	EC	1	2.4	-	92	Root	<0.02	<0.1	CH-724 -077
	EC	2	2.4	-	22	Root	0.3	<0.1	
	EC	2	2.4	-	42	Root	0.05	<0.1	
	EC	3	2.4	-	20	Root	0.2	<0.1	
	EC	3	2.4	-	42	Root	0.08	<0.1	
	GR	1	2.3	-	92	Root	<0.02	<0.1	
	Gr/Ec	2	2.3+1.2	-	22	Root	0.09	<0.1	

Location Country, year	Application				PHI, days	Sample	Residues, mg/kg Parent Met	Ref.
	Form	No.	kg ai/ha	kg ai/hl				
	Gr/Ec	3	2.3+2x1.2	-	23	Root	0.07 <0.1	
	Gr/Ec	4	2.3+3x1.2	-	20	Root	0.02 <0.1	
	Gr/Ec	4	2.3+3x1.2	-	42	Root	0.09 <0.1	
	EC	1	2.4	-	89	Root	0.06 <0.1	
	EC	2	2.4	-	22	Root	0.5 <0.1	
	EC	2	2.4	-	42	Root	0.2 <0.1	
	EC	3	2.4	-	20	Root	0.2 <0.1	
	EC	3	2.4	-	42	Root	0.1 <0.1	
	EC	7	2.4+6x0.78	-	20	Root	0.04 <0.1	
	EC	7	2.4+6x0.78	-	41	Root	0.05 <0.1	
	GR	1	2.3	-	89	Root	0.02 <0.1	
	Gr/ec	2	2.3+1.2	-	22	Root	0.2 <0.1	
	Gr/ec	3	2.3+2x1.2	-	23	Root	0.07 <0.1	
	Gr/ec	4	2.3+3x1.2	-	20	Root	0.2 <0.1	
	Gr/ec	4	2.3+3x1.2	-	42	Root	0.05 <0.1	
Kirton End UK 1992/3	EC	1	2.4	-	21	Root	0.2 <0.1	CH-724 -077
	EC	1	2.4	-	42	Root	0.2 <0.1	
	EC	2	2.4	-	19	Root	0.3 <0.1	
	EC	2	2.4	-	40	Root	0.3 <0.1	
Cawood UK 1992/3	EC	1	2.4	--	22	Root	0.2 <0.1	CH-724 -077
	EC	1	2.4	-	42	Root	0.2 <0.1	
	EC	2	2.4	-	22	Root	0.2 <0.1	
	EC	2	2.4	-	42	Root	0.4 <0.1	
Ely UK 1992/3[8]	EC	1	2.4	-	24	Root	0.3 <0.1	CH-724 -077
	EC	1	2.4	-	43	Root	0.3 0.2	
	EC	2	2.4	-	28	Root	0.4 0.2	
	EC	2	2.4	-	42	Root	0.3 0.2	

Results underlined once or twice are considered comparable with the 4 kg ai/ha EC or WP spray post-planting GAP in The Netherlands

Double underlined residues are from maximum GAP treatments and have been used for estimating the STMR

[1] Duration of sample storage unspecified

[2] Some results were missing from the submitted report

[3] Only the JMPR residue trial summary sheets were supplied (no study report with further information).

[4] No detailed study report; only very brief details of the trial and analyses were available.

[5] Information is taken from residue trial summary sheets submitted by The Netherlands. Full study reports were submitted but were in Dutch

[6] Residues of apparent chlorfenvinphos in control carrots were 0.03 mg/kg

[7] High analytical recovery, >120%

[8] Residues of apparent "acetophenone" in control carrots were 0.02-0.03 mg/kg

Met = 1-(2,4-dichlorophenyl)ethanol

Table 27. Residues of chlorfenvinphos in commercially grown over-wintered field carrots of known treatment history during 1989-92 in the UK. All EC formulations. Roots analysed (Anon., 1989-92).

Soil type	Application		PHI, months	Chlorfenvinphos, mg/kg
	No.	kg ai/ha[1]		
Organic	2	2.4	6	0.20
Silty loam	2	1.2	7	0.20
Sandy loam	1	2.35	5	<0.02
Sandy loam	1	2.4	6	<0.02
Sandy loam	1	2.4	9	0.05
Sandy loam	2	2.4+0.84	6	0.09
Sandy loam	1	2.36	3	0.12
Sandy loam	1	2.35	6	0.13
Sandy loam	1	0.6	5	0.15
Sandy loam	1	2.4	9	0.20
Sandy loam	1	2.35	5	0.36
Sandy loam	1	2.36	5	0.83
Sandy loam	1	2.4	9	1.04
Sandy loam	2	2.4	6	1.30
Peaty loam	1	2.36	3	<0.01
Peaty loam	1	2.4	3	<0.01
Peaty loam	2	2.4+N/S	5	<0.02
Peaty loam	1	2.35	3	0.02
Peaty loam	1	2.4	3	0.04
Peaty loam	2	2.4	6	0.05
Peaty loam	2	2.35	3	0.10
Peaty loam	2	2.4+N/S	5	0.17
Peaty loam	2	2.35	3	0.19
Peaty loam	2	2.4	5	0.19[2]
Peaty loam	2	2.4+N/S	5	0.29
Peaty loam	2	2.4+N/S	5	0.31
Peaty loam	1	2.4	6	0.38
Peaty loam	2	2.4	5	1.4[2]
Peaty loam	2	2.4	5	1.6[2]
Unknown	2	2.4	5	0.01
Unknown	1	2.4	6	0.01
Unknown	1	2.4	6	0.20

[1] Approved in the UK as a spray application up to 2.35 kg ai/ha
[2] Mean of duplicate results
N/S Not specified

Parsley root. No GAP was reported for parsley root (i.e. Hamburg parsley) although summarized reports of residue trials were available from Germany.

Table 28. Supervised field trials on parsley root, Germany, 1979. All single granular applications, 5.0 kg ai/ha (Anon., 1995).

Location	PHI, days	Sample	Chlorfenvinphos, mg/kg
Stuttgart	93	leaves	<0.02
	128	leaves	<0.02
	170	leaves	0.08
	170	root	0.2
Buttelborn	78	leaves	0.2
	161	leaves	<0.02
	78	root	1.7
	161	root	0.2
Lübeck	132	leaves	0.1
	152	leaves	0.1
	138	root	1.3
	152	root	1.5
Münster	83	leaves	0.03
	111	leaves	<0.02
	83	root	0.4
	111	root	0.3
Hurthfischenich	50	leaves	0.05
	85	leaves	<0.02
	115	leaves	<0.02
	85	root	0.08
	115	root	0.03
	128	leaves	0.02
	128	root	0.21

Only the JMPR residue trial summary sheets were supplied (no study report with further information).

Parsnip. GAP was reported for The Netherlands and the UK. The UK provided government-generated data on residues in overwintered commercial parsnips of known treatment history. Two residues were from treatments according to UK GAP (2.35 kg ai/ha). The residues were 0.14 and 0.16 mg/kg.

Table 29. Residues of chlorfenvinphos in commercially grown overwintered field parsnips of known treatment history during 1989-92 in the UK. All EC. Roots analysed (Anon., 1989-92).

Soil type	Application		PHI, months	Chlorfenvinphos, mg/kg
	No.	kg ai/ha		
Peat	1	4.8	5	<0.02
Flinty sand	1	0.59	3	0.07
Sand	1	2.35	7	0.14
Sand	1	2.36	5	0.16
Sand	N/S	N/S	N/S	0.35

Double underlined residues are from maximum UK GAP treatments (spray application up to 2.35 kg ai/ha) and have been used for estimating the STMR
N/S Not specified

Potatoes. There are registered uses in The Netherlands and Poland.

Residue trials were carried out in the UK, Spain, Australia and Poland, but they were very old and poorly reported with few details.

Table 30. Supervised field trials on potatoes. Tubers analysed.

Location, Country, Year	Application			PHI, days	Residues, mg/kg		Ref.
	Form.	No.	kg ai/ha		Parent	Met	
Kent UK 1963	EC	1	4.5 soil application	112	<0.02	<0.05	CH-601-001
Kent UK 1966	EC	1	0.25 foliar spray	65	<0.02	<0.05	CH-601-001
Spain 1966	EC	1	0.25 foliar spray	13	<0.02	<0.05	CH-601-001
Seville Spain 1965	EC	1	1 foliar spray	28	<0.02	<0.05	CH-601-001 & CH-640-002
Australia undated	EC	8	0.25 foliar spray	5	0.01	-----	CH-601-001
Poland undated	FSD	1	0.5 foliar spray	69	0.02	-----	CH-601-001
Poland undated	EC	1	0.24 foliar spray	69	0.02	-----	CH-601-001

No detailed study reports; only very brief details of the trials and analyses were available.
Met = 1-(2,4-dichlorophenyl)ethanol

Radishes. GAP was reported for Germany, The Netherlands and the UK.

Residue trials (Table 31) were in Germany and Switzerland. Several of the trials were very old and none were reported in detail. In addition the UK provided government-generated data on residues (four results) in overwintered commercial radishes of known treatment history (Table 32). The residues following applications close to GAP were all <0.1 mg/kg.

Table 31. Supervised field trials on radishes. All single applications.

Location Country, year	Application		PHI, days	Portion analysed	Chlorfenvinphos, mg/kg	Ref.
	Form.	kg ai/ha				
Germany 1964[1]	GR GR EC EC GR GR	4 8 4 8 4 8	63 63 63 63 56 56	root root root root root root	<0.02 <0.02 <0.02 <0.02 <0.02 0.05	CH-601 -001
Oldenburg Germany	GR	4.0	27 33	whole plant root	0.12 0.08	Anon 1995

Location Country, year	Application		PHI, days	Portion analysed	Chlorfenvinphos, mg/kg	Ref.
	Form.	kg ai/ha				
1983[2]			40	root	0.06	
Braunschweig Germany 1983[2]	GR	4.0	29 42 57	whole plant root root	1.1 0.07 <0.02	Anon 1995
Germany 1965[1]	GR	2	28	root	0.95	CH-601-001
Germany 1966[1]	GR GR	2 3	35 35	root root	<0.04 <0.05	CH-601 -001
Switzerland 1966[1]	GR	2	17	root	<0.02	CH-601-001

Residues underlined once or twice are considered comparable with the German GAP for granular applications
Double underlined residues are from maximum GAP treatments and have been used for estimating the STMR

[1] No detailed study report; only very brief details of the trial and analyses were available.

[2] Only the JMPR residue trial summary sheets were supplied (no study report with further information provided)

Table 32. Residues of chlorfenvinphos found in commercially grown field radishes of known treatment history during 1989-92 in the UK, 1989-92. All granular applications at 2.24 kg ai/ha. Roots analysed (Anon., 1989-92).

PHI, months	1	1	1	1
Chlorfenvinphos, mg/kg	<0.1	<0.1	<0.1	<0.1

UK GAP is a granule application up to 2.0 kg ai/ha

Swedes and turnips. GAPs for swedes and turnips was reported for The Netherlands and the UK.

One field trial in the UK on swedes and three in the UK or USA on turnips were reported, but the analytical recovery was high (>120%) in the trial on swedes and the others were old and poorly described with no detailed study reports. The Meeting also received reports of six German trials on swedes or turnips in which the commodity was described as "turnip cabbage". This was an error in translation from the original German and the correct description was "swede/turnip". These trials did not comply with UK or Netherlands GAP.

Table 33. Supervised field trials on swedes and turnips.

Crop, Location Country, year	Application			PHI, days	Sample	Chlorfenvinphos, mg/kg	Ref.
	Form	No.	kg ai/ha				
SWEDE							
Wellesbourne UK 1964[1,2]	GR GR GR GR EC	1 1 1 1 1	2.8 2.8 2.8 2.8 2.8	109 109 126 126 99	root root root root root	<0.05 <0.05 <0.05 <0.05 <0.05	CH-724 -065
TURNIP							
Kent UK undated[3]	GR GR EC	1 1 1	4.5 4.5 4.5	112 112 112	root root root	<0.02 <0.02 <0.02	CH-601 -001
Wellesbourne UK	EC	1	0.84	0 0	foliage root	14 <0.02	CH-640-002

Crop, Location Country, year	Application			PHI, days	Sample	Chlorfenvinphos, mg/kg	Ref.
	Form	No.	kg ai/ha				
1965[3]				10	root	<0.02	
				18	root	<0.02	
				30	foliage	<0.02	
				30	root	<0.02	
USA undated[3]	GR	1	1.12	70	root	<0.05	CH-601 -001
	GR+ EC	1+ 3	1.12+ 1.12	21	root	<0.21	
	GR+ EC	1+3	1.12 1.12	56	root	0.08	
SWEDE or TURNIP							
Geisenheim Germany 1980[1]	EC	1+2	4.88 0.144	0	root	0.09	CH-721 -013
				7		<0.02	
				14		<0.02	
				21		<0.02	
				28		<0.02	
Bamberg Germany 1980[1]	EC	1+2	4.88 0.144	0	root	0.5	CH-721 -013
				7		<0.02	
				14		<0.02	
				21		<0.02	
				28		<0.02	
Frankfurt Germany 1980[1]	EC	1+2	4.88 0.144	0	root	0.2	CH-721 -013
				7		0.05	
				14		<0.02	
				21		<0.02	
				28		<0.02	
Geisenheim Germany 1980[1]	GR	1	0.1 kg/m^2	49	root	0.10	CH-721 -016
				56		0.04	
				70		0.02	
	GR	1	0.1 g/plant	49		0.5	
				56		0.2	
				70		0.1	
Bamburg Germany 1980[1]	GR	1	0.1 kg/m^2	49	root	0.2	CH-721 -016
				63		0.02	
				70		<0.02	
	GR	1	0.1 g/plant	49		0.7	
				63		0.1	
				70		0.06	
Frankfurt Germany 1980[1]	GR	1	0.1 kg/m^2	49	root	0.10	CH-721 -016
				60		0.02	
				70		<0.02	
	GR	1	0.1 g/plant	49		1.6	
				60		0.6	
				70		0.2	

[1] Duration of sample storage unspecified

[2] High analytical recovery (>120%)

[3] No detailed study report; only very brief details of the trial and analyses were available.

Sweet potatoes. No GAP was reported although reports of residue trials in Trinidad were submitted.

Table 34. Supervised field trials on sweet potatoes in Trinidad. All EC applications. Tubers analysed. Duration of sample storage was not specified.

Location, year	Application		PHI, days	Residues, mg/kg		Ref.
	No.	kg ai/ha		Parent	Met	
Shell Station Trinidad 1971	1	4	168	<0.02	<0.05	CH-790 -027
	1	8	168	<0.02	<0.05	
Sell Station Trinidad 1972	1	4	532	<0.02	<0.02	CH-790 -030
	2[1]	4	196	<0.02	<0.02	
	1	8	532	<0.02	<0.02	
	2[1]	8	196	<0.02	<0.02	
Shell Station Trinidad 1973	1	4	868	<0.02	<0.02	CH-790 -032
	3[1]	4	154	<0.02	<0.02	
	1	8	868	<0.02	<0.02	
	3[1]	8	154	<0.02	<0.02	

[1] Only one application was made in any one year. Met = 1-(2,4-dichlorophenyl)ethanol

Celery. There is a registered use in The Netherlands.

One group of residue trials was reported, at an unspecified location. It was poorly described, with no detailed study report.

Table 35. Supervised field trials on celery (undated). Stems analysed.

Application				PHI, days	Residues, mg/kg		Ref.
Form.	No.	kg ai/ha	kg ai/hl		Parent	Met	
GR	1	2	-	112	0.2	ND	CH-601 -001
GR	1	2	-	112	0.02	ND	
GR	1	1	-	91	0.03	ND	
GR	1	2	-	91	0.05	ND	
undated	1	17 mg/plant	root dip	77	0.5	ND	

No detailed study report; only very brief details of the trial and analyses were available.
Met = 1-(2,4-dichlorophenyl)ethanol

Rape seed. GAP for rape was reported for Austria, Germany, The Netherlands and Poland.

Several field trials were carried out in France and Germany. Six German trials complied with German GAP for EC spray. Residues in all the trials were <0.02 mg/kg. There were no trials with the broadcast application of granules at 3 kg ai/ha used in The Netherlands, although in two French trials with an application rate of 1 kg ai/ha the residues were <0.02 mg/kg.

Table 36. Supervised field trials on rape.

Location, Country, year	Application			PHI, days	Sample	Residues, mg/kg		Ref.
	Form.	No.	kg ai/ha			Parent	Met	
Mornay France 1988	GR	1	1.0	322	Seed	<0.02	-----	CH-750-011
Saulz-le-Duc France 1988	GR	1	1.0	336	Seed	<0.02	-----	CH-750 -011
	GR	1	1.0	322	Seed	<0.02	-----	
Villefargeu France 1991	EC	1	0.6	126	Seed	<0.02	-----	CH-750 -013
Buscieres sur Are France 1991	EC	1	0.6	105	Seed	<0.02	-----	CH-750-013
Saulay France 1991	EC	1	0.6	133	Seed	<0.02	-----	CH-750-013
Le Mee France 1991	EC	2	0.6	147	Seed	0.09	-----	CH-750-013
Lübeck Germany 1973	EC	1	0.144	77	Seed	<0.02	<0.02	CH-750-007
Ansbach Germany 1974	EC	1	0.192	70	Seed	<0.02	-----	CH-750 -008
				77	Seed	<0.02	-----	
Frankfurt Germany 1980	EC	2	0.144	35	Seed	<0.02	<0.02	CH-750-009
München Germany 1989	EC	2	0.144	0	plant	3.12	-----	CH-750 -012
				34	plant	0.025	-----	

Location, Country, year	Application			PHI, days	Sample	Residues, mg/kg		Ref.
	Form.	No.	kg ai/ha			Parent	Met	
				44	Seed	<0.02	-----	
Solms Oberbiel Germany 1989	EC	2	0.144	0 38 50	plant plant Seed	1.68 0.02 <0.02	----- ----- -----	CH-750 -012
Hanau Germany 1989	EC	2	0.144	0 28 39	plant plant Seed	2.74 0.055 <0.02	----- ----- -----	CH-750 -012
Bad Segeberg Germany 1989	EC	2	0.144	0 50 62	plant plant Seed	2.22 <0.02 <0.02	----- ----- -----	CH-750 -012

Duration of sample storage was not specified.
Results underlined once or twice are considered comparable with German GAP for EC sprays.
Double underlined residues are from maximum GAP treatments and have been used for estimating the STMR
Met = 1-(2,4-dichlorophenyl)ethanol

Parsley. There are registered uses in The Netherlands and the UK with WP or EC spray applications.

Summarized reports of residue trials were available from Germany, but all the trials were with granular formulations whereas the reported GAP applications are by spraying.

Table 37. Supervised field trials on parsley in Germany. All single GR applications at 5.0 kg ai/ha. Leaves analysed (Anon., 1995).

Location, year	PHI, days	Chlorfenvinphos, mg/kg
Oldenburg 1979	89 96 104	0.1 0.04 0.04
Berlin 1979	69 79 90 128	0.07 0.04 0.04 <0.02
Nahermittenhausen 1979	83	<0.02
Hurthfischenich 1979	50 85	0.06 <0.02
Buttelborn	70 70	0.2 0.03
Münster 1975	88	0.01
Stenkamp Asche 1975	96	0.03

Only the JMPR residue trial summary sheets were supplied (no study report with further information provided).

Maize. GAP was reported for The Netherlands.

Residue trials were carried out in France but were very old and poorly described with no detailed study reports.

Table 38. Supervised field trials on Maize in France. All EC applications. Cobs analysed.

Location, year	Application		PHI, days	Residues, mg/kg Parent	Met	Ref.
	No.	kg ai/ha				
Sauveterre 1965	1 1	1 2	14 14	<0.02 <0.02	----- -----	CH-640-002
1965	1	1	98	<0.02	<0.02	CH-601-001
1966	2	0.6	45	<0.02	<0.02	CH-601-001

There were no detailed study reports; only very brief details of the trials and analyses were available.
Met = 1-(2,4-dichlorophenyl)ethanol

Wheat. There are registered uses in the UK. Two residue trials in the UK were very old and poorly reported with inadequate detail.

Table 39. Supervised field trials on wheat in the UK. Single applications. Grain analysed. Undated.

Location	Application		PHI, days	Residues, mg/kg Parent	Met	Ref.
	Form.	kg ai/ha				
Lincolnshire	GR DS	1.75 22.8kg/ tonne seed	310	<0.02 <0.02	<0.02 <0.02	CH-601-001
Cambridgeshire	GR DS	1.75 22.8kg/ tonne seed	310	<0.02 <0.02	<0.02 <0.02	CH-601-001

Met = 1-(2,4-dichlorophenyl)ethanol

A limited number of poorly reported trials on pasture, sorghum, peanuts, cotton seed, apples, tangerines and sugar beet were also submitted (Anon undated; Beynon, 1966). They have not been reviewed as no GAP is reported for these crops.

Residues in following crops

Lettuce. No GAP was reported for lettuce, but measurable residues could occur in lettuce planted as a following crop as a result of treatment of the primary crop.

Rotational crop trials on lettuce and lamb's lettuce were reported from Germany. The lettuce or lambs lettuce was planted 1-4 months after the treatment of radishes as the primary crop at 4 kg ai/ha. The dates of harvest of the radish crop and the residue levels in the soil were not recorded. The residues in lamb's lettuce at harvest were <0.04 (4) and 0.19 mg/kg, and in lettuce <0.04 (5), 0.05, 0.07 and 0.11 mg/kg. The trials data were submitted in JMPR summary format only with no accompanying study reports.

German GAP for radishes is a “spreading” application at 3 kg ai/ha (field) or 4 kg ai/ha (glass). Similar GAP for soil treatment was reported at comparable application rates for several other crops in a number of countries.

Table 40. Residues in lettuce and lamb's lettuce planted in the field as rotational crops following a single treatment of radishes as the primary crop with granules at 4.0 kg ai/ha. Leaves analysed. Germany, 1983 (Anon., 1995).

CROP Location	PHI, days[1]	Chlorfenvinphos, mg/kg
LAMB'S LETTUCE		
Oldenburg	168 189 217	<0.04 0.19 0.16
Braunschweig	144 161 179	<0.04 <0.04 <0.04
München	71 90 105	<0.04 <0.04 <0.04
Hurth-Fischenich	183 190 197	<0.04 <0.04 <0.04
Mainz-Bretzenheim	118	<0.04
HEAD LETTUCE		
Mainz-Bretzenheim	118	<0.04
Hurth-Fischenich	126 134 141	<0.04 <0.04 <0.04
Lübeck	118 127 135	0.11 <0.04 <0.04
München	36 50 64	<0.04 <0.04 <0.04
Freiburg	91 105 114	<0.04 0.05 <0.04
Frankfurt	69 82 90	<0.04 <0.04 <0.04
	62 75 83	<0.04 <0.04 <0.04
Stuttgart	73 84 93	<0.04 <0.04 <0.04
Oldenburg	75 84 92	0.06 0.07 <0.04

Only the JMPR residue trial summary sheets were supplied (no study report with further information provided).
Residues underlined once or twice are considered to reflect possible commercial practice.
Double underlined residues are from maximum GAP treatments and have been used for estimating the STMR

[1] The PHIs are from the last treatment of the radish crop to the harvesting of the secondary lettuce or lamb's lettuce crop.

Livestock feeding or topical treatment trials

In a 1966 Australian study designed to find out whether residues occur in the milk of cattle grazing on treated pasture, chlorfenvinphos was applied once to grass at 0.42 kg ai/ha and lactating cows were admitted to the pasture two days after treatment (Elgar, 1966e). The mean residues of chlorfenvinphos in the grass four days, 1 week, 2 weeks and 3 weeks after treatment were 17, 5.7, 4.4 and 2.5 mg/kg respectively.

No residues of chlorfenvinphos (<0.01 mg/kg), 2,4-dichorophenacyl chloride (<0.002 mg/kg), 1-(2,4-dichlorophenyl)ethanol (<0.01 mg/kg) or 2,4 -dichloroacetophenone (<0.005 mg/kg) were found in milk samples taken from the cows at these times.

In a briefly reported study (Schroder, 1984), two heifers and two steer calves were dipped in an unspecified formulation containing 0.037 kg ai/hl of chlorfenvinphos. At the time of dipping, the dipwash had been in the tank for up to 57 weeks. Tissue samples were taken 7 days after dipping. The residues were all below the LOD in liver (<0.1 mg/kg), muscle (<0.05 mg/kg) and kidney (<0.05 mg/kg). In ‘fat’ the residues were in the range <0.1 to 0.27 mg/kg.

FATE OF RESIDUES IN STORAGE AND PROCESSING

In storage

No data were submitted.

In processing

The distribution of chlorfenvinphos in carrots with incurred residues following EC treatments was investigated as part of a UK government research programme (Anon., 1989-92). The results are given in Table 41.

The highest concentrations of chlorfenvinphos were in the crowns of the carrots. The distribution varied but the data indicate that most consumers would remove 30% of the residue during preparation.

The results of a preliminary study of the distribution of residues between the core and peel of carrots and the effects of cooking topped but unpeeled carrots are given in Table 42. The effect of peeling and taking the top portion (crown and next 1 cm) from the roots was to remove 97-99% of the residue.

The effect of cooking topped (but not peeled) roots had, at most, a moderate effect on the concentration of chlorfenvinphos.

Table 41. Mean distribution of chlorfenvinphos residues along 7 average-sized carrot roots taken from samples of commercially grown crops.

Sample No	Crown			1 cm slice below crown			Remainder		
	sample wt., g	Residue, mg/kg	Residue, %[1]	Sample wt., g	Residue mg/kg	Residue, %[1]	sample wt., g	Residue, mg/kg	Residue, %[1]
1	4	11.3	19	25	3.0	34	389	0.27	47
2	4	1.6	24	21	0.33	29 26	450	0.03	48 50
3	6	3.2	39	42	0.32	27 25	621	0.03	34 36
4	5	2.2	34 37	30	0.11	9	391	0.05	57
5	6	9.4	14	28	1.5	11	986	0.29	75
6	2	3.7	21	26	0.51	31	429	0.05	47
7	3	11.6	61	29	0.45	27	363	0.02	12
Mean		1			6			94	
		30			24			46	

[1] % of total residue in carrot

Table 42. The effects of peeling and boiling on residues of chlorfenvinphos in carrots.

Part of root and process	Sample wt., g uncooked	% of carrot wt.	Sample wt., g cooked	chlorfenvinphos, mg/kg	µg in sample	% of residue
Sample No 1 whole root, uncooked	491			0.20		
calc. topped root before cooking[1]	309			0.21	66	
topped root after cooking	408		370	0.19	70	
top slice taken from root, uncooked	4	1		7.7	32	33
peel, uncooked	64	21		0.98	63	64
peeled core, uncooked	245	79		0.01	3	3
Sample No 2 whole root, uncooked	708			0.20		
calc. topped root before cooking[1]	746			0.37	280	
topped root after cooking	738		683	0.11	75	
top slice taken from root, uncooked	8	1		10.4	79	22
peel, uncooked	91	12		3.1	278	77
peeled core, uncooked	655	88		0.003	2	1

[1] Calculated from sum of uncooked peel and uncooked peeled core. Note that the peeled and boiled carrots were different sub-samples, hence results are unlikely to correspond exactly

Carrots - commercial cooking. In a study carried out in 1966 (Elgar, 1966a), carrots grown in soil treated with ‘Birlane’ were used to investigate the effect that cooking (specifically the process used commercially in preparing baby foods) had on chlorfenvinphos residues. The raw carrots, containing residues of either 0.05 or 0.07 mg/kg, were made into cooked purée by blanching in water, diluting with brine and macerating, then cooking under steam pressure for 35 minutes at 120°C. Samples were analysed for residues of chlorfenvinphos, 2,4-dichloroacetophenone and 2,4-dichlorophenacyl chloride after extraction with acetone and petroleum spirit. The acetone was removed and the petroleum extracts dried by filtering through anhydrous sodium sulfate. After clean-up on Florisil, the residues were determined by GLC with an ECD. Where recoveries were low, an enzyme-inhibition method was used for the determination of residues, the details of which were not given.

The final chlorfenvinphos residue in the cooked purée from both batches of carrots was 0.02 mg/kg. It was stated that the reduction in the residue from raw carrots to cooked purée was due to two factors, the addition of brine and the cooking. No residues (<0.01 mg/kg) of the metabolites 2,4-dichloroacetophenone or 2,4-dichlorophenacyl chloride were detected in the raw or cooked purée.

Carrots - canning. Carrots treated in June 1966 with 'Birlane' at 2.24 kg ai/ha and harvested in the following December were made into a purée and canned (Elgar, 1967c). Six cans of carrots were analysed by GLC with EC detection. No residues of chlorfenvinphos (<0.01 mg/kg) were found. The treated carrots were not analysed before canning.

RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

National monitoring data were supplied by Australia, The Netherlands, Poland, and the UK.

The results of monitoring analyses of samples taken randomly from export and domestic sources undertaken by Australia from 1 July 1993 to 31 December 1995 are shown in Table 43 (Anon, 1996b).

Table 43. Australian monitoring data for chlorfenvinphos.

Commodity	Australian MRL, mg/kg	Reporting limit	Total samples	No. with residues
Beef fat	0.2	0.01	7151	0
Buffalo fat	0.2	0.1	15	0
Deer fat		0.1	65	0
Emu fat		0.1	10	0
Game goat fat	0.2	0.1	176	0
Goat fat	0.2	0.1	198	0
Game pig fat		0.1	240	0
Horse fat		0.1	259	1 (0.39%)[1]
Kangaroo fat		0.1	223	0
Ovine fat	0.2	0.1	6146	0
Porcine fat		0.1	2060	0
Poultry fat		0.1	244	0
Barley whole		0.01	711	0
Bran from wheat		0.01	129	0
Canola whole		0.01	19	0
Faba beans whole		0.01	9	0
Flour from wheat whole		0.01	129	0
Lupins whole		0.01	184	0
Oats whole		0.01	67	0
Peas whole		0.01	67	0
Sorghum whole		0.01	16	0
Wheat whole	0.05	0.01	2563	0

[1] Determined residue was described as being in the range "Reporting limit - <0.2 x Reporting limit"
Samples described as fat are portions of adhering fat taken from animal carcases

The results of monitoring in The Netherlands in 1991-1994 are shown in Tables 44 and 45 (Olthof, 1996).

Table 44. Monitoring data for chlorfenvinphos in The Netherlands, 1991-93.

