MANCOZEB (50)

EXPLANATION

Mancozeb was originally evaluated in 1967, and has been reviewed several times since. MRLs for dithiocarbamate fungicides were consolidated by the CCPR into a combined list in 1977 under the heading DITHIOCARBAMATES (105).

Mancozeb was scheduled for re-evaluation in 1993 in the CCPR periodic review programme.

The Meeting was provided with extensive information on use patterns, supervised residues trials, fate of residues, and miscellaneous studies by the Mancozeb Task Force and basic manufacturers. Information was also supplied by Australia, Canada, Finland, Germany and Spain.

IDENTITY

ISO common name: mancozeb
Chemical name:

IUPAC manganese ethylenebis(dithiocarbamate)(polymeric) complex with zinc salt

CA [[1,2-ethanediylbis[carbamodithioato]](2-)]manganese mixture with [[1,2-ethanediylbis[carbamodithioato]](2-)]zinc

CAS No: 8018-01-7
CIPAC No: CIPAC-34
Synonyms: Dithane M-45^{R}, Penncozeb®, Manzate^{R} 200

Structural formula:

$$[-MnSC(:S)NHCH_2CH_2NHC(:S)S-]_x\ Zn_y \quad \text{where } x/y = 11$$

A polymer coordination complex of zinc and manganese ethylenebis(dithiocarbamate) containing 20% manganese and 2.5% zinc.

Molecular weight per monomer unit: 271.2

Physical and chemical properties

Pure active ingredient

Vapour pressure: Negligible
Solubility: Water, 6 mg/l at 25°C (Schweitzer, 1987). Essentially insoluble in most organic solvents.
Hydrolysis: Half-lives for aqueous hydrolysis of 10 mg/l suspended in distilled water:

pH 5: 36 hours
pH 7: 55 hours
pH 9: 16 hours

Technical material

Dithane M-45 is a polymeric, non-crystalline solid, a light yellow free-flowing powder with decomposition occurring at 150°C, a slight sulphurous odour, and an active ingredient content of about 80%.

Bulk density: 0.43 (loose), 0.48 (packed).
Stability: Stable in the absence of moisture, heat, flame, oxidising agents and acids. Decomposed by water under acidic conditions. Thermal decomposition may yield carbon disulphide and hydrogen sulphide.

USE PATTERN

Mancozeb is a protective fungicide effective against a wide range of foliar fungal diseases. It is registered for use in many countries on horticultural and agricultural food crops as well as on ornamentals and tobacco, and in forestry.

The registered uses of mancozeb are summarized in Tables 1-11.

Table 1. Citrus fruits.
Table 2. Pome fruits.
Table 3. Stone fruits.
Table 4. Berries and other small fruits.
Table 5. Tropical and subtropical fruits.
Table 6. Bulb vegetables and root and tuber vegetables.
Table 7. Brassica vegetables, leafy vegetables, and stalk and stem vegetables
Table 8. Fruiting vegetables.
Table 9. Legume vegetables.
Table 10. Cereals, tree-nuts and oilseed crops.
Table 11. Miscellaneous crops, including hops, coffee and tea.

Table 1. Registered uses of mancozeb on citrus fruits.

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Citrus fruits	Australia	2	6.0-13	0.16	
Citrus fruits	Brazil	4		0.12	14
Citrus fruits	Chile	2	3.0-7.7	0.14-0.19	21
Citrus fruits	Japan	2	1.9-4.0	0.094-0.19	60
Citrus fruits	Korea	2	5.2	0.15	21
Citrus fruits	Spain	2	13	0.32	15
Citrus fruits	Taiwan	3	3.2	0.16	40

Table 2. Registered uses of mancozeb on pome fruits.

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Apple	Australia	6	2.3-4.8	0.11-0.16	14
Apple	Brazil	10		0.16	7
Apple	Canada	6	4.5	0.53	45
Apple	Chile	6	2.9-5.8	0.14-0.19	21
Apple	France		1.6	0.16	
Apple	Japan	3	6.3-9.4	0.13-0.19	60

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Apple	Korea	2	7.5	0.15	21
Apple	Netherlands			0.15-0.16	
Apple	Portugal	4	1.6	0.16	15
Apple	Spain	3	2.4	0.16	15
Apple	UK			0.15-0.2	30
Apple	USA	4	5.4		not past bloom
Apple	USA	7	2.7		77
Crab-apple	USA	4	5.4		not past bloom
Crab-apple	USA	7	2.7		77
Medlar	Spain	3	2.4	0.16	15
Pear	Australia	8	2.3-4.8	0.11-0.16	14
Pear	Brazil	10		0.16	14
Pear	Canada	3	4.0-6.5	0.6	45
Pear	Chile	6	2.9-5.8	0.14-0.19	15
Pear	Japan	5	5.0-7.5	0.13-0.19	45
Pear	Korea	1	7.5	0.15	14
Pear	Netherlands			0.15-0.16	
Pear	Portugal	4	1.6	0.16	15
Pear	UK			0.15-0.2	30
Pear	USA	4	5.4		not past bloom
Pear	USA	7	2.7		77
Pome fruits	Austria	8	2.4-3.2	0.16	45
Pome fruits	Belgium	8		0.12-0.16	14
Pome fruits	Bulgaria	8	2.4-3.6	0.24	45
Pome fruits	Eire	10	3.6		28
Pome fruits	France	10		0.16	
Pome fruits	Germany	12	1.3-2.4	0.16	28
Pome fruits	Greece	6	4.0	0.2	7
Pome fruits	Hungary	8	2.1-3.2	0.16	45
Pome fruits	Italy	12	3.2	0.16	28
Pome fruits	Netherlands	4	1.2	0.12	56
Pome fruits	Romania	8	2.1-3.6	0.15-0.18	45
Pome fruits	Switzerland	4	1.2	0.12	21
Pome fruits	Turkey	6	4.0	0.2	21
Pome fruits	UK	10	3.6	0.18	28
Quince	USA	4	5.4		not past bloom
Quince	USA	7	2.7		77

Table 3. Registered uses of mancozeb on stone fruits.

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Apricot	Australia	2	2.3-4.8	0.11-0.16	14
Apricot	Chile	5	2.9-3.8	0.14-0.19	14
Cherry	Australia	2	2.3-4.8	0.11-0.16	14
Cherry	France	Po[1]		0.16	
Nectarine	Australia	2	2.3-4.8	0.11-0.16	14
Nectarine	Chile	5	2.9-3.8	0.14-0.19	14
Peach	Australia	2	2.3-4.8	0.11-0.16	14
Peach	Brazil	10		0.16	
Peach	Chile	5	2.9-3.8	0.14-0.19	14
Peach	Spain	2	2.4	0.16	15
Plum	Australia	2	2.3-4.8	0.11-0.16	14
Plum	Brazil	6		0.16	21
Plum	Chile	5	2.9-3.8	0.14-0.19	14
Plum	France	3		0.16	30
Stone fruits	Austria	4	2.1-3.2	0.16	45-60
Stone fruits	Bulgaria	4	2.1-3.2	0.24	45-60
Stone fruits	Germany	12	1.3-2.4	0.16	28
Stone fruits	Hungary	4	2.1-3.2	0.16	45-60
Stone fruits	Portugal	4	1.6	0.16	15
Stone fruits	Romania	4	2.3-3.2	0.16	45-60
Stone fruits	Spain	4	2.4-4.8	0.16-0.32	15
Stone fruits	Switzerland	2	1.6	0.16	21

[1] Po: Post-harvest.

Table 4. Registered uses of mancozeb on berries and other small fruits.

CROP	COUNTRY	APPLICATION			PHI, days [1]
		Max no.[2]	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Black currants	Eire	8	2.4		28
Black currants and gooseberries	Finland			0.16	
Black currants and gooseberries	UK	8	2.4	0.12	28
Cranberry	USA	3	5.4		30
Grapes	Australia	4	1.6-2.4	0.15	14
Grapes	Austria	5	0.80-1.9	0.24	40-60
Grapes	Brazil	8	2.8	0.28	7
Grapes	Bulgaria	5	2.4	0.24	40-60
Grapes	Canada	4	5.4	0.36	30
Grapes	Chile	3	2.2-3.8	0.14-0.19	66
Grapes	Columbia	15	1.7-4.8		30-45
Grapes	France	5+5	2.8 then 1.4		30
Grapes	Germany	8	0.96-4.8	0.16	56
Grapes	Greece	5	2.0	0.2	7
Grapes	Hungary	5	0.96-1.6	0.16	40-60
Grapes	Italy	6	1.6	0.16	28
Grapes	Japan	2fg	1.9-3.1	0.075-0.13	60
Grapes	Korea	?	3.7	0.12	30
Grapes	Philippines	12	0.6-1.5	0.2-0.38	
Grapes	Romania	5	0.96-1.6	0.16	40-60
Grapes	Spain	4	2.4		28
Grapes	Switzerland	4	1.4	0.2	1st postblossom
Grapes	Taiwan	3	2.0	0.13	14
Grapes	Turkey	5	1.6	0.16	21
Grapes	USA	6	2.2-3.6		66
Strawberry	Chile	4	0.9-2.7	0.14-0.19	2
Strawberry	France	5	1.6		
Strawberry	Japan	6g	1.9	0.13	76
Strawberry	Spain	2	1.6	0.16	3
Vine	Portugal	6	1.6-2.8	0.33-0.93	T 45, W 75

[1] T: table grapes; W: wine grapes.
[2] g: use in glasshouse; fg: use in field and glasshouse.

Table 5. Registered uses of mancozeb on tropical and subtropical fruits.

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Avocado	Brazil	10		0.16	21
Banana	Australia	24	1.7-3.6	0.16+oil	7
Banana	Brazil	1	2.0	0.2-4.0	21
Banana	Columbia	20	1.1-1.5		0
Banana	Philippines	5	1.6-2.2	5.3-7.2 a[1]	
Banana	Taiwan	8	1.6	5.3 a	14
Banana	USA	10	2.7		0
Fig	Brazil	6		0.16	21
Mango	Australia	10	1.6-2.4	0.16	14
Mango	Brazil	6		0.16	20
Mango	Malaysia	?		0.16-0.20	14
Mango	Philippines	12	4-7.5	0.20-0.38	
Mango	Taiwan	4	5.0	0.25	30
Olive	Greece	3	4.0	0.2	7
Olive	Spain	2	2.4	0.16	15
Papaya	Philippines	10	2.5-4.7	0.20-0.38	
Papaya	USA	14	2.2		0
Passion fruit	Australia	4	1.4	0.16	14
Persimmon	Japan	2	5.0-7.5	0.13-0.19	45

[1] Aerial application.

Table 6. Registered uses of mancozeb on bulb vegetables and root and tuber

vegetables.

CROP	COUNTRY	APPLICATION Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	PHI, days
Beet	Brazil	6	1.6	0.16	7
Beet	Columbia	4	0.8-2.4		7
Beetroot	Australia	4	1.3-1.8	0.11-0.16	14
Carrot	Australia	4	1.3-1.8	0.11-0.16	7
Carrot	Brazil	6	1.6	0.16	7
Carrot	Canada	4	1.8	0.3	7
Carrot	Columbia	4	0.8-2.4		7
Carrot	Portugal	2	1.6	0.16	
Carrot	Switzerland	3	1.0	0.2	21
Carrot	UK		1.4-1.8		7
Celeriac	Hungary	3	0.84-1.6	0.16	20-30
Chinese yam	Japan	4	3.1-4.7	0.13-0.19	21
Garlic	Philippines	15	1.6-3.0	0.2-0.38	7
Garlic	Brazil	4	1.6	0.16	7
Garlic	Chile	6	1.6-2.0	0.14-0.19	7
Garlic	France	8	1.6		21, 30 ?
Garlic	Japan	5	2.5-3.8	0.13-0.15	7
Garlic	Portugal	2	1.6	0.16	35
Garlic	Spain	2	1.6	0.16	35
Ginseng	Canada	6	3.5	0.18	30
Leek	Belgium	10		0.28	28
Leek	Chile	6	1.6-2.0	0.14-0.19	7
Leek	France	10	1.6		60
Leek	Japan	3	1.9-2.8	0.13-0.19	21
Leek	Philippines	15	1.6-3.0	0.2-0.38	7
Lotus (East Indian)	Japan	3fg[1]	1.1	3.8	1
Onion	Australia	5	1.6-2.8	0.11-0.16	7
Onion	Belgium	8	2.4		28
Onion	Brazil	4	1.6	0.16	7
Onion	Canada	5	2.6	0.43	10
Onion	Chile	6	1.6-2.0	0.14-0.19	7
Onion	France	8	1.6		30
Onion	Greece	4	2.0	0.20	3
Onion	Hungary	3	0.84-1.6	0.16	30-45
Onion	Japan	5	1.3-2.8	0.13-0.19	7
Onion	Korea		1.9	0.12	7
Onion	Netherlands	6	2.4	0.4	28
Onion	Philippines	15	1.6-3.0	0.2-0.38	7
Onion	Portugal	2	1.6	0.16	35
Onion	Romania	3	0.9-1.0	0.16	30-45
Onion	Spain	2	1.6	0.16	35
Onion	Sweden	5	0.5-2.0		30
Onion	Switzerland	5	1.0	0.2	21
Onion	Turkey	3	1.6	0.16	28
Onion	UK		1.8-2.7		7
Onion	USA	10	2.7		7
Potato	Australia	6	1.3-1.8	0.11-0.16	
Potato	Austria	5	1.6-2.4	0.27-0.40	30-45
Potato	Bangladesh		2		14
Potato	Belgium	10	1.5-3.2		21
Potato	Brazil	10	2.4	0.24	7
Potato	Bulgaria	5	0.96-1.6	0.16	30-45
Potato	Canada	6	1.8	0.3	1
Potato	Chile	10	0.9-1.9	0.14-0.19	
Potato	Columbia	10	0.8-2.4		15-20
Potato	Denmark	5	0.5-4		14
Potato	Eire	10	1.8		7
Potato	Finland	2	0.5-2.4		21
Potato	France	10	1.6		21
Potato	Germany	1	st[2]		
Potato	Germany	5	1.1		7
Potato	Greece	4	2.0	0.20	3
Potato	Hungary	5	0.84-1.6	0.16	30-45
Potato	Indonesia	12	0.96-1.9		7
Potato	Italy	6	2.4	0.24	28
Potato	Japan	7	1.9-9.4	0.13-0.19	14
Potato	Korea		1.9	0.12	14
Potato	Netherlands	14	2.4-3.2	0.4	14
Potato	Norway	5	0.5-2		14
Potato	Philippines	20	1.1-4.4	0.58	

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Potato	Portugal	4	1.6	0.16	28
Potato	Romania	5	1.6-2.0	0.26-0.33	30-45
Potato	Spain	4	1.6	0.16	28
Potato	Sweden	5	0.5-2.0		30
Potato	Switzerland	8	2.4	0.4	21
Potato	Turkey	4	1.6	0.16	14
Potato	UK	10	1.4		7
Potato	USA	7	1.8		3
Shallot	Belgium	8	2.4		28
Shallot	France	8	2		30
Shallot	Indonesia	5	0.8-1.6		7
Shallot	Philippines	15	1.6-3.0	0.2-0.38	7
Sugar beet	Canada	5	1.8		21
Sugar beet	Chile	5	1.8-2.7	0.14-0.19	14
Sugar beet	France	3	3.2		30
Sugar beet	Japan	4	1.9-2.8	0.13-0.19	45
Sugar beet	Spain	2	1.6		28
Sugar beet	USA	7	1.8		14

[1] Use in field and glasshouse.
[2] Seed treatment

Table 7. Registered uses of mancozeb on brassica vegetables, leafy vegetables and stalk and stem vegetables.

CROP	COUNTRY	APPLICATION	PHI, days

		Max no.[1]	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Artichoke	Spain	2	1.6	0.16	15
Asparagus	Belgium	8	2.8		28
Asparagus	France	8	1.6	0.16	
Asparagus	Germany	4	0.96		early applic
Asparagus	Netherlands	4	2.4	0.4	
Asparagus	Spain	4	1.6	0.16	15
Asparagus	USA	4	1.8		180
Asparagus	USA (CA, AZ)	4	1.8		120
Broccoli	Australia	4	1.3-1.8	0.11-0.16	7
Broccoli	Brazil	8	1.6	0.16	7
Broccoli	Chile	5	0.6-1.9	0.14-0.19	15
Broccoli	Philippines	15	1.2-3.0	0.2-0.38	
Brussels sprouts	Australia	4	1.3-1.8	0.11-0.16	7
Brussels sprouts	Chile	5	0.6-1.9	0.14-0.19	15
Cabbage	Australia	4	1.3-1.8	0.11-0.16	7
Cabbage	Brazil	8	1.6	0.16	7
Cabbage	Chile	5	0.6-1.9	0.14-0.19	15
Cabbage	Columbia	4	0.8-2.4		7
Cabbage	Japan	3	1.9-3.8	0.13-0.19	45
Cabbage	Malaysia			0.16-0.20	21
Cabbage	Philippines	15	1.2-3.0	0.2-0.38	
Cauliflower	Australia	4	1.3-1.8	0.11-0.16	7
Cauliflower	Brazil	8	1.6	0.16	7
Cauliflower	Chile	5	0.6-1.9	0.14-0.19	15
Cauliflower	Malaysia			0.16-0.20	21
Cauliflower	Philippines	15	1.2-3.0	0.2-0.38	
Celery	Australia	5	1.3-1.8	0.11-0.16	7
Celery	Belgium	10		0.16	30-60
Celery	Canada	3	1.8-2.4	0.3	14
Celery	Chile	6	0.6-1.9	0.14-0.19	14
Celery	Columbia	4	0.8-2.4		7
Celery	France	10	1.6		30-60
Celery	Philippines	15	1.2-3.0	0.2-0.38	14
Celery	Portugal	2fg	1.6	0.53	
Celery	Switzerland	5	1.0	0.2	21
Celery	UK		1.8		14
Chard	Australia	4	1.3-1.8	0.11-0.16	14
Chinese cabbage	Indonesia	5	0.8-1.9		7
Chinese cabbage	Japan	3	1.9-2.8	0.13-0.19	30
Cole	Portugal	1fg	1.6	0.16	
Endive	France	5	1.6		root dip
Kale	Brazil	8	1.6	0.16	14
Lettuce	Australia	5	1.3-1.8	0.11-0.16	14
Lettuce	Chile	5	0.6-1.9	0.14-0.19	15
Lettuce	Columbia	4	0.8-2.4		7
Lettuce	France	10	1.4		
Lettuce	Malaysia			0.16-0.20	21
Lettuce	Portugal	4fg	1.6	0.16	21
Lettuce	Spain	4fg	1.6	0.16	15
Lettuce	Switzerland	5fg	0.8	0.16	21
Lettuce	UK	8	3.1		14
Lettuce	UK	2g	3.1		21
Rhubarb	Australia	4	1.3-1.8	0.11-0.16	14
Spinach	Australia	4	1.3-1.8	0.11-0.16	14
Spinach	Columbia	4	0.8-2.4		7
Spinach	Malaysia			0.16-0.20	21

[1] g: use in glasshouse; fg: use in field and glasshouse.

Table 8. Registered uses of mancozeb on fruiting vegetables.

CROP	COUNTRY	APPLICATION	PHI, days

		Max no.[1]	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Cantaloupe	Australia	4	1.3-1.8	0.11-0.16	7
Cantaloupe	Canada	1	2.6	0.43	14
Cantaloupe	Columbia	4	0.8-1.5		15
Cantaloupe	Philippines	12	0.6-2.6	0.2-0.38	
Cantaloupe	USA	8	2.7		5
Cucumber	Australia	4	1.3-1.8	0.11-0.16	7
Cucumber	Brazil	8	1.6	0.16	7
Cucumber	Canada	1	2.6	0.43	14
Cucumber	Chile	6	1.6-2.0	0.14-0.19	5
Cucumber	Columbia	4	0.8-1.5		15
Cucumber	Japan	3g	2.5-3.8	0.13-0.19	1
Cucumber	Korea		2.4	0.12	2
Cucumber	Philippines	12	0.6-2.6	0.2-0.38	
Cucumber	Spain	4	1.6-2.4	0.16	15
Cucumber	USA	8	2.7		5
Cucurbits	Belgium	10fg		0.2	3
Cucurbits	France	10	1.6		3
Cucurbits	Greece	3	2.0	0.2	3
Cucurbits	Malaysia			0.16-0.20	0
Cucurbits	Turkey	3fg	1.6	0.16	14
Eggplant	Brazil	6	2.4	0.24	7
Eggplant	Columbia	4	0.8-2.4		7
Eggplant	Greece	4	2.0	0.2	3
Eggplant	Philippines	10	1.6-3.4	0.2-0.38	7
Fruiting vegetables, edible peel	Austria	4	0.8-1.92	0.16-0.24	4-14
Fruiting vegetables, edible peel	Romania	4	0.9-1.6	0.16	21-35
Melon	Australia	4	1.3-1.8	0.11-0.16	7
Melon	Canada	1	2.6	0.43	14
Melon	Chile	6	1.6-2.0	0.14-0.19	5
Melon	Japan	5g	2.5-5.6	0.13-0.19	7
Melon	Philippines	12	0.6-2.6	0.2-0.38	
Melon	Portugal	4fg	1.6	0.16	3
Melon	Spain	4	1.6-2.4	0.16	15
Melon	Turkey	3	1.6	0.16	7
Melon	USA	8	2.7		5
Peppers	Brazil	6	2.4	0.24	7
Peppers	Columbia	4	0.8-2.4		7
Peppers	Greece	4	2.0	0.2	3
Peppers	Malaysia			0.16-0.20	14
Peppers, chilli	Philippines	10	1.6-3.4	0.2-0.38	7
Peppers	Portugal	4fg	1.6	0.16	3
Peppers	Spain	4	1.6-2.4	0.16	15
Pumpkin	Australia	4	1.3-1.8	0.11-0.16	7
Pumpkin	Brazil	10	1.6	0.16	14
Pumpkin	Canada	1	2.6	0.43	14
Roselle	Indonesia	6	1.2-2.2		
Squash	Australia	4	1.3-1.8	0.11-0.16	7
Squash	Canada	1	2.6	0.43	14
Squash	Chile	6	1.6-2.0	0.14-0.19	5
Squash	Japan	3	1.9-3.0	0.13-0.19	30
Squash	Philippines	12	0.6-2.6	0.2-0.38	
Summer squash	Australia	4	1.3-1.8	0.11-0.16	7
Summer squash	USA	8	2.7		5
Sweet corn	Philippines	20	1.2-3.0	0.2-0.38	7
Sweet corn	USA	15	1.3		7
Tomato	Australia	6	1.4-2.8	0.11-0.16	7
Tomato	Belgium	10		0.16	3
Tomato	Brazil	10	2.4	0.24	7
Tomato	Bulgaria	5	1.6-2.4	0.16	20-30
Tomato	Canada	2	fg 2.6	0.43	7
Tomato	Chile	10	1.4-2.2	0.14-0.19	5
Tomato	Columbia	12	0.8-2.4		0
Tomato	Eire	10	2.3-2.7		5
Tomato	France	10	1.6		15
Tomato	Germany	4	1.2-1.4		7
Tomato	Greece	6	2.0	0.2	3
Tomato	Hungary	4	0.84-1.6	0.16	3
Tomato	Indonesia	10	1.3-1.9		7
Tomato	Italy	6	2.4	0.24	28
Tomato	Japan	5g	2.5-3.8	0.13-0.19	1
Tomato	Malaysia			0.24	14
Tomato	Philippines	10	1-3.4	0.2-0.38	
Tomato	Portugal	4fg	1.6	0.16	3

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.[1]	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Tomato	Spain	4	1.6-2.4	0.16	15
Tomato	Switzerland	6	1.0	0.2	21
Tomato	Taiwan	3	2.0	0.2	7
Tomato	Turkey	6fg	1.6	0.16	14
Tomato	UK		1.4-2.7		5
Tomato	USA	7	1.8-2.7		5
Watermelon	Canada	1	2.6	0.43	14
Watermelon	Chile	6	1.6-2.0	0.14-0.19	5
Watermelon	Columbia	4	0.8-1.5		15
Watermelon	Japan	5	2.5-3.8	0.13-0.19	7
Watermelon	Korea		2.4	0.16	5
Watermelon	Philippines	12	0.6-2.6	0.2-0.38	
Watermelon	Portugal	4fg	1.6	0.16	3
Watermelon	Turkey	3	1.6	0.16	7
Watermelon	USA	8	2.7		5

[1] g: use in glasshouse; fg: use in field and glasshouse.

Table 9. Registered uses of mancozeb on legume vegetables.

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Azuki bean	Japan	3	1.3-1.9	0.13-0.19	14
Beans	Australia	4	1.3-1.8	0.11-0.16	7
Beans	Belgium	2		0.16	28
Beans	Brazil	6	1.6	0.16	14
Beans	Chile	4	1.4-2.2	0.14-0.19	14
Beans	France	2	1.6		21
Beans	Greece	4	2.0	0.2	3
Beans	Malaysia			0.16-0.20	14
Beans	Philippines	12	1-3.4	0.2-0.38	
Beans	Portugal	2	1.6	0.16	
Beans	Spain	2	1.6-2.4	0.16	15
Broad bean	Australia	2	1.2-2.0	0.11-0.16	7
Chickpea	Chile	4	1.4-2.2	0.14-0.19	14
French bean	Brazil	6	1.6	0.16	7
Green bean	Columbia	5	0.8-2.4		15-20
Green pea	Chile	4	1.4-2.2	0.14-0.19	14
Kidney bean	Japan	4	1.3-1.9	0.13-0.19	30
Lentil	Chile	4	1.4-2.2	0.14-0.19	14
Mung bean	Philippines	12	1-3.4	0.2-0.38	
Peas	Brazil	6	1.6	0.16	7
Peas	Columbia	5	0.8-2.4		15-20
Peas	France	2	1.6		
Peas	Malaysia			0.16-0.20	14
Peas	Philippines	12	1-3.4	0.2-0.38	
Peas	Portugal	2	1.6	0.16	
Peas	Spain	2	1.6-2.4	0.16	15
Soya bean	Australia	4	1.8		7
Soya bean	Hungary	3	0.84-1.6	0.15	30-45
Soya bean	Philippines	6	1-3.4	0.2-0.38	
Soya bean	Taiwan	4	2.4	0.2	

Table 10. Registered uses of mancozeb on cereals, tree-nuts and oilseed crops.

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Almond	Australia	2	2.3-4.8	0.11-0.16	14
Barley	Brazil	3	2.0		21
Barley	Canada	st			
Barley	Chile	3	1.6-2.0		26
Barley	Columbia	2	2.0		14-20
Barley	Eire	3	2.0		26
Barley	UK	3	1.6		gs

CROP	COUNTRY	APPLICATION			PHI, days
		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Barley	USA	3	1.8		26
Cereals	Chile	st[1]			
Cereals	Spain	2	3.2		28
Cereals	UK		1.6-1.8		26-28
Coconut	Indonesia	6	0.24-1.44		7
Cotton	Philippines	15	1.2-3.0	0.2-0.38	
Cotton	USA	4	1.8		45
Flax	Canada	st			
Maize	Canada	st			
Maize	USA	10	1.3		40
Oats	Canada	st			
Oats	Chile	3	1.6-2.0		26
Oats	Eire	3	2.0		26
Oats	USA	3	1.8		26
Peanut	Australia	4	1.4-1.8		14
Peanut	Columbia	3	1.5		15-20
Peanut	Indonesia	4	0.8-1.6		7
Peanut	Korea		2.4		14
Peanut	Malaysia			0.16-0.20	14
Peanut	Philippines	12	1-3.4	0.2-0.38	14
Peanut	Taiwan	4	2.4	0.20	
Peanut	Turkey	2	1.6	0.16	14
Peanut	USA	8	1.8		14
Rice	Brazil	3	3.6		25
Rice	Bulgaria	3	0.96	0.16	40-50
Rice	Columbia	2	2.0-4.0		14-20
Rice	Philippines	15	0.32-0.9	0.2-0.38	
Rice	Taiwan	4	2.0	0.17	
Rye	Chile	3	1.6-2.0		26
Rye	Eire	3	2.0		26
Rye	USA	3	1.8		26
Sesame	Korea		2.4		7
Sorghum	Columbia	2	1.3-2.4		15-20
Wheat	Belgium	3	1.6		28
Wheat	Brazil	3	2.0		32
Wheat	Canada	2	1.8		40
Wheat	Canada	st			
Wheat	Chile	3	1.6-2.0		26
Wheat	Columbia	2	2.0		14-20
Wheat	Eire	3	2.0		26
Wheat	France	3	3.2		
Wheat	Netherlands	2	1.5	0.25	28
Wheat	Portugal	2	3.2		35
Wheat	Romania	1	1.6-1.8	0.36-0.46	35
Wheat	UK	3	1.6		gs[2]
Wheat	USA	3	1.8		26
Winter oilseed rape	UK	2	1.4		gs

[1] st: seed treatment.
[2] gs: growth stage restriction.

Table 11. Registered uses of mancozeb on miscellaneous crops including hops, coffee and tea.

CROP	COUNTRY	APPLICATION	PHI, days

		Max no.	Rate per applicn. kg ai/ha	Spray concn. kg ai/hl	
Cacao	Indonesia	6	0.8-0.96		7
Cacao	Brazil	4	3.0	0.3	14
Coffee	Brazil	6	4.0	1.0	21
Coffee	Columbia	3	0.8-1.2		0
Coffee	Indonesia	6	0.24-1.44		7
Fennel	USA	8	1.8		14
Hops	Belgium	10		0.16	42
Hops	Germany	12	1.8-6.4	0.16	35
Hops	Hungary	3	2.1-3.2	0.16	30-45
Hops	Turkey	2	1.2	0.12	42
Tea	Indonesia	5	0.34-0.67		7

RESIDUES RESULTING FROM SUPERVISED TRIALS

Residue data from supervised trials on horticultural and agricultural crops are summarized in Tables 12 to 50.

Table 12. Citrus fruits. Australia, Brazil, Japan and Spain.
Table 13. Citrus fruits. USA.
Table 14. Pome fruits. Australia, Austria, Belgium, Brazil, Hungary, Japan and The Netherlands.
Table 15. Pome fruits. France.
Table 16. Pome fruits. Germany.
Table 17. Pome fruits. Italy.
Table 18. Apples. UK.
Table 19. Pome fruits. USA.
Table 20. Stone fruits. Australia, Brazil and France.
Table 21. Berry fruits. Australia, Brazil, Hungary, Japan, Portugal and Spain.
Table 22. Cranberries. USA.
Table 23. Grapes. France.
Table 24. Grapes. Italy.
Table 25. Black currants. UK.
Table 26. Tropical and subtropical fruits. Australia, Brazil, Honduras and Japan.
Table 27. Tropical fruits. USA.
Table 28. Bulb vegetables. Australia, Brazil, Finland, France, Japan and The Netherlands.
Table 29. Onions. USA.
Table 30. Brassica vegetables. Brazil, Germany, Japan and Spain.
Table 31. Cucurbits. Australia, Brazil, France, Germany and Japan.
Table 32. Cucumbers. Australia, Brazil, France, Germany, Japan and Spain.
Table 33. Cucurbits. USA.
Table 34. Fruiting vegetables other than cucurbits. Brazil, France, Germany, Italy, Japan, The Netherlands, Portugal and Spain.
Table 35. Fruiting vegetables other than cucurbits. USA.
Table 36. Leafy vegetables. Brazil and Spain.
Table 37. Legume vegetables. Australia, Brazil, France, Japan, The Netherlands and Spain.
Table 38. Root and tuber vegetables. Australia, Brazil, Finland, France, Germany, Italy, Japan, The Netherlands and UK.
Table 39. Potatoes. Germany.
Table 40. Root and tuber vegetables. USA.
Table 41. Stalk and stem vegetables. Australia, France and The Netherlands.
Table 42. Stalk and stem vegetables. USA.
Table 43. Cereal grains. Brazil, Canada, France, Germany, The Netherlands, Spain and UK.
Table 44. Cereal grains. USA.
Table 45. Dry hops. Germany.
Table 46. Oilseeds. Australia, France, The Netherlands and USA.
Table 47. Tree nuts, cocoa and coffee. Australia, Brazil and USA.
Table 48. Cereal straws. Canada, France, Germany, The Netherlands and UK.
Table 49. Cereal fodder and straw. USA.
Table 50. Legume animal feeds and miscellaneous fodder and forage crops. Australia, Italy, Japan and USA.

The information supplied was sometimes only in summary form, but most trials were fully or adequately described. Some residues were adjusted for analytical recoveries and some were not; in summary sheets very often no statement was made either way. Analytical recoveries were mostly high (>80%) for both dithiocarbamates and ETU, so adjustment of results should not influence interpretations. US results were adjusted; Australian were not. Attention is drawn to cases where analytical recoveries were less than 70%.

In the French trials of 1990, recoveries from 10 crops and wine (23 tests) ranged from 46 to 114%, with a mean recovery of 86%, at concentrations of 0.8-2.7 mg/kg (Wasser, 1993n). In the French trials of 1991, recoveries from 8 crops and wine (13 tests) ranged from 47 to 88%, with a mean recovery of 68%, at concentrations of 0.14-1.5 mg/kg (Mellet, 1993a).

Dithiocarbamate residues are expressed as mg CS_2/kg throughout the Tables and text. EBDC is used as an abbreviation for ethylenebis(dithiocarbamate)s in the Tables.

Where residues were not detected, data are recorded in the Tables as less than the limit of determination (LOD), e.g. <0.1 mg/kg. Residues have generally been rounded to 2 significant figures or, near the LOD, to 1 significant figure. When residues were detected in control samples they are recorded in the Tables. In the majority of cases no residues were detected in control samples; these are not recorded.

Plot sizes in the Australian trials were usually 8-20 m of 1-2 rows (4 replicates) for row crops and 1 tree (4 replicates) for tree crops. Mancozeb was applied with a hand-held high-volume sprayer or a self-propelled small-plot sprayer. Analytical recoveries exceeded 70% except in the following trials: peaches (AUE-91-027, Table 20) dithiocarbamates 62%; bananas (2495/89, Table 26) ETU 55-111%, dithiocarbamates 58%; watermelon (AUK-92-005, Table 32) dithiocarbamates 60%; beans (3137/88/5, Table 37) ETU 53-57%, dithiocarbamates in straw 67%.

Mancozeb was applied by a tractor-mounted sprayer in the Canadian trials on onions and lettuce. Plot size was the equivalent of 50-120 m of row.

Plot sizes in the Netherlands trials (PH references) were apples 5 trees, barley 25 m^2, beans 20 m^2, onions 3.6-20 m^2, potatoes 20-25 m^2, wheat 25 m^2-1 ha. Mancozeb was applied to crops in these trials with a propane-pressure knapsack (beans, onions, potato, tomatoes, wheat), a knapsack mist blower (apples) and a motorised compressed air sprayer (potato). Recoveries of dithiocarbamates were all satisfactory. ETU recoveries were sometimes low (<70%). Low recoveries in individual tests were reported in the analysis of apples, barley straw, onions, potatoes, tomatoes and wheat.

Dithiocarbamate residues or apparent residues were detected in untreated control samples in US trials on citrus (Table 13), apples (Table 19), cranberries (Table 22), bananas and papayas (Table 27), onions (Table 29), cucurbits (Table 33), tomatoes (Table 35), sugar beet (Table 40), celery (Table 42), cereal grains (Table 44), cereal fodder (Table 49) and sugar beet tops (Table 50). Control samples also occasionally showed low residues of ETU: citrus (Table 13), cranberries (Table 22) and onions (Table 29).

In the extensive series of French trials dithiocarbamate or apparent dithiocarbamate residues were detected in untreated control samples. Instances are recorded in the Tables: pome fruits (Table 15), plums (Table 20), grapes (Table 23), bulb vegetables (Table 28), tomatoes (Table 34), carrots and potatoes (Table 38), asparagus (Table 41), cereal grains (Table 43) and cereal fodder (Table 48).

Contamination could have occurred in some cases from a high-level sample during handling or shipment (Wasser, 1993n). A coextractive from carrots, tomatoes and asparagus may have contributed to a false colour in the Cullen's reagent in the analysis leading to a dithiocarbamate reading for a control sample (Wasser, 1993d and related references). Mellet (1993d) reported that the extraction-distillation step of potato analysis produces a yellow colour in the sodium hydroxide trap that fades after a few minutes. An excess of that contamination might account for apparent residues in some of the untreated potato samples. Similar explanations were provided for cereal grain and straw, and garlic.

ETU was detected (about 0.01 mg/kg) in samples of orange concentrate made from untreated fruit in Brazilian orange trials (81-0191, Table 12).

There was some detection of dithiocarbamates in control apples from the Belgian trials (Table 14) at 0.01-0.02 mg/kg, which is near the limit of determination.

In the UK apple trials (R71.16, Table 18) treated areas were 2-3 ha in the first four studies, where samples were taken for residue decline measurement. Samples were also taken from 11 commercial orchards with recorded spray programmes (R71.16, Table 18).

Mancozeb was applied by air-blast equipment in the US apple trials (ETU 91-02, Table 19). The plot size was 8 trees.

Cranberries in the US trials (Table 22) were grown on plots of 10-40 m^2, and were hand-sprayed.

In five separate experiments in France in 1976 (Haines, 1978), wine was produced from grapes treated with mancozeb (6-9 times, final application 0.8-1.2 kg ai/ha) and harvested 50-70 days after the final application. Neither dithiocarbamates (<0.05 mg/kg as CS_2) nor ETU (<0.02 mg/kg) were detected in the wine.

In a similar set of experiments with 3 wines in Germany (Haines, 1979) dithiocarbamate residues were not detected (<0.05 mg/kg as CS_2) but ETU was detected in one wine at 0.21 mg/kg and identified by GC-MS. In this case the final mancozeb application had been at 2.2 kg ai/ha 72 days before harvest.

Samples of wine, 1989 vintage ready for commercialisation, were taken from two different French vineyards with accurately recorded pesticide use (R78.85, R78.82, Table 23). Dithiocarbamate residues were not detected (Wasser, 1993m). The results agreed with a previous similar investigation in 1988 reported by Wasser (1993l) on three French vineyards (R78.78, R78.89, R79.1, Table 23).

UK residue data on black currants are summarized in Table 25. The first three trials were supervised trials on 5 m row plots (4 replicates) with application by a motorised knapsack sprayer. The remainder were grower trials on areas of approximately 1 ha. Analytical recoveries of dithiocarbamates were low (61%).

Papayas in the US (Florida) trials were on 1.2 ha plots and were ground-sprayed (Table 27). The trials in Hawaii were on a smaller scale, 300 m^2 plot, and the papayas were hand-sprayed.

The plot size was 2.7-4.4 ha for three of the four onion trials in the USA where mancozeb was applied by aerial and ground equipment (Table 29). The plot sizes in the remaining trials were 5-30 m^2.

Cucurbit vegetables in the US trials (Table 33) were mostly sprayed with ground equipment (some hand-spraying). The plot size was in the 15-45 m^2 range.

Mellet (1993j) reported that an apparent dithiocarbamate residue of 0.23 mg/kg in untreated tomatoes from a Spanish trial (R80.30, Table 34) could be due to interference in the analytical method by a co-extractive forming a yellow colour with Cullen's reagent, or contamination may have occurred during handling or shipping samples.

Plants in the first five tomato trials listed in Table 35 were hand-sprayed on 10 m^2 plots.

Carrot trials in France (R77.33/34, Table 38) in 1990 were carried out on plots of 3.2 × 10 m.

A series of trials on potatoes in 1975-76 in 9 States of the USA (Table 40) showed that dithiocarbamate residues were rarely detectable in potatoes even when mancozeb was used at exaggerated application rates. Analytical recoveries for ETU were sometimes down to 60%, but ETU was not detectable in these trials. Plot sizes ranged from 15 m^2 for ground-sprayed carrots to 2.2 ha for aerial spraying. Four of the sugar beet trials were on 3-4 ha plots, while two trials were on 40 ha fields.

ETU residues were not detected (<0.02 mg/kg) in cooked and processed products (baked potato skin, baked potato, boiled potato, chips, flakes and French fries) produced from potatoes in trials 75-537-02, 75-538-02 and 75-514-02 (Table 40). ETU residues were not detected (<0.02 mg/kg) in cooked and processed products (chips, flakes and French fries) produced from potatoes in trials 75-459-02, 75-494-02 and 75-443-02 (Table 40).

Mancozeb was aerially and ground-applied to celery in US trials (Table 42), with three trials on 4 ha plots and one (85-0165) on 80 ha.

Detection of apparent dithiocarbamate residues in control wheat straw (Table 48) from the Canadian trials may have been interference in the analytical method by hydrogen sulphide (Frank *et al.*, 1986).

Wheat trials were conducted in 1975 and 1981 in 5 different States of the USA with 8 different wheat varieties (Tables 44, 49). Dithiocarbamate residues were detected in some control grain and straw samples, probably as a result of drift to the control plots. Dithiocarbamate residues were detected in bran, flour and bread prepared from control wheat (81-0167, 81-0168, 81-0428, 81-0429, 81-0430, 81-0426, 81-0427, 81-0212, 81-0214). Details of the milling are recorded in Table 75.

