BENOMYL (069)

[See also CARBENDAZIM (072)]

EXPLANATION

Benomyl was first evaluated in 1973, and the last evaluations were in 1994 (residues) and 1995 (toxicology and environmental). The present review is a re-evaluation under the Periodic Review Programme of the CCPR. Data on supervised trials with apricots, citrus fruits, pineapple, rice and tomatoes were to be provided for the 1998 JMPR The three main manufacturers compiled a joint submission to the present Meeting. As benomyl is metabolized in plants to carbendazim, much of the information on benomyl is reviewed in the monograph on carbendazim.

IDENTITY

ISO common name: benomyl

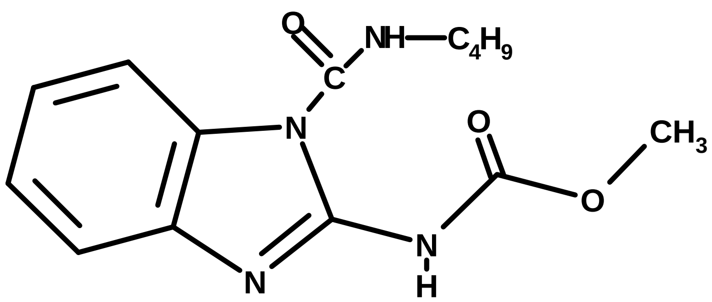
Chemical name

IUPAC: methyl 1-(butylcarbamoyl)benzimidazol-2-ylcarbamate

CA: methyl [1-[(butylamino)carbonyl]-1*H*-benzimidazol-2-yl]carbamate

CAS number: 17804-35-2

Structural formula



Molecular formula: $C_{14}H_{18}N_4O_3$
Molecular weight: 290.3

Physical and chemical properties

Pure active ingredient

Hydrolysis. Benomyl is degraded both by hydrolysis and elimination in aqueous solution, with faster degradation under alkaline conditions. The half-lives of benomyl in pH 5, 7 and 9 buffered solutions were approximately 3.5 hours, 1.5 hours and <1 hour, respectively (Wheeler, 1985). Benomyl is mainly hydrolysed to carbendazim at pH 5, while at pH 9 3-butyl-1,3,5-triazino[1,2a]benzimidazole-2,4(1*H*,3*H*)-dione (STB) is the main transformation product (Wheeler, 1985). At pH 7 the ratio of carbendazim to STB was about 3:1.

Photolysis was not a significant degradation pathway for benomyl in either buffered or natural water. In pH 5 buffered water the dark control solution showed similar degradation kinetics to the irradiated solution, so the degradation was due to hydrolysis rather than photolysis. Degradation was rapid, with a half-life of 4 hours. Carbendazim was the only significant degradation product, accounting for 99% of the initial radioactivity, with STB contributing the remaining 1% in both irradiated and control solutions. In natural river water benomyl was readily degraded to carbendazim which was not degraded further under the conditions of the study.

Technical material

Purity: Not reported

Melting point: Differential scanning calorimetry (DSC) analysis indicates that decomposition of benomyl technical occurs at about 100°C, but thermogravimetric analysis (TGA) indicates a temperature of about 80°C. TGA was with a relatively fast increase of temperature so the actual temperature at which decomposition starts to occur may be lower.

Relative density: The absolute density of technical benomyl was not reported. The bulk density is 449 kg/m^3.

Vapour pressure: <5.0 x 10^{-6} Pa at 25°C.

Colour: white
Physical state: crystalline solid
Odour: negligible

Spectra: benomyl technical, 98.3 or 95% pure, was used for the NMR, IR and mass spectra, and a benomyl analytical standard (unspecified purity) for the ultraviolet/visible spectrum.
NMR spectrum, chemical shifts, in ppm: 11.44 (a); 10.18 (b); 8.36-8.47 (c); 7.20-7.34 (d, e or f); 3.84(g); 3.48 (h); 1.69 (i); 1.49 (j) and 1.01(k).
Mass spectrum (CI): m/z 331, 319, 291, 259, 192 and 100.
IR spectrum: wave numbers, cm^{-1}: 1649.1 (urea carbonyl); 1724.4 (methyl carbamate carbonyl); 1462.0 (urea N-C-N asymmetric stretch); 1278.8 (methyl carbamate C-O-C stretch); 1620.2 and 1595.1 (imidazole C = N and C = C).
UV spectrum: maximum absorbance at 294 nm in acetonitrile.

Solubility at 25°C
water: 3.6, 2.9 and 1.9 µg/ml at pH 5, 7 and 9 respectively.
chloroform: 9.4 g/100g
dimethyl formamide: 5.3 g/100g
acetone: 1.8 g/100g
xylene: 1.0 g/100g
ethanol: 0.4 g/100g
heptane: 0.04 g/100g

Partition coefficient (n-octanol/water): 23.4 (not concentration-dependent)

Stability in air/photochemical degradation: not applicable owing to the low vapour pressure of benomyl.

Flammability: flammable solid (average time of combustion <45 seconds).

Auto-flammability: not applicable as the melting point of benomyl is >40°C.

Explosive properties: not impact-explodable.

Oxidising properties: on structural evidence, technical benomyl is not an oxidizer.

Stability: stable under normal, dry storage conditions. Subject to decomposition in the presence of moisture.

Formulations

The formulations registered for use internationally are Benlate (50 g benomyl/kg) for foliar and soil application and Benlate T (200 g /kg benomyl + 200 g/kg thiram) for seed treatment. Both are wettable powders.

[For information on the following see the monograph on carbendazim:

METABOLISM AND ENVIRONMENTAL FATE

METHOD OF RESIDUE ANALYSIS

STABILITY OF RESIDUES IN STORED ANALYTICAL SAMPLES]

USE PATTERN

Table 1 shows the registered uses of benomyl on the crops for which data were provided¸ as of February 1998.

Table 1. Registered uses of WP formulations of benomyl. Unless otherwise indicated, application is by foliar spray, from the ground and in the field. NA = not applicable (post-harvest use or seed treatment).

Crop	Country	Application			Mode of application	PHI. days
		Number	kg ai/ha	kg ai/hl		
Citrus fruit	Argentina	2	0.750-1.5			15
	Australia	1-3	1.5	0.025		NA
	Bolivia	1-3	1-1.5	0.05-0.07		15
	Brazil	2-3	-	0.025-0.050	8-10l/plant	1
	Chile	2	1.5-3.0			0
	Colombia	1-2/year		12.5		
	Ecuador	2	0.25	0.125		2
	France	1-3	0.9 - 1.12	0.03-0.042		2
	Indonesia	6	0.4	0.03-0.05		-
	Japan	1-4	0.51-1.25	0.017-0.025		7
	Mexico		1.0-2.0	0.001-0.0025		1
	New Zealand	1-2	0.5	0.0125		7
	Spain	3		0.03		14
	Thailand	-		0.187-0.562		NA
	Turkey			0.03		0

Crop	Country	Application			Mode of application	PHI. days
		Number	kg ai/ha	kg ai/hl		
	Uruguay	1-3	0.44-1.20	0.022-0.030		14
	USA	1-2	0.84-1.68	0.6-1.8		2
	Venezuela	1-2	-	0.5		-
	Korea	1-4	2.22-3.25	0.065		7
Orange	Japan	1-4	0.24-1.25	0.008-0.025		1
	Peru	2	0.05			-
Pome fruit	Argentina	-	0.250-.0.50	0.007-0.010		30
	Argentina	1	0.75	0.025		30
	Australia	1-3	1.5	0.025		
	Bolivia	1-3	0.2	0.01 -0.030		30
	Chile	1-4	0.9	15-25		0
	Germany	3	0.15	0.03		7
	Italy		0.03-0.05	0.03-0.05		15
	New Zealand	1-2	0.25	12.5		7
Apple	Brazil	4-8*	*	0.03		1
	Bulgaria	1-2	2.0	0.32		20
	Canada	every 7-14 days	0.275-0.55	0.025		1
	Cyprus	1-2	1.0-2.0	0.05		7
	France	1-4	0.15-0.45	0.03		7
	Greece			0.03-0.05		14
	Indonesia	3	0.6	0.2		-
	Japan	-		0.05	dipping	-
	Japan	1-6	0.51-1.75	0.017-0.025		7
	Korea	1-6	2.22-3.25	0.065		7
	Mexico		-	0.05-0.07		14
	Netherlands	1-2		0.025-0.03		14
	Portugal	2-6	0.20-0.30	0.020-0.030		7
	Turkey			0.03		14
	Uruguay	1-2	0.120-0.375	0.020-0.025		14
	Uruguay	1-3	0.21-0.75	0.035-0.050		14
	USA	6 -13	0.42	0.45		14
	Venezuela	1-2	-	0.075		-
	Yugoslavia	3	0.45	0.002-0.03		14
Pear	Bulgaria	1-3	4.5	1.5		20
	Canada	every 7-14	0.275	0.025		1
	Cyprus	1-2	1.0-2.0	0.05		7
	France	1-4	0.15-0.45	0.03		7
	Greece			0.03-0.05		14
	Japan	1-6	0.51-1.25	0.017-0.025		7
	Korea	1-6	1.75-3.25	0.05-0.065		7
	Mexico			0.05-0.07		14
	Netherlands	1-2		0.025-0.03		14
	Portugal	2-6	0.20-0.30	0.020-0.030		
	Turkey			0.03		14
	Uruguay	1-2	0.120-0.375	0.020-0.025		14
	Uruguay	1-3	0.21-0.75	0.035-0.050		14
	USA	3 - 6	0.42-0.84	0.9		14
	USA	NA	0.56	2.4	aerial	NA
	Yugoslavia	3	0.45	0.002-0.03		14
Stone fruit	Argentina	3	0.75-0.9			30
	Australia	1-2	2.0	0.025		NA
	Bolivia	1-3	0.7 - 0.9	0.06 -0.07		30
	Chile	3-4	1.5-2.25			0
	Cyprus	1-2	1.0-1.5	0.05		7
	Greece	2-4		0.01-0.03		14
	Italy	-	0.03-0.05	0.03-0.05		15
Apricot	Canada	2	0.425	0.025		2
	France	1-4	0.15-0.45	0.03		7