Commodity	Samples analysed	Samples without residues (LOD 0.05 mg/kg)	Samples with residues < MRL	Samples with residues ≥ MRL	Mean, mg/kg	MRL, mg/kg
CITRUS FRUIT						1
Lemons	181	160	19	2	0.09	1
Tangerines	523	504	19	0	<0.05	1
Oranges	958	937	21	0	<0.05	1
MISC. FRUIT						0.05*
Kiwifruit	309	307	2	0	<0.05	0.05*
ROOT AND TUBER VEGETABLES						0.5
Carrots	609	497	106	6	<0.05	0.5
BULB VEGETABLES	106					0.5
Onions		104	2	0	0.05	0.5
BRASSICA VEGETABLES						0.1
Red cabbage	134	131	3	0	<0.05	0.1
STEM VEGETABLES						
Celery	807	805	2	0	<0.05	0.5

Residues <LOD are assumed to be at half the LOD for the calculation of the mean

Table 45. Monitoring data for chlorfenvinphos in The Netherlands, 1994.

Commodity	Samples analysed	Samples without residues (LOD 0.05 mg/kg)	Samples with residues < MRL	Samples with residues ≥ MRL	Mean, mg/kg	MRL, mg/kg
CITRUS FRUIT						1
Grapefruit	111	109	2	0	<0.05	1
Lemons	102	90	12	0	0.09	1
Tangerines	215	208	7	0	<0.05	1
Oranges	348	342	6	0	<0.05	1
STONE FRUIT						0.05*
Peaches	113	112	1	0	<0.05	0.05*
BERRIES AND SMALL FRUIT						0.05*
Grapes	336	335	1	0	<0.05	0.05*
ROOT AND TUBER VEGETABLES						0.5
Carrots	141	94	47	0	0.05	0.5
STEM VEGETABLES						
Celery	84	78	6	0	<0.05	0.5
BRASSICA VEGETABLES						0.1
Kale	47	45	2	0	<0.05	0.1
LEAF VEGETABLES AND FRESH HERBS	1277					0.1
Lettuce	511	1276	1	0	<0.05	0.1
Endive		510	1	0	<0.05	0.1
CEREALS						0.05*
Maize	19	18	1	0	<0.05	0.05*

Residues <LOD are assumed to be at half the LOD for the calculation of the mean.

In 1994, 120 samples of glasshouse and 20 samples of field-grown cucumbers were analysed for chlorfenvinphos residues in Poland (Anon 1996a). No measurable residues were found although the LOD was not reported.

Monitoring in the UK gave the results shown in Table 46 (Anon, 1989-92).

Table 46. Residues of chlorfenvinphos reported during routine UK monitoring in retail samples during 1989-92.

Commodity	Source	No. analysed	LOD, mg/kg	Below LOD, No	%	Residues above LOD, mg/kg
citrus, soft (satsumas, clementines, mandarins and tangerines)	EC	26	0.05	24	92	0.2, 0.3
	Other	41		41	100	
	Unknown	1		1	100	
grapefruit	EC	2	0.05	2	100	
	Other	22		22	100	
	Unknown	1		1	100	
limes	Other	12	0.02	12	100	
lemons	EC	9	0.05	8	89	0.4
	Other	3		2	67	0.2
carrots	EC	13	0.05	12	92	0.3
	Other	2		2	100	
fresh immature carrots	Unknown	32		30	94	0.3 (UK), 0.7
canned immature carrots	Unknown	10	0.05	10	100	
frozen immature carrots	Unknown	14	0.05	14	100	
radishes	Unknown	7	0.1	7	100	
parsnips	UK	20	0.05	20	100	
	Unknown	3		3	100	
sweet corn	UK	15	0.1	15	100	
	EC	3	0.1	3	100	
	Other	1	0.1	1	100	
	Unknown	1	0.1	1	100	
mushrooms	UK	29	0.05	29	100	
	EC	10		10	100	
chicken	UK	90	0.02	90	100	
	EC	7	0.02	7	100	
	Unknown	21	0.02	21	100	
lamb	UK	6	0.02	6	100	
	Other	103	0.02	103	100	
	Unknown	3	0.02	3	100	
paté	UK	11	0.05	11	100	
	EC	23	0.02	23	100	
	Unknown	3	0.02	3	100	
sausages (pork)	Unknown	4	0.05	4	100	

Commodity	Source	No. analysed	LOD, mg/kg	Below LOD, No	%	Residues above LOD, mg/kg
sausages (beef)	Unknown	12	0.05	12	100	
pies and pasties	UK	191	0.05	191	100	
canned meat	UK	13	0.2	13	100	
	EC	15	0.02	15	100	
	Other	8	0.02	8	100	
	Unknown	1	0.02	1	100	
rabbit	UK	7	0.05	7	100	
	Other	11	0.05	11	100	
	Unknown	16	0.05	16	100	
sheep kidney	UK	55	0.02	55	100	
cattle meat	Unknown	41	0.02	41	100	
pig meat	Unknown	37	0.02	37	100	
cattle kidney fat	UK	81	0.02	81	100	
pig kidney fat	UK	77	0.02	77	100	
sheep kidney fat	UK	82	0.02	82	100	

NATIONAL MAXIMUM RESIDUE LIMITS

The national MRLs for chlorfenvinphos shown below were reported.

Country	Crop	MRL, mg/kg	Reference
Australia	broccoli	0.05	Anon 1996b
	Brussels sprouts	0.05	Anon 1996b
	cabbages, head	0.05	Anon 1996b
	carrot	0.4	Anon 1996b
	cattle, edible offal of	0.2	Anon 1996b
	cattle meat (in the fat)	0.2	Anon 1996b
	cauliflower	0.1	Anon 1996b
	celery	0.4	Anon 1996b
	cotton seed	0.05	Anon 1996b
	egg plant (aubergine)	0.05	Anon 1996b
	goat, edible offal of	0.2	Anon 1996b
	goat meat (in the fat)	0.2	Anon 1996b
	horsemeat	0.1	Anon 1996b
	leek	0.05	Anon 1996b
	maize	0.05	Anon 1996b
	milks (in the fat)	0.2	Anon 1996b
	mushrooms	0.05	Anon 1996b
	onion, bulb	0.05	Anon 1996b
	peanut	0.05	Anon 1996b
	potato	0.05	Anon 1996b
	radish	0.1	Anon 1996b
	rice	0.05	Anon 1996b
	sheep, edible offal of	0.2	Anon 1996b

Country	Crop	MRL, mg/kg	Reference
	sheep meat (in the fat)	0.2	Anon 1996b
	swede	0.05	Anon 1996b
	sweet potato	0.05	Anon 1996b
	tomato	0.1	Anon 1996b
	turnip, garden	0.05	Anon 1996b
	wheat	0.05	Anon 1996b
Austria	carrot	0.5	Anon 1996c
	celery	0.4	Anon 1996c
	citrus	1	Anon 1996c
	coffee	0.4	Anon 1996c
	milk	0.05	Anon 1996c
	parsley	0.5	Anon 1996c
	potato	0.1	Anon 1996c
	rape	0.1	Anon 1996c
	sugar beet	0.1	Anon 1996c
Belgium	cabbage	0.1 to 0.5	Anon 1996c
	carrot	0.5	Anon 1996c
	leek	0.1	Anon 1996c
	onions	0.5	Anon 1996c
	potato	0.05	Anon 1996c
France	asparagus	0.5	Anon 1996c
	bean	0.1	Anon 1996c
	cabbage	0.1	Anon 1996c
	carrot	0.5	Anon 1996c
	celery	0.5	Anon 1996c
	cereals	0.05	Anon 1996c
	corn salad	0.1	Anon 1996c
	courgette	0.1	Anon 1996c
	cress	0.1	Anon 1996c
	eggplant	0.1	Anon 1996c
	garlic	0.5	Anon 1996c
	gherkin	0.1	Anon 1996c
	melon	0.1	Anon 1996c
	mushrooms	0.05	Anon 1996c
	onions	0.5	Anon 1996c
	parsley	0.5	Anon 1996c
	potato	0.5	Anon 1996c
	radish	0.5	Anon 1996c
	rape	0.02	Anon 1996c
	shallot	0.5	Anon 1996c
	soya bean	0.1	Anon 1996c
	spinach	0.1	Anon 1996c
	turnip	0.5	Anon 1996c
Germany	cabbage	0.5	Anon 1996c
	carrot	0.5	Anon 1996c
	celery	0.5	Anon 1996c
	citrus	1	Anon 1996c

Country	Crop	MRL, mg/kg	Reference
	citrus juice	0.05	Anon 1996c
	coffee	0.5	Anon 1996c
	cucumber	0.1	Anon 1996c
	leek	0.5	Anon 1996c
	onions	0.5	Anon 1996c
	parsley	0.5	Anon 1996c
	potato	0.05	Anon 1996c
	radish	0.5	Anon 1996c
	rape	0.1	Anon 1996c
	root/tuber veg	0.5	Anon 1996c
	shallot	05	Anon 1996c
	sugar beet	0.1	Anon 1996c
	turnip	0.5	Anon 1996c
Ireland	carrot	0.5	Anon 1996c
	parsnip	0.5	Anon 1996c
Italy	cabbage	0.1	Anon 1996c
	carrot	0.5	Anon 1996c
	celery	0.5	Anon 1996c
	maize	0.05	Anon 1996c
	mushrooms	0.05	Anon 1996c
	potato	0.1	Anon 1996c
	rape	0.05	Anon 1996c
	sugar beet	0.1	Anon 1996c
Japan	apricot	0.5	Anon 1996c
	broccoli	0.05	Anon 1996c
	cabbage	0.2	Anon 1996c
	cauliflower	0.1	Anon 1996c
	chestnut	0.2	Anon 1996c
	citrus	3 to 5	Anon 1996c
	cucumber	0.2	Anon 1996c
	eggplant	0.2	Anon 1996c
	kidney bean	0.2	Anon 1996c
	maize	0.05	Anon 1996c
	onions	0.05	Anon 1996c
	peanuts	0.05	Anon 1996c
	pears	0.2	Anon 1996c
	persimmon	0.2	Anon 1996c
	potato	0.1	Anon 1996c
	radish	0.1	Anon 1996c
	rice	0.05	Anon 1996c
	soya bean	0.02	Anon 1996c
	sugar cane	0.05	Anon 1996c
	sweet pot	0.05	Anon 1996c
	wheat	0.05	Anon 1996c
Luxembourg	carrot	0.5	Anon 1996c
	maize	0.05	Anon 1996c
	onions	0.5	Anon 1996c

Country	Crop	MRL, mg/kg	Reference
	potato	0.05	Anon 1996c
Netherlands (manufacturer's submission)	bulb veg	0.5	Anon 1996c
	celery	0.5	Anon 1996c
	cereals	0.05	Anon 1996c
	citrus	1	Anon 1996c
	meat	0.2	Anon 1996c
	milk	0.008	Anon 1996c
	mushrooms	0.05	Anon 1996c
	parsley	0.5	Anon 1996c
	peanuts	0.05	Anon 1996c
	potato	0.05	Anon 1996c
	root/tuber veg	0.5	Anon 1996c
	tea	0.2	Anon 1996c
Netherlands (country submission)	citrus	1	Olthof 1996
	root and tuber vegetables	0.5	Olthof 1996
	bulb vegetables	0.5	Olthof 1996
	parsley	0.5	Olthof 1996
	celery leaves	0.5	Olthof 1996
	celery	0.5	Olthof 1996
	other vegetables	0.1	Olthof 1996
	tea	0.2	Olthof 1996
	meat	0.2	Olthof 1996
	milk	0.008	Olthof 1996
	other food commodities	0.05*	Olthof 1996
Poland	citrus fruit	1.0	Anon 1996a
	fruits (other than citrus)	0.05	Anon 1996a
	root vegetables	0.5	Anon 1996a
	potato	0.05	Anon 1996a
	vegetables, other	0.05	Anon 1996a
	mushroom	0.05	Anon 1996a
	rapeseed	0.2	Anon 1996a
	cereal grains	0.05	Anon 1996a
Portugal	brassica	0.1	Anon 1996c
	bulb veg	0.5	Anon 1996c
	citrus	1	Anon 1996c
	fruity veg	0.1	Anon 1996c
	grapes	0.05	Anon 1996c
	leafy veg	0.1	Anon 1996c
	legumes	0.1	Anon 1996c
	mushrooms	0.05	Anon 1996c
	pome fruit	0.05	Anon 1996c
	root/tuber veg	0.5	Anon 1996c
	stem veg	0.5	Anon 1996c
	stone fruit	0.05	Anon 1996c
Spain	brassica	0.1	Anon 1996c
	bulb veg	0.5	Anon 1996c

Country	Crop	MRL, mg/kg	Reference
	citrus	1	Anon 1996c
	fruity veg	0.1	Anon 1996c
	grapes	0.05	Anon 1996c
	leafy veg	0.1	Anon 1996c
	legumes	0.1	Anon 1996c
	mushrooms	0.05	Anon 1996c
	pome fruit	0.5	Anon 1996c
	root/tuber veg	0.5	Anon 1996c
	stem veg	0.5	Anon 1996c
	stone fruit	0.05	Anon 1996c
Switzerland	cabbage	0.1	Anon 1996c
	carrot	0.3	Anon 1996c
	onions	0.01	Anon 1996c
	radish	0.1	Anon 1996c
UK	citrus fruit	1.0	Anon 1994a
	oranges	1.0	Anon 1994a
	apples	0.05	Anon 1994a
	pears	0.05	Anon 1994a
	peaches and nectarines	0.05	Anon 1994a
	plums	0.05	Anon 1994a
	grapes	0.05	Anon 1994a
	strawberries	0.05	Anon 1994a
	raspberries	0.05	Anon 1994a
	blackcurrants	0.05	Anon 1994a
	bananas	0.5	Anon 1994a
	carrots	0.5	Anon 1994a
	swedes	0.5	Anon 1994a
	turnips	0.5	Anon 1994a
	onions	0.5	Anon 1994a
	tomatoes	0.1	Anon 1994a
	cucumbers	0.1	Anon 1994a
	cauliflower	0.1	Anon 1994a
	Brussels sprouts	0.1	Anon 1994a
	cabbage	0.1	Anon 1994a
	lettuce	0.1	Anon 1994a
	beans	0.1	Anon 1994a
	peas	0.1	Anon 1994a
	celery	0.5	Anon 1994a
	leek	0.1	Anon 1994a
	mushrooms	0.05	Anon 1994a
	milk	0.008	Anon 1994a
	meat, fat and preparations of meat	0.2	Anon 1994a

Only the residue definition applying in the UK, The Netherlands and Poland was specified. In these countries the definition is “the sum of *Z*- and *E*- isomers of chlorfenvinphos”.

In 1994 the US EPA proposed to revoke the tolerances in or on certain raw agricultural commodities, processed foods and animal feeds for 17 pesticide chemicals including chlorfenvinphos. The EPA stated that they were initiating this action for those pesticides which have no food use (national) registrations (Anon, 1994b).

APPRAISAL

Chlorfenvinphos is a contact and soil-applied organophosphorus insecticide available as granules, EC or WP sprays and seed-treatment formulations. It is used for the control of various pests, including wheat bulb fly, cabbage root fly and carrot fly, on a range of crops.

Chlorfenvinphos is present in the form of two configurational isomers and is liquid at 25°C. Data on physico-chemical properties were provided only for the technical material. The data on the solubility of chlorfenvinphos in water, fat and organic solvents and the octanol-water partition coefficient, were not supported by full study reports and have therefore not been included in the evaluation.

In briefly reported studies on humans, rats and dogs, chlorfenvinphos was extensively metabolized, and a number of metabolites were identified.

A number of briefly reported metabolism studies on ruminants were submitted in which cows were treated by injection or spraying, but none in which cattle were treated by oral ingestion. A number of metabolites were identified and a metabolic pathway proposed in which it was postulated that incorporation of some of the metabolites took place by conjugation with glucuronide. Most of the radioactive residue was found in the omental or renal fat, with little or no residue in the liver, kidney or other tissues even at high doses. However, these studies were old and briefly reported with limited experimental detail. The Meeting considered that new data on metabolism in lactating ruminants and/or laying poultry to meet modern standards are required if significant residues occur in relevant feed items. In addition, data on the ruminant metabolism of chlorfenvinphos applied externally are required to support the approved use for dipping in Australia.

In plants two main investigations were conducted, one with foliar applications to potatoes, cabbages and maize and the other with soil applications to cabbages, carrots and onions. Significant residues of parent chlorfenvinphos remained in crops sampled several weeks after treatment. The main metabolite from foliar applications was the conjugate of 1-(2,4-dichlorophenyl)ethanol. Traces of desethyl-chlorfenvinphos were also detected. After soil applications the metabolite 2,4-dichloroacetophenone was identified together with some polar unextractable material. These metabolism studies were old and briefly reported with limited experimental detail: the full metabolic pathway in plants was not elucidated. Although the data appeared to show that chlorfenvinphos was the major component of the residue the Meeting considered that new data on metabolism and translocation in plants according to modern standards are required to confirm this.

In a laboratory study of degradation in soil a number of products were identified and a degradation pathway was proposed. Chlorfenvinphos was the major single compound identified although 1-(2,4-dichlorophenyl)ethanol, the sodium salt of desethyl-chlorfenvinphos, and 2,4-dichloroacetophenone were present in significant concentrations. Degradation was slower in organic than in mineral soils. In the field, half-lives of chlorfenvinphos were 14-84 days in mineral soils and more than 150 days in peat soil.

The analysis of crop and soil samples for chlorfenvinphos and its metabolites was based on GLC with FP, EC or NP detection. The reported limits of determination were 0.01-0.05 mg/kg. Only limited data on validation of the methods were presented.

A definition of the residue as "chlorfenvinphos, sum of (*E*)- and (*Z*)- isomers" was recommended, but the Meeting agreed that the definition might have to be reconsidered when new data on plant and animal metabolism have been reviewed.

The information on GAP supplied by the manufacturer was incomplete. No copies of the product labels were submitted, only summary sheets.

Reports of residue trials on leeks, onions, head cabbage, Savoy cabbage, cauliflower, mushrooms, kale, carrots, parsley root, parsnips, potatoes, swedes, sweet potatoes, radishes, turnips, celery, rape seed, parsley, maize, and wheat were submitted, but as no GAP was reported for parsley root or sweet potatoes the Meeting could not estimate maximum residue levels for these commodities. No residue trials were reported on several crops for which GAP and/or CXLs exist, and the Meeting recommended withdrawal of the unsupported CXLs.

Many of the trials were very old with no detailed study reports. Details such as the method of analysis, the duration of sample storage, analytical recoveries and plot size were lacking. The Meeting agreed that such data were inadequate for the estimation of maximum residue levels. In many other trials the duration of sample storage before analysis was not reported and the Meeting agreed that although the data could be used to estimate maximum residue levels, such levels could not be recommended as MRLs because data on the stability of residues in stored analytical samples of representative substrates were required to confirm the validity of the results.

Onions. GAP was reported for several countries. A number of residue trials on bulb onions together with one on spring onions were reported. Four French trials with residues of <0.02 mg/kg complied with the granular application rate in France, but a PHI of 15 days was reported by the manufacturer as French GAP, whereas the PHIs in the trials were 133-182 days. One German trial according to GAP for pre-planting spray treatment in Belgium and The Netherlands gave residues below 0.02 mg/kg after 175 days (shorter PHIs were not considered to accord with GAP). A further five German trials were considered to comply with GAP for pre-planting granular treatments in Belgium, Denmark, Germany and The Netherlands: all residues were below the LOD (<0.02 mg/kg). Two replicated Japanese trials reflected Japanese foliar GAP (which has a low application rate), with residues of <0.02 mg/kg 7-8 days after treatment. The only measurable parent residues reported were from the higher application rate of 4.8 kg ai/ha in a German spray trial (0.04 mg/kg, at a 60-day PHI) and in one UK trial (0.07 mg/kg, PHI of 61 days) which was very old and poorly described with no detailed study report. These trials were not comparable with any reported GAP.

The Meeting estimated an STMR of 0.02 mg/kg and a maximum residue level of 0.02* mg/kg. These estimates were based partly on trials which lacked information on the duration of sample storage.

Cabbage. Registered uses on head cabbage were reported in Belgium, Denmark, France, Germany, Ireland, Italy, Japan, The Netherlands, Sweden, Switzerland, and the UK, and on Savoy cabbage in Germany and The Netherlands. Residue trials on head cabbage were reported from the UK, Germany, the USA and India, and on Savoy cabbage from Germany. Seven German trials on head cabbage and three on Savoy cabbage complied with GAP for pre-planting soil treatments at 0.1 kg ai/m^2. Six further trials on head cabbage reflected the German granular seedbed GAP of 2 g/100 plants and three trials on Savoy cabbage the German 2 kg ai/ha GAP. All residues in all these trials were below 0.02 mg/kg. The German granular treatment at 0.1 g/plant (in some cases in combination with an earlier pre-planting soil treatment at 0.1 kg ai/m^2) was represented by four acceptable trials on Savoy cabbage and one on head cabbage with residues of 0.02, 0.03, 0.15, 0.3 and 0.9 mg/kg. One UK trial complied with UK Gap for pre-emergence sprays but was very old and poorly reported without details. No trials were considered comparable with the GAP for foliar treatments reported in several countries, which have shorter PHIs. The Meeting agreed that there were insufficient data to estimate a maximum residue level on the basis of the German 0.1 g/plant granular treatment. However in view of the many trials conforming to German GAP for pre-planting and seedbed applications, all with residues below 0.02 mg/kg, the Meeting estimated an STMR of 0.02 mg/kg and a maximum residue level of 0.02* mg/kg. The trials on which these estimates were based included some which lacked information on the duration of sample storage and others for which this information was not clear to the reviewer because the study was not reported in the working language of the Meeting.

Cauliflower. GAP was reported for Germany, Ireland, The Netherlands and the UK. Residue trials were carried out in Germany, India, the USA and the UK. There were three German trials according to each of three different German GAP treatments: 2 g/100 plants nursery granular, the 0.1 g/plant single bed treatment and the 2 kg ai/ha granular “spreading” application. The UK and Dutch spray treatment (ca. 4-5 kg ai/ha) at the time of drilling or transplanting was reflected by four German trials. All the residues in these trials were <0.02 mg/kg.

The Meeting estimated an STMR of 0.02 mg/kg and a maximum residue level of 0.02* mg/kg. Again some of the trials had no information on the duration of sample storage and others were not reported in English.

Mushrooms. GAP was reported only for the UK as either compost or casing incorporation. Only one trial was available which was poorly described with no detailed study report. There were insufficient data to estimate an STMR or maximum residue level and the Meeting recommended that the existing CXL of 0.05 mg/kg should be withdrawn.

Kale. There are registered uses in Germany, The Netherlands, Portugal and Spain, but residue trials were available only from Germany. Five trials were according to the Dutch GAP for spray treatments at planting or before sowing. Residues were all <0.02 mg/kg. In one of these trials the residue of dichlorophenylethanol was 0.07 mg/kg. Three further trials complied with the German granular single plant treatment, and in two others this treatment was combined with soil treatment according to German GAP. Residues in these trials were <0.02 (2), 0.02, 0.07 and 0.09 mg/kg. There were insufficient data to estimate an STMR or maximum residue level.

Carrots. GAP was reported for Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, The Netherlands, Switzerland and the UK. Residue trials were available from Canada, France, Germany, The Netherlands, South Africa, Spain, Sweden, Switzerland, Trinidad and the UK. In addition the UK government provided data on residues in overwintered commercial carrots whose treatment history had been recorded. The highest residues resulted from post-planting EC or WP sprays at *c*. 4 kg ai/ha which corresponds to GAP in The Netherlands and France. Similar treatments at *c*. 2.5 kg ai/ha are GAP in Ireland and the UK. The PHIs reported for these countries ranged between 21 and 60 days which reflects second generation carrot fly control. French GAP was also reported to include an EC spray at 5 kg ai/ha with a PHI of 15 days, but the Meeting was informed that the use in practice was at the time of sowing. Several trials in France, Germany and The Netherlands complied with the higher rate GAP, with residues of <0.02, 0.05, 0.08, 0.12, 0.14, 0.2(3), 0.22, 0.3, 0.37, 0.45, 0.9, 1.2, 1.8, 2.0, and 3.8 mg/kg. In the overwintered commercial carrots treated in accordance with UK GAP the residues were <0.02-1.6 mg/kg.

The Meeting estimated an STMR of 0.22 mg/kg and a maximum residue level of 5 mg/kg. This estimation was based in part on trials for which no information on the duration of sample storage was reported.

Parsnips. GAP was reported for The Netherlands and the UK. The UK provided government-generated data on residues in overwintered commercial parsnips of known treatment history. Two residues were from treatments according to UK GAP (2.35 kg ai/ha). The residues were 0.14 and 0.16 mg/kg. The estimates of the STMR and maximum residue level for carrots are based on the post-planting EC or WP spray at 4 kg ai/ha reported as GAP in The Netherlands. Since GAP for parsnips in The Netherlands is the same as for carrots the Meeting agreed that the data on carrots could be used to estimate maximum and mean residue levels for parsnip by extrapolation.

The Meeting estimated an STMR of 0.22 mg/kg and a maximum residue level of 5 mg/kg. The estimates were based in part on trials for which there was no information on the duration of sample storage.

Potatoes. There are registered uses in The Netherlands and Poland. Residue trials were carried out in the UK, Spain, Australia and Poland, but they were very old and poorly reported with few details. There were insufficient data to estimate an STMR or maximum residue level and the Meeting recommended that the existing CXL of 0.05 mg/kg should be withdrawn.

Radishes. GAP was reported for Germany, The Netherlands and the UK. Residue trials were in Germany and Switzerland. Several of the trials were very old and none were reported in detail. In addition the UK provided government-generated data on residues (four results) in overwintered commercial radishes of known treatment history. The residues following applications close to GAP were all <0.1 mg/kg. There were insufficient data to estimate an STMR or maximum residue level and the Meeting recommended that the existing CXL of 0.1 mg/kg should be withdrawn.

Swedes and turnips. GAP for swedes and turnips was reported for The Netherlands and the UK. One field trial in the UK on swedes and three in the UK or USA on turnips were reported, but the analytical recovery was high (>120%) in the trial on swedes and the others were old and poorly described with no detailed study reports. The Meeting also received reports of six German trials on swedes or turnips in which the commodity was described as "turnip cabbage". This was an error in translation from the original German and the correct description was "swede/turnip". These trials did not comply with UK or Netherlands GAP.

There were insufficient data to estimate an STMR or maximum residue level and the Meeting recommended that the existing CXLs of 0.05 mg/kg should be withdrawn.

Celery. There is a registered use in The Netherlands. One group of residue trials was reported, at a unspecified location. It was poorly described, with no detailed study report.

There were insufficient data to estimate an STMR or maximum residue level and the Meeting recommended that the existing CXL of 0.4 mg/kg should be withdrawn.

Rape seed. GAP for rape was reported for Austria, Germany, The Netherlands and Poland. Several field trials were carried out in France and Germany. Six German trials complied with German GAP for EC spray. Residues in all the trials were <0.02 mg/kg. There were no trials with the broadcast application of granules at 3 kg ai/ha used in The Netherlands, although in two French trials with an application rate of 1kg ai/ha residues were <0.02 mg/kg.

The Meeting estimated an STMR of 0.02 mg/kg and a maximum residue level of 0.02* mg/kg. The estimates were based on trials without information on the duration of sample storage.

Parsley. There are registered uses in The Netherlands and the UK with WP or EC spray applications. Summarized reports of residue trials were available from Germany, but all the trials were with granular formulation whereas the reported GAP applications are by spraying.

There were insufficient data to estimate an STMR or maximum residue level.

Maize. GAP was reported for The Netherlands. Residue trials were carried out in France but were very old and poorly described with no detailed study reports.

There were insufficient data to estimate an STMR or maximum residue level and the Meeting recommended that the existing CXL of 0.05 mg/kg should be withdrawn.

Wheat. There are registered uses in the UK. Two residue trials in the UK were very old and poorly reported with inadequate detail.

There were insufficient data to estimate an STMR or maximum residue level and the Meeting recommended that the existing CXL of 0.05 mg/kg should be withdrawn.

Lettuce and lamb's lettuce as rotational crops. Trials were carried out in Germany, but the data were submitted in JMPR summary format only with no accompanying study reports.

The lettuce or lamb's lettuce was planted 1-4 months after the treatment of radishes as the primary crop at 4 kg ai/ha. The dates of harvest of the radish crop and the residue levels in the soil were not recorded. The residues in lamb’s lettuce at harvest were <0.04 (4) and 0.19 mg/kg, and in lettuce <0.04 (5), 0.05, 0.07 0.11 mg/kg. German GAP for radishes is a “spreading” application at 3 kg ai/ha (field) or 4 kg ai/ha (glass). Similar GAP for soil treatment was reported at comparable application rates for several other crops in a number of countries.

Although no GAP was reported for chlorfenvinphos on lettuce or lamb’s lettuce, the trials demonstrated that significant residues may occur in these crops when grown in rotation following soil applications of chlorfenvinphos. Since the trials were reported only in summary form, the Meeting agreed not to estimate a maximum residue level for lamb’s lettuce or head lettuce.

Livestock. In a briefly reported trial calves were dipped in a chlorfenvinphos solution at a concentration of 0.037 kg ai/hl. Residues in liver, muscle and kidney were below the LODs of 0.1, 0.05 and 0.05 mg/kg respectively, but residues in the fat were in the range <0.1-0.27 mg/kg. In a trial in which cattle were grazed on treated pasture containing residues of 2.5-17 mg/kg the residues of chlorfenvinphos in the milk were all below 0.01 mg/kg.

The Meeting concluded that there were insufficient data on residues in ruminant feed items to estimate maximum residue levels for the meat, milk or edible offal of ruminants and that the existing CXLs for meat and milk should be withdrawn.

Domestic preparation and processing trials indicated that most of the residue in carrots treated with an EC spray is associated with the crown and the top 1 cm of the root. Removal of the crown alone was reported to lead to the loss of approximately 30% of the residue. Domestic boiling was found to have only a moderate effect on residues, but when carrots were peeled and the top of the roots (crown and next 1 cm) removed only 1-3% of the total residue remained. In a further study residues of 0.07 mg/kg in raw carrots were reduced to 0.02 mg/kg by commercial cooking, which included the addition of brine.

National monitoring data were supplied from Australia, Poland, The Netherlands and the UK.

The Meeting agreed that in view of the lack of studies according to modern standards on metabolism, the stability of residues in stored analytical samples, the mobility of chlorfenvinphos in soil and the residues found in following crops, the estimated maximum residue levels could not be recommended as MRLs. For any further future consideration of MRLs, submission of data on such studies would be needed.

RECOMMENDATIONS

1. The Meeting estimated the following maximum residue levels and STMRs, but the maximum residue levels are not recommended for use as MRLs.