The US barley trials (Tables 44, 49) in Idaho and Washington State were on 5 ha plots. The other two trials were on 20 m^2 plots.

Analytical recoveries were lower than usual for mancozeb in peanuts 69-87% and peanut hay 68-75%, and for ETU in peanuts 53-110% and peanut hay 56-58% in a US trial (74-171-02, Table 46, 50). Mancozeb recoveries were 58-90% from peanuts in trial 74-180-02 (Table 46).

Table 12. Mancozeb residues (as CS_2) in citrus fruits from supervised trials in Australia, Brazil, Japan and Spain. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application				Day	Residues, mg/kg[1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
CITRUS "SUMMER" ORANGES, SOUR								
Japan, 1990 (Kawano-amanatsu)	WP	5.0	0.13	2	60 75 90	pu 0.010, pe 1.5 pu 0.011, pe 1.3 pu 0.006, pe 1.0	pu <0.01, pe 0.02 pu <0.01, pe 0.01 pu <0.01, pe <0.01	Hei.-3-3-5
Japan, 1990 (Amanatsu)	WP	5.0	0.13	2	63 75 91	pu <0.004, pe 0.78 pu 0.005, pe 0.58 pu <0.004, pe 0.32	pu <0.01, pe 0.01 pu <0.01, pe 0.01 pu <0.01, pe <0.01	Hei.-3-3-5
LEMONS								
Spain, 1992 (Verna)	WP		0.3	1	0 7 14 21	2.5 0.19 0.10 0.01		MAPA 23.06.93

CROP Country, year (Variety)	Application				Day	Residues, mg/kg[1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
MANDARINS								
Japan, 1977 (Okitsuwase)	WP	3.8- 4.7	0.19	2	30 44 60	pu 0.04, pe 1.6 pu 0.04, pe 0.93 pu 0.06, pe 1.8	pu <0.01, pe 0.07 pu <0.01, pe 0.05 pu <0.01, pe 0.06	53P-7-68
Japan, 1977 (Okitsuwase)	WP	3.8- 4.7	0.19	4	30 44 60	pu 0.06, pe 1.6 pu 0.07, pe 1.4 pu 0.07, pe 2.1	pu 0.01, pe 0.08 pu 0.01, pe 0.08 pu 0.01, pe 0.08	53P-7-68
Japan, 1977 (Miyakawa)	WP	9.4	0.19	2	29 46 60	pu 0.12, pe 3.5 pu 0.04, pe 1.5 pu 0.07, pe 1.8	pu <0.01, pe 0.10 pu <0.01, pe 0.06 pu 0.01, pe 0.08	53P-7-68
Japan, 1977 (Miyakawa)	WP	9.4	0.19	4	29 46 60	pu 0.07, pe 3.1 pu 0.12, pe 3.1 pu 0.12, pe 3.7	pu 0.01, pe 0.13 pu 0.01, pe 0.11 pu 0.01, pe 0.12	53P-7-68
Spain, 1989 (Clementine)	WP	17	0.32	1	0 14 22	2.2 1.1 1.2		MAPA 7/5/91
Spain, 1989 (Satsuma)	WP	17	0.32	1	0 14 22	2.7 1.2 1.0		MAPA 7/5/91
Spain, 1989 (Clementine)	SC	15	0.25	1	0 7 14 21 28	1.7 1.8 1.4 1.1 0.80		7404/VI/89
Spain, 1989 (Satsuma)	WP	9.6	0.32	1	0 7 14 22	2.5, w 0.30 2.1, w 0.14 1.7 0.76, w 0.36		R77.11
Spain, 1990 (Clementine)	WP	4.3	0.16	1	0 6 14	2.3, w 0.12 3.9, w 0.34 2.0		R80.5
Spain, 1990 (Clementine)	WP	8.6	0.32	1	0 6 14	2.2, w 0.35 6.8, w 0.05 6.6, w 0.45		R80.5
Spain, 1990 (Satsuma)	WP	5.2	0.16	1	0 6 14	4.4, w 0.34 5.3, w 0.23 2.1		R80.7
Spain, 1990 (Satsuma)	WP	10.4	0.32	1	0 6 14	6.5, w 1.9 9.2, w 1.4 4.7, w 0.15		R80.7
ORANGES								
Australia, 1992 (Valencia)	WG		0.15	2	0 7 14 21 28	0.3 0.4 0.2 0.4 0.5		AUE-92-001
	WG		0.30	2	0 7 14 21 28	1.8 1.6 1.0 1.7 1.6		
Brazil, 1989 (Natal)	WP	1.2		1	0 7 14 21 56	0.31, j <0.03 0.36, j <0.03 0.25, j <0.03 0.76, j <0.03 0.19, j <0.03	<0.01, j <0.01 0.01, j <0.01 <0.01, j <0.01 <0.01, j <0.01 <0.01, j <0.01	89-0191
Brazil, 1989 (Natal)	WP	2.4		1	0 7 14 21 56	0.54, j 0.05 1.7, j 0.04 0.53, j <0.03 0.59, j <0.03 0.23, j <0.03	0.01, j <0.01 0.04, j 0.02 <0.01, j <0.01 <0.01, j <0.01 <0.01, j <0.01	89-0191
Spain, 1989 (Havelina)	SC	15	0.25	1	0 7 14 21 28	0.52 0.38 0.24 0.26 0.19		7404/VI/89
Spain, 1989 (Havelina)	SC	15	0.25	1	0 7 14 21 28	1.4 0.80 0.68 0.67 0.47		7404/VI/89
Spain, 1989 (Newhall)	WP	9.6	0.32	1	0 7 14	2.2, w 0.06 2.3, w 0.09 0.93, w 0.10		R77.12

CROP Country, year (Variety)	Application				Day	Residues, mg/kg[1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					22	0.66, w 0.09		
Spain, 1990 (Navel)	WP	0.88 0.88 0.88	0.044 0.044 0.044	1 1 1	24 16 10	0.12 0.90 1.3		R80.4
Spain, 1990 (Navel)	WP	17	0.32	1	0 14 22	1.2 0.85 0.49		MAPA 7/5/91
Spain, 1990 (Valencia)	WP	17	0.32	1	0 14 22	0.78 0.64 0.53		MAPA 7/5/91
Spain, 1991 (Valencia)	WP	16	0.32	1	0 7 14 21 28 56	1.4 0.96 0.80 0.84 0.66 0.69		MAPA 7/5/91
Spain, 1991 (Valencia)	WP	13	0.32	1	0 14	1.7 1.3		MAPA 7/5/91

[1] pu: pulp; pe: peel; w: washed fruit; j: juice.

Table 13. Mancozeb residues (as CS_2) in citrus fruits from supervised trials in the USA.

CROP State, year (Variety)	Application				Day	Residues, mg/kg[1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
GRAPEFRUIT								
TX, 1986 (Ruby Red)	WP	9.0	0.78	4	0 7 14 28	7.3 6.2 4.6 1.4	0.31 0.42 0.20 0.12	34A-88-13
	WP	18	1.6	4	0 7 14 28	12 10 6.2 2.2	0.40 0.15 0.30 0.21	
CA, 1986 (Ruby White)	WP	11	0.24	4	0 7 15 27	3.4 2.3 1.3 0.98	0.03 0.04 0.05 0.04	34A-88-13
	WP	22	0.48	4	0 7 15 27	7.8 6.7 5.1 3.3	0.07 0.07 0.06 0.11	
CA, 1986 (Ruby Red)	WP	11	0.24	4	0 7 15 27	7.3 6.2 5.0 3.2	0.04 0.05 0.06 0.06	34A-88-13
	WP	22	0.48	4	0 7 15 27	16 14 11 5.6	0.20 0.13 0.20 0.16	
LEMONS								
CA, 1986 (Eureka)	WP	5.6	0.12	4	0 0 0 7 14 28	7.9 pe 17 pu 0.46 5.6 3.3 2.3	0.24 pe 0.25 pu 0.054 0.13 0.16 0.12	86-0148
	WP	11.2	0.24	4	0 7 14 28	20 17 11 6.7 c pe 0.14	0.44 0.39 0.42 0.26 c 0.02	
CA, 1986 (Eureka)	WP	5.6	0.12	4	0 0 0 7 14 28	10 pe 26 pu 1.2 6.9 5.9 3.5	0.27 pe 0.34 pu 0.041 0.23 0.25 0.19	86-0149
	WP	11.2	0.24	4	0 7 14	20 12 9.2	0.64 0.28 0.33	

CROP State, year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					28	6.9 c pe 0.07	0.27	
FL, 1987 (Bearss)	WP	9.0	0.10	4	0 0 0 6 12 20 27	3.4 pe 6.2 pu 0.34 2.7 1.5 1.2 1.4	0.032 pe 0.065 pu 0.01 0.079 0.044 0.061 0.062	87-0017
	WP	18	0.20	4	0 6 12 20 27	13 6.6 3.5 2.6 1.6 c pe 0.15	0.19 0.37 0.25 0.13 0.12 c pe 0.01	
FL, 1987 (Meyer)	WP	18	0.57	5	0 0 0 6 11 19	27 pe 120 pu 0.67 21 18 9.3	0.39 pe 1.4 pu 0.029 0.50 0.38 0.17 c 0.01	87-0024
FL, 1987 (Bearss)	WP	9.0	0.19	5	0 0 0 6 12 20 27	5.7 pe 7.7 pu 0.26 3.9 1.8 1.3 0.82	0.052 pe 0.14 pu 0.02 0.052 0.044 0.063 0.041	87-0018
	WP	18	0.38	5	0 6 12 20 27	14 7.5 3.5 3.0 2.3 c pe 0.30	0.23 0.12 0.091 0.10 0.086	
LIMES								
FL, 1987 (Persian)	WP	9.0	0.10	4	0 0 0 6 12 20 27	4.8 pe 28 pu 0.15 2.6 2.0 1.0 0.49	0.21 pe 0.26 pu 0.01 0.051 0.12 0.086 0.080	87-0020
	WP	18	0.20	4	0 6 12 20 27	12 8.2 5.6 2.2 1.6 c pe 0.05	0.43 0.21 0.24 0.19 0.21 c 0.02	
FL, 1987 (Persian)	WP	9.0	0.19	4	0 0 0 6 12 20 27	4.0 pe 17 pu 0.67 3.3 2.3 1.5 1.1	0.15 pe 0.24 pu 0.01 0.062 0.052 0.058 0.076	87-0019
	WP	18	0.38	4	0 6 12 20 27	10.3 8.3 7.0 4.9 2.4 c 0.27 c pe 0.69 c pu 0.07	0.13 0.30 0.15 0.15 0.22 c 0.025	
ORANGES								
FL, 1986 (Valencia)	WP	9.0	0.1	4	0 7 15 28	3.1 1.1 0.88 0.38	0.038 0.01 0.01 <0.01	86-0134
	WP	18	0.2	4	0 7 15 28	5.4 2.4 1.2 0.93 c 0.04	0.074 0.043 0.026 0.034	
USA (TX), 1986 (Valencia)	WP	9.0	0.38	4	0 7 14 28	6.2 3.4 2.9 1.2	0.056 0.16 0.19 0.21	86-0495
		18	0.77	4	0 7 14 28	10 6.2 5.6 2.9	0.25 0.28 0.32 0.22	
CA, 1986	W?	11	0.24	4	0 8	7.8 4.2	0.050 0.065	86-0599

CROP State, year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
(Navel)					16 26	3.4 1.6	0.073 0.02	
		22	0.48	4	0 8 16 26	14 7.0 6.2 3.2	0.18 0.15 0.18 0.057	
FL, 1987 (Valencia)	WP	9.0	0.29	4	0 0 0 6 11 19 26	15 pe 35 pu 0.30 13 11 7.7 5.3	0.30 pe 1.1 pu 0.025 0.24 0.25 0.17 0.11	87-0025
	WP	18	0.58	4	0 6 11 19 26	29 23 18 15 10 c pe 0.16	0.63 0.56 0.34 0.24 0.19	
FL, 1987 (Valencia)	WP	9.0	0.10	4	0 0 0 6	3.8 pe 20 pu 0.29 1.7	0.13 pe 0.31 pu 0.018 0.057	87-0040
	WP	18	0.20	4	0 6	9.3 2.7	0.14 0.049 c 0.01	

[1] pe: peel; pu: pulp; c: control sample.

Table 14. Mancozeb residues (as CS_2) in pome fruits from supervised trials in Australia, Austria, Belgium, Brazil, Hungary, Japan and The Netherlands. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application				Day	Residues, mg/kg		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Apples								
Australia, 1991 (Hi-Early Red Delicious)	WG		0.15	14	0 7 14 22 28	3.8 3.7 <u>2.2</u> <u>1.8</u> <u>2.1</u>		AUE-90-026
	WG		0.30	14	0 7 14 22 28	5.9 2.9 3.3 2.5 2.4		
Austria, 1983 (Golden Delicious)	WG	1.7	0.14	10	0 7 14 21 28	7.2 5.3 5.0 3.1 <u>1.4</u>		R72.21
Belgium, 1991 (Jonagold)	WP	2.4	0.24	8	0 54 75	5.9 1.8 0.53		R&H/BA 7.138/1991
Belgium, 1991 (Jonagold)	WP	2.4	0.80	8	0 54 75	2.7 0.55 0.15		R&H/BA 7.138/1991
Brazil, 1989	WP		0.13	2	1 4 7 14 22	3.1 2.0 <u>1.5</u> <u>0.39</u> <u>0.28</u>		FPA-89-007
Brazil, 1989	WP		0.26	2	1 4	3.9 2.0		FPA-89-007

CROP Country, year (Variety)	Application				Day	Residues, mg/kg		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					7 14 22	1.7 0.78 0.67		
Hungary, 1986	SC	1.4	0.14	6	0 1 3 7 11 18 25 32	7.6[1] 6.4[1] 5.2[1] 3.6[1] 3.2[1] 1.9[1] 0.71[1] 0.39[1]		R65.29
Hungary, 1989	WG	2.3	0.23	1	1 3 5 7 9 29	1.5 1.3 0.56 0.58 1.6 0.27		R72.20
Japan, 1986 (Tsugaru)	WP	7.5	0.15	3	30 45	0.22 0.16	<0.01 <0.01	Saku62P-2-54
Japan, 1986 (Starking)	WP	7.5	0.15	3	30 45 60	0.58 0.30 0.29	<0.01 <0.01 <0.01	Saku62P-2-54
Netherlands, 1984 (Golden Delicious)	WP SC SC		0.12-0.16 0.12-0.16 0.11-0.14	10 10 10	49 49 49	0.21, <0.01 0.08, 0.02 0.14, <0.01	<0.002 (2) 0.004, <0.002 <0.002 (2)	PH8410
Netherlands, 1984 (Golden Delicious)	WP SC SC		0.12-0.16 0.12-0.16 0.11-0.14	9 9 9	58 58 58	0.08, <0.01 0.04, 0.12 <0.01 (2)	<0.002 (2) <0.002 (2) 0.004, <0.002	PH8411
Netherlands, 1985 (Golden Delicious)	WP SC SC	1.2-1.6 1.2-1.6 1.2-1.6	0.12-0.16 0.12-0.16 0.11-0.14	9 9 9	81 81 81	<0.01 (2) <0.01 (2) <0.01 (2)	0.031, <0.002 0.029, 0.040 <0.002, 0.007	PH8510
Netherlands, 1985 (Golden Delicious)	WP SC SC	1.2-1.6 1.2-1.6 1.2-1.6	0.12-0.16 0.12-0.16 0.11-0.14	10 10 10	85 85 85	<0.01 (2) <0.01 (2) <0.01 (2)	0.016, 0.019 <0.002, 0.040 0.020, 0.027	PH8512
Netherlands, 1986 (Golden Delicious)	WP SC SC SC WP SC	1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6	0.12-0.16 0.12-0.16 0.12-0.16 0.07-0.10 0.12-0.16 0.11-0.14	7 7 7 7 7 7	88 88 88 88 88 88	<0.01, 0.03 <0.01, 0.02 <0.01 (2) 0.06, <0.01 <0.01 <0.01 (2)	<0.002 (2) <0.002 (2) <0.002 (2) <0.002 (2) <0.002 (2) <0.002 (2)	PH8610
Netherlands, 1987 (Golden Delicious)	WP SC SC WG WP SC	1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6	0.12-0.16 0.12-0.16 0.12-0.16 0.12-0.16 0.12-0.16 0.11-0.14	8 8 8 8 8 8	79 79 79 79 79 79	0.14, 0.10 0.18, 0.08 0.04, 0.06 0.17, 0.14 0.10, 0.06 0.08, 0.04	0.003, <0.002 0.002 (2) <0.002, 0.002 <0.002, 0.006 <0.002 (2) 0.002, 0.004	PH8711
Netherlands, 1987 (Golden Delicious)	WP SC SC WG WP SC	1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6	0.12-0.16 0.12-0.16 0.12-0.16 0.12-0.16 0.12-0.16 0.11-0.14	10 10 10 10 10 10	81 81 81 81 81 81	0.04, 0.06 0.04, 0.08 0.03, 0.03 0.06, 0.08 0.08, 0.10 <0.02 (2)	0.003, 0.005 0.002, 0.004 0.002, 0.006 <0.002, 0.005 <0.002, 0.005 <0.002 (2)	PH8712
Netherlands, 1988 (Golden Delicious)	WP SC WG SC	1.2-1.6 1.2-1.6 1.2-1.6 1.2-1.6	0.12-0.16 0.12-0.16 0.12-0.16 0.11-0.14	9 9 9 9	71 71 71 71	0.14 0.13, <0.05 0.14, <0.05 0.11, 0.14	0.003, 0.002 0.004, 0.003 <0.001, 0.003 0.002, 0.004	PH8845
Netherlands, 1988 (Golden Delicious)	WP SC WG	1.2-1.6 1.2-1.6 1.2-1.6	0.12-0.16 0.12-0.16 0.12-0.16	9 9 9	>63 >63 >63	0.32, 0.18 0.45, 0.48 0.34, 0.43	0.005 (2) 0.006, 0.011 0.004 (2)	PH8847

CROP Country, year (Variety)	Application				Day	Residues, mg/kg		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
	SC	1.2-1.6	0.11-0.14	9	>63	0.63, 0.33	0.011, 0.004	
Netherlands, 1989 (Golden Delicious)	WP	1.2-1.6	0.12-0.16	8	75	0.37, 0.46	0.006, <0.002	PH8959
Netherlands, 1990 (Jonagold)	WG SC	1.2-1.6 1.2-1.6	0.12-0.16 0.12-0.16	9 9	72 72	0.12, 0.10 0.09, 0.17	<0.002 (2) <0.002 (2)	PH9042
Netherlands, 1990 (Golden Delicious)	WG SC	1.2-1.6 1.2-1.6	0.12-0.16 0.12-0.16	8 8	65 65	<0.05, 0.15 <0.05, 0.14	<0.002 (2) <0.002 (2)	PH9044
PEARS								
Australia, 1992 (Beurre Bosc)	WG		0.15	6	0 8 14 21 28 42	1.3 1.0 0.5 0.6 0.6 0.3		AUE-91-026
	WG		0.30	6	0 8 14 21 28 42	2.4 2.0 2.0 1.0 0.9 0.6		
Brazil, 1990	WP		0.16	3	0 14 21 35	2.8 2.2 2.0 1.1		094/90
Brazil, 1990	WP		0.32	3	0 14 21 35	3.6 2.5 2.2 2.0		094/90
Japan, 1986 (Kosui)	WP	6.0	0.15	3	30 45 60	0.38 0.14 0.10	0.0004 0.005 0.005	Saku61P-6-136
Japan, 1986 (Hosui)	WP	6.0	0.15	5	30 45 60	0.47 0.18 0.10	0.016 0.007 0.008	Saku61P-6-136

[1] fruit without stalk.

Table 15. Mancozeb residues (as CS_2) in pome fruits from supervised trials in France. Underlined residues are from treatments according to GAP.

CROP Year (Variety)	Application [1]				Day	EBDC residues, mg/kgas CS_2	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
APPLES							
1989 (Golden Delicious)	WP	1.4	0.28	8	122	0.45[2]	R73.21
1989 (Golden Delicious)	WP	1.4 +0.7 +1.4	0.9 +0.5 +0.9	1 +3 +3	135	0.05[2]	R73.20
1989 (Golden Delicious)	WP	2.1 +1.1 +2.1	0.21 +0.1 +0.21	1 +7 +8	104	0.2[2]	R73.18
1989 (Golden Delicious)	WP	2.1 +2.8 +1.1 +1.4	0.21 +0.28 +0.10 +0.14	1 +1 +2 +4	132	0.25[2]	R73.17
1989 (Golden Delicious)	WP	1.8	0.12	7	116	0.1	R73.13
1989 (Golden Delicious)	WP	1.8	0.12	6	110	0.25	R73.12
1990 (Golden Delicious)	WP	1.6	0.13	10	90	0.07	R79.4

CROP Year (Variety)	Application [1]				Day	EBDC residues, mg/kgas CS_2	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
1990 (Golden Delicious)	WP	2.3 +2.0 +2.1 +2.3 +2.8 2.9		1 +1 +1 +1 +1 +1	56	1.1	R78.50
1990 (Bertane)	WP	2.0t[1] +1.0 +1.2 +1.0 +1.2 +1.0	0.66t +0.33 +0.4 +0.33 +0.4 +0.33	1t +3 +2 +1 +2 +1	123	<0.05	R78.67
1990 (Golden Delicious)	WP	2.4 +2.0	0.64 +0.53	1 +3	162	<0.05	R78.70
1990 (Golden Delicious)	WP	1.7	0.17	2	147	<0.05	R79.56
1990 (Golden Delicious)	WP	1.8 +1.4	0.15 +0.12	3 +1	126	0.1	R79.59
1990 (Golden Delicious)	WP	1.6 +2.0	0.16 +0.2	2 +1	107	0.3	R79.60
1990 (Granny Smith)	WP	2.0t +1.0		1t +16	11	<0.05	R78.69
1990 (Golden Delicious)	WP	1.9	0.16	7	89	0.28	R78.13
1990 (Starkrimson)	WP	2.0 +1.6 +0.8 +1.6 +2.0	0.4 +0.32 +0.16 +0.32 +0.4	2 +4 +3 +4 +1	86	<0.05	R78.14
1990 (Granny Smith)	WP	2.4 +0.8	0.16 +0.05	4 +1	6	1.8	R78.15
1990 (Welspur, Melrose, Granny Smith)	WP	1.4 +1.1	0.23 +0.21	10 +11	83	0.88 0.49 1.1 [3] c 0.08 [4]	R78.34
1991 (Golden Delicious)	WP	2.0-2.6	0.2-0.26	20	44	2.7 [2]	R80.32
1991 (Granny Smith)	WP	2		4	86	<0.1 [2]	R80.33
PEARS							
1990 (Beurre-Hardy)	SC	1.4 +1.1	0.23 +0.21	3 +7	83 7	0.34 0.72 c 0.08	R78.36
1990y(Doyenné de Comice)	SC	1.4 +1.1	0.23 +0.21	3 +7	83 7	0.24 0.22 c 0.15	R78.38
1990 (Williams)	SC	1.4 +1.1	0.23 +0.21	3 +7	83 7	0.44 0.84 c 0.05	R78.42
1990 (Passe Crassone)	SC	1.4 +1.1	0.23 +0.21	3 +7	83 7	0.28 0.40 c 0.14	R78.40

[1] t: thiram
[2] whole fruit without stalk
[3] 3 trials with 3 apple varieties.
[4] c: control sample.

Table 16. Mancozeb residues (as CS_2) in pome fruits from supervised trials in Germany. Underlined residues are from treatments according to GAP.

CROP Year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Apples								
1982 (Roter Boskoop)	WP	2.4	0.48	10	0 7 14	4.8 2.3 2.6	<0.02	R68.7
1982 (Jonathon)	WP	2.4	0.16	12	0 7 14	2.2 2.2 1.9	<0.02	R68.7
1982 (Cox's Orange)	WP	2.4	0.16	12	0 7 14	8.7 1.8 4.0	<0.02	R68.7

CROP Year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1983 (Gravenstein)	WP	3.4	0.16	10	21 28	0.26 0.34	 <0.02	R68.4
1983 (Cox's Orange)	WP	2.4	0.16	10	21 28	0.68 0.59	s <0.02 <0.02, s <0.02	R65.13
1983 (Boskoop)	WP	2.4	0.5	10	21 28	4.0 2.4	s 0.1 <0.02, s 0.1	R65.13
1986 (Idared)	WG	2.3	0.15	15	0 7 14 21 28 35	0.76 0.79 0.97 0.87 0.63 0.36	 <0.02 <0.02	R65.28
1986 (Cox's Orange)	WG	2.3	0.15	12	0 14 21 28 35	3.0 1.8 1.7 2.6 1.1	 <0.02	R65.28
1986 (Idared)	WG	2.3	0.45	12	0 7 14 21 28 35	2.9 1.7 1.3 1.4 1.1 1.1	 <0.02	R65.28
1986 (Cox's Orange)	SC	2.4	0.16	12	0 14 21 28 35	2.1 2.3 3.7 4.1 2.8	 <0.02	R65.27
1986 (Idared)	SC	2.4	0.48	12	0 7 14 21 28 35	3.9 3.9 2.8 2.5 2.9 2.8	 <0.02	R65.27
1986 (Cox's Orange)	WP	2.4	0.16	10	0 14 21 28 35	4.2 3.7 2.2 3.0 2.2	 <0.02	R65.26
1986 (Idared)	WP	2.4	0.16	14	0 7 14 21 28 35	0.70 1.8 1.3 0.78 0.92 0.33	 <0.02 <0.02	R65.26
1986 (Idared)	WP	2.4	0.48	12	0 7 14 21 28 35	2.9 3.0 2.2 2.2 1.5 1.5	 <0.02	R65.26
1991 (Gloster)	WG	2.3	0.75	8	0 28 35 41 41	2.4 1.1 0.56 0.56 w 0.49		R80.38
1991 (Cox's Orange)	WG	1.5	0.15	8	0 42	1.4 0.09		R80.38
1991 (Jonagold)	WP	1.6	0.64	8	0 28 35 42 49 56	8.9 0.54 0.37 0.35 0.26 0.28		R80.39
1991 (Golden)	WG	2.4	0.48	8	0 28 35 42	4.0 0.72 0.53 0.74		R80.39
1991 (Gloster)	WG	2.4	0.16	8	0 28 35 41	4.2 1.2 1.0 0.67		R80.39
1991 (Cox's Orange)	WG	1.6	0.16	8	0 42 49 56	1.0 0.14 0.07 0.06		R80.39
PEAR								

CROP Year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1982 (Conference)	WP	2.4	0.48	10	0 7 14	5.6 3.5 2.3	 0.04	R68.7
1982 (Charneu)	WP	2.4	0.16	12	0 7 14	8.3 6.6 4.0	 <0.02	R68.7
1982 (Charneu)	WP	0.8	0.05	14	0 3 7	1.3 1.4 <0.05	 <0.02	R68.7
1983 (Charneu)	WP	2.4	0.16	10	21 28	2.0 1.5	cm <0.02 <0.02, cm <0.02	R65.13
1983 (Conference)	WP	2.4	0.5	10	21 28	1.9 1.1	cm <0.02 <0.02, cm 0.02	R65.13
1983 (Williams)	WP	2.4	0.16	10	21 28	0.93 0.64	 0.09	R68.4
1983	WP	2.4	0.48	10	21 28	1.9 1.1	 <0.2	R65.13

[1] s: sauce. w: washed fruit. cm: compote.

Table 17. Mancozeb residues (as CS_2) in pome fruits from supervised trials in Italy. Analyses were on whole fruit without stalk. Underlined residues are from treatments according to GAP.

CROP Year (Variety)	Application				Day	Residues, mg/kg		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Apples								
1989 (Double Red)	WP	7.4	0.2	1	10	1.6	<0.01	R72.5/6/7
1989 (Double Red)	WP	2.1 +3.2 +4.2	0.16	1 +4 +7	10[1] 97[1]	0.73 0.77	<0.01 <0.01	R72.5/6/7
1989 (Double Red)	WG	2.1 +3.2 +4.2	0.16	1 +4 +7	97	0.15	<0.01	R72.5/6/7
1989 (Double Red)	SC	2.1 +3.2 +4.2	0.16	1 +4 +7	97	0.77	<0.01	R72.5/6/7
1989 (Double Red)	WP	2.1 +3.2 +4.2 +5.6	0.16	1 +4 +7 +5	29[1] 29[1] 29[1]	0.67 0.48 0.88	<0.01 <0.01 <0.01	R72.5/6/7
1989 (Double Red)	WG	2.1 +3.2 +4.2 +5.6	0.16	1 +4 +7 +5	29	0.76	<0.01	R72.5/6/7
1990 (Rome Beauty)	WP	2.6	0.16	10 15 16 17	132 56 42 28	<0.1 0.72 1.3 1.7	<0.01 <0.01 0.01 0.02	R75.5
1990 (Golden)	WP	1.6-2.0	0.12- 0.16	14	28 42	0.64 0.47	<0.01 <0.01	R75.5
1990 (Golden)	WP	1.6-2.0	0.12- 0.16	8 11	104 55	<0.1 0.14	<0.01 <0.01	R75.5
1990 (Morgenduft)	WP	1.6	0.16	8	116	<0.1	<0.01	R75.5
1990 (Morgenduft)	WP	1.6 +2.4	0.16	8 +5	52	0.38	<0.01	R75.5
1990 (Morgenduft)	WP	1.6 +2.4	0.16	8 +6	37	0.92	<0.01	R75.5
1990 (Morgenduft)	WP	1.6 +2.4	0.16	8 +7	19 28	1.4 1.3	 <0.01	R75.5
1990 (Jonathan)	WP	1.9 +2.4	0.16	3 +4	89	0.32	<0.01	R75.5
1990 (Jonathan)	WP	1.9 +2.4	0.16	3 +6	62	0.37	0.01	R75.5

CROP Year (Variety)	Application				Day	Residues, mg/kg		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1990 (Jonathan)	WP	1.9 +2.4	0.16	3 +7	42	0.38	0.01	R75.5
1990 (Jonathan)	WP	1.9 +2.4	0.16	3 +8	28	0.82	0.01	R75.5
1990 (Jonathan)	WP	1.9 +2.4	0.16	3 +9	14	1.6	0.01	R75.5
1990 (Super Stark)	WP	1.6	0.16	3	155	<0.1	<0.01	R75.5
1990 (Super Stark)	WP	1.6 +1.9	0.16	3 +3	123	<0.1	<0.01	R75.5
1990 (Super Stark)	WP	1.6 +1.9 +2.2	0.16	3 +3 +4	55	0.26	0.03	R75.5
1990 (Super Stark)	WP	1.6 +1.9 +2.2	0.16	3 +3 +5	28	0.40	<0.01	R75.5
1990 (Hi Early Starking)	WP	2.4	0.16	15 18 20 21	98 56 42 28	0.31 0.52 0.91 1.4		R75.5
1990 (Golden Granny)	WP	2.4	0.16	7	114	<0.1		R75.5
1990 (Badami)	WP	2.4	0.16	13	56	0.20		R75.5
1990 (Neijpling Early)	WP	2.4	0.16	14	42	0.86		R75.5
1990 (Acrynae)	WP	2.4	0.16	15	28	1.5		R75.5
1990 (Cooper)	WP	2.0	0.16	10	92	<0.1		R75.5
1990 (Golden)	WP	2.0	0.16	13 14 15	56 42 28	0.60 0.61 0.79		R75.5
1990 (Cooper 7)	WP	2.4	0.16	13	111	0.59		R75.5
1990 (Perleberg)	WP	2.4	0.16	19	56	1.2		R75.5
1990 (Starkrimson)	WP	2.4	0.16	21 22	42 28	1.2 1.2		R75.5
1990 (Golden)	WP	2.9	0.16	12 16 18	90 56 28	0.36 0.68 1.1		R75.5
1990 (Golden Stark)	WP	2.4	0.24	10 15 17 18	123 56 42 28	0.15 0.37 0.74 1.9		R75.5
1990 (Golden)	WP	2.4	0.8	9 13 13 14	113 56 42 28	<0.1 0.42 0.57 0.91		R75.5
1990 (Double Red)	WP	3.2	0.16	14	92	0.19		R75.5
1990 (Low Red)	WP	3.2	0.16	17 20 22	56 48 28	0.36 0.63 0.92		R75.5
PEARS								
1990 (William)	WP	2.6	0.16	9 10 11 12	71 56 42 28	0.18 0.30 0.41 0.76	<0.01 <0.01 <0.01 <0.01	R75.5
1990 (William)	WP	2.4	0.16	7 13 14 15	114 56 42 28	<0.1 0.13 0.74 1.7		R75.5

[1] trials with different formulations.

Table 18. Mancozeb residues (as CS_2) in apples from supervised trials in the UK. Underlined residues are from treatments according to GAP.

Year (Variety)	Application				Day	Residues, mg/kg		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1989 (Bramley)	WP	3.6	0.36	3	0 7 14 28 46 83	6.7[1] 2.8[1] 1.2[1] 0.58[1] 0.38 0.14	<0.006[1]	R71.16
1989 (Cox)	WP	2.4 +1.7 +3.6	0.48 +0.34 +0.90	2 +1 +1	0 7 14 28 46 83	5.4[1] 1.6[1] 1.6[1] 0.39[1] 0.24 0.78	<0.006[1]	R71.16
1989 (Bramley)	WP	4.0 +3.4	0.8 +0.7	2 +2	0 7 14 28 46 84	4.0[1] 2.8[1] 3.5[1] 0.30[1] 0.60 <0.05	<0.006[1]	R71.16
1989 (Bramley)	WP	3.4-3.8	0.9-1.1	5	0 7 14 28 46 88	2.2[1] 4.6[1] 2.5[1] 2.3[1] 2.6 1.1	0.16[1]	R71.16
1989 (Bramley)	WG	1.6	0.32	3	31 69	0.13[2] 0.13[2]		R71.16
1989 (Bramley)	WG	3.4 +1.6 +3.0	0.68 +0.32 +0.60	2 +1 +1	19 57	1.4[2] 0.14[2]		R71.16
1989 (Idared) (Golden) (Cox) (Red Delicious)	WG WG WG WG	3.4+1.6 3.4+1.6 3.4+1.6 3.4+1.6	0.7+0.3 0.7+0.3 0.7+0.3 0.7+0.3	2+1 2+1 2+1 2+1	69 69 69 69	0.12[2] 0.11[2] 0.13[2] 0.12[2]		R71.16
1989 (Bramley)	WG	1.6	0.32	2	57	0.17[2]		R71.16
1989 (Bramley)	WG	3.4	1.7	2	26 57	1.5[2] 0.36[2]		R71.16
1989 (Cox)	WG	2.4 +1.7 +3.4	0.48 +0.34 +0.68	2 +1 +1	28	0.35[2]		R71.16
1989 (Cox)	WG	1.6 +2.5	0.32 +0.50	2 +1	42	0.10[2]		R71.16
1989 (Bramley)	WG WG	1.7 +2.6 1.7 +2.6		1 +1 1 +2	44 96 34 87	<0.05[2] <0.05[2] 0.39[2] <0.05[2]		R71.16
1989 (Bramley)	WG	1.6 +2.1	0.53 +0.70	2 +1	29 71	0.77[2] 0.49[2]		R71.16
1989	WG	1.6 +2.5	0.38 +0.56	1 +3	3 25 70	4.5[2] 1.1[2] 0.31[2]		R71.16

[1] nut-sized immature fruit. [2] fruit without stalk.

Table 19. Mancozeb residues (as CS_2) in pome fruits from supervised trials in the USA (Loftus, 1991. ETU 91-02). Underlined residues are from treatments according to GAP.

CROP State, year (Variety)	Application	Day[1]	Residues, mg/kg[2]	Ref.

	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
APPLES								
MI, 1990 (Paula Red)	WP	5.4		4	fb 96	0.01	<0.005	ETU 91-02
MI, 1990 (Paula Red)	WP	2.7		4	fb 96	<0.01	<0.005	ETU 91-02
MI, 1990 (Paula Red)	WP	5.4		7	70	<0.01	<0.005	ETU 91-02
MI, 1990 (Paula Red)	WP	2.7		7	70	<0.01	<0.005	ETU 91-02
MI, 1990 (Paula Red)	WP	5.4		12	0 10 21 38	3.2 0.78 0.25 0.08	0.031 <0.005 0.011 <0.005 c 0.006	ETU 91-02
NY, 1990 (Twenty Ounce)	WP	5.4		4	fb 126	<0.01	<0.005	ETU 91-02
NY, 1990 (Twenty Ounce)	WP	2.7		4	fb 126	<0.01	<0.005	ETU 91-02
NY, 1990 (Twenty Ounce)	WP	5.4		7	77	0.05	<0.005	ETU 91-02
NY, 1990 (Twenty Ounce)	WP	2.7		7	77	<0.01	<0.005	ETU 91-02
NY, 1990 (Twenty Ounce)	WP	5.4		12	42	0.49	0.016	ETU 91-02
OH, 1990 (MacIntosh)	WP	10.8		2	fb 120	0.02	<0.005	ETU 91-02
OH, 1990 (MacIntosh)	WP	5.4		2	fb 120	<0.01	<0.005	ETU 91-02
OH, 1990 (MacIntosh)	WP	10.8 +5.4		2 +3	75	0.16	<0.005	ETU 91-02
OH, 1990 (MacIntosh)	WP	5.4 +2.7		2 +3	75	0.07	<0.005	ETU 91-02
OH, 1990 (MacIntosh)	WP	10.8 +5.4		2 +8	42	0.22	0.017	ETU 91-02
PA, 1990 (Empire)	WP	5.4		4	fb 119	<0.01	<0.005	ETU 91-02
PA, 1990 (Empire)	WP	2.7		4	fb 119	0.01	<0.005	ETU 91-02
PA, 1990 (Empire)	WP	5.4		7	74	0.02	<0.005	ETU 91-02
PA, 1990 (Empire)	WP	2.7		7	74	0.08	<0.005	ETU 91-02
PA, 1990 (Empire)	WP	5.4		12	42	0.32	0.022	ETU 91-02
VA, 1990 (Red Delicious)	WP	7.2		3	fb 110	0.08	0.005	ETU 91-02
VA, 1990 (Red Delicious)	WP	7.2		3	fb 110	0.13	<0.005	ETU 91-02
VA, 1990 (Red Delicious)	WP	7.2 +5.4		3 +3	70	0.34	<0.005	ETU 91-02
VA, 1990 (Red Delicious)	WP	3.6 +2.7		3 +3	70	0.31 c 0.03	<0.005	ETU 91-02
VA, 1990 (Red Delicious)	WP	7.2 +5.4		3 +8	42	1.8	0.033	ETU 91-02
WA, 1990 (Red Delicious)	WP	5.4		4	fb 158	<0.01	<0.005	ETU 91-02
WA, 1990 (Red Delicious)	WP	2.7		4	fb 158	<0.01	<0.005	ETU 91-02
WA, 1990 (Red Delicious)	WP	5.4		7	104	0.16	<0.005	ETU 91-02
WA, 1990 (Red Delicious)	WP	2.7		7	104	0.17	<0.005	ETU 91-02
WA, 1990 (Red Delicious)	WP	5.4		12	21 42	0.73 1.3	0.034 0.031	ETU 91-02
PEARS								
CA, 1985 (Bartlett)	WP	1.8	0.19	6	7 14 22	5.5 3.3 2.4	0.01 <0.01 <0.01	85-0223

CROP State, year (Variety)	Application				Day[1]	Residues, mg/kg[2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
CA, 1985 (Bartlett)	WP	1.8	0.19	6	8 15 22	5.5 3.4 1.9	0.02 0.01 <0.01	85-0224
PA, 1985 (Bartlett)	WP	7.2	0.19	6	7 14 21	2.9 2.4 1.5	0.046 0.054 0.048	85-0315

[1] fb: final application at full bloom.
[2] c: control sample.