Crop	Country	Application Number	Application kg ai/ha	Application kg ai/hl	Mode of application	PHI. days
	Portugal	2-6	0.30-0.50	0.030-0.050		7
	Turkey			0.03		14
	USA	2-4	0.60-1.12	1.2		3
	USA	2-6	1.12	2.4	aerial	3
Cherries	Canada	1-2	0.425-0.875	0.025		1, 2, 5
	France	2-6	0.15-0.45	0.03		7
	Japan		0.51-1.19	0.017		14
	Netherlands	1-3		0..25		-
	Portugal	6	0.30-0.50	0.030-0.050		7
	Turkey	1-2		0.03		0
	USA	3-6	0.60-1.12	0.6-1.2		3
	USA	3 - 6	0.60-1.12	2.4	aerial	3
	Yugoslavia	3 - 6	0.45	0.03		42
Nectarine	Canada	2	0.425	0.025		2
	USA	2-4	0.60-1.12	1.2		3
	USA	2-6	1.12	2.4	aerial	3
Peach	Bulgaria	1-2	-	0.032		20
	Canada	2	0.425	0.025		2
	France	1-4	0.15-0.45	0.03		7
	Japan		0.51-1.25	0.017-0.025		3
	Mexico	1-2	0.0035-0.05	0.07-0.10		3
	Peru	1-3	0.05			-
	Portugal	2-6	0.30-0.50	0.030-0.050		7
	New Zealand	1-3	2.0	0.025		NA
	Turkey	1-2		0.03		14
	USA	2-4	0.60-1.12	1.2		3
	USA	2-6	1.12	2.4	aerial	3
	Venezuela		0.035	0.025		-
	Yugoslavia	2	0.45	0.03		21
Plum	Canada	2	0.425	0.025		2
	France	1-4	0.15-0.45	0.03		7
	Japan	1-3	0.51-1.25	0.017-0.025		60
	Mexico		0.0035-0.05	0.07-0.10		3
	Portugal	2-6	0.30-0.50	0.030-0.050		7
	USA	2 - 6	0.84-1.12	1.2-2.4	ground/aerial	3
Prunes	USA	2-4	0.60-1.12	1.2		3
	USA	2-6	1.12	2.4	aerial	3
Berries	Bolivia	1-3	0.25	0.02 -0.03		15
Blackberry	Canada	every 7 days	0.55	0.025		2
	USA	1-5	0.42			3
Blueberry	USA	1-3	0.56	0.6		21
	USA	1-3	0.56	2.4	aerial	21
Boysenberry	USA	1-5	0.42			3
Grapes	Argentina	2	1.8	0.06		15
	Australia	1-4	3.0	0.05		3
	Brazil	2-8	*	0.03	aerial	18
	Bulgaria	1-3	1.5	0.5		20
	Canada	3	0.75	0.025		7
	Chile	4	1.0-1.5			7
	Colombia	1-2/year		12.5		
	Cyprus	2	0.35-0.5	0.05		14
	France	1-4	0.25-0.50	0.05		14
	Greece	5		0.03-0.04		14
	Italy	5-6	0.045	0.03		15
	Japan	1-3	0.51-1.25	0.017-0.025		60
	Japan	-	2-7.5	0.1-0.25		
	Korea	NA	0.65-0.98	0.065		7
	Mexico			0.050-0.070		7 days
	New Zealand	1	0.500	0.025		7

Crop	Country	Application			Mode of application	PHI. days
		Number	kg ai/ha	kg ai/hl		
	Portugal	4	0.60	0.060		7
	Spain	-	0.03-1.0	-		14
	Thailand	-		0.187-0.562		7
	Uruguay	1-3	0.15-0.30	0.03		14
	USA	4-8	0.42-0.84	0.9		50
	USA	4-8	0.42-0.84	1.2	aerial	50
	Venezuela	2	0.025	0.0125		-
	Vietnam		0.5			
Raspberry	Australia	1-4	1.0	0.025		4
	Canada	every 7 days	0.55	0.025		2
	Chile	3-4	0.9			3
	New Zealand	1	0.250	0.025		1
	USA	5	0.42			3
Strawberry	Argentina	-	0.050-0.060	0.025-0.030		15
	Australia	1-4	2.0	0.025		4
	Brazil	2-4*	*	0.03		3
	Bulgaria	1-3	1.5	0.5		20
	Canada	every 7 days	0.875	0.025		2
	Chile	2-3	1			0
	Colombia	1-2/year		0.065		
	Ecuador	3	0.25	0.125		1
	Greece	3-4		0.06-0.12		14
	Japan	1-3		0.1	dipping	-
	Japan	1-3	30	0.1	drench	-
	Mexico		0.350-0.50	0.050-0.07		0
	Netherlands	every 10-14 days		0.03-0.0375		14
	New Zealand	1	0.250	-		1
	Portugal	4	0.30-0.50	0.03-0.05		7
	Spain	-	-	0.03		14
	Uruguay	1-3	0.066-0.210	0.022-0.030		14
	USA	5-10	0.28-0.56	0.6		1
	USA	1-10	0.56	1.2	aerial	1
	Venezuela	1-2	-	0.075		-
Avocado	Mexico			0.04-0.06		30
	New Zealand	1-3	1.5	0.025		14
	USA	3 - 6	0.56-1.12	1.2-2.4	ground/aerial	30
	Venezuela	1-2	-	0.075		-
Banana	Australia	2-6	0.150	-		NA
	Brazil**	4-8*	0.125-0.15	0.3-1.5		3
	Central America	-	0.125-0.15	-		-
	Colombia	4-6		0.125	aerial	
	Ecuador	4-6	-	0.14	aerial	-
	France	6	125	-		0
	Portugal	1	0.30-0.50	0.03-0.05		1
	Venezuela	4-6	-	0.125-0.75	aerial	7-15
Mango	Mexico			0.040-0.060		14
	Peru	1-2	0.05			-
	Thailand	-		0.187-0.562		14
	USA	3 - 6	0.56-1.12	0.56-1.12		14
Pineapple	Brazil**	2-4*	*	0.25		1
	Central America	1		2-4lb/100gl	dipping	-
	Central America	1		1.25lb/100gl	seed dressing	
	Colombia	1-2/year		0.0125		
	Mexico			0.25-0.50		-
	USA	1	NA	NA	dipping	NA

Crop	Country	Application Number	Application kg ai/ha	Application kg ai/hl	Mode of application	PHI. days
	Venezuela	2	0.025	0.0125		-
Brussels sprouts	Australia	1-4	2.0	0.05		5
	New Zealand	1-4	0.250			7
	UK	2	0.55			21
	USA	1-3	1.12	4.8	aerial	NA
	USA	1-3	1.12	1.2		7
	USA	1-3	1.12	8	aerial	7
Cucurbits	Australia	1-3	0.750	0.025		5
	Chile	3-4	0.25-0.5	-		0-7
	Colombia	1-2	12.5			
	France	1-3	0.15-0.45	0.03		7
	Greece	1		0.03		14
	Mexico		0.3-0.35			14
	New Zealand	1-3	0.250			7
	Spain	-	-	0.03		14
Cucumber	Argentina	3-4	0.030-0.120	0.015-0.060		30
	Brazil	3-6*	*	0.035		1
	Canada	3	0.425	.04-.09		14
	Canada	1-2	0.425	.04-.09	Greenhouse	14
	France	1-3	0.15-0.45	0.03		7
	Japan	1-3	0.17-0.5	0.017-0.025		1
	Mexico		0.30-0.35			14
	Netherlands	every 10-14 days		0.05		3
	Romania	1-2	0.95	0.035	1 l/plant	14
	Thailand	-		0.062-0.187		NA
	Turkey			0.03		14
	Venezuela	1-2	0.25	0.175		-
	Vietnam		0.5			
	USA	4 - 8	0.14-0.28	0.12		1
	USA	4	0.28	1.2	aerial	1
Melon	Brazil**	3-6*	*	0.035		1
	Canada	3	0.425	0.04-0.09		14
	Netherlands	every 10-14 days		0.05		3
	Romania	1-2	0.84	0.035	1 l/ plant	14
	USA	4 - 8	0.28	0.12		1
	USA	4	0.28	1.2	aerial	1
	Venezuela	1-2	0.25	0.175		-
Squash , Summer	Mexico		0.30-0.38			14
	USA	4-8	0.12-0.28	0.12		1
	USA	4	0.28	1.2	aerial	1
Watermelon	Brazil	3-6*	*	0.035		1
	Japan	1-5	0.17-0.5	0.017-0.025		1
	Korea	1-5	0.5-0.98	0.05-0.065		2
	Venezuela	1-2	0.25	0.175		-
	Turkey			0.03		14
Tomato	Argentina	-	0.060-0.120	0.030-0.060		20
	Australia	1-3	0.75	0.25-0.50		5
	Bolivia	1-3	0.20 - 0.30	0.03 - 0.06		20
	Brazil	2-6*	*	0.05		1
	Bulgaria	1-3	0.75	0.25		20
	Canada	2	0.42-0.55	0.025		7
	Canada	1- 2	0.55	0.025	greenhouse	7
	Chile	3-4	0.25-0.5	-		0-7
	Ecuador	4	0.25	0.125		7
	France	1-3	0.15 - 0.3	0.03		14
	Greece	1		0.03		14