Definition of the residue for compliance with MRLs and for estimation of dietary intake: chlorfenvinphos, sum of (*E*)- and (*Z*)- isomers.

The residue is fat-soluble.

Commodity		Maximum residue level, mg/kg	STMR, mg/kg
CCN	Name		
VB 0041	Cabbages, head	0.02*	0.02
VR 0577	Carrot	5	0.22
VB 0404	Cauliflower	0.02*	0.02
VA 0385	Onion, Bulb	0.02*	0.02
VR 0588	Parsnip	5	0.22
SO 0495	Rape seed	0.02*	0.02

2. The Meeting recommended that the following existing CXLs should be withdrawn.

Commodity		Existing CXL, mg/kg
CCN	Name	
VB 0400	Broccoli	0.05
VB 0402	Brussels sprouts	0.05
VB 0041	Cabbages, Head	0.05
VR 0577	Carrot	0.4
VB 0404	Cauliflower	0.1
VS 0624	Celery	0.4
FC 0001	Citrus fruits	1
SO 0691	Cotton seed	0.05
VO 0440	Egg plant	0.05
VR 0583	Horseradish	0.1
VA 0384	Leek	0.05
GC 0645	Maize	0.05
MM 0095	Meat (from mammals other than marine mammals)	0.2 (fat) V
ML 0107	Milk of cattle, goats and sheep	0.008 F V
VO 0450	Mushrooms	0.05
VA 0385	Onion, Bulb	0.05
SO 0697	Peanut	0.05
VR 0589	Potato	0.05
VR 0494	Radish	0.1
GC 0649	Rice	0.05
CM 1205	Rice, polished	0.05
VR 0497	Swede	0.05
VR 0508	Sweet potato	0.05
VO 0448	Tomato	0.1
VR 0506	Turnip, Garden	0.05
GC 0654	Wheat	0.05

FURTHER WORK OR INFORMATION

Desirable

1. The following physico-chemical properties of the pure active ingredient:
vapour pressure, melting point, octanol/water partition coefficient, solubility in organic solvents, solubility in water, specific gravity.

2. If significant residues occur in relevant feed items, a study of metabolism and distribution in a lactating ruminant and/or in laying poultry carried out according to modern standards in which treatment is made through oral ingestion.

3. Data on metabolism in a ruminant after the external application of chlorfenvinphos to support the reported approved dipping use in Australia.

4. Plant metabolism and translocation studies carried out according to modern standards.

5. Studies on the stability of pesticide residues in representative analytical samples stored for at least two years. These would help to support data evaluated by the Meeting on residue trials for which the duration of sample storage was not reported.

6. Studies to assess the nature and levels of residues in representative rotational crops other than lettuce and lamb’s lettuce.

7. If significant residues are found in animal feed, a transfer study on ruminants according to modern standards (see 1993 JMPR report, Section 2.7).

8. A study of the mobility of chlorfenvinphos in soil, including leaching, adsorption and desorption, according to modern standards.

9. Copies of the product labels supporting the information submitted on GAP.

10. The full reports of the rotational crop studies on lamb's lettuce and lettuce.

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CHLORFENVINPHOS (014)

EXPLANATION

Chlorfenvinphos was evaluated for residues by the JMPR in 1971 and 1984 and maximum residue levels for a number of commodities were estimated.

Chlorfenvinphos was proposed for re-evaluation by the Working Group on Priorities at the 1989 CCPR (ALINORM 89/24A, para 298 and Appendix V). The review was scheduled for 1994 at the 1990 CCPR (ALINORM 91/24, Appendix V Part II) and confirmed by the 1991 CCPR on the understanding that new data would be available (ALINORM 91/24A, para 316 and Appendix VI, Annex I).

Information on current GAP and data on residues were requested from governments by CL 1991/15-PR.

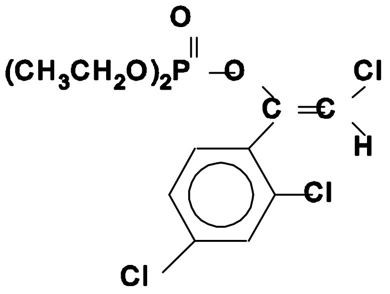
The manufacturer informed FAO that data on residues would not be available in time for the 1994 JMPR and the review was therefore delayed until the 1996 Meeting.

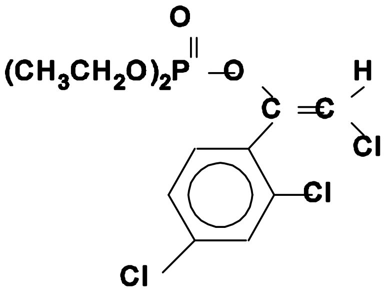
The Meeting received data on residues and information on GAP from the manufacturer, and additional information was provided by Australia, Germany, The Netherlands, Poland and the UK.

IDENTITY

ISO common name:	chlorfenvinphos
Chemical name	
IUPAC:	2-chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate
CA:	2-chloro-1-(2,4-dichlorophenyl)ethenyl diethyl phosphate
CAS registry no:	470-90-6 (formerly 2701-86-2) (*Z*)- + (*E*)- isomers; 18708-87-7 (*Z*)- isomer; 18708-86-6 (*E*)- isomer
CIPAC No:	88
Synonyms:	“Birlane”, “Supona”, CL 58,085, SD 7859, GC 4072

Structural formula:





	Z-isomer	**E-isomer**	
Ratio	**8.4**	**1**	1

Molecular formula: $C_{12}H_{14}Cl_3O_4P$

Molecular weight: 359.6

Physical and chemical properties

Pure active ingredient

No information was submitted.

Technical material

Purity:

Typical specification based on the analysis of 12 manufacturing batches in 1994 was 90-91.4% (total (*E*)- + (*Z*)-).

The purity of the technical material with which the physical and chemical properties listed below were determined was 93.1% (83.3% (*Z*)- isomer, 9.8% (*E*)- isomer) or 94.5% (84.2% (*Z*)- isomer, 10.3% (*E*)- isomer).

Colour:	amber
Physical state:	liquid at 25°C
Odour:	weak inherent smell
Melting point:	below -30°C
Boiling Point:	above 280°C
Relative Density	1.351
Surface tension of aqueous solutions	
	90% sat 51.8 mN/m
	80% sat 53.0 mN/m
Vapour Pressure at 25°C:	(*Z*)- isomer 0.37×10^{-3} Pa
	(*E*)- isomer 5.4×10^{-5} Pa

Flash Point: No flash point was observed up to a temperature of 285°C.

Auto-flammability: 542.6°C ± 1.1°C (mean of 5 assays)

Hydrolysis: Half-life in hours for the (*Z*)- isomer 6300 (pH 4), 6500 (pH 7) and 2100 (pH 9); (*E*)- isomer 6600 (pH 4), 4900 (pH 7) and 1700 (pH 9).

Photolysis: Half-life for phototransformation in water at 21°C and a nominal pH of 7 was 482 hours (Calmels, 1992; Robson 1992, 1993, 1994)

Data on the solubility of chlorfenvinphos in water, fat and organic solvents and the octanol-water partition coefficient were also supplied but were not supported by full study reports (Anon, 1996c)

Formulations

Chlorfenvinphos is formulated as GR, WP and EC products.

METABOLISM AND ENVIRONMENTAL FATE

Animal metabolism

Humans. In a volunteer study (Hutson, 1969) a male was given a single oral dose of 12.5 mg of [^{14}C]chlorfenvinphos in olive oil. The radiolabel was rapidly excreted in the urine with 72% of the applied dose excreted in the first 4.5 hours and 94.2% in 26.5 hours. Five metabolites were identified in the urine, two of which were quantified. These were 2-chloro-1-(2,4-dichlorophenyl)vinyl ethyl hydrogen phosphate and 2,4-dichloromandelic acid, which accounted for 23.8 and 23.9 % of the applied dose respectively. The other three metabolites were tentatively identified as [1-(2,4-dichlorophenyl)ethyl-â-D-glucopyranosidyl]uronic acid, 2,4-dichlorophenylethanediol glucuronide and 2,4-dichlorohippuric acid (*N*-2,4-dichlorobenzoylglycine).

Rats and dogs. In a study on rats and dogs (Hutson and Hathway, 1966) rats were given single oral doses of 2 mg/kg [^{14}C]chlorfenvinphos. Within 96 hours 87% of the applied dose was excreted in the urine, 1.4% in expired air and 11% in the faeces. Most of the radiolabel in the urine was excreted in the first 24 hours.

Dogs were given single oral doses of 0.3 mg/kg [^{14}C]chlorfenvinphos in gelatine capsules. In the first 24 hours 86% of the applied dose was excreted in the urine, and in 96 hours 89.4% was excreted in the urine and 4.5% in the faeces.

The urine was analysed for metabolites: five were identified from the rats and four from the dogs. Their relative proportions are shown in Table 1.

Table 1. Metabolites of chlorfenvinphos in rat and dog urine.

Metabolite	% of ^{14}C in urine	
	Rat	Dog
2,4-dichlorophenylethanediol glucuronide	3	3
[1-(2,4-dichlorophenyl)ethyl-â-D-glucopyranosidyl]uronic acid	47	4
2,4-dichlorohippuric acid	5	absent
2,4-dichloromandelic acid	8	5
2-chloro-l-(2,4-dichlorophenyl)vinyl ethyl hydrogen phosphate	37	78

Cattle. In a briefly reported study (Hutson and Hoadley, 1969; Hunter, 1969), one small (400 kg) Friesian cow was given a single intramuscular injection of 233 mg of [*vinyl*-1,2-^{14}C]chlorfenvinphos (unspecified radiochemical purity; specific radioactivity 2.8 µCi/mg) in 'Infonutrol'. The cow had free access to water and hay, was fed 3.6 kg of concentrate per day over the five day duration of the study and was milked twice daily (at 10 am and 4 pm).

Milk samples were analysed for total radioactive residues by LSC, and were found to contain a maximum initial radioactive residue of 0.076 mg/kg chlorfenvinphos equivalents. Overall, only 0.2% of the administered dose was recovered in the milk (Table 2).

Table 2. Radioactive residues in milk after intramuscular administration of [*vinyl*-^{14}C]chlorfenvinphos to a cow.

Day	Time	^{14}C	
		% of administered dose	mg/kg parent equivalents
1	4 pm	0.13	0.076
2	10 am	0.04	0.011
2	4 pm	0.01	0.006
3	10 am	0.01	0.004
3	4 pm	0.009	0.006
4	10 am	0.006	0.002
4	4 pm	0.0005	0.0003
5	10 am	0.001	0.0005

The nature of the residues was investigated in the first milk sample. The second sample was analysed for the parent compound only. The milk was separated into cream, residual whey, and precipitated protein by centrifugation. The cream was extracted with acetone and hexane. The radioactivity was distributed as follows: hexane-soluble fat 52%, acetone-soluble fat 28%, insoluble fat residue 3%, whey 13%, and insoluble protein 4%. A fat sample was prepared by mixing dried cream with sodium sulfate before dissolution in acetone/hexane and concentration by evaporation. The fat content of the milk was estimated as 5%. TLC of the fat solution with reference standards showed mainly chlorfenvinphos (0.049 mg/kg) with the metabolites (found in the range 0.0004 to 0.0023 mg/kg) shown in Table 3. The levels of unchanged chlorfenvinphos in the first and second milk samples represented 75% and 60% of the total radioactive residue (TRR) respectively. The major metabolite found in milk was 2,4-dichloroacetophenone (III), found only at a level of 0.0023 mg/kg (3.6% of the TRR). Of the radioactivity remaining in the whey, 29% was extracted with ether at neutral pH (postulated as parent) and 23% was extracted at pH 2 (considered to be indicative of metabolites VI and IX).

Table 3. Distribution and nature of the radioactive residue in milk fat.

Metabolites		Residue in milk fat expressed as mg/kg in whole milk
I	chlorfenvinphos	0.049
II	2,4-dichlorophenacyl chloride	0.0008
III	2,4-dichloroacetophenone	0.0023
IV	1-(2,4-dichlorophenyl)ethanol	0.0014
V	1-(2,4-dichlorophenyl)ethane-1,2-diol	not detected
VI	2,4-dichloromandelic acid	0.0011
VII	2,4-dichlorobenzoic acid	<0.0014
VIII	2-chloro-1-(2,4-dichlorophenyl)ethanol	0.0004
IX	desethyl-chlorfenvinphos	0.0007

Urine was sampled at an unspecified time and found to contain 29% of the administered dose, of which 90% was extracted with ether/ethanol. Paper chromatography in butanol/ammonia revealed the presence of metabolites IV, V, VI, and IX accounting for 34%, 23%, 12% and 57% of the extracted radioactive residue.

The proposed metabolic pathway for chlorfenvinphos in ruminants is given in Figure 1 below.

A number of investigations with [^{32}P]chlorfenvinphos were briefly reported in a paper published in 1966. In the first of these [^{32}P]chlorfenvinphos (unspecified radiochemical purity) was applied dermally to two calves in two litres of spray (one at 0.25% and the other at 0.05% concentration). Omental fat samples were taken at 3, 7 and 15 days after spraying and were found to contain radioactive residues of 0.675, 0.055 and “0” mg/kg from the 0.25% treatment and 0.06, 0.001 and “0” mg/kg from the 0.05% treatment.

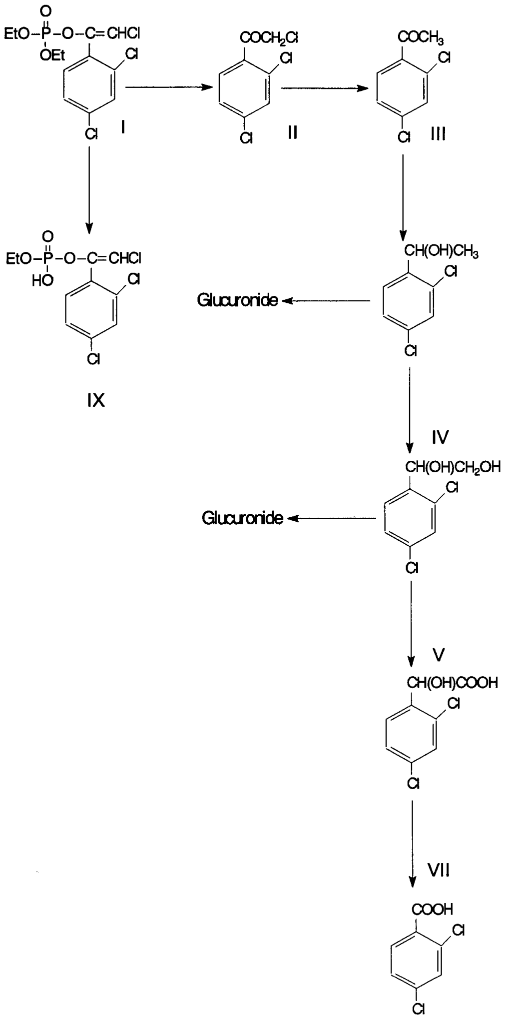
In a second investigation, two calves were similarly treated dermally with 2 litres of a spray emulsion, one at 0.25% and the other at 0.5% concentration. Both animals were killed 7 days after treatment and samples of renal and omental fat, heart, kidney, and muscle were taken for radiometric analysis. The results are shown in Table 4.

Table 4. Radioactive residues in fat and tissues of calves 7 days after treatment with a [^{32}P]chlorfenvinphos spray.

Sample	^{32}P as chlorfenvinphos, mg/kg	
	0.25% spray	0.5% spray
Renal fat	0.042	0.204
0mental fat	0.036 (0.36[1])	0.223
Heart	0.002	0.015
Kidney	0.001	0.008
Muscle	0.001	0.008

[1] Additional sample taken by omentectomy 24 hours after treatment

Figure 1. Proposed metabolic pathways of chlorfenvinphos in ruminants.



In a third investigation, three Hereford calves were treated “to saturation” with a 0.25% spray emulsion of chlorfenvinphos. The calves were killed 7 (calf A), 16 (calf B) and 28 (calf C) days after treatment. Samples of omental and renal fat, muscle, heart, kidney, liver, brain, and spleen were analysed for the parent compound by GLC (Table 5).

Table 5. Residues of chlorfenvinphos in fat and tissues of cattle sprayed ‘to saturation’ with a 0.25% spray of chlorfenvinphos.

Sample	Chlorfenvinphos, mg/kg, at intervals, days, after spraying		
	7	16	28
Omental fat	0.085	0.006	<0.005
Renal fat	0.021	<0.005	<0.005
Muscle	<0.004	<0.004	<0.004
Heart	<0.004	<0.004	<0.004
Kidney	<0.004	<0.004	<0.004

Sample	Chlorfenvinphos, mg/kg, at intervals, days, after spraying		
	7	16	28
Liver	<0.004	<0.004	<0.004
Brain	<0.004	<0.004	<0.004
Spleen	<0.004	<0.004	<0.004

In a fourth, more comprehensive, investigation (Ivey *et al.*, 1966) six Hereford cattle (group A) were sprayed 12 times at weekly intervals with a 1% emulsion of chlorfenvinphos. Another group (B) of six cattle was sprayed six times at two-week intervals with the same concentration of spray. Control animals were sprayed with “formulation blank”. Fat samples were taken by omentectomy from three animals from group A, one week after the 1st, 2nd, 4th, 6th, 8th, 10th and 12th spray treatments, and from three animals from group B two weeks after each treatment. The samples were analysed for chlorfenvinphos and the metabolite 2,4-dichlorophenacyl chloride by GLC. 2,4-dichlorophenacyl chloride was not detected in any of the samples. The residues of chlorfenvinphos in the omental fat of the cattle in groups A and B are shown in Tables 6 and 7 respectively. All results were corrected for blanks and a recovery of 80%.

Table 6. Residues of chlorfenvinphos in omental fat from cattle sprayed weekly with a 0.1% emulsion.

Animal	Residues, mg/kg, in omental fat 7 days after indicated spray						
	1st	2nd	4th	6th	8th	10th	12th
A.1	0.012				0.161		0.010
A.2	0.009		0.065		0.121		0.010
A.3	0.056		0.142		0.245		0.020
A.4		0.047		0.051		0.020	
A.5		0.070		0.065		0.019	
A.6		0.020		0.035		0.009	

Table 7. Residues of chlorfenvinphos in omental fat from cattle sprayed biweekly with a 0.1% emulsion.

Animal	Residues, mg/kg, in omental fat 14 days after indicated spray					
	1st	2nd	3th	4th	5th	6th
B.1	<0.005		<0.005		0.247	
B.2	0.006		0.006		0.170	
B.3	<0.005		<0.005		0.080	
B.4		0.009		<0.005		0.180
B.5		0.008		0.007		0.110
B.6		<0.005		<0.005		

No residues of chlorfenvinphos were detected in omental or renal fat taken from animals of group A or B slaughtered 14 and 28 days after the last spray respectively.

In a very briefly reported study (Roberts *et al.*, 1961) two dairy cows were sprayed with ^{32}P-labelled chlorfenvinphos (unspecified radiochemical purity; specific activity 3.4 mCi/g). One cow (Holstein) was treated with 400 ml of a water-based spray formulated from a simple EC containing 5 g of the radiolabelled compound. This was done by spraying 200 ml on each side of the cow, avoiding the udder, and working into the hair with a comb. The second cow (Jersey) was similarly treated with 5 g of ^{32}P-labelled chlorfenvinphos (unspecified radiochemical purity; specific activity 1.7 mCi/g), using a different EC formulation based on xylene and lanolin in a total spray volume of 60 ml; this was not worked into the hair, and resulted in a loss of about 5%. Duplicate milk samples (200 ml) were taken from the morning milk just before treatment and up to 12 days after treatment. The organosoluble radioactivity was extracted and determined with a Geiger tube. The maximum residues were found in the milk sampled 5 hours after treatment, 0.06 mg/kg in the Holstein and 0.03 mg/kg in the Jersey. One day after treatment the residues had decreased to 0.011 mg/kg and 0.005 mg/kg in the Holstein and Jersey milk, and residues were finally eliminated in 12 and 10 days after treatment respectively.

Chamberlain and Hopkins (1962) applied [^{32}P]chlorfenvinphos (radiochemical purity in the range 76 to 87%) at 55, 25 and 8 mg/kg body weight to the back and sides of three steers, A, B and C respectively, in a volume of 300 ml as an EC spray using a chromatography spray bottle held 1.2 cm from the surface of the skin, with subsequent combing into the skin. Blood samples and excreta were taken at regular intervals for 1 week after treatment and radioassayed with a gas-flow proportional counter. The results are shown in Table 8. It was stated that 18 to 42% of the chloroform-soluble radioactivity in the blood co-chromatographed with unchanged chlorfenvinphos. Twenty five to 35% of the applied radioactivity was excreted in the urine, but only 2% was recovered from the faeces.

It was reported, although full details were not given, that 9 or 10 radioactive compounds were excreted in the urine, one of which (representing 2 to 14% of the TRR) co-chromatographed with dimethyl hydrogen phosphate. Another metabolite (in the range 0.4 to 7%) was tentatively identified as diethyl 1-methyl-2-chlorovinyl hydrogen phosphate. The predominant component, which represented "49% of all the radioactive material in early hourly samples", remained unidentified. It was stated to decrease in concentration with time. A further unidentified component was reported in the range 6 to 44% of the TRR.

Table 8. Total radioactive residues in blood, urine and faeces of dermally treated steers.

Time	^{32}P as chlorfenvinphos, mg/kg								
	Steer A			Steer B			Steer C		
	Blood[1]	Urine	Faeces	Blood[1]	Urine	Faeces	Blood[1]	Urine	Faeces
1 h	7.1 (1.4)	741					0.7	2.8	
2 h	7.8 (1.2)	2504		3.9 (0.3)			0.9	16	
3 h	6.7 (0.8)	2966	7.2	3.9 (0.7)	1148	1.1	0.8 (0.04)	27	0.5
6 h	3.8 (0.8)	2589	13	2.2 (0.3)	1117	2.9	0.6	84	2.2
9 h	3.2 (0.4)	1556	113				0.4	74	
12 h	3.3	1445					0.3	57	
18 h	2.9	918	428	0.8 (0.2)	408	56	0.2	56	
1 day	2.1	684	441	0.7	193	52	0.2	38	7.6
2 days	1.5	196	108		121	32	0.2	26	4.9
4 days	1.1	46	26	0.6	57	42	0.2	17	5.0
7 days	0.9	18	21	0.4	18	7	0.3	6.6	3.8

[1] Chloroform-soluble residues are shown in parentheses

A further study on the toxicology and metabolism of chlorfenvinphos (Herbst and Herbst, 1995) was submitted but was not evaluated because it was written in German.

Plant metabolism

In a 1965 study, later described in two papers and summarized in a further review (Beynon and Wright 1965, 1967; Beynon *et al.* 1973; Anon, undated) [^{14}C]vinyl-labelled (*E)*-chlorfenvinphos (radiochemical purity not specified) was applied to soil around cabbage plants at a rate of 4 mg per plant (growth stage not specified) to soil eight weeks after it had been sown with carrots at an application rate of 3.4 kg ai/ha, and to soil ten weeks after it had been sown with onions at a rate of 4.5 kg ai/ha. Cabbages were harvested 12-14 weeks, and carrots and onions 18 weeks, after treatment. All three crops were grown in the laboratory.

The samples were extracted with acetone and analysed by TLC (only brief details supplied). Quantification of the unextractable residues was by combustion analysis.

The results are summarized in Tables 9-11 below. In cabbages no radiolabel (<0.01 mg/kg as chlorfenvinphos) was detected in the heart but 0.11 mg/kg was found in the outer leaves, of which 0.05 mg/kg was extractable but not characterized. An acetone extract of the stump/root was found to contain a residue of 0.26 mg/kg, of which 95% was chlorfenvinphos and 5% 2,4-dichloroacetophenone. A total residue of 0.15 mg/kg was found in the roots of carrots, of which 0.12 mg/kg was chlorfenvinphos, and a total residue of 0.08 mg/kg in onion bulbs, of which 0.07 mg/kg was chlorfenvinphos.

Table 9. Residues of (*E*)-[*vinyl*-^{14}C]chlorfenvinphos and its breakdown products in cabbages grown indoors following application to the soil around the roots at transplanting.

Sample	^{14}C as chlorfenvinphos[1]	
	Acetone-extractable	Acetone-unextractable
Heart	0.005	0.005
Outer leaf	0.05	0.06
Dead leaf (on soil)	0.15	0.04
Stump and root	0.26[2]	0.26

[1] Controls <0.005 mg/kg

[2] 95% chlorfenvinphos, 5% 2,4-dichloroacetophenone

Table 10. Residues of (*E*)-[*vinyl*-^{14}C]chlorfenvinphos and its breakdown products in carrots grown indoors.

Sample	Acetone extractability	Component	^{14}C as chlorfenvinphos[1]
edible root	Extractable	Chlorfenvinphos	0.12
		2,4-dichloroacetophenone	0.01
	Unextractable	Unidentified	0.024
leaf	Extractable	Chlorfenvinphos	0.33
	Unextractable	Unidentified	0.02

[1] Recovery of [^{14}C]chlorfenvinphos at approximately 1 mg/kg was 82%

Table 11. Residues of (*E*)-[*vinyl*-^{14}C]chlorfenvinphos and its breakdown products in onions grown indoors.

Sample	Acetone extractability	Component	^{14}C as chlorfenvinphos[1]
Bulb	Extractable	Chlorfenvinphos	0.07
	Unextractable	Unidentified	0.01
Leaf	Extractable	Unidentified	0.05
	Unextractable	Unidentified	0.01

[1] Recovery of [^{14}C]chlorfenvinphos at approximately 0.7 mg/kg was 90-95%. Control plants showed ^{14}C corresponding to <0.01 mg/kg

In reviews of the metabolism and degradation of vinyl phosphate insecticides (Beynon *et al.*, 1973; Beynon and Wright, 1968) it was reported that [^{14}C]vinyl-labelled (*E)*-chlorfenvinphos of unspecified radiochemical purity was foliar-applied (precise method and rate not specified) to potatoes, cabbage and maize growing in a greenhouse. Analyses of crop samples taken 28-112 days after treatment gave the results shown in Table 12. The methods used to extract and analyse the samples were not described.

In potatoes, 39% of the applied ^{14}C was found in the foliage after 28 days and less than 0.5% in the tubers after 80 days. Evidence for identification was not given, but the authors indicated that 21% of the applied radiolabel represented chlorfenvinphos, 11% a conjugate of 1-(2,4-dichlorophenyl)ethanol and 7.2% could not be extracted with acetone. They suggested that plant metabolism studies with tetrachlorvinphos indicated that the unextracted residues were mainly further quantities of conjugates of 1-(2,4-dichlorophenyl)ethanol.

Twenty per cent of the radiolabel applied to cabbages was found in the foliage 24 days after treatment: 6.7% of the dose as chlorfenvinphos and 6.7% as the 1-(2,4-dichlorophenyl)ethanol conjugate; 6.7% could not be extracted with acetone and again appeared to consist mainly of conjugates of 1-(2,4-dichlorophenyl)ethanol.

In maize, 54% of the applied radiolabel was found in the foliage after 24 days and less than 0.5% in the grain after 112 days. In the foliage 26% of the dose was chlorfenvinphos, 12% the 1-(2,4-dichlorophenyl)ethanol conjugate and 16%, unextractable with acetone, apparently also conjugates of 1-(2,4-dichlorophenyl)ethanol.

Table 12. Metabolites found after foliar treatment of glasshouse crops with [^{14}C]chlorfenvinphos.

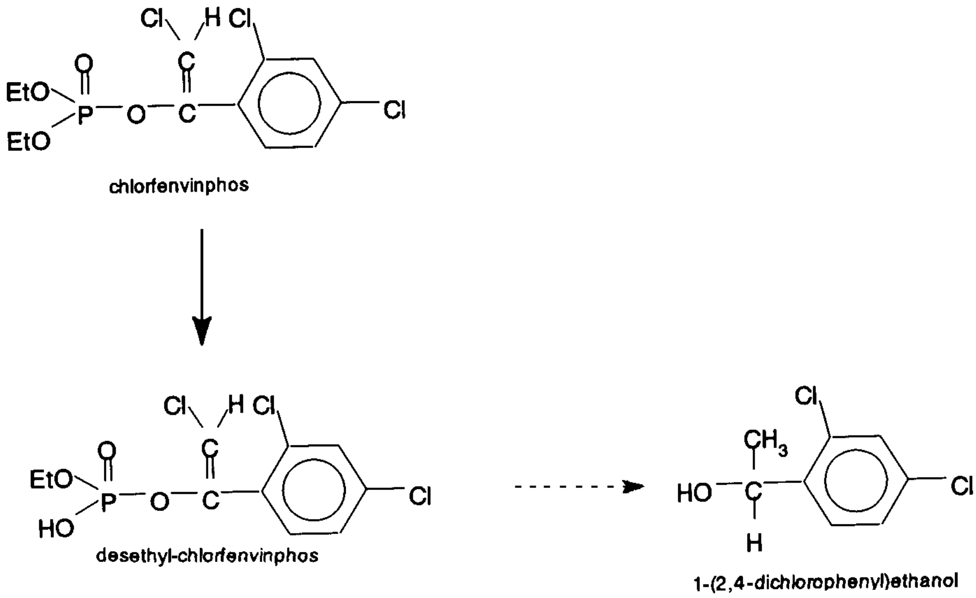
Crop	Sample	Days from treatment to sampling	% of applied ^{14}C			
			Chlorfenvinphos	Conjugate of 1-(2,4-dichlorophenyl)ethanol[1]	Unextracted by acetone[2]	Total
Potato	Whole plant above ground Tubers	28 80	21 -	11 -	7.2 -	39 <0.5
Cabbage	Whole plant above ground	24	6.7	6.7	6.7	20
Maize	Whole plant above ground Grain	24 112	26 -	12 -	16 -	54 <0.5

[1] Approximately 1% of the activity ascribed to the conjugate could be from desethyl-chlorfenvinphos

[2] Probably also mainly conjugates of 1-(2,4-dichlorophenyl)ethanol

The metabolic pathway proposed on the basis of foliar application is shown in Figure 2.

Figure 2. Metabolism of chlorfenvinphos in plants following foliar treatment.