Table 20. Mancozeb residues (as CS_2) in stone fruits from supervised trials in Australia, Brazil and France. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application				Day	Residues, mg/kg[1], EBDC as CS_2	Ref.
	Form	kg ai/ha	kg ai/hl	No.			
APRICOT							
Australia, 1992 (Moorpark)	WG		0.15	6	0 7 14 21	6.3 4.0 2.2 1.3	AUI-91-034
	WG		0.30	6	0 7 14 21	20 11 5.0 2.9	
Australia, 1992 (Moorpark)	WP		0.16	6	0 7 14 21	7.9 3.3 2.1 1.2	AUI-91-034
	WP		0.32	6	0 7 14 21	16 11 4.5 3.3	
PEACH							
Australia, 1991 (Red Haven)	WG		0.15	4	43 51 57	2.0 1.0 1.6	AUE-91-027
	WG		0.30	4	43 51 57	3.7 3.0 2.5	
Brazil, 1989	WP		0.16	4	0 14 21 35	1.1 0.95 0.39 0.1	072/90
Brazil, 1989	WP		0.32	4	0 14 21 35	2.2 1.1 0.56 0.45	072/90
PLUMS							
Brazil, 1990	WP		0.16	4	0 14 21 28	2.7 1.4 0.45 0.28	071/90
Brazil, 1990	WP		0.32	4	0 14 21 28	3.4 2.5 0.84 0.36	071/90
France, 1990 (Ente 707)	WP	1.9	0.15	4	62	0.14 c 0.08	R78.54/5
France, 1990 (Ente 707)	WP	1.6	0.16	3	54	0.16	R78.56
France, 1990 (Mirabellier)	WP	1.6 1.6 1.6 1.6		1 4 5 6	88 67 48 34	0.48[2] 0.33[2] 0.49[2] 0.55[2]	R78.59

[1] c: control sample
[2] fruit without stone

Table 21. Mancozeb residues (as CS_2) in berry fruits from supervised trials in Australia, Brazil, Hungary, Japan, Portugal and Spain. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
GRAPES								
Australia, 1990 (Rhine Reisling)	WP		0.16	3 4	7[1] 0 7 14 28	29 50 36 29 13		867/90
	WP		0.32	3 4	7[1] 0 7 14 28	49 83 59 38 38		
Australia, 1990 (Rhine Reisling)	WG		0.15	3 4	7[1] 0 7 14 28	22 42 29 16 12		867/90
	WG		0.30	3 4	7[1] 0 7 14 28	30 57 40 31 20		
Australia, 1990 (Rhine Reisling)	WG		0.15	2 3	19[1] 0 7 14 28 42 56	13 39 29 25 14 5.6 4.5	0.33 0.78 0.69 0.32 0.28 0.14 0.10	868/90 868/90/5
	WG		0.30	2 3	19 0 7 14 28 42 56	23 55 36 40 26 6.7 5.6	0.43 0.81 0.67 0.58 0.36 0.22 0.15	
Brazil, 1990	WP	2.8		2	0 7 14 21	2.0 1.7 0.56 <0.03		030/90
Brazil, 1990	WP	5.6		2	0 7 14 21	3.9 3.6 1.1 0.17		030/90
Hungary, 1986	SC	1.4	0.13	7	0 2 3 6 10 14 20 30 37	0.41 0.59 0.58 0.52 0.53 0.63 0.67 0.49 0.34		R65.33
Japan, 1989 (Delaware)	WP	1.9	0.075	2	46 60	0.59 0.04	0.02 <0.01	Saku1P-6-139
Japan, 1989 (Delaware)	WP	1.9	0.075	2	42 60	0.81 0.12	0.04 <0.01	Saku1P-6-139
Japan, 1989 (Kyoh_)	WP	1.9	0.075	2	45 60	0.56 0.15	0.03 <0.01	Saku1P-6-139
Japan, 1989 (Kyoh_)	WP	1.9	0.075	2	45 60	0.09 0.04	<0.01 <0.01	Saku1P-6-139
Portugal, 1991 (Cardinal)	WP	0.93 +1.6	0.38 +0.66	3 +3	43	0.91[2]		R80.27
STRAWBERRIES								
Japan, 1983 (Reik_)	WP	1.9	0.13	3 6	97 76	0.04 0.05		?
Japan, 1983 (Reik_)	WP	1.9	0.13	3 6	97 76	0.05 0.06		?

CROP Country, year (Variety)	Application				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Spain, 1985 (Cruz)	WP	3.2	0.16	1	0 4 7 14 21	13 6.0 4.3 3.2 2.0		R66.22/23
Spain, 1985 (Cruz)	WP	3.2	0.16	1	0 3 7 14 21	3.5 2.2 2.0 1.8 1.5		R66.22/23
Spain, 1986 (Douglas)	WP	4.8	0.24	3	0 3 7 14 21	5.0 3.7 2.8 1.8 0.4		R66.22/23

[1] sampled one hour before the final application
[2] whole cluster

Table 22. Mancozeb residues (as CS_2) in cranberries from supervised trials in the USA. Underlined residues are from treatments according to GAP.

State, year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
WA, 1985 (McFarlin)	WP	4.5	0.60	3	15 30 44	0.55 0.24 0.073	0.01 <0.01 <0.01	85-0294
WA, 1985 (McFarlin)	WP	5.4	0.72	3	15 30 44	0.50 0.29 0.11	<0.01 <0.01 <0.01	85-0295
OR, 1985 (McFarlin)	WP	5.4	1.9	4	15 30 45	13 3.1 2.5 c 0.03	0.054 0.025 0.025 c 0.01	85-0341
NJ, 1985 (Franklin)	WP	5.4	0.19	3	2 17 31	6.4 2.4 1.5	0.02 0.02 0.01	85-0456
NJ, 1985 (Early Black)	WP	5.4	0.19	3	15 29 47	0.31 0.15 0.059	0.02 0.02 0.02	85-0457
NJ, 1985 (Early Black)	WP	5.4	0.19	3	29 46	0.29 0.12	0.01 <0.01	85-0458
MA, 1988 (Crowley)	WP	5.4		4	30	2.7	0.058	88-0282

[1] c: control sample.

Table 23. Mancozeb residues (as CS_2) in grapes from supervised trials in France. Underlined residues are from treatments according to GAP.

Year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1975 (Chardonnay + Pinot Meunier)	WP	2.8 +0.7 +0.6 +0.8		6 +1 +1 +1	56 71	w <0.1 w <0.1	w <0.02 w <0.02	R60.9
1976 (Pinot Meunier)	WP	3.0 +2.4 +1.2		4 +1 +1	74	w <0.1	w <0.02	R60.9
1976 (Pinot Meunier + Chardonnay)	WP	2.8 +1.0		5 +1	54 64	w <0.1 w <0.1	w <0.02 w <0.02	R60.9
1976 (Pinot Noir + Pinot Meunier)	WP	2.8 +1.0		3 +3	60 66	w <0.1 w <0.1	w <0.02 w <0.02	R60.9
1976 (Chardonnay + Pinot Meunier)	WP	2.1 +2.8 +1.0		2 +2 +2	53 62	w <0.1 w <0.1	w <0.02 w <0.02	R60.9
1988 (Carbernet + Merlot)	WP	1.2 +1.4 +0.4		1 +8 +5	44	w <0.05		R78.78
1988 (Carbernet + Merlot)	WP	1.4 +0.4		8 +2	38	w <0.05		R78.82

Year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1988 (Carbernet + Merlot)	WP	2.5 +4.6 +2.1 +1.4 +2.3 +0.4 +1.4 +2.3		1 +1 +1 +3 +1 +1 +2 +1	39	w <0.05		R78.89
1988 (Carbernet + Merlot)	SC	0.95 +1.4 +3.0 +1.6		1 +4 +1 +3	48	w <0.05		R79.1
1989 (Carbernet + Merlot)	WP	2.5 +1.4 +0.4		2 +4 +2	46	w <0.05		R78.85
1990 (Pinot Noir)	WP	1.4 +0.4	0.35 +0.1	4 +4	31	1.0 w 0.23		R78.44
1990 (Pinot)	WP	1.4	0.42	2	118	<0.05[2] w 0.1		R78.57
1990 (Carignan)	WP	1.0 +0.91 +1.0 +0.32 +0.28 +0.32	0.87 +0.76 +0.87 +0.26 +0.23 +0.26	1 +1 +2 +2 +1 +3	43	0.66[2] w <0.05		R78.62/63
1990 (Gamay)	WP	1.4 +0.4	0.56 +0.15	6 +1	37	1.1[2] w <0.05		R79.5
1990 (Carignan)	WP	1.6	1.1	6	47 54	0.21[2] 0.4 j <0.05		R79.26
1990 (Carignan)	WP	1.4	0.93	5	52	0.7[2] w <0.05		R79.30
1990 (Cabernet Sauvignon)	WP	1.8 +1.2 +0.4	1.2 +0.77 +0.26	2 +3 +2	69	0.13[2]		R78.46
1990 (Pinot Noir)	WP	2.8	2.8	8	61	1.8[2]		R78.69
1990 (Carignan)	WP	2.8	1.1	8	32	3.2[2] c 0.32		R78.64
1990 (Pinot Meunier)	WP	2.8	2.8	6	68	0.44[2]		R78.65
1990 (Meunier)	WP	2.8	1.9	8	71	2.0[2] c 0.12		R78.66
1990 (Auxerrois)	WP	2.8	1.3	4	117	0.48[2]		R78.68
1990 (Merlot)	WP	2.4 +1.4 +1.6 +0.36	0.96 +0.56 +0.62 +0.14	2 +5 +1 +2	23	2.0[2] w 0.09		R78.71
1990 (Ugni blanc)	WP	2.8	0.56	10	38	2.0[2] c 0.08		R79.8
1990 (Malbec)	WP	2.8 +1.4 +0.4		2 +2 +2	81	0.87[2]		R79.13
1990 (Syrah)	WP	2.8	1.4	8	24	4.1[2] c 0.23		R79.16
1990 (Cabernet Sauvignon)	WP	2.8	0.56	10	13	1.5[2] c 1.8		R79.29
1990	WP	3.2 +1.0		4 +3	93	0.35[2]		R79.50/51
1991 (Grenache)	WP	0.7 +2 +1.8 +2.4 +0.4	0.46 +1.3 +1.2 +1.6 +0.26	1 +1 +1 +1 +2	28	0.28[2]		R80.13
1991 (Merlot)	SC	1.4 +1.8 +1.2 +1.5 +1.7	0.9 +1.2 +0.76 +0.98 +1.1	1 +1 +1 +2 +2	46	1.2[2]		R80.24
1991 (Carignan)	WP	1.2 +1.6	0.48 +0.64	4 +1	40	1.3[2]		R80.34
1991 (Sauvignon)	WG	2.8 +1.4 +1.6	1.9 +0.93 +1.1	3 +3 +2	30	w <0.1		R79.65

Year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
		+2.8 +1.4 +0.4	+1.9 +0.93 +0.26	+3 +3 +2				
1991 (Merlot Noir)	WG	2.8 +1.4 +1.6 +2.8 +1.4 +0.4	1.9 +0.93 +1.1 +1.9 +0.93 +0.26	3 +3 +2 +3 +3 +2	39	w <0.1		R79.73

[1] j: juice. w: wine. c: control sample.
[2] whole cluster

Table 24. Mancozeb residues (as CS_2) in grapes from supervised trials in Italy. Underlined residues are from treatments according to GAP.

Year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1989 (Barbera)	WP	1.3	0.16	6	28	2.1	<0.01	R72.1
1989 (Barbera)	WG	1.3	0.16	6	28	2.1	<0.01	R72.1
1989 (Barbera)	WP	1.3	0.16	6	28	2.1	<0.01	R72.1
1989 (Barbera)	SC	1.3	0.16	6	28	2.8	<0.01	R72.1
1989 (Garganega)	WP	1.4 +0.4	0.1 +0.03	4 +4	39	0.2 m 0.1 w <0.1	<0.01 m <0.01 w <0.01	R72.1
1989 (Garganega)	WP	1.4	0.1	4	90	0.13 m <0.1 w <0.01	<0.01 m <0.01 w <0.01	R72.1
1989 (Merlot)	WP	0.38 +0.50 +0.56 +0.44 +0.56 +0.64	0.018 to 0.032	1 +3 +3 +1 +3 +1	37	0.16 w <0.1	<0.01 w <0.01	R72.1
1989 (Refosco)	WP	0.8 +1.0 +1.2 +0.38	0.1 +0.1 +0.12 +0.038	2 +2 +1 +5	31	0.27 w <0.1	0.01 w <0.01	R72.1
1989 (Trebbiano)	WP	1.5 +0.48 +1.5	0.037 to 0.15	4 +4 +1	28	0.2	<0.01	R72.1
1989 (Trebbiano)	WP	1.0 +1.25 +1.5 +0.48	0.032 to 0.15	1 +1 +2 +7	43	0.25	<0.01	R72.1
1989 (Sangiovese)	WP	1	0.1	3	84	<0.1	<0.01	R72.1
1990 (Pinot Nero)	WP	1.1 +0.9 +1.1 +1.3 +0.36	0.088 +0.075 +0.075 +0.087 +0.024	1 +1 +1 +1 +4	35	0.56 m 0.20 w <0.1	w <0.01	R75.1
1990 (Pinot Nero)	WP	1.05 +0.90 +1.1 +1.3	0.088 +0.075 +0.075 +0.087	1 +1 +1 +1	95	0.60 m 0.30 w <0.1	w <0.01	R75.1
1990 (Müller Thurgau)	WP	0.65 +0.80 +0.22 +0.25	0.048 to 0.170	1 +1 +2 +1	35	<0.1 m <0.1 w <0.1	m <0.01 w <0.01	R75.1
1990 (Chardonnay)	WP	0.65 +0.80		1 +1	84	<0.1 m <0.1 w <0.1	m <0.01 w <0.01	R75.1
1990 (Sangiovese)	WP	0.28	0.09	8	35	0.27 m <0.1 w <0.1	m <0.01 w <0.01	R75.1
1990 (Sangiovese)	WP	0.28		4	83	0.17 m <0.1 w <0.1	m <0.01 w <0.01	R75.1
1990 (Trebbiano)	WP	2.1 +1.5 +0.36	0.024 to 0.16	1 +3 +7	38	0.2 m <0.1 w <0.1	m <0.01 w <0.01	R75.1

Year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1990 (Trebbiano)	WP	2.1 +1.5		1 +3	121	<0.1 m <0.1 w <0.1	m <0.01 w <0.01	R75.1
1990 (Italia)	WP	1.0	0.1	6	29	0.3	<0.01	R75.1
1990 (Sangiovese)	WP	2.0 +0.56	0.1 +0.028	2 +5	30	0.4		R75.1
1990 (Sangiovese)	WP	3.2	0.16	2	111	<0.25		R75.1
1990 (Sangiovese)	WP	1.9		5	37	0.52		R75.1
1990 (Sangiovese)	WP	1.9		3	98	<0.25		R75.1
1990 (Sangiovese)	WP	0.8	0.1	5	37	0.29		R75.1
1990 (Sangiovese)	WP	0.26	0.032	5	37	<0.25		R75.1
1990	SC		0.16 0.12	1 1	79 79	0.08 0.13		4579-6/2

[1] m: must; w: wine.

Table 25. Mancozeb residues (as CS_2) in black currants from supervised trials in the UK. Underlined residues are from treatments according to GAP.

Year (Variety)	Application				Day	Residues, mg/kg		Ref.
	Form	kg ai/ha	kg ai/hl	No.		Dithiocarbamates as CS_2	ETU	
1990 (Ben Lomond)	WG	2.3	0.11	5	0 6 15 21 31	7.0 2.9 2.7 2.0 2.0	0.016	R80.35
1990 (Baldwin)	WG	2.3	0.10	5	0 6 15 21 31	11 5.3 4.4 3.5 3.0	0.071	R80.35
1990 (Baldwin)	WG	2.3	0.11	5	0 7 19 21 31	13 6.7 3.5 3.4 3.0	0.032	R80.35
1990 (Baldwin)	WG	2.3	0.05	6	2 27	8.0 5.1	0.18	R80.35
1990 (Baldwin)	WG	2.3	0.3	7	0 26	14 4.3	0.084	R80.35
1990 (Baldwin)	WG	2.3	0.05	8	0 24	17 5.4	0.012	R80.35
1991 (Ben Lomond)	WG	2.3	0.11	5	0 21	5.2 2.6		R80.36
1991 (Ben Lomond)	WG	2.3	0.11	5	0 27	4.2 1.4		R80.36
1991 (Ben Lomond)	WG	2.3	0.11	5	0 20	2.9 3.0		R80.36

Table 26. Mancozeb residues (as CS_2) in tropical and subtropical fruits from supervised trials in Australia, Brazil, Honduras and Japan. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application [1]	Day	Residues, mg/kg [2]	Ref.

	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
AVOCADO								
Brazil, 1982	WP		0.18 0.36	3 3	21 21	0.60 0.80		SR 179/82
Bananas								
Australia, 1989 (Cavendish)	SC	1.0		7	1 7 14 28	pu <0.1, pe 1.3, f 0.6 pu <0.1, pe 1.7, f 0.8 pu <0.1, pe 1.3, f 0.6 pu <0.1, pe 0.8, f 0.4	pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1	2495/89/5 2495/89
Australia, 1989 (Cavendish)	SC	1.5		7	1 7 14 28	pu <0.1, pe 1.9, f 0.9 pu <0.1, pe 1.3, f 0.6 pu <0.1, pe 1.5, f 0.7 pu <0.1, pe 0.3, f 0.2	pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1	2495/89/5 2495/89
Australia, 1989 (Cavendish)	SC	1.8		7	1 7 14 28	pu <0.1, pe 3.3, f 1.4 pu <0.1, pe 2.5, f 1.1 pu <0.1, pe 2.1, f 1.0 pu <0.1, pe 0.6, f 0.4	pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1	2495/89/5 2495/89
Australia, 1989 (Cavendish)	WP	1.8		7	1 7 14 28	pu <0.1, pe 2.7, f 1.2 pu <0.1, pe 1.9, f 0.9 pu <0.1, pe 1.2, f 0.6 pu <0.1, pe 1.0, f 0.5	pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1 pu <0.1, pe <0.1, f <0.1	2495/89/5 2495/89
Brazil, 1986 (Nanacao)	WP	3.5 7.0		4 4	21 21	0.23 0.75	<0.01 0.05	86-0091
Honduras, 1988 (Grand Nain)	SC	2.1	0.29	a 45	9	0.11 pe 0.51 pu <0.005	<0.01 pe <0.01 pu 0.01	88-0040
FIGS								
Brazil, 1982	WP		0.16	3	7 21	1.1 0.62		181/82
Brazil, 1982	WP		0.32	3	7 21	2.8 1.6		181/82
MANGO								
Australia, 1990 (Kensington)	WP		0.16	9	1 7 14 28	1.7 1.5 0.9 0.5		90/3058
	WP		0.32	9	1 7 14 28	1.9 1.8 1.5 0.7		
Brazil, 1986 (Imperial)	WP	2.0 4.0		2 2	20 20	0.33 0.62	<0.01 0.01	86-0047
PASSION FRUIT								
Australia, 1991 (Barlow's E23)	WG		0.15	1	0 7 14 21	0.8 1.7 1.9 0.5		AUH-91-012
	WG		0.30	1	0 7 14 21	1.6 3.7 1.1 0.7		
PERSIMMON, JAPANESE								
Japan, 1989 (Hiratanenashi)	WP	7.5	0.19	6	20 30 45	0.54 0.43 0.11	0.02 0.02 0.01	Saku1P-7-186
Japan, 1989 (Fuyuu)	WP	7.5	0.19	6	21 30 45	0.40 0.22 0.15	0.06 0.05 0.02	Saku1P-7-186

[1] a: aerial application.

[2] pu: pulp; pe: peel; f: residues calculated on whole fruit basis from residues in pulp and peel and measured weights of peel and pulp.

Table 27. Mancozeb residues (as CS_2) in tropical fruits from supervised trials in the USA. Underlined residues are from treatments according to GAP.

CROP State, year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		Dithiocarbamates as CS_2	ETU	
BANANAS								
HI, 1988 (Valarie)	WG	3.6	0.64	8	0	0.20 pe 5.0 pu 0.21 c 0.20 c pe 1.5 c pu 0.12	<0.01 pe <0.01 pu <0.01	88-0029
HI, 1988 (Williams)	WG	3.6	0.64	11	0	0.48 pe 5.2 pu 0.55 c 0.23 c pe 3.3 c pu 0.27	<0.01 pe <0.01 pu <0.01	88-0030
Papayas								
FL, 1985 (Florida Type)	WP	2.2	0.14	10	0 7 14 21	2.5 0.98 0.49 0.40	<0.01 <0.01 0.01 0.02	85-0206
FL, 1985 (Florida Type)	WP	2.2	0.14	14	0 7 15 21	2.3 1.7 0.81 0.43	0.025 0.054 0.02 0.02	85-0594
HI, 1985 (Kapoho)	WP	3.4	0.36	12	7	3.1 c 0.12	0.074	85-0625
HI, 1985 (Kapoho)	WP	3.4	0.36	12	13	2.2 c 0.17	0.059	85-0632
HI, 1985 (Kapoho)	WP	3.4	0.36	12	21	1.1	0.031	85-0638
HI, 1988 (Kapoho Solo)	WP	2.2		13	0 0 0 0	6.6 pu 2.7 w 3.2 w pu 1.1	0.46 pu 0.17 w 0.47 w pu 0.16	88-0266

[1] pe: peel; pu: pulp; w: washed fruit; c: control sample.

Table 28. Mancozeb residues (as CS_2) in bulb vegetables from supervised trials in Australia, Brazil, Finland, France, Japan and The Netherlands. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application	Day	Residues, mg/kg [1]	Ref.

	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
GARLIC								
Brazil, 1990	WP	1.6		4	0 7 14 21	<0.03 <0.03 <0.03 <0.03		070/90
Brazil, 1990	WP	3.2		4	0 7 14 21	<0.03 <0.03 <0.03 <0.03		070/9
France, 1990 (Blanc de Lomange)	WP	2.0		6	29	0.05 c 0.1		R77.32
France, 1989 (Blanc de Lomange)	WP	2.5	0.5	7	22	<0.05		R73.25
France, 1989	WP	1.5		2	34	<0.05		R75.6
France, 1989	WP	1.5		3	19	<0.05		R75.6
France, 1989	WP	2.0		7	21	<0.05		R75.6
France, 1989		1.5		2	34	<0.05		Malet, 1990
France, 1989		1.5		3	19	<0.05		Malet, 1990
France, 1989	WP	2.0		7	21	<0.05		Malet, 1990
Japan, 1990 (Kanchi-white)	WP	3.8	0.19	5	3 7 14	0.01 0.02 <0.005	<0.01 <0.01 <0.01	Hei.-3-1-27
Japan, 1990 (Fukuchi-white)	WP	3.8	0.19	5	3 7 14	<0.005 <0.005 <0.005	<0.01 <0.01 <0.01	Hei.-3-1-27
LEEK (including CHINESE LEEK)								
France, 1991 (Nebraska)	WP	8.0	1.6	4 7 9	68 30 8	<0.1 0.16 0.20		R79.63
France, 1990 (Nebraska)	WP	2.0	0.4	4 7	60 30	<0.05 0.08		R77.49
France, 1990	WP	2.0		3	51	<0.02		R75.8
France, 1990	WP	2.0	0.66	15 18	59 30	0.15 0.23		RF 0062-3
France, 1991 (Carentan)	WG	2.0	0.4	7 9 11	60 35 15	0.30 <0.1 0.21 c 0.21		R79.42
Japan, 1988 (Ichimonji- kuronobori)	WP	1.9	0.13	3	14 21 30	0.34 0.10 0.04	0.06 0.02 0.01	P-3-69
Japan, 1988 (Bohzu-shirazu)	WP	1.9	0.13	3	14 21 30	0.34 0.12 <0.01	0.02 <0.01 <0.01	P-3-69
Japan, 1990 (Jakko-natsu)	WP	1.9	0.13	3	14 21 30	0.17 0.03 0.01	0.01 <0.01 <0.01	?2?12?27?
Japan. 1990 (Kujoh)	WP	1.9	0.13	3	14 21 30	0.22 0.03 <0.01	<0.01 <0.01 <0.01	?2?12?27?
ONION								
Australia, 1991 (Golden Brown)	WG WG	2.3 4.5		8 8	0 3 7 14 21 0 3 7 14 21	0.8 2.0 1.7 0.7 0.9 3.0 2.1 1.3 2.5 1.0		AUK-91-009
Brazil, 1984 (Bala Pirie)	WP WP	1.6 3.2		6 6	7 7	0.06 0.05		84-0245
Canada, 1985 (Rocket)	WP	1.6	0.29	3	0 7 14	0.44 0.12 0.14		#74
Finland, 1979	WP	0.64		3	14 28	<0.1 <0.1		R67.4
Japan, 1981	WP	1.9	0.19	5	3	0.08	<0.01	58P-2-52

CROP Country, year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
(Sapporo-k_)					7 14 20	0.07 0.08 0.14 c 0.12	<0.01 <0.01 <0.01	
Japan, 1982 (Momiji)	WP	2.8	0.19	5	4 7 14 21	0.10 0.10 0.12 0.14 c 0.12	<0.01 <0.01 <0.01 <0.01	58P-2-52
Netherlands, 1984 (Jumbo)	WP SC SC	2.4 2.4 2.2	1.0 1.0 0.86	8 8 8	29 29 29	0.01 (2) 0.01 (2) 0.01, 1.6	0.002 (2) 0.13, 0.03 0.002, 0.004	PH8426
Netherlands, 1985 (Balstora)	WP SC SC	2.4 2.2 2.2	1.2 1.1 1.1	7 7 7	31 31 31	<0.01 (2) <0.01 (2) <0.01 (2)	0.005, 0.002 0.004, 0.005 0.005, <0.002	PH8523
Netherlands, 1985 (Jumbo)	WP SC SC	2.4 2.2 2.2	1.2 1.1 1.1	7 7 7	26 26 26	<0.01 (2) <0.01 (2) <0.01 (2)	0.002, <0.002 0.003, <0.002 0.004, <0.002	PH8524
Netherlands, 1986 (Balstora)	WP SC SC SC WP SC	2.4 2.2 2.2 1.5 2.4 2.2	1.2 1.1 1.1 0.73 1.2 1.1	7 7 7 7 7 7	42 42 42 42 42 42	<0.01 <0.01 <0.01 0.03 <0.01 <0.01	<0.002 <0.002 <0.002 <0.002 <0.002 <0.002	PH8623
Netherlands, 1990 (Marbella)	WG	2.4	0.80	5	9	0.07, 0.04	<0.002 (2)	PH9038
Netherlands, 1990 (Hysam)	WG	2.4	0.12-0.16	6	28	0.09, 0.14	<0.002 (2)	PH9041

[1] c: control sample.

Table 29. Mancozeb residues (as CS_2) in bulb onions from supervised trials in the USA. Underlined residues are from treatments according to GAP. All WP.

State, year (Variety)	Application [1]			Day	Residues, mg/kg [2]		Ref.
	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
FL, 1985 (429)	2.7		10	4 7 14	0.08 0.04 <0.03	<0.01 <0.01 <0.01	85-0130
TX, 1985 (Uno Grande)	2.2	2.4	9 ga	4 8 11 16	<0.03 <0.03 <0.03 <0.03	<0.01 <0.01 <0.01 <0.01	85-0176
CA, 1985 (Austbrn.100)	1.8		6 ga	3 7 14	0.14 0.10 0.06	<0.01 <0.01 <0.01	85-0274
CA, 1985 (Austbrn.100)	1.8		6 ga	c 3 7 14	c 0.04 0.08 0.04 <0.03	c <0.01 <0.01 <0.01 <0.01	85-0275
CA, 1985 (Austbrn.100)	1.8		6 ga	c 3 7 14	c 0.04 0.26 0.17 0.11	c <0.01 <0.01 <0.01 <0.01	85-0276
OH, 1985 (Spartan)	2.7	0.58	10	3 7 10 14	0.05 0.03 0.05 <0.03	0.02 <0.01 <0.01 <0.01	85-0403
OH, 1985 (Spartan Bann)	2.7	0.26	f 1	135	<0.03	<0.01	85-0404
MI, 1985 (Spartan Bann)	2.7	0.58	6	3 7 10 14	0.05 <0.03 <0.03 <0.03	0.01 <0.01 <0.01 <0.01	85-0504
MI, 1985 (Spartan Bann)	2.7	0.82	f 1	110	<0.03	<0.01	85-0512
NY, 1985 (Down.Y.Globe)	2.7	0.29	f 1	119	<0.03	<0.01	85-0652
NY, 1985 (Down.Y.Globe)	2.7	0.29	f 1	119	<0.03	<0.01	85-0653
CA, 1987 (BRB)	2.7	2.9	10	0 7 14	0.50 0.03 <0.03	0.19 0.02 <0.01	88-0041

[1] ga: ground and aerial application. f: furrow drench application at sowing.

[2] c: control sample.

Table 30. Mancozeb residues (as CS_2) in brassica vegetables from supervised trials in Brazil, Germany and Japan. Underlined residues are from treatments according to GAP. All WP.

CROP Country, year (Variety)				Day	Residues, mg/kg [1]		Ref.
	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
BROCCOLI							
Brazil, 1989 (Ramoso)	1.2		5	1 4 7 13	0.84 0.12 0.1 0.06		100/90
Brazil, 1989 (Ramoso)	2.5		5	1 4 7 13	1.1 0.73 0.39 0.28		100/90
CABBAGE							
Brazil, 1988 (Repolho Louco)	0.66		9	1 7 14	0.17 0.1 <0.03		101/90
Brazil, 1988 (Repolho Louco)	1.3		9	1 7 14	0.34 0.22 0.06		101/90
Japan, 1979 (Masuda-kohai-chusei-risoh)	2.8-3.8	0.19	3	21 30 45	0.08 0.06 0.06		55P-3-55
Japan, 1979 (Yahiko)	2.8-3.8	0.19	3	21 30 45	0.09 0.06 0.05		55P-3-55
CAULIFLOWER							
Brazil, 1989		0.16	7	0 7 14 21	0.22 0.17 0.11 0.06		730/89
Brazil, 1989		0.32	7	0 7 14 21	0.34 0.28 0.11 0.10		730/89
Germany, 1972	0.8	0.16	2	47	0.58		R67.27
Spain, 1992	3.8	0.19	1	0 3 14 21	0.43 0.18 0.04 0.06		MAPA 24.06.93
Spain, 1992	4.8	0.24	1	0 3 14 21	0.52 0.29 0.09 0.06		MAPA 24.06.93
CHINESE CABBAGE							
Japan, 1991 (Akogare)	1.9	0.13	3	14 21 30	0.34 0.34 0.06	0.02 <0.01 <0.01	Hei-4-3-11
Japan, 1991 (Ryokei)	1.9	0.13	3	14 21 30	0.25 0.05 0.01, <0.01 c 0.10	0.01 <0.01 <0.01	Hei-4-3-11
Spain, 1992 (Kasumi)	4.8	0.24	1	0 3 7 14 21	5.7 7.2 3.3 2.5 0.17		MAPA 25.06.93
KALE							
Germany, 1972	0.8	0.16	2	47	<0.3		R67.27

[1] c: control sample

Table 31. Mancozeb residues (as CS_2) in cucurbits from supervised trials in Australia, Brazil, France, Germany and Japan. Underlined residues are from treatments according to GAP. All WP.

CROP Country, year (Variety)		Day	Residues, mg/kg [2]	Ref.

	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
GHERKIN							
Germany, 1974 (Delikatess)	1.6	0.16	5	0 2 3 4 7	pe 0.60, pu <0.3 pe 0.56, pu <0.3 pe 0.96, pu <0.3 pe 0.57, pu <0.3 pe 0.45, pu <0.3		R69.13
MELON (Cantaloupe)							
France, 1989	1.6		3	3	<0.1		R75.6
France, 1989	0.91		4	3	<0.1		R75.6
France, 1989	1.4		4	3	<0.1		R75.6
France, 1989	1.5		3	3	<0.05		R75.6
France, 1990	1.6		3	3	0.11		R75.6
France, 1990	1.6		5	3	0.06		R75.6
France, 1990	1.5		5	3	<0.02		R75.6
MELON							
France, 1989	1.5		3	3	<0.05		Malet, 1990
France, 1989	1.6		3	3	<0.05		Malet, 1990
France, 1989	0.91		4	3	<0.1		Malet, 1990
France, 1989	1.4		4	3	<0.1		Malet, 1990
France, 1989	1.6		3	3	<0.1		Malet, 1990
France, 1990	1.5		5	3	<0.02		Malet, 1990
France, 1990	1.6		5	3	0.04		Malet, 1990
France, 1990	1.5		5	3	<0.02		Malet, 1990
France, 1990	1.6		5	3	0.08		Malet, 1990
France, 1990	1.6		3	3	0.11		Malet, 1990
Germany, 1972 (Diamex)	1.6	0.5	4	9	pu <0.3		R67.27
Japan, 1987	5.6	0.19	5i	1 3 7	pu 0.11 pu 0.16 pu 0.08	pu <0.01 pu <0.01 pu 0.01	Saku62P-9-238
Japan, 1987	3.8	0.19	5i	1 3 7	pu 0.24 pu 0.14 pu 0.28	pu 0.02 pu 0.04 pu 0.04	Saku62P-9-238
PUMPKIN							
Australia, 1992 (Jarrahdale)	1.8 3.5		5 5	0 7 14 21 28 0 7 14 21 28	<0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1 <0.1		AUK-92-004
Brazil, 1990	1.6		2	0 14 21 28	0.22 0.11 0.06 0.04		102/90
Brazil, 1990	3.2		2	0 14 21 28	0.56 0.22 0.17 0.11		102/90
SQUASH							
France, 1990	1.5		4	6	<0.02		R75.6
France, 1990	1.5		5	3	<0.02		R75.6
France, 1990	1.6		5	3	0.05		R75.6
France, 1990	1.6		4	6	<0.02		R75.6
France, 1990	2.0		2	2 6	<0.002 <0.002		R75.6
France, 1990	2.0		1	3 10	<0.002 <0.002		R75.6
Japan, 1989	1.9-2.5	0.13	3	21 30	0.17 0.06	0.02 0.02	Hei-1-10-27

CROP Country, year (Variety)				Day	Residues, mg/kg [2]		Ref.
	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
(Miyako)				45	0.03	0.02	
Japan, 1989 (Ebisu)	1.9	0.13	3	21 30 45	0.03 0.01 0.02	<0.01 <0.01 0.01	Hei-1-10-27
SUMMER SQUASH							
Australia, 1992 (Black Regal)	1.8		5	0 6 13 20 27	<0.1 <0.1 <0.1 <0.1 <0.1		AUK-92-006
	3.5		5	0 6 13 20 27	0.2 0.3 <0.1 <0.1 <0.1		
France, 1990	1.6		5	3	0.05		Malet, 1990
France, 1990	1.5		4	6	<0.02		Malet, 1990
France, 1990	1.6		4	6	<0.02		Malet, 1990
France, 1990	1.5		5	3	<0.02		Malet, 1990
WATERMELON							
Australia, 1992 (War Paint)	1.8		5	0 7 14 21 28	<0.1 <0.1 <0.1 <0.1 <0.1		AUK-92-005
	3.5		5	0 7 14 21 28	<0.1 <0.1 <0.1 <0.1 <0.1		
Japan, 1984 (Fujik_)	3.6	0.19	7i	7 14	pu 0.017 pu <0.006	pu <0.01 pu <0.01	Saku59P-8-212
Japan, 1984 (Akadoma)	3.6	0.19	7i	1 7 14	pu 0.011 pu <0.006 pu <0.006	pu 0.02 pu 0.01 pu 0.01	Saku59P-8-212

[1] i: indoors.
[2] pe: peel; pu: pulp.

Table 32. Mancozeb residues (as CS_2) in cucumbers from supervised trials. Underlined residues are from treatments according to GAP. All WP.

Country, year (Variety)				Day	Residues, mg/kg		Ref.
	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Australia, 1992 (Marketer)	1.8		4	0 7 14 21 28	0.1 <0.1 <0.1 <0.1 <0.1		AUK-92-003
	3.5		4	0 7 14 21 28	0.1 0.1 <0.1 <0.1 <0.1		
Brazil, 1988 (Capira)		0.15	3	7 14 21	<0.03 <0.03 <0.03		FPA-88-023
Brazil, 1988 (Capira)		0.30	3	7 14 21	<0.03 <0.03 <0.03		FPA-88-023
France, 1988	1.4		6	7	<0.01		R75.6
France, 1988	1.4		3	3	<0.1		R75.6
France, 1988	0.91		3	3	<0.1		R75.6
France, 1988	1.4		6	7	<0.01		Malet, 1990
France, 1989	1.6		3	3	<0.1		R75.6
France, 1989	1.6		5	3	<0.1		R75.6

Country, year (Variety)	kg ai/ha	kg ai/hl	No.	Day	Residues, mg/kg EBDC as CS_2	Residues, mg/kg ETU	Ref.
France, 1989	0.91		3	3	<0.1		R75.6
France, 1989	0.91		3	3	<0.1		Malet, 1990
France, 1989	1.4		3	3	<0.1		Malet, 1990
France, 1989	1.6		5	3	<0.1		Malet, 1990
France, 1989	1.4		3	3	<0.1		Malet, 1990
France, 1989	0.91		3	3	<0.1		Malet, 1990
France, 1989	1.6		3	3	<0.1		Malet, 1990
France, 1990	1.6		3	2	0.03		R75.6
France, 1990	1.6		3	2	0.03		Malet, 1990
Germany, 1974 (Pepiner)	3.2	0.32	5i	0 2 3 4 7	1.4 0.84 <0.3 0.64 <0.3		R67.8
Germany, 1974 (Femdom)	3.2	0.32	5i	0 2 3 4 7	0.50 0.60 0.65 0.40 <0.3		R67.8
Japan, 1983 (Hokkoyku-2 goh)	3.8	0.19	3	1 3 7	0.18 0.25 0.05	0.01 0.01 0.01	59P-1-32
Japan, 1983 (Hokkoyku-2 goh)	2.5	0.13	3i	1 3 7	0.12 0.19 0.07	<0.01 <0.01 0.01	59P-1-32
Japan, 1983 (Kash_-fushinari 2 goh kairy_)	3.8	0.19	3i	1 3 7	0.19 0.12 0.02	<0.01 <0.01 <0.01	59P-1-32
Spain, 1989	2.4		1	0 2 7	0.61 0.15 0.07		MAPA 24.06.93

[1] i: indoors.

Table 33. Mancozeb residues (as CS_2) in cucurbits from supervised trials in the USA. Underlined residues are from treatments according to GAP. All WP.

CROP State, year (Variety)	kg ai/ha	kg ai/hl	No.	Day	Residues, mg/kg [1] EBDC as CS_2	Residues, mg/kg [1] ETU	Ref.
CANTALOUPE							
FL, 1985 (Tania)	2.7	0.29	12	3 5 10	2.4 1.8 1.1	0.029 0.051 0.058	85-0161
CA, 1985 (Top Mark)	2.7	0.82	5	3 5 10	0.76 0.43 0.16	0.01 <0.01 <0.01	85-0280
CUCUMBER							
FL, 1985 (Slicer)	2.7	0.29	8	4 5 10	0.14 0.09 <0.03	0.01 <0.01 <0.01	85-0126
FL, 1985 (Model)	2.7	0.29	12	3 5 10	1.1 0.65 0.25	0.024 0.02 <0.01	85-0163
OH, 1985 (Market More)	2.7	0.58	8	3 5 7 10	0.25 0.19 0.13 0.10	0.01 <0.01 <0.01 <0.01	85-0325
OH, 1985 (Carolina)	2.7	0.48	6	3 5 7 10	0.20 0.12 0.07 0.06	0.01 <0.01 <0.01 <0.01	85-0339
GA, 1986 (Poinsett)	1.8	0.58	7	0 10	0.54 0.28	0.035 0.02	86-0560
GA, 1986 (Poinsett)	1.8	0.58	7	0 10	0.83 0.27 c 0.62	0.02 0.011	86-0645

CROP State, year (Variety)				Day	Residues, mg/kg [1]		Ref.
	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
TX, 1987 (P76)	2.7	1.4	9	5	0.05	0.043	87-0482
CA, 1987	2.7	1.4	3	5	0.06	0.041	88-0045
SUMMER SQUASH							
FL, 1985 (Prolific St)	2.7	0.29	8	4 5 10	0.40 0.23 0.03	0.01 <0.01 <0.01	85-0127
FL, 1985 (Senator)	2.7	0.29	8	4 5 10	0.32 0.25 0.14	<0.01 <0.01 <0.01	85-0128
VA, 1985 (Crookneck)	2.8	0.60	7	3 5 10	0.16 0.08 0.04	0.02 0.01 <0.01	85-0310
VA, 1985 (Senator)	2.8	0.60	7	3 5 10	0.10 0.07 0.05	<0.01 <0.01 <0.01	85-0311
OH, 1985	2.7	0.58	7	3 5 10	0.12 0.10 0.05	<0.01 <0.01 <0.01	85-0312
NJ, 1985 (Black Beauty)	2.7	0.32	5	2 4 10	1.0 0.83 0.65	0.02 0.02 0.01	85-0428
IN, 1985 (Yellow St Nk)	2.7	0.29	7	3 5 10	0.28 0.21 0.17	<0.01 <0.01 <0.01	85-0484
WATERMELON							
FL, 1985 (Sugar Baby)	2.7	0.29	12	3 5 10	0.81 0.38 0.20	<0.01 <0.01 <0.01	85-0162
WINTER SQUASH							
FL, 1985 (Tatabutu)	2.7	0.29	8	4 5 10	0.27 0.20 0.05	<0.01 <0.01 <0.01	85-0129
OH, 1985 (Acorn)	2.7	0.58	7	3 5 10	0.13 0.08 0.05	0.02 0.02 0.028	85-0460
VA, 1985 (Waltham)	2.8	0.60	7	3 5 10	0.26 0.10 0.08	0.025 0.035 0.025	85-0479
VA, 1985 (Tay Belle)	2.8	0.60	7	3 5 10	0.56 0.38 0.18 c 0.24	0.038 0.033 0.031	85-0480
OH, 1985 (Acorn)	2.7	0.29	7	3 5 10	0.57 0.38 0.18 c 0.36	0.030 0.027 0.02	85-0485

[1] c: control sample.