Crop	Country	Application: Number	Application: kg ai/ha	Application: kg ai/hl	Mode of application	PHI. days
	Indonesia	2	0.25	0.05	drench	20
	Japan	1-3		0.05	drench	
	Japan	1-5	0.17-0.5	0.017-0.025		1
	Japan	1		0.1	soaking	-
	Mexico		0.4-0.5			0
	Netherlands	-	-	0.04		3
	New Zealand	1-3	3.0	1.0		3
	New Zealand	1-2	0.500	0.025	Individual plant	3
	Portugal	-	0.15-0.30	0.015-0.03		4
	Romania	1-2	0.22	0.025		14
	Thailand	-		0.062-0.187		NA
	Uruguay	1-3	0.066-0.210	0.022-0.030		14
	USA	5-10	0.28-0.56	0.24		1
	USA	5-10	0.28-0.56	2.4	aerial	1
	Vietnam		0.5			
Bean, broad	Argentina	2	0.375-0.500			28
Bean	Australia	1-2	1			5
	Bolivia	2	0.25-0.80	0.05-0.1		30
	Brazil	2-6*	*	0.25		17
	Canada	1	1.13	0.025		14
	Chile	2	1.5-2.0			14
	Colombia	2		12.5		
	Greece	1		0.03		14
	Mexico		0.35-0.50			14
	Netherlands	1-2	1.0-2.0	-		14
	New Zealand	1-2	1.0			14
	Japan	1-4	0.33-0.5	0.033-0.05		7
	Peru	2	0.05			-
	Thailand	-		0.187-0.375		14
	UK	2	0.55			21
	USA	1-2	0.84-1.12	0.96		28
	USA	2	0.84-1.12	8	aerial	28
	Venezuela	2	0.25	0.175		-
	Vietnam		0.6			
Beans, dry, snap	Argentina	-	0.04	0.02		28
	USA	1-2	0.84-1.12	0.96		14
Beans, Snap	USA	1	0.56	0.8		NA
Pea	Greece	1		0.03		14
	Japan	1-4	0.25-1	0.025-0.05		7
	UK	2	0.55			21
Soya bean	Argentina	2	0.125			35
	Bolivia	1	0.25 - 0.30	0.05		35
	Brazil	2-3	*	0.25	ground/aerial	12
	Colombia	2		0.25	aerial	
	Ecuador	1-3	0.25	0.125	aerial	35
	Japan	1-4	0.25-0.5	0.025-0.05		14
	Japan	1			dressing	-
	Mexico		0.350-0.500			35
	Thailand	-	0.187-0.375			NA
	USA	1 - 2	0.28-0.56	0.6		35
	USA	1 - 2	0.28-0.56	2.4	aerial	35
	Venezuela	2	0.25	0.175		-
	Vietnam		0.6			
Carrot	Ecuador	4	0.25	0.125		7
	Colombia	2				
	Australia	1-4	2.0	0.050		5
	Canada	3	0.55	0.055		15
	USA	3 - 12	0.14-0.56	0.6		4

Crop	Country	Application			Mode of application	PHI. days
		Number	kg ai/ha	kg ai/hl		
	USA	3 - 12	0.14-0.56	2.4	aerial	4
Sugar beet	Bulgaria	1-3	2.4	1.2		20
	Chile	3	0.5-1.0	-		21
	Japan	1-4	0.125-0.25	0.0125-0.025		21
	Portugal	-	0.30-0.50	0.03-0.05		21
	Romania	1-2	0.15	0.035		14
	Spain	-	-	0.03		14
	Turkey			0.02		0
	Yugoslavia	2	0.1-0.2	0.033-0.060		42
Cereals	Chile	2	0.525			26
	Germany	1	0.25	0.06		56
	Spain	1-2	0.250	-		14
Rice	Argentina	2	0.250-0.50			21
	Bolivia	2	0.25 - 0.50	0.05		21
	Brazil	1-3	*	0.25		36
	Colombia	1-2		0.125	aerial	
	Ecuador	2	0.25	0.125		21
	France	2	1.125	-		21
	Indonesia	3	0.40	0.03-0.05		20
	Korea	NA	0.65-1.5	0.065-0.1		21
	Mexico	2-3	0.05			21
	Peru	2	0.05			-
	Thailand	-		0.375		21
	Turkey			0.03		21
	Uruguay	1-2	0.500	-	aerial	14
	USA	1-2	0.56-1.12	1.2		21
	USA	1-2	0.56-1.12	8	aerial	21
	Venezuela	2	0.175	0.125		-
	Vietnam		0.6			-
Wheat	Argentina	2	0.125			35
	Australia	1	0.25			126
	Brazil	1-2	*	0.25		14
	Colombia	1-2	0.25	0.125		21
	Japan	1	0.17-0.25	0.017-0.025		-
	Netherlands	1	0.25	-		35
	New Zealand	1	0.25	0.15-0.25		60
	Italy	2	0.20-0.250	0.02-0.04		30
	Uruguay	1	0.25	-		14
	USA	1-2	0.28-1.12	0.2-1.6	ground/aerial	21
	Yugoslavia	1	0.3	-	seed dressing	42
Winter wheat	Bulgaria	1	4	4 / ROW	seed dressing	-
	UK	1	0.250	0.125		***
	Yugoslavia	2	0.2-0.3	0.060-0.075		42
Almonds	USA	2 -3	0.56-0.84	1.8	ground/aerial	50
	Italy	2-4	0.05	0.05		15
Macadamia Nuts	USA	3	0.98	1.05		NA

Crop	Country	Application			Mode of application	PHI, days
		Number	kg ai/ha	kg ai/hl		
Peanut	Argentina	2	0.07			14
	Australia	1	0.150	0.150		21
	Bolivia	2	0.15 - 0.25	0.04	aerial	14
	Brazil	2-4*	*	0.125		2
	Indonesia	5	0.4	0.03-0.05		20
	Japan	1-4	0.17-0.5	0.017-0.025		7
	Korea	1-4	0.65-0.98	0.065		7
	Mexico		0.25-0.35			14
	Thailand	-		0.187-0.375		N/A
	USA	12	0.14	0.15		14
	USA	12	0.14	0.6	aerial	14
	Vietnam		0.6			

* Not specified on the current label; will be included after re-evaluation by regulatory authorities expected by end of 1998 (typical agricultural practice indicated)
** Recommended on the current labels, but subject to withdrawal because of request for additional data by regulatory authorities.
*** Apply before detectable 1st node

RESIDUES RESULTING FROM SUPERVISED TRIALS

The results of residue trials are shown in Tables 2-31. In some trials separate sub-plots were treated, separated from each other by sufficient distance to avoid contamination by spray drift. Residues from sub-plots treated by exactly the same application regime are regarded as being from one trial. Unless otherwise indicated, all trials were conducted outdoors with foliar sprays. Underlined and double underlined residues were from treatments within the range covered by GAP (± 30%) and from those at the maximum GAP rate respectively. The latter were considered for estimating maximum residue levels and STMRs. All residues are expressed as carbendazim.

Grapefruit and limes. Seven trials were carried out in the USA, of which two on grapefruit were according to GAP for citrus fruit (1-2 x 0.56-1.68 kg ai/ha), giving residues at a PHI of 2 days of 0.08 and 0.09 mg/kg (Table 2).

Table 2. Results of residue trials with benomyl on grapefruit and limes in Florida, USA.