Environmental fate in soil and water/sediment systems

In the study of plant metabolism following soil application described above (Beynon and Wright, 1965), further work was carried out to identify degradation products in the soil. In addition, a second phase of the study involved the treatment of different soil types with higher rates of [*vinyl*-^{14}C]chlorfenvinphos (15 mg/kg) in closed containers. Acetone extracts of soil samples taken from below the onion crop were reported to contain chlorfenvinphos at 2.4 mg/kg, desethyl-chlorfenvinphos (near 0.02 mg/kg) and 2,4-dichlorophenacyl chloride. Further treatment of the soil with acid extracted 0.35 mg/kg chlorfenvinphos equivalents, which consisted of chlorfenvinphos (0.28 mg/kg), desethyl-chlorfenvinphos (0.07 mg/kg) and a trace of 2,4-dichlorophenacyl chloride. The authors stated that the desethyl-chlorfenvinphos in the acid extract may have been present as such in the soil but was more likely to have been in the form of a salt or conjugate which was hydrolysed to desethyl-chlorfenvinphos by the acid. Few further details were given, and no results of the second phase were presented.

In a summarized study of the degradation of chlorfenvinphos in soil under laboratory conditions (Anon., undated; Beynon *et al.*, 1973) [*vinyl*-^{14}C]chlorfenvinphos was applied to 4 different soils at an initial concentration of 15 mg/kg. The pH and water contents of the soils are given in Table 13. The soils were incubated in the dark at 22°C and samples were taken for analysis at intervals for 4 months.

Table 13. Characteristics of experimental soils.

Soil type	pH	Water content (% w/w)
Clay	8.0	21.1
Loam	8.0	15.1
Sand	7.9	13.9
Peat	6.4	88.6

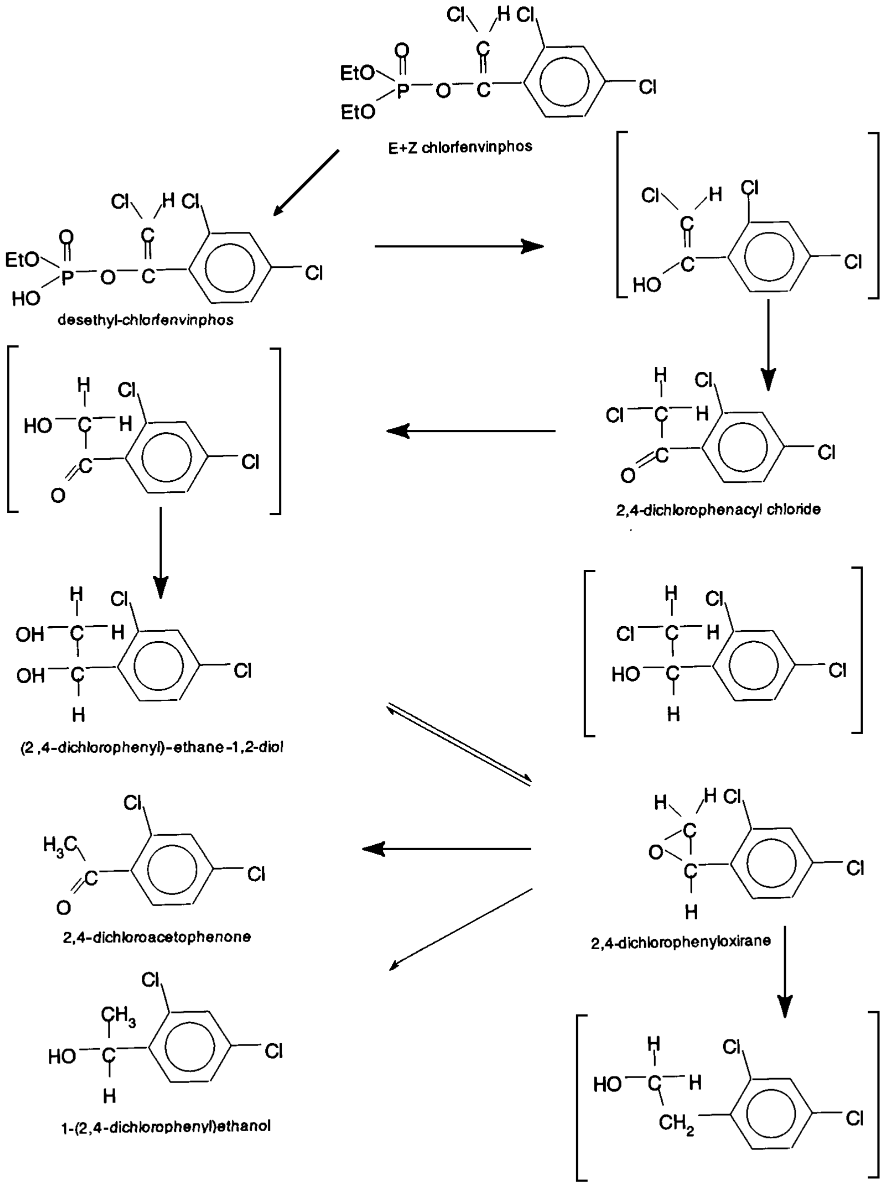
Extracts of the soils were examined for products of degradation by TLC with radio-analysis, with the results shown in Table 14. Radioactivity designated as unextractable was obtained by oxidation of the treated soil by "Van Slyke oxidation".

Table 14. Residues of [^{14}C]chlorfenvinphos and its degradation products in soils four months after treatment.

Compound or fraction	Residue, mg/kg moist soil			
	Clay	Loam	Sand	Peat
desethyl-chlorfenvinphos	0.2	0.1	0.2	0.1
(2,4-dichlorophenyl)ethan-1,2-diol	≤0.02	≤0.02	≤0.03	≤0.02
unknown	0.07	0.06	0.04	0.1
1-(2,4-dichlorophenyl)ethanol	1.0	0.1	0.06	0.2
chlorfenvinphos	2.0	4.2	1.0	4.7
2,4-dichloroacetophenone	0.5	0.2	0.1	0.2
2,4-dichlorophenacyl chloride	≤0.005	≤0.005	≤0.005	≤0.005
2,4-dichlorophenyloxirane	≤0.005	≤0.005	≤0.005	≤0.005
salts or conjugates of desethyl-chlorfenvinphos	0.1	0.5	0.6	<0.05
unextractable radioactivity	2.0	1.8	-	-

The pathways for the degradation of chlorfenvinphos proposed by the authors are shown in Figure 3. Structures enclosed in brackets were described as “transient intermediates”, although no derivative of the phenethyl alcohol "intermediate" is suggested.

Figure 3. Proposed degradation pathways of chlorfenvinphos in soil.



The high application rate was employed to identify products which might not be identified at lower rates. Radioactivity which was not recovered from the soils represented 60-80% of the applied dose; it included $^{14}CO_2$ and residues which could not be extracted with common organic solvents. The predominant products were 1-(2,4-dichlorophenyl)ethanol, 2,4-dichloroacetophenone and the sodium salt of desethyl-chlorfenvinphos.

In additional summarized experiments (Beynon *et al.*, 1973) onions and carrots grown in boxes containing John Innes No 2 compost under glasshouse conditions were treated with [^{14}C]chlorfenvinphos at the commercial rate of 3.4-4.5 kg/ha. Eight weeks after application of the insecticide the ^{14}C in the compost, expressed as mg chlorfenvinphos equivalents/kg moist soil, was accounted for by 2.7 mg/kg of chlorfenvinphos, 0.09 mg/kg of desethyl-chlorfenvinphos and 0.03 mg/kg of 2,4-dichloroacetophenone or 2,4-dichlorophenacyl chloride.

A summarized study (Anon., undated), presented as a poor copy which was illegible in places, described three further experiments on degradation in field soils. In all of these it was unclear whether the application rate referred to product/ha or active ingredient/ha. In the first experiment, chlorfenvinphos was applied at 4.5 or 9 kg/ha to crops in the field at 4 sites in the UK in spring or summer. Soil samples were taken for analysis at intervals up to 6 months. The soils were a brick-earth, a sandy loam, a loam and a peat. Half-lives of chlorfenvinphos were in the range of about 14-84 days in the mineral soils and more than 150 days in the peat soil. 2,4-dichlorophenacyl chloride was found in peat samples taken 4 weeks or more after treatment at concentrations up to 0.1 mg/kg of soil (105 day sample) after application of chlorfenvinphos at 9 kg/ha. The properties of the soils were not given.

In the second experiment, chlorfenvinphos was applied to field soils at rates of 4.5, 6.7, 9 or 22 kg/ha. Samples of soil were taken for analysis at intervals up to 6 months after application in spring or summer and examined for the degradation products 1-(2,4-dichlorophenyl)ethanol, 2,4-dichloroacetophenone and 2,4-dichlorophenacyl chloride. There was no evidence of isomerisation of the (*Z*)- isomer in soil. 2,4-Dichlorophenacyl chloride was not detected in the soils within 6 months of application at 4.5 or 6.7 kg/ha but was found at a concentration of 0.1 mg/kg 105 days after application at 9 kg/ha. The highest residue of 2,4-dichloroacetophenone was 0.2 mg/kg, found 30 days after application at 9 kg/ha. 1-(2,4-dichlorophenyl)ethanol was not detected within 6 months of treatment at 4.5-9 kg/ha with a limit of detection of 0.2 mg/kg, but was found at 0.6 mg/kg 28 days after application of the unrealistically high rate of 22 kg/ha.

In the third experiment, carried out in 1966-7, labelled chlorfenvinphos was applied as a GR to a brick loam soil and as an EC to clay loam soil in the UK at 4 kg ai/ha. The residues remaining in soil samples taken at intervals are given in Table 15.

Table 15. Decay of chlorfenvinphos residues in soils.

Interval	Chlorfenvinphos equivalents, mg/kg	
	Faversham brick loam	Woodstock clay loam
0 days	-	3.2
2 days	4.6	-
1 week	4.4	-
2 weeks	2.6	-
4 weeks	4.4	3.3
10 weeks	1.1	1.9
20 weeks	-	1.1
52 weeks	0.11	0.4
82/86 weeks	0.05	0.3
99 weeks	Illegible	-
107 weeks		0.04

A further paper was submitted which provided an overview of the occurrence and fate of residues in soil, mainly of the work described above (Anon., 1985). Laboratory data on the degradation of chlorfenvinphos in water/sediment systems (Wable, 1993) and in fresh water aquatic systems (Edwards and Gibb, 1981) were also submitted but not reviewed.

METHODS OF RESIDUE ANALYSIS

Analytical methods

Fruit and vegetables. The Netherlands submitted a qualitative multi-residue TLC method which allows the determination of the (*E*)- and (*Z*)- isomers of chlorfenvinphos (Anon., 1988a). Samples are extracted with ethyl acetate in the presence of sodium sulfate. An aliquot of the extract is run on a TLC plate using an organic solvent mixture (chloroform/diethyl ether, benzene/acetone, benzene/acetone/hexane, or hexane/acetone). The plate is then sprayed with a homogenate of bee heads, incubated at 370°C and subsequently sprayed with a solution of 2-naphthyl acetate and Fast Blue B. The cholinesterase from the bee heads hydrolyses 2-naphthyl acetate to 2-naphthol, which reacts with the Fast Blue B to form a dye. Where inactivators of cholinesterase are present no dye is formed, so such places appear as white spots on a pink-violet background.

It was reported that 0.2 mg/kg of the (*E*)- isomer and 2 to <20 mg/kg of the (*Z*)- isomer could be detected. The method is not suitable for quantitative determination.

Fruit and vegetables, animal products, and grains. A quantitative multi-residue method, also submitted by The Netherlands, allowed determination of the (*E*)- and (*Z*)- isomers of chlorfenvinphos (Anon., 1988b,c). Samples are extracted with ethyl acetate in the presence of sodium sulfate, cleaned up where necessary by gel permeation chromatography using cyclohexane/ethyl acetate as eluant, and determined in the filtered extract by GLC with a phosphorus-specific detector. The LOD was stated to be in the range 0.01-0.05 mg/kg with a recovery of >80%, although no further information on validation of the method was given.

Carrots and onions. The Netherlands provided brief details of the methods of analysis used in the trials which they reported (Olthof, 1996). Extraction with petroleum ether or ethyl acetate is followed by analysis by GLC with FP detection. The limits of determination ranged from 0.005 to 0.02 mg/kg.

Crops and soil. In a method developed by Shell (Anon., 1966) samples were extracted by maceration with acetone in petroleum spirit in the presence of anhydrous sodium sulfate. After filtering, determination was by GLC with EC detection. Interfering co-extractives were removed with a Florisil column clean-up. An LOD of 0.01 mg/kg was reported although no chromatograms or details of the commodities with which this had been achieved were submitted. No recovery or other validation data were provided.

In a second reported method (Anon., 1990) soil was mixed with anhydrous sodium sulfate before extraction of soil and crop samples with acetone/hexane, and extracts of oily crops were partitioned between hexane and aqueous acetonitrile. The extracts were cleaned up on Florisil before analysis by GLC with an NPD. The method was validated with three soils (clay loam, sandy loam and silty clay), apples, soya beans, wheat grain and cabbage by fortifying with 0.05-0.5 mg/kg of each isomer. Recoveries were consistently between 75 and 115%. At each level the standard deviation was ≤12% of the mean. Sample chromatograms showed resolution of the isomers. The limit of determination was 0.01 mg/kg of each isomer in all samples.

A further method (Anon., 1969) was submitted for the determination of 2,4-dichloroacetophenone, 1-(2,4-dichlorophenyl)ethanol, and 2,4-dichlorophenacyl chloride. Crop and soil samples were extracted with a mixture of acetone and petroleum spirit. The extracts were washed with water, dried, and analysed by GLC with an ECD. Where required, an alumina column clean-up (elution with diethyl ether in petroleum spirit) was included. The method was stated to be suitable for determining metabolites down to a level of 0.01 mg/kg except 2,4-dichloroacetophenone, 2,4-dichlorophenacyl chloride and 1-(2,4-dichlorophenyl)ethanol. The LOD for the dichlorophenylethanol was 0.1 mg/kg.

Analysis of crops in supervised trials. Several other methods (Mathews, 1972; Bosio, 1981i) included in the reports of residue trials were modifications of the methods for crops reviewed above. Extraction was into either acetone/hexane or acetone/petroleum spirit and determination was by GLC with either FP or EC detection. LODs in the range 0.01-0.05 mg/kg were reported although generally no sample chromatograms were submitted. Some samples were analysed for 1-(2,4-dichlorophenyl)ethanol, 2,4-dichlorophenacyl chloride and 2,4-dichoroacetophenone, but with limited data on validation of the methods and few sample chromatograms. Confirmation of residues, when carried out, was by GC-MS.

Grass. Samples were extracted by tumbling with anhydrous sodium sulfate, acetone and petroleum spirit. The extracts were filtered and analysed without clean-up by GLC with an ECD (Elgar, 1966e).

Milk. In a briefly summarized method (Elgar, 1966e), samples of milk were diluted with ethanol and extracted with an ether/hexane mixture. After drying over anhydrous sodium sulfate the solvent was evaporated and the fatty residue washed with hexane and extracted into acetonitrile. The acetonitrile extract was cleaned up on Florisil columns, eluting with ether in petroleum spirit. Analysis was by GLC with EC detection.

Stability of pesticide residues in stored analytical samples

No data were submitted.

Residue definition

The studies of animal and plant metabolism indicate that chlorfenvinphos is the main residue in products of animal and plant origin. A definition of the residue as "chlorfenvinphos, sum of (*E*)- and (*Z*)- isomers" is therefore considered appropriate.

USE PATTERN

Chlorfenvinphos is registered in a number of countries for use on a wide range of vegetable crops, but no uses were reported on fruit crops. Topical veterinary uses on cattle and other animals were reported for Australia.

The information on GAP supplied by the manufacturer (Anon., 1996c) was incomplete. No copies of product labels were submitted, only summary sheets. In some cases the reported PHI appeared to be inappropriate for the type of treatment (e.g. a 21-day PHI for pre-planting or pre-emergence application).

Details of registered use patterns are given in Tables 16-18.

Table 16. Registered uses of chlorfenvinphos on vegetables.

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
Asparagus	Netherlands	WP, EC	F	Spraying without incorporation into soil	3.84-4.0[1]	0.5-0.768	1	within two days after casing	Olthof 1996	Soil treatment
Broccoli	Germany	GR	F	Spreading and mixing	$100\ g/m^2$	--------	1	pre-planting	Anon 1996d	Soil treatment
	Germany	GR	F	Spreading	0.1 g/plant	--------	1	5-6 days after planting	Anon 1996d	Treatment of single plants
	Germany	GR	F	Spreading with rain	2 g/100 plants	--------	1		Anon 1996d	Nursery bed seedbed
	Germany	GR	F	Spreading	2 kg/ha	--------	1	5-6 days after planting	Anon 1996d	Row treatment
	Netherlands	WP, EC, GR	F	Spraying/granular application onto plant beds	3.84-4.0[1]	0.0768-0.08	1	60 before sowing	Olthof 1996	Soil application
	Netherlands	WP, EC, GR	F	Spraying/granular application onto "production fields"	1-3.75[2]	0.05 g (WP & EC) and 0.75 g (Gr) ai/plant	1	60	Olthof 1996	At planting or after cabbage fly eggs have set
	UK	EC	F	Seed bed spray	1.34[1]	0.268-0.446	1	pre-emergence	Anon 1996e	Applied immediately after drilling
	UK	EC	F	Overall soil incorporated spray	2.35[1]	0.47-0.78	1	21 pre-planting	Anon 1996e	
	UK	EC	F	Soil drench to base of plant	---------	0.0044	1	21 post-emergence	Anon 1996e	Applied April or within 4 days of transplanting if this is later
	UK	GR	F	Sub-surface band	4.5	-----------	1	21 Pre- and post-emergence	Anon 1996e	Plants or seed placed into line of granules at drilling or transplanting
	UK	GR	F	Incorporated into peat blocks	--------	50 g ai/640 litre peat	1	21 pre-planting	Anon 1996e	To protect seedlings before planting out
Brussels sprouts	Netherlands	WP /EC/ GR	F	Spraying/granular application onto plant beds	3.84-4.0[1]	0.0768-0.08	1	60 before sowing	Olthof 1996	Soil application
	Netherlands	WP /EC/ GR	F	Spraying/granular application onto "production fields"	1-3.75	0.05 g (WP & EC) and 0.75 g (Gr) ai/plant	1	60	Olthof 1996	At planting or after cabbage fly eggs have set
	UK	EC	F	Seed bed spray	1.34[1]	0.268-0.446	1	pre-emergence	Anon 1996e	Applied immediately after drilling
	UK	EC	F	Overall soil incorporated spray	2.35[1]	0.47-0.78	1	21 pre-planting	Anon 1996e	
	UK	EC	F	Soil drench to base of plant	---------	0.0044	1	21 post-emergence	Anon 1996e	Applied April or within 4 days of transplanting if this is later
	UK	GR	F	Sub-surface band	4.5	-----------	1	21 Pre- and post-emergence	Anon 1996e	Plants or seed placed into line of granules at

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
										drilling or transplanting
	UK	GR	F	Incorporated into peat blocks	--------	50 g ai/640 litre peat	1	21 pre-planting	Anon 1996e	To protect seedlings before planting out
Cabbage	Belgium	EC	-	-------------	0.01 g/plant	--------	-	56	Anon 1996c	Post-emergence
	Belgium	GR	-	-------------	3-5	--------	-	56	Anon 1996c	Post-emergence
	Denmark	EC	-	--------------	0.96	--------	-	56	Anon 1996c	Post-emergence
	Denmark	EC	-	-------------	3.8	--------	-	56	Anon 1996c	Pre-planting
	Denmark	EC	-	-------------	4	--------	-	70	Anon 1996c	Pre-planting
	France	GR	-	soil treatment	6	--------	-	15	Anon 1996c	
	France	EC	-	soil treatment	0.6-6	--------	-	15	Anon 1996c	
	France	----	-	soil treatment	6	--------	-	15	Anon 1996c	
	Germany	EC	-	furrow treatment	1.4	--------	-	28	Anon 1996c	
	Germany	GR	-	seed bed treatment	0.02 g ai/ plant	--------	-		Anon 1996c	
	Germany	GR	-	single plant treatment	0.1 g ai/ plant	--------			Anon 1996c	
	Germany	GR	-	row treatment	2	--------	-		Anon 1996c	
	Germany	GR	-	incorporation before sowing	0.1 kg^2 soil	--------	-		Anon 1996c	
, Chinese	Germany	GR	F	Spreading	0.1 kg^2 soil	--------	1	pre-planting	Anon 1996d	Soil treatment spreading and mixing
, Chinese	Germany	GR	F	Spreading	0.1 g ai/ plant	--------	1	5-6 days after planting	Anon 1996d	Treatment of single plants
, Chinese	Germany	GR	F	Spreading	2 g ai/100 plants	--------	1		Anon 1996d	Nursery bed seedbed spreading with rain
, Chinese	Germany	GR	F	Spreading	2 kg/ha	--------	1	5-6 days after planting	Anon 1996d	Row treatment
, red	Germany	GR	F	Spreading	100 g/m^2	--------	1	pre-planting	Anon 1996d	Soil treatment spreading and mixing
, red	Germany	GR	F	Spreading	0.1 g/plant	--------	1	5-6 days after planting	Anon 1996d	Treatment of single plants
, red	Germany	GR	F	Spreading	24 g/100 plants	--------	1		Anon 1996d	Nursery bed seedbed spreading with rain
, red	Germany	GR	F	Spreading	2 kg/ha	--------	1	5-6 days after planting	Anon 1996d	Row treatment
, Savoy	Germany	GR	F	Spreading	100 g^2	-------	1	pre-planting	Anon 1996d	Soil treatment spreading and mixing
, Savoy	Germany	GR	F	Spreading	0.1 g/plant	--------	1	5-6 days after planting	Anon 1996d	Treatment of single plants
, Savoy	Germany	GR	F	Spreading	2 g/100 plants	--------	1		Anon 1996d	Nursery bed seedbed

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
										spreading with rain
, Savoy	Germany	GR	F	Spreading	2 kg/ha	--------	1	5-6 days after planting	Anon 1996d	Row treatment
, white	Germany	GR	F	Spreading	100 g/m^2	-------	1	pre-planting	Anon 1996d	Soil treatment spreading and mixing
, white	Germany	GR	F	Spreading	0.1 g/plant	------------	1	5-6 days after planting	Anon 1996d	Treatment of single plants
, white	Germany	GR	F	Spreading	2 g/100 plants	--------	1	--------	Anon 1996d	Nursery bed seedbed spreading with rain
, white	Germany	GR	F	Spreading	2 kg/ha	--------	1	5-6 days after planting	Anon 1996d	Row treatment
	Ireland	GR	-	----------------	2.25	--------	---	21	Anon 1996c	at planting
	Ireland	EC	-	----------------	2.4	--------	---	21	Anon 1996c	
	Italy	GR	-	---------------	2-3	--------	---	30	Anon 1996c	at transplanting
	Italy	EC	-	foliar applied	----------	0.0438-0.0614	---	30	Anon 1996c	
	Italy	WP	-	foliar applied	----------	0.0625-0.075	---	30	Anon 1996c	
	Italy	GR	-	broadcast	0.018-0.023	------------	---	30	Anon 1996c	
	Italy	EC	-	foliar applied	---------	0.05-0.0583	---	30	Anon 1996c	
	Japan	DP	-	foliar applied	0.6-0.9	------------	4	14	Anon 1996c	
	Japan	EC	-	foliar applied	----------	0.024-0.048	---		Anon 1996c	
	Netherlands	GR	-	----------------	0.075 g/plant	--------	---	60	Anon 1996c	at planting
, Chinese , Oxhead , Red , Savoy , White	Netherlands	WP /EC/ GR	F	Spraying/granular application onto plant beds	3.84-4.0[1]	0.0768-0.08	1	60 before sowing	Olthof 1996	Soil application
, Chinese , Oxhead , Red , Savoy , White	Netherlands	WP /EC/ GR	F	Spraying/granular application onto "production fields"	1-3.75	0.05 g (WP & EC) and 0.75 g (Gr) ai/plant	1	60	Olthof 1996	At planting or after cabbage fly eggs have set
	Sweden	GR	-	---	0.8-1.0 and 2	------	---	at planting	Anon 1996c	
	Sweden	GR	-	---------	1-1.5	------	---	at drilling	Anon 1996c	
	Sweden	GR	-	---	1.5-2	------	---	before drilling	Anon 1996c	
	Sweden	GR	-	---	1.5-2	------	---	at planting	Anon 1996c	
	Switzerland	EC	-	----	15 g/plant[3]	------	---	21	Anon 1996c	Treatment during vegetation period
	Switzerland	WG	-	---	0.025 g/plant	------	---	21	Anon 1996c	After planting
	UK	GR	-	---------	2.25	------	1	21	Anon 1996c	At planting

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
	UK	EC	-	---	4.7	------	2	21	Anon 1996c	Pre-emergence
	UK	EC	-	---	2.4	------	2	21	Anon 1996c	Post-emergence
	UK	EC	F	Seed bed spray	1.34[1]	0.268-0.446	1	pre-emergence	Anon 1996e	Applied immediately after drilling
	UK	EC	F	Overall soil incorporated spray	2.35[1]	0.47-0.78	1	21 pre-planting	Anon 1996e	
	UK	EC	F	Soil drench to base of plant	---------	0.0044	1	21 Post-emergence	Anon 1996e	Applied April or within 4 days of transplanting if this is later
	UK	GR	F	Sub-surface band	4.5	-----------	1	21 Pre- and post-emergence	Anon 1996e	Plants or seed placed into line of granules at drilling or transplanting
	UK	GR	F	Incorporated into peat blocks	--------	50 g ai/640 litre peat	1	21 pre-planting	Anon 1996e	To protect seedlings before planting out
Carrots	Belgium	GR	-	---	3-5	-----	---	pre-planting	Anon 1996c	
	Belgium	EC	-	---	3-5	-----	---	pre-planting	Anon 1996c	
	Denmark	GR	-	---	4	-----	---	84	Anon 1996c	Pre-planting
	Denmark	EC	-	---	4	-----	---		Anon 1996c	Pre-planting
	France	----	-	soil treatment	5	-----	---	15	Anon 1996c	
	France	GR	-	soil treatment	5	-----	---	15	Anon 1996c	
	France	EC	-	soil treatment	0.6-5	-----	---	15	Anon 1996c	
	Germany	GR	-	incorporated by sowing	5	-----	---		Anon 1996c	
	Germany	GR	-	---	5	-----	---		Anon 1996c	Post-emergence
	Germany	EC	-	In furrow	1.44	-----	---		Anon 1996c	
	Germany	GR	-	Incorporation before sowing	5	-----	---		Anon 1996c	
	Germany	GR	F	Spreading	---	----	1		Anon 1996d	Post-emergence, at planting, after planting and Before sowing
	Ireland	GR	-	---	2.25 or 4.5	-----	---	21	Anon 1996c	Before drilling
	Ireland	EC	-	---	5	-----	---	21	Anon 1996c	Pre-emergence
	Ireland	EC	-	---	2.4	-----	---	21	Anon 1996c	Post-emergence
	Italy	GR	-	broadcast	0.0018-0.0023	-----	---	30	Anon 1996c	
	Italy	EC	-	foliar	---	0.05-0.0583	---	30	Anon 1996c	

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
	Italy	WP	-	foliar	---	0.04-0.05	---	30	Anon 1996c	
	Italy	EC	-	foliar	---	0.0351-0.0438	---	30	Anon 1996c	
	Italy	GR	-		2-3	----	---	30	Anon 1996c	Pre-sowing, pre-transplanting
	Luxembourg	EC	-		4	-----	---		Anon 1996c	Pre-planting
	Netherlands	GR	-	In furrow	2	-----	---	60	Anon 1996c	
	Netherlands	WP	-	seed treatment	25 g ai/kg seed	-----	---	60	Anon 1996c	
	Netherlands	EC	-	-------	3-4	-----	---	60	Anon 1996c	Pre-planting
	Netherlands	WP	-	-------	3-4	-----	---	60	Anon 1996c	Post-emergence
	Netherlands	WP	-	---	3-4	-----	---	60	Anon 1996c	Pre-planting
	Netherlands	EC	-	-------	3-4	-----	---	60	Anon 1996c	Post-emergence
	Netherlands	GR	-	-------	3-4	-----	---	60	Anon 1996c	Broadcast
	Netherlands	WP/ EC/ GR	F	Broadcast spraying or granular application followed by incorporation into 5-7 cm of soil	3.84-4.0[1]	0.5-1.92	1	60 (before sowing)	Olthof 1996	Lower dosages (2.88-4 kg ai/ha) for soils with low organic matter (<3%)
	Netherlands	WP/ EC	F	soil treatment by spraying	3.84-4.0	0.5-1.92	1	60 (post - emergence at 2-leaf stage)	Olthof 1996	Lower dosages (2.8-4 kg ai/ha) for soils with low organic matter (<3%)
	Netherlands	WP	F	seed treatment	25 g ai per kg seed	---	1	---	Olthof 1996	
, winter	Netherlands	GR	F	Granular application in furrow	2.0	-----	---	60	Olthof 1996	
	Switzerland	WG	-	-------	max 0.4	-----	1	56	Anon 1996c	Treatment at vegetation period every two years
	Switzerland	WG	-	-------	max 0.6	-----	1	56	Anon 1996c	Treatment at vegetation period every two years
	UK	EC	-	---	5	-----	3	21	Anon 1996c	Pre-emergence
	UK	EC	-	---	2.4	-----	3	21	Anon 1996c	Post-emergence
	UK	GR	-	---	2.25 or 4.5	-----	1	21	Anon 1996c	Before drilling
	UK	EC	F	Overall and soil incorporated spray	2.35 (mineral soils) 4.7 (organic soils)	0.235-0.94 or 0.47-1.88	1	---	Anon 1996e	Pre-planting
	UK	EC	F	Overall spray	2.35	0.235-0.39	1-2	21	Anon	Post-