Table 34. Mancozeb residues (as CS_2) in fruiting vegetables other than cucurbits from supervised trials in Brazil, France, Germany, Italy, Japan, The Netherlands, Portugal and Spain. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application [1]	Day	Residues, mg/kg [2]	Ref.

	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
EGG PLANT								
Brazil, 1984 (Pira F 100)	WP	2.4 4.8		8 8	7 7	0.26 0.28 c 0.02		84-0105
PEPPERS								
Brazil, 1989	WP		0.24	4	0 7 14 21	2.5 0.56 0.08 <0.02		745/89
Brazil, 1989	WP		0.48	4	0 7 14 21	5.3 0.90 0.78 0.03		745/89
Spain, 1986	WP	2.9	0.16	3	0 4 7 14 21	1.8 1.6 1.0 0.6 0.3		R66.22/23
Spain, 1987 (Cristal)	WP	3.4	0.16	1	0 3 7 14 21	2.2 1.8 1.1 0.49 0.17		MAPA 24.06.93
Spain, 1988 (Magister)	WP	3.8	0.16	1	0 3 7	0.34 0.30 0.19		MAPA 24.06.93
TOMATOES								
Brazil, 1988 (Rio Grande)	WG	2.4		15	1 3 7 14	0.12 0.06 0.03 0.07		Du Pont FPA 88-027 A
Brazil, 1988 (Rio Grande)	WG	4.8		15	1 3 7 14	0.20 0.21 0.08 0.03		Du Pont FPA 88-027 A
France, 1990 (Merveille des Marchés)	WP	1.6	0.32	9	0 2 4 7 10	2.2 0.84 0.72 0.77 0.85 c 0.20		R77.35
France, 1990 (Merveille des Marchés)	WP	0.33	0.06	9	0 2 4 7 10	1 0.7 0.28 0.64 2.9		R77.36
France, 1990 (Merveille des Marchés)	WP	1.2	0.23	9	0 2 4 7 10	1.9 0.81 0.3 1 0.36		R77.37
France, 1990 (Merveille des Marchés)	WP	1.2	0.23	8	0 2 4 7	w 0.1 w 0.11 w 0.25 w 0.25		R77.40
France, 1990 (Merveille des Marchés)	WP	0.33	0.06	8	0 2 4 7	w 0.11 w <0.05 w 0.07 w 0.15		R77.39
France, 1990 (Merveille des Marchés)	WP	1.6	0.32	8	0 2 4 7	w 0.4 w <0.05 w 0.67 w 0.28 c 0.08		R77.38
France, 1990 (Merveille des Marchés)	WP	0.33	0.06	8	0 2 4 7	1.3 0.61 0.43 0.6		R77.42
France, 1990 (Merveille des Marchés)	WP	1.6	0.32	8	0 2 4 7	4.1 1.4 1.1 0.55 c 0.05		R77.41
France, 1990 (Merveille des Marchés)	WP	1.2	0.23	8	0 2 4 7	3.2 1.9 1.3 0.54		R77.43
France, 1990 (Merveille des	WP	1.2	0.23	9	0 2	w 0.4 w 0.11		R77.46

CROP Country, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Marchés)					4 7 10	w 0.16 w 0.22 w 0.13		
France, 1990 (Merveille des Marchés)	WP	0.33	0.06	9	0 2 4 7 10	w 0.34 w <0.05 w 0.16 w 0.06 w 0.13		R77.45
France, 1990 (Merveille des Marchés)	WP	1.6	0.32	9	0 2 4 7 10	w 0.11 w 0.31 w 0.26 w 0.37 w 0.4 c 0.13		R77.44
France, 1990 (Ferline)	WP	1.6	0.31	6	3	1.4 c 0.06		R78.53
France, 1990	WP	1.6	0.31	6	3	1.5 c 0.15		R80.8
France, 1991	WG	1.6	0.32	8	0 3 4 7	2.6 1.3 0.94 1.6		R79.43
France, 1991 (Roma)	WG	1.6	0.32	8	7 7 14 14	0.81 w 0.12 0.57 w <0.1		R79.44
Germany, 1974 (Namaza Lizzy)	WP	1.6	0.16	6	0 2 3 4 7	4.3 4.2 1.8 3.8 2.1		R67.28
Germany, 1974 (Rot-käppchen)	WP	3.2	0.16	8	0 2 3 4 7	0.82 0.85 0.52 <0.3 <0.3		R69.14
Germany, 1974 (Rubin)	WP	3.2	0.16	8	0 2 3 4 7	0.95 0.68 0.60 <0.3 <0.3		R69.14
Germany, 1974 (Rheinlands- Ruhm)	WP	0.96	0.16	6	2 3 4 7	1.2 1.3 1.7 1.3		R69.14
Germany, 1975 (MM Nota)	WP	2.4	0.5	8	0 2 3 4 7	1.3 0.84 1.0 0.91 0.63	0.015 0.005 0.005 0.003	R69.14
Germany, 1975 (1080)	WP	0.96	0.16	6	0 2 3 4 7	0.33 <0.2 <0.2 <0.2 <0.2	<0.003 0.003 0.003 0.003 0.003	R69.14
Germany, 1975 (Rot-käppchen)	WP	3.2	0.16	8	0 2 3 4	0.65 0.92 <0.3 <0.3		R69.14
Germany, 1975 (Rheinlands- Ruhm)	WP	1.6	0.16	8 i	0 1 3 4 7 9	1.5 0.95 3.7 1.7 0.89 0.79	0.008 0.008 0.015 0.007 0.007 <0.007	R69.14
Italy, 1986 (HY23)	WP	2.2	0.3	7 6 4	21 28 42	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.43
Italy, 1986 (HY23)	WP	4.3	0.6	7 6 4	21 28 42	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.43
Italy, 1986 (OC1023)	WP	2.8	0.3	7 6 4	21 28 42	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.43
Italy, 1986 (OC102)	WP	4.3	0.6	7 6 4	21 28 42	0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.43

CROP Country, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Italy, 1986 (UC105)	WP	2.1	0.3	7 6 4	21 28 42	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.43
Italy, 1986 (OC1053)	WP	4.1	0.6	7 6 4	21 28 42	0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.43
Italy, 1987 (Rio Grande)	WP	1.4	0.24	8 7 5	21 28 42	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R66.19
Italy, 1987 (Rio Grande)	WP	2.9	0.48	8 7 5	21 28 42	0.29 0.12 <0.1	<0.02 <0.02 <0.02	R66.19
Italy, 1987 (Improy)	WP	1.4	0.24	8 7 5	21 28 42	0.21 <0.1 <0.1	<0.02 <0.02 <0.02	R66.20
Italy, 1987 (Improy)	WP	2.9	0.48	8 7 5	21 28 42	0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R66.20
Japan, 1985 (Zuiken)	WP	1.9	0.094	5i	1 3 7	0.19 0.17 0.27	0.01 0.02 <0.01	60P-5-57
Japan, 1985 (Kyoryoku- kairyo-shuko)	WP	1.9	0.094	5i	1 3 7	0.30 0.31 0.33	0.02 0.02 <0.01	60P-5-57
Netherlands, 1984 (Abunda)	WP SC SC		0.16 0.15 0.14	6 6 6	15 15 15	0.07, <0.01 <0.01, 0.04 <0.01, 0.20	<0.002, 0.002 <0.002 (2) <0.002 (2)	PH8405
Netherlands, 1984 (Abunda)	WP SC SC WP SC SC		0.16 0.15 0.14 0.16 0.15 0.14	3 3 3 8 8 8	15 15 15 4 4 4	0.02, <0.01 <0.01 (2) <0.01 (2) 0.16, 0.01 <0.01, 0.02 0.20, 0.04	<0.002, 0.002 <0.002 (2) 0.01, <0.002 0.046, 0.002 <0.002	PH8406
Portugal, 1990 (Petopride)	WP	1.6	0.45	4 2 2	54, 55 83 84	0.49, w 0.57 0.30, w 0.20 0.13		R79.53
Portugal, 1990 (Rio Fuego)	WP	1.6 m 1.6 1.6	0.45 0.45 0.45	4 2 2	82 82 104	0.46, w 0.32 0.16, w 0.29 0.57, w 0.23		R79.54
Spain, 1986 (Rubí)	WP	3.8	0.19	2	0 3 7 14 21	1.1 0.72 0.52 0.43 0.34		MAPA 24.06.93
Spain, 1986 (Rubí)	WP	3.2	0.16	2	0 3 7 14 21	1.1 0.72 0.46 0.26 0.18		MAPA 24.06.93
Spain, 1987 (Quarenteno)	WP	4.8	0.16	1	0 3 7 14 21	2.2 1.9 0.37 0.31 0.07		MAPA 24.06.93
Spain, 1988	WP	0.24		1	0 2 7 10 15	1.0 0.58 0.57 0.37 0.20		MAPA 24.06.93
Spain, 1990 (Rio Fuego)	WG	1.4	0.22	3	24	0.34		R79.20
Spain, 1990 (Centurion)	WP	0.44 0.4+1.44 0.4+1.44 0.4+1.44 0.4+1.44	0.04	1 1+6 1+5 1+4 1+2	98 9 21 38 65	0.16 0.68 0.3 0.24 0.27		R79.19
Spain, 1990 (Ovad Red)	WP	0.64+0.8 0.64+0.80. 64+0.8 0.64+0.80. 64+0.8	0.13+0.16 0.13+0.16 0.13+0.16 0.13+0.16 0.13+0.16	1+1 1+2 1+3 1+4 1+5	91 73 51 37 1	<0.05 <0.05 <0.05 0.06 0.08		R80.10
Spain, 1990 (Quarenteno)	WP	4.8	0.19	1	0 3 7 14	0.61 0.53 0.19 0.22		MAPA 24.06.93

CROP Country, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					21	0.15		
Spain, 1991 (Cristina)	WP	0.2	0.02	1	0 3 7 15	2.1 1.4 0.94 0.45 c 0.23		R80.30
	WP	0.2	0.02	2	0 3 8 15	1.9 1.9 0.84 0.78		

[1] i: indoors; m: metiram also early in spray programme.
[2] w: washed fruit; c: control sample.

Table 35. Mancozeb residues (as CS_2) in fruiting vegetables from supervised trials in the USA. Underlined residues are from treatments according to GAP.

CROP State, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
SWEET CORN								
PA, 1987 (Penn Fresh)	WP	1.3	0.29	7	7	e 0.21 c&k <0.03 h 1.3	e <0.01 c&k <0.01 h 0.01	34-89-04
	WP	6.7	1.4	7	7	e 0.90 c&k 0.03 h 6.7	e 0.02 c&k 0.02 h 0.18	
OR, 1987 (Gold Jubilee)	WP	1.3	0.36	15	7 7 7	c&k <0.03 e&h 1.3 h 2.9	c&k <0.01 e&h 0.01 h 0.02	87-0384
TOMATOES								
CA, 1971	WP	2.7		6	0 3 7 14	8.7 2.8 4.1 2.5		3-71-51
CA, 1971	WP	5.4		6	0 3 7 14	4.7 3.5 1.8 1.8		3-71-52
DL, 1971 (C-28)	WP	2.7		8	0 3 7 14	0.92 0.72 0.61 0.44	0.05 0.04 0.03 0.03	3-71-61
OH, 1971 (C-28)	WP	2.7		10	0 3 7 14	0.69 0.68 0.53 0.34	0.04 0.04 0.02 0.02	3-71-59
FL, 1972 (Homestead 24)	WP	1.3		13 14	0 0 3 7 14	0.56 0.50 0.47 0.41 0.21	0.02 0.02 0.02 0.03 0.02	3-72-01
FL, 1972 (Homestead 24)	WP	1.3	0.19	13 14	0 0 3 7 14	0.35 0.39 0.30 0.34 0.19	0.03 0.05 0.02 0.01 <0.01	23-72-7
CA, 1985 (785)	WP	2.7	0.58	8	2 5 12	0.59 0.42 0.12	0.01 <0.01 0.03	85-0555
CA, 1985	WP	2.7	0.58	7	3	1.8	0.01	85-0368
CA, 1985	WP	2.7	0.58	6	2 5	1.3 0.81	0.01 <0.01	85-0369
CA, 1985	WP	2.7	0.58	8	2 5	5.1 3.0	0.046 0.031	85-0554
CA, 1985 (785)	WP	2.7	0.58	8	2 5	0.59 0.42	0.01 <0.01	85-0555
CA, 1985 (C16)	WP	2.7	1.4	a 6	2 5 9	0.45 0.17 0.09	<0.01 0.01 0.01	85-0346

CROP State, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
CA, 1985 (C16)	WP	2.7	1.4	a 6	2 5	0.44 0.14	<0.01 <0.01	85-0347
CA, 1985	WP	2.7	1.4	a 6	2 5 9	0.32 0.18 0.06	0.02 0.02 <0.01	85-0348
CA, 1985 (C16)	WP	2.7	1.4	a 6	2 5 9	0.47 0.23 0.06	0.02 0.01 0.02	85-0349
NJ, 1986 (US28)	WP WG	2.7 2.7	0.34 0.34	7 7	8 8	0.84 0.84 c 0.3	0.054 0.054	86-0596
CA, 1987 (Harris 3075)	WP	2.7	1.4	4	0 5 10	4.6 2.7 1.8	0.10 0.047 0.047	88-0058

[1] a: aerial application.
[2] c&k: cob and kernel; e&h: ear and husk; h: husk; c: control sample.

Table 36. Mancozeb residues (as CS_2) in leafy vegetables from supervised trials in Brazil, Canada and Spain. Underlined residues are from treatments according to GAP. All WP.

CROP Country, year (Variety)	Application			Day	Residues, mg/kg, EBDC as CS_2	Ref.
	kg ai/ha	kg ai/hl	No.			
ENDIVE						
Canada, 1981 (Green Curled)	1.6	0.29	3	0 1 3 7 10 14	22 19 14 7.2 4.4 0.84	#71
KALE						
Brazil, 1989		0.16	4	0 7 14 21	11 1.8 0.95 0.03	731/89
Brazil, 1989		0.32	4	0 7 14 21	13 4.6 1.0 0.13	731/89
LETTUCE						
Canada, 1981 (leaf lettuce, Grand Rapids)	1.6	0.29	3	0 1 3 7 10 14	15 16 13 4.0 2.0 0.47	#71
Canada, 1981 (cos lettuce, Paris Island Cos)	1.6	0.29	3	0 1 3 7 10 14	14 11 7.2 1.4 1.4 0.15	#71
Canada, 1983 (Ithaca)	1.6	0.29	3	0 1 3 10	4.2 3.3 1.9 0.31	#72

CROP Country, year (Variety)	Application			Day	Residues, mg/kg, EBDC as CS_2	Ref.
	kg ai/ha	kg ai/hl	No.			
Canada, 1984 (Ithaca)	1.6	0.29	3	0 1 3 7 10 14	2.9 3.7 1.9 0.99 0.66 0.15	#73
Spain, 1985 (Batavia)	1.9	0.16	3	0 3 7 14 21	8.8 6.3 4.7 3.0 1.4	R66.22/23
Spain, 1985 (Inverne)	3.0	0.16	3	0 3 7 14 21	11 9.7 6.8 3.5 1.9	R66.22/23
Spain, 1985 (Batavia)	2.7	0.16	3	0 3 7 15 22	11 9.2 5.8 3.0 2.6	R66.22/23
Spain, 1986 (Verdia)	4.8	0.24	2	0 3 7 14 21	27 22 15 6.0 3.7	R66.23
Spain, 1987 (Romana)	4.5	0.16	1	0 3 7 14 21 28	17 14 11 10 6.1 2.5	MAPA 25.06.93
Spain, 1989 (Samy)	3.3	0.19	1	0 7 22	5.6 3.9 0.79	MAPA 25.06.93

Table 37. Mancozeb residues (as CS_2) in legume vegetables from supervised trials in Australia, Brazil, France, Japan. The Netherlands and Spain. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application	Day	Residues, mg/kg [1]	Ref.

	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
AZUKI BEANS (RED BEANS)								
Japan, ? (Takara-azuki)	WP	1.9	0.19	3	14 21 30	s 0.04 s 0.02 s 0.02		Saku54P-10-110
Japan, ? (Ketobuki-azuki)	WP	1.9	0.19	3	14 21 30	s 0.02 s 0.01 s 0.01		Saku54P-10-110
BEANS								
Australia, 1988 (Fiord)	WP	2.0 4.0		4 4	64 64	<0.3 <0.3	0.2 0.2	3137/88/5
Brazil, 1986 (Carioquinha)	WP	1.6 3.2		2 2	14 14	db <0.03 db <0.03	db <0.01 db <0.01	AR 34A-89-24
France, 1973	WP	4.0		1	88	db <0.3		R67.12
France, 1973	WP	2.4		6	26	db <0.3		R67.12
France, 1973	WP	2.4		3	67	db <0.3		R67.12
France, 1990 (Mange tout)	WG	1.6	0.4	1	3 7 10	3.0 2.3 1.6		R73.11
Netherlands, 1989 (Victor)	WP SC WG WP	3.2 3.2 3.2 3.2	0.53 0.53 0.53 0.53	5 5 5 5	45 45 45 45	0.40, 0.43 1.1, 0.38 0.36, 0.47 0.53, 0.48	0.048, <0.01 0.039, 0.023 0.028, 0.047 0.034, 0.036	PH8969
Netherlands, 1989 (Victor)	WP SC WG WP	3.2 3.2 3.2 3.2	0.53 0.53 0.53 0.53	4 4 4 4	15 15 15 15	0.51, 1.1 1.7, 2.8 1.5, 2.7 1.0, 1.9	0.051, 0.036 0.057, <0.01 0.055, 0.11 0.061, <0.01	PH8970
Netherlands, 1990 (Victor)	WG SC	3.5 3.2	0.60 0.53	5 5	23 23	0.11, 0.16 0.10, 0.32	0.013, 0.007 0.005 (2)	PH9031
Netherlands, 1990 (Alfred)	WG SC	3.5 3.5	0.60 0.60	5 5	61 61	0.05, 0.08 0.08, 0.11	0.009, 0.008 0.005 (2)	PH9032
Spain, 1992 (Eagle)	WP	2.2	0.24	1	0 3 7	0.16 0.11 0.06		MAPA 25.06.93
FRENCH BEANS								
Brazil, 1990 (Manteiga)	WP	1.6		5	1 3 6 15 22	0.56 <0.03 <0.03 <0.03 <0.03		FPA-89-032 Du Pont
Brazil, 1990 (Manteiga)	WP	3.2		5	1 3 6 15 22	0.84 <0.03 <0.03 <0.03 <0.03		FPA-89-032 Du Pont
KIDNEY BEANS								
Japan, 1990 (Honkintoki)	WP	1.3	0.13	4	20 30 45	db 0.01 db <0.004 db <0.004	db 0.04 db 0.04 db 0.01	Hei.2-12-7
Japan, 1990 (Shin-edogawa)	WP	1.3	0.13	4	21 30 45	db 0.02 db <0.004 db <0.004	db <0.01 db 0.01 db 0.01	Hei.2-12-7
PEAS								

CROP Country, year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Brazil, 1988 (Mikado)	WG		0.15	6	1 7 14	0.11 0.03 0.08		FPA 88-020 Du Pont
Brazil, 1988 (Mikado)	WG		0.30	6	1 7 14	0.53 0.06 0.21		FPA 88-020 Du Pont
France, 1990 (Belinda)	WP	1.8	0.45	2	36 36	g 0.17 p 0.47		R80.6
France, 1991 (Ascona)	SC	2.0	0.66	2 3	41 41	g 0.1 g <0.1		R79.32
France, 1991 (Ascona)	SC	2.0	0.66	2 3	42 42	g <0.1 g <0.1		R79.31

[1] db: dry beans; g: grain or seeds; p: pods; s: immature seeds.

Table 38. Mancozeb residues (as CS_2) in root and tuber vegetables from supervised trials in Australia, Brazil, Finland, France, Germany, Italy, Japan, The Netherlands and the UK. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
BEET								
Brazil, 1989	WP		0.16	4	0 7 14 21	0.12 0.11 0.10 0.08		715/89
Brazil, 1989	WP		0.32	4	0 7 14 21	0.16 0.15 0.11 0.10		715/89
CARROT								
Australia, 1991 (Majestic Red)	WG WG	1.7 3.3		3 3	0 3 7 14 21 0 3 7 14 21	0.3 0.05 <0.05 <0.05 <0.05 0.55 0.25 0.45 0.05 <0.05		AUK-91-008
Brazil, 1990	WP	0.32	0.16	4	0 7 14 21	2.5 0.78 0.67 0.36		288/90
Brazil, 1990	WP	0.64	0.32	4	0 7 14 21	3.3 2.1 0.78 0.42		288/90
France, 1989	WG	1.6	0.5	8	14 26	<0.05 0.05		R72.10
France, 1990 (Tantale)	WP	1.5	0.3	7	15 30	0.11, c 0.29 0.19, c 0.35		R77.33
France, 1990 (Tantale)	WP	1.6	0.32	7	15 30	0.19, c 0.29 0.13, c 0.35		R77.34
France, 1990 (Touchon)	WP	1.6	0.53	14-15	19 30	0.09 0.19		R77.50
France, 1991 (Rouge		1.6	0.32	11-13	15	<0.1		R79.41

CROP Country, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Touchon)					30	<0.1		
France, 1991 (Lindoro)	WP	1.6	0.32	7	15 30	<0.1 <0.1		R79.61
France, 1991 (Lindoro)	WP	1.5	0.3	7	15 30	<0.1 <0.1		R79.62
Germany, 1972	WP	0.8	0.16	1	56	<0.3		R67.27
LOTUS (EAST INDIAN)								
Japan, 1989 (Bicch_)	WP	1.1	3.8	3	1 3 7 14	<0.02 <0.02 <0.02 <0.02	<0.01 <0.01 <0.01 <0.01	Hei.-1-10-11
Japan, 1989 (Bicch_)	WP	1.1	3.8	3	1 3 7 14	<0.02 <0.02 <0.02 <0.02	<0.01 <0.01 <0.01 <0.01	Hei.-1-10-11
POTATO								
Australia, 1990 (Norchip)	WG	1.7		8	0 6 14 21	<0.05 <0.05 <0.05 <0.05	<0.05 <0.05 <0.05 <0.05	AUE-90-02
Australia, 1990 (Norchip)	WG	3.3		8	0 6 14 21	<0.05 <0.05 <0.05 <0.05	<0.05 <0.05 <0.05 <0.05	AUE-90-02
Australia, 1990 (Norchip)	WP	1.8		8	0 6 14 21	<0.05 <0.05 <0.05 <0.05		AUE-90-02
Australia, 1990 (Norchip)	WP	3.7		8	0 6 14 21	<0.05 <0.05 <0.05 <0.05		AUE-90-02
Brazil, 1988 (Radosa)	WG	2.25		4	1 7 14	<0.03 <0.03 <0.03		Du Pont FPA 88-024
Brazil, 1988 (Radosa)	WG	4.5		4	1 7 14	<0.03 <0.03 <0.03		Du Pont FPA 88-024
Finland, 1985 (Bintje)	WP	1.6		4	21		<0.009	R.65.2
France, 1990 (Bintje)	WG	1.6 1.3	0.4 0.32	8 4	25 27	0.05 <0.05		R79.27/28
France, 1990 (Bintje)	WG	1.6 1.3	0.4 0.32	8 4	25 27	0.06 <0.05 c 0.12		R79.27
France, 1990 (Bintje)	WP	1.6	0.4	6	10	<0.05 c 0.07		R78.4
France, 1990 (Bintje)	WP	1.6	0.29	10 20	23 19	0.09 0.34		R78.5
France, 1990 (Bintje)	WP	st+1.6	0.4	7	54	<0.05		R78.6
France, 1990 (Bintje)	WP	1.6	0.32	13 1	58 58	<0.05 0.32		R78.10
France, 1990 (Bintje)	WP	1.6	0.32	9	35	0.06 c 0.07		R78.22
France, 1990 (Bintje)	WP	1.6	0.32	14	36	<0.05		R78.23
France, 1990 (Bintje)	WP	1.6 st+1.6		8 8	107 107	<0.05 0.05		R78.25
France, 1991 (Kaptah)	WP	4.8	1.6	10	17	0.15		R78.60
France, 1991 (Stella)	WP	4.8	1.6	7	10	<0.1 c 0.1		R78.61
France, 1991 (Kaptah Vandel)	WP	6.4	1.6	14	13	0.16 c 0.16		R79.55
France, 1991 (Bintje)	WP	1.6 1.6	0.25 0.25	7 9	46 32	<0.1 <0.1 c <0.1 (2), c 0.1		R79.58
Italy, 1986 (Spunta)	WP	2.3	0.24	8 7	21 28	<0.1 <0.1	<0.02 <0.02	R65.39

CROP Country, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
				5	41	<0.1	<0.02	
Italy, 1986 (Spunta)	WP	4.6	0.48	8 7 5	21 28 41	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.39
Italy, 1986 (Arsy)	WP	2.4	0.24	8 7 5	21 28 41	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.39
Italy, 1986 (Arsy)	WP	4.8	0.48	8 7 5	21 28 41	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.39
Italy, 1986 (Primura)	WP	2.6	0.24	8 7 5	21 28 41	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.39
Italy, 1986 (Primura)	WP	5.1	0.48	8 7 5	21 28 41	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R65.39
Italy, 1987 (Favorita)	WP	1.8	0.24	8 7 5	21 28 42	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R66.21
Italy, 1987 (Favorita)	WP	3.6	0.48	8 7 5	21 28 42	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R66.21
Italy, 1987 (Primora)	WP	1.4	0.24	8 7 5	21 28 42	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R66.18
Italy, 1987 (Primora)	WP	2.9	0.48	8 7 5	21 28 42	<0.1 <0.1 <0.1	<0.02 <0.02 <0.02	R66.18
Japan, 1977 (Danshaku)	WP	2.8-3.8	0.19	4 6	14 21 14 21	0.01 0.02 0.01 0.03	<0.01 <0.01 <0.01 <0.01	53P-7-65-66
Japan, 1977 (Nohrin 1 goh)	WP	4.7	0.19	4 7	15 22 15 22	0.01 0.01 0.01 <0.01	<0.01 <0.01 <0.01 <0.01	53P-7-65-66
Netherlands, 1984 (Bintje)	WP SC SC	1.6-3.2 1.6-3.2 1.4-2.9	0.27-0.53 0.27-0.53 0.24-0.48	5 5 5	14 14 14	<0.01 (2) <0.01 (2) <0.01 (2)	0.002, 0.007 0.009, 0.003 0.008, 0.007	PH8419
Netherlands, 1984 (Bintje)	WP SC SC	1.6-3.2 1.6-3.2 1.4-2.9	0.27-0.53 0.27-0.53 0.24-0.48	5 5 5	11 11 11	<0.01 (2) <0.01 (2) <0.01 (2)	0.01, 0.003 0.006, 0.002 0.003, 0.009	PH8420
Netherlands, 1984 (Bintje)	WP SC SC	1.6-3.2 1.6-3.2 1.4-2.9	0.27-0.53 0.27-0.53 0.24-0.48	10 10 10	7 7 7	<0.01 (2) <0.01 (2) <0.01 (2)	0.003, 0.008 0.005, 0.008 0.002, 0.007	PH8421
Netherlands, 1985 (Bintje)	WP SC SC	1.6-3.2 1.6-3.2 1.4-2.9	0.27-0.53 0.27-0.53 0.24-0.48	9 9 9	9 9 9	<0.01 (2) <0.01 (2) <0.01 (2)	0.015, 0.006 0.004, 0.006 0.010, 0.005	PH8518
Netherlands, 1985 (Bintje)	WP SC SC	1.6-3.2 1.6-3.2 1.4-2.9	0.27-0.53 0.24-0.49 0.24-0.48	8 8 8	17 17 17	<0.01 (2) <0.01 (2) <0.01 (2)	0.011, 0.017 0.009, 0.011 0.009, 0.006	PH8520
Netherlands, 1986 (Bintje)	WP SC SC SC WP SC	1.6-3.2 1.5-2.9 1.5-2.9 1.0-1.9 1.6-3.2 1.5-2.9	0.27-0.53 0.24-0.49 0.24-0.49 0.16-0.32 0.27-0.53 0.24-0.49	9 9 9 9 9 9	20 20 20 20 20 20	<0.01 (2) <0.01, 0.04 <0.01 (2) 0.08, <0.01 <0.01, 0.04 <0.01 (2)	<0.002 (2) 0.002, 0.006 <0.002, 0.008 <0.002 (2) 0.005, <0.002 0.006, 0.007	PH8620
Netherlands, 1987 (Bintje)	SC SC WG SC	1.5-2.9 1.5-2.9 1.6-3.2 1.5-2.9	0.24-0.49 0.24-0.49 0.27-0.54 0.24-0.49	8 8 8 8	12 12 12 12	<0.02 (2) <0.02 (2) <0.02 (2) <0.02 (2)	<0.002, 0.009 0.003, 0.004 0.004, 0.003 0.002, 0.009	PH8719
Netherlands, 1988 (Bintje)	SC WP WG	1.6-3.2 1.6-3.2 1.6-3.2	0.27-0.54 0.27-0.54 0.27-0.54	9 9 9	6 6 6	<0.05, 0.06 <0.05, 0.14 0.10, <0.05	0.009, 0.008 0.011, 0.006 0.014, 0.018	PH8824
Netherlands, 1988 (Bintje)	SC WP WG	1.6-3.2 1.6-3.2 1.6-3.2	0.27-0.54 0.27-0.54 0.27-0.54	8 8 8	31 31 31	<0.05 (2) <0.05 (2) <0.05, 0.10	0.001, 0.010 0.002, 0.014 0.001, 0.016	PH8826
Netherlands, 1988 (Bintje)	WP SC WG	1.6-3.2 1.5-2.9 1.6-3.2	0.27-0.54 0.24-0.49 0.27-0.54	7 7 7	22 22 22	<0.05 (2) <0.05 (2) 0.21, <0.05	0.004, 0.009 0.007 (2) 0.008 (2)	PH8827
Netherlands, 1988 (Bintje)	WP SC WG	1.6-3.2 1.5-2.9 1.6-3.2	0.27-0.54 0.24-0.49 0.27-0.54	10 10 10	18 18 18	<0.05 (2) <0.05 (2) <0.05 (2)	0.007, 0.004 0.009, 0.004 0.005, 0.006	PH8829

CROP Country, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
Netherlands, 1989 (Bintje)	WP SC SC	1.6-3.2 1.6-3.2 1.6-3.2	0.27-0.54 0.27-0.54 0.27-0.54	7 7 7	12 12 12	0.14, 0.11 <0.05, 0.07 0.06, <0.05	0.005, 0.010 0.011, 0.008 0.008, 0.010	PH8938
Netherlands, 1989 (Bintje)	WP SC SC	1.6-3.2 1.6-3.2 1.6-3.2	0.27-0.54 0.27-0.54 0.27-0.54	7 7 7	10 10 10	<0.05 (2) <0.05, 0.06 0.13, 0.07	0.013, 0.031 0.010, 0.007 0.010, 0.023	PH8939
Netherlands, 1990 (Bintje)	SC WG	1.6-3.2 1.6-3.2	0.27-0.54 0.27-0.54	8 8	22 22	0.03 (2) 0.03, 0.04	0.015, 0.011 0.015, 0.013	PH9055
Netherlands, 1990 (Bintje)	SC WG	1.6-3.2 1.6-3.2	0.40-0.80 0.40-0.80	9 9	37 37	0.03, 0.04 0.03 (2)	0.008, 0.025 0.005, 0.014	PH9057
Netherlands, 1990 (Bintje)	WP SC	1.6-3.2 1.6-3.2	0.27-0.54 0.27-0.54	8 8	21 21	0.03, 0.04 0.04 (2)	0.010, 0.004 <0.002, 0.007	PH9059
Netherlands, 1990 (Bintje)	WP SC	1.6-3.2 1.6-3.2	0.27-0.54 0.27-0.54	7 7	11 11	0.05, 0.03 0.04, 0.03	0.018, 0.013 0.011, 0.032	PH9060
UK, 1991 (Movis Piper)	WG	1.3	0.52	5	20	<0.01		OA/0011
UK, 1991 (Movis Piper)	WG	1.3	0.52	5	26	0.01		OA/011
UK, 1991 (King Edward)	WG	1.3	9.52	4	47	<0.01		OA/011
SUGAR BEET								
France, 1983 (Major)	SC	3.2	0.8	2	51	<0.3		R65.34
France, 1983 (Massabel)	SC	3.2	0.8	2	51	<0.3		R65.34
Italy, 1989 (Kaweduka)	WP	2.0 4.0	0.7 1.4	3 3	28 28	<0.1 0.17		R72.4
Italy, 1989 (Maribo Monou)	WP	2.0 4.0	0.7 1.4	3 3	28 28	0.1 0.1	<0.01 <0.01	R72.4
Italy, 1989 (Monohil)	WP	2.0 4.0	0.4 0.8	3 3	28 28	<0.1 0.2	<0.01 <0.01	R72.4
Japan, 1991 (Mono_su-s)	WP	2.8	0.19	5	14 21 30	<0.005 <0.005 <0.005	<0.01 <0.01 <0.01	3P-7-246
YAM, CHINESE								
Japan, 1983	WP	4.7	0.19	4 6	7 14 21 7 14 21	<0.004 <0.004 <0.004 <0.004 <0.004 <0.004		58-11-9

[1] st: seed treatment.
[2] c: control sample.

Table 39. Mancozeb residues (as CS_2) in potatoes from supervised trials in Germany. Underlined residues are from treatments according to GAP.

Year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1971 (Bintje)	WP	3.4	0.34	st+5	11	<0.3		R67.24
1974 (Saskia)	WP	1.4	0.24	3	0 3 5 7 10	pu <0.3, pe <0.3 pu <0.3, pe <0.3 pu <0.3, pe <0.3 pu <0.3, pe <0.3 pu <0.3, pe <0.3		R69.12
1974 (Saskia)	WP	1.8	0.3	3	0 3 6 8 14	<0.3 <0.3 <0.3 <0.3 <0.3		R69.12
1980 (Amigo)	WP	4.3 +1.2 +1.4	1.1 +0.3 +0.35	1 +1 +2	7 32 56	0.05 <0.02 <0.02	<0.02 <0.02 <0.02	R65.3

Year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1980 (Grandi-Folia)	WP	1.2 +1.4	0.3 +0.36	1 +2	11 36	0.02 0.02	<0.02 <0.02	R65.3
1980 (Hansa)	WP	1.4	0.36	st+4	7 14 22	0.03 <0.02 <0.02	<0.02 <0.02 <0.02	R65.3
1981 (Amigo)	WP	4.0		st+3	0 7 14	<0.02 <0.02 <0.02	<0.02 <0.02 <0.02	R69.21
1981 (Steffi)	WP	1.4	0.24	st+4	0 7 14	<0.02 <0.02 <0.02	<0.02 <0.02 <0.02	R69.21
1988 (Nicola)	WP	1.4	0.48	6	0 3 5 7	<0.05 <0.05 <0.05 <0.05	 <0.02	R73.4
1988 (Rosi)	WP	1.4	0.48	6	0 3 5 7	<0.05 <0.05 <0.05 <0.05	 <0.02	R73.4
1988 (Quarta)	WP	1.4	0.48	6	7	<0.05	<0.02	R73.4
1988 (Secura)	WP	1.4	0.48	6	7	0.13	<0.02	R73.4
1988 (Hansa)	WP	1.4	0.28	6	7	<0.05	<0.02	R73.4
1988 (Hansa)	WP	1.4	0.28	6	7	<0.05	<0.02	R73.4
1988 (Hansa)	WG	1.4	0.28	6	7	<0.05	<0.02	R73.5
1988 (Hansa)	WG	1.4	0.28	6	7	<0.05	<0.02	R73.5
1988 (Rosi)	WG	1.4	0.48	6	7	<0.05	<0.02	R73.5
1988 (Nicola)	WG	1.4	0.48	6	0 3 5 7	<0.05 <0.05 <0.05 <0.05		R73.5
1988 (Quarta)	WG	1.4	0.48	6	7	0.05	0.02	R73.5
1988 (Secura)	WG	1.4	0.48	6	7	0.26	0.02	R73.5
1990 (Kapta-vandel)	WP	1.6	0.4	12	6	<0.05		R78.26
1990 (Manon)	WP	1.6	0.4	8	11	0.09		R78.27
1990 (Bintje)	WP	1.6	0.53	7	33	0.47		R78.28
1990 (Bintje)	WP	1.6	0.53	6	26	0.21		R78.29
1990 (Bintje)	WP	1.6	0.4	6	10	<0.05		R78.4
1990 (Bintje)	WP	1.6	0.29	10 20	23 19	0.09 0.34		R78.5
1990 (Bintje)	WP	1.6	0.4	st+7	54	<0.05		R78.6
1990 (Bintje)	WP	1.6	0.32	13	58	<0.05		R78.10
1990 (Bintje)	WP	1.6	0.32	9	35	0.07		R78.22
1990 (Bintje)	WP	1.6	0.32	14	36	<0.05		R78.23
1990 (Bintje)	WP	1.6		8	27	<0.05		R78.25

[1] st: seed treatment
[2] pu: pulp; pe: peel.

Table 40. Mancozeb residues (as CS_2) in root and tuber vegetables from supervised trials in the USA. Underlined residues are from treatments according to GAP.

CROP Year (Variety)	Application [1]	Day	Residues, mg/kg [2]	Ref.

	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
CARROT								
CA, 1985 (Emperator)	WP	1.8	0.32	5	3 7 14	<0.03 0.04 0.05	<0.01 <0.01 <0.01	85-0221
CA, 1985 (Emperator)	WP	1.8	0.32	5	3 7 14	<0.03 <0.03 0.04	<0.01 <0.01 <0.01	85-0222
CA, 1985 (Emperator)	WP	1.8	0.32	a 5	3 6 14	<0.03 0.06 <0.03	<0.01 <0.01 <0.01	85-0258
OH, 1985 (Scar. Nantes)	WP	1.8	0.38	5	3 7 10 14	0.08 0.03 <0.03 <0.03	<0.01 <0.01 <0.01 <0.01	85-0279
TX, 1985 (Danver 126)	WP	1.6	3.8	a 6	3 7 10	0.16 0.10 0.04	<0.01 <0.01 <0.01	85-0303
MI, 1985 (Trophy)	WP	1.8	0.38	5	2 6 9 13	0.24 0.10 0.07 0.03 c 0.29	<0.01 <0.01 <0.01 <0.01	85-0506
GINSENG								
WI, 1986	SC SC	1.8 3.6	0.19 0.38	33 24	15 351	0.16 0.031	0.028 0.02	86-0321
WI, 1986	SC SC	1.8 3.6	0.19 0.38	24 24	351 351	<0.03 0.035	<0.01 <0.01	86-0354
WI, 1986	SC SC	1.8 3.6	0.19 0.38	13 13	351 351	<0.03 <0.03	<0.01 <0.01	86-0322
WI, 1987	WP WP	1.8 1.8	0.19 0.19	4 5	14 0	0.24 1.1	0.01 0.02	87-0215
POTATO								
ID, 1975 (Rus Burbank)	WP	1.8	1.9	a 7	50	<0.03	<0.02	75-537-02
ME, 1975 (Rus Burbank)	WP	0.26-0.80 +1.2		ga 6 +6	23	<0.03	<0.02	75-538-02
NY, 1975 (Katahdin)	WP	0.8 +1.2 +1.6		1 +1 +6	27	<0.03	<0.02	75-514-02
OH, 1975 (Norchip)	WP	1.8		ga 9	1	0.1	<0.02	75-459-02
OR, 1975 (Rus Burbank)	WP	1.8	1.9	a 5	1	<0.03	<0.02	75-555-02
PA, 1975 (Katahdin)	WP	1.8	6.4	a 14	1	<0.03	<0.02	75-494-02
WI, 1975	WP	2.2		ga 13	1	<0.03	<0.02	75-443-02
FL, 1976 (Sebago)	WP	1.8		ga 13	0 4 8 12	0.05 <0.03 0.05 <0.03	<0.02 <0.02 <0.02 <0.02	76-0083
FL, 1976 (Red La Soto)	WP	1.8		ga 13	0	<0.03	<0.02	76-0084
FL, 1976 (Norchip)	WP	1.5	0.22	14	0	<0.03	<0.02	76-0155
ID, 1976 (Russet)	WP	1.8	1.9	a 4	2	<0.03	<0.02	76-0408
ID, 1976 (Russet)	WP	1.8	1.9	a 5	9	<0.03	<0.02	76-0409
ID, 1976 (Russet)	WP	1.8	0.74	5	13	<0.03	<0.02	76-0435
ME, 1976 (Superior)	WP	1.1 +1.7	4.0 +6.0	a 2 a 6	1	<0.03	<0.02	76-0699
ME, 1976 (Katahdin)	WP	1.0 +1.7	0.27 +0.40	7 +3	12	<0.03	<0.02	76-0700
ME, 1976 (Chippwa)	WP	1.1	0.4	4	56	<0.03	<0.02	76-0701
ME, 1976 (Superior)	WP	1.1 +1.7	0.34 +0.51	6 +4	12	<0.03	<0.02	76-0703
NY, 1976 (162)	WP	1.8	6.4	a 9	0		<0.02	76-0614
NY, 1976 (Kennebec)	WP	1.8	6.4	a 8	6	<0.03	<0.02	76-0647
OH, 1976 (Norchip)	WP	2.2	4.8	a 8	0 4	0.05 <0.03	<0.02 <0.02	76-0329

CROP Year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					6 15	<0.03 <0.03	<0.02 <0.02	
OH, 1976 (Superior)	WP	2.2	4.8	a 9	0	<0.03	<0.02	76-0394
OH, 1976 (Superior)	WP	2.2	4.8	a 9	0	<0.03	<0.02	76-0395
PA, 1976 (Katahdin)	WP	1.8	2.1	a 6	0	<0.03	<0.02	76-0407
PA, 1976 (Kathdan)	WP	1.8	0.55	6	0	<0.03	<0.02	76-0421
PA, 1976 (Man Ken Kath)	WP	1.8	6.4	a 10	0	<0.03	<0.02	76-0434
NY, 1976 (162)	WP	1.8	6.4	a 9	0	<0.03	<0.02	76-0613
NY, 1976 (162)	WP	1.8	6.4	a 9	0	<0.03		76-0614
PA, 1976 (Kathadin)	WP	1.8		11	0 3 7 14	<0.03 <0.03 <0.03 <0.03	<0.02 <0.02 <0.02 <0.02	76-0629
WA, 1976	WP	1.8	0.32	7	0	<0.03	<0.02	76-0652
WI, 1976 (Superior)	WP	2.8	6.0	a 13	0 4 7 14	<0.03 <0.03 <0.03 <0.03	<0.02 <0.02 <0.02 <0.02	76-0617
WI, 1976 (Superior)	WP	2.8	6.0	a 14	3	<0.03	<0.02	76-0649
WI, 1976 (Burbank)	WP	1.7	4.5	a 14	2	<0.03	<0.02	76-0650
WI, 1976 (Burbank)	WP	1.7	0.40	13	5	<0.03	<0.02	76-0651
CA, 1987 (Russet Burbank)	WP	2.7	1.4	a 5	0 5 15	<0.03 <0.03 <0.03	<0.01 0.02 0.025	88-0059
SUGAR BEET								
CA, 1985	WP	1.8		a 5	6 14 21	0.04 0.05 <0.03	<0.01 <0.01 <0.01	85-0264
CA, 1985	WP	1.8	0.32	ga 5	6 13 20	0.78 0.39 0.21	0.01 <0.01 <0.01	85-0292
TX, 1985 (Monohy D2)	WP	1.8	3.8	a 6	7 10 14 21 28	0.17 0.12 0.06 0.03 <0.03 c 0.07	<0.01 0.01 <0.01 <0.01 <0.01	85-0329
ID, 1985 (WS-78)	WP	1.8	1.0	8	7 15 21	0.15 0.18 0.07	0.025 0.017 <0.01	85-0363
ID, 1985 (WS-78)	WP	1.8	1.0	8	7 15 21	0.13 0.18 0.10	0.042 <0.01 <0.01	85-0365
MN, 1985 (KW-3394)	WP	1.8	0.33	7	7 14 21	0.13 0.04 0.03	0.02 0.02 0.01	85-0499
ND, 1985 (Monofort)	WP	1.8	3.8	a 5	7 14 21	0.13 0.08 0.05 c 0.03	0.02 0.02 0.02	85-0500
ND, 1985 (Beta 1230)	WP	1.8	3.8	a 5	7 14 21	0.09 0.06 <0.03	0.01 <0.01 <0.01	85-0501
MN, 1985 (KW-3394)	WP	1.8	0.33	7	14	0.12 c 0.10	0.02	85-0515

[1] a: aerial application; ga: ground and aerial application.
[2] c: control sample.