Report No. Commodity Year	Application			PHI, days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
Beno/Res16	3	0.56-1.12	-	53	0.20	Trial 2
grapefruit	4	0.56-1.12	0.015-0.048	24	0.11	Trial 3
1972	3	0.56-1.12	0.024-0.05	17	0.24	Trial 4
1973	1	0.070	-	28	<0.05, <0.05	Trial 5
1974	1	0.561	-	2	0.08, <0.05	Trial 6
	1	1.12	-	2	0.08, 0.09	
1972 lime	4	0.56-1.12	0.024-0.048	0	0.79	

Oranges. Of twelve trials on oranges in the USA, 2 were according to GAP for citrus fruit, yielding residues in the fruit of 0.29 and 0.43 mg/kg at a PHI of 2 days. In Brazil, four trials with single applications, instead of the specified 2 or 3, at the recommended rate (0.025-0.05

kg ai/hl) gave residues in the fruit at the GAP PHI of 1 day of 0.13-0.36 mg/kg. Two trials with 1 application at a double rate gave much higher residues (Table 3). The results in Brazil show that residue levels decrease significantly from 1 to 7 days, although one trial in the USA did not show a significant decrease in residues from 0 to 10 days (0.22 and 0.19 mg/kg respectively).

Table 3. Residues from trials with benomyl on oranges.

Country Report N° Year, Location	Application			PHI, days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
USA Beno/Res 16 1968	3	0.28	0.01	10 20	<0.02 <0.02	Test 1
Florida	1	0.417	0.05	8	0.42	Test 2
1969	1	0.28	0.024	0 10 30	0.22 0.19 <0.02	Test 3
	1	-	0.10	24	0.28	Test 4
1970	1	0.417	0.05	8 15	0.79 0.86	Test 6
1971	4	1.12-1.68	-	15	0.38	Test 7
	4	1.12-3.38	-	15	0.48	Test 8
	4	1.12-3.36	-	20	0.92	Test 9
1972	4	0.561	-	17	0.32	Test 11
	4	0.56-1.12	0.018-0.0682	22	0.45	Test 13
	4	0.561-1.12	0.015-0.048	24	0.26	Test 15
1974	1	0.841	-	2	0.29; 0.23	Test 16
		1.12	-	2	0.43	
Brazil BRG92-027 1992 São Paulo	1	0.025	0.025	0 1 7 14 21	0.13 0.13 0.05 <0.01 <0.01	
	1	0.05	0.05	1 7	0.36 0.23	
	1	0.1	0.1	1 7	0.82 0.38	
BRG.92-028 1992 São Paulo	1	0.025	0.025	1 7	0.14 0.02	
	1	0.05	0.05	1 7	0.24 0.03	
	1	0.1	0.1	1 7	0.63 0.17	

Pome fruit

Apples. Fourteen trials in France were at the GAP recommended rate (1-4 x 0.15-0.45 kg ai/ha) but only in eleven were samples harvested at the recommended PHI of 7 days, giving residues ranging from <0.05 to 1.75 mg/kg (Table 6). In three trials in Germany and in 9 in the UK at higher rates (up to 15 applications of 8.4 kg ai/ha) than the German GAP for pome fruit (1-3 x 0.15 kg ai/ha) the residues on the day of application varied from 0.18 to 1.2 mg/kg, and after 7 days from 0.09 to 0.74 mg/kg.

In a total of 39 trials in the USA from 1972 to 1996, 23 according to GAP (6-13 x 0.12-0.42 kg ai/ha) gave residues at a PHI of 14 days ranging from <0.1 to 1.6 mg/kg. Four trials at twice the GAP rate at the same PHI and twelve other trials within the GAP range at with PHIs from 9 to 64 days yielded residues within the same range. Decline studies showed that the decrease of residues from 0 to 21 days varied over a wide range up to about 90% (Table 4).

Table 4. Results from trials with benomyl on apples.

Country Report No. year location	Application			PHI, days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
France BEA118910BG 1971 Bouches du Rhone	1	0.3	0.03	1 8 13	0.12 <0.05 <0.05	Test 6
1988 Bouches du Rhone	1	0.3	0.03	1 8 15	0.85 0.60 0.31	Test 7 control=0.13 mg/kg
	1	0.3	0.03	1 8 15	1.98 1.8 1.49	Test 8 control=0.09 mg/kg
Gironde	1	0.30	0.030	4	<0.05	
	3	0.22-0.342	0.030	5	0.81	control=0.07 mg/kg
BEA119122BG 1990	2	0.32	0.083	8	<0.05	Trial1
Lafrancaise	2	0.33	0.083	2	<0.05	Trial 2
Cordes	2	0.345	0.045	7	0.15	Trial 1
Tolosannes	2	0.345	0.045	1	0.12	Trial 2
Trizay	4	0.21	0.030	7	0.16; 0.19	Trial 1/2
BEA119213BG 1991 Tarn et Garonne	2	0.45	0.124	6	0.49	
Cordes Tolosannes	2	0.27	0.036	7	0.11	
A119412 Balma 1993	1	0.6	0.096	3 7 15 21 30	0.30 0.19 0.16 0.12 0.07	
	2	0.6	0.096	7 15	0.28 0.17	
Germany BENO/RESO 10 1968 Weinstraße	7	1.0	0.050	4 8 11 15 21 29	0.82 0.22 0.27 0.66 0.16 <0.1	
Heidelberg	10	0.5	0.025	3 7 11 14 21 28	1.5 0.53 0.66 0.34 0.43 0.34	
Neustadt 1969	7	0.36	0.015-0.025	0 1 3 7 14 21	0.92 0.79 0.66 0.59 0.39 <0.1	
UK BENORES/10 Nottingham 1969	1	0.56	0.060	0 3 7 14	0.18 0.24 0.09 <0.05	

Country Report No. year location	Application			PHI, days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
Nottingham 1970	2	2.24	1.120	0	0.48	
Suffolk 1969	1	0.56	0.060	0 3 7 14	0.49 0.38 0.29 0.09	
	12	6.72	0.060	0 7	0.91 0.74	
Thurgarton 1969	8	0.56	0.060	0 7	0.80 0.38	
	9	5.04	0.060	0 7	1.2 0.25	
Norton 1969	9	5.04	0.060	0 7	0.90 0.28	
Ipswich 1969	7	3.92	0.060	0 7	0.54 0.13	
Faversham, 1969	15	8.4	0.060	0 7	0.99 0.32	
USA BENO/RES 10 1972	14	0.420	0.015-	13	<0.1	Trial 1
	12	0.420	0.015	13	0.28	trial 2
NY	9	0.560	0.030	14	<0.1; 0.36	Trial 1/2
PA	6	0.210	0.0075	28	0.15; 0.16	Trial 1/3
	6	0.420	0.015	28	0.31; 0.17	Trial 2/4
Ohio	9	0.63	0.067	9	0.27	Trial 1
	9	0.630	0.067	9	0.40	Trial 2
	9	0.630- 0.113	0.030-0.067	9	0.79; 0.43	Trial 3/4[1]
MO	12	0.735	0.022	23	0.11; 0.26	Trial 1/2
VA	12	0.420	0.015	56	0.14	Trial 1
	12	0.210	0.0075	56	0.17	Trial 2
	9	0.420	0.015	64	<0.1; <0.1	Trial 1/2
MI	11	0.210	0.022	41	0.14; 0.14	Trial 1/3
	11	0.140	0.015	41	0.12	Trial 2
ME	12	0.350	0.015	22	0.28; 0.39	Trial1/2
AMR 1594-90[2] 1990 PA	7	0.28-0.42	0.048-0.072	0 3 7 10 14 21	0.92 0.60 0.54 0.78 0.54 0.48	Test 1
	7	0.56-0.84	0.097-0.14	0 3 7 10 14 21	2.2 1.1 1.6 1.1 1.2 1.0	
MD	6	0.28-0.42	0.031-0.046	0 3 7 10 14 21	0.28 0.31 0.35 0.31 0.18 0.24	Test 2
IL	7	0.28-0.42	0.020-0.030	0 3 7 10 14 21	0.92 0.55 0.59 0.58 0.78 0.51	Test 3

Country Report No. year location	Application			PHI, days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
NY	7	0.28-0.42	0.030-0.045	0 3 7 10 14 21	0.72 0.49 0.60 0.61 0.27 0.21	Test 4
	7	0.56-0.84	0.060-0.090	0 3 7 10 14 21	1.7 1.2 0.98 1.4 0.92 0.50	
MI	7	0.28-0.42	0.024-0.036	0 3 7 10 14 21	1.7 2.0 1.8 1.4 1.6 0.98	Test 5
	7	0.28-0.42	0.020-0.030	0 3 7 10 14 21	0.32 0.16 0.23 0.16 0.20 0.14	Test 6
CA	7	0.28-0.42	0.023-0.030	0 3 7 10 14 21	0.50 0.35 0.19 0.09 0.16 0.11	Test 7
	7	0.56-0.84	0.047-0.07	0 3 7 10 14 21	1.5 1.0 1.4 0.20 0.20 0.17	
WA	7	0.28-0.42	0.030-0.045	0 3 7 10 14 21	0.72 0.61 0.53 0.58 0.60 0.48	Test 8
	7	0.56-0.84	0.060-0.090	0 3 7 10 14 21	1.4 1.4 1.3 0.98 1.2 1.0	
AMR3742-96[2] 1996 NY	7	0.28-0.42	0.030-0.045	14	0.48; 0.51	Trial1/2
PA	7	0.28-0.42	0.026-0.040	14	0.37; 0.25	Trial 1/2
	7	0.28-0.42	0.058-0.086	14	0.38; 0.34	Trial 1/2
MD	7	0.28-0.42	0.027-0.040	14	0.78; 0.48	Trial 1/2
MI	7	0.28-0.42	0.030-0.045	14	1.2; 1.4	Trial 1/2