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
									1996e	emergence^2
	UK	GR	F	Broadcast incorporated	2.25 (mineral soils), 4.5 (organic soils)	----	1	21	Anon 1996e	Pre-planting
Cauliflower	Germany	GR	F	Soil treatment spreading and mixing	100 g/m^2	----	1		Anon 1996d	Pre-planting
	Germany	GR	F	Spreading	0.1 g/plant	-----	1	5-6 days after planting	Anon 1996d	Treatment of single plants
	Germany	GR	F	Spreading	2 g/100 plants	-----	1	---	Anon 1996d	Nursery bed seedbed spreading with rain
	Germany	GR	F	Spreading	2 kg/ha	-----	1	5-6 days after planting	Anon 1996d	Row treatment
	Ireland	GR	-	------	2.25	-----	---	21	Anon 1996c	
	Ireland	EC	-	-------	2.4	---	---	21	Anon 1996c	
	Netherlands	GR	-	---	0.075 g ai/plant	-----	---	60	Anon 1996c	At planting
	Netherlands	WP /EC/ GR	F	Spraying/granular application onto plant beds	3.84-4.0^1	0.0768-0.08	1	60 before sowing	Olthof 1996	Soil application
	Netherlands	WP /EC/ GR	F	Spraying/granular application onto "production fields"	1-3.75	0.05 g (WP & EC) and 0.75 g (Gr) ai/plant	1	60	Olthof 1996	At planting or after cabbage fly eggs have set
	UK	EC	-	-------	5	-----	2	21	Anon 1996c	Pre-emergence
	UK	GR	-	-------	2.25	-----	1	21	Anon 1996c	At planting
	UK	EC	-	---	2.4	-----	2	21	Anon 1996c	Post-emergence
	UK	EC	F	Seed bed spray	1.34	0.268-0.446	1	pre-emergence	Anon 1996e	Applied immediately after drilling
	UK	EC	F	Overall soil incorporated spray	2.35	0.47-0.78	1	21	Anon 1996e	Pre-planting
	UK	EC	F	Soil drench to base of plant	---	0.0044	1	21	Anon 1996e	Applied post-emergence in April or within 4 days of transplanting if this is later
	UK	GR	F	Sub-surface band	4.5	----	1	21	Anon 1996e	Plants or seed placed into line of granules at drilling or transplanting
	UK	GR	F	Incorporated into peat blocks	------	50 g ai/640 litre peat	1	21	Anon 1996e	To protect seedlings before planting out
Celeriac	Netherlands	WP/ EC/ GR	F	Spraying or granular application	3.84-4.0	0.5-1.92	1	---	Olthof 1996	Broadcast; incorporation before sowing
	UK	EC	F	Overall spray	2.35	0.39-0.78	1	21	Anon	Pre-planting

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
									1996e	
	UK	GR	F	Broadcast incorporated	2.25 (mineral soils) 4.5 (organic soils)	---	1	---	Anon 1996e	Pre-planting
Celery, leaf and blanched	Netherlands	WP/ EC	F	Spraying directly to soil followed by incorporation before sowing	3.84-4.0	0.5-1.92	1	---	Olthof 1996	
Cucumber	Germany	GR	F	Spreading	---	3 kg ai/ha	1	---	Anon 1996d	At planting, after planting, before sowing
Fennel Bulb	Netherlands	WP/ EC	F	Spraying soil treatment	3.84-4.0	0.5-1.92	1	---	Olthof 1996	Incorp. at sowing
Horseradish	UK	EC	F	Overall and soil incorporated spray	2.35 (mineral soils) 4.7 (organic soils)	0.235-0.94 or 0.47-1.88	1	---	Anon 1996e	Pre-planting
	UK	EC	F	Overall spray	2.35	0.235-0.39	1-2	21	Anon 1996e	Post-emergence[2]
	UK	GR	F	Broadcast incorporated	2.25 (mineral soils), 4.5 (organic soils)	----	1	21	Anon 1996e	Pre-planting
Kale	Germany	GR	F	Soil treatment spreading and mixing	100 g/m^2	----	1	---	Anon 1996d	Pre-planting
	Germany	GR	F	Spreading	0.1 g/ plant	-----	1	5-6 days after planting	Anon 1996d	Treatment of single plants
	Germany	GR	F	Spreading	2 g/100 plants	-----	1	---	Anon 1996d	Nursery bed seedbed spreading with rain
	Germany	GR	F	Spreading	2 kg/ha	-----	1	5-6 days after planting	Anon 1996d	Row treatment
	Netherlands	WP/ EC/ GR	F	Spraying or granular application to soil. Incorporation before sowing	3.84-4.0	0.0768-0.08	1	60	Olthof 1996	Application on plant beds
	Netherlands	WP /EC/ GR	F	Spraying/granular application onto "production fields"	1-3.75	0.05 g (WP & EC) and 0.75 g (Gr) ai/plant	1	60	Olthof 1996	At planting or after cabbage fly eggs have set
	Portugal	24% EC	-	-------	100 ml/30-50l water	-----	---	42	Anon 1996c	Pre-emergence
	Spain	EC	-	-------	2	-----	---	30	Anon 1996c	Pre-planting
	Spain	EC	-	Spray	2	-----	---	30	Anon 1996c	
	Spain	GR	-	Broadcast	2-3	-----	---	30	Anon 1996c	
Kohlrabi	Germany	GR	F	Soil treatment spreading and mixing	100 g/m^2	----	1	---	Anon 1996d	Pre-planting
	Germany	GR	F	Spreading	0.1 g/plant	-----	1	5-6 days after planting	Anon 1996d	Treatment of single plants
	Germany	GR	F	Spreading	2 g/100	-----	1	---	Anon	Nursery bed

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
					plants				1996d	seedbed spreading with rain
	Germany	GR	F	Spreading	2 kg/ha	-----	1	5-6 days after planting	Anon 1996d	Row treatment
	Netherlands	WP /EC/ GR	F	Spraying/granular application onto plant beds	3.84-4.0[1]	0.0768-0.08	1	60 before sowing	Olthof 1996	Soil application
	Netherlands	WP /EC/ GR	F	Spraying/granular application onto “production fields”	1-3.75	0.05 g (WP & EC) and 0.75 g (Gr) ai/plant	1	60	Olthof 1996	At planting or after cabbage fly eggs have set
	UK	EC	F	Overall spray at pre-planting or root dip at transplanting	2.35	0.39-0.78	1	21	Anon 1996e	
Leek	Germany	EC	F	Spraying	0.144	0.024	1	28	Anon 1996d	At infestation
	Netherlands	WP/ EC/ GR	F	Spraying or granular soil treatment.	5.76-6.0	0.75-2.88	1	60	Olthof 1996	Incorp. before sowing
Mooli	UK	GR	F	Broadcast incorporated	2.0	----	1	---	Anon 1996e	pre-planting
Mushroom	UK	EC		Compost incorporated spray before spawning (inside)	------	72 4 g ai per tonne compost	1	---	Anon 1996e	Maximum of one treatment per spawning
	UK	EC		Casing incorporated spray before adding to bed (inside)	---	54 g ai per tonne casing	1	---	Anon 1996e	Maximum of one treatment per spawning
	UK	GR		Compost incorporated (inside)	------	110 g ai per tonne compost	1	21	Anon 1996e	At spawning
	UK	GR		Casing incorporated before adding to bed (inside)	---	50 g ai per tonne casing	1	21	Anon 1996e	At spawning
, edible fungi other than mushrooms	UK	EC	F	Compost incorporated spray before spawning	------	72 g ai per tonne compost	1	---	Anon 1996e	Maximum of one treatment per spawning
	UK	EC		Casing incorporated spray before adding to bed (inside)	---	54 g ai per tonne casing	1	---	Anon 1996e	Maximum of one treatment per spawning
	UK	GR		Compost incorporated (inside)	------	110 g ai per tonne compost	1	21	Anon 1996e	At spawning
	UK	GR		Casing incorporated before adding to bed (inside)	---	50 g ai per tonne casing	1	21	Anon 1996e	At spawning
Onion	Belgium	EC	-	------	3-5	-----	---	---	Anon 1996c	Pre-planting
	Belgium	GR	-	------	3-5	-----	---	---	Anon 1996c	Pre-planting
	Denmark	GR	-	-------	4	-----	---	35	Anon 1996c	Pre-planting
	Denmark	EC	-	-------	1	-----	---	56	Anon 1996c	Post-emergence

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
	France	GR	-	Soil treatment	5	-----	---	15	Anon 1996c	
	France	EC	-	Soil treatment	0.6-5	-----	---	15	Anon 1996c	
	France	---	-	Soil treatment	5	-----	---	15	Anon 1996c	
	Germany	GR	-	Incorporated by sowing	5	-----	---	---	Anon 1996c	
	Germany	EC	-	In furrow	1.4	-----	---	---	Anon 1996c	
	Germany	GR	-	Incorporation before sowing	5	-----	---	---	Anon 1996c	
	Germany	GR	--	---	5	-----	---	---	Anon 1996c	Post-emergence
	Germany	GR	F	Spreading	5 kg ai/ha	----	1	---	Anon 1996d	At planting, after planting, before sowing, post emergence
	Japan	DP	-	Broadcast	0.6-13.5	-----	---		Anon 1996c	
	Japan	EC	-	Foliar	---	0.024-0.032	---	7	Anon 1996c	
	Luxembourg	EC	-		4.8	-----	---		Anon 1996c	Pre-planting
	Netherlands	GR	-	In furrow	1.2	-----	---	60	Anon 1996c	
	Netherlands	WP	-	-------	6	-----	---	60	Anon 1996c	Pre-planting
	Netherlands	EC	-	---	6	-----	---	60	Anon 1996c	Pre-planting
	Netherlands	GR	-	Broadcast	6	-----	---	60	Anon 1996c	
, Bulb, Silverskin	Netherlands	WP/ EC/ GR	F	Spraying or granular broadcast soil application	5.76-6.0	0.75-2.88	1	---	Olthof 1996	Incorp. before sowing
, Bulb, Silverskin	Netherlands	GR	F	Granular application	1.2	----	1	---	Olthof 1996	Incorp. at sowing
	Sweden	GR	-	------	0.8-1	-----	---	---	Anon 1996c	Post-emergence
	Sweden	GR	-	---	1	-----	---	---	Anon 1996c	At planting
	Switzerland	WG	-	---	1-2 g ai/m soil	-----		21	Anon 1996c	Post-emergence. One treatment every two years
	Switzerland	EC	-	-------	37.5 ml ai/m	-----		21	Anon 1996c	Treatment at vegetation period
Parsley	Netherlands	WP	F	Spraying	3.84-4.0	0.4-1.92	1	---	Olthof 1996	Soil incorporation directly after treatment
	Netherlands	EC	F	Spraying	3.84-4.0	0.4-1.92	1	---	Olthof 1996	Soil incorporation directly after treatment
	Netherlands	WP	F	Spraying	3.84-4.0	0.5-1.92	1	---	Olthof 1996	Soil incorporation at sowing

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
	Netherlands	EC	F	Spraying	3.84-4.0	0.5-1.92	1	---	Olthof 1996	Soil incorporation at sowing
	UK	EC	F	Overall and soil incorporated spray	2.35 (mineral soils) 4.7 (organic soils)	0.235-0.94 or 0.47-1.88	1	---	Anon 1996e	Pre-planting
	UK	EC	F	Overall spray	2.35	0.235-0.39	1-2	21	Anon 1996e	Post-emergence[2]
Parsnip	Netherlands	WP	F	Spraying	3.84-4.0	0.4-1.92	1	---	Olthof 1996	Soil incorporation directly after treatment
	Netherlands	EC	F	Spraying	3.84-4.0	0.4-1.92	1	---	Olthof 1996	Soil incorporation directly after treatment
	UK	EC	F	Overall and soil incorporated spray	2.35 (mineral soils)4.7 (organic soils)	0.235-0.94 or 0.47-1.88	1	---	Anon 1996e	Pre-planting
	UK	EC	F	Overall spray	2.35	0.235-0.39	1-2	21	Anon 1996e	Post-emergence[2]
	UK	GR	F	Broadcast incorporated	2.25 (mineral soils), 4.5 (organic soils)	----	1	21	Anon 1996e	Pre-planting
Potato, seed, starch, ware	Netherlands	WP/ EC	F	Spraying of aerial parts	0.120-0.125	0.0208-0.06	1	14	Olthof 1996	At larvae infestation
	Poland	44% EC	F	High volume spray	220-330 ml/ha	---	1-2	14	Anon 1996a	
Radish, long	Germany	GR	F / G	Spreading	3 kg/ha (field) 4 kg/ha (glass)	-----	1	---	Anon 1996d	Before sowing and below/after planting
, small	Germany	GR	F / G	Spreading	3 kg/ha (field) 4 kg/ha (glass)	-----	1	---	Anon 1996d	
	Netherlands	WP/ EC/ GR	F	Soil incorporation before sowing	2.88-3.0	0.375-1.44	1	---	Olthof 1996	
, black	Netherlands	WP/ EC/ GR	F	Soil incorporation before sowing	2.88-3.0	0.375-1.44	1	---	Olthof 1996	
	UK	EC	F	Overall and incorporated spray	2.35	0.47-0.94	1	21	Anon 1996e	Pre-planting
Salsify	UK	EC	F	Overall and soil incorporated spray	2.35 (mineral soils) 4.7 (organic soils)	0.235-0.94 or 0.47-1.88	1	---	Anon 1996e	Pre-planting
	UK	EC	F	Overall spray	2.35	0.235-0.39	1-2	21	Anon 1996e	Post-emergence[2]
	UK	GR	F	Broadcast incorporated	2.25 (mineral soils), 4.5 (organic	----	1	21	Anon 1996e	Pre-planting

Commodity	Country	Form.	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate kg ai/ha	Spray conc, kg ai/hl	No.			
					soils)					
Shallots	Netherlands	WP/ EC/ GR	F	Spraying or granular broadcast application of soil	5.76-6.0	0.75-2.88	1	---	Olthof 1996	Before sowing
	Netherlands	GR	F	Granular application of soil in furrow	1.2	----	1	---	Olthof 1996	Incorp. before sowing
Swede	Netherlands	WP/ EC/ GR	F	Soil treatment followed by incorporation	2.88-3.0	0.375-1.44	1	---	Olthof 1996	Before sowing
	UK	EC	F	Overall soil incorporated spray	2.35	0.47-0.78	1	---	Anon 1996e	Applied immediately before drilling
	UK	EC	F	Band spray in furrow	2.35	----	---		Anon 1996e	Pre-emergence
	UK	EC	F	Overall post-emergence spray	0.72	0.12	2	21	Anon 1996e	1st application July/August, 2nd application 14 days later
	UK	GR	F	Band application incorporated	4.5	----	1	21	Anon 1996e	Post and pre-emergence
Turnip	Netherlands	WP/ EC/ GR	F	Soil treatment followed by incorporation	2.88-3.0	0.375-1.44	1	---	Olthof 1996	
	UK	EC	F	Overall soil incorporated spray	2.35	0.47-0.78	1		Anon 1996e	Applied immediately before drilling
	UK	EC	F	Band spray in furrow	2.35	----	---		Anon 1996e	Pre-emergence
	UK	EC	F	Overall spray in furrow	0.72	0.12	2	21 (pre-emergence)	Anon 1996e	1st application July/August, 2nd application 14 days later
	UK	GR	F	Band application in furrow incorporated	4.5	----	1	21 (pre-emergence)	Anon 1996e	

F = Field G = Glasshouse

[1] Application rate calculated from estimated l/ha
[2] Calculated from 0.05 g/plant
[3] For lifting October/November apply 1st week August, for lifting December or later apply 1st week August and repeat 4-6 weeks later (according to advice or pest level)
[4] Application rate appears high but is as stated by the manufacturer

Table 17. Registered uses of chlorfenvinphos on oilseeds and cereals.

Commodity	Country	Form	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate, kg ai/ha	Spray conc, kg ai/hl	No.			
Maize	Netherlands	WP or EC	F	Spraying of aerial parts at infestation	0.48-0.50	0.08-0.24	1	42 For cutting maize.	Olthof 1996	Application if and when the attack is expected in the 2-3 leaf stage of the crop.
, regrowth of potatoes in maize crop	Netherlands	WP or EC	F	Spraying of aerial parts at infestation	0.120-0.125	0.02-0.06	1	42 For cutting maize	Olthof 1996	Application if larvae of the Colorado beetle have the size of a wheat grain
Rape seed	Austria	EC	-	----------------	0.15	-----------	---	21	Anon 1996c	Treatment when pests occur
	Germany	EC	-	----------------	0.14	------------	---	56	Anon 1996c	Treatment at infestation
	Germany	EC	F	Spraying	0.144	0.024	1	56	Anon 1996d	Treatment at infestation
	Netherlands	GR	-	Broadcast	3	------------	---	60	Anon 1996c	
, winter	Poland	44% EC	F	High volume spray	440 ml/ha	----------	1	35	Anon 1996a	Pest, ceutor-rhynchid beetle
	Poland	44% EC	F	High volume spray	330-400 ml/ha	----------	1	35	Anon 1996a	Pest, Pollen beetle
Rye and triticale	UK	EC	F	Overall soil incorporated spray	1.34	0.39-0.59	1	21[1]	Anon 1996e	Pre-planting
	UK	EC	F	Overall spray	1.01	0.29-0.44	1	21[1]	Anon 1996e	Autumn application after planting
	UK	EC	F	Overall spray	0.67 or 1.34 on organic soils	0.19-0.27 or 0.39-0.59	1	21[1]	Anon 1996e	Application at egg hatch of pest normally Jan/Feb
	UK	EC	F	Conventional seed treatment machine	---------	966 g ai /tonne seed	1		Anon 1996e	Pre-planting
Wheat ...., winter	UK	EC	F	Overall soil incorporated spray	1.34	0.39-0.59	1	21[1]	Anon 1996e	Pre-planting
...., winter	UK	EC	F	Overall spray	1.01	0.29-0.44	1	21[1]	Anon 1996e	Autumn application after planting
...., winter	UK	EC	F	Overall spray	0.67 or 1.34 on organic soils	0.19-0.27 or 0.39-0.59	1	21[1]	Anon 1996e	Application at egg hatch of pest normally Jan/Feb
...., winter	UK	LS	F	Conventional seed treatment machine	966 g ai/tonne seed		1	----------	Anon 1996e	
, durum	UK	EC	F	Overall soil incorporated spray	1.34	0.39-0.59	1	21[1]	Anon 1996e	Pre-planting
, durum	UK	EC	F	Overall spray	1.01	0.29-0.44	1	21[1]	Anon 1996e	Autumn application after

Commodity	Country	Form	F or G	Application				PHI, days	Ref.	Remarks
				Method	Rate, kg ai/ha	Spray conc, kg ai/hl	No.			
										planting
, durum	UK	EC	F	Overall spray	0.67 or 1.34 on organic soils	0.19-0.27 or 0.39-0.59	1	21[1]	Anon 1996e	Application at egg hatch of pest normally Jan/Feb
, durum	UK	EC	F	Conventional seed treatment machine	---------	966 g ai /tonne seed	1	----------	Anon 1996e	

[1] This 21-day interval which is currently stated on the UK notices of approval for use on winter wheat is shorter than that required in practice. The latest time of application in wheat would be March and the earliest time of harvest July

Table 18. Registered topical uses of chlorfenvinphos on livestock in Australia.

Animal	Application				Ref.	Remarks
	Form.	Method	Spray or dip conc, kg ai/hl	No.		
Cattle (cattle ticks, buffalo fly and lice), Horses, deer, goats, sheep and dogs may also be treated	138 g/l liquid	Plunge dip or spray	0.0552	Used at 19-21 day intervals	Anon 1996b	Treat in early Autumn when infestations first occur

The use of chlorfenvinphos on roses in The Netherlands was also reported (Olthof, 1996).

RESIDUES RESULTING FROM SUPERVISED TRIALS

The results of the residue trials are given in Tables 19-39. They were carried out under field conditions and reported in sufficient detail with acceptable analytical information unless otherwise indicated. Where analytical recoveries were outside the range 70-120% and/or where samples were stored for longer than 6 months or for an unspecified time this is indicated in a footnote. Analytical results have generally been rounded to one significant figure for residues below 0.1 mg/kg. Data in the JMPR format were submitted by the manufacturer only for carrots (some results), onions, kale, cabbage, cauliflower and rape seed.

Many of the trials were very old with reports which lacked details such as the method of analysis, duration of sample storage, recovery data and plot size.

The trials which were considered unsatisfactory have been identified by shading in the Tables. The acceptability of the results of some other trials in which the duration of sample storage was not reported will depend on the future availability of satisfactory data on the stability of residues in representative stored samples.

In most of the trials the samples were analysed for 1-(2,4-dichlorophenyl)ethanol, identified in the Tables as “met”. Several of the trials also included analyses for 2,4-dichlorophenacyl chloride and 2,4-dichoroacetophenone, but the residues were below the LODs of 0.02 mg/kg and 0.05 mg/kg respectively in all the analysed samples. Residues discussed in the text are parent chlorfenvinphos unless otherwise indicated.

Where residues of the (*E*)- and (*Z*)- isomers were originally reported separately their sum is given in the Tables. The limit of determination of the individual isomers reported in the studies was generally 0.01 mg/kg.

Leeks. GAP for leeks was reported for Germany and The Netherlands. The maximum application rates were 0.144 kg ai/ha at infestation and 6 kg ai/ha pre-sowing, with PHIs of 28 and 60 days respectively.

One trial was available from Germany. It was poorly reported and did not reflect the reported GAP.

Table 19. A supervised field trial on leeks in Germany (undated).[1]

Application				PHI, days	Portion analysed	Residues, mg/kg Parent Met	Ref.
Form.	No.	kg ai/ha	kg ai/hl				
GR	1	3	-	150	stem	ND ND	CH-601-001

[1] No detailed study report; only very brief details of the trial and analysis were available.
Met = 1-(2,4-dichlorophenyl)ethanol

Onions. GAP was reported for a number of countries. The maximum application rates were 1-13.5 kg ai/ha with PHIs between 7 and 60 days or as governed by pre-planting, pre-sowing or post-emergence treatments.

Residue trials on bulb onions were reported from Canada, France, Germany, Japan, Switzerland, Spain, the USA and the UK, as well as one trial on spring onions from The Netherlands. The application rates in four French trials with residues of <0.02 mg/kg were comparable with the granular application rates in France, but a PHI of 15 days was reported by the manufacturer as French GAP whereas the PHIs in the trials were 133-182 days. One German trial (CH-722-007), with a PHI of 175 days, was comparable with the Belgian and Netherlands GAP for pre-planting spray treatment. The residues were <0.02 mg/kg after 175 days. A further five German trials with granules were considered to accord with pre-planting GAP in Belgium, Denmark, Germany and The Netherlands. All showed residues below the LOD (<0.02 mg/kg). Two replicated Japanese trials reflected Japanese foliar GAP (which has a low application rate) with residues of <0.02 mg/kg 7-8 days after treatment. The only measurable residues of the parent reported were at the higher application rates of 4.8 kg ai/ha in a German spray trial (0.04 mg/kg, 60-day PHI) and 4.48 kg ai/ha in a UK trial (0.07 mg/kg, PHI 61 days) which was poorly reported with no detailed study report. These PHIs imply that the crops were immature and hence that the trials were not comparable with any reported GAP.

Table 20. Supervised field trials on bulb and spring onions. Bulbs analysed.

Location, Country, year	Application				PHI, days	Residues, mg/kg Parent	Met	Reference
	Form	No.	kg ai/ha	kg ai/hl				
Bulb onions								
Guelph Canada 1969[1]	GR	1	1.1	-	154	<0.02 <0.02 <0.02 <0.02 <0.02 <0.02 <0.02 <0.02	----- ----- ----- ----- ----- ----- ----- -----	CH-722 -002

Location, Country, year	Application				PHI, days	Residues, mg/kg		Reference
	Form	No.	kg ai/ha	kg ai/hl		Parent	Met	
Althen les Paluds S. France 1969[1]	GR	1	5	-	182	<0.02	-----	CH-722-003
	GR	1	5	-	182	<0.02	-----	
	GR	1	6	-	182	<0.02	-----	
Le Thor S. France 1969[1]	GR	1	5	-	168	<0.02	-----	CH-722-003
	GR	1	5	-	168	<0.02	-----	
	GR	1	6	-	168	<0.02	-----	
	GR	1	5	-	154	<0.02	-----	
	GR	1	5	-	154	<0.02	-----	
	GR	1	5	-	154	<0.02	-----	
	GR	1	6	-	154	<0.02	-----	
Le Thor S. France 1971[1]	GR	1	4	-	133	<0.02	<0.02	CH-790-029
	GR	1	8	-	133	<0.02	<0.02	
Le Thor S. France 1972[1]	GR	2	4	-	175	<0.02	<0.02	CH-790-031
	GR	2	8	-	175	<0.02	<0.02	
Baden Germany 1973[1]	EC	1	4.8	-	60	0.04	<0.02	CH-722-007
München Germany 1973[1]	EC	1	4.8	-	56 74	<0.02 <0.02	----- <0.02	CH-722-007
Frankfurt Germany 1973[1]	EC	1	4.8	-	49 70 175	0.39 0.08 ≤0.02	----- ----- <0.02a	CH-722-007
Baden Germany 1973[1]	WP	1	seed treatment 25 g ai/kg seed	-	42 56	<0.02 <0.02	----- <0.02	CH-722-008
Freising Germany 1973[1]	WP	1	seed treatment 25 g ai/kg seed	-	49 77 126	<0.02 <0.02 <0.02	----- ----- <0.02	CH-722-008
Fischenich Germany 1973[1]	WP	1	seed treatment 25 g ai/kg seed	-	91 112 133 161	<0.02 <0.02 <0.02 <0.02	----- ----- ----- <0.02	CH-722-008
Baden Germany 1973[1]	GR	1	5	-	42 60	0.70 <0.02b	----- <0.02	CH-722-009
Frankfurt Germany 1973[1]	GR	1	5	-	49 70 175	1.37 0.21 ≤0.02	----- ----- <0.02b	CH-722-009
Freising Germany 1973[1]	GR	1	5	-	49 77 147	0.72 <0.02 ≤0.02	----- ----- <0.02b	CH-722-009
Frankfurt Germany[1]	GR	1	5.0	-	86 100	<0.02 <0.02	----- -----	CH-722-013

Location, Country, year	Application				PHI, days	Residues, mg/kg		Reference
	Form	No.	kg ai/ha	kg ai/hl		Parent	Met	
					114	<0.02b	-----	
Bonn Bad Godesberg Germany[1]	GR	1	5.0	-	35	<0.02	-----	CH-722 -013
					69	<0.02	-----	
					83	<0.02b	-----	
Bad Segeberg Germany[1]	GR	1	5.0	-	55	<0.02	-----	CH-722 -013
					69	<0.02	-----	
					83	<0.02b	-----	
Germany 1965[1]	GR	1	3	-	120	<0.02	-----	CH-722-001
Chuo Japan 1972[1]	EC	5	0.32	0.032	8	<0.02	<0.02c	CH-722 -005
					8	<0.02	<0.02c	
					14	<0.02	<0.02	
					14	<0.02	<0.02c	
	EC	9	0.32	0.032	8	<0.02	<0.02c	
					8	<0.02	<0.02c	
					14	<0.02	<0.02c	
					14	<0.02	<0.02c	
Kimitami Japan 1972[1]	EC	6	0.32	0.032	7	<0.02	<0.02c	CH-722 -005
					7	<0.02	<0.02c	
					14	<0.02	<0.02c	
					14	<0.02	<0.02c	
	EC	9	0.32	0.032	7	<0.02	<0.02c	
					7	<0.02	<0.02c	
					14	<0.02	<0.02c	
					14	<0.02	<0.02c	
Seville Spain 1971[1]	GR	1	2	-	133	<0.02	0.01	CH-722 -004
	GR	1	3	-	133	<0.02	0.02	
	GR	1	4	-	133	<0.02	0.03	
Seville Spain 1972[1]	GR	1	4	-	140	<0.02	<0.02	CH-722 -006
	GR	1	8	-	140	<0.02	<0.02	
Seville Spain 1973[1]	GR	1	4	-	140	<0.02	<0.02	CH-722 -010
	GR	2	8	-	140	<0.02	<0.02	
Seville Spain 1974[1]	GR	1	4	-	175	<0.02	-----	CH-722 -011
	GR	1	8	-	175	<0.02	-----	
	GR	1	4	-	175	<<0.02	-----	
	GR	1	8	-	175	<0.02	-----	
UK undated[2]	pure ai	1	4.48	- -	61	0.07	----	CH-601-001
USA undated[2]	GR	1	2.8	-	72	<0.05	----	CH-601-001
Switzerland undated[2]	EC	1	1	-	31	<0.02	----	CH-601-001

Spring onions								
Alkmaar Netherlands 1982[3]	GR	1	6	-	90	0.01 0.01 0.04 0.03 0.04	----- ----- ----- ----- -----	J. W. Dornseiffen 1985

Results underlined once or twice are considered comparable with

a - Belgian and Netherlands GAP for spray treatments

b - GAP in Belgium, Denmark, Germany and The Netherlands for pre-planting granular treatments

c - Japanese GAP for foliar treatments

Double underlined residues are from maximum GAP treatments and have been used for estimating the STMR

[1] Duration of sample storage unspecified

[2] No detailed study report; only very brief details of the trial and analysis were available

[3] Information is taken from residue trial summary sheets submitted by The Netherlands. Full study reports were submitted but were in Dutch

Met = 1-(2,4-dichlorophenyl)ethanol

Head cabbage. GAP was reported for Belgium, Denmark, France, Germany, Ireland, Italy, Japan, The Netherlands, Sweden, Switzerland, and the UK. The maximum application rates were 0.96-6 kg ai/ha with PHIs of 14-70 days or as governed by pre-planting or post-emergence treatment .

Residue trials were available from the UK, Germany, the USA and India. In 7 German trials complying with German GAP at 100 g/m^2 all residues were <0.02 mg/kg. In 6 more German trials reflecting German GAP for granular seedbed treatment (2 g/100 plants) residues were again all <0.02 mg/kg. Residues of 0.07 mg/kg and 0.02 mg/kg were found in two Indian trials in samples taken 17 and 11 days after treatment, but no Indian GAP was reported. One UK trial was considered comparable with the UK pre-emergence spray GAP, but it was poorly reported with few details. No trials were considered to comply with GAP for foliar treatments, which have shorter PHIs.

Table 21. Supervised field trials on head cabbages. Heads analysed.