Table 41. Mancozeb residues (as CS_2) in stalk and stem vegetables from supervised trials in Australia, France and The Netherlands. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application	Day	Residues, mg/kg[1]	Ref.

	Form	kg ai/ha	kg ai/hl	No.[2]		EBDC as CS_2	ETU	
ASPARAGUS								
France, 1990 (Aneto)	WP	2.1	0.42	8	175	0.16, c 0.22		R77.30
France, 1990 (Aneto)	WP	2.1		8	161	0.18, c 0.16		R77.31
France, 1990 (Aneto)	WP	1.5	0.5	7	151	0.36, c 0.21		R77.47
France, 1990 (Juno, Oesto, Cibo)	WP	2.1	1.4	4	233	0.49, c 0.23		R77.29
France, 1991 (Desto)	WP	2.1	0.7	7	142	<0.05, c <0.05		R78.11
France, 1991 (Larac)	WP	2.1	0.42	9	191	<0.05, c <0.05		R78.12
CHARD (SILVER BEET)								
Australia, 1992 (Ford Hook Giant)	WP	1.8		3	0 7 14 21 28	8.3 0.6 0.2 0.3 0.2		AUK-92-007
	WP	3.5		3	0 7 14 21 28	14 1.5 <0.1 0.6 0.3		
WITLOOF								
France, 1984	SC	12 24		1i 1i	24 24	<0.3 <0.3	b 0.28 b 0.25	R65.15
France, 1984	SC	12		1i	20	<0.3	b <0.005	R65.16
France, 1985	SC	6 12		1i 1i	21 21	<0.3 <0.3	<0.01 <0.01	R65.17
France, 1990	WP	1.5[3]		1	208	<0.02		R73.22
France, 1990	SC		0.3[3]	1	24	<0.02		R72.11
France, 1990	WP	150		1	21	0.11		R80.9
Netherlands, 1989	SC		0.65[3]	1	21	<0.05	<0.02	R72.22

[1] c: control sample; b: boiled.
[2] i: indoors.
[3] application to roots.

Table 42. Mancozeb residues (as CS_2) in stalk and stem vegetables from supervised trials in the USA. Underlined residues are from treatments according to GAP.

CROP State, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
ASPARAGUS								
WA, 1985 (WSU1)	WP	1.3	0.29	4	231	<0.03	<0.01	85-0134
MI,1985	WP	1.8	0.80	5	252	<0.03	<0.01	85-0136
WA, 1985	WP	1.8	1.9	a 1	321	0.05	<0.01	85-0278
CA, 1986 (Colossal)	WP	1.8		4	124	0.04	<0.01	86-0083
CA, 1986 (Colossal)	WP	1.8		4	124	<0.03	<0.01	86-0084
CA, 1986 (Colossal)	WP	1.8		a 4	124	<0.03	<0.01	86-0085
CELERY								
FL, 1985 (June Belle)	WP	1.5	0.15	a 17	0 3 5 7 10 14 21	2.7 2.0 1.6 1.3 1.1 0.81 0.56 c 0.08	0.03 0.02 0.01 0.02 <0.01 <0.01 <0.01	85-0165
CA, 1985 (5270R)	WP	1.8		ga 8	7 14 21	1.8 0.78 0.46 c 0.06	0.02 0.02 0.01	85-0350
CA, 1985 (5275)	WP	1.8		ga 8	8 14 21	2.6 2.1 0.68 c 0.41	0.01 <0.01 <0.01	85-0397

CROP State, year (Variety)	Application [1]				Day	Residues, mg/kg [2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
OH, 1985 (Florida 683)	WP	1.8	0.38	9	7 14 21 28	0.27 0.17 0.10 0.07	0.02 0.01 <0.01 <0.01	85-0401
CA, 1985 (5270R)	WP	1.8	0.96	ga 8	7 14	0.60 0.28	<0.01 <0.01	85-0454
CA, 1985 (Florida 683)	WP	1.8		ga 8	7 14 21	0.81 0.60 0.36 c 0.20	<0.01 <0.01 <0.01	85-0455
MI, 1985 (Florida 683)	WP	1.8	0.38	7	7 14 21 28	0.53 0.28 0.20 0.12	0.01 <0.01 <0.01 <0.01	85-0503
CA, 1985 (5275)	WP	1.8		ga 8	7 14 21	0.05 0.34 0.20	0.01 0.01 0.01	85-0561
FL, 1989 (June Belle)	WP	1.8	0.68	4 a 4	14 14	s 0.15 s+l 0.84 s 0.10 s+l 0.50	s 0.043 s+l 0.16 s 0.026 s+l 0.074	89-0124

[1] a: aerial application; ga: ground and aerial application.
[2] s: analysis on stalk; s+l: analysis on stalk + leaf; c: control sample

Table 43. Mancozeb residues (as CS_2) in cereal grains from supervised trials in Brazil, Canada, France, Germany, The Netherlands, Spain and the UK. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
BARLEY								
Brazil, 1989	WP	2.0		3	0 7 14 21	1.7 1.1 0.03 $<\underline{0.03}$		021/90
Brazil, 1989	WP	4.0		3	0 7 14 21	11 2.8 2.6 <0.03		021/90
Netherlands, 1986 (Hasso)	WP WP	1.6 1.6	0.27 0.27	2 2	58 58	<0.01, 0.14 <0.01, 0.38	<0.002 (2) <0.002 (2)	PH8616
Netherlands, 1987 (Hasso)	WP SC	1.6 1.6	0.27 0.27	2 2	67 67	0.28, <0.03 <0.03, 0.11	0.046, 0.016 <0.002 (2)	PH8717/2
Netherlands, 1988 (Prisma)	WP WP	1.6 1.6	0.27 0.27	2 2	58 58	<0.05 (2) 0.14, <0.05	<0.002 (2) <0.002 (2)	PH8835
Netherlands, 1988 (Trumpf)	WP WP	1.6 1.6	0.27 0.27	2 2	60 60	0.65, 0.30 0.61, 0.41 c 0.68, c 0.24	<0.002 (2) <0.002 (2) c 0.003	PH8838
RICE								
Brazil, 1990	WP	1.6		3	18 25 40	2.5 $\underline{2.0}$ $<\underline{0.03}$		281/90
Brazil, 1990	WP	3.6		3	18 25 40	3.1 $\underline{2.2}$ $\underline{0.34}$		281/90
Brazil, 1990	WP	7.2		3	18 25 40	4.8 4.2 0.42		281/90
SUMMER WHEAT								
Germany, 1985	WP	1.6	0.4	2	0 27 42 63	e 9.6 e 9.6 $<\underline{0.05}$ $<\underline{0.05}$	 <0.02	R60.6
Germany, 1985	WP	1.6	0.4	2	0 31 39	e 8.7 e 2.0 $\underline{0.4}$		R60.6

CROP Country, year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					63	<0.05	<0.02	
Germany, 1986 (Ralle)	SC	1.6	0.4	2	0 15 31 43	e 15 e 4.8 e 2.2 <0.05	<0.02	R60.7
WHEAT								
Brazil, 1983	WP	2.2		3	32	0.07		R&H 3318322
Brazil, 1988	WP	4.4		3	32	0.14		R&H 3318322
Canada, 1985	WP	1.8		1	46	<0.1 b <0.05 f <0.1	<0.02 b <0.02 f <0.04	#13
Canada, 1985	WP	1.8		2	46-58	<0.1 b <0.05 f <0.1	<0.02 b <0.02 f <0.04	#13
Canada, 1985	WP	1.8 +3.6		2	40 & 60	<0.1 b <0.05 f <0.1	<0.02 b <0.02 f <0.04	#13
France, 1990 (Scipion)	WP	1.5	0.375	2	64	0.29 c 0.12		R78.17
France, 1990 (Cando)	WP	1.5	0.375	2	62	0.26 c 0.30		R78.18
France, 1990 (Scipion)	WP	1.5	0.375	2	49	0.08 c 0.11		R78.20
France, 1990 (Cando)	WP	1.5	0.375	2	47	0.11 c 0.15		R78.19
France, 1990 (Beauchamps)	WP	1.5	0.375	2	64	0.16		R78.21
France, 1991 (Hornet)	SC	2.0	0.66	1	55	<0.1		R80.3
France, 1991 (Hornet)	SC	1.5 +2.0	0.5 & 0.66	2	55	<0.1		R80.3
France, 1991 (Foxal)	SC	2.2	0.75	1	91	<0.1		R80.2
France, 1991 (Scipion)	SC	2.2	0.75	1	89	<0.1		R80.1
Spain, 1991 (Mexicali)	SC	1.6	0.45	1 2 1	91 76 76	<0.1 0.17 <0.1		R80.31
WINTER WHEAT								
Germany, 1974 (Diplomat)	WP	1.6	0.27	1	21 35 57 64	<0.2 <0.2 <0.2 <0.2		R60.5
Germany, 1974 (Kormoran)	WP	1.6	0.27	1	35 62 70	<0.2 <0.2 <0.2		R60.5
Germany, 1974 (Diplomat)	WP	1.6	0.27	1	35 43 80	<0.2 <0.2 <0.2		R60.5
Germany, 1985	WP	1.6	0.4	2	0 34 54 66	e 13 e 1.1 <0.05 <0.05	<0.02	R60.6
Germany, 1985	WP	1.6	0.4	2	0 19 41 62	e 10 e 5.4 <0.05 <0.05	<0.02	R60.6
Germany, 1985 (Kanzler)	SC	1.6	0.8	2	0 14 24 47	e 10 e 1.7 e 1.6 <0.05	<0.02	R60.7
Germany, 1986 (Kanzler)	SC	1.6	0.4	2	0 20 39 46	e 13 e 1.8 <0.05 <0.05	<0.02 <0.02	R60.7
Germany, 1986 (Diplomat)	SC	1.6	0.4	2	0 24 39 52	e 21 e 3.4 e 1.3 <0.05	<0.02	R60.7
Germany, 1986 (Okapi)	SC	1.6	0.4	2	0 25 40	e 10 e 1.6 e 0.89		R60.7

CROP Country, year (Variety)	Application				Day	Residues, mg/kg [1]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					56	<0.05	<0.02	
Netherlands, 1984 (Okapi)	WP SC SC	1.6 1.5 1.4	0.49 0.45 0.44	2 2 2	61 61 61	<0.02 (2) <0.02 (2) <0.02 (2)	<0.02 (2) <0.02 (2) <0.02 (2)	PH8431
Netherlands, 1985 (Saiga)	WP SC SC	1.6 1.5 1.4	0.40 0.36 0.36	2 2 2	68 68 68	0.75, 0.49 <0.01, 0.24 <0.01, 0.82	0.002, <0.002 <0.002 (2) <0.002 (2)	PH8526
Netherlands, 1985 (Marksman)	WP SC SC	1.6 1.5 1.4	0.32 0.29 0.29	2 2 2	57 57 57	<0.01 (2) <0.01 (2) <0.01 (2)	<0.002 (2) <0.002 (2) <0.002 (2)	PH8527
Netherlands, 1986 (Okapi)	SC SC SC	1.5 0.96 1.5	0.36 0.24 0.36	2 2 2	66 66 66	<0.01 (2) <0.01, 0.06 <0.01 (2)	<0.002 (2) <0.002 (2) <0.002 (2)	PH8626
Netherlands, 1987 (Arminda)	WP SC WG	1.6 1.6 1.6	0.26 0.26 0.26	2 2 2	64 64 64	<0.02 (2) <0.02 (2) <0.02 (2)	<0.002 (2) <0.002 (2) <0.002 (2)	PH8727
Netherlands, 1987 (Obelisk)	SC	3.2	0.64	2	0 28 42 60	e 12 e 3.9 e 42 <0.05	 <0.02	R60.8
Netherlands, 1987 (Okapi)	SC	3.2	0.64	2	0 28 42 60	e 14 e 9.6 e 3.4 <0.05	 <0.02	R60.8
Netherlands, 1987 (Obelisk)	SC	3.2	0.64	2	0 28 42 60	e 11 e 2.9 e 2.1 <0.05	 <0.02	R60.8
Netherlands, 1987 (Okapi)	SC	3.2	0.64	2	0 28 42 60	e 14 e 13 e 7.0 <0.05	 <0.02	R60.8
Netherlands, 1988 (Obelisk)	SC WG SC	1.5 1.5 1.5	0.25 0.25 0.25	2 2 2	68 68 68	<0.05, 0.05 <0.05, 0.14 <0.05, 0.08	<0.002, 0.003 0.003, <0.002 0.004 (2)	PH8839
Netherlands, 1990 (Obelisk)	WG SC	1.6 1.6	0.27 0.27	2 2	63 63	<0.03 (2) 0.12, <0.03	<0.002 (2) <0.002, 0.008	PH9047
Netherlands, 1990 (Obelisk)	WP SC WG	1.6 1.6 1.6	0.27 0.27 0.27	2 2 2	68 68 68	<0.03 (2) <0.03 (2) 0.09, 0.05	0.013, 0.016 0.006, 0.012 0.024, 0.072	PH9050
Netherlands, 1990 (Obelisk)	WP SC WG	1.6 1.6 1.6	0.27 0.27 0.27	2 2 2	76 76 76	0.04 (2) <0.03 (2) <0.03, 0.03	0.017, <0.002 <0.002 (2) <0.002 (2)	PH9052
Netherlands, 1990 (Pagode)	SC WG	1.6 1.6	0.27 0.27	2 2	60 60	0.06, 0.20 0.03 (2)	0.020, <0.002 0.024, 0.019	PH9054
UK, 1990 (Haven)	WP	1.6	0.64	3 2	37 50	0.25 0.18 c 0.08	0.024 0.01 c 0.01	R78.1
UK, 1990 (Hornet)	WP	1.6	0.64	3 2	36 50	0.42 0.26	0.01 0.006	R78.1
UK, 1990 (Hornet)	WP	1.6	0.64	3 2	46 56	0.05 0.07	0.005 0.007	R78.1
UK, 1990 (Apollo)	WP	1.6	0.64	3 2	47 57	0.5 0.09	0.01 0.008	R78.1

[1] b: bran; e: ears; f: flour; c: control sample.

Table 44. Mancozeb residues (as CS_2) in cereal grains from supervised trials in the USA. Underlined residues are from treatments according to GAP. All WP.

CROP State, Year (Variety)	Application	Day	Residues, mg/kg [2]	Ref.

	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
BARLEY							
ND, 1985 (Morex)	1.8	3.2	3[1]	25	0.55	<0.01	85-0272
ND, 1985 (Robust)	1.8	3.2	3[1]	25	0.46	<0.01	85-0273
WA, 1985 (Sevin)	1.8	3.2	3[1]	20	0.19	<0.01	85-0352
MAIZE							
GA, 1983 (F-4333)	1.8	1.5	4	10 20	0.078 0.045	 <0.02	83-0200
FL, 1983 (NK508)	1.3	0.41	11 14	25 11	0.028 0.16	<0.02	83-0228
IN, 1983 (PA63709)	3.4	7.2	2	10 20	0.11 0.041	 0.02	83-0237
IA, 1983 (P80)	1.7 3.4	2.6 5.2	2 2	11 21 11 21	<0.03 <0.03 <0.03 <0.03	 <0.02 <0.02	83-0253
IL, 1983 (Funk G4740)	1.7	3.6	2	10 20	<0.03 0.03 c 0.08	 <0.02	83-0358
FL, 1983 (Pioneer)	1.3	0.14	16	7 14	<0.03 <0.03		83-0419
AR, 1985 (North Upking)	1.3	1.4	5[1]	20 29 40	e <0.03 e <0.03 e <0.03	e <0.01 e <0.01 e <0.01	85-0337
IA, 1985	1.7	0.45	4	3 7 14 39	e 0.73 e 0.19 e 0.095 e <0.03	e 0.02 e 0.01 e 0.01 e <0.01	85-0453
WHEAT							
MN, 1975 (Era)	1.8		2[1]	28	0.17	<0.02	75-421-02
MN, 1975 (Era)	1.8		2[1]	47	0.1	<0.02	75-467-02
MN, 1975 (Era)	1.8		2[1]	42	0.1	<0.02	75-468-02
AL, 1981 (Coker 747)	1.8 1.8	3.8 3.8	2 3	28 28	0.07 0.09 c 0.05	<0.01 <0.01	81-0167
AL, 1981 (Coker 747)	1.8 1.8	3.8 3.8	2 3	28 28	0.10 0.05 c 0.03	<0.01 <0.01	81-0168
TN, 1981 (McNair 1003)	1.8		2	51	0.02	<0.01	81-0212
TN, 1981 (Arthur 71)	1.8	3.8	3	42	0.04	<0.01	81-0214
TX, 1988 (NK812)	1.8	3.8	3[1]	46	0.050	<0.01	88-0105
OK, 1988 (Florida 302)	1.8	3.8	3[1]	56	0.035	<0.01	88-0131
MO, 1988 (Caldwell)	1.8	0.69	3	36	<0.03	<0.01	88-0185

[1] aerial application; [2] e: ears; c: control sample.

Table 45. Mancozeb residues (as CS_2) in dry hops from supervised trials in Germany. Underlined residues are from treatments according to GAP. All WP.

Year (Variety)	Application				Day	Residues, mg/kg		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
1982 (Brewer's Gold)	WP	0.32 +0.42 +0.53 +0.63 +0.79 +1.2 +1.1	0.053	2 +2 +1 +1 +3 +1 +3	42	2.2	<0.1 beer 0.04	R69.23
1982 (Tettnanger Frühhopfen)	WP	0.32 +0.42 +0.53 +0.79 +0.87 +0.95 +1.1	0.053	2 +1 +3 +1 +1 +3 +2	35	<1	<0.1 beer 0.02	R69.23

Table 46. Mancozeb residues (as CS_2) in oilseeds from supervised trials in Australia, France, The Netherlands and the USA. Underlined residues are from treatments according to GAP.

CROP Country (State), year (Variety)	Application[1]				Day	Residues, mg/kg[2]		Ref.
	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
PEANUT								
Australia, 1992 (Virginia Bunch)	WP	1.8		6	0 7 14 21 28	<0.1 <0.1 <0.1 <0.1 <0.1		AUK-92-008
	WP	3.5		6	0 7 14 21 28	<0.1 <0.1 <0.1 <0.1 <0.1		
USA (GA), 1974 (Florunner)	WP	1.8 3.6	2.3 2.3	6 6	27 27	<0.03 <0.03	<0.02 <0.02	74-171-02
USA (AL), 1974 (Florunner)	WP	1.3 2.7	1.0 2.1	7 7	7 7	<0.03 <0.03	<0.02 0.02	74-180-02
USA (NC), 1984 (Florigiant)	WP	2.7	1.9	4	24	<0.03	<0.01	85-0383
USA (TX), 1984 (Florunner)	WP	2.7		5	47	<0.03	<0.01	85-0452
USA (TX), 1984 (Florunner)	WP	2.7		5	48	<0.03	<0.01	85-0454
USA (VA), 1984 (Florigiant)	WP	2.7	1.4	6	14	<0.03	<0.01	85-0002
RAPESEED								
France, 1985 (Jet Neuf)	SC	3.2	0.64	2	51	<0.1		R65.37
France, 1985 (Bien-Venu)	SC	3.2	0.64	2	52	<0.1		R65.35
France, 1985 (Tamdem)	SC	3.2	0.64	1	48	<0.1		R65.36
Netherlands, 1984 (Jet Neuf)	WP WP	1.6 1.6		a 2 ga 3	58 58	0.43, 2.5 0.22, 1.0 c 0.04, 1.0	0.48, 0.31 0.58, 0.51 c 0.28, 0.15	PH8418

[1] a: aerial application; ga: ground and aerial application.
[2] c: control sample.

Table 47. Mancozeb residues (as CS_2) in tree nuts, cocoa and coffee from supervised trials in Australia, Brazil and the USA. Underlined residues are from treatments according to GAP.

CROP Country (State), Year (Variety)	Form	Application			Day	Residues, mg/kg		Ref.
		kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
ALMONDS								
Australia, 1991 (Californian Papershell)	WG		0.15	7	0 7 14	0.8 0.5 0.2		AUI-91-032
	WG		0.30	7	0 7 14	2.0 <0.2 <0.2		
USA (CA), 1988 (Nonpareil)	WP	5.4	0.21	3	160	<0.03	<0.01	89-0006
USA (CA), 1988 (Nonpareil)	WG	5.4	0.21	3	160	<0.03	<0.01	89-0007
USA (CA), 1988 (Thompson)	WG	5.4	0.33	3	161	<0.03	<0.01	89-0016
USA (CA), 1988 (Thompson)	WP	5.4	0.33	3	161	<0.03	<0.01	89-0017
USA (CA), 1988 (Nonpareil)	WP	5.4	0.58	3	136	<0.03	<0.01	89-0023
COCOA								
Brazil, 1990	WP	2.4		4	0 7 14	1.7 0.34 0.34		289/90

CROP Country (State), Year (Variety)	Form	Application			Day	Residues, mg/kg		Ref.
		kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					21	0.45		
Brazil, 1990	WP	4.8		4	0 7 14 21	2.0 0.56 0.39 0.50		289/90
COFFEE								
Brazil, 1989	WP	4.0		2	3 7 14 21	13 10 3.1 0.90		117/90
Brazil, 1989	WP	8.0		2	3 7 14 21	39 27 5.6 1.4		117/90

Table 48. Mancozeb residues (as CS_2) in cereal straws from supervised trials in Canada, France, Germany, The Netherlands and the UK. Underlined residues are from treatments according to GAP.

CROP Country, year (Variety)		Application			Day	Residues, mg/kg [1]		Ref.
		kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
BARLEY STRAW								
Netherlands, 1986 (Hasso)	WP WP	1.6 1.6	0.27 0.27	2 2	58 58	3.8 3.6 c 6.4	0.25 0.23	PH8616
Netherlands, 1987 (Hasso)	WP SC	1.6 1.6	0.27 0.27	2 2	67 67	0.20 <0.05	1.4 2.2 c 2.6	PH8717/2
Netherlands, 1988 (Trumpf)	WP WP	1.6 1.6	0.27 0.27	2 2	60 60	2.2 3.3 c 0.98	0.25 0.078 c 0.21	PH8838
WHEAT STRAW								
Canada, 1985	WP	1.8		1	46	1.3 c 1.1	<0.04	#13
Canada, 1985	WP	1.8		2	54	0.95 c 0.4	0.05	#13
Canada, 1985	WP	1.8 +3.6		2	60	2.9 c 0.4	0.05	#13
Canada, 1985	WP	1.8 +3.6		2	40	0.84 c 0.4	<0.04	#13
France, 1990 (Scipion)	WP	1.5	0.38	2	64	11 c 0.41		R78.17
France, 1990 (Cando)	WP	1.5	0.38	2	62	1.8 c 0.08		R78.18
France, 1990 (Scipion)	WP	1.5	0.38	2	49	4.8 c 0.55		R78.20
France, 1990 (Cando)	WP	1.5	0.38	2	47	1.4 c 0.18		R78.19
France, 1990 (Beauchamps)	WP	1.5	0.38	2	64	13		R78.21
France, 1991 (Hornet)	SC	2.0	0.66	1	55	1.4		R80.3
France, 1991 (Hornet)	SC	1.5 & 2.0	0.5 & 0.66	2	55	2.6 c 0.14		R80.3
France, 1991 (Foxal)	SC	2.2	0.75	1	91	0.64 c 0.53		R80.2
France, 1991 (Scipion)	SC	2.2	0.75	1	89	1.1 c 0.36		R80.1
Germany, 1974 (Diplomat)	WP	1.6	0.27	1	21 35 57 64	8.4 7.9 <0.2 <0.2		R60.5
Germany, 1974 (Kormoran)	WP	1.6	0.27	1	22	14		R60.5

CROP Country, year (Variety)		Application			Day	Residues, mg/kg [1]		Ref.
		kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					35 62 70	7.3 <0.2 <0.2		
Germany, 1974 (Diplomat)	WP	1.6	0.27	1	25 35 43 80	9.6 2.4 <0.2 <0.2		R60.5
Germany, 1985	WP	1.6	0.4	2	66	3.0	<0.04	R60.6
Germany, 1985	WP	1.6	0.4	2	63	2.8	<0.04	R60.6
Germany, 1985	WP	1.6	0.4	2	63	2.4	<0.04	R60.6
Germany, 1985	WP	1.6	0.4	2	62	4.6	<0.04	R60.6
Germany, 1985 (Kanzler)	SC	1.6	0.8	2	47	2.5		R60.7
Germany, 1986 (Kanzler)	SC	1.6	0.4	2	46	8.9		R60.7
Germany, 1986 (Diplomat)	SC	1.6	0.4	2	52	2.9		R60.7
Germany, 1986 (Ralle)	SC	1.6	0.4	2	43	3.1		R60.7
Germany, 1986 (Okapi)	SC	1.6	0.4	2	56	6.5		R60.7
Netherlands, 1987 (Obelisk)	SC	3.2	0.64	2	60	2.0		R60.8
Netherlands, 1987 (Okapie)	SC	3.2	0.64	2	60	1.1		R60.8
Netherlands, 1987 (Obelisk)	SC	3.2	0.64	2	60	7.2		R60.8
Netherlands, 1987 (Okapie)	SC	3.2	0.64	2	60	0.9		R60.8
Netherlands, 1987 (Arminda)	WG	1.6	0.26	2	64	0.29	<0.002	PH8727
Netherlands, 1988 (Obelisk)	SC WG SC	1.5 1.5 1.5	0.25 0.25 0.25	2 2 2	68 68 68	1.0 3.0 0.4	<0.01 <0.01 0.02	PH8839
UK, 1990 (Haven)	WP	1.6	0.64	3 2	37 50	7.7 4.2 c 1.9		R78.1
UK, 1990 (Hornet)	WP	1.6	0.64	3 2	36 50	13 7.1		R78.1
UK, 1990 (Hornet)	WP	1.6	0.64	3 2	46 56	8.2 6.7		R78.1
UK, 1990 (Apollo)	WP	1.6	0.64	3 2	47 57	3.9 3.8		R78.1

[1] c: control sample.

Table 49. Mancozeb residues (as CS_2) in cereal fodder and straw from supervised trials in the USA. Underlined residues are from treatments according to GAP. All WP.

CROP State, year	Application			Day	Residues, mg/kg [2]		Ref.
	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
BARLEY STRAW							
ND, 1985 (Morex)	1.8	3.2	3[1]	25	24	0.18	85-0272
ND, 1985 (Robust)	1.8	3.2	3[1]	25	11	0.19	85-0273
ID, 1985 (Sevin)	1.8	3.2	3[1]	20 20	29 s 1.4	0.33 s <0.01	85-0351
WA, 1985 (Sevin)	1.8	3.2	3[1]	20	5.2	0.11	85-0352
MAIZE FODDER							
GA, 1983 (F-4333)	1.8	1.5	4	10 20	co <0.03, h 0.35, p 1.4 co <0.03, h 0.31, p 0.77	h <0.02	83-0200
FL, 1983 (NK508)	1.3	0.41	11 14	25 11	co <0.03, h 0.73, p 6.3 co <0.03, h 19, p 86	co <0.02, h 0.02	83-0228
IN, 1983 (PA63709)	3.4	7.2	2	10 20	co 0.03, h 1.7, p 18 co <0.03, h	h 0.02	83-0237

CROP State, year	Application			Day	Residues, mg/kg [2]		Ref.
	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
					0.76, p 5.0		
IA, 1983 (P80)	1.7	2.6	2	11 21	co <0.03, h 8.1, p 11 co <0.03, h 4.7, p 5.2	co <0.02, p 0.02	83-0253
	3.4	5.2	2	11 21	co <0.03, h 4.3, p 3.1 co <0.03, h 4.5, p 1.6	p 0.02	
IL, 1983 (Funk G4740)	1.7	3.6	2	10 20	co 0.28, h 1.5, p 0.44 co 0.77, h 1.1, p 0.35 c p 0.10	co <0.02, h <0.02, p <0.02	83-0358
FL, 1983 (Pioneer)	1.3	0.14	16	7 14	co <0.03, h 1.1 co <0.03, h 2.8	h <0.01 h <0.01	83-0419
AR, 1985 (North Upking)	1.3	1.4	5[1]	20 29 40	p 3.9 p 2.8 p 1.4	p 0.02 p 0.01 p 0.01	85-0337
IA, 1985	1.7	0.45	4	3 7 14 39	p 13 p 5.9 p 3.6 p 1.2 c p 0.09	p 0.040 p 0.026 p 0.02 p 0.01	85-0453
WHEAT STRAW							
MN, 1975 (Era)	1.8		2[1]	28	10	0.05	75-421-02
MN, 1975 (Era)	1.8		2[1]	47	4.7	<0.02	75-467-02
MN, 1975 (Era)	1.8		2[1]	42	2.0	0.02	75-468-02
AL, 1981 (Coker 747)	1.8 1.8	3.8 3.8	2 3	28 28	10 18 c 1.4	0.034 0.045	81-0167
AL, 1981 (Coker 747)	1.8 1.8	3.8 3.8	2 3	28 28	5.3 1.2	0.01 0.01	81-0168
MN, 1981 (Era)	1.8		2	28	0.38 c 0.90	<0.01 c 0.01	81-0428
ND, 1981 (Spr/Manitou)	1.8	3.8	2	26	0.55 c 1.6	<0.01	81-0429
ND, 1981 (Rough Rider)	1.8	3.8	2	27	<0.3 c 0.45	<0.01	81-0430
SD, 1981 (Olaf)	1.8		2	24	3.8 c 0.51	0.02	81-0426
SD, 1981 (James)	1.8		2	24	4.8 c 0.45	0.01	81-0427
TN) (McNair 1003)	1.8		2	51	3.2 c 0.63	0.05	81-0212
TN, 1981 (Arthur 71)	1.8	3.8	3	42	7.7	0.05	81-0214
TX, 1988 (NK812)	1.8	3.8	3[1]	46	11	0.037	88-0105
OK, 1988 (Florida 302)	1.8	3.8	3[1]	56	0.50	0.01	88-0131
MO, 1988 (Caldwell)	1.8	0.69	3	36	2.0	0.11	88-0185

[1] aerial application.
[2] s: straw heads; co: cobs; h: husks; p: plants; c: control sample.

Table 50. Mancozeb residues (as CS_2) in legume animal feeds and miscellaneous fodder and forage crops from supervised trials in Australia, Italy, Japan and the USA. Underlined residues are from treatments according to GAP.

CROP Country (State), year (Variety)	Application	Day	Residues, mg/kg	Ref.

	Form	kg ai/ha	kg ai/hl	No.		EBDC as CS_2	ETU	
ALMONDS HULLS								
USA (CA), 1988 (Nonpareil)	WP	5.4	0.21	3	160	3.1	0.48	89-0006
USA (CA), 1988 (Nonpareil)	WG	5.4	0.21	3	160	3.5	0.43	89-0007
USA (CA), 1988 (Thompson)	WG	5.4	0.33	3	161	3.1	0.15	89-0016
USA (CA), 1988 (Thompson)	WP	5.4	0.33	3	161	3.0	0.54	89-0017
USA (CA), 1988 (Nonpareil)	WP	5.4	0.58	3	136	3.0	0.19	89-0023
BEAN PODS AND FOLIAGE								
Australia, 1991 (Fiord)	WG WG	1.5 3.0		1 1	0 3 8 20 29 0 3 8 20 29	28 8.7 6.3 1.5 0.7 44 16 17 6.1 3.7		AUA-91-021
BEAN STRAW								
Australia, 1988 (Fiord)	WP WP	2.0 4.0		4 4	64 64	1.9 7.9	0.1 0.5	3137/88/5
PEANUT HAY								
USA (GA), 1974 (Florunner)	WP	3.6	2.3	6	27	3.6	0.02	74-171-02
USA (NC), 1984 (Florigiant)	WP	2.7	1.9	4	24	13	<0.01	85-0383
USA (TX), 1984 (Florunner)	WP	2.7		5	47	1.3	<0.01	85-0452
USA (TX), 1984 (Florunner)	WP	2.7		5	48	0.43	<0.01	85-0454
PEANUT FOLIAGE								
Australia, 1992 (Virginia Bunch)	WP WP	1.8 3.5		6 6	0 7 14 21 28 0 7 14 21 28	13 3.6 3.3 1.8 1.9 30 8.4 8.8 5.3 4.0		AUK-92-008
SUGAR BEET LEAVES								
Italy, 1989	WP	2.0 4.0	0.7 0.14	3 3	28 28	2.8 2.8	<0.01 <0.01	R72.4
Japan, 1991 (Mono_su-s)	WP	2.8	0.19	5	14 21 30	2.8 1.8 0.10	0.11 0.09 <0.01	3P-7-246
USA (TX), 1985 (Monohy D2)	WP	1.8	3.8	6[1]	7 10 14 21 28	9.3 6.7 5.0 2.8 1.7	0.029 0.02 0.01 <0.01 <0.01	85-0329
USA (MN), 1985 (KW3394)	WP	1.8	0.33	7	7 14 21	22 17 9.3 c 0.06	0.10 0.078 0.046	85-0499
USA (MN), 1985 (KW3394)	WP	1.8	0.33	7	14	11	0.042	85-0515

Animal transfer studies

Animal transfer studies on lactating dairy cows and laying hens were made available to the Meeting.

Cows. Dithiocarbamate and ETU residues were measured in the milk and tissues of lactating Holstein cows fed with aged mancozeb residues incorporated in the feed in a US study in 1985 (Predmore and Shaffer, 1986).

Groups of 4 cows were fed 5 and 15 ppm and 3 cows were fed 45 ppm of aged mancozeb residues in the diet for 28 days. Milk was collected in the morning and evening and composited daily for analysis. On day 29 all cows but one from each group were slaughtered for tissue and organ collection. The remaining one from each group was placed on a residue-free diet and slaughtered on day 36.

Animals weighed 410-610 kg and consumed 19 kg of feed each per day; all animals gained weight during the study. Mean milk production was 13-26 kg/cow/day. The mancozeb dose was regulated by including a portion of finely ground alfalfa containing aged mancozeb residues. Analysis of the treated alfalfa at the beginning and end of the study gave 375 and 324 mg/kg mancozeb equivalents and 1.1 and 0.81 mg/kg ETU respectively. ETU was not detected in other components of the diet, but dithiocarbamates at less than 1 mg/kg were present in some other items.

Dithiocarbamates were not detected in the milk from any group (<0.04 mg/kg as CS_2). ETU residues were not detected (<0.01 mg/kg) in milk from the 45 ppm feeding group; milk from the other groups was not analysed for ETU.

Dithiocarbamate and ETU residues in the tissues are shown in Tables 51 and 52 respectively.

The levels of dithiocarbamates (3 mg/kg) in the thyroids of the cows from the two lower feeding groups after 7 days on residue-free feed are not readily explained. The residues were much higher than those in both the thyroid from the high-dose cow taken at the same time and the thyroids of all the animals slaughtered at the end of 28 days of mancozeb intake.

ETU was detected in the thyroids of all the animals, with the highest mancozeb doses causing the highest levels. Residues in the thyroids decreased during the 7 days on residue-free feed. ETU was not detected in the fat from the highest dose group; it was present in muscle, heart, liver and kidney samples from the highest feeding group on day 29, but disappeared after 7 days on the residue-free diet.

Table 51. Dithiocarbamate residues in dairy cows on diets containing 5, 15 and 45 ppm aged mancozeb residues for 28 days (Predmore and Shaffer, 1986). Animals slaughtered on day 36 had been on residue-free feed since day 28.

Tissue/ organ	Dithiocarbamate residues, mg/kg as CS_2 [1, 2, 3]					
	5 ppm feed		15 ppm feed		45 ppm feed	
	Day 29	Day 36	Day 29	Day 36	Day 29	Day 36
Muscle	-	-	-	-	<0.02 (6)	-
Heart	-	-	-	-	<0.02 (2)	-
Liver	-	-	0.10, 0.10 0.03	-	0.07, 0.12	0.03
Thyroid	0.21, 0,22 0.16	3.3 [2.9]	<0.14, 0.22, 0.16	2.6 [2.8]	0.24, 0.21	0.44 [0.24]
Kidney	-	-	-	-	0.04, 0.04	-
Fat	-	-	-	-	0.04, 0.06 0.04, 0.04 0.04, 0.04	-

[1] Numbers in parentheses are numbers of samples.
[2] Residues in square brackets are independent re-analyses.
[3] - : no analysis.

Table 52. Ethylenethiourea residues in dairy cows on diets containing 5, 15 and 45 ppm aged mancozeb residues for 28 days (Predmore and Shaffer, 1986). Animals slaughtered on day 36 had been on residue-free feed since day 28.

Tissue/ organ	ETU residues, mg/kg [1, 2]

	5 ppm feed		15 ppm feed		45 ppm feed	
	Day 29	Day 36	Day 29	Day 36	Day 29	Day 36
Muscle	-	-	<0.01 (9)	<0.01 (3)	0.01, 0.028 0.01, 0.025 0.034, <0.01	<0.01 (3)
Heart	<0.01 (3)	<0.01	<0.01, <0.01, 0.013	<0.01	0.022, 0.028	<0.01
Liver	-	-	<0.02 (3)	-	0.031, 0.039	-
Thyroid	0.17, 0.23, 0.20	0.089	0.45, 0.68, 0.21	0.26	1.0, 2.7	0.032
Kidney	-	-	<0.01 (3)	<0.01	0.018, 0.038	<0.01
Fat	-	-	-	-	<0.01 (6)	-

[1] Numbers in parentheses are numbers of samples.
[2] - : no analysis.

Hens. Dithiocarbamate and ETU residues were measured in the eggs and tissues of laying White Leghorn hens fed with aged mancozeb residues incorporated in the feed in a US study in 1985 (Jameson and Shaffer, 1986).