Country Report No. year location	Application			PHI, days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
	7	0.28-0.42	0.058-0.091	14	1.0; 0.98	Trial 1/2
UT	7	0.28-0.42	0.029-0.043	14	1.2; 1.04	Trial 1/2
CA	7	0.28-0.42	0.014-0.021	14	0.98; 1.6	Trial 1/2
WA	7	0.28-0.42	0.020-0.030	14	0.72; 0.72	Trial 1/2
	7	0.28-0.42	0.030-0.045	14	0.72; 0.98	Trial 1/2
	7	0.28-0.42	0.029-0.039	14	0.59; 0.65	Trial 1/2
OR	7	0.28-0.42	0.038-0.051	14	1.0; 0.50	Trial 1/2

[1] Orchard spray + post harvest dip
[2] One application at lowest and 6 at highest rate

Pears. In three trials in the UK with 1 or 6 applications 0.06 kg ai/hl, residues from 0 to 11 days varied from 0.16 to 1.5 mg/kg. No GAP was reported to evaluate the trials. In eight trials in the USA according to GAP (3-6 x 0.42-0.84 kg ai/ha) the residues at the recommended PHI of 14 days varied from 0.50 to 2.4 mg/kg. One trial at a higher rate gave residues of 1.7 mg/kg after 14 days. One decline study showed that the residues did not change significantly from day 0 to day 21 (1.4 and 1.3 mg/kg respectively) (Table 5).

Table 5. Residues from trials with benomyl on pears.

Country Report No. Year location	Application			PHI, days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
UK BENO/RES 8 1969 Thurgarton	6	0.56	0.060	0 7	0.51 0.22	
Ipswich	6	0.56	0.060	0 7	1.5 0.16	
Essex	1	-	0.060	11	0.59	
USA AMR1595-90 1990 CA	4	0.56-0.84	0.043-0.074	0 3 7 10 14 21	1.4 1.11 0.92 0.92 1.3 1.3	Test 1
MI,	4	0.82-1.23	0.058-0.088	14	1.7	Test 1
OR	4	0.56-0.84	0.030-0.045	14	0.65	Test 3
AMR3742-96 1996 NY	4	0.56-0.84	0.060-0.090	14	0.50; 0.52	Trial 1/2
CA	4	0.56-0.84	0.039-0.057	14	0.78; 1.1	Trial 1/2
	4	0.56-0.84	0.060-0.090	14	0.72; 0.59	Trial 1/2
WA	4	0.56-0.84	0.060-0.090	14	0.59; 0.72	Trial 1/2
	4	0.56-0.84	0.040-0.060	14	2.4; 2.2	Trial 1/2
OR	4	0.56-0.84	0.063-0.091	14	0.85; 0.85	Trial 1/2

Stone fruit

Apricots and nectarines. In one trial on apricots in Switzerland the application was according to French GAP (1-4 x 0.03 kg ai/hl) but the sample was taken much later than the recommended PHI of 7 days. In two trials in the USA on apricots and four on nectarines at a lower application rate than the recommended GAP (2-4 x 0.60-1.2 kg ai/hl) the residues ranged from <0.06 to 1.4 mg/kg after 0 to 19 days (Table 6). In a decline study the residues increased slightly from day 1 to day 19 (0.65 and 0.72 mg/kg respectively).

Table 6. Residues from trials with benomyl on apricots and nectarines .

Country Report No. year	Application			PHI, days	Residues, mg/kg*	Reference
	No	kg ai/ha	kg ai/hl			
Apricots						
Switzerland BENO/RES 14 1971	4	-	0.030	30	0.45	
USA BENO/RES 14 1967 California	1	-	0.030	4	<0.06	
1969	3	-	0.030	8	1.7	
Nectarines						
USA	1	-	0.030	1	0.65	

Country Report No. year	Application			PHI, days	Residues, mg/kg*	Reference
	No	kg ai/ha	kg ai/hl			
BENO/RES 17 1967 California				3	0.72	
				5	1.3	
				7	0.92	
				12	0.98	
				19	0.72	
1969	3	-	0.03	1	1.4	
	2	-	0.030	0	1.0	
	3	-	0.03	13	1.1	

* Results were corrected for blanks and recovery

Cherries. Two trials in Italy in 1996 according to French GAP (2-6 x 0.15-0.45 kg ai/ha) gave residues at 7 days of 0.24 and 0.65 mg/kg. In a decline study residues were similar 0 and 7 days after the application.

Forty one trials in the USA from 1967 to 1976 were at rates above and below the recommended GAP (3-6 x 0.60-1.12 kg ai/ha, PHI 3 days). Residues from 0 to 26 days after application varied from <0.03 to 8.2 mg/kg (Table 7).

Table 7. Residues from trials with benomyl on cherries.

Country Report No. year	Application			PHI, Days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
Italy AMR 3830-96 1996 Vignola	4	0.312-0.615	0.03-0.05	0	0.53, 0.54	Test 2
				1	0.58, 0.67	
				3	0.19, 0.44	
				5	0.84, 0.19	
				7	0.50, 0.65	
AMR 3831-96	4	0.312-0.615	0.03-0.05	7	0.24, 0.23	Test 5
USA BENO/RESO 15* 1967 CA	3	-	0.030	1	1.6	Trial 1N
	2	-	0.030	1	1.2	Trial 2N
	2	-	0.030	21	0.47	Trial 3N
	2	-	0.030	1	0.78	Trial 1S
	2	-	0.030	21	<0.06	Trial 2S
DE	4	-	0.007	7	0.36	Trial 1
				19	0.10	
	4	-	0.022	7	0.99	Trial 2
1968	3	-	0.030	13	0.78	Trial 1
CA	2	-	0.030	26	0.34	Trial 2
1969	2	-	0.060	2	8.2	
CA	2	-	0.030	0	0.12	
TAS-000-005 1967 CA	3	0.28	0.030	1	1.6	STCA67L1
	2	0.28	0.030	1	1.2	STCA67L2
	2	0.28	0.030	21	0.47	STCA67L3
	2	0.28	0.030	1	0.78	STA67RA1
	2	0.28	0.030	21	<0.06	STA67RA2
DE	4	0.07	0.030	7	0.34	NEDE67M1 NEDE67M2
				19	0.10	
	4	0.21	0.030	7	0.98	NEDE67M3

Country Report No. year	Application			PHI, Days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
1968	2	0.28	0.030	13	0.78	STCA68L1
CA	2	0.28	0.030	26	0.34	STCA68L2
1969	2	0.56	-	2	8.23	
CA	2	0.28	-	0	0.12	LICA69RA
	2	0.28	0.030	0	0.12	LICA69RA1
1971 CA	1	1.12	0.12	1	0.18	
1972	3	0.63	0.067	10	0.14	ELMI72M1
MI	3	0.35	0.037	10	0.22	ELMI72M2
	3	0.35	0.037	10	0.78	ELMI72M3
1973	5	0.56	0.060	0	1.2	
WI	5	0.56	0.060	0	1.4	
1974	4	0.42	0.045	0	0.65	
MI	5	0.42	0.045	0	1.3	
1975	5	0.56	0.024	0	0.61	
MI	5	0.56	0.020	0 7	0.93 0.57	
	5	0.56	0.020	0 7	0.33 0.31	
	4	0.56	0.060	14	1.2	
1976 MI	1	1.68	0.18	0 3 7	0.65 0.21 0.12	
	7	2.24	0.240	0	3.53	
CA	3	6.72	0.18	14 25	0.09 <0.03	
	3	8.96	0.24	14 25	0.16 <0.03	
	3	8.96	0.24	7	<0.03	
	3	6.72	0.18	7	<0.03	

Peaches. A total of 9 trials were in Europe from 1988 to 1996 and 21 in the USA from 1967 to 1990 (Table 8). Four of five trials in France were according to GAP (1-4 x 0.15-0.45 kg ai/ha, 7 days PHI) giving residues in the fruit from 0.07 to 0.15 mg/kg. Two trials in Portugal and two in Spain according to Portuguese GAP (2-6 x 0.3-0.5 kg ai/ha) gave residues at 7 days - from 0.08 to 0.56 mg/kg.

Seven trials in the USA according to GAP (2-4 x 0.60-1.12 kg ai/ha) gave residues at 3 days from 0.21 to 1.0 mg/kg. Residues from 3 trials at twice the GAP rate ranged from 0.59 to 1.7 mg/kg 3 days after application.