Location, Country, year	Application				PHI, days	Residues, mg/kg		Ref.
	Form.	No.	kg ai/ha	kg ai/hl		Parent	Met	
Wellesbourne UK 1965[1]	EC	1	0.84	-	0 4 10 20	4.2 2.89 0.29 <0.02	----- ----- ----- -----	CH-640-002
Unknown UK undated[1]	GR	1	4.48	-	112	<0.05	----	CH-601-001
	GR	1	8.96	-	112	<0.05	----	
Unknown USA undated[1]	GR	1	0.52kg/1000 m row	-	77	<0.05	----	CH-601-001
Geisenheim Germany 1980[2]	GR	1	0.1kg/m^2	-	63 74 94	0.2 0.05 <0.02a	----- ----- -----	CH-721 -014
Bamberg Germany 1980[2]	GR	1	0.1kg/m^2	-	70 84 98	0.3 0.10 <0.02a	----- ----- -----	CH-721 -014
Frankfurt Germany 1980[2]	GR	1	0.1kg/m^2	-	70 84 98	0.4 0.2 <0.02a	----- ----- -----	CH-721 -014
Frankfurt Germany 1989[2]	GR	1	100g/m^2	-	144 180 190	<0.02 <0.02 <0.02a	----- ----- -----	CH-721 -018
	GR	1	2g/100 plants	-	144	<0.02	-----	

Location, Country, year	Application				PHI, days	Residues, mg/kg		Ref.
	Form.	No.	kg ai/ha	kg ai/hl		Parent	Met	
					180	<0.02	-----	
					190	≤0.02b	-----	
	EC	1	0.14	-	0	0.1	-----	
					16	<0.02	-----	
					21	<0.02	-----	
					28	<0.02	-----	
					35	<0.02	-----	
Bonn Germany 1989^2	GR	1	100g/m^2	-	82	<0.02	-----	CH-721 -018
					103	<0.02	-----	
					113	≤0.02a	-----	
	GR	1	2g/100 plants	-	70	<0.02	-----	
					86	<0.02	-----	
					96	≤0.02b	-----	
	GR	1	2g/100 plants	-	105	<0.02	-----	
					129	<0.02	-----	
					139	≤0.02b	-----	
	EC	1	0.14	-	0	1.0	-----	
					14	0.01	-----	
					21	<0.02	-----	
					28	<0.02	-----	
					35	<0.02	-----	
München Germany 1989^2	GR	1	100g/m^2	-	108	<0.02	-----	CH-721 -018
					126	<0.02	-----	
					136	≤0.02a	-----	
	EC	1	0.14	-	0	0.3	-----	
					14	<0.02	-----	
					21	<0.02	-----	
					28	<0.02	-----	
					35	<0.02	-----	
Hannover Germany 1989^2	GR	1	100g/m^2	-	107	<0.02	-----	CH-721 -018
					121	<0.02	-----	
					132	≤0.02a	-----	
Poona India 1974^2	EC	1	0.25	-	17	<0.02	-----	CH-721 -002
	EC	1	0.5	-	17	0.07	-----	
Holibazar India 1974^2	EC	3	0.25	-	11	<0.02	-----	CH-721 -002
	EC	3	0.50	-	11	0.02	-----	
Geisenheim Germany 1978^2	GR	2	0.1kg/m^2 and 0.1g/plant	- -	30	10.1	0.05	CH-721 -008 & CH- 721-010
					50	1.6	<0.02	
					60	0.9c	<0.02	
München Germany 1990^3	EC	2	0.144	0.024	0	1.2	-----	CH-721 -032
					14	<0.02	-----	
					21	<0.02	-----	
					28	<0.02	-----	
					35	<0.02	-----	
Bonn Germany 1990^3	EC	2	0.144	0.024	0	0.07	-----	CH-721 -033
					14	<0.02	-----	
					21	<0.02	-----	

Location, Country, year	Application				PHI, days	Residues, mg/kg		Ref.
	Form.	No.	kg ai/ha	kg ai/hl		Parent	Met	
					28	<0.02	-----	
					35	<0.02	-----	
Buttelborn Germany 1990[3]	EC	2	0.144	0.024	0	0.6	-----	CH-721 -033
					14	<0.02	-----	
					21	<0.02	-----	
					28	<0.02	-----	
					35	<0.02	-----	
Frankfurt Germany 1990[3]	GR	1	2g/100 plants	-	65	<0.02	-----	CH-721 -034
					98	0.04	-----	
					108	<0.02b	-----	
			2g/100 plants					
	GR	1			60	<0.02	-----	
					84	<0.02	-----	
					98	<0.02b	-----	
Bonn Germany 1990[3]	GR	1	2g/100 plants	-	55	<0.02	-----	CH-721 -034
					99	<0.02	-----	
					109	<0.02b	-----	
Munich Germany 1990[3]	GR	1	2g/100 plants	-	42	<0.02	-----	CH-721 -034
					56	<0.02	-----	
					66	<0.02b	-----	
Hannover Germany 1990 [3]	GR	1	2g/100 plants	-	64	<0.02	-----	CH-721 -034
					80	<0.02	-----	
					90	<0.02b	-----	
Bonn Germany 1990[3]	GR	1	0.1	-	80	<0.02	-----	CH-721 -035
					114	<0.02	-----	
					124	<0.02	-----	
Frankfurt Germany 1990[3]	GR	1	0.1	-	100	<0.02	-----	CH-721 -035
					144	<0.02	-----	
					154	<0.02	-----	
Hannover Germany 1990[3]	GR	1	0.1	-	97	<0.02	-----	CH-721 -035
					113	<0.02	-----	
					123	<0.02	-----	
München Germany 1990[3]	GR	1	0.1	-	89	<0.02	-----	CH-721 -035
					103	<0.02	-----	
					113	<0.02	-----	

Results underlined once or twice are considered comparable with

a - German GAP for pre-planting soil treatments at 100 g/m^2

b - German GAP for granular treatments at 2 g/100 plants

c - German GAP for granular nursery bed treatment at 0.1 g/plant in combination with pre-planting soil treatment at 100 g/m^2

Double underlined residues are from maximum GAP treatments and have been used for estimating the STMR

[1] No detailed study report; only very brief details of the trial and analysis were available.

[2] Duration of sample storage unspecified

[3] Report not in English

Met = 1-(2,4-dichlorophenyl)ethanol

Savoy cabbage. GAP was reported for Germany and The Netherlands. A variety of treatment regimes are used although all applications are either before or soon after planting.

Only Germans trials were submitted. The German soil treatment at 0.1kg ai/m^2 was reflected by three trials, with all residues <0.02 mg/kg. The 0.1 g/plant granular treatment was used in 3 acceptable trials with residues of 0.02, 0.03 and 0.15 mg/kg. In one additional trial a combination of these two treatments gave a residue of 0.3 mg/kg. In three trials with the German 2 kg ai/ha GAP application all residues were <0.02 mg/kg.

Table 22. Supervised field trials on Savoy cabbage in Germany. Heads analysed.

Location, year	Application				PHI, days	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl		Parent	Met	
München 1973[1]	EC	1	4.8	-	35 49 56	<0.02 <0.02 <0.02	----- ----- <0.02	CH-721-003
Baden 1973[1]	EC	1	4.8	-	49 59	<0.02 <0.02	----- <0.02	CH-721-003
Kiel 1973[1]	EC	1	4.8	-	0 10 28	33.3 1.0 0.3	----- ----- 0.04	CH-721-003
Geisenheim 1977[1]	EC	1	4.8	-	40 60 80	0.2 0.03 <0.02	<0.02 <0.02 <0.02	CH-721-004 & CH-721-005
Frankfurt 1977[1]	EC		4.8	-	30 50 63	0.04 <0.02 <0.02	<0.02 <0.02 <0.02	CH-721-004 & CH-721-005
Bamberg 1977[1]	EC	1	4.8	-	40 60 80	0.02 <0.02 <0.02	<0.02 <0.02 <0.02	CH-721-004 & CH-721-005
Geisenheim 1980[1]	EC	1+ 2	4.88 + 1.4	-	0 7 14 21 28	2.9 0.2 0.04 <0.02 <0.02	----- ----- ----- ----- -----	CH-721-012
Bamburg 1980[1]	EC	1+ 2	4.88 + 1.4	-	0 7 14 21 28	4.5 0.7 0.3 0.08 <0.02	----- ----- ----- ----- -----	CH-721-012
Geisenheim 1980[1]	GR	1	2	-	49 56 77	0.03 <0.02 <0.02d	----- ----- -----	CH-721-015
	GR	1	0.1kg/m^2	-	49 56 77	0.08 0.03 <0.02a	----- ----- -----	
	GR	1	4 g/200 plants	-	49 56 77	0.2 0.03 <0.02	----- ----- -----	
Bamberg 1980[1]	GR	1	2	-	49 63 77	0.09 <0.02 <0.02d	----- ----- -----	CH-721-015
	GR	1	0.1 kg/m^2	-	49 63 77	0.2 0.05 <0.02a	----- ----- -----	

Location, year	Application				PHI, days	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl		Parent	Met	
	GR	1	4 g/200 plants	-	49 63 77	0.3 0.05 <0.02	----- ----- -----	
Frankfurt 1980[1]	GR	1	2	-	49 63 77	0.3 0.04 <0.02d	----- ----- -----	CH-721 -015
	GR	1	0.1 kg/m^2	-	49 63 77	0.3 0.05 <0.02a	----- ----- -----	
	GR	1	4 g/200 plants	-	49 56 77	0.4 0.03 <0.02	----- ----- -----	
Bad Segeberg 1981[1]	EC	1+ 2	4.9 + 0.17	-	0 7 14 21	0.9 0.4 0.2 0.1	----- ----- ----- -----	CH-721 -017
Vorwohle 1981[1]	EC	1+ 2	4.9 + 0.17	-	0 7 14 21	0.5 0.07 <0.02 <0.02	----- ----- ----- -----	CH-721 -017
Hannover 1986[2]	GR	1	0.1 g/plant	-	40 60 81	0.2 0.1 0.08	---- ---- ----	Anon 1995
Saarlouis 1986[2]	GR	1	0.1 g/plant	-	40 60 80	0.4 0.03 0.05	---- ---- ----	Anon 1995
Frankfurt 1986[2]	GR	1	0.1 g/plant	-	40 60 81	0.07 <0.02 <0.02	---- ---- ----	Anon 1995
Berlin 1986[2]	GR	1	0.1 g/plant	-	105 124 145	0.06 0.05 <0.02	---- ---- ----	Anon 1995
Bonn 1986[2]	GR	1	0.1 g/plant	-	40 60 80	0.1 0.06 <0.02	---- ---- ----	Anon 1995
Lübeck 1986[2]	GR	1	0.1 g/plant	-	38 63 83	0.3 0.2 0.07	---- ---- ----	Anon 1995
München 1986[2]	GR	1	0.1 g/plant	-	40 60 80	0.74 0.06 0.01	---- ---- ----	Anon 1995
Münster 1986[2]	GR	1	0.1 g/plant	-	42 63 84	0.2 0.02 0.01	---- ---- ----	Anon 1995
Braunschweig 1986[2]	GR	1	0.1 g/plant	-	39 60 80	0.2 0.04 0.08	---- ---- ----	Anon 1995
Stuttgart 1986[2]	GR	1	0.1 g/plant	-	40 60 80	0.34 0.03 <0.02	---- ---- ----	Anon 1995
Geisenheim 1977[1]	GR	1	0.1 g/plant	-	40 60 80	2.03 0.14 0.03b	<0.02 <0.02 <0.02	CH-721 -006 & CH-721-007

Location, year	Application				PHI, days	Residues, mg/kg		Ref.
	Form	No.	kg ai/ha	kg ai/hl		Parent	Met	
Frankfurt 1977[1]	GR	2	0.1 kg/m^2 and 0.1 g/plant	- -	30	3.4	<0.02	CH-721-006 & CH-721-007
					50	0.25	<0.02	
					63	0.15c	<0.02	
	GR	1	0.1 g/plant	-	30	0.9	<0.02	
					50	0.20	<0.02	
					63	0.15b	<0.02	
Bamberg 1977[1]	GR	2	0.1 kg/m^2 and 0.1 g/plant	- -	40	0.4	<0.02	CH-721-006 & CH-721-007
					60	0.1	<0.02	
					80	0.02c	<0.02	
	GR	1	0.1 g/plant	-	40	0.4	<0.02	
					60	0.1	<0.02	
					80	0.02b	<0.02	
Geisenheim 1978[1]	GR	2	0.1 kg/m^2 and 0.1 g/plant	- -	30	3.1	0.02	CH-721-009 & CH-721-011
					50	0.4	<0.02	
					60	0.3c	<0.02	

Results underlined once or twice are considered comparable with

a - the German 0.1 kg ai/m^2 soil treatment
b - the German 0.1 g/plant granular nursery bed treatment
c - a combination of the German 0.1 kg ai/m^2 soil treatment and 0.1 g/plant granular treatment
d - the German 2 kg ai/ha treatment 5-6 days after planting

Double underlined residues are from maximum GAP treatments and have been used for estimating the STMR

[1] Duration of sample storage unspecified

[2] Only the JMPR residue trial summary sheets were supplied, no study report with further trial and analytical information

Met = 1-(2,4-dichlorophenyl)ethanol

Cauliflower. GAP was reported for Germany, Ireland, The Netherlands and the UK. Application is usually pre-emergence or at planting although post-emergence application is allowed in the UK and Ireland.

Residue trials were reported from Germany, India, the USA and the UK. There were three German trials according to each of three different German GAP treatments: 2 g/100 plants nursery granular, the 0.1 g/plant single bed treatment and the 2 kg ai/ha granular “spreading” application. The UK and Dutch spray treatment (ca. 4-5 kg ai/ha) at the time of drilling or transplanting was reflected by four German trials. All the residues in these trials were <0.02 mg/kg.

Table 23. Supervised field trials on cauliflower. Heads analysed.

Location, Country, year	Application				PHI, days	Chlorfenvinphos, mg/kg	Ref.
	Form	No.	kg ai/ha	kg ai/hl			
Frankfurt Germany 1980[1]	EC	1+2	4.8+ 0.14	- -	0	<0.02	CH-721 -022
					7	<0.02	
					14	<0.02	
					28	<0.02	
Geisenheim Germany 1980[1]	GR	1	4 g/200 plants	-	49	0.10	CH-721 -023
					77	<0.02	
					84	<0.02	
					91	<0.02a	
	GR	1	0.1 g/ plant	-	49	0.5	
					77	<0.02	
					84	<0.02	
					91	<0.02b	
	GR	1	2	-	49	0.1	
					77	<0.02	
					84	<0.02	
					91	<0.02c	
Bamberg Germany 1980[1]	GR	1	4 g/200 plants	-	70	<0.02	CH-721 -023
					77	<0.02	
					84	<0.02 a	
	GR	1	0.1 g/ plant	-	70	<0.02	
					77	<0.02	
					84	<0.02b	
	GR	1	2	-	70	<0.02	

Location, Country, year	Application				PHI, days	Chlorfenvinphos, mg/kg	Ref.
	Form	No.	kg ai/ha	kg ai/hl			
					77 84	<0.02 <0.02c	
Frankfurt Germany 1980[1]	GR	1	4 g/200 plants	-	49 77 84 91	0.3 <0.02 <0.02 <0.02a	CH-721 -023
	GR	1	0.1 g/ plant	-	49 77 84 91	1.9 0.02 <0.02 <0.02b	
	GR	1	2	-	49 77 84 91	0.4 <0.02 <0.02 <0.02c	
Bad Segeberg Germany 1981[1]	EC	1+ 2	4.9 + 0.17	-	0 7 14 21	1.0 0.1 0.05 0.07	CH-721 -024
Vorwohl Germany 1981[1]	EC	1+2	4.9 + 0.17	-	0 7 14 21	0.80 0.10 0.06 <0.02	CH-721 -024
Frankfurt Germany 1989[1]	EC	2	0.144	0.019	0 14 21 28	<0.02 <0.02 <0.02 <0.02	CH-721 -025
	EC	1	4.8	1.2	119 126 140	<0.02 <0.02 <0.02d	
Bonn Germany 1989[1]	EC	1	4.8	1.2	91 98 112	<0.02 <0.02 <0.02d	CH-721 -025
USA undated[2]	GR	1.1 2	1.12	-	20 48	<0.05 <0.05	CH-601-001
USA undated[2]	GR + EC	1+ 3	1.12+ 1.12	- -	20 48	1.3 <0.05	CH-601-001
Nasik India 1972[1]	EC	3	0.25	-	7	0.1	CH-721 -019
	EC	3	0.50	-	7	0.2	
Wellesbourne UK 1964[1,3]	WP	1	root dip	0.05	88	<0.05	CH-724 -065
	WP	1	root dip	0.05	88	<0.05	
	EC	1	root dip	0.1	88	<0.05	
	EC	1	root dip	0.1	88	<0.05	
Bonn Germany 1990[4]	EC	2	0.144	0.024	0 14 21 28	0.55 0.16 0.06 <0.02	CH-721 -030

Location, Country, year	Application				PHI, days	Chlorfenvinphos, mg/kg	Ref.
	Form	No.	kg ai/ha	kg ai/hl			
					35	<0.02	
Buttelborn Germany 1990[4]	EC	1	4.8	0.48	83 90 104	<0.02 <0.02 <0.02d	CH-721 -031
Bonn Germany 1990[4]	EC	1	4.8	0.48	129 136 150	<0.02 <0.02 <0.02d	CH-721 -031

Results underlined once or twice are considered comparable with

a - the German 2 g/100 plants nursery granular treatment
b - the German 0.1 g/plant single bed treatment
c - the Germans 2 kg ai/ha granular treatment
d - the UK and Dutch spray treatments (ca. 4-5 kg ai/ha) at time of drilling or transplanting.

Double underlined residues are from maximum GAP treatments and have been used for estimating the STMR

[1] Duration of sample storage unspecified
[2] No detailed study report; only very brief details of the trial and analysis were available.
[3] High analytical recovery (>120%)
[4] Report not in English

Mushrooms. GAP was reported only for the UK as either compost or casing incorporation. Only one trial was available which was poorly described with no detailed study report.

Table 24. Supervised residue trials on protected mushrooms, UK, undated. Fruit analysed.[1]

Application				PHI, days	Chlorfenvinphos, mg/kg	Ref.
Form.	No.	kg ai/ha	kg ai/hl			
GR	1	5 kg/tonne compost	-	30	<0.02	CH-601 -001
GR	1	17 kg/tonne compost	-	30	<0.02	

[1] No detailed study report; only very brief details of the trial and analysis were available

Kale. There are registered uses in Germany, The Netherlands, Portugal and Spain, but residue trials were available only from Germany. Five trials were according to the Dutch GAP for spray treatments at planting or before sowing. Residues were all <0.02 mg/kg. In one of these trials the residue of dichlorophenylethanol was 0.07 mg/kg. Three further trials complied with the German granular single plant treatment, and in two others this treatment was combined with soil treatment according to German GAP. Residues in these trials were <0.02 (2), 0.02, 0.07 and 0.09 mg/kg.

Table 25. Supervised field trials on kale in Germany.[1]

Location, year	Application			PHI, days	Residues, mg/kg Parent	Met	Ref.
	Form	No.	kg ai/ha				
Lübeck 1973	EC	1	4.8	56 63 140	<0.02 <0.02 <0.02a	----- ----- <0.02	CH-726 -001
Kiel	EC	1	4.8	0	1.58	-----	CH-726

ZIRAM (DITHIOCARBAMATES, 105)

EXPLANATION

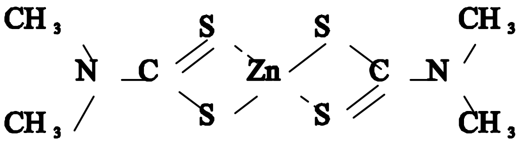
Ziram was originally evaluated in 1965 (toxicology) and 1967 (toxicology and residues) and is included in the dithiocarbamate group of compounds. It is a contact fungicide with protective action and is registered for use on fruit, vegetables, tree nuts and ornamentals in many countries. Ziram, applied to dormant fruit trees is also used to repel hares and rabbits.

The compound was evaluated at the present Meeting within the CCPR periodic review programme.

IDENTITY

ISO common name:	ziram
Chemical name	
IUPAC:	zinc bis(dimethyldithiocarbamate)
CA	(T-4)-bis(dimethylcarbamodithioato-*S*,*S*¢)zinc
CAS No.:	137-30-4
CIPAC No.:	31
EEC No.:	205-288-3

Structural formula:



Ziram

Molecular formula:	$C_6H_{12}N_2S_4Zn$
Molecular mass:	305.81

Physical and chemical properties

Pure active ingredient

Vapour pressure: $<2.5\times10^{-4}$ Pa at 25°C (Lemal, 1987)

Melting point: 246°C

Octanol/water partition coefficient: log P_{OW} 1.086 (Lemal and Debondue, 1984)

Solubility:
water: 18 mg/l at 20°C
water: 10.3 mg/l (Lemal and Debondue, 1984)
acetone: 0.8 g/l at 20°C (quoted - Wyss-Benz, 1994)
chloroform: 6.4 g/l at 20°C (quoted - Wyss-Benz, 1994)
petroleum ether 40-60: 21 mg/l at 20°C (quoted - Wyss-Benz, 1994)

Specific gravity: 1.66 at 25°C

Hydrolysis:
half-life at 25°C (Heasook 1995)
10 min at pH 5
18 hours at pH 7
6.3 days at pH 9

Photolysis: not photosensitive

Lemal (1987) measured the vapour pressure of ziram by a gas- saturation method. Nitrogen gas was passed through ziram coated on a support material with a very high surface area and maintained at 25°C, then through a cotton wool dust filter followed by traps containing water. The contents of the absorption traps were acidified with nitric acid and analysed for zinc by atomic absorption spectrophotometry. No zinc was detected in the traps. The vapour pressure of ziram at 25°C did not exceed 2.5×10^{-4} Pa.

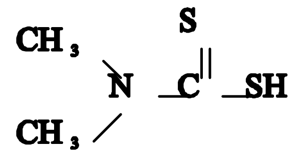
Lemal and Debondue (1984) measured the octanol-water partition coefficient of ziram (98% phyto quality) according to OECD Guideline 107 (OECD 1981a). In a series of tests the values of log P_{OW} ranged from 0.954 to 1.196, with a median value of 1.086.

Heasook (1995) measured the rate of hydrolysis of [^{14}C]ziram in sterile aqueous buffer solutions in the dark at pH 5, 7 and 9 and identified the products of hydrolysis.

In the rate experiments the ziram concentration was 2.8 and 2.9 mg/l and the buffer solutions contained 1% acetone to help solubility. Measurements were made for 1 hour, 72 hours and 30 days in the experiments at pH 5, 7 and 9 respectively. In the experiments designed to identify reaction products ziram concentrations were 10 mg/l and acetone was present at 3.9%.

Ziram half-life at 25°C

pH 5	10.4 mins
pH 7	17.7 hours
pH 9	6.3 days



Dimethyldithiocarbamic acid

The major hydrolysis product at pH 5 and 7 was CS_2, which was also produced at pH 9. In total 11 products were observed but the short-lived ones were eventually converted to CS_2 and could not be isolated and identified. Dimethyldithiocarbamic acid, carbon oxysulfide, isothiocyanic acid or thiocyanic acid and *N*,*N*-dimethylformamide were identified as hydrolysis products at pH 9.

Technical material

Purity: typically 970 g/kg
Melting range: 240-244°C
Stability: very stable in test at 54°C for 14 days
Water solubility: 3 mg/l at 20°C (Christiaens and Verberckt, 1987)

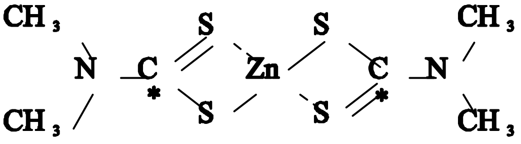
Christiaens and Verberckt (1987) stirred technical ziram with bi-distilled water in flasks at 30°C for 24, 48 or 72 hours. The flasks were then moved to a thermostatted bath at 20°C for 24 hours and shaken from time to time. The supernatant liquid was then centrifuged and the zinc content of the solution was measured by atomic absorption spectrophotometry. Measurements were made on 10 batches of technical ziram, with measured solubilities falling in the range 2.9-3.7 mg ziram/l (mean 3.35 mg/l). The procedure followed the OECD Guideline 105 (OECD, 1981b).

Formulations

WG 900 g/kg, WP 900 g/kg, WG 810 g/kg, WG 760 g/kg and WP 750 g/kg

METABOLISM AND ENVIRONMENTAL FATE

Animal metabolism



^{14}C label

Information was made available to the Meeting on studies of ziram metabolism in lactating goats.

Residues in the tissues, milk and excreta residues were measured in 2 lactating goats each weighing about 40 kg, dosed orally once daily after morning milking for 6 consecutive days by capsule with [*thiocarbonyl*-^{14}C]ziram at 11.9 and 13.2 mg/kg bw/day, equivalent to 300 ppm ziram in the feed (Bodden, 1993). The feed consumption was 1 kg/animal/day of a grain-based milking ration as well as alfalfa grass hay provided *ad libitum*; the mean total daily feed consumption was 1.7 kg. The goats were milked twice daily, producing 1.9-2.7 kg per day. Milk and excreta were collected throughout, and the animals were slaughtered 6 hours after the final dose for tissue collection.

A large part of the administered ^{14}C was not accounted for (54% and 34%). By analogy with the animal metabolism of thiram losses as CS_2 and CO_2 in expired air would be expected, but ^{14}C was not measured in the expired air. More of the ^{14}C dose was in the faeces (42% and 61%) than in the urine (3%), tissues (0.93% and 0.78%) or milk (0.28% and 0.51%).

The levels of ^{14}C in the milk increased for the first 2 or 3 days of feeding and then reached a plateau (Table 1). The levels of ^{14}C were higher in the liver than in other tissues (Table 2).

Tissues, milk and urine were analysed for dithiocarbamate residues by a colorimetric CS_2 evolution method with a detection limit of 0.5 mg/kg as CS_2. In the liver approximately 10% of the ^{14}C was present as CS_2-liberating compounds (1.1 and 1.2 mg/kg as CS_2). CS_2 was not detected in the other tissues and milk, but the total ^{14}C levels were generally too low to expect its detection. In the urine samples on day 5 from the 2 goats 14% and 27% of the ^{14}C was present as CS_2-liberating compounds.

Nitrosodimethylamine was not detected in the milk, tissues or urine (LOD 1 ì g/kg).

The ^{14}C residues in milk, liver, kidney, muscle and fat were not extractable with a chloroform/methanol/water mixture until after protease treatment. The liberated ^{14}C was present in polar water-soluble compounds. ^{14}C was present in lactose and casein isolated from milk and urea isolated from urine, showing that some of the ^{14}C had been incorporated into natural products.

Table 1. Levels of ^{14}C in milk produced by 2 goats dosed daily with [*thiocarbonyl*-^{14}C]ziram equivalent to 300 ppm in the feed (Bodden, 1993).

Day	^{14}C (as ziram), mg/kg milk			
	Goat 1, am milking	Goat 1, pm milking	Goat 2, am milking	Goat 2, pm milking
1		0.44		1.02
2	0.25	0.56	0.41	1.34
3	0.61	0.74	1.85	1.74
4	0.92	0.95	1.54	1.47
5	0.86	0.87	1.74	1.75
6	0.74	0.78	1.66	1.44

Table 2. Levels of ^{14}C in samples from 2 goats dosed daily with [^{14}C]ziram equivalent to 300 ppm in the feed and slaughtered 6 hours after the final dose (Bodden, 1993).

Sample	^{14}C as ziram, mg/kg,	
	Goat 1	Goat 2
Bile	3.1	2.3
Blood	0.87	1.6
Fat (omental)	0.16	0.20
Fat (renal)	0.17	0.18
Kidney	2.9	3.4
Liver	28.0	22.0
Muscle	0.45	0.81

Plant metabolism

Information was made available to the Meeting on ziram metabolism in apples.

Apples and apple leaves on trees were treated once by hand-spraying with [*thiocarbonyl*-^{14}C]ziram at a rate equivalent to 34 kg ai/ha, which is 5 times the label rate (Wyss-Benz, 1994). The apples were 3.5-5.0 cm at the time of treatment. Leaves and apples were sampled for analysis at intervals of 0, 14, 28, 56 and 80 days after treatment, the final occasion at apple maturity. The distribution and levels of ^{14}C in the apples and leaves at the various sampling intervals are shown in Table 3. Residues on the surface of the apples and leaves (found in washings) disappeared more quickly than incorporated residues.

Extracts of apple peel and pulp were analysed by a head-space GLC CS_2 evolution procedure. No CS_2-related residues were detected in the extracts of apple pulp (LOD ~ 0.02 mg/kg as CS_2); they constituted 3.6%, 1.6% and 5.4% of the total ^{14}C residues in apple peel on days 0, 14 and 80, but were not detected in the peel sampled on days 28 and 56. On a whole-apple basis the highest level of CS_2-related residue was 0.016 mg/kg CS_2 in the day 80 sample.

Parent ziram was detected in washings from apples and leaves sampled on days 0, 14 and 28 after treatment. The levels became too low for identification at later samplings. TLC showed that ^{14}C was present in more polar fractions than ziram. [^{14}C]ziram was detected by HPLC in apple pulp (0.014 mg/kg) from apples sampled on the day of treatment, but not at later sampling times. The extractable incorporated ^{14}C at the various sampling times was in polar material. Reference compounds which were possible metabolites did not correspond to any of the radioactive fractions.

Table 3. Distribution and levels of ^{14}C (as ziram) in apples and leaves after treatment with [*thiocarbonyl*-^{14}C]ziram at a rate equivalent to 34 kg ai/ha (Wyss-Benz, 1994).

Days after applic.	Apples						Leaves			
	washings		peel		pulp		washings		washed leaves	
	mg/kg	%[1]	mg/kg	%[1]	mg/kg	%[1]	mg/kg	%[2]	mg/kg	%[2]
0	94	*97*	2.5	*2.6*	0.63	*0.7*	5930	*98*	117	*1.9*
14	2.4	*24*	4.0	*40*	3.5	*36*	93	*45*	114	*55*
28	1.0	*19*	2.3	*41*	2.2	*40*	37	*26*	107	*74*
56	0.15	*4.6*	1.3	*40*	1.8	*56*	3.4	*6.6*	48	*93*
80	0.11	*4.2*	1.2	*46*	1.3	*50*	2.9	*6.1*	45	*94*

[1] Of total ^{14}C in apples
[2] Of total ^{14}C in leaves

METHODS OF RESIDUE ANALYSIS

Analytical methods

The methods rely on acid hydrolysis to release CS_2, which is then measured colorimetrically or by head-space gas chromatography. They are the same as those for other dithiocarbamates.

In the method of the Dutch Method Manual dithiocarbamates are converted to CS_2 by treatment with hydrochloric acid in the presence of stannous chloride (Ministry of Welfare, Health and Cultural Affairs, The Netherlands, 1988). The CS_2 in the head space is determined by GLC with either an ECD or FPD in the sulphur mode. Wyss-Benz (1994) used a similar head-space method to measure levels of CS_2-generating compounds in apples in the metabolism study.

Wyss-Benz (1994) separated $[^{14}C]$ziram from $[^{14}C]CS_2$ in the apple metabolism study on a styrene-divinylbenzene column with an EDTA tetrabutylammonium hydroxide aqueous mobile phase. The compounds were detected with a ^{14}C scintillation detector.