Groups of 10 laying hens were fed nominal 5, 15 and 50 ppm levels of aged mancozeb residues in the diet for 28 days. Eggs were collected each day for analysis. On day 29 six hens from each group were slaughtered for tissue and organ collection. The remaining hens from each group were placed on a residue-free diet and slaughtered on days 36 and 43.

Birds consumed 130 g feed each per day; they lost weight (20-70 g, controls 30 g) during the study, probably because of the low energy ration. Egg production per day was 78-89%.

The mancozeb dose was regulated by mixing a portion of finely ground alfalfa containing aged mancozeb residues with a commercial laying mash, a pellet binder and other alfalfa meal to produce pellets. Pellet analysis during the study gave <0.2, 4.1-4.3, 12-17 and 39-45 mg/kg mancozeb equivalents and <0.04, 0.07-0.08, 0.10-0.29, and 0.57-0.81 mg/kg ETU for the control and three treatment levels.

Dithiocarbamates were not detected in the eggs from any group (<0.04 mg/kg as CS_2). ETU residues were not detected (<0.04 mg/kg) in eggs from the 5 and 15 ppm feeding groups; eggs from the 50 ppm feeding group were re-analysed with a lower detection limit and ETU residues were not detected (<0.01 mg/kg) in eggs collected on days 2, 6 and 13, but were detected on days 20 (0.013 mg/kg) and 27 (0.017 mg/kg).

Dithiocarbamate and ETU residues in the tissues and organs are shown in Tables 53 and 54 respectively.

Dithiocarbamate residues (CS_2-generating) were detected in the fat of controls as well as treated birds. The reason for this is not clear. Chicken fat from other sources also yielded CS_2 residues when analysed. In the metabolism study with ^{14}C-labelled mancozeb on laying hens by Jameson (1985) levels of ^{14}C in the fat were lower than in any other tissue suggesting that dithiocarbamates are not deposited in the fat.

ETU residues were not detected in the tissues or organs but were detected in the excreta at levels related to feed levels.

Table 53. Dithiocarbamate residues in laying hens on diets containing 5, 15 and 45 ppm aged mancozeb residues for 28 days (Jameson and Shaffer, 1986). Birds slaughtered on day 36 or 43 had been on residue-free feed since day 28.

Tissue/ organ	Dithiocarbamate residues, mg/kg as CS_2 [1]

	Control		5 ppm feed		15 ppm feed		45 ppm feed	
	Day 29	Day 36 or [43]	Day 29	Day 36 or [43]	Day 29	Day 36 or [43]	Day 29	Day 36 or [43]
Muscle	<0.02 0.03	0.03	<0.02 0.06	0.03	0.03 0.08	<0.02	<0.02 0.09	<0.02
Liver	<0.02	-	<0.02	-	0.03	<0.02	0.03	-
Heart	<0.1	-	0.17	-	0.17	-	<0.1	-
Gizzard	<0.04	<0.04	<0.04	<0.04	0.10	<0.04	0.49	<0.04
Kidney	<0.2	-	<0.2	-	<0.2	-	<0.2	-
Fat	0.25	0.36 [0.19]	0.33	0.24 [0.38]	0.62	0.56 [0.43]	1.6	0.29 [0.24]

[1] - : no analysis.

Table 54. Ethylenethiourea residues in laying hens on diets containing 5, 15 and 45 ppm aged mancozeb residues for 28 days (Jameson and Shaffer, 1986). Birds slaughtered on day 36 had been on residue-free feed since day 28.

Tissue/ organ	ETU residues, mg/kg [1]					
	Control		5 ppm feed	15 ppm feed	45 ppm feed	
	Day 29	Day 36	Day 29	Day 29	Day 29	Day 36
Muscle	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01
Liver	<0.02	-	<0.02	<0.02	<0.02	-
Heart	<0.04	-	<0.04	<0.04	<0.04	-
Gizzard	<0.04	-	<0.04	<0.04	<0.04	-
Kidney	<0.08	-	<0.08	<0.08	<0.08	-
Fat	<0.04	-	<0.04	<0.04	<0.04	-

[1] - : no analysis.

FATE OF RESIDUES

In animals

Metabolism studies on lactating goats and laying hens were made available to the Meeting.

Goats. Tissue, milk and excreta residues were measured in six lactating goats (weighing 52-60 kg each) dosed for 7 days by capsule with radiolabelled mancozeb ([^{14}C]ethylenediamine) equivalent to 3, 14 and 36 ppm mancozeb in the feed (Schweitzer, 1986a; Predmore, 1985). Feed consumption was 2 kg/day. Milk was collected each day; animals were slaughtered on day 8 for tissue collection.

The concentration of ^{14}C in the milk reached a steady level by day 3 at all dosing rates.

Most of the ^{14}C (94-97% of that recovered) was excreted in the faeces and urine. Excretion levels reached a plateau by day 2. The distribution of the ^{14}C is shown in Table 55.

Table 55. Distribution of ^{14}C in lactating goats fed radiolabelled mancozeb ([^{14}C]-ethylenediamine) at 3, 14 and 36 ppm in the feed for 7 days before slaughter (Schweitzer, 1986a; Predmore, 1985).

Component	^{14}C as % of administered dose		
	3 ppm in feed	14 ppm in feed	36 ppm in feed
Faeces	50	47	41
Urine	31	32	34
Milk	0.17	0.70	1.5
Muscle	1.1	0.60	1.2
Fat	0.33	0.08	0.16

Component	^{14}C as % of administered dose		
	3 ppm in feed	14 ppm in feed	36 ppm in feed
Heart	0.02	0.02	0.03
Kidney	0.07	0.04	0.09
Liver	1.7	0.85	0.99
Gall bladder contents	0.07	0.01	0.01
Blood	0.31	0.23	0.37

Tissue concentrations of ^{14}C were higher in liver (0.82, 2.1, 6.2 mg/kg mancozeb equivalents) and kidney (0.21, 0.58, 2.8 mg/kg) than in the other tissues. Schweitzer (1986b) examined the distribution of the ^{14}C among the biochemical fractions of the kidney and liver (Table 56). The majority of the ^{14}C was incorporated into natural products.

The metabolites identified in the kidneys are listed in Table 57. About 30-40% of the metabolites (10-14% of the ^{14}C dose) were not identified.

Table 56. Distribution of ^{14}C among biochemical fractions in the kidney and liver from lactating goats fed radiolabelled mancozeb ([^{14}C]ethylenediamine) at 3, 14 and 36 ppm in the feed for 7 days before slaughter (Schweitzer, 1986b).

Biochemical fraction	^{14}C as % of total ^{14}C in the organ

	Kidney	Liver
Lipids	4-8%	1.7-9%
Glycogen	4-8%	1.8-3.3%
Creatines	6-10%	6-16%
Metabolites (Table 57)	29-37%	32-36%
Bound	34-47%	45-51%
Bound, released by protease	27-31%	32-39%
Unextractable	6-15%	10-14%

Table 57. Metabolites identified in kidneys from goats fed radiolabelled mancozeb ([^{14}C]ethylenediamine) at 3, 14 and 36 ppm in the feed for 7 days before slaughter (Schweitzer, 1986b).

Metabolite	Mancozeb metabolites, mg/kg		
	3 ppm	14 ppm	36 ppm
Glycine	0.004	0.013	0.068
N-formylglycine	0.002	0.005	0.038
Ethylenediamine (EDA)	0.001	0.002	-
N-acetylethylenediamine	0.001	0.009	0.017
Ethyleneurea (EU)	0.002	0.004	0.014
Ethylenethiourea (ETU)	0.001	0.003	0.031
Hydantoin	0.001	0.003	0.006
5,6-dihydro-3*H*-imidazo[2,1-*c*][1,2,4]dithiazole-3-thione (DIDT) or Ethylenebisisothiocyanate sulphide (EBIS)	0.001	0.001	0.005

Hens. Tissue, egg and excreta residues were measured in groups of 5 laying hens, each bird weighing 1.02-1.37 kg, dosed orally for 7 days by capsule with radiolabelled mancozeb ([^{14}C]ethylenediamine) equivalent to 3, 14 or 36 ppm mancozeb in the feed (Smith, 1986a; Jameson, 1985). The feed intake was 88-96 g/bird/day. Eggs and excreta were collected throughout, and the birds were slaughtered 24 hours after the final dose for tissue collection.

Most of the ^{14}C (and over 99% of that recovered) was excreted in the faeces. Its distribution is shown in Table 58.

Radioactivity was higher in the liver (0.097, 0.79 and 1.9 mg/kg expressed as mancozeb) and kidney (0.15, 0.75 and 2.0 mg/kg) than in the other tissues.

Residue levels in whole eggs were still increasing at the end of the dosing period, but declined rapidly from a group of hens in which dosing was discontinued.

The metabolites identified in the eggs and tissues from the 36 ppm group are listed in Table 59. Ethyleneurea was the main identified metabolite (0.02-0.06 mg/kg as mancozeb equivalents).

Tissues and eggs from the highest dosing group were also analysed chemically for dithiocarbamates and ETU. The levels of dithiocarbamates expressed as CS_2 were muscle 0.02-0.04 mg/kg, liver 0.09 mg/kg, gizzard 0.08 mg/kg, kidney 0.08 mg/kg, fat 0.07 mg/kg and eggs 0.007-0.02 mg/kg. At the highest dosing rate (36 ppm in the feed) ETU levels were at or below the limit of detection (0.007 mg/kg) in the tissues, while the level in eggs was 0.06 mg/kg. The level in eggs dropped below the limit of detection in four days when dosing ceased. ETU was not detected (<0.007 mg/kg) in eggs from the lower dosing groups.

Bound ^{14}C was released by protease or acid hydrolysis and further investigated (Smith, 1986b). The major components identified in all the tissues and eggs were ethylenediamine and glycine, together constituting 27-42% of the bound activity in eggs, muscle and liver. ETU accounted for less than 1%.

Table 58. Distribution of ^{14}C in tissues, eggs and excreta of laying hens fed radiolabelled mancozeb ([^{14}C]ethylenediamine) at 3, 14 and 36 ppm in the feed for 7 days before slaughter (Jameson, 1985).

Component	^{14}C as % of administered dose		
	3 ppm in feed	14 ppm in feed	36 ppm in feed
Excreta	83	82	87
Whole egg	0.19	0.38	0.46
Egg yolk	0.033	-	-
Egg white	0.092	-	-
Muscle	0.039	0.048	0.068
Fat	0.0016	0.0055	0.0048
Heart	0.0051	0.0055	0.0063
Kidney	0.047	0.052	0.055
Liver	0.089	0.13	0.14
Gizzard	0.045	0.084	0.076

Table 59. Metabolites in eggs and tissues of laying hens fed radiolabelled mancozeb ([^{14}C]ethylenediamine) at 36 ppm in the feed for 7 days before slaughter (Smith, 1986a).

Metabolite	Metabolite expressed as % of ^{14}C in the eggs or tissue			
	Eggs	Breast muscle	Thigh muscle	Liver
Residue - not extractable	44	35	39	49
EBIS (DIDT)*	0.12			
Ethylenethiourea (ETU)	6.8			<0.3
Ethyleneurea (EU)	20	36	14	4.5
Glycine and ethylenediamine	1.5		2.8	4.1
N-acetylethylenediamine	3.1		1.0	0.4
Hydantoin and imidazoline			2.6	2.2

* See Table 57 for chemical name

In plants

Metabolism studies on tomatoes, soya beans, sugar beet and wheat were made available to the Meeting.

Tomatoes. A tomato crop was treated with radiolabelled mancozeb ([^{14}C]ethylenediamine) at 2.7 kg ai/ha on nine occasions at approximately weekly intervals, and ripe tomatoes were harvested 5 days after the final treatment (Mazza and Schweitzer, 1989). The distribution of the radiolabel in the ripe tomato fractions was protein 14%, soluble carbohydrate 33%, lipids 14%, ethyleneurea 13% and bound residue 9%. A high proportion of the label had been incorporated into the carbon pool and appeared in a range of natural products. The concentration of ethyleneurea was 0.085 mg/kg.

The tomatoes were analysed for residues of mancozeb (0.02 mg/kg as CS_2) and ETU (not detectable at 0.01 mg/kg) using regulatory methods.

Soya beans. A crop was treated twice with radiolabelled mancozeb ([^{14}C]ethylenediamine) at 3.4 kg ai/ha, 69 and 56 days prior to harvest (Yeh, 1985). The beans were analysed for residues of mancozeb (not detectable at 0.04 mg/kg as CS_2) and ETU (not detectable at 0.014 mg/kg) using regulatory methods. In lyophilised pods ETU was not detectable (<0.01 mg/kg) while dithiocarbamates by analysis and calculated from ^{14}C were 0.75 and 7.9 mg/kg respectively (expressed as CS_2). Dithiocarbamate concentrations, expressed as CS_2, calculated from ^{14}C levels were beans 1.3 mg/kg, pods 3.5 mg/kg and stems 1.6 mg/kg (Satterthwaite, 1985).

Pods and beans were extracted with a methanol/chloroform/water mixture for examination for possible metabolites. None of the normal range of expected metabolites was detected in the extract of the beans (53% of the ^{14}C was extractable). A major component constituting 82% of the extractable ^{14}C could not be identified. In the pods 36% of the total ^{14}C was extractable; the identified metabolites are shown in Table 60.

Much of the ^{14}C in the beans was distributed among protein (25%), oil (11%) and whey solubles including 6% of the protein (37%).

A further study (Yeh, 1986b) showed that 19% of the total pod ^{14}C was incorporated into lignin, and that at least 2% was incorporated into oligo-, di- and mono-saccharides. In the beans 9-16% of the ^{14}C was associated with proteins of molecular weight greater than 25,000.

The studies suggest that most of the carbon in the ethylenediamine portion of the dithiocarbamate molecule is incorporated into natural products.

Table 60. Metabolites identified in a solvent extract of soya bean pods from a crop treated 69 and 56 days prior to harvest with 3.4 kg ai/ha ^{14}C-labelled mancozeb (Yeh, 1985).

Metabolite	Metabolite ^{14}C expressed as % of extractable ^{14}C
1-(2-imidazolin-2-yl)-2-imidazolidinethione (Jaffe's base)	36
Ethyleneurea	15
Hydantoin	11
EBIS (DIDT)*	13

* See Table 57 for chemical name

Sugar beets. A crop was treated three times with radiolabelled mancozeb ([^{14}C]ethylenediamine) at 2.2 kg ai/ha, 63, 32 and 14 days prior to harvest (Yeh, 1986a). The ^{14}C was distributed 77% in the leaf and stem, and 23% in the root.

Samples of leaf + stem at harvest were analysed for dithiocarbamates and ETU. ETU was not detected (<0.007 mg/kg). The dithiocarbamate level (as CS_2) was 0.39 mg/kg by analysis, and 5 mg/kg calculated from the ^{14}C content. The method used for dithiocarbamates was Haines (1982), and for ETU Haines and Adler (1973).

Neither ETU nor dithiocarbamate was detected in the sugar beet root by analysis(<0.007 mg/kg and <0.02 mg/kg as CS_2 respectively). The total ^{14}C calculated as residues of CS_2 was 0.3 mg/kg.

The fate of the radiolabel in metabolites and natural products was investigated by TLC in an extract of leaf and stem (73% of the ^{14}C was extracted). The distribution expressed as a percentage of the total ^{14}C in the leaf and stem was simple and complex carbohydrates 7.0%, amino acids 13%, ethyleneurea 1.6%, ETU + hydantoin 0.19%, ethylenediamine +

2-imidazoline + *N*-formylethylenediamine 2.2%, 1-(2-imidazolin-2-yl)-2-imidazolidinethione 3.9% and EBIS 2.1%.

From the sugar beet root 80% of the ^{14}C was extractable with water. The distribution of the radiolabel expressed as a percentage of the total ^{14}C in the roots was sucrose 36%, amino acids 17%, proteins etc. 7%, ethyleneurea 3.2%.

Wheat. Radiolabelled mancozeb ([^{14}C]ethylenediamine) was applied three times at 2.2 kg ai/ha to a wheat crop, which was harvested 46 days after the final application (Reibach, 1986a). The total ^{14}C in the seed, chaff and straw was measured by combustion analysis and dithiocarbamate residues were measured by a CS_2 evolution method (Table 61). The levels of the parent dithiocarbamate in the grain would be expected to be low because its polymeric and insoluble nature should result in minimal absorption and translocation.

Samples were extracted with ethanol and other solvents, and further solubilised by hydrolysis with 2N hydrochloric acid. The distribution of the radiolabel among metabolites and natural products is summarized in Table 62. ETU was not detected (<0.007 mg/kg) as ^{14}C or by chemical analysis. Levels of EBIS and ethyleneurea did not exceed 0.03 mg/kg. Stronger acid hydrolysis released more ^{14}C but a large part of the label remained in an acid-resistant non-extractable material, identified as lignin (Reibach, 1986b).

Table 61. Dithiocarbamate residues in wheat components resulting from foliar application of ^{14}C-labelled mancozeb (Reibach, 1986a).

Wheat component	Dithiocarbamate residues as CS_2, mg/kg	
	Calculated from total ^{14}C	Analysis as evolved CS_2
Seed	1.3	0.02
Chaff	8.8	1.3
Straw	13.2	1.2

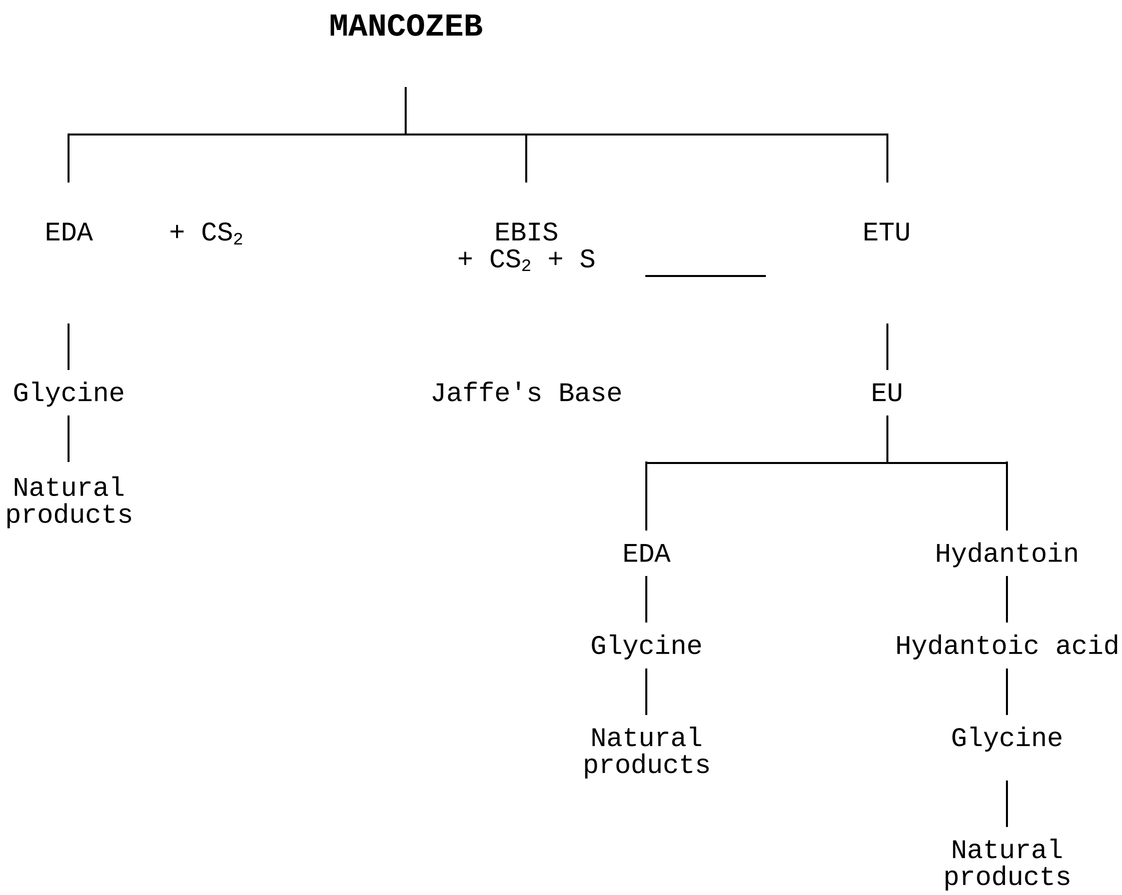
Table 62. Distribution of ^{14}C label in metabolites and natural products in wheat resulting from foliar application of ^{14}C-labelled mancozeb (Reibach, 1986a).

Metabolite	Metabolite content expressed as % of ^{14}C in the seed, chaff or straw.		
	Seed	Chaff	Straw
Sugars	32	13 (sugars + ethyleneurea)	8.2
Ethyleneurea (EU)	0.87		0.71
Amino acids	5.6	5.5	4.2
EBIS (DIDT)* + 2-imidazoline + 1-(2-imidazolin-2-yl)-2-imidazolidinethione (Jaffe's base)	1.6	2.6	2.1
Ethylenediamine (EDA)	0.84	4.1	3.1
Protein	2.5	4.2	3.7
Non-extractables	32	59	65
Solubles	68	41	35

* See Table 57 for chemical name

The metabolic pathways of mancozeb are summarized in Figure 1.

Figure 1 Mancozeb metabolism.



ETU: ethylenethiourea
EU: ethyleneurea
EBIS: 5,6-dihydro-3*H*-imidazo[2,1-*c*][1,2,4]dithiazole-3-thione (DIDT)
EDA: ethylenediamine
Jaffe's base: 1-(2-imidazolin-2-yl)-2-imidazolidinethione

In storage and processing

Processing studies were made available to the Meeting on apples, grapes, sweet corn, tomatoes, potatoes, sugar beet, barley, wheat, maize and peanuts.

Apples. Eleven applications of mancozeb (trial 85-0308, treatment 1×: 7.2 kg ai/ha, treatment 2×: 14.3 kg ai/ha) were made to Delicious and Macintosh apples in the USA (PA) (Ollinger *et al.*, 1986a). Apples were harvested 21 days after the final application and processed according to the scheme in Figure 2. Results are summarized in Table 63.

The washing process removed 30-50% of the mancozeb residues, and 90% of the remaining residue went with the peel fraction. ETU was generated during the heating of peels, cores and slices, and was detected in the unclarified juice and dry pomace from the 2× treatment. It was not detected in the other fractions or in the 1× treatment.

Figure 2. Processing of apples field-sprayed with mancozeb (Ollinger *et al.*, 1986a).

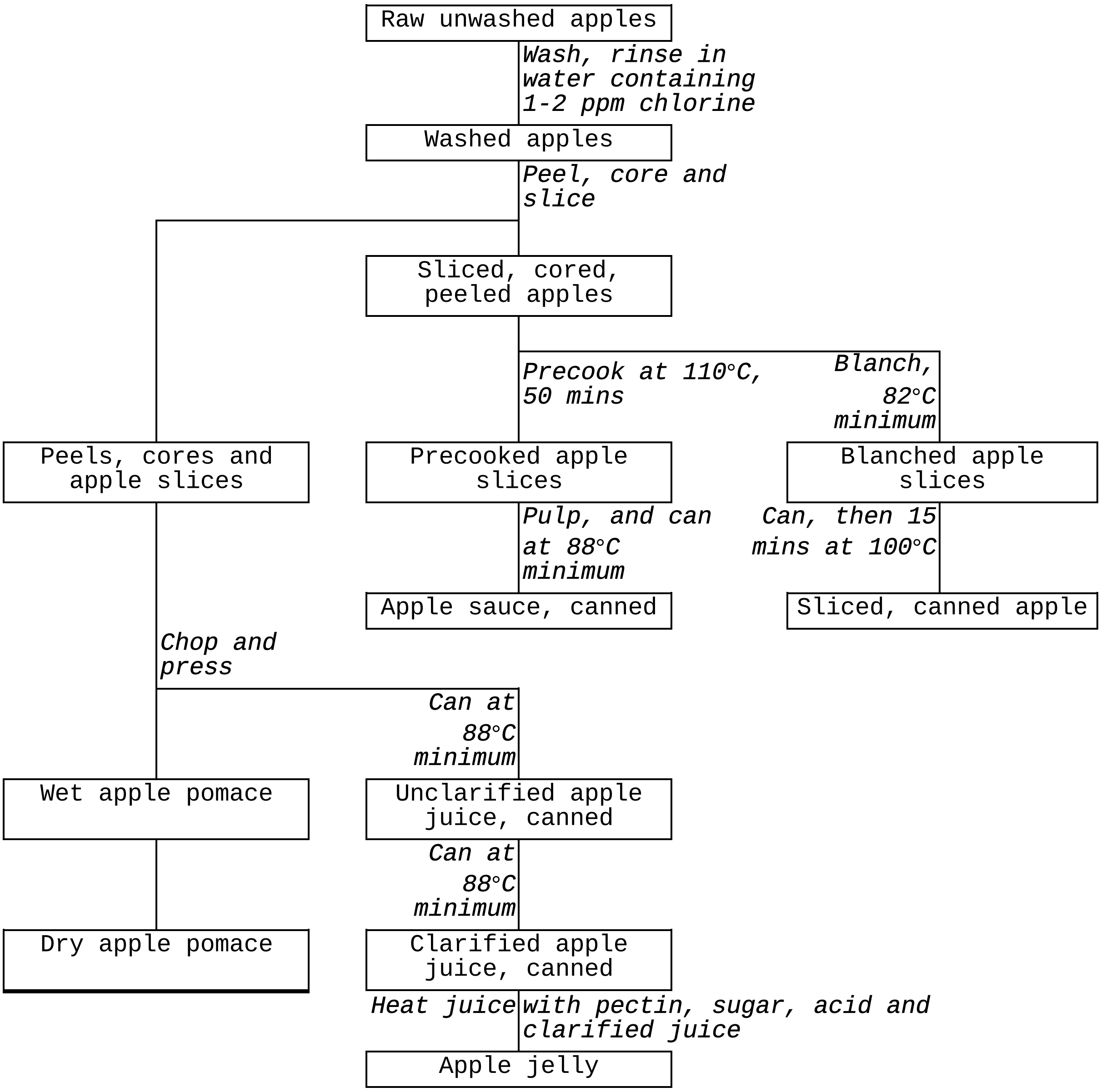


Table 63. Analysis of processed apples for dithiocarbamates and ETU (Ollinger *et al.*, 1986a). Apples had received 11 applications of mancozeb (trial 85-0308, treatment 1×: 7.2 kg ai/ha, treatment 2×: 14.3 kg ai/ha), with the final application 21 days prior to harvest. Each reported result is the mean of duplicate analyses.

Commodity	Dithiocarbamate residues, mg/kg as CS_2	ETU residues, mg/kg

	Treatment 1×	Treatment 2×	Treatment 1×	Treatment 2×
Unwashed apples	2.5	3.8	<0.03	<0.03
Washed apples	1.2	2.8	<0.03	<0.03
Sliced, cored, peeled apples	0.11	0.28	<0.03	<0.03
Peels, cores, slices before processing	5.3	5.3	<0.03	<0.03
Precooked apple slices	<0.1	<0.1	<0.03	<0.03
Apple sauce, canned	<0.1	<0.1	<0.03	<0.03
Blanched apple slices	<0.1	<0.1	<0.03	<0.03
Sliced apple, canned	<0.1	<0.1	<0.03	<0.03
Unclarified apple juice, canned	0.31	1.1	<0.03	0.04
Clarified apple juice, canned	<0.1	<0.1	<0.03	<0.03
Apple jelly	<0.1	<0.1	<0.03	<0.03
Wet apple pomace	7.6	9.7	<0.03	<0.03
Dry apple pomace	24	50	<0.03	0.10

Applications of mancozeb (in trial 84-0239, 8 at 7.2, 1 at 5.4 and 1 at 3.6 kg ai/ha; in trial 84-0262, 13 at 7.2 and 2 at 3.6 kg ai/ha; in trial 84-0468, 1 at 7.4, 4 at 7.2, 2 at 5.4 and 3 at 3.6 kg ai/ha) were made to Delicious, Winesap and Prime Gold apples in the USA (MI) (Satterthwaite, 1986n). Apples were harvested 21 days after the final application and processed on a small experimental scale. Results are summarized in Table 64.

The report makes no mention of any washing or cleaning of the apples before conversion to juice and pomace. Mancozeb residues on the surface of the apples would be expected to enter the process, and would be more likely to finish in the pomace than in the juice.

Table 64. Dithiocarbamate and ETU residues in apples, juice and pomace (Satterthwaite, 1986n).

Commodity	Dithiocarbamate residues, mg/kg as CS_2			ETU residues, mg/kg		
	Trial 84-0239	Trial 84-0262	Trial 84-0468	Trial 84-0239	Trial 84-0262	Trial 84-0468
Apples	1.1, 0.84	3.9, 3.9	4.5, 4.9	0.01, 0.015	0.01, 0.01	0.01, 0.015
Apple juice	0.29	0.55	0.44	<0.01	0.01	<0.01
Wet apple pomace	0.95	2.2	1.1	0.03	0.06	0.04
Dry apple pomace	6.7	13	6.7	0.06	0.14	0.06

Grapes. Ollinger *et al.* (1986c) treated grapes with 8 applications of mancozeb (trial 85-0353, treatment 1×: 3 at 4.4 kg ai/ha and 5 at 2.0 kg ai/ha; treatment 2×: 3 at 4.4 kg ai/ha and 5 at 4.0 kg ai/ha) in a processing trial in the USA. Grapes were harvested 7 days after the final application to achieve sufficiently high residues to be measured in the processed fractions. The recommended pre-harvest interval is 66 days, except in California where mancozeb cannot be applied after bloom.

Grapes were processed, one box for each treatment and process, into juice, jelly and dried raisins (Elkins and Kim, 1986). The processes are described in Figures 3 and 4. Grapes were subjected to steam for 30 seconds and then dried in a forced air oven at 38-43°C to produce raisins. Residues of dithiocarbamate and ETU are given in Table 65.

Dithiocarbamate residue concentrations decreased through the various processing steps, except raisin production where removal of water would be expected to increase the concentration of residues. Raisins in this study were not washed; the commercial procedure is to wash the raisins, which would be likely to reduce residues. Dithiocarbamates were not detectable in clear solutions of juice or jelly.

ETU was generated in processes where dithiocarbamate residues were boiled or heated. The ETU residue level in a processed product was not related to its level in the raw commodity.

Figure 3. Processing of grapes to produce juice and pomace (Elkins and Kim, 1986).

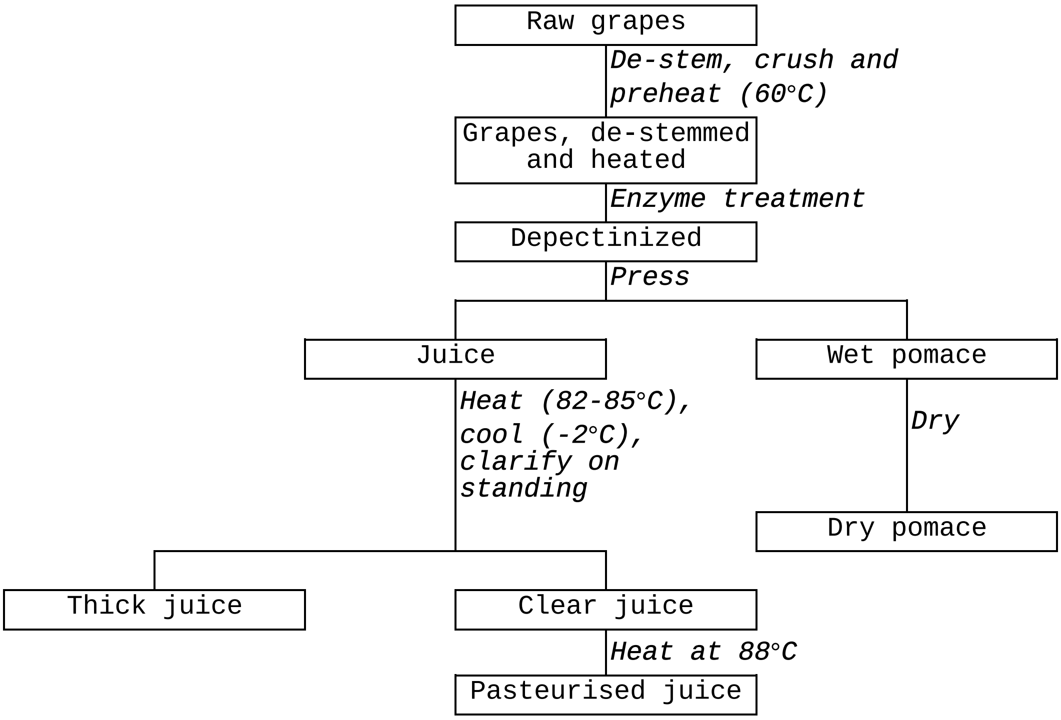


Figure 4. Processing of grapes to produce jelly (Elkins and Kim, 1986).

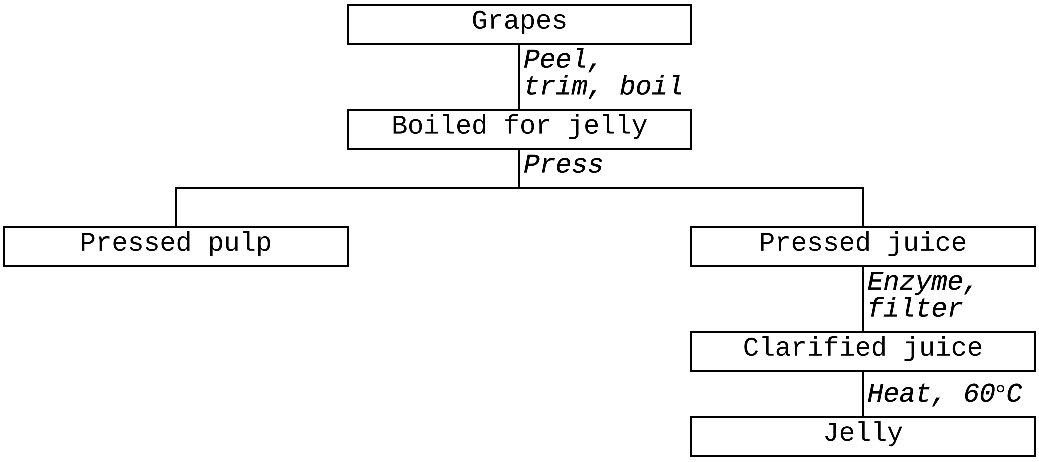


Table 65. Residues of dithiocarbamates (as CS_2) and ETU in grapes and their processed products, trial 85-0353 (Ollinger *et al.*, 1986c; Elkins and Kim, 1986). The processes are described in Figures 3 and 4. Reported results are from duplicate samples.

Commodity	Dithiocarbamate residues, as CS_2, mg/kg	ETU residues, mg/kg

	Treatment 1×	Treatment 2×	Treatment 1×	Treatment 2×
Raw grapes	21, 17	49, 36	0.01, 0.01	0.28, 0.35
De-stemmed and heated	3.9, 3.4	18, 20	0.07, 0.04	0.28, 0.33
Depectinized	3.1, 2.2	13, 13	0.04, 0.03	2.4, 2.4
Wet pomace	4.5, 5.6	9.5, 15	0.03, 0.02	0.29, 0.19
Dry pomace	12, 14	20, 18	0.20, 0.21	1.3, 0.90
Clear juice	<0.1, <0.1	<0.1, <0.1	0.19, 0.23	2.4, 2.6
Thick juice	2.4, 2.6	1.4, 1.2	0.08, 0.08	4.3, 4.3
Pasteurised juice	<0.1, <0.1	<0.1, <0.1	0.08, 0.09	0.93, 0.90
Canned juice	<0.1, <0.1	<0.1, <0.1	0.13, 0.11	1.3, 1.3
Boiled for jelly	0.84, 0.78	19, 17	0.22, 0.26	4.9, 4.2
Pressed pulp	2.2, 1.5	11, 12	0.32, 0.37	0.37, 0.29
Pressed juice	0.4, 0.5	2.2, 3.0	1.5, 1.2	2.9, 2.7
Clarified juice	<0.1, <0.1	<0.1, <0.1	0.21, 0.20	3.1, 3.0
Cooled jelly	<0.1, <0.1	<0.1, <0.1	0.71, 0.74	1.6, 1.1
Heated raisins	22, 30	34, 37	0.05, 0.05	0.09, 0.08
Dried raisins	46, 53	135, 136	0.31, 0.37	1.0, 0.92

Grapes grown in the USA (CA) for processing studies were treated once (Trial 85-0336) with mancozeb at 7.2 kg ai/ha 64 days prior to harvest (Satterthwaite, 1986f). In a second trial (85-0342), grapes were treated five times with mancozeb at 2.0 kg ai/ha (1×) or 4.0 kg ai/ha (2×) with a pre-harvest interval of 21 days. Raisins, white wine and red wine were produced from the grapes.

The grapes were dried to <16% moisture content then processed to remove chaff, stems, leaves and small fruit to produce raisins. The material removed was the raisin waste. The wine production process is shown in Figure 5. Dithiocarbamate and ETU residues in the wine, raisins and by-products from both trials are listed in Table 66.

The use patterns were not GAP and were designed to produce exaggerated residues for the processing study.

In the production of raisins some dithiocarbamate residues were lost while no ETU was generated. Dithiocarbamate residues were not found in the wine produced from the treated grapes, but ETU was generated in the process.

Figure 5. Process for wine production (Satterthwaite, 1986f). The red wine was produced by fermenting skins and juice together, with additional sugar.

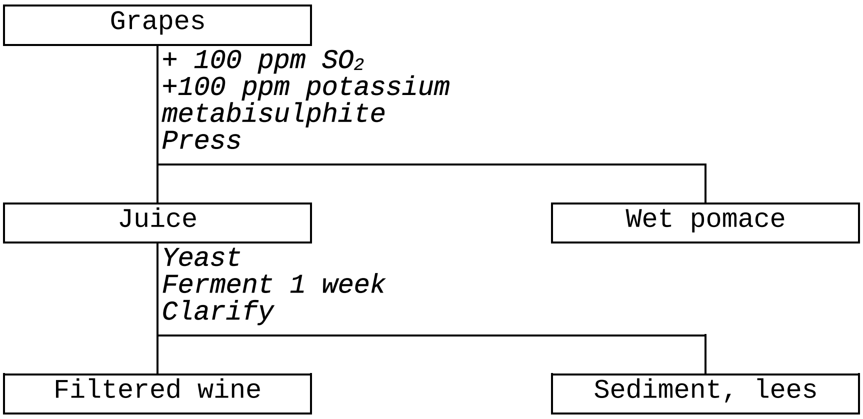


Table 66. Residues of dithiocarbamates (as CS_2) and ETU in grapes and their processed products (Satterthwaite, 1986f). The wine production process is described in Figure 5.

Commodity	Dithiocarbamate residues, mg/kg as CS_2			ETU residues, mg/kg		
	Trial 85-0336	Trial 85-0342 1×	Trial 85-0342 2×	Trial 85-0336	Trial 85-0342 1×	Trial 85-0342 2×
Fruit	1.6	3.6	9.0	<0.01	<0.01	0.02
Raisins	0.90	0.78	2.8	<0.01	<0.01	<0.01
Raisin waste	7.9	5.0	1.8	0.04	0.05	0.17
RED WINE						
Unfiltered juice	1.5	6.7	21	<0.01	<0.01	0.03
Pomace	0.29	0.84	3.7	<0.01	<0.01	<0.01
Lees		8.4	12		0.06	0.57
Red wine filtered		<0.03	0.06		0.08	0.64
WHITE WINE						
Unfiltered juice	1.2	4.5	5.3	0.01	0.01	0.02
Pomace	0.49	1.4	3.8	<0.01	<0.01	0.01
Lees	7.9	8.4	33	0.07	0.16	1.0
White wine filtered	<0.03	<0.03	<0.03	0.09	0.22	0.79

Mancozeb was applied three times at 3.6 kg ai/ha to grapes for a processing study in the USA (CA) (Satterthwaite, 1990a). The grapes were harvested 82 days after the final application and processed into raisins and juice, which were analysed for residues of dithiocarbamates and ETU (Table 67). Raisins were produced by drying the Thompson seedless grapes in the sun for 13 days, when the moisture content was less than 16%. They were then cleaned and sized. The initial analysis of the grapes for ETU showed 0.23 mg/kg, which appeared anomalous in the light of previous experience. Re-analysis showed 0.061 mg/kg.

Table 67. Residues of dithiocarbamates (as CS_2) and ETU in grapes, raisins and juice (Satterthwaite, 1990a).

Commodity	Mancozeb residues, mg/kg as CS_2	ETU residues, mg/kg
Grapes	0.23	0.061
Raisins	0.52, 0.16, 0.19, 0.24	<0.01 (4)
Raisin waste	6.9	0.20
Juice	0.28	0.43, 0.046
Fermented wet pomace	0.26	0.046
Dry pomace	0.21	0.022

Sweet corn. Sweet corn was treated with mancozeb on 7 occasions at 1.3 kg ai/ha or 6.7 kg ai/ha, and harvested 7 days after the final application (trial 87-0328) in the USA (PA) (Schweitzer, 1989b). The sweet corn was put through a small-scale cannery process. Residues of dithiocarbamates and ETU were measured in the sweet corn and its products (Table 68).