Table 8. Residues from trials with benomyl on peaches.

Country Report No. Year, Location	Application			PHI, days	Residues, mg/kg*	Reference
	No	kg ai/ha	kg ai/hl			
France BEA118910-BG 1988 Bouches du Rhone	1	0.3	0.03	1 5 10	0.23 0.12 <0.05	

Country Report No. Year, Location	Application			PHI,	Residues,	
	No	kg ai/ha	kg ai/hl	days	mg/kg*	Reference
Gard	1	0.3	0.03	1 4 11	1.2 0.54 0.24	
1988 Trizay	2	-	0.03	7	0.07	
AMR3425-95 1995 Les Valance	4	0.294-0.298	0.03-0.04	0 1 3 5 7	0.44 0.39 0.21 0.18 0.09	
AMR 3426-95	4	0.294-0.298	0.03-0.04	7	0.15	
Portugal AMR 3426-95 1995	4	0.288-0.383	0.03	7	0.56	
AMR3831	4	0.295-0.457	0.03	7	0.09	
Spain AMR3426-95 1995 Binefar	4	0.298-0.603	0.03-0.04	7	0.26	
AMR3831-96 1995 Huesca	4	0.301-0.456	0.03	7	0.08	
USA BENO/RES 18* 1967	2	-	0.030	0	0.14	
CA	2		0.030	9	0.16	
1968 SC	4		0.022	6	<0.06	
GA	6		0.022	2 9	0.44 0.09	
FL	7	-	0.022	12	0.20	
1969	2	-	0.030	14	0.51	Trial 1
CA	2	-	0.060	14	1.4	Trial 3
	3	-	0.030	6	4.1	
	4	-	0.030	0	5.4	
	2	-	0.030	0	3.1	
NC	9	-	0.30	1 7 14	3.6 2.1 1.7	
AMR1599-90 1990 SC	2	1.12	0.060	0 3 7 10 14	0.37 0.21 0.25 0.02 0.19	Trial 3
	2	2.24	0.120	0 3 7 10 14	0.98 0.59 0.52 0.31 0.28	Trial 4
MI	2	1.12	0.060	0 3 7	1.2 1.0 1.1	

Country Report No. Year, Location	Application			PHI, days	Residues, mg/kg*	Reference
	No	kg ai/ha	kg ai/hl			
				10 14	2.0 1.0	
	2	2.24	0.120	0 3 7 10 14	1.4 1.4 0.20 1.2 0.85	
CA	2	1.12	0.085-0.093	0 3 7 10 14	0.05 <u>0.61</u> 0.72 0.92 0.64	
	2	2.24	0.170-0.186	0 3 7 10 14	0.92 1.7 1.3 2.6 1.2	
AMR 1691-90 1990 CA	2	1.12	0.116	3	<u>0.30</u>	PS
SC	2	1.12	0.096	3	<u>0.51</u>	PS
AMR 1692-90 1990 CA	2	1.12	0.120	3	<u>0.72</u>	PS
SC	2	1.12	0.120	3	<u>1.0</u>	PS

*Results were corrected for blanks and recoveries

<u>Plums</u>. In seven trials in France and Italy according to French GAP (1-4 x 0.15-0.45 kg ai/ha) the residues at 7 days ranged from <0.05 to 0.34 mg/kg. In two decline studies, residues at day 0 either did not change or increased slightly after 7 days. In two trials in Spain according to Portuguese GAP (2-6 x 0.3-0.5 kg ai/ha) the residues were 0.07 and 0.05 mg/kg after 7 days.

In four trials in the USA according to GAP (2-4 x 0.60-1.12 kg ai/ha) the residues at 3 days ranged from 0.02 to 0.24 mg/kg in the fruit. In eight other trials at lower (0.03 kg ai/hl) or higher rates (4 x 1.96 kg ai/ha) the residues in the fruit ranged from 0.23 to 4.0 mg/kg after 0 to 7 days. In 6 of the US trials residues were measured in the fresh fruit and after processing to prunes.

In eleven decline studies in Europe and the USA residues either increased or did not change significantly from day 0 to day 7 or 14. The results are shown in Table 9.

Table 9. Residues from trials with benomyl on plums.

Country Report No. year location	Application			PHI, days	Sample	Residues, mg/kg*
	No	kg ai/ha	kg ai/hl			
France AMR 3830-96 1996 Armon	4	0.298-0.303	0.04	0 1 3 5	fresh fruit	<0.05 <0.05 <0.05 <0.05

Country Report No. year location	Application			PHI, days	Sample	Residues, mg/kg*
	No	kg ai/ha	kg ai/hl			
				7		<0.05
AMR 3831-96 Fronton	4	0.281-0.326	0.03-0.04	7	fresh fruit	0.34
Italy AMR 3425-95 1995 Trentino, TN	4	0.283-0.365	0.02-0.03	0 1 3 5 7	fresh fruit	<0.05 <0.05 <0.05 <0.05 <0.05
AMR 3426-95 Trentino, TN	4	0.283-0.365	0.02-0.03	7	fresh fruit	0.05
AMR 3830-96 1996	4	0.294-0.506	0.03	0 1 3 5 7	fresh fruit	0.06 0.06 0.06 0.05 0.08
AMR 3831-96 Collebeato, Bs	4	0.294-0.506	0.03	7	fresh fruit	0.06
Bordano	4	0.294-0.506	0.03	7	fresh fruit	0.10
Spain AMR 3426-95 1995 Binefar, Huesca	4	0.303-0.459	0.03-0.04	7	fresh fruit	0.07
AMR 3831-96	4	-	0.03	7	fresh fruit	0.05
USA BENO/RES 19* 1969	4	-	0.030	1	fresh fruit	0.92
	2	-	0.030	0 5	fresh fruit	0.42 0.44
TAS-000-005 1985 CA	3	1.12	-	7	fresh fruit/prunes	0.65/0.54
	4	0.985	-	0 1 3 7 14	fresh fruit/prunes	0.23/0.13 1.4/0.13 0.65/0.65 3.0/0.078 0.92/0.078
	4	1.96	-	0 1 3 7 14	fresh fruit/prunes	2.8/0.05 3.3/0.61 4.0/0.61 3.1/0.40 3.1/0.32
AMR 1418 1988 CA	3	1.12	-	7	fresh fruit/prunes	0.65/0.54
	4	0.988	-	0 1 3 7 14	fresh fruit/prunes	0.23/0.13 1.4/0.14 0.66/0.16 3.0/0.08 0.92/0.08
	4	1.96	-	0 1 3 7 14	fresh fruit/prunes	2.8/0.50 3.3/0.63 4.0/0.60 3.1/0.40 3.1/0.32
AMR 1613-90	2	0.60	-	0	fresh fruit	0.01

Country Report No. year location	Application			PHI, days	Sample	Residues, mg/kg*
	No	kg ai/ha	kg ai/hl			
1990 CA				3 7 10 14		0.02 0.01 0.01 0.02
	2	1.12	-	0 3 7 10 14	fresh fruit	0.07 0.06 0.11 0.06 0.05
	2	0.60	-	0 3 7 10 14	fresh fruit	0.09 0.24 0.17 0.20 0.22
	2	1.12	-	0 3 7 10 14	fresh fruit	0.10 0.21 0.17 0.20 0.07

* Results were corrected for blanks and recovery

Berries

Cane berries. Thirteen trials were conducted on berries in the USA and Canada in 1967 and 1971 (Table 10). In three trials on blackberries and blueberries in the USA according to GAP (1-5 x 0.42 kg ai/ha, PHI 3 days 1-3 x 0.56 kg ai/ha, PHI 21 days) the residues at the GAP PHI were 0.42 to 1.7 mg/kg.

Table 10. Residues from trials with benomyl on cane berries.

Country/Report No. Berry Location	Application			PHI, days	Residues, Mg/kg
	No	kg ai/ha	kg ai/hl		
USA/ TAS000-005/1969 Blackberries					
OR	3	0.56	0.060	2	2.0
	5	0.45	0.013	6	3.3
	3	0.45	0.013	0 3 7 14	3.9 1.7 1.6 1.0
	4	0.45	0.013	0 3 7 14	2.0 1.6 1.2 0.49
Boysenberries					
CA	2	1.12	0.06	1	1.8
	3	0.56	0.06	2	2.1
Blueberries					

Country/Report No. Berry Location	Application			PHI, days	Residues, Mg/kg
	No	kg ai/ha	kg ai/hl		
WA	4	0.84	-	50	1.3
	5	0.70	-	39	<0.03
	1	0.84	-	31	0.91
MI	5	0.56	-	21	0.42
Canada/TAS000-005/1971 Raspberries					
Ontario	4	0.28	0.030	1	3.7
	4	0.28	0.030	7	0.98
	3	0.28	0.030	12	0.98

Grapes. Twenty two trials were conducted in Europe (Table 11). In two trials in Greece according to GAP (0.03-0.04 kg ai/hl) and four in France and Italy according to French GAP (1-4 x 0.25-0.50 kg ai/ha) the residues were 0.30 to 1.0 mg/kg at the GAP PHI of 14 days. In two trials in Germany at higher than usual rates in Europe the residues were 0.24 and 0.94 mg/kg after 14 days. One trial in Portugal and two in Spain according to Spanish GAP (0.03-1.0 kg ai/ha, 14-day PHI) gave residues of 0.46 to 0.86 mg/kg.