Brielbeck and Marx (1994a) described the CS_2 evolution photometric method used in many of the ziram residue trials. Samples were cut up, treated with a stannous chloride hydrochloric acid mixture and heated for one hour. The evolved gases were carried by a stream of nitrogen from the reaction flask through traps to remove H_2S and the CS_2 was then collected in a methanolic potassium hydroxide trap. Measurement of the UV absorbance of the solution at 302 nm gave the concentration of xanthogenate formed. Standard solutions of CS_2 dissolved in methanol were used to prepare a calibration curve. The LOD for peaches was 0.1 mg CS_2/kg. Recoveries were satisfactory in the range 0.25-4 mg ziram /kg, but tended to be elevated at the lowest level tested.

Ohs (1994b) described the CS_2 evolution colorimetric method used in ziram residue trials. CS_2 was released by reacting samples with a stannous chloride-hydrochloric acid mixture. It was collected in a trap and determined colorimetrically after reaction with copper acetate and diethanolamine. The LOD was 0.05 mg CS_2/kg. The method has been used for dithiocarbamate residue analysis for many years. Ziram recoveries were satisfactory in the 0.05-5.0 mg CS_2/kg range. Balluff (1995g) reported essentially the same method for ziram residues in supervised trials, although the LOD in this case was 0.5 mg ziram/kg. A method based on the same chemistry was used in the goat metabolism study to measure the levels of CS_2-generating compounds in milk and tissues (Bodden, 1993).

Holstege and Westberg (1987) described the CS_2 evolution head-space GLC procedure used in the US trials on ziram. The sample was reacted with stannous chloride-hydrochloric acid reagent at 100°C in a sealed reaction flask. An aliquot of the head-space gas was analysed by GLC and compared with ziram standards similarly reacted and injected. Recoveries were satisfactory over the range 0.05-7 mg ziram/kg. The LOD was 0.05 mg ziram/kg. The same method was used in the apple processing study (Meikle, 1992), where recoveries on apples, juice and pomace were found to be satisfactory. Koch (1996) used a similar method in the frozen storage stability study of ferbam and ziram in apples. Satisfactory recoveries were recorded for apples fortified at 0.2 and 2 mg ziram/kg.

Samples in the apple trial in Belgium (66/09) were analysed by a polarographic method, but no summary or details were available (Vervier and Cigot, 1966).

Stability of pesticide residues in stored analytical samples

The Meeting received information on the frozen storage stability of ziram in apples, peaches, almond kernels and almond hulls.

Koch (1996) tested the stability of ziram in macerated apples fortified at 1 mg/kg and stored in head-space bottles at -20°C for 18 weeks. Samples were analysed by a CS_2 evolution GLC head-space method. Ziram was stable under these conditions for the duration of the experiment.

Table 4. Stability of ziram in macerated apples fortified at 1 mg/kg and stored at -20°C (Koch, 1996).

Storage period	Ziram, mg/kg (as ziram)	Method recovery, %, at time of stored sample analysis
0	0.87 0.86	86 88
2 weeks	0.86 0.82	87 81
4 weeks	0.80 0.83	85 83
18 weeks	1.05 1.05	100 107

Bookbinder (1989j) showed that ziram was stable for limited periods in apples, peaches, almond kernels and almond hulls during freezer storage. The sample (4 g ground with dry ice) was fortified with ziram at 2 mg/kg and stored in glass reaction vessels (160 ml) in a freezer at -20±2°C for intervals up to 6 months (Table 5). Samples were analysed by a CS_2 evolution GLC head-space method. Analytical method recoveries were tested on each occasion for each commodity and the ranges were almond kernels 77-91%, hulls 73-93%, apples 80-98%, and peaches 84-104%.

The data suggest that ziram residues in apples and peaches are not sufficiently stable to allow storage of samples in a freezer longer than 3 months.

Table 5. Freezer storage stability of ziram on almond kernels and hulls, apples and peaches fortified at 2 mg/kg and stored at -20±2°C for intervals up to 6 months (Bookbinder, 1989j).

Storage interval	% of original ziram remaining			
	almond kernels	almond hulls	apples	peaches
0 days	76 81	76 79	87 89	96 94
2 weeks	91 86	81 78	90 97	98 100
1 month	91 94	84 82	87 80	97 106
3 months	86 94	74 76	69 69	70 71
4 months			53 45	58 62
6 months	84 91		46 43	56 54

Residue definition

Ziram residues are measured as evolved CS_2 by the methods that are used for the other dithiocarbamates. All samples from the supervised trials on ziram have been analysed by these methods. The Meeting agreed that ziram should be included in the definition of the dithiocarbamate residues: *The MRLs refer to total dithiocarbamates, determined as CS_2 evolved during acid digestion and expressed as mg CS_2/kg.*

For dietary intake purposes and comparison of calculated intakes with the ADI it is preferable to express the residues as ziram because the ADI is expressed in terms of ziram (ziram = $CS_2 \times 2.01$).

USE PATTERN

Ziram is a contact fungicide with protective action. Ziram formulations are registered for use on fruit, vegetables, tree nuts and ornamentals in many countries. Ziram, applied to dormant fruit trees, is also used to repel hares and rabbits.

The Meeting was provided with information on registered uses on fruits, vegetables, tree nuts and cereals Table 6).

Table 6. Registered uses of ziram.

Crop	Country	Form	Application				PHI, days, or application stage
			Method	Max rate per applic., kg ai/ha	Spray conc., kg ai/hl	No.	
Almond	UK	PA	spray	3.2			stage PB
Almond	USA	WG	foliar	6.8	0.72	3	stage 5PF
Apple	Australia	WG	foliar		0.11		7
Apple	Belgium	WG	foliar	1.8	0.080-0.16	6[1]	28
Apple	France	WG	foliar	2.2	0.18	6	14
Apple	Greece	WG	foliar	2.3	0.23	6	15
Apple	Italy	WG	foliar	2.3	0.23	6	10
Apple	Netherlands	WP	foliar	0.75-1.7	0.075-0.11	4	14
Apple	Netherlands	WP	foliar	2.3	0.15	4	14
Apple	UK	PA	spray	3.2			stage PB
Apple	UK	PA	spray	8.0			W
Apple	USA	WG	foliar	5.2-6.8	0.54-0.72		14
Apricot	Greece	WG	foliar	2.3	0.15	4	15
Apricot	USA	WG	foliar	6.8	0.72	4	30
Barley	Germany	SC	spray	3.3	2.2	1	stage 4L
Bean	Greece	WG	foliar		0.20-0.23	3	15
Bean	Italy	WG	foliar		0.15-0.20	1	10
Bean	Portugal	WG	foliar		0.13-0.18	3	14
Berries	Netherlands	WP	foliar	1.9-3.2	1.0-1.6	1	60
Berry fruit except strawberries	Germany	SC	paint	13		2	W
Berry fruit except strawberries	Germany	SC	spray	13	16	2	W
Blackberry	Netherlands	WP	foliar	2.3-2.7	0.23	3	stage[2]
Broccoli	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Brussels sprouts	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Cabbage, red	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10

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[1] Maximum of 4 applications after flowering

[2] Until beginning of flowering.

Crop	Country	Form	Application				PHI, days, or application stage
			Method	Max rate per applic., kg ai/ha	Spray conc., kg ai/hl	No.	
and white							
Cauliflower	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Celery	Australia	WP WG	foliar		0.11		7
Celery	Italy	WG	foliar		0.15-0.20	1	10
Cherry	Italy	WG	foliar	2.3	0.23	3	10
Cherry	Netherlands	WP	foliar	2.0	0.13	2	
Cherry	UK	PA	spray	3.2			stage PB
Cherry	UK	PA	spray	8.0			W
Cherry	USA	WG	foliar	3.4-4.3	0.36-0.46	5	7 west
Cherry	USA	WG	foliar	3.4-4.3	0.36-0.46	5	14 east
Chestnut	UK	PA	spray	3.2			stage PB
Chinese cabbage	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Citrus fruit	Italy	WG	foliar		0.15-0.20		10
Climbing French beans	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Crab apple	UK	PA	spray	8.0			W
Crab apple	UK	PA	spray	3.2			stage PB
Cucumber	Italy	WG	foliar		0.15-0.20	1	10
Cucumber	Portugal	WG	foliar		0.18	2	14
Currant	France	WG	foliar		0.19	2	
Damson	UK	PA	spray	8.0			W
Damson	UK	PA	spray	3.2			stage PB
Dwarf French beans	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Fodder beet	Germany	SC	spray	3.3	2.2	1	stage PE14
Garden peas	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Garlic	Portugal	WG	foliar		0.18	2	14
Grape	Australia	WG	foliar		0.11		7
Grape	Spain	WG WP	foliar		0.25-0.35	4	7
Hazelnut	UK	PA	spray	8.0			W
Hazelnut	UK	PA	spray	3.2			stage PB
Kale	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Kohlrabi	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Lettuce	Spain	WG WP	foliar		0.25-0.35	4	7
Maize	Germany	SC	spray	3.3	2.2	1	stage 4L
Medlar	Portugal	WG	foliar		0.13-0.18	3	28
Melon	Greece	WG	foliar		0.20-0.23		
Nectarine	USA	WG	foliar	6.8	0.72		14 east
Nectarine	USA	WG	foliar	6.8	0.72		30 west
Oats	Germany	SC	spray	3.3	2.2	1	stage 4L
Olive	France	WG	foliar		0.19	2	
Olive	Portugal	WG	foliar		0.23	2	
Onion	Italy	WG	foliar		0.15-0.20	1	10
Onion	Portugal	WG	foliar		0.13-0.18	2	14

Crop	Country	Form	Application				PHI, days, or application stage
			Method	Max rate per applic., kg ai/ha	Spray conc., kg ai/hl	No.	
Pea	Italy	WG	foliar		0.15-0.20	1	10
Pea	Portugal	WG	foliar		0.18	2	14
Peach	France	WG	foliar	2.2	0.18	3	14
Peach	Greece	WG	foliar	2.3	0.15	4	15
Peach	Italy	WG	foliar	2.3	0.23	3	10
Peach	Italy	WG	foliar	5.3	0.53	2	stage[1]
Peach	Netherlands	WP	foliar	1.3-1.6	0.13	3	stage[2]
Peach	Netherlands	WP	foliar	2.0	0.13	2	
Peach	USA	WG	foliar	6.8	0.72		14 east
Peach	USA	WG	foliar	6.8	0.72		30 west
Pear	Australia	WG	foliar		0.11		7
Pear	Belgium	WG	foliar	1.8	0.080-0.16	6[Errore. Il segnalibro non è definito.]	28
Pear	Greece	WG	foliar	2.3	0.23	6	15
Pear	Italy	WG	foliar	2.3	0.23	6	10
Pear	Netherlands	WP	foliar	2.3	0.15	4	14
Pear	Netherlands	WP	foliar	0.75-1.7	0.075-0.11	4	14
Pear	UK	PA	spray	8.0			W
Pear	UK	PA	spray	3.2			stage PB
Pear	USA	WG	foliar	5.2-6.8	0.54-0.72		5 west
Pear	USA	WG	foliar	5.2-6.8	0.54-0.72		14 east
Pecan	USA	WG	foliar	6.8	0.72	5	55
Plum	Italy	WG	foliar	2.3	0.23	3	10
Plum	Netherlands	WP	foliar	2.0	0.13	2	
Plum	UK	PA	spray	8.0			W
Plum	UK	PA	spray	3.2			stage PB
Pome fruit	Australia	WP	foliar		0.11		7
Pome fruit	France	WG	foliar		0.14-0.19	6	
Pome fruit	Germany	SC	spray	13	16	2	W
Pome fruit	Germany	SC	paint	13		2	W
Pome fruit	Greece	WG	foliar		0.17-0.20	6	15
Pome fruit	Italy	WG	foliar	2.4	0.15-0.20	6	10
Pome fruit	Portugal	WG	foliar		0.13-0.18	5	28
Pome fruit	Spain	WG WP	foliar		0.25-0.35	5	7
Potato	Greece	WG	foliar		0.20-0.23	3	15
Potato	Italy	WG	foliar		0.15-0.20	1	10
Quince	UK	PA	spray	3.2			stage PB
Quince	UK	PA	spray	8.0			W
Raspberry	France	WG	foliar		0.19	2	

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[1] Application after harvest and before regrowth.

[2] From bud burst until beginning of flowering.

Crop	Country	Form	Application				PHI, days, or application stage
			Method	Max rate per applic., kg ai/ha	Spray conc., kg ai/hl	No.	
Rye	Germany	SC	spray	3.3	2.2	1	stage 4L
Savoy cabbage	Germany	SC	spray	3.3	0.54-0.81	1	stage PE10
Stone fruit, except apricot	Australia	WG	foliar		0.11		7
Stone fruit, except apricot	Australia	WP	foliar		0.18		7
Stone fruit	France	WG	foliar		0.19	3	
Stone fruit	Germany	SC	spray	13	16	2	W
Stone fruit	Germany	SC	paint	13		2	W
Stone fruit	Greece	WG	foliar		0.15-0.20	4	15
Stone fruit	Italy	WG	foliar	2.4	0.15-0.20	3	10
Stone fruit	Portugal	WG	foliar		0.13-0.18	3	28
Stone fruit	Spain	WG WP	foliar		0.25-0.35	4	7
Strawberries	Spain	WG WP	foliar		0.25-0.27	3	7
Sugar beet	Germany	SC	spray	3.3	2.2	1	stage PE14
Tomato	Greece	WG	foliar		0.20-0.23	g 3	7
Tomato	Greece	WG	foliar		0.20-0.23	3	15
Tomato	Italy	WG	foliar		0.15-0.20	1	10
Tomato	Spain	WG WP	foliar		0.25-0.35	4	7
Tree nuts	Portugal	WG	foliar		0.13-0.18	3	14
Tree nuts	Spain	WG WP	foliar		0.25-0.35	4	7
Triticale	Germany	SC	spray	3.3	2.2	1	stage 4L
Vines	Australia	WP	foliar		0.11		7
Walnut	UK	PA	spray	3.2			stage PB
Walnut	UK	PA	spray	8.0			W
Water melon	Portugal	WG	foliar		0.18	2	14
Watermelon	Greece	WG	foliar		0.20-0.23		
Wheat	Germany	SC	spray	3.3	2.2	1	stage 4L

5PF: Up to 5 weeks after petal fall.
W: Treat woody parts in winter to repel hares and rabbits.
PE10: Up to 10 days post-emergence or after planting.
4L: Up to 4th leaf stage.
PE14: Up to 14 days post-emergence.
PB: Before bud burst.

RESIDUES RESULTING FROM SUPERVISED TRIALS

Residue data from supervised trials on fruit and tree nuts are summarized in Tables 7-16.

Table 7. Apples. Belgium, France, Italy, Netherlands, Spain, USA.
Table 8. Pears. Belgium, France, Italy, Netherlands, Spain, USA.
Table 9. Apricots. USA.
Table 10. Cherries. Spain, USA.
Table 11. Nectarines. Italy, USA.

Table 12.	Peaches. France, Italy, Spain, USA.
Table 13.	Plums. France, Spain.
Table 14.	Almonds. USA.
Table 15.	Pecans. USA.
Table 16.	Almond hulls. USA.

Where residues were not detected, the results are recorded in the Tables as below the limit of determination (LOD), e.g. <0.05 mg/kg. Residues, application rates and spray concentrations have generally been rounded to 2 significant figures or, for residues near the LOD, to 1 significant figure. Only when residues were detected in control samples are they recorded in the Tables. Dithiocarbamate (CS_2) residues were detected in control samples in 3 apple trials, 4 pear trials, and 1 trial each on nectarines, peaches, plums and almonds (hulls).

The trials were generally fully reported and well documented. Ziram residues had been expressed as CS_2 in some cases and as ziram in others. All the residues in the supervised trials in this monograph are expressed as CS_2 irrespective of the mode of expression in the original. The theoretical factor 0.497 was used to calculate CS_2 levels from ziram levels.

In some trials on tree crops a treated plot within the trial was divided for sampling purposes into sub-plots. In such cases the separate analytical results for each subplot are recorded in the Tables and provide some information on the variation of residue levels which can occur even from within one sprayed plot.

Knapsack air sprayers, mistblowers and wheelbarrow sprayers were use to apply ziram to apple trees in the European trials. Plot sizes ranged from 8 to 20 trees. Freezer storage stability studies suggest that the duration of freezer storage can affect ziram residue levels. No direct information was available on the duration of sample storage in trials B 93-2, B 93-7, B 93-8, B 93-1 or B 93-5. However, an upper limit can be calculated from the dates of sampling and the final date for each study. The maximum periods of sample storage in these five apple trials were in the range 5-9 months. The duration of sample storage before analysis was 2-3 months for trial 304662 and 1½-3 months for 94021/01-FPAP. In the 5 ground application trials on apples in the USA ziram was applied by airblast sprayers and backpacks with handgun sprayers. Aerial application in one trial was by helicopter. Plot sizes were 24-120 m^2 for ground application and 2200 m^2 for aerial application. The intervals between harvest and analysis were 1-2 months.

In the pear trials in Europe plot sizes were in the range 8 to 20 trees. In some trials in France and Spain plots were samples as 3 sub-plots. Ziram was applied by knapsack mistblower and wheelbarrow sprayers. Only a summary was available for a Belgian trial in 1966. No direct information was available on the duration of sample storage before analysis in 4 trials (2-37, B 93-12, B 94-1 and B 94-2), but the upper limits could be calculated as before, giving estimated intervals of 5-20 days in trial 2-37, 9.5-11 months in B 93-12, 7-8 months in B 94-12, and 7.5-8.5 months in trial B 94-2. Intervals between harvest and analysis in other trials were 2-3 months in trial 304727, 3½-4 months in trial 94021/02, 3½-5 months in trial 94021/01, and 6-14 weeks in trials 90A-88, 89B-88 and 90C-88. In the US pear trials ziram was applied by airblast sprayer; plot sizes ranged from 35 m^2 to 1.1 ha.

In the US trials on apricots ziram was applied by aircraft and by airblast sprayer from the ground. Plot sizes were 1100-3700 m^2 for the ground applications and 5 ha for aerial spraying. Samples were stored in a freezer for 3-4 months between harvest and analysis.

Cherry trees were sprayed with a plot knapsack sprayer in the Spanish trials where the plot of

8 trees was treated as 3 sub-plots for sampling. Intervals between harvesting and analysis of the samples were 4-6 months, which may have allowed some decrease in residue levels. In the 5 cherry trials in the USA the trees in 3 (plot sizes 300-1100 m^2) were sprayed with airblast sprayers and in 2 (plot sizes 1900-3000 m^2) from fixed-wing aircraft. The periods of sample storage in a freezer before analysis were mostly 3-4 months, but 2 samples were stored for 5 months.

In the Italian trial on nectarines ziram was applied by a compressed air operated sprayer. The plot size was 9 trees. About 2-4 months elapsed between sampling and analysis. In the US trials on nectarines ziram was applied by airblast sprayer and by aircraft. Plot sizes were 300 and 1100 m^2 for ground application and 2000 m^2 for aerial application. Samples were stored between harvest and analysis for 2-3 months.

Ziram was applied to peach trees in trials in France, Italy and Spain with a backpack airblast sprayer, a wheelbarrow sprayer and a plot knapsack sprayer respectively. Plot sizes ranged from 8 to 14 trees. In the US trials ziram was applied with airblast or back-pack sprayers in 6 trials and by fixed-wing aircraft in the seventh trial. Plot sizes in the US ground spraying trials ranged from 15 to 1100 m^2; the plot size in the aerial spraying trial was 2000 m^2. No direct information was available on the duration of sample storage before analysis in trials UCB 211 and B 93-6, but from the sampling and report dates it could be calculated that samples were stored no longer than 3.5 months in UCB 211 and 11-12 months in B 93-6. Periods of sample storage in other trials were 2-3 months in trial 304646, 2½5 months in trial 94021 and 1½3 months in the US trials. No field report was available for trial UCB 211 so there was no information about the sprayer, plot sizes or whether other dithiocarbamates were used.

In the French and Spanish trials on plums plots of 8 trees were sprayed with knapsack sprayers and plots were sampled as 3 sub-plots. Samples were held in a freezer for 3-3½ and 5-6 months before analysis in the French and Spanish trials respectively.

Airblast sprayers were used for ground application in 5 almond trials (plot sizes 40-5000 m^2) in the USA while in the other two trials (plot sizes 1400 and 12000 m^2) ziram was applied by helicopter and fixed-wing aircraft. Samples from 2 trials were stored in a freezer for 3-4 months and those from 5 trials for 6-6½ months before analysis.

Pecan trees were treated with ziram with an airblast sprayer or a hand-held wand sprayer. Plot sizes ranged from 80 to 1300 m^2. The duration of freezer storage between harvest and analysis was 119-164 days.

In all trials (Tables 7-16) underlined residues are from treatments according to GAP and are valid fro the estimation of maximum residue levels.

Table 7. Residues of ziram (as CS_2) in apples from foliar application of ziram in supervised trials in Belgium, France, Italy, The Netherlands, Spain and the USA.

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
Belgium, 1966 (Reine des Reinettes)	WP	7×3.6 +4×2.7	7×0.18 +4×0.15	11	0 14 21	0.60 [1] <0.2 0.50	66/09

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
Belgium, 1966 (Ellison's Orange)	WP	7×3.6	7×0.18	11	0	1.9 [1]	66/09
		+4×2.7	+4×0.15		2	0.50	
					7	0.45	
					14	<0.2	
					21	<0.2	
Belgium, 1993 (Jonagold)	WG	2.4	0.23-0.37	6	0	0.90 c 0.92	UCB B 93-1
					7	1.2	93101-RU-010-1
					14	0.58	
					21	0.53	
					28	0.61	
					35	0.45	
France, 1993 (Wellspur)	WG	2.4	0.28-0.42	6	0	4.0	UCB B 93-7
					7	2.0	93101-RU-010-4
					14	1.4	
					21	1.3	
					28	0.78	
					35	0.83 c0.39	
France, 1993 (Golden Delicious)	WG	2.4	0.24	6	0	1.5	UCB B 93-5
					6	1.2	93101-RU-010-3
					13	0.53	
					20	0.21	
					27	0.29	
					34	0.33	
France, 1993 (Golden Delicious)	WG	2.4	0.28-0.42	6	0	5.2	UCB B 93-8
					7	5.6	93101-RU-010-5
					14	1.9	
					21	1.1	
					28	2.4	
					35	2.0	
Italy, 1993 (Perleberg 3)	WG	2.4	0.16	4	7	2.5	304662
				5	0	4.5	RA-2095/93
					10	0.90	
					21	0.55	
					28	0.36	
					35	0.29	
Netherlands, 1993 (Golden Delicious)	WG	2.4	0.25-0.37	6 dt[2]	0	2.1	UCB B 93-2
					7	0.71	93101-RU-010-2
					14	0.70	
					21	0.54	
					28	0.44	
					35	0.23	
Spain, 1994 (Granny Smith)	WG	2.3	0.23	4	0	2.6 4.3 4.4	94021/01-FPAP
					21	2.0 3.0 1.5	
					28	1.9 1.2 1.6	
USA (CA), 1988 (Newton Pippin)	WG	6.8	0.83	4	5	3.1 2.3 4.0 4.2	83A-88
					14	2.4 1.6 2.4 2.3	

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[1] Residues in this trial were measured as ziram by a polarographic method. Residues in the Table are calculated and expressed as CS_2.

[2] Metiram used in May, approximately 4 months before harvest

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
USA (GA), 1988 (Red Delicious)	WG	6.8	1.5	7	14 21	0.38 1.8	82G-88
USA (IL), 1988 (Lodi, Red Delicious, Jonathan)	WG	6.8-7.9	1.45-1.7	7	14 21	1.9 3.5	82F-88
USA (MI), 1988 (Macspur)	WG	6.8	1.45	7	14 21	1.1 0.52 c0.05	82E-88
USA (NY), 1988 (Twenty Ounce)	WP	6.8	2.0	7	14 21	0.98 0.48	82A-88
USA (NY), 1988 (Twenty Ounce)	WG	6.8	2.0	7	14 21	1.2 1.4	82A-88
USA (NY), 1988 (Twenty Ounce)	SC	6.8	2.0	7	14 21	0.97 0.84	82A-88
USA (WA), 1988 (Red Delicious, Red Chief)	WG	6.8	8.1	4 a	5 14	0.36 0.16	83D-88

dt: other dithiocarbamates also used during the growing period.
c: control sample.
a: application by aircraft.

Table 8. Residues of ziram (as CS_2) in pears from foliar application of ziram in supervised trials in Belgium, France, Italy, The Netherlands, Spain and USA. Underlined residues are from treatments according to GAP and are valid data for MRL estimation.

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
Belgium, 1966 (Conference)	WP	7×3.6 +4×2.7	7×0.18 +4×0.15	11	0 2 7 14 21	0.60 [1] 0.45 0.80 0.60 <0.2	66/09
Belgium, 1994 (Conference)	WG	2.3	0.23	4	0 15 20	3.8 c 0.13 0.66 c 0.09 0.54 c 0.14	UCB B 94-1 93101-RU-010-8
France, 1992 (Conference)	WG	2.4	0.20	14	0 15 32	1.3 0.78 0.26	2-37
France, 1992 (Conference)	WG	4.8	0.40	14	0 15 32	2.3 0.78 0.27	2-37

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[1] Residues in this trial were measured as ziram, by a polarographic method. Residue data in the table are calculated and expressed as CS_2.

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
France, 1993 (Williams)	WG	2.9[1]	0.54	6	0 6 13 20 27 34	4.9 4.3 3.6 2.4 3.8 1.5	UCB B 93-12 93101-RU-010-7
France, 1994 (Guyot)	WG	2.3	0.23	4	0 7 14 21 28	1.8 3.4 2.5 2.7 1.0 1.2 c 0.2 0.94 0.65 1.5 0.80 1.0 1.6 0.50 1.1 0.40	94021/02-FPBI
Italy, 1993 (William)	WG	2.8	0.16	4 5	7 0 10 21 28 35	1.8 3.3 0.64 0.47 0.33 0.23	304727 RA-2095/93
Netherlands, 1994 (Conference)	WG	2.4	0.23	4	0 14	1.6 c 0.15 0.58 c 0.07	UCB B 94-2 93101-RU-010-9
Spain, 1994 (Ercolini)	WG	2.3	0.23	4	0 7 14 21 28	1.3 1.6 3.3 1.1 1.6 1.9 1.1 0.85 1.1 1.0 0.50 0.85 0.80 1.4 0.50	94021/01-FPBI
USA (CA), 1988 (Bartlett)	WG	6.8	1.8	4 dt	5 14	1.8 1.1 0.86 1.1 0.53 0.67 0.49 0.64 c 0.12 c 0.14	90A-88
USA (NY), 1988 (Bartlett)	WG	6.8	1.8	7	14 21	0.42 0.84 0.94 0.62 0.21 0.59 0.04 0.29	89B-88
USA (WA), 1988 (Red D'Anjou)	WG	6.8	1.45	4	5 14	2.0 1.2	90C-88

dt: other dithiocarbamates also used during the growing period.
c: control sample.
a: application by aircraft.

Table 9. Residues of ziram (as CS_2) in apricots from foliar applications of ziram in supervised trials in the USA.

State, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
CA, 1988 (Modesto)	WG	5.1	1.2	5	30 45 60	0.97 1.4 1.3 1.5 1.0 1.4 1.6 0.90 0.89 0.75 0.78 0.90	84D-88
CA, 1990 (Royal	WG	6.8	1.45	5	30	2.8 4.8	90101

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[1] Nominal application rate 2.4 kg ai/ha, measured 2.9 ± 0.2 kg ai/ha.

State, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
Blenheim)					45 60	3.0 1.2 2.4 1.0	
CA, 1990 (Royal Blenheim)	WG	6.8	7.3	5 a	30 45 60	5.3 0.88 0.80 0.55 1.9 0.46 0.37 0.32 1.4 0.34 0.37 0.33	90101
WA, 1990 (Tilton)	WG	6.8	1.45	5	30 45 60	3.7 3.6 3.4 2.8 2.4 2.4 1.5 1.5 1.1	90102

a: application by aircraft.

Table 10. Residues of ziram (as CS_2) in cherries from foliar applications of ziram in supervised trials in Spain and the USA.

CHERRY Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
Spain, 1994 (Sunburst)	WG	2.3	0.23	3	0 7 14 21 28	2.9 0.70 3.1 0.60 0.45 0.70 0.35 0.25 0.35 0.35 0.20 0.30 0.20 0.20 0.25	94021/01-FPKI Loc 1
Spain, 1994 (Stark Hardi)	WG	2.3	0.23	3	0 7 14 21 28	2.5 0.65 2.9 0.85 0.85 0.55 0.45 0.65 0.40 0.35 0.30 0.40 0.30 0.30 0.50	94021/01-FPKI Loc 2
USA (CA), 1988 (Bing and Black Tartarian)	WG	5.1	1.1	5	30 45 60	1.1 1.4 0.61 0.95 1.3 1.3 0.95 0.57 0.95 1.2 0.91 0.81	86A-88
USA (CA), 1988 (Bing and Black Tartarian)	WG	5.1	5.5	5 a	30 45 60	0.12 0.22 0.24 0.20 0.15 0.25 0.23 0.11 0.08 0.10 0.08 0.09	86B-88
USA (MI), 1988 (Montmorency)	WG	5.1	1.1	8	7 14 21	1.6 0.79 1.3	85A-88
USA (MI), 1988 (Montmorency)	WG	5.1	5.5	8 a	7 14 21	1.1 0.84 0.80	85B-88
USA (WA), 1988 (Bing)	WG	5.1	1.1	5	30 45 60	1.0 0.53 0.34	86E-88

a: application by aircraft.

Table 11. Residues of ziram (as CS_2) in nectarines from foliar applications of ziram in supervised trials in Italy and the USA.

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
Italy, 1993 (Famtalade)	WG	2.4	0.16	2	7	0.54	304719 RA-2082/93
				3	0	0.71 c 0.12	
					7	0.35	
					10	0.27	
					14	0.23	
					21	0.28	
					28	0.12 c <0.05	
					35	0.11	
USA (GA), 1988 (Red Gold)	WG	6.8	1.5	10	7	1.5	87G-88
					14	1.1	
					21	0.91	
USA (CA), 1988 (Sun Red)	WG	6.8	1.5	7	30	0.04 0.10 0.07 0.12	88C-88
					45	0.04 0.05 0.05 0.06	
					60	0.03 0.06 0.04 0.03	
USA (CA), 1988 (Sun Red)	WG	6.8	7.3	a 7	30	0.07 0.08 0.20 0.18	88H-88
					45	0.07 0.04 0.11 0.03	
					60	0.08 0.12 0.14 0.07	

c: control sample.
a: application by aircraft.

Table 12. Residues of ziram (as CS_2) in peaches from foliar applications of ziram in supervised trials in France, Italy, Spain and the USA.