Table 68. Residues of dithiocarbamates (as CS_2) and ETU in sweet corn and processed products (Schweitzer, 1989b).

Commodity	Dithiocarbamate residues, mg/kg as CS_2		ETU residues, mg/kg	
	Applicn. rate 1.3 kg ai/ha	Applicn. rate 6.7 kg ai/ha	Applicn. rate 1.3 kg ai/ha	Applicn. rate 6.7 kg ai/ha
Whole ear	0.21	0.90	<0.01	0.022
Cob + kernel	<0.03	0.03	<0.01	0.021
Husk	1.3	6.7	0.010	0.18
Frozen corn	<0.03	0.05	<0.01	<0.01
Canned corn	<0.03	<0.03	<0.01	0.014
Cannery waste	0.39	3.0	0.015	0.11

Tomatoes. Five applications of mancozeb (trial 85-0378, treatment 1×: 2.7 kg ai/ha; treatment 2×: 5.4 kg ai/ha) were made to crops of tomatoes in the USA (PA) for processing studies (Ollinger *et al.*, 1986b). Tomatoes were harvested 5 days after the final application and processed according to the scheme in Figure 6. Results are summarized in Table 69.

Mancozeb residues (50% or more) were removed from the tomatoes during the washing process. ETU was generated during some of the cooking processes. The products with the highest levels of ETU were puree, paste and ketchup. Levels of ETU increased during the heat treatment of canned juice and canned puree.

Figure 6. Processing of tomatoes field-sprayed with mancozeb (Ollinger *et al.*, 1986b).

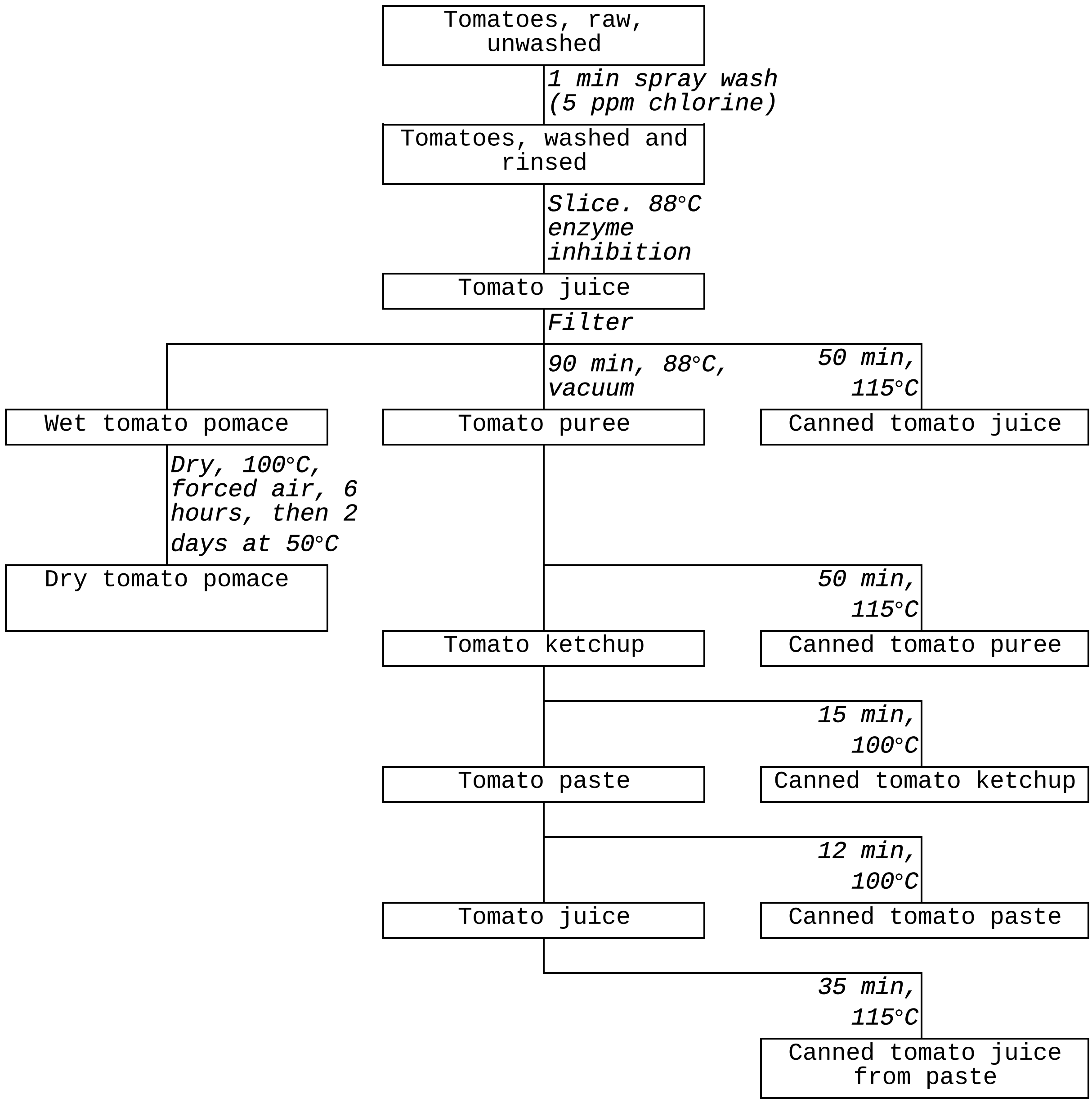


Table 69. Dithiocarbamates ETU in processed tomatoes (Ollinger *et al.*, 1986b). Tomatoes had received 5 applications of mancozeb (trial 85-0378, treatment 1×: 2.7 kg ai/ha; treatment 2×: 5.4 kg ai/ha), with the final application 5 days prior to harvest. Each reported result is the mean of duplicate analyses.

Commodity	Dithiocarbamate residues, mg/kg as CS_2	ETU residues, mg/kg

	Treatment 1×	Treatment 2×	Treatment 1×	Treatment 2×
Raw unwashed tomatoes	0.2	0.5	<0.01	<0.01
Washed rinsed tomatoes	<0.1	0.2	<0.01	0.02
Tomato juice	<0.1	0.1	0.015	0.05
Canned tomato juice	<0.1	<0.1	0.02	0.09
Wet tomato pomace	<0.1	<0.1	<0.01	0.01
Dry tomato pomace	<0.1	<0.1	0.03	0.05
Tomato puree	<0.1	0.2	0.07	0.12
Canned tomato puree	<0.1	0.1	0.08	0.25
Canned tomato ketchup	<0.1	0.1	0.04	0.19
Canned tomato paste	0.1	0.4	0.14	0.25
Tomato juice from paste	<0.1	0.1	0.03	0.07
Canned juice from paste	<0.1	<0.1	0.03	0.04

Tomatoes were commercially processed in 80 tonne lots to determine the fate of field-applied mancozeb (Schweitzer, 1988). The application rate was 2.7 kg ai/ha on each of 5 (trial 87-0306) or 6 (trial 87-0305) occasions, and the interval between final application and harvest was 5 days for trial 87-0305 and 11 days for trial 87-0306. Residues in the processed fractions are summarized in Table 70.

Washing removed almost all of the mancozeb residues. In the commercial procedure the tomatoes are immersed in troughs of continuously replaced water for 5-10 minutes, and are sprayed with fresh water on exit. In the previous small-scale experiment (Ollinger *et al*., 1986b) with a 30-second water spray, only about 50-60% of the mancozeb residue was removed.

The removal of most of the dithiocarbamate before heating or cooking steps restricts the capacity to form ETU. Levels of ETU in the end products were substantially lower than in the earlier study (Ollinger *et al*., 1986b).

Table 70. Dithiocarbamate and ETU residues in commercially processed tomatoes (Schweitzer, 1988). Numbers in parentheses are numbers of samples.

Commodity	Dithiocarbamate residues, mg/kg as CS_2		ETU residues, mg/kg	
	Trial 87-0305	Trial 87-0306	Trial 87-0305	Trial 87-0306
Unwashed tomatoes	0.41, 0.20, 0.47, 0.39, 0.42, 0.51	0.18, 0.16, 0.18, 0.73, 0.35, 0.39	<0.01 (6)	<0.01 (6)
Washed tomatoes	0.03, <0.03 (23)	0.03, 0.05, 0.04, <0.03 (21)	0.01 (10), <0.01 (13), 0.015	<0.01 (24)
Hot break juice	<0.03 (6)	<0.03 (6)	0.031, 0.023, 0.034, 0.022, 0.016, 0.016	0.020, 0.020, 0.016, 0.022, 0.025, 0.039
Wet pomace	<0.03 (6)	<0.03 (6)	<0.01 (5), 0.016	<0.01 (6)
Concentrate	<0.03 (6)	<0.03 (6)	0.027, 0.037, 0.044, 0.033, 0.049, 0.035	0.049, 0.038, 0.025, 0.042, <0.01 (2)
Tomato sauce	0.04, 0.03, <0.03		<0.01 (3)	
Tomato ketchup		<0.03, 0.03, 0.03		0.016 (2), <0.01 (3), 0.01

Potatoes. Harvested potatoes (23 kg) were sprayed in the laboratory with mancozeb at a rate estimated to produce a mancozeb residue of 1 mg/kg , and then sent for processing (Ollinger *et al.*, 1986d). Processing details are summarized in Figure 7. Dithiocarbamate and ETU residues in each of the processed potato fractions are given in Table 71.

Dithiocarbamate residues were essentially only on the peel of the potatoes. Some ETU was formed during the baking of peel containing dithiocarbamate residues.

Figure 7. Processing of potatoes sprayed with mancozeb to produce a nominal 1 mg/kg mancozeb residue. (Ollinger *et al.*, 1986d).

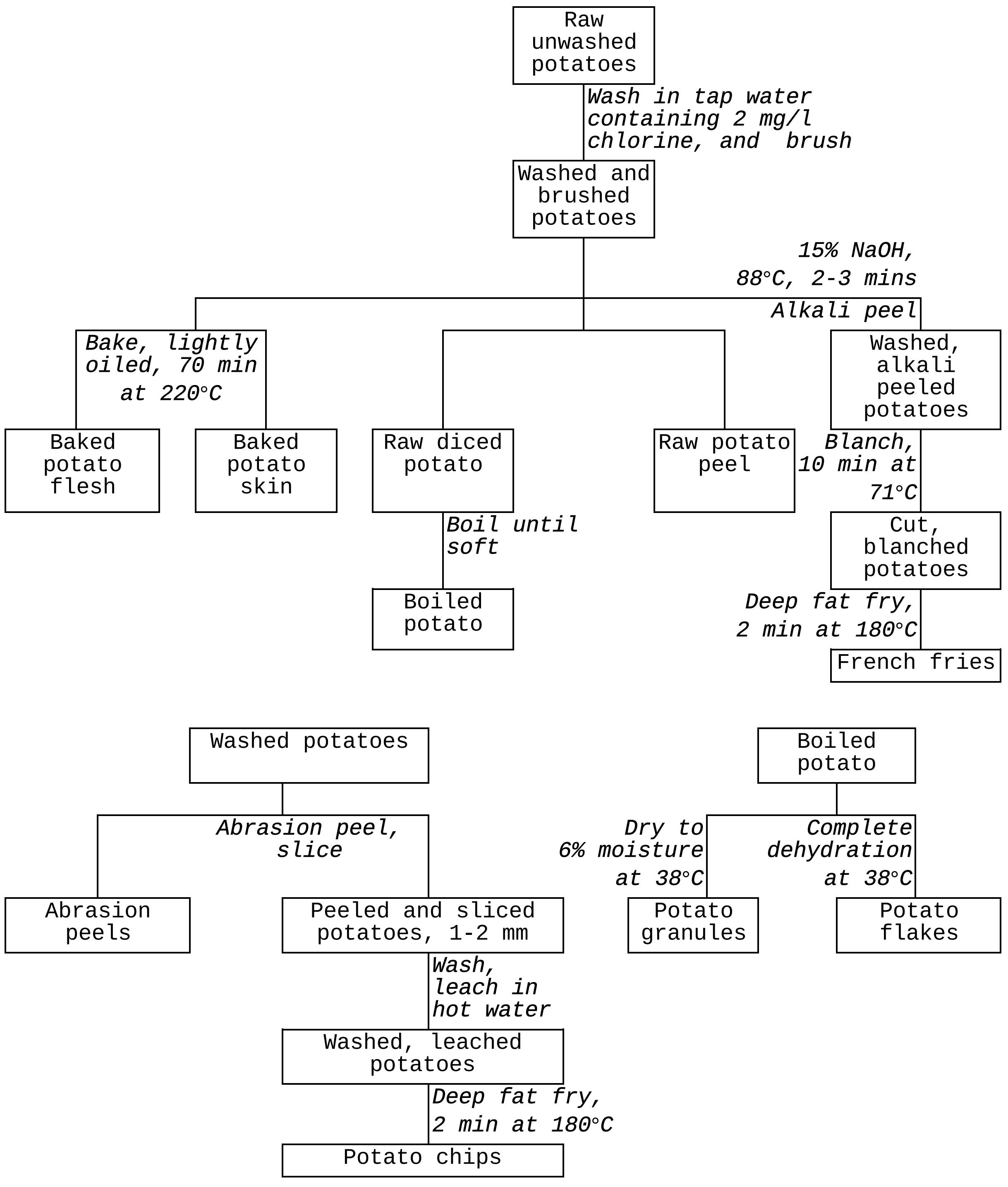


Table 71. Analysis of processed fractions from potatoes sprayed with mancozeb to produce a nominal 1 mg/kg mancozeb residue. (Ollinger *et al.*, 1986d). Each reported result is the mean of duplicate analyses.

Commodity	Dithiocarbamate residues, mg/kg as CS_2	ETU residues, mg/kg
Unwashed potatoes	0.32	<0.01
Washed and brushed potatoes	<0.06	<0.01
Baked potato pulp	<0.06	0.013
Baked potato peel	<0.06	0.04
Raw potato peels	0.53	<0.01
Raw, diced potato	<0.06	<0.01
Boiled potato	<0.06	<0.01
Washed, alkali-peeled potatoes	<0.06	<0.01
Cut, blanched potatoes	<0.06	<0.01
French fries	<0.06	<0.01
Abrasion peels	0.66	<0.01
Peeled and sliced potatoes	<0.06	<0.01
Washed, leached potatoes	<0.06	<0.01
Potato chips	<0.06	<0.01
Potato granules	<0.06	<0.01
Potato flakes	<0.06	0.01

Mancozeb was foliar-applied on two occasions to potato crops in the USA at 1.8 and 9.0 kg ai/ha, at a site in Ohio, to provide potatoes for a processing study (Schweitzer, 1989c). The potatoes were processed (approximately 5 kg each process) according to Figure 7 for potato chips, granules and flakes. Residues are shown in Table 72.

Mancozeb is not systemic, so residues in the tubers from foliar application would be expected to be a sporadic occurrence from soil contamination or exposure of tubers at the soil surface. During processing, where dithiocarbamate might be transferred from the peel by operations such as abrasion peeling, there would be an opportunity for the formation of ETU during cooking. The results show that residues are not generally detectable, but enough dithiocarbamate is sometimes present to generate ETU.

Table 72. Residues of dithiocarbamates and ETU in potatoes harvested 14 days after foliar applications of mancozeb and in the processed potato commodities (Schweitzer, 1989c). Each result is the mean of duplicate analyses.

Commodity	Dithiocarbamate residues, mg/kg as CS_2	ETU residues, mg/kg

	Appl. rate 1.8 kg ai/ha	Appl. rate 9.0 kg ai/ha	Appl. rate 1.8 kg ai/ha	Appl. rate 9.0 kg ai/ha
Raw unwashed potatoes	<0.1	<0.1	<0.02	<0.02
Washed, abrasion-peeled potatoes	<0.1	<0.1	<0.02	0.04
Abrasion peels	<0.1	<0.1	<0.02	0.03
Sliced, washed, leached, potatoes	<0.1	<0.1	<0.02	0.02
Potato chips	<0.1	0.16	<0.02	<0.02
Washed, hand-peeled potatoes	<0.1	<0.1	<0.02	<0.02
Peels from hand-peeling	<0.1	<0.1	<0.02	<0.02
Boiled potatoes	<0.1		<0.02	
Potato granules	<0.1	<0.1	<0.02	0.08
Potato flakes	0.36	<0.1	0.09	0.23

Sugar beet. Beets grown in the USA (MN) were treated with mancozeb (trial 85-0515) at 1.8 (1×) and 7.2 (4×) kg ai/ha on 7 occasions and harvested 14 days after the final application in a residue processing study (Satterthwaite, 1986k). The simulated commercial process used 140 kg of sugar beet. The first stage of the process was washing the roots. Residues are shown in Table 73.

Table 73. Dithiocarbamate and ETU residues in processed sugar beet products (Satterthwaite, 1986k). Beets were treated with mancozeb (trial 85-0515) at 1.8 (1×) and 7.2 (4×) kg ai/ha on 7 occasions and harvested 14 days after the final application.

Commodity	Dithiocarbamate residues, mg/kg as CS_2		ETU residues, mg/kg	
	Treatment 1×	Treatment 4×	Treatment 1×	Treatment 4×
Sugar beet root	0.14	0.16	0.018	0.025
Molasses	<0.03	<0.03	<0.01	<0.01
Pulp	0.12	0.45	<0.01	0.02
White sugar	<0.03	<0.03	<0.01	<0.01

Barley. A crop was treated with mancozeb on 3 occasions at 1.8 kg ai/ha, and harvested 25 days after the final application in a barley milling trial (85-0273) in the USA (ND) (Satterthwaite, 1986h). The barley was put through a small-scale flour-milling process. Residues of dithiocarbamates and ETU were measured in the barley and milled products (Table 74).

Table 74. Residues of dithiocarbamates (as CS_2) and ETU in barley and milled products (Satterthwaite, 1986h).

Commodity	Dithiocarbamate residues, mg/kg as CS_2	ETU residues, mg/kg
Whole kernels (harvested grain from which dirt and straw had been removed)	1.6	0.03
Cleaned grain	0.46	<0.01
Kernel (no husk)	0.15	0.03
Husk	3.3	0.16
Bran	<0.03	0.015
Flour	<0.03	<0.01
Rough	3.1	0.07
Shorts and germ	<0.03	0.015

Maize was treated with mancozeb on 7 occasions at 1.7 kg ai/ha or on 8 occasions at 3.4 kg ai/ha, and harvested 21 days after the final application in a maize-processing trial (85-0568) in the USA (IL) (Satterthwaite, 1986j). In a small-scale process the maize was milled to produce meal, flour, germ, grits, crude oil, refined oil, hulls and soapstock.

Neither dithiocarbamates nor ETU were detected (<0.03 mg/kg for dithiocarbamates as CS_2, and <0.01 mg/kg for ETU) in the maize kernels or any of the products.

Wheat. Mancozeb was sprayed at 1.8 kg ai/ha on 2 or 3 occasions and wheat was harvested approximately 26 days after the final application. The wheat was milled and bread baked (Table 75). More details of the location of the trials and the mancozeb application are provided in the "Residues resulting from supervised trials" section, Table 44. Residues of dithiocarbamates in the grain and milled products were less than 0.5 mg/kg, and usually much less. Residues of ETU were undetectable (<0.01 and <0.02 mg/kg).

Table 75. Residues of dithiocarbamates (as CS_2) and ETU in wheat and milled products in a series of studies in the USA in 1975 and 1981. The mancozeb application details are recorded in Table 44.

Dithiocarbamate residues, mg/kg as CS_2				ETU residues, mg/kg				Study
Grain	Bran	Flour	Bread	Grain	Bran	Flour	Bread	
0.07	0.07	0.04	0.03	<0.01	<0.01	<0.01	<0.01	81-0167
0.09	0.14	0.04	0.03	<0.01	<0.01	<0.01	<0.01	81-0167
0.10	0.05	0.04	0.02	<0.01	<0.01	<0.01	<0.01	81-0168
0.05	0.04	0.04	0.02	<0.01	<0.01	<0.01	<0.01	81-0168
0.17	0.39	0.17	0.05	<0.02	<0.02	<0.02	<0.02	75-421-02
0.1	0.2	0.05	<0.05	<0.02	<0.02	<0.02	<0.02	75-467-02
0.1	0.2	0.08	<0.05	<0.02	<0.02	<0.02	<0.02	75-468-02
-	0.02	<0.03	<0.01	-	<0.01	<0.01	<0.01	81-0428
-	0.03	0.04	0.02	-	<0.01	<0.01	<0.01	81-0429
-	0.03	0.04	<0.01	-	<0.01	<0.01	<0.01	81-0430
-	0.05	0.06	<0.01	-	<0.01	<0.01	<0.01	81-0426
-	0.1	0.06	0.02	-	<0.01	<0.01	<0.01	81-0427
0.02	0.06	0.06	0.02	-	<0.01	<0.01	<0.01	81-0212
0.04	0.12	0.07	0.04	<0.01	<0.01	<0.01	<0.01	81-0214

Peanuts. Mancozeb was applied to a peanut crop 6 times at 1.8 kg ai/ha or 3.6 kg ai/ha in a processing trial (85-0516) in the USA (GA) (Satterthwaite, 1986d). The peanuts were harvested 14 days after the final application and processed into meal, crude oil, refined oil and soapstock in a small-scale simulation of a commercial process.

Neither dithiocarbamates nor ETU were detected (<0.03 mg/kg for dithiocarbamates as CS_2, and <0.01 mg/kg for ETU) in the raw peanuts or any of the products.

Johnson (1991) reported on the effects of typical consumer practices during food preparation on residues of dithiocarbamates and ETU in potatoes, tomatoes, onions and apples.

Potatoes were treated with mancozeb to obtain a residue of 0.5 mg/kg (as mancozeb). Some were washed for 5 seconds under running water with light rubbing by the operator's fingers encased in polypropylene gloves. A second set was thoroughly scrubbed with a vegetable brush under running water for 5 seconds. A third set was treated similarly and then towel-dried with a clean cotton cloth. A fourth set, after drying, was peeled with a standard kitchen potato peeler, keeping the amount of pulp removed with the peel to an absolute minimum. Dithiocarbamate and ETU residues were measured after each process (Table 76).

Tomatoes and apples were also treated at 0.5 mg mancozeb/kg and similarly washed and dried. Onions were treated at 50 mg mancozeb/kg and peeled. It was necessary to work at a higher level because naturally-occurring sulphur compounds caused analytical interference at lower levels. Results are summarized in Table 76.

Mancozeb residues are on the surface and are removed by washing, cleaning and peeling. Combinations of washing, scrubbing and drying remove quite a high proportion of the residue (70-90%). Very little ETU is produced during these typical food preparation steps.

In Table 76 the reduction factor is defined as the ratio of the mancozeb concentration after each process to its applied concentration (0.5 or 50 mg/kg). The ETU conversion factor is defined as the ratio of the ETU residue after the process to the applied mancozeb concentration.

Table 76. Reduction factors for mancozeb and conversion factors for ETU as a result of typical consumer practices in food preparation (Johnson, 1991).

Process	Potato		Tomatoes		Apples		Onions	
	Mancozeb reduction factor	ETU conversion factor	Mancozeb reduction factor	ETU conversion factor	Mancozeb reduction factor	ETU conversion factor	Mancozeb reduction factor	ETU conversion factor
Unwashed	0.65	0.01	0.48	0.01	0.91	0.02	1.0	0.01
Washed	0.70	0.01	0.18	0.01	-	0.01		
Washed + brushed	0.42	0.01						
Washed + brushed + dried	0.30	0.01						
Washed + brushed + dried + peeled	0.02	0.02						
Washed + dried			0.09	0.01	0.32	0.01		
Peeled							0.05	0.0

Studies on the fate of mancozeb residues during food processing were included in a recent review in the open literature of the effects of processing on pesticide residues (Holland *et al.*, *in press*).

Stability of pesticide residues in stored analytical samples

Schweitzer (1989a) reported the results of a two-year freezer storage stability study on mancozeb and ETU in apples, tomatoes and wheat.

Apples, tomatoes and wheat were homogenised and analysed to establish the absence of dithiocarbamates and ETU. Samples (10 g) were weighed into separate containers, fortified with mancozeb (1 mg/kg) or ETU (0.1 mg/kg) and then stored in a freezer at -20°C. Containers were periodically removed for residue analysis. The results are summarized in Table 77.

The stability of mancozeb was within the normally acceptable range, with more than 70% remaining after for the longest storage interval. ETU was somewhat more labile, suggesting that samples containing ETU residues at this level should be analysed without excessive storage.

Table 77. Freezer storage stability of mancozeb and ETU in apple, tomato and wheat samples (Schweitzer, 1989a).

Freezer storage time	Residues, mg/kg					
	Mancozeb			ETU		
	Apples	Tomatoes	Wheat	Apples	Tomatoes	Wheat
Day 0	1.00	1.03	0.98	0.095	0.096	0.092
1 month	1.03	1.01	1.00	0.103	0.101	0.102
6 months	1.01	0.98	1.02	0.064	0.082	0.087
12 months	0.75	0.71	0.81	0.046	0.076	0.072
24 months	0.76	0.76	0.76	0.050	0.058	0.060

Loftus (1990b) reported on the freezer storage stability of mancozeb and ETU residues in matrices of vegetables, meat and milk (Tables 78 and 79). The studies showed that mancozeb was stable at -20 ± 5°C in dry beans, corn, lettuce, meat, milk, raw potato (marginal stability), and tomatoes; ETU was stable in dry beans, corn, lettuce (marginal stability), meat, milk, raw potato (marginal stability), and tomatoes.

Oxygen plays a role in the conversion of ETU to ethyleneurea. Surface residues would be more susceptible to degradation; fortified residues would probably be more susceptible to loss than incurred residues.

The stability of ETU was tested with both coarsely and finely ground samples. Short term studies (12 days) were conducted on finely ground matrices because the analytical protocol required subsamples to be extracted for analysis within five days of grinding.

Table 78. Stabiltiy of mancozeb residues to freezer storage (Loftus, 1990b). The finely ground commodity was fortified with mancozeb and stored in individual reaction flasks at -20° ± 5°C. Results were adjusted for the analytical recovery associated with the particular type of sample before the remaining residue was calculated.

Commodity and fortification level, mg/kg	Storage period	% of initial residue remaining
Dry beans, 2.0 mg/kg	0 days	84
	14 days	123
	1 month	102
	50 days	117
	3 months	108
	4 months	98
Frozen corn, 2.0 mg/kg	0 days	85
	14 days	113
	1 month	101
	50 days	96
	3 months	90
	4 months	86
Lettuce, 2.0 mg/kg	0 days	97
	12 days	96
	30 days	91, 91
	60 days	87
	90 days	95
Raw potato, 2.0 mg/kg	0 days	100
	14 days	84
	1 months	77
	3.5 months	59
Tomatoes, 2.0 mg/kg	0 days	96
	14 days	90
	1 month	91
	3 months	92
	6 months	100
Meat, 0.50 mg/kg	0 days	100
	14 days	98
	1 month	92
	3 months	112
		112
	6 months	
Milk, 0.50 mg/kg	0 days	102
	14 days	109
	1 month	89
	3 months	98
	6 months	79

Table 79. Stabiliy of ETU residues to freezer storage (Loftus, 1990b). The coarsely or finely ground commodity was fortified with ETU and stored in individual glass jars at -20° ± 5°C. Results were adjusted for the analytical recovery associated with the particular type of sample before the remaining residue was calculated.

Commodity and fortification level, mg/kg	Coarsely ground matrix		Finely ground matrix	
	Storage period	% of initial residue remaining	Storage period	% of initial residue remaining
Dry beans, 0.50 mg/kg	0 days	91	0 days	79
	14 days	96	5 days	95
	1 month	97	12 days	95
	3 months	81		
	4 months	85		
Frozen corn, 0.50 mg/kg	0 days	83	0 days	85
	14 days	97	5 days	103
	1 month	102	12 days	101
	3 months	95		
	4 months	95		
Lettuce, 0.50 mg/kg	0 days	113	0 days	97
	14 days	94	5 days	103
	30 days	107	12 days	117
	60 days	84		
	90 days	55		
Raw potato, 0.50 mg/kg	0 days	99	0 days	92
	14 days	84	5 days	72
	1 month	64	12 days	76
	3.5 months	47		
Raw tomato, 0.50 mg/kg	0 days	100	0 days	97
	14 days	104	5 days	103
	1 month	105	12 days	97
	3 months	93		
	6 months	89		
Meat, 0.10 mg/kg	0 days	102	0 days	101
	14 days	108	5 days	112
	1 month	106	12 days	108
	3 months	95		
	6 months	110		
Milk, 0.10 mg/kg	0 days	94		
	14 days	97		
	1 month	106		
	3 months	95		
	6 months	96		

Residues in the edible portion of food commodities

Residues of dithiocarbamates in citrus fruit treated with mancozeb were mainly in the peel (Table 12). In Japanese trials with mancozeb on "summer" citrus and mandarins, residue levels in the pulp were either undetectable (<0.004 mg/kg, as CS_2), or amounted to an average of 2.8% of the levels in the peel. ETU residues in the pulp were generally undetectable (<0.01 mg/kg), but in some cases reached about 10% of the level in the peel.

Washing mandarins and oranges treated with mancozeb (in Spanish trials) removed on average 89% of the dithiocarbamate residues (Table 12).

Dithiocarbamate residues were mostly undetectable (<0.03 mg/kg, as CS_2) in orange juice produced from oranges sprayed with mancozeb (Brazil), and were on average less than 10% of the levels in the oranges (Table 12). ETU residues were mostly undetectable (<0.01 mg/kg) in both oranges and juice.

Dithiocarbamate residues in the pulp of lemons, limes and oranges from supervised mancozeb trials in the USA were approximately 7% of the levels in the whole fruit (Table 13). The samples were taken on the day of the final spray application and the results may have reflected pulp residues arising from previous applications, with whole fruit residues present in all samples. ETU residues in the pulp were on average 17% of the levels in the whole fruit.

ETU residues in apple sauce were approximately 2-4% of the mancozeb levels (as CS_2) in the apples (Germany, Table 16) and those in pear compote were less than 2% of the mancozeb levels (as CS_2) in the pears.

In the commercial processing of apples (Table 63) washing removed 30-50% of the mancozeb residues. Most (90%) of the remaining mancozeb went into the fraction containing the peel. Neither mancozeb (<0.1 mg/kg as CS_2) nor ETU (<0.03 mg/kg) was detected in clarified apple juice produced from apples containing mancozeb at 2.5 and 3.8 mg/kg (as CS_2). Mancozeb residues were carried through the process into the wet apple pomace with dithiocarbamate levels 3-6 times those in the washed apples.

In another processing trial on mancozeb-treated apples (Table 64), where washing was apparently not included, dithiocarbamate residues in the juice were on average 18% of the levels in the apples. There was no conversion to ETU.

Residues of dithiocarbamates were mostly undetectable (<0.05, <0.1, <0.25 mg/kg) in wine produced from mancozeb-treated grapes in France and Italy (Tables 23, 24). ETU was also not detectable (<0.01 or <0.02 mg/kg) in wine produced from these grapes.

De-stemming and cleaning removed an average of about 70% of the mancozeb residues from bunches of grapes (Table 65). Dithiocarbamate residues were not detectable (<0.1 mg/kg as CS_2) in clear grape juice produced from de-stemmed grapes containing 3.4-20 mg/kg as CS_2. Residue levels in thick juice averaged about 40% of the levels in the de-stemmed grapes, but with wide variation. Dithiocarbamate residues were not detectable (<0.1 mg/kg as CS_2) in grape jelly.

ETU was generated in the production of clear grape juice (14%), thick juice (18%) and jelly (20%). Estimated mean conversion yields of mancozeb in the de-stemmed grapes to ETU in the final product are shown in parentheses, with the assumption that 1 kg of product was derived from 1 kg of grapes.

Mancozeb residue levels in dried raisins were on average 3 times as high as in the raw grapes, mainly owing to the reduction in moisture. Conversion to ETU was 1% or less.

Less than 1% of the dithiocarbamate residue in mancozeb-treated grapes reached the red and white wines produced from them (Table 66). About 7% conversion to ETU occurred during wine production. Dithiocarbamate residue levels in raisins were about 20-50% of the levels in the grapes. No ETU was generated in raisin production.

Mancozeb residues were lost during the production of raisins which were dried in the sun for 13 days and then cleaned (Table 67), although the mean residue levels in the raisins were 120% of the levels in the grapes owing to the loss of moisture. No ETU was generated in this process.

In Australian banana trials (Table 26) dithiocarbamate residues were not detected (<0.1 mg/kg as CS_2) in the pulp. ETU was not detectable (<0.1 mg/kg) in the peel or the pulp.

Washing reduced mancozeb residues in papayas by 50% (USA, Table 27) but did not influence ETU residue levels. Mancozeb residues in the pulp were 35-40% and ETU residues were 35% of the levels in the whole fruit.

Mancozeb residues in frozen corn and canned corn were less than 10% of the levels in the raw sweet corn whole ears (Table 68). ETU was not generated in the products.

In a tomato processing trial 50% or more of the mancozeb residues were removed by a 30-second water spray wash (Table 69). Dithiocarbamate residues were undetectable (<0.1 mg/kg as CS_2) in canned tomato juice and tomato pomace produced from tomatoes with residues of 0.2 and 0.5 mg/kg. Conversion to ETU occurred in the production of canned tomato juice (20-50%). The estimated yield of ETU is shown in parentheses and was calculated with the assumption that 1 kg of washed rinsed tomatoes produced 1 kg of juice.

The commercial washing of tomatoes removed more than 90% of the mancozeb residues (Table 70), which were then not detectable (<0.03 mg/kg as CS_2) in tomato juice or pomace. ETU residues in the juice were of the same order as dithiocarbamate residue levels in the washed tomatoes.

Dithiocarbamate residues were essentially not detectable (<0.1 mg/kg as CS_2) in potatoes field-treated with mancozeb at an exaggerated application rate or in the processed potato products, except chips and flakes (Table 72). ETU was detected in potato granules (0.08 mg/kg) and flakes (0.23 mg/kg) produced from potatoes containing less than 0.1 mg/kg dithiocarbamate residues as CS_2.

Dithiocarbamate and ETU residues were undetectable (<0.03 and <0.01 mg/kg respectively) in white sugar produced from sugar beet containing dithiocarbamate residues of 0.14 and 0.16 mg/kg, as CS_2 (Table 73).

Mancozeb was undetectable in bran and flour from milled barley; the detection limit was less than 7% of the level in the cleaned grain. Cleaning the grain prior to milling reduced the residue level by 70% (Table 74).

In wheat milling and baking trials (Table 75) dithiocarbamate residues in the bread were either undetectable or, on average, 30% of the levels in the grain. ETU was not detectable in the bread.

Mancozeb was used on hops in two German trials (Table 45), leading to dithiocarbamate residues in the dry hops of 2.2 and <1 mg/kg. ETU levels in the beer produced using the hops were 0.04 and 0.02 mg/kg respectively.

Typical consumer practices were shown to reduce mancozeb residue levels in potatoes, tomatoes, apples and onions (Table 76). Residue levels in potatoes subjected to washing, brushing, drying and peeling were reduced by 97%. Residues in tomatoes and apples after washing and drying were reduced by 80% and 65% respectively. Residues in onions were reduced by 95% on peeling.

RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

In a US Food and Drug Administration monitoring programme a variety of baby foods (864 samples) were monitored for pesticide residues (Yess *et al.*, 1993). ETU residues were detected in 65 samples as follows: baked goods (1 of 29 samples), cereals (6 of 56), combination meat dinners (0 of 103), combination poultry dinners (0 of 72), desserts (9 of 70), fruits and fruit juices (38 of 310), infant formulas (0 of 48) and vegetables (11 of 167). The highest levels detected were 0.06 mg/kg.

A large survey of food items in the USA in 1989-90 for dithiocarbamate and ETU residues was conducted by the four US registrants (Slesinski, 1990). Approximately 300 samples of each of 19 different raw and processed food commodities were collected according to a statistically designed protocol at biweekly intervals at urban, suburban and rural grocery stores across the USA. Attention was paid to analytical methods to achieve limits of determination for ethylenebis(dithiocarbamate)s and ETU of 0.003 mg/kg (as CS_2) and 0.001 mg/kg respectively. The survey was conducted according to GLP. The results are summarized in Table 80.

Most of the samples (91% of 5241 samples apart from broccoli and onions, which were excluded because of endogenous CS_2 generation, did not contain measurable dithiocarbamate residues. No measurable residues of ETU were found in 82% of the samples.

Weighted means were calculated taking into account the percentage of the crop which might theoretically have been treated, the distribution of the grocery stores and their commodity volumes, and assigining residues of half the LOD to residue levels which were below that limit.

Table 80. Summary of US survey of food items for dithiocarbamate and ETU residues in 1989-90 (Slesinski, 1990).

Commodity	No. of samples	Dithiocarbamates (as CS_2)			ETU		
		No. with residues >LOD	Range, mg/kg	Weighted mean, mg/kg	No. with residues >LOD	Range, mg/kg	Weighted mean, mg/kg
Green beans, raw	22	1	<0.01-0.018	0.003	0		0.002
Green beans, frozen	26	0		0.002	0		0.002
Green beans, canned	13	0		0.002	0		0.002
Green beans, infant	13	0		0.002	3	<0.01-0.04	0.006
Dry beans	311	0		0.002	0		0.0014
Dry beans, canned	296	0		0.002	0		0.0011
Broccoli, raw	306	306	0.027-1.6	0.26	6	<0.0025-0.015	0.0013
Broccoli, frozen	298	99	<0.01-0.62	0.014	23	<0.0025-0.094	0.0028
Celery	26	7	<0.01-0.19	0.017	1	<0.01-0.024	0.002
Corn, raw	296	0		0.001	6	<0.005-0.013	0.0006
Corn, frozen	298	1	<0.01-0.016	0.001	0		0.0005
Corn, canned	297	0		0.001	2	<0.005-0.028	0.0006
Cucumbers	317	60	<0.01-0.45	0.013	70	<0.0025-0.053	0.0040
Lettuce	306	10	<0.01-0.79	0.010	4	<0.0025-0.013	0.0014
Onions	345	334	<0.01-0.31	0.10	94	<0.0025-0.043	0.0031
Potato, raw	316	7	<0.003-0.13	0.001	104	<0.002-0.045	0.0021
Potato, frozen	298	5	<0.003-0.004	0.0013	180	<0.002-0.023	0.0044
Tomatoes, raw	316	205	<0.003-0.25	0.016	146	<0.002-0.034	0.0027
Tomato juice	298	16	<0.005-0.015	0.001	74	<0.002-0.022	0.0015
Tomato ketchup	298	6	<0.005-0.031	0.001	94	<0.002-0.017	0.0016
Tomato paste	298	14	<0.01-0.17	0.004	170	<0.002-0.098	0.0061
Tomato puree	298	13	<0.005-0.011	0.001	108	<0.002-0.029	0.0031
Meat	298	19	<0.001-0.004	0.0001	0		0.000005
Milk	298	41	<0.001-0.002	0.0002	0		0.000005

Grape juice samples (100) were taken from major grape juice producers in the USA to determine likely dithiocarbamate and ETU residues in juice commercially processed from grapes grown where dithiocarbamate fungicides had been used on the 1990 crop (Honeycutt, 1991). The sampling plan aimed at a representative sample of the juices.

Samples were analysed for dithiocarbamates (limit of determination 0.01 mg/kg as CS_2) and ETU (limit of determination 0.005 mg/kg). ETU was not detected in any of the samples. Dithiocarbamate residues (as CS_2) were detected in 92 samples. The median value was approximately 0.022 mg/kg as CS_2. Residue levels in 46 of the samples fell in the 0.02-0.05 mg/kg range, 45 samples had residues up to 0.02 mg/kg, and 9 above 0.05 mg/kg.

If the dithiocarbamates were ethylenebis(dithiocarbamate)s, ETU should also have been detected because the production of grape juice involves several heating steps: 2 hours at 60°C during pressing and juice filtration, 1 minute at 88°C for filtered juice pasteurisation and again during filling, and finally 4-5 minutes at 74-77°C after bottling. There was some suggestion that ferbam, a dithiocarbamate fungicide which does not generate ETU, may have been the source of some of the dithiocarbamate residues.

A further 17 samples of grape juice produced from grapes from districts in the USA where dithiocarbamates were not used contained no detectable residues of dithiocarbamates or ETU.

In an Australian study, samples of tomatoes and commercially processed tomato products were analysed for ETU residues (Dukes, 1991; Zalewski and Edwards, 1992). In all samples ETU levels were less than the limit of determination (0.1 mg/kg). The numbers of samples included in the study were tomatoes 7, tomato paste 30, and thin pulp 4.

METHODS OF RESIDUE ANALYSIS

Methods for dithiocarbamates rely on the generation of CS_2, which can be measured by GLC or by colorimetry.