Decline studies showed that residues either decreased by 23-42%, remained unchanged or increased by 53% within periods of 14 to 35 days.

Table 11. Residues from trials with benomyl on grapes.

Country Report No. Year location	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
France AMR 3449-95 1995 Nambsheim	4	0.270-0.526	0.05-0.07	0 1 3 7 14	0.78 0.84 1.1 0.72 0.45
AMR3938-96 1996	4	0.50	0.06	14	1.0
Germany BENO/RES 20 1968 Weinstrasse	3	0.9-1.8	0.15-0.30	14 21 28 35 52	0.24 <0.06 0.24 0.24 0.35
	4	0.9	0.15	4 8 14 22 28	0.47 0.47 0.94 0.53 0.72
Greece 1995	4	0.320-0.417	0.05	14	1.0
AMR3938-96 1996	4	0.258-0.499	0.05	14	0.30
Italy AMR 3450-95 1995 Puglia	4	0.49	0.05	14	0.36
AMR3938-96	4	0.349-0.507	0.05	0	1.3

Country Report No. Year location	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
Puegnago del Garda				1 3 7 14	0.73 0.96 0.67 1.0
Portugal AMR3938-96 1996	4	0.288-0.510	0.05	14	0.84
Spain 1995 Barcelona	4	0.274-0.341	0.05	14	0.86
AMR3938-96 1996 Sevilla	4	0.500-0510	0.05	14	0.46

Strawberries. The application in a Canadian trial approximated the GAP rate (0.875 kg ai/ha) but no samples were taken at the GAP PHI of 2 days. Residues after 1 and 4 days were 0.91 and 0.72 mg/kg. Eighteen trials in the USA were at lower or higher rates, or longer or shorter PHIs, than GAP (5-10 x 0.28-0.56 kg ai/ha, 1-day PHI). The residues at 0 to 14 days varied from 0.13 to 2.4 mg/kg. Residues decreased or increased irregularly during the 6-7 days after the last application. The results are shown in Table 12.

Table 12. Residues from trials with benomyl on strawberries.

Country Report No. year	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
Canada TAS000-005 1975 Vineland	5	1.12	0.12	1 4 7	0.91 0.72 0.60
USA TAS000-005 1969 OR	4	0.56	0.060	8	0.42
	4	1.12	0.120	8	0.72
	4	0.84	0.090	2	0.98
	5	0.84	0.090	1	0.58
	5	0.84	0.090	1 3 4 7	0.58 0.98 0.65 1.1
	4	1.68	0.180	2	1.3
	5	1.68	0.180	1 3 4 7	1.3 1.8 1.5 2.1
CA	3	0.56	0.040	0	1.1
	5	0.56	0.040	0 7	0.98 0.10
	5	0.56	0.030	3	1.1

Country Report No. year	Application No	kg ai/ha	kg ai/hl	PHI, days	Residues, mg/kg
	1	0.56	0.030	0 2 4 6	0.59 0.92 0.84 0.42
	1	1.12	0.060	0 2 4 6	0.92 1.9 2.4 0.50
WA	5	0.28	0.03	3	1.1
1974	5	1.12	-	0	0.32
WA	5	2.24	-	0	0.74
	5	3.36	-	0	0.92
1976	7	0.28	0.015	7	0.24, 0.13
NY	8	0.28	0.015	14	0.21, 0.24

Tropical fruits

Avocados. In two trials in the USA according to GAP (3-6 x 0.56-1.12 kg ai/ha, 30 days PHI) the residues in the fruit were 0.11 and <0.06 mg/kg after 22-30 days. In eight other trials at shorter PHIs residues in samples harvested after 11 to 21 days varied from 0.09 to 1.1 mg/kg (Table 13).

Report No. year	Application No	kg ai/ha	kg ai/hl	PHI, days	Residues, mg/kg
TAS000-005 1968 TX	3	1.12	0.024	22	0.11
1971 FL	6	0.56	0.006	30	<0.06
1973 FL	4	1.12	0.030	1 3 12	1.0 0.91 0.78
	8	0.56-1.12	0.015-0.030	1 4 11	0.84 0.43 0.54
1974 FL	6	1.12	0.12	10 14 21	0.39 0.36 0.23
	7	1.12	0.12	10 14 21	1.4 1.5 1.1
	4	1.12	0.059	10 14 21	0.48 0.22 0.25
	4	1.12	0.059	14 21	0.07 0.16
	6	1.12	0.059	14 21	0.28 0.18

Report No. year	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
	6	1.12	0.059	14 21	0.18 0.09
	6	1.12	0.059	14 21	0.35 0.36

Bananas. Twenty three trials were conducted in Central America where the GAP rate is 0.125-0.15 kg ai/ha with no specification of the number of applications or PHI. Residues in the whole fruit and pulp in 14 trials with 4 to 14 applications of 0.14 kg ai/ha ranged from <0.03 to 0.11 mg/kg at PHIs of 0 or 1 day. Eight trials at twice this rate and one at a lower rate gave similar results. One trial in Brazil according to GAP (0.125-0.130 kg ai/ha) and one at a double rate gave residues in the pulp of 0.44 and 0.07 mg/kg respectively. One trial in Jamaica according to Central American GAP and one at a double rate gave residues at day 0 of <0.03 and 0.04 mg/kg in the fruit and <0.03 mg/kg in the pulp respectively (Table 14).

Table 14. Residues from trials with benomyl on bananas.

Country Report No. year	Application			PHI, days	Portion analysed	Residues, mg/kg
	No	kg ai/ha	kg ai/hl			
COSTA RICA BENO/RES 21 1969[1]	6	0.14	0.5	0	fruit peel pulp	<0.06 <0.06 <0.06
1970[1]	7	0.14	0.5	0	fruit peel pulp	<0.06 <0.06 <0.06
1977[2]	6	0.14	0.75	1	fruit pulp	0.06, <0.03 <0.03, <0.03
	6	0.28	1.5	1	fruit pulp	0.07, 0.08 <0.03, <0.03
	6	0.14	0.75	1	fruit pulp	<0.03, 0.11 <0.03, <0.03
	6	0.28	1.5	1	fruit pulp	<0.03, 0.07 <0.03, <0.03
	6	0.14	0.75	1	fruit pulp	0.03, 0.05 <0.03, <0.03
	6	0.28	1.5	1	fruit pulp	0.06, 0.12 <0.03, <0.03
	7	0.14	0.75	1	fruit pulp	<0.03, <0.03 <0.03, <0.03
	7	0.28	1.5	1	fruit pulp	<0.03, 0.09 0.06, <0.03
	7	0.14	0.75	1	fruit pulp	<0.03 <0.03
	7	0.28	1.5	1	fruit pulp	<0.03 <0.03
	7	0.14	0.75	1	fruit pulp	<0.03 <0.03
	7	0.28	1.5	1	fruit pulp	<0.03 <0.03

Country Report No. year	Application			PHI, days	Portion analysed	Residues, mg/kg
	No	kg ai/ha	kg ai/hl			
	7	0.14	0.75	1	fruit pulp	<0.03 ≤0.03
	7	0.28	1.5	1	fruit pulp	<0.03 <0.03
	7	0.14	0.75	1	fruit pulp	<0.03 ≤0.03
	7	0.28	1.5	1	fruit pulp	<0.03 <0.03
HONDURAS 1970[1]	6	0.146	-	1	pulp	0.10
1971[1]	4	0.140	1.5	29	fruit pulp	<0.06 <0.06
	4	0.140	0.601	29	fruit pulp	<0.06 <0.06
1977-1978[2]	14	0.140	0.03	1	fruit pulp	<0.03 ≤0.03, <0.03
	14	0.07	0.015	1	fruit pulp	<0.03 <0.03
JAMAICA 1977[2]	5	0.140	-	0	fruit pulp	<0.03, <0.03 ≤0.03, <0.03
	5	0.280	-	0	fruit pulp	0.04, 0.04 <0.03, <0.03
BRAZIL 1985[2]	8	0.15	0.05	3	peel pulp	0.06 0.44
São Paulo	8	0.30	0.1	3	peel pulp	0.65 0.07

[1] Aerial spray
[2] Ground spray

Mangoes. Of nineteen trials in the USA 9 were at a lower rate (0.28 kg ai/ha) and 4 at higher rates (up to 3.92 kg ai/ha) than the recommended GAP (3-6 x 0.56-1.12 kg ai/ha, 14 days PHI). Of 6 trials at rates within the GAP range, 3 were with too many applications. The residues in all the trials ranged from <0.06 to 3.0 mg/kg in samples taken 2 to 29 days after the last application (Table 15).

Table 15. Residues from trials with benomyl on mangoes in the USA (FL).