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
France, 1993 (Red Haven)	WG	2.4	0.24	3 dt[1]	0	fs 2.1 2.5 1.9	UCB B 93-6 B93508 93101-RU-010 RU 0593
					7	fs 2.5 1.3 2.6	
					14	fs 1.1 0.43 0.45	
					21	fs 0.24 0.47 0.55	
					28	fs 0.69 0.32 0.70	
Italy, 1992 (Red Haven)	WG	2.4	0.16	3	0	5.1	UCB 211
					7	2.1	
					10	0.96	
					15	1.8	
					20	0.64	
Italy, 1993 (Red Haven)	WG	2.4	0.16	2	7	1.0	304646 RA-2082/93
				3	0	2.0 c 0.06	
					10	1.4	
					21	1.3	

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[1] Thiram applied in March.

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
					28 35	1.0 c0.14 0.53	
Spain, 1994 (Baby Gold 8)	WG	2.3	0.23	3	0 14 21	fs 3.4 2.0 1.4 fs 0.89 0.40 0.65 fs 0.89 0.94 0.55	94021/01-FPPF Loc1
Spain, 1994 (Maria Serena)	WG	2.3	0.23	3	0 14 21	fs 2.5 1.7 2.1 fs 1.8 0.80 0.80 fs 1.4 0.70 0.75	94021/01-FPPF Loc2
USA (CA), 1988 (Fairtimes)	WG	6.8	1.5	7	30 45 60	<0.03 (2) 0.05 0.03 0.63 0.34 0.41 0.58 0.08 0.77 0.67 0.12	88B-88
USA (CA), 1988 (Ryanson)	WG	6.8	1.45	8	30 45 60	0.49 0.44 0.42 0.50 0.11 0.22 0.27 0.26 0.12 0.34 0.29 0.31	88A-88
USA (CA), 1988 (Fairtimes)	WG	6.8	7.7	7 a	30 45 60	0.07 0.04 0.03 0.03 0.07 0.03 0.08 0.08 0.03 0.03 0.03 0.04	88G-88
USA (MI), 1988 (Harbelle)	WG	6.7	0.40	10	7 14	3.4 2.3	87C-88
USA (NJ), 1988 (Red Haven)	WG	6.8	1.2	10	7 14 21	<0.03 0.43 0.34	87B-88
USA (SC), 1988 (Crest Haven)	SC	6.8	1.45	10	7 14 21	12 5.3 4.8	87A-88
USA (WA), 1988 (Delp Hale)	WG	6.8	1.45	9	30 45 60	0.72 0.58 0.67	88F-88

dt: other dithiocarbamates also used during the growing period.
fs: fruit without stone.
c: control sample.
a: application by aircraft.

Table 13. Residues of ziram (as CS_2) in plums from foliar applications of ziram in supervised trials in France and Spain.

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
France, 1994 (Ente 707)	WG	2.3	0.23	3	0 7 14 21	0.65 1.8 0.70 0.80 0.45 1.7 1.7 0.25 1.0 c0.15 0.50 0.30 0.45	94021/02-FPPL
Spain, 1994 (Red Beaut)	WG	2.3	0.23	3	0 8 14	0.65 0.20 0.30 <0.2 0.2 <0.2 2.5 <0.2 0.3	94021/01-FPPL

Country, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
					21 28	0.40 0.2 <0.2 <0.2 <0.2 <0.2	

c: control sample.

Table 14. Residues of ziram (as CS_2) in almond kernels from foliar applications of ziram on almond orchards in supervised trials in the USA.

State, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
CA), 1988 (Nonpareil)	WG	6.8	1.45	4 3	149 184	<0.02 <0.02	80A-88
CA), 1988 (Nonpareil)	SC	6.8	1.45	4 3	149 184	<0.02 <0.02	80A-88
CA), 1988 (Nonpareil)	WP	6.8	1.45	4 3	149 184	<0.02 <0.02	80A-88
CA), 1988 (Monterey)	SC	6.8	1.45	4 3	167 205	0.03 (3) <0.02 <0.02 (4)	80B-88
CA), 1988 (Monterey)	WG	6.8	1.45	4 3	167 205	<0.02 (4) <0.02 (4)	80B-88
CA), 1988 (Monterey)	WP	6.8	1.45	4 3	167 205	<0.02 (4) <0.02 (4)	80B-88
CA), 1988 (Nonpareil)	WG	6.8	1.45	4 3	143 178	<0.02 (4) <0.02 (4)	80C-88
CA), 1988 (Nonpareil)	SC	6.8	1.45	4 3	143 178	<0.02 (4) <0.02 (4)	80C-88
CA), 1988 (Nonpareil)	WP	6.8	1.45	4 3	143 178	<0.02 (4) <0.02 (4)	80C-88
CA), 1988 (Nonpareil)	SC	8.2	8.7	a 4 a 3	142 177	<0.02 (4) <0.02 (4)	80E-88
CA), 1988 (Monterey and Carmel)	WG	6.8	7.3	a 4	176	<0.02 (4)	80F-88
CA), 1988 (Nonpareil)	WG	6.8	2.4	4 3	156 191	<0.02 (4) <0.02 (4)	80G-88
CA), 1988 (Nonpareil)	WG	6.8	1.4-1.8	4	139	<0.02 (4)	80H-88

a: aerial application

Table 15. Residues of ziram (as CS_2) in pecan kernels from foliar applications of ziram in the USA.

State, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
GA, 1988 (Stuart)	SC WG WP	6.8 6.8 6.8	0.77 0.77 0.77	8 8 8	51 51 51	<0.02 <0.02 <0.02	91A-88
TX, 1988 (Wichita)	SC WG	6.8 6.8	0.40 0.40	8 8	57 57	0.03 <0.02	91B-88
OK, 1988 (indigenous)	SC	6.8	1.0	8	63	<0.02	91D-88
NM, 1988 (Western Schley)	SC	5.6	0.30	8	83	<0.02	91E-88

Table 16. Residues of ziram (as CS_2) in almond hulls from foliar applications of ziram on almond orchards in supervised trials in the USA.

State, year (variety)	Application				PHI, days	Ziram residues as CS_2, mg/kg	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
CA, 1988 (Nonpareil)	WG	6.8	1.45	4 3	149 184	2.8 0.24	80A-88
CA, 1988 (Nonpareil)	SC	6.8	1.45	4 3	149 184	4.6 0.60	80A-88
CA, 1988 (Nonpareil)	WP	6.8	1.45	4 3	149 184	2.0 0.43	80A-88
CA, 1988 (Monterey)	SC	6.8	1.45	4 3	167 205	8.8 6.2 6.0 4.9 0.28 0.60 0.35 0.34	80B-88
CA, 1988 (Monterey)	WG	6.8	1.45	4 3	167 205	4.9 4.3 5.3 4.2 0.17 0.18 0.19 0.17	80B-88
CA, 1988 (Monterey)	WP	6.8	1.45	4	167	5.0 5.0 5.8 3.6	80B-88
CA, 1988 (Nonpareil)	WG	6.8	1.45	4 3	143 178	5.4 6.1 5.7 5.0 0.47 0.33 0.23 0.25	80C-88
CA, 1988 (Nonpareil)	SC	6.8	1.45	4 3	143 178	8.4 8.4 5.0 9.3 0.71 0.71 1.1 0.64	80C-88
CA, 1988 (Nonpareil)	WP	6.8	1.45	4 3	143 178	6.4 6.7 6.1 5.3 0.42 0.52 0.42 0.86	80C-88
CA, 1988 (Nonpareil)	SC	8.2	8.7	4 a 3 a	142 177	3.0 3.5 4.5 3.1 1.3 1.3 1.1 1.3	80E-88
CA, 1988 (Monterey and Carmel)	WG	6.8	7.3	4 a 3 a	176 211	1.8 3.0 0.85 1.5 0.20 0.18 0 14 0.18	80F-88
CA, 1988 (Nonpareil)	WG	6.8	2.4	4 3	156 191	1.3 1.0 0.92 0.86 0.31 0.46 0.20 0.21 c 0.12	80G-88
CA, 1988 (Nonpareil)	WG	6.8	1.4-1.8	4 3	139 174	0.02 0.62 6.9 6.0 0.38 0.40 0.37 0.34	80H-88

c: control sample.

a: aerial application

FATE OF RESIDUES IN STORAGE AND PROCESSING

In storage

No information was available.

In processing

Information was made available on the fate of ziram residues during the processing of apples.

In a 1989 US processing study Monroe apples in an orchard in New York were treated 7 times by airblast spray with ziram at an exaggerated rate of 34 kg ai/ha (9.1 kg ai/hl) and harvested 5 days after the final treatment for processing (Meikle, 1992). Lots of approximately 60 kg apples were processed into juice and pomace. The processing equipment included a hammer-mill, a crusher-stemmer, a press and a drier. Apples and processed commodities were analysed for ziram by a CS_2 evolution method.

Commodity	Ziram (as CS_2), mg/kg
Apple, whole fruit	8.4
Apple juice	0.79 0.84
Wet pomace	10.8 11.7
Dry pomace	15.1 15.4

The process did not include washing the fruit. Juice had no additional filtering after the press cloth. Wet pomace was dried at 77-88°C for 1-4 hours to achieve a moisture level below 10% (dry pomace).

Ziram residue levels in the juice were about 10% of those in the apples, while levels in the wet pomace were slightly higher than in the apples. Levels in dry pomace were 30-40% higher than in the wet pomace. Much of the ziram residues must be lost during the drying process because dry pomace is 20-25% by weight of wet pomace.

Residues in the edible portion of food commodities

Ziram residue levels in apple juice were about 10% of the levels in the apples.

RESIDUES IN FOOD OR AT CONSUMPTION

Monitoring data on dithiocarbamates are included in the monograph on thiram.

NATIONAL MAXIMUM RESIDUE LIMITS

National MRLs for dithiocarbamates are included in the monograph on thiram.

APPRAISAL

Ziram was originally evaluated in 1965 (toxicology) and 1967 (toxicology and residues) and is included in the dithiocarbamate group of compounds. It was evaluated at the present Meeting within the CCPR periodic review programme.

Ziram is a dithiocarbamate contact fungicide with protective action and is registered for use on fruit, vegetables, tree nuts and ornamentals in many countries. Ziram, applied to dormant fruit trees, is also used to repel hares and rabbits.

The Meeting received information on the metabolism of ziram in goats and apples, methods of residue analysis, the stability of residues in stored analytical samples, approved use patterns, supervised residue trials and the fate of residues during the processing of apples.

Ziram is hydrolysed very quickly at pH 5 (half-life 10.4 minutes) and more slowly at pH 7 (half-life 17.7 hours) and pH 9 (half-life 6.3 days). The major hydrolysis product at pH 5 and 7 is CS_2. At pH 9 CS_2 was produced, but dimethyldithiocarbamic acid, carbon oxysulphide, isothiocyanic or thiocyanic acid and *N*,*N*-dimethylformamide were also identified.

When two lactating goats were dosed for 6 days with [*thiocarbonyl*-^{14}C]ziram at a rate equivalent to 300 ppm ziram in the feed the levels of ^{14}C in milk increased for the first 2 or 3 days of feeding and then reached a plateau. A large part of the administered ^{14}C was not accounted for (39% and 58%). By analogy with the animal metabolism of thiram losses as CS_2 and CO_2 in expired air would be expected, but ^{14}C was not measured in the expired air. More of the ^{14}C dose was in the faeces (42% and 61%) than in the urine (3%), tissues (0.93% and 0.78%) or milk (0.28% and 0.51%).

The levels of ^{14}C were higher in the liver than in other tissues and approximately 10% of the ^{14}C in the liver was liberated as CS_2 when treated with hot acid. Liberated CS_2 was not detected in the other tissues and milk but the total ^{14}C levels were generally too low to expect its detection. The ^{14}C residues in the milk and tissues were not extractable until after protease treatment. The liberated ^{14}C was present in polar water-soluble compounds. Since lactose and casein containing ^{14}C were isolated from milk some ^{14}C had evidently been incorporated into natural products.

Because of the fairly rapid hydrolysis of ziram the parent compound would not be expected to occur in animal tissues, which generally agrees with the findings of the goat metabolism study. Dimethyldithiocarbamic acid, identified as a hydrolysis product of ziram at pH 9, was the major intermediate in the metabolism of thiram. It is probably also a hydrolysis product of ziram at lower pHs, but would disappear too quickly for identification. The presence of dimethyldithiocarbamic acid as a hydrolysis product suggests that the metabolites of ziram are likely to be the same as those of thiram.

When apples and apple leaves on a tree were treated with [*thiocarbonyl*-^{14}C]ziram the parent compound was detected in washings from the apples and leaves 0, 14 and 28 days after treatment. Residues on the surface disappeared more quickly than incorporated residues. The parent compound was detected in the pulp from apples sampled on the day of treatment, but not at later sampling times. The extractable incorporated ^{14}C was in polar material and was not identified because the reference compounds which had been chosen as possible metabolites did not correspond to the ^{14}C fractions.

Extracts of apple peel and pulp were analysed by a CS_2 evolution head-space GLC procedure. CS_2-related residues were not detected in the extracts of pulp, but constituted up to 5% of the total ^{14}C residues in the peel. In whole-apples the highest level of CS_2-related residue was 0.016 mg/kg as CS_2.

Ziram residues are essentially on the surface. Most of the residue which becomes incorporated into tissue no longer contains the CS_2 structure. As in animal metabolism, because dimethyldithiocarbamic acid is a hydrolysis product of ziram it is quite likely that the plant metabolites of ziram are the same as those of thiram.

Studies of environmental fate were not provided for review by the FAO Panel, but the Meeting was informed that studies were available and had been supplied to the Environmental Core Assessment Group. They would be supplied for future evaluation by the FAO Panel. The Meeting agreed that the recommended MRLs would be temporary pending the review of data on environmental fate by the FAO panel.

The analytical methods for ziram residues rely on acid hydrolysis to release CS_2, which is then measured colorimetrically or by head-space gas chromatography. The methods are the same as those for other dithiocarbamates (see also the monograph on thiram). The methods used in the trials gave satisfactory recoveries and LODs were about 0.05-0.1 mg/kg.

The Meeting received information on the frozen storage stability of ziram residues in apples, peaches, almond kernels and almond hulls.

Ziram in macerated apples fortified at 1 mg/kg and stored at -20°C was stable for the duration of the test (18 weeks).

Ziram in macerated apples and peaches fortified at 2 mg/kg stored at -20±2°C was of marginal stability (about 70% remaining) after 3 months storage and had decreased to approximately half the fortification level after 6 months. Ziram residues were stable in almond kernels and almond hulls at -20±2°C for the intervals tested, 6 months and 3 months respectively.

The Meeting was informed that storage stability studies are in progress on ziram residues in whole peaches, whole apples, almond kernels and almond hulls. Summary data for 12 months storage generally showed adequate stability but the Meeting agreed to await full reports of the studies.

Ziram residues are measured as evolved CS_2 by the methods that are used for the other dithiocarbamates. All samples from supervised trials on ziram have been analysed by these methods. The Meeting agreed that ziram should be included in the definition of the dithiocarbamate residues.

For estimates of dietary intake and comparison of calculated intakes with the ADI it is preferable to express the residues as ziram because the ADI is expressed in terms of ziram.

Because the residues in the supervised trials are expressed as CS_2 it is convenient to discuss them in this form and convert them to a ziram basis (ziram = $CS_2 \times 2.01$) for recommendations for STMRs.

The Meeting received data from supervised residue trials on, apples (Belgium, France, Italy, The Netherlands, Spain, USA), pears (Belgium, France, Italy, The Netherlands, Spain, USA), apricots (USA), cherries (Spain, USA), nectarines (Italy, USA), peaches (France, Italy, Spain, USA), plums (France, Spain), almonds (USA), pecans (USA) and almond hulls (USA).

The residues are expressed as CS_2 in the following discussion. In some trials other dithiocarbamates had been used on the crop; if this occurred during the growing season the trials were not considered valid for ziram.

Because the frozen storage stability studies had shown that ziram residues in fruit had decreased to about 70% of the initial level after 3 months freezer storage, trials on fruit were considered invalid where no information was provided on the storage conditions or duration or where the duration of storage was excessive. Residues would be expected to be more stable when samples were stored as whole unchopped fruit, as was demonstrated by the storage stability of thiram on whole plums. The stability of ziram and thiram in frozen storage should be comparable.

In France ziram is registered for use on apples at 2.2 kg ai/ha with a PHI of 14 days. The residues in apples in a trial in Belgium where ziram was used at 2.4 kg ai/ha were 0.58 and 0.61 mg/kg as CS_2 14 and 28 days after the final application respectively. In 3 trials in France also close to the registered use pattern dithiocarbamate residues as CS_2 were 0.53, 1.4 and 2.4 mg/kg. The residue as CS_2 was 0.70 mg/kg in an apple trial in The Netherlands which closely followed French GAP.

In Italy ziram is registered for use on apples at 2.3 kg ai/ha (0.23 kg ai/hl) with a PHI of 10 days. In a trial in Italy at 2.4 kg ai/ha the residues was 0.90 mg/kg as CS_2 10 days after the final application.

Ziram is registered in Spain for use on pome fruit at a spray concentration of 0.25-0.35 kg ai/hl with a PHI of 7 days. Residues of 3.0 mg/kg as CS_2 were recorded in apples in a Spanish trial 21 days after application at 0.23 kg ai/ha. Although this residues was obtained from an application approximating GAP and residues appeared to be decreasing quite slowly 21 days is too remote from 7 days to be considered for evaluation.

US GAP on apples permits ziram applications at 5.2-6.8 kg ai/ha with harvest 14 days after the final application. In 8 US trials according to this use pattern residues as CS_2 in apples were 0.16, 0.97, 0.98, 1.1, 1.4, 1.8, 2.4 and 3.5 mg/kg. In 3 of the trials the residues at 21 days were higher than at 14 days and are therefore included in the evaluation.

In summary, ziram residues as CS_2 in apples from 14 trials in rank order (median underlined) were 0.16, 0.53, 0.61, 0.70, 0.90, 0.97, 0.98, 1.1, 1.4, 1.4, 1.8, 2.4, 2.4 and 3.5 mg/kg.

GAP for pears in The Netherlands permits the application of 2.3 kg ai/ha (0.15 kg ai/hl) of a WP formulation and harvest 14 days after the last of 4 applications. Trials with WG formulations in Belgium, France and The Netherlands were evaluated according to this use pattern because in this situation residues from the use of WP and WG formulations would be expected to be similar. Ziram residues as CS_2 in 1 Belgian trial, 2 French trials and 1 trial in the Netherlands approximating Netherlands GAP were 0.66, 3.8, 1.6 and 0.58 mg/kg. In the French trials residues from longer PHIs were higher and replaced the residue at the GAP PHI.

In Italy ziram is registered for use on pears at 2.3 kg ai/ha (0.23 kg ai/hl) with a PHI of 10 days. In a trial in Italy at 2.8 kg ai/ha the ziram residue was 0.64 mg/kg as CS_2 10 days after the final application.

Ziram is registered in Spain for use on pome fruit at a spray concentration of 0.25-0.35 kg ai/hl with a PHI of 7 days. Ziram residues of 1.9, 1.6 and 1.1 mg/kg as CS_2 were recorded in pears in 3 sub-plots of a Spanish trial where fruit were harvested 7 days after the final ziram application at a spray concentration of 0.23 kg ai/hl, which is at the lower end of the acceptable range for evaluation purposes.

US GAP on pears allows ziram application at 5.2-6.8 kg ai/ha with a PHI of 5 days in the west and 14 days in the east. Residues as CS_2 in 2 US trials according to these 2 use patterns were 0.94 and 2.0 mg/kg. A third US trial could not be evaluated because other dithiocarbamates had been used during the growing period.

In summary, valid results on pears were available from 8 trials with residues as CS_2 or 0.58, 0.64, 0.66, 0.94, 1.6, 1.9, 2.0 and 3.8 mg/kg.

The Meeting concluded that the residues in apples and pears appeared to be from similar populations and could be combined to represent pome fruit. Ziram residues as CS_2 in pome fruit in rank order (median underlined) were 0.16, 0.53, 0.58, 0.61, 0.64, 0.66, 0.70, 0.90, 0.94, 0.97, 0.98, 1.1, 1.4, 1.4, 1.6, 1.8, 1.9, 2.0, 2.4, 2.4, 3.5 and 3.8 mg/kg.

The Meeting estimated a maximum residue level of 5 mg/kg as CS_2 for dithiocarbamates in pome fruits arising from the use of ziram and noted that this level was consistent with the MRL already established. The Meeting estimated an STMR for ziram on pome fruit of 1.04 mg/kg as CS_2, equivalent to 2.1 mg/kg as ziram.

US GAP on apricots permits application of ziram at 6.8 kg ai/ha and harvest of the fruit 30 days after the final application. The maximum ziram residues as CS_2 with GAP on apricots from 3 US trials at 6.8 kg ai/ha and 1 US trial at 5.1 kg ai/ha were 1.6, 3.7, 4.8 and 5.3 mg/kg.

The stone fruit registration in Spain permits 4 ziram applications at spray concentrations of 0.25-0.35 kg ai/hl with a 7-day PHI. In two Spanish trials on cherries where ziram was applied at 0.23 kg ai/hl and fruit were harvested 7 days after the last of 3 applications the residues as CS_2 in the three sub-plots of each trial were 0.45, 0.60 and 0.70 mg/kg and 0.55, 0.85 and 0.85 mg/kg.

US GAP for cherries permits ziram application at 3.4-4.3 kg ai/ha with 7- and 14-day PHIs in the west and east respectively. The application rate in the US trials was 5.1 kg ai/ha, but data from 3 trials could not be used because the shortest interval between the final application and harvest was 30 days, which is too remote from the registered 7 days. In the remaining 2 trials the residues as CS_2 14 days after the final application were 0.84 and 0.79 mg/kg (replaced for evaluation by residues at 14 days of 1.3 mg/kg).

In summary, the residues as CS_2 from the 4 valid trials on cherries were 0.70, 0.84, 0.85, and 1.3 mg/kg.

The stone fruit registration in Italy permits ziram applications at 2.4 kg ai/ha (spray concentrations of 0.15-0.20 kg ai/hl) with a 10-day PHI. In an Italian trial on nectarines ziram was applied at 2.4 kg ai/ha. The residues as CS_2 were 0.27 mg/kg after 10 days and 0.28 mg/kg after 21 days.

The US registration for nectarines permits ziram application at 6.8 kg ai/ha with harvest 14 and 30 days after the final application in the east and west respectively. The residues as CS_2 in 2 nectarine trials from the west and 1 from the east according to these use patterns were 0.12, 0.20 and 1.1 mg/kg.

In summary, residues as CS_2 from the 4 valid trials on nectarines were 0.12, 0.20, 0.28 and 1.1 mg/kg.

In 2 Italian trials on peaches according to GAP the residues as CS_2 were 1.4 and 0.96 mg/kg after 10 days. In the second trial the residue at 15 days was 1.8 mg/kg and this higher residue was used for evaluation.

Ziram may be applied 3 times at 2.2 kg ai/ha to peaches with harvest 14 days after the final application according to the registration in France. One trial in France and 2 in Spain conformed to this use pattern and the maximum residues as CS_2 in each trial were 1.1, 0.94 and 1.8 mg/kg.

US GAP for peaches is the same as for nectarines. The residues as CS_2 in 3 peach trials according to the use pattern in the east were 0.43, 2.3 and 5.3 mg/kg. The highest residues as CS_2 in each of 4 trials according to the use pattern in the west were 0.08, 0.50, 0.72 and 0.77 mg/kg. In one of these trials the residue in a 60-day sample, 0.77 mg/kg, was much higher than the residues in samples from 30 days, 0.03 and 0.05 mg/kg.

In summary, the residues as CS_2 from the 12 valid trials on peaches (median underlined) were 0.08, 0.43, 0.50, 0.72, 0.77, 0.94, 1.1, 1.4, 1.8, 1.8, 2.3 and 5.3 mg/kg

In a Spanish trial on plums according to GAP for stone fruit where ziram was applied at 0.23 kg ai/hl and fruit were harvested 8 days and after the final application ziram residues as CS_2 in the three sub-plots of the trial were <0.2, <0.2 and 0.2 mg/kg. Residues in plums harvested on day 14 were <0.2, 0.3 and 2.5 mg/kg. The 2.5 mg/kg value seemed inconsistent with the other results, but the analysis had been repeated. A French trial where ziram was applied to plums at a spray concentration of 0.23 kg ai/hl and fruit were harvested 7 days after the final application was evaluated against Spanish GAP. The residues as CS_2 in the three sub-plots were 0.45, 0.80 and 1.7 mg/kg. In summary, the residues as CS_2 on plums from two valid trials were 1.7 and 2.5 mg/kg.

The use patterns for ziram on the different stone fruits within a country are generally the same and the Meeting concluded that the data from the trials on stone fruits could be combined although the residues on apricots tended to be higher than on the other fruits. The residues from the valid trials were 3.7, 4.8, 5.3 mg/kg on apricots, 0.70, 0.84, 0.85, 1.3 mg/kg on cherries, 0.12, 0.20, 0.28, 1.1 mg/kg on nectarines, 0.08, 0.43, 0.50, 0.72, 0.77, 0.94, 1.1, 1.4, 1.8, 1.8, 2.3, 5.3 mg/kg on peaches and 1.7, 2.5 mg/kg on plums. The residues as CS_2 in 26 trials on stone fruit in rank order (median underlined) were 0.08, 0.12, 0.20, 0.28, 0.43, 0.50, 0.70, 0.72, 0.77, 0.84, 0.85, 0.94, 1.1, 1.1, 1.3, 1.4, 1.6, 1.7, 1.8, 1.8, 2.3, 2.5, 3.7, 4.8, 5.3 and 5.3 mg/kg .

The Meeting estimated a maximum residue level of 7 mg/kg (as CS_2) for dithiocarbamates in stone fruit arising from the use of ziram and an STMR of 2.2 mg/kg as ziram (1.1 mg/kg as CS_2) for ziram in stone fruit.

Ziram is registered for use on almonds in the USA with an application rate of 6.8 kg ai/ha and with the last of 3 applications to be completed by 5 weeks after petal fall. The pre-harvest intervals in the supervised trials were in the range 139-167 days and the conditions were taken to comply with US GAP. In 12 of the 13 trials no residues were detected (<0.02 mg/kg as CS_2) while in one trial the residue was 0.03 mg/kg. The median residue for the 13 trials was <0.02 mg/kg.

The Meeting estimated a maximum residue level of 0.1* mg/kg CS_2 in almonds from the use of ziram. This is a practical LOD which can be achieved by regulatory methods. The Meeting estimated an STMR of 0.04 mg/kg as ziram (0.02 mg/kg as CS_2) for ziram in almonds.

The residues as CS_2 on the almond hulls from the 13 almond trials in rank order (median underlined) were 1.3, 2.0, 2.8, 3.0, 4.5, 4.6, 5.3, 5.8, 6.1, 6.7, 6.9, 8.8 and 9.3 mg/kg. No information was available on the moisture content of the almond hulls; residue levels in animal feed materials should be expressed on a dry-weight basis.

The Meeting estimated a maximum residue level of 10 mg/kg for dithiocarbamates as CS_2 on almond hulls arising from the use of ziram and an STMR of 10.6 mg/kg as ziram (5.3 mg/kg as CS_2) for ziram on almond hulls.

Ziram is registered for use on pecans in the USA with an application rate of 6.8 kg ai/ha and a PHI of 55 days. In the 7 trials the interval between the final application and harvest was 51-83 days. In 6 of the 7 trials no residues were detected (<0.02 mg/kg as CS_2) while in one trial the residue was 0.03 mg/kg. The median residue for the 7 trials was <0.02 mg/kg.

The Meeting estimated a maximum residue level of 0.1* mg/kg CS_2 in pecans from applications of ziram, taking into account MRLs recommended by the 1993 JMPR for dithiocarbamates in almonds and peanut at a practical LOD of 0.1* mg/kg, and an STMR of 0.04 mg/kg as ziram (0.02 mg/kg as CS_2) for ziram in pecans.

In a processing study on apples sprayed with ziram at an exaggerated rate (34 kg ai/ha) ziram residue levels in the juice were about 10% of those in the apples while the residues in the wet pomace were 1.34 times those in the apples. The levels of ziram in dry pomace were 30-40% higher than in wet pomace which suggests loss of ziram during the drying process because dry pomace is only 20-25% by weight of wet pomace. The processing factors from apples to juice, wet pomace, and dry pomace were 0.097, 1.34 and 1.82 respectively. The process did not include a washing step. Because ziram residues are on the apple surface a commercial process with an initial washing and cleaning step would be expected to reduce the residue.

The supervised trials median residues (STMR-Ps) for the processed apple commodities, calculated from the processing factors and the STMR for pome fruit (2.1 mg/kg) are apple juice 0.204 mg/kg, wet apple pomace 2.81 mg/kg, dry apple pomace 3.82 mg/kg, all expressed as ziram.

Monitoring data for dithiocarbamate residues in commodities in trade are included in the monograph on thiram.

RECOMMENDATIONS

On the basis of the data from supervised trials the Meeting estimated the maximum residue levels listed below, which are recommended for use as TMRLs. The estimates are temporary pending the review of data on environmental fate. Consolidated recommendations for MRLs for dithiocarbamates are listed in the monograph on dithiocarbamates.

Definition of the residue

For compliance with MRLs: The MRLs refer to total dithiocarbamates, determined as CS_2 evolved during acid digestion and expressed as mg CS_2/kg.

For estimation of dietary intake: ziram.

Residues expressed as ziram may be calculated from residues expressed as CS_2 from the relation ziram = $CS_2 \times 2.01$.

Commodity		Recommended MRL[1], mg/kg		Based on PHI, days	STMR[2], mg/kg	STMR-P[2], mg/kg
CCN	Name	New	Current			
AM 0660	Almond hulls	10 T	20		10.6	
TN 0660	Almonds	0.1* T	0.1*		0.04	
TN 0672	Pecan	0.1* T		51-83	0.04	
FP 0009	Pome fruits	5 T	5	5-15	2.1	
FS 0012	Stone fruits	7 T		7-30	2.2	
	Apple juice					0.204
	Apple pomace, wet					2.81
	Apple pomace, dry					3.82

[1] Expressed as CS_2.
[2] Expressed as ziram.

FURTHER WORK OR INFORMATION

Required (by 1997)

Information on the environmental fate of ziram in soil and in water/sediment systems.

Desirable

1. Information on the effect of washing on ziram residues on fruits.

2. Final reports of freezer storage stability studies now in progress on peaches, apples and almonds.

3. Information on attempts to develop specific methods of analysis for ziram, whether successful or not.

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