The methods used in the survey of US food items by Slesinski (1990) for ethylenebis(dithiocarbamate) residues in crops, processed commodities, meat, and milk were described by Westberg (1989a-c). The methods rely on the formation of CS_2 from dithiocarbamate residues during reaction with hydrochloric acid + stannous chloride at 100°C in a sealed reaction flask. CS_2 is then measured by GLC headspace analysis (flame-photometric detector). Calibration relies on an ethylenebis(dithiocarbamate) standard similarly prepared and injected.

The laboratory sample (wet and dry crops, meat) was chopped or ground while frozen with dry ice. Frozen milk was quick-thawed to a slush using a cold water bath. The analytical portion (4 g for crops, 10 g for meat, 20 g for milk) was placed in the reaction flask for CS_2 generation. Samples had to be kept frozen at all times until the addition of the reagent, including during weighing (samples kept on dry ice before and after weighing). The detection limit for dithiocarbamates (as CS_2) was 0.01 mg/kg in crops and 0.001 mg/kg in meat and milk.

Rogers *et al.*, (1989a-c) described methods used in the Slesinski (1990) survey for ethylenethiourea in crops, meat and milk. ETU was extracted from the sample with water (pH adjusted to 11-12 with ammonia) + ethanol or methanol, the extract was cleaned up on an alumina column, and the ETU was determined by HPLC.

Samples of crops or meat were ground while frozen with dry ice. Milk was thawed to a slush for weighing. Samples must be kept frozen until the extraction solvent is added. All glassware that comes into contact with extracts or ETU solutions must be silanized. Determination was by HPLC with electrochemical detection.

Loftus (1990a) assembled the validation data for these methods. Dithiocarbamate recoveries were tested with celery, snap beans, dry beans, frozen corn and potatoes fortified with mancozeb at 0.02, 0.2 and 2.0 mg/kg, tomatoes fortified at 0.005, 0.01 and 0.02 mg/kg, and meat and milk at 0.002, 0.005 and 0.02 mg/kg. The work was distributed among three laboratories. Recoveries exceeded 70% except from dry beans (55-62%) and frozen corn (67-73%), both analysed in the same laboratory.

ETU recoveries were tested with celery, snap beans, dry beans and corn fortified with ETU at 0.01, 0.1 and 1.0 mg/kg, potatoes, tomatoes and tomato paste fortified at 0.002, 0.005 and 0.01 mg/kg, and meat and milk fortified at 0.001, 0.003 and 0.01 mg/kg. Recoveries exceeded 70% except from meat (67-74%).

There was some evidence that ethylenebis(dithiocarbamate) residues could be converted to ETU during analysis, with estimated conversion rates of 0.22-8.5%. Experimental techniques which minimize the time taken to perform critical steps and ensure that reagents such as HPLC-grade water do not degrade the dithiocarbamates are needed to reduce the conversion.

Bulb onions (Pennwalt study BR-88-15) and broccoli (Pennwalt study BR-89-09, and Rohm and Haas data) were shown to contain endogenous CS_2 or compounds which produced CS_2 in the dithiocarbamate analytical method. Twelve samples of bulb onions (10 varieties, from 10 sites in the USA) certified not to have been treated with dithiocarbamates showed, on analysis, CS_2 residues ranging from undetectable (<0.03 mg/kg) to 0.13 mg/kg, with a median of 0.05 mg/kg. The CS_2 in eight samples of broccoli (6 varieties, from 6 sites in the USA), certified as not treated with dithiocarbamates, ranged from undetectable (<0.01 mg/kg) to 0.79 mg/kg, median 0.32 mg/kg.

Kallio and Salorinne (1990) reported carbon disulphide as one of the 27 volatile compounds identified by headspace GC-MS of onions.

Larese (1988a) analysed bananas for dithiocarbamate residues by boiling the sample with dilute acid to release CS_2, which was carried by an air stream into an ethanol trap at dry-ice temperature. The CS_2 was measured by GLC with flame-photometric detection in the sulphur mode. This method was used in the US supervised residue trials on bananas and wheat.

An earlier method (Keppel, 1971) measured the trapped CS_2 colorimetrically with a cupric acetate/diethanolamine reagent. It was used in the US supervised residue trials for the analysis of almonds, asparagus, bananas, carrots, celery, cucumbers, oranges, peanuts, potatoes, summer squash, tomatoes, wheat and winter squash.

Larese (1988b) extracted ETU from bananas with methanol, and cleaned up the extract on an aluminium oxide column. The ETU was derivatised with bromobutane to form butyl-ETU, which was determined by GLC with flame-photometric detection in the sulphur mode. The method was used in the US supervised trials to analyse almonds, asparagus, bananas, celery, cucumbers, oranges, peanuts, potatoes, tomatoes, and wheat.

Australian residue analyses were by methods for dithiocarbamates (Shields, 1990e) and ETU (McCarthy, 1990), similar to those described by Westberg (1989a) and Rogers *et al.*, (1989a).

Shields (1990e) described a GLC method for measuring the carbon disulphide evolved from dithiocarbamate residues. Samples were cut up and representative portions (100 g) taken for analysis. The maceration of crop samples was not recommended because contact between plant acids and dithiocarbamates may cause loss of residues.

Carbon disulphide was generated in a hydrolysis flask by treating the sample with 40% stannous chloride in hydrochloric acid under reflux. The evolved carbon disulphide was swept by a current of air into an ethanol trap maintained at a low temperature in a dry-ice/acetone trap. The ethanol solution was then analysed for CS_2 in a gas chromatograph equipped with a flame-photometric detector (S filter).

Recoveries of mancozeb from the trial crops were in the range 55-115%, mean 84% (n = 38).

McCarthy (1990) described an HPLC method for ETU residues in plant material. The sample was mixed with the anti-oxidant cysteine hydrochloride and extracted with water (adjusted to pH 11-12 using concentrated ammonia) and methanol. The extract was filtered and the filtrate reduced in volume by rotary evaporation. Clean-up was effected by absorption of the aqueous concentrate into 10 g of GLC column support material followed by elution of the ETU from this material with methanol/chloroform through a small alumina column.

The solvent was removed and the residue taken up in water for HPLC analysis with UV detection. The ease of oxidation of ETU and danger of loss of residues were stressed. Precautions such as the use of silanized glassware and the addition of the anti-oxidant were needed. Recoveries were in the range 44-137%, mean 81% (n = 9).

Mellet (1993a, and related reports) described the method used for measuring the dithiocarbamate residues in the French trials. The analytical sample was treated with stannous chloride in hydrochloric acid under hot conditions to liberate carbon disulphide, which was swept with a current of air into an absorption trap containing a colorimetric reagent (diethanolamine and cupric acetate). The absorbance of the coloured solution was measured at 435 nm. Known amounts of mancozeb were run through the procedure to establish the calibration.

Recoveries were determined and controls analysed with each crop in the residue trials. Some types of sample can give a false response if they contain sulphur compounds which generate CS_2 during the hydrolysis step, or if they give a false colour with the reagent. Some examples are discussed in the section on supervised trials.

A UK Panel on the Determination of Dithiocarbamate Residues (1981) examined the headspace method for dithiocarbamate residues in lettuce. The Panel drew attention to the loss of residues which can occur between beginning to cut the sample and inserting it into the reaction bottle. Vegetables and fruits must be analysed as soon as possible after cutting or picking, and any further cutting or dicing of the whole commodity should be carried out immediately before placing in the reaction flask, and should be kept to a minimum. Foodstuffs should be frozen whole, when this becomes necessary, and chopped and mixed in the frozen state immediately before taking the analytical samples.

It should be noted that the previously described freezer storage studies on spiked homogenised samples showed that mancozeb residues were stable under freezer conditions, but the evidence suggests that if storage is necessary samples should be frozen whole.

Onley *et al.*, (1977) reported a method for ETU residues in crops and food, which minimized the conversion of ethylenebis(dithiocarbamate) residues to ETU. Extracts were cleaned up by adsorption on GLC column support material and alumina. The final determination of ETU was by HPLC or GLC (as the S-butyl derivative). TLC was used for additional identification. Collaborative testing of the method was reported by Onley (1977). The HPLC method was used to determine the ETU residues in US supervised trials on carrots, celery, summer squash and winter squash.

Krause (1989) extracted ETU with a methanol/aqueous sodium acetate solution and cleaned up the extract on a diatomaceous earth column. The final analysis was by HPLC on a graphitized carbon column with electrochemical detection. The limit of determination was 0.01-0.02 mg/kg. Celery samples showed low recoveries.

Doerge and Miles (1991) extracted and cleaned up ETU residues in crop samples by the method of Krause (1989), and used particle beam liquid chromatography/mass spectrometry for quantitative determination and positive identification of ETU down to 5 ìg/kg.

NATIONAL MAXIMUM RESIDUE LIMITS

The Meeting was aware that the following national MRLs had been established.

Country (residue definition)	MRL, mg/kg	Commodity
Australia (as CS_2)	0.01	potato
	*0.2	milks
	0.2	bulb onion, peanut
	*0.5	edible offal (mammalian), eggs, meat (mammalian)
	0.5	cereal grains
	1	banana, carrot, fruiting vegetables, cucurbits
	2	beans except broad bean and soya bean, broad bean (green pods and immature seeds), brassica (cole or cabbage) vegetables
	3	chard, fig, head lettuce, leaf lettuce, pome fruits, stone fruits, tomato
	5	celery, grapes
Canada (as zineb)	nr[1]	carrot, maize, onions, potato, sugar beet (sugar)
	4	cucumber, tomato
	5	celery
	7	apple, apricot, asparagus, beet, blackberry, blackeyed pea, blueberry, broccoli, Brussels sprouts, cabbage, cauliflower, cherries, collards, common bean, cranberry, currant, date, egg plant, gooseberry, grapes, green onions, guava, head lettuce, huckleberry, kale, kohlrabi, loganberry, mango, melon (not watermelon), mushrooms, mustard greens, papaya, peach, peanuts, pear, peas, pepper, plum, pumpkin, quince , radish, raspberry, rutabaga, spinach, squash, strawberry, turnip
Germany	0.2	potatoes
	2	asparagus, pome fruits, stone fruits, wine grapes
	25	hops
Mexico (mancozeb)	0.1	asparagus, corn grain, fresh corn

Country (residue definition)	MRL, mg/kg	Commodity
	0.5	bulb onions dry, cotton seed, garlic, green onions, onions, peanuts, potatoes
	2	beets, carrots, sugar beets
	4	bananas, cucumbers, melons, squash, summer squash, tomatoes, watermelons
	5	barley grain, celery, oat grain, rye grain, wheat grain
	7	apples, grapes, pumpkin
	10	papayas, pears, spinach
Spain (as CS_2)	0.2	cereals, potatoes, sugar beet
	3	apples, citrus fruit, medlars, olives, persimmon, stone fruit, vegetables
	4	grapes, hops, strawberries
USA (mancozeb)	0	papayas edible pulp
	0.1	asparagus, corn grain
	0.5	bananas pulp without peel, cotton seed, dry bulb onions, fresh corn, kidney, liver, peanuts, popcorn, potatoes, sweet corn
	1	barley flour, oat flour, rye flour, wheat flour
	2	carrots, sugar beets
	4	bananas, cucumbers, melons, summer squash, tomatoes
	5	barley grain, celery, corn fodder, corn forage, oat grain, rye grain, wheat grain
	7	apples, cranberries, grapes
	10	crab-apples, fennel, papayas, pears, quinces
	20	barley bran, barley milled feed, oat bran, oat milled feed, rye bran, rye milled feed, wheat milled feed
	25	barley straw, oat straw, rye straw, wheat straw
	65	peanut vine hay, sugar beet tops

[1] nr: residues up to 0.1 mg/kg are acceptable

APPRAISAL

Mancozeb, evaluated in 1967 and several times since, was scheduled for review in 1993 in the CCPR periodic review programme (ALINORM 93/24A, para 71).

The Meeting received extensive information on GAP, supervised residue trials, animal transfer studies, metabolic fate in farm animals and crops, fate during processing and storage, residues in food in commerce and at consumption, and methods of residue analysis.

When lactating goats were dosed with [^{14}C]mancozeb ([^{14}C]ethylenediamine) in the feed, most of the ^{14}C was excreted in the faeces and urine. Excretion levels reached a plateau by day 2. The concentration of ^{14}C in milk reached a plateau by day 3 at all dosing levels. Concentrations of ^{14}C were higher in liver and kidney than in the other tissues or organs, most of it being incorporated into natural products. The main metabolites identified in the kidney were glycine, *N*-formylglycine, ethylenediamine, *N*-acetylethylenediamine, ethyleneurea, ethylenethiourea (ETU) and ethylenebisisothiocyanate sulphide.

When laying hens were dosed with [^{14}C]mancozeb in the feed, most of the ^{14}C was excreted in the faeces. ^{14}C levels in whole eggs were still increasing at the end of the 7-day dosing period, but declined rapidly in eggs from a group of hens in which dosing was discontinued. Ethyleneurea was the identified metabolite present at highest levels in eggs and tissues. ^{14}C was present at higher levels in liver and kidney than in other organs or tissues. In the highest dosed group (equivalent to 36 ppm mancozeb in the feed) dithiocarbamate levels (as CS_2) by direct chemical analysis were muscle 0.02-0.04 mg/kg, liver 0.09 mg/kg, and eggs 0.007-0.02 mg/kg. ETU levels in the tissues of this group were either at or below the level of detection (0.007 mg/kg), and in eggs were 0.06 mg/kg. ETU levels in eggs were not detectable (<0.007 mg/kg) in the group dosed at the equivalent of 14 ppm.

Most of the ^{14}C was incorporated into the carbon pool, appearing in a range of natural products, when a tomato crop was treated with [^{14}C]mancozeb. Ethyleneurea was the major primary metabolite identified.

When a soya bean crop was treated with [^{14}C]mancozeb the primary metabolites identified in soya bean pods were 1-(2-imidazolin-2-yl)-2-imidazolidinethione, ethyleneurea, hydantoin and ethylenebisisothiocyanate sulphide. Much of the ^{14}C was incorporated into protein, lignin and oil.

In a sugar beet crop treated with [^{14}C]mancozeb, 1-(2-imidazolin-2-yl)-2-imidazolidinethione was the major primary metabolite to be identified. The total ^{14}C label was distributed 77% in the leaf and stem, and 23% in the root.

The primary metabolites identified in wheat which had received foliar applications of [^{14}C]mancozeb were ethyleneurea, ethylenediamine, ethylenebisisothiocyanate sulphide, 2-imidazoline and 1-(2-imidazolin-2-yl)-2-imidazolidinethione. Much of the ^{14}C was incorporated into carbohydrates.

Mancozeb is registered as a protective fungicide for use on citrus fruits, pome fruits, stone fruits, berries and other small fruits, tropical and subtropical fruits, bulb vegetables, root and tuber vegetables, Brassica vegetables, leafy vegetables, stalk and stem vegetables, fruiting vegetables, legume vegetables, cereals, tree nuts, oilseeds and miscellaneous crops in very many countries.

Typical spray concentrations for high-volume application of mancozeb were 0.15-0.20 kg ai/hl to a wide variety of crops in many countries, but higher concentrations were recommended in some cases. The application rate for high-volume application depended on the volume of spray per hectare required for the particular crop and the typical spray concentration.

The Meeting received extensive residue data from supervised trials on the following crops and commodities:

grapefruit (*USA*), lemons (*Spain, USA*), limes (*USA*), mandarins (*Japan, Spain*), oranges (*Australia, Brazil, Spain, USA*);

apples (*Australia, Austria, Belgium, Brazil, France, Germany, Hungary, Italy, Japan, Netherlands, UK, USA*), pears (*Australia, Brazil, France, Germany, Italy, Japan, USA*);

apricots (*Australia*), peaches (*Australia, Brazil*), plums (*Brazil, France*);

black currants (*UK*), cranberries (*USA*), grapes (*Australia, Brazil, France, Hungary, Italy, Japan, Portugal*), strawberries (*Japan, Spain*);

avocados (*Brazil*), bananas (*Australia, Brazil, Honduras, USA*), figs (*Brazil*), mangoes (*Australia, Brazil*), papayas (*USA*), passion fruit (*Australia*), persimmons (*Japan*);

garlic (*Brazil, France, Japan*), leeks (*France, Japan*), onions (*Australia, Brazil, Finland, Japan, Netherlands, USA*);

broccoli (*Brazil*), cabbage (*Brazil, Germany, Japan*), cauliflower (*Brazil, Spain*), Chinese cabbage (*Japan, Spain*);

cantaloupes (*USA*); cucumbers (*Australia, Brazil, France, Germany, Japan, Spain, USA*), gherkins (*Germany*), melons (*France, Germany, Japan*), pumpkins (*Australia, Brazil*), squash (*France, Japan*), summer squash (*Australia, France, USA*), watermelons (*Australia, Japan, USA*), winter squash (*USA*);

egg plants (*Brazil*), peppers (*Brazil, Spain*), sweet corn (*USA*), tomatoes (*Brazil, France, Germany, Italy, Japan, Netherlands, Portugal, Spain, USA*);

kale (*Brazil*), lettuce (*Spain*);

azduki beans (*Japan*), beans (*Australia, Brazil, France, Netherlands, *Spain*), French beans (*Brazil*), kidney beans (*Japan*), peas (*Brazil, France*);

beet (*Brazil*), carrots (*Australia, Brazil, France, Germany, USA*), lotus (*Japan*), potatoes (*Australia, Brazil, Finland, France, Germany, Italy, Japan, Netherlands, UK, USA*), sugar beet (*France, Italy, Japan*), yams (*Japan*);

asparagus (*France, USA*), celery (*USA*), chard (*Australia*), witloof (*France, Netherlands*);

barley (*Brazil, Netherlands, USA*), maize (*USA*), rice (*Brazil*), summer wheat (*Germany*), wheat (*Brazil, Canada, France, Spain, USA*), winter wheat (*Germany, Netherlands, UK*);

hops (*Germany*);

peanuts (*Australia, USA*), rape seed (*France, Netherlands*);

almonds (*USA*), cocoa (*Brazil*), coffee (*Brazil*),

barley straw (*Netherlands, USA*), maize fodder (*USA*), wheat straw (*Canada, France, Germany, Netherlands, UK, USA*);

almond hulls (*USA*), bean pods and foliage (*Australia*), bean straw (*Australia*), peanut foliage (*Australia*), peanut hay (*USA*), sugar beet leaves (*Italy, Japan, USA*).

Dithiocarbamate residues are expressed as mg CS_2 /kg throughout.

Mancozeb is used as a cover fungicide, often with the same spray concentrations for high-volume application, on a wide range of crops. Because the residue is on the surface and there is no translocation from foliage to fruits, residue levels are often similar on fruits of a similar size.

Mancozeb use patterns are common across the citrus fruits in each country. Spanish trials on mandarins (GAP spray concentration 0.32 kg ai/hl, PHI 15 days) produced dithiocarbamate residues up to 4.7 and 6.6 mg/kg at 14 days. For a similar use pattern on oranges, residues of dithiocarbamates were mostly less than 1 mg/kg (highest 1.3 mg/kg). Japanese trials showed that most of the residues are in the peel while the Spanish trials confirmed that washing the fruit generally removes 90% or more of the residue. The Meeting estimated maximum residue levels of 10 mg/kg and 2 mg/kg for mandarins and oranges respectively, based on mancozeb uses.

US trials on lemons, limes and oranges demonstrated that most residues of both dithiocarbamates and ETU were on the peel with little in the pulp. US data on citrus could not be evaluated because there was no US GAP.

Residue data and mancozeb GAP for apples were available from many countries. The mancozeb spray concentrations used in high-volume applications were quite similar in most countries (0.15-0.2 kg ai/hl). GAP information from France did not include a PHI so French data were evaluated according to the German GAP for pome fruit. Residues in apples above 1 mg/kg were recorded in trials in Australia, Austria, Brazil, Germany, Italy and the UK when mancozeb was used within GAP. The highest recorded residue exceeded 4 mg/kg. The Meeting estimated a maximum residue level of 5 mg/kg for apples.

Use patterns on pears were the same as on apples, with the highest recorded residue being 2.2 mg/kg. The Meeting recommended an MRL for pome fruit of 5 mg/kg for dithiocarbamates, based on mancozeb uses.

The number of trials on apricots, peaches and plums was inadequate to recommend MRLs. No data were available for cherries. The Meeting agreed to withdraw the MRL recommendations for cherries, peaches and plums.

Grape residue data were supplied from many countries. The highest residues from the main population of data were in the 2.1-2.8 mg/kg range (Italy) suggesting an MRL of 5 mg/kg. Australian trials produced residues higher than 20 mg/kg when mancozeb was used according to GAP, and residues seemed somewhat anomalous when compared with similar uses elsewhere. The Australian use pattern is currently under review; Australian residue data were not included in the current evaluation.

The number of trials on strawberries was inadequate to permit the estimation of a maximum residue level. The Meeting recommended the withdrawal of the strawberry MRL.

A consistent series of mancozeb trials on cranberries in the USA in 1985 and 1988 suggested an MRL of 5 mg/kg.

The highest residues in black currants from the UK mancozeb trials exceeded 5 mg/kg (5.1, 5.4 mg/kg). The Meeting estimated an MRL of 10 mg/kg for currants.

Residue data on bananas and mangoes are mutually supportive with similar uses leading to a similar range of residues. The Meeting estimated a maximum residue level of 2 mg/kg for bananas and mango. Data on papayas, where the use pattern permits harvest on the same day as application, suggested an MRL of 5 mg/kg. The number of trials for avocados, figs and passion fruit was too limited for recommendations.

Residue data on garlic were made available from trials in Brazil, France and Japan. Generally, residues were not detectable (<0.05 mg/kg and lower) as would be expected from a foliar-applied non-systemic fungicide. However, residues were detected in a control sample at 0.1 mg/kg, and the possibility should not be excluded that some varieties of garlic or some conditions of production and storage could generate endogenous CS_2 as in onions. Mancozeb trials on leeks in France and Japan were made available for evaluation. The highest residue of 0.30 mg/kg and the possibility of endogenous CS_2 (a control sample registered 0.21 mg/kg of CS_2) suggested a maximum residue level of 0.5 mg/kg for garlic and leeks.

Onion trials in Brazil, Japan, The Netherlands and the USA showed residues up to 0.17 mg/kg, with control samples in Japan at 0.12 mg/kg. The highest residues in onions were in an Australian trial at 1.7 mg/kg but appeared to be an order of magnitude higher than others and difficult to explain for an immobile residue such as mancozeb. The Meeting agreed to evaluate bulb onions, garlic and leeks as a group, and estimated a maximum residue level of 0.5 mg/kg for onions resulting from mancozeb use.

Residue data from trials on broccoli and cauliflower in Brazil in 1989 according to GAP were mutually supportive, and suggested a maximum residue of 0.2 mg/kg. Broccoli has, however, been shown to contain endogenous CS_2. In a US study 8 samples of broccoli (6 varieties, 6 sites in the USA) certified to be untreated with dithiocarbamates, on analysis contained CS_2 residues ranging from undetectable (<0.01 mg/kg) to 0.79 mg/kg, median 0.32 mg/kg. The Meeting had no information on endogenous CS_2 levels in cauliflower. It did not estimate a maximum residue level for broccoli or cauliflower because of the limited number of trials. The Meeting drew attention to the endogenous CS_2 levels in broccoli and possible endogenous CS_2 in related crops.

The highest residue in cabbages from trials according to GAP in Brazil and Japan was 0.22 mg/kg. Chinese cabbage from trials in Japan contained residues of 0.1 mg/kg in the untreated control, again suggesting endogenous CS_2 in the various Brassica vegetables. The Meeting was unable to recommend MRLs for cabbage or Chinese cabbage because of the limited data.

Cucumber residue data from trials according to GAP were supplied from Australia, Brazil, France, Japan and the USA, with residues up to 0.3 mg/kg in US trials. The Meeting estimated a maximum residue level of 0.5 mg/kg for cucumbers, based on mancozeb uses.

Residues in melons from the same use patterns were generally in the same range as in cucumbers. The Meeting recommended an MRL of 0.5 mg/kg for melons except watermelon.

There were only two trials on pumpkins according to GAP, one from Australia and one from Brazil, but residues were generally consistent with those in other cucurbits. The Meeting estimated a maximum residue level of 0.2 mg/kg for pumpkins.

Summer squash in trials in Australia, France and the USA showed residues from undetectable levels to 0.83 mg/kg, the last in a US trial where the harvest took place on day 4 after the last application. Residues would have been higher than on day 5 (the recommended PHI), but the level on day 10 was still 0.65 mg/kg. The Meeting estimated an MRL of 1 mg/kg for summer squash.

US data on winter squash could not be evaluated because no US GAP was available. Residues in squash in trials in France and Japan were quite similar, even though there was quite a difference in the use patterns, with PHIs of 3 and 30 days in France and Japan respectively. The Meeting estimated an MRL of 0.1 mg/kg for winter squash.

A US watermelon trial with mancozeb used 12 applications, but this would probably have little influence on the residues since US GAP allows a maximum of 8. The residue level on day 5 after the final treatment was 0.38 mg/kg. In the Australian trials residues were not detected (<0.1 mg/kg), and in the Japanese trials residues were measured on the watermelon pulp rather than the whole fruit. Residues in the pulp were at quite low levels, 0.01-0.02 mg/kg. The Meeting estimated a maximum residue level of 0.5 mg/kg, based on mancozeb uses on watermelon.

When mancozeb was used according to GAP on peppers in Brazil and Spain the highest residues were in the 0.5-0.6 mg/kg range. The Meeting recommended an MRL of 1 mg/kg for sweet peppers.

Sixty-eight trials with mancozeb on tomatoes were available from many countries. Many of the measured residue levels were in the 0.1-1 mg/kg range, but residues up to 4.1 mg/kg were recorded in the US trials. The Meeting recommended an MRL of 5 mg/kg for tomatoes.

US trials on sweet corn showed that dithiocarbamate residues were on the husk rather than in the kernels. Residues were not detected (<0.03 mg/kg) in the cob + kernels. Additional data were available from US processing studies where application of mancozeb at the recommended US rate produced undetectable residues (<0.03 mg/kg) in cob + kernels. The residue level was 0.03 mg/kg when mancozeb was used at 5 times the recommended rate. Mancozeb, an immobile residue, would not be expected in the cob and kernels, which are protected by the husk from direct application. The Meeting recommended an MRL for sweet corn of 0.1* mg/kg as being a practical limit of quantification.

In supervised mancozeb residue trials on kale in Brazil dithiocarbamate residues 14 days after the last application were 0.95 and 1.0 mg/kg for label rate and double label rate of application, but the number of trials was too limited to allow the estimation of a maximum residue level.

When lettuce was sprayed with mancozeb at 0.16 kg ai/hl in trials in Spain and harvested 14 days after the final application residues in the 3-10 mg/kg range were found. The Meeting estimated a maximum residue level of 10 mg/kg for mancozeb use on head lettuce.

Trials in Japan on adzuki beans and kidney beans, and in Brazil on beans and French beans generally demonstrated undetectable or low residues on bean seeds, but the LOD for some of the older results was too high to be useful. The Meeting was unable to recommend an MRL for dry beans because of the limited data. It was not completely clear whether the commodity analysed in the Brazilian trials on peas included peas + pods, or peas only. The Meeting did not recommend an MRL for beans or peas.

Information on mancozeb residues in beetroot from trials in Brazil was made available, but the number of trials was insufficient to recommend an MRL.

Most residue levels in carrots arising from approved uses of mancozeb were less than 0.2 mg/kg, but a number of values were found in the 0.5-1 mg/kg range in the Brazilian trials. The Meeting estimated a maximum residue level of 1 mg/kg for carrots.

Dithiocarbamate residues were not detected (<0.02 mg/kg) in East Indian lotus in two trials from Japan, but the data were insufficient to estimate a maximum residue level.

One hundred and seventeen mancozeb potato trials, but many not within GAP, were available from 9 countries for review. Residues were mostly undetectable even when mancozeb had been used at exaggerated application rates. Residues were sometimes detected, and the residues are more likely to depend on the inadvertent spraying of exposed potatoes than on the application rates or pre-harvest intervals. The highest residues were found in a French trial at 0.32 mg/kg and a German trial at 0.26 mg/kg, but they appeared exceptional when compared with all the other results. The Meeting estimated a maximum residue level of 0.2 mg/kg for uses of mancozeb on potatoes.

Dithiocarbamate residues from sugar beet trials in France, Italy and the USA were mostly around 0.1 mg/kg or lower, but residues in the 0.2-0.4 mg/kg range were recorded in US trials. The Meeting recommended a maximum residue level of 0.5 mg/kg for mancozeb use on sugar beet.

The US use pattern for mancozeb on asparagus requires a long PHI, 120 days in some states and 180 days in others. As expected, residues were low after this interval in the US trials. The French trials on asparagus could not be evaluated because no information on the French PHI was available. The Meeting recommended a maximum residue level of 0.1 mg/kg for asparagus.

No US GAP for mancozeb uses on celery was available to permit evaluation of US trials. Only one trial on chard according to GAP was available, from Australia, and this was insufficient in the absence of data from other similar vegetables which could have provided mutual support. Witloof trial data from France and The Netherlands could not be evaluated in the absence of GAP information.

Results of barley trials in Brazil, The Netherlands and the USA were made available to the Meeting. Dithiocarbamate residues up to 0.55 mg/kg were recorded in the US trials, and an MRL of 1 mg/kg for barley is recommended.

Results of a large number of mancozeb trials on wheat were supplied from 8 countries. The highest dithiocarbamate residues were recorded from trials in France (0.26 mg/kg), Germany (0.4 mg/kg), The Netherlands (0.82, 0.75 and 0.49 mg/kg) and the UK (0.42, 0.5 mg/kg), but in many of the trials residues were not detected. The Meeting estimated a maximum residue level of 1 mg/kg for mancozeb uses on wheat.

The PHI for the use of mancozeb on maize in the USA is 40 days; most of the residue data in the supervised trials were from shorter treatment-to-harvest intervals, and so could not be evaluated. In two trials where the longer interval was observed the commodity analysed was the "ear". Presumably this is the cob + grain. The appropriate commodity for a maize MRL is the grain.

Data from two supervised trials on rice according to the conditions of Brazilian GAP were made available to the Meeting. The data suggest a maximum residue level of 2 mg/kg, but trials covering a wider range of conditions are desirable for such an important crop. Also, if dithiocarbamate residues in this range or higher are likely, information on their fate during milling and cooking is desirable.

Two German trials with mancozeb on hops led to dithiocarbamate levels in dry hops of 2.2 and <1 mg/kg, but the information was too limited to permit the estimation of a maximum residue level.

Dithiocarbamate residues were not detected (<0.1, <0.03 mg/kg) in peanuts in Australian and US trials even when exaggerated application rates were employed. An MRL of 0.1* mg/kg was recommended.

Residues were detected in almonds in an Australian trial at the recommended application rate, but not at twice this rate. Because mancozeb is a surface residue only it is likely that any residues detected in the kernel were physically transferred during the cracking process. In the US trials dithiocarbamate residues were present in the almond hulls at 3 mg/kg, but no residues were detected (<0.03 mg/kg) in the almonds. The Meeting estimated a maximum residue level of 0.1* mg/kg for the use of mancozeb on almonds.

Mancozeb trials on cocoa and coffee in Brazil were insufficient for the Meeting to estimate maximum residue levels for cacao beans or coffee beans.

Residue data were available for wheat straw and fodder harvested at the same time as the wheat in the previously mentioned trials. Data on barley straw from trials in The Netherlands were also included for evaluation. Many of the residues were in the 2-5 mg/kg range but residues ranged up to 18 mg/kg. Two additional trials on barley with an identical use pattern were available from the USA, with residues of 24 mg/kg on barley straw from one of them. Wheat straw and barley straw should be assessed together for the same use pattern. The Meeting estimated maximum residue levels of 25 mg/kg for both. This level is compatible with animal commodity MRLs recommended on the basis of animal transfer studies.

Dithiocarbamate residues of 1.2 and 1.4 mg/kg were found in maize plants in two US trials 39 and 40 days after the final application of mancozeb. The Meeting estimated a maximum residue level of 2 mg/kg for maize fodder.

Dithiocarbamate residues up to 3.3 mg/kg on peanut foliage from previously mentioned Australian trials permitted the Meeting to estimate a maximum residue level of 5 mg/kg for peanut fodder. Data on almond hulls and peanut hay from US trials could not be evaluated because no US GAP was available for almonds and application rates on the peanuts were in excess of recommended rates.

When mancozeb was used on sugar beet crops according to US GAP, dithiocarbamate residues up to 17 mg/kg were found on sugar beet leaves. The Meeting estimated a maximum residue level of 20 mg/kg for sugar beet leaves or tops from mancozeb use.

Animal transfer studies with lactating dairy cows and laying hens were made available to the Meeting.

When dairy cows were fed a diet containing aged mancozeb residues equivalent to 5, 15 and 45 ppm mancozeb for 28 days dithiocarbamate residues were not detected (<0.04 mg/kg as CS_2) in the milk from any group. In the highest feeding group residues were not detected (<0.02 mg/kg,as CS_2) in muscle, while residues in the kidney and liver were 0.04 and 0.1 mg/kg respectively. The Meeting estimated maximum residue levels of 0.05*, 0.02* and 0.1 mg/kg for milks, meat and edible mammalian offal, respectively. These levels should accommodate animals eating 45 ppm mancozeb (25 ppm as CS_2) in the diet.

ETU residues were not detected (<0.01 mg/kg) in milk from the highest feeding group, but were detected in the thyroids of all the animals, with the highest doses causing the highest levels. ETU was detectable in muscle, liver and kidney of the highest feeding group, but had disappeared from the tissues of an animal returned to a residue-free diet for 7 days.

When laying hens were fed aged mancozeb residues (5, 15 and 45 ppm as mancozeb) for 28 days, dithiocarbamate residues were not detected (<0.04 mg/kg as CS_2) in the eggs from any feeding group. In the middle and highest feeding groups residues were 0.08 and 0.09 mg/kg (as CS_2) in muscle, while residues in the liver were 0.03 mg/kg. Measured residues in control samples were also around 0.03 mg/kg. The Meeting estimated maximum residue levels of 0.05*, 0.1 and 0.1 mg/kg for eggs, poultry meat and poultry edible offal, respectively.

ETU residues were detected in some eggs from the highest feeding group (0.01-0.02 mg/kg), but were not detected in tissues.

Processing studies were made available to the Meeting on apples, grapes, sweet corn, tomatoes, potatoes, sugar beet, barley, wheat, maize and peanuts.

In general, mancozeb residues (which are on the surface) can be substantially diminished by vigorous washing. The remaining residues tend to remain with the insoluble fractions, so that clear juices are unlikely to contain them. The remaining mancozeb residues may, however, be converted to ETU if processing includes a heating step.

In the commercial processing of apples, washing removed 30-50% of the residue, the remainder being carried through the process into the pomace. Neither mancozeb nor ETU residues were detectable in clarified apple juice.

De-stemming and cleaning removed about 70% of the mancozeb residues from bunches of grapes. Dithiocarbamate residues were not detectable in clear grape juice, but were present in the thick juice. ETU was generated in the production of the grape juices and jelly.

Less than 1% of the dithiocarbamate residues in mancozeb-treated grapes entered red and white wines produced from them. Approximately 7% conversion to ETU occurred during the wine production.

In one study mancozeb residue levels in dried raisins were on average 3 times as high as in the raw grapes, while in another study levels in the raisins were 20-50% of the levels in the grapes. No ETU was generated in raisin production.

Mancozeb residues in frozen corn and canned corn were less than 10% of the levels in the raw sweet corn whole ears; ETU was not generated in the process.

The commercial washing of tomatoes removed more than 90% of the mancozeb residues. Dithiocarbamate residues in the tomato juice and pomace produced from the washed tomatoes were undetectable. ETU residues in the juice were of the same order as the dithiocarbamate levels in the washed tomatoes.

Dithiocarbamate residues were essentially undetectable (<0.1 mg/kg) in potatoes field-treated with mancozeb at an exaggerated rate, and in the processed potato products. ETU was present in potato granules (0.08 mg/kg) and potato flakes (0.23 mg/kg).

Dithiocarbamate and ETU residues were not detected (<0.03 and <0.01 mg/kg respectively) in white sugar produced from mancozeb-treated sugar beet containing dithiocarbamate residues of 0.15 mg/kg.

The cleaning of barley grain prior to milling reduced residue levels by 70%. Mancozeb residues were not detectable in bran or flour.

Milling and baking trials on wheat harvested after foliar mancozeb applications showed that dithiocarbamate residues in the bread were either undetectable or, on average, 30% of the levels in the grain. ETU was not detectable (<0.01 mg/kg) in the bread.

Maize was field-treated with mancozeb and harvested for processing into meal, flour, germ, grits, crude oil, refined oil and soapstock.

Neither dithiocarbamates nor ETU were detected in the maize kernels or any of the products (<0.03 and <0.01 mg/kg respectively).

A peanut crop was field-treated with mancozeb and harvested for processing into meal, crude oil, refined oil and soapstock. Neither dithiocarbamates nor ETU were detected in the raw peanuts or any of the products (same limits as above).

The ETU level was 0.04 mg/kg in beer produced from mancozeb-treated hops (dithiocarbamates 2.2 mg/kg as CS_2).

Typical consumer practices were shown to reduce mancozeb residue levels in potatoes, tomatoes, apples and onions. Residues in potatoes subjected to washing, brushing, drying and peeling were reduced by 97%. Residues in tomatoes and apples subjected to washing and drying were reduced by 80% and 65% respectively. Residues in onions were reduced by 95% on peeling.

Mancozeb residues were stable (>70% remaining) in homogenised samples of apples, tomatoes and wheat stored for 2 years at -20°C. ETU residues were more labile; more than 70% of the ETU remained in tomato and wheat matrices after 12 months storage, but not after two years. ETU residues in an apple matrix had declined to less than 70% after 6 months storage and to less than 50% after 12 months.

Mancozeb residues were shown to be stable at -20 ± 5°C in stored analytical samples of dry beans, corn, lettuce, meat, milk, raw potato (marginal stability), and tomato. ETU residues were shown to be stable at -20 ± 5°C in stored analytical samples of dry beans, corn, lettuce (marginal stability), meat, milk, raw potato (marginal stability), and tomato.

Under a US Food and Drug Administration monitoring programme a variety of baby foods (864 samples) were monitored for pesticide residues. ETU residues were detected in 65 samples; the highest levels detected were 0.06 mg/kg.

In 1989-90 in the USA a large survey of food items (approximately 300 samples each of 19 different raw and processed commodities) was conducted for dithiocarbamate and ETU residues. Most of the samples (91% of 5241 samples) did not contain measurable dithiocarbamate residues (<0.003 mg/kg as CS_2); broccoli and onions were excluded because of endogenous CS_2 generation. No measurable residues of ETU (LOD 0.001 mg/kg) were found in 82% of the samples.

Grape juice samples (100), from major grape juice producers in the USA using grapes from districts where dithiocarbamates had been used on the 1990 crop, contained no detectable ETU residues (LOD 0.005 mg/kg). Dithiocarbamates were detected in 92 of the samples (median value approximately 0.022 mg/kg as CS_2). If the dithiocarbamates were ethylenebis(dithiocarbamate)s, ETU should also have been detected because the production of grape juice involves several heating steps. There was a suggestion that ferbam, a dithiocarbamate fungicide but not an ethylene-bis(dithiocarbamate), may have been the source of some of the dithiocarbamate residues.

In an Australian study in 1991, ETU residues were not detected (<0.1 mg/kg) in tomatoes, commercially produced tomato paste or thin pulp (41 samples).

Analytical methods for dithiocarbamates rely on the generation of CS_2, which can be measured by GLC or by colorimetry.

Reaction with hydrochloric acid + stannous chloride at 100°C is needed for quantitative conversion to CS_2, which can be analysed by head-space GLC. Alternatively, the evolved CS_2 can be swept by a current of air into an ethanol trap maintained at dry ice/acetone temperature, and the ethanol solution then analysed by GLC. In the colorimetric approach the evolved CS_2 is swept into a trap of cupric acetate/diethanolamine reagent. Some types of sample can give a false response by generating a false colour in the reagent.

A UK Panel on the Determination of Dithiocarbamate Residues (1981) drew attention to the loss of dithiocarbamate residues which can occur between commencement of cutting of the sample and insertion into the reaction bottle. Vegetables and fruits must be analysed for residues as soon as possible after cutting or picking, and any further cutting or dicing of the whole commodity should be carried out immediately before placing in the reaction flask, and should be kept to a minimum. Foodstuffs should be frozen whole, when this becomes necessary, and chopped and mixed in the frozen state immediately before taking the analytical samples.

ETU methods rely on HPLC or GLC for final analysis. Samples are typically extracted with aqueous ammonia (pH 11-12) + methanol or ethanol and the extract cleaned up on an alumina column. ETU is easily oxidised or lost during the analysis; precautions are needed, such as the use of silanized glassware. Precautions must also be taken to prevent ethylenebisdithio-carbamate residues from being converted to ETU during the analysis.

The Meeting was aware of national MRLs established in Australia, Canada, Germany, Mexico, Spain and the USA.

RECOMMENDATIONS

The recommendations for mancozeb are included under DITHIOCARBAMATES (105).

FURTHER WORK OR INFORMATION

Desirable

1. Supervised trials on rice covering a wider range of conditions.

2. Fate of mancozeb residues during the milling and cooking of rice.

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