Report No. year	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
TAS000-005	12	1.96	0.030	9	0.17
1968	17	1.96	0.030	9	3.0
	5	3.92	0.060	21	0.91
	11	3.92	0.06	19	2.0
1969	11	1.12	0.030	22	0.43
1970	6	0.28	0.015	15	<0.06
	6	0.28	0.015	15	<0.06
	6	0.6	0.018	6	0.72

Report No. year	Application No	kg ai/ha	kg ai/hl	PHI, days	Residues, mg/kg
	6	0.6	0.018	6	0.85
1971	5	1.12	0.03	14	0.09
	12	1.12	0.030	14	0.14
	7	1.12	0.030	2	0.28
	8	0.28	0.03	29	<0.06
	8	0.28	0.03	29	<0.06
	6	0.28	0.030	12	0.10
	5	0.28	0.030	17	0.15
	7	0.28	0.030	2	0.28
	6	0.28	0.030	12	<0.06
	5	0.28	0.030	17	0.08

Pineapples. Eight trials in Costa Rica according to Mexican GAP (0.25-0.50 kg ai/hl) gave residues at day 0 from 1.9 to 3.3 mg/kg in the fruit and <0.03 mg/kg in the pulp (Table 16).

Table 16. Residues from trials with benomyl on pineapples in Costa Rica.

Report No. year	Application No	kg ai/ha	kg ai/hl	PHI, days	Sample	Residues, mg/kg	Reference
AMR 3300-95 1995	1	5.11	0.25	0	fruit* pulp	2.0 <0.03	Test 1
	1	4.94	0.25	0	fruit pulp	2.1 <0.03	Test 2
	1	5.26	0.25	0	fruit pulp	2.5 <0.03	Test 3
	1	5.13	0.25	0	fruit pulp	3.3 <0.03	Test 4
1996	1	4.74	0.25	0	fruit pulp	2.9 <0.03	Test 5
	1	5.04	0.25	0	fruit pulp	2.7 <0.03	Test 6
	1	5.21	0.25	0	fruit pulp	1.9 <0.03	Test 7
	1	5.29	0.25	0	fruit pulp	2.3 <0.03	Test 8

* Residues in the whole fruit were calculated from the residues in the pulp and peel

Vegetables

Brussels sprouts. Six trials in the UK according to GAP (2 x 0.55 kg ai/ha, 21-day PHI) gave residues from <0.05 to 0.27 mg/kg at 21 days, and two in the USA at the GAP rate (1-3 x 1.12 kg ai/ha) gave residues at the GAP PHI of 7 days of 2.4 and 2.9 mg/kg (Table 17).

Table 17. Residues from trials with benomyl on Brussels sprouts.

Country Report No. Year Location	Application No	kg ai/ha	kg ai/hl	PHI, Days	Residues, mg/kg	Reference
UK AMR 4050-96 1995 Derbyshire	2	0.56	0.03	21	0.04	
North Yorkshire	2	0.56	0.03	21	<0.05	
Lincolnshire	2	0.56	0.03	21	0.08	
AMR 4015-96 Derbyshire	2	0.55	0.3	21	0.27	
N. Yorks	2	0.55	0.3	21	0.05	
Lincolnshire	2	0.55	0.3	21	0.16	
USA[1] TAS 000-005 1976 NY	1	0.56	-	0 7 14 21	3.0 2.3 1.1 0.45	
	1	1.12	-	0 7 14 21	5.57 2.9 1.4 2.1	
-	3	1.12	-	0 7 14	5.6 2.4 2.0	IR-4 NPRP

[1] Residues corrected for blanks

Cucumbers. In two greenhouse trials in Canada above and below the rate required by GAP (1-2 x 0.425 kg ai/ha, 14 days PHI), two trials in Greece above the recommended rate (1 x 0.03 kg ai/hl) and six in the USA at lower or higher rates and/or longer PHIs than GAP (4-8 x 0.14-0.28 kg ai/ha, PHI 1 day) the residues after 0 to 17 days ranged from <0.03 to 0.36 mg/kg. One trial in the USA according to GAP gave residues of <0.06 mg/kg at 1 day PHI.

Two trials in Germany with a soil drench and three indoor trials in the UK could not be evaluated in the absence of information on GAP.

In six trials in Portugal and Spain at the Spanish GAP rate (0.03 kg ai/hl) the residues after 7 days were <0.03 mg/kg. Although the recommended PHI is 14 days it is unlikely that the residues after 7 days would increase so these residues could be used in estimating maximum residue levels (Table 18).

Table 18. Residues from trials with benomyl on cucumbers.

Country Report No. year	Application No	kg ai/ha	kg ai/hl	PHI, days	Residues, mg/kg
Canada[1,3] TAS000-005 1969	4	0.28	0.03	0 7 14	0.34 0.17 0.08
	4	0.56	0.06	0	0.36

Country Report No. year	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
				7	0.24
Germany [1, 2] BENO/RES 22	3	3.75-7.5	-	3 17	0.07 0.05
1969 Veitshochheim	2	3.75-7.5	-	3	0.10
Greece AMR 3427-95 1995 Attica	3	0.156-0.232	0.03	0 1 3 5 7	0.06 <0.03 <0.03 <0.03 ≤0.03
AMR 3889-96 1996	3	0.265-0.298	0.03	7	≤0.03
Portugal AMR 3427-95 Lisbon, 1995	3	0.192-0.204	0.03	0 1 3 5 7	0.03 <0.03 <0.03 <0.03 ≤0.03
AMR 3889-96 1996	3	0.215-0.247	0.03	7	0.05
Spain AMR 3427-95 1995 Huesca	3	0.228-0.239	0.03	0 1 3 5 7	<0.03 <0.03 <0.03 0.03 ≤0.03
	3	0.231-0.240	0.03	0 1 3 5 7	<0.03 0.05 <0.03 0.04 ≤0.03
AMR 3889-96 1996 Sevilla	3	0.190	0.03	0 1 3 5 7	<0.03 <0.03 <0.03 <0.03 ≤0.03
	3	0.179-0.185	0.03	0 1 3 5 7	<0.03 <0.03 <0.03 <0.03 ≤0.03
UK BENO/RES 22 1969[1, 2, 3] Suffolk	1	0.22	0.022	15	0.28
1970[3]	2	0.30	0.03	0	0.42
1972[1, 2, 3] Essex	9	0.22	0.022	7	0.33
USA[3] TAS000-005 1967 CA	4	0.42	-	0 9	0.23 <0.03
1968	2	0.28	-	3	<0.03
TX	2	0.44	-	3	0.08

Country Report No. year	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
				7	<0.03
SC	6	0.21	-	15 17	<0.06 <0.06
	2	0.21	-	1	<0.06
	3	0.21	-	1	<0.06
CA	3	0.28	-	11	<0.06

[1]Indoor
[2] Soil drench
[3]Residues were corrected for blanks

Melons and watermelons. In two trials on melons in Canada at lower rates but shorter PHIs than GAP (3 x 0.425 kg ai/ha, 14 days PHI) the residues were 0.18 and <0.06 mg/kg after 0 and 6 days. In two trials in France according to GAP for cucurbits (1-3 x 0.15-0.45 kg ai/ha) the residues at the GAP PHI of 7 days were <0.05 and 0.19 mg/kg. In five trials on melons in the USA the rates and/or PHIs did not comply with GAP (4-8 x 0.28 kg ai/ha, 1-day PHI). The residues were <0.03 to 0.21 mg/kg.

Four trials were conducted in the USA on watermelons, but no information on GAP was provided. The results are shown in Table 19.

Table 19. Residues from trials with benomyl on melons and watermelons.

Country Report No. year	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
Melons					
Canada TAS 000-005[1]	7	0.14	-	0	0.18
1968	6	0.21	-	6	<0.06
France BEA118908-BG Tarn	4	0.37	0.03	3 7 14	0.10 <0.05 <0.05
1988	4	0.39	0.03	3 7 14	0.33 0.19 0.08
USA TAS 000-005[1] 1967 CA	4	0.28	-	0 7	0.08 <0.03
AZ 1968	7	0.28	-	3	<0.03
TX	2	0.28	-	3	<0.03
	2	0.45	-	3 7	0.07 0.05
	5	0.22	-	13	0.21
Watermelons					
USA	7	0.42	-	1	0.18

Country Report No. year	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
TAS 000-005[1]				7	<0.06
SC	7	0.21		1 7	<0.06 <0.06
	7	0.42		1 7	0.09 0.12
	4	0.42		1 7	0.09 0.09

[1]Residues corrected for blanks

Summer squash. Four trials in the USA were at higher rates than GAP (4-8 x 0.12-0.28 kg ai/ha, 1-day PHI). The residues after 0 to 3 days varied from 0.06 to 0.36 mg/kg (Table 20).

Table 20. Residues from trials with benomyl on summer squash in the USA.

Report No. year	Application			PHI, days	Residues, mg/kg[1]
	No	kg ai/ha	kg ai/hl		
TAS000-005 1967 CA	4	0.42	-	0 7	0.36 <0.03
FL	5	0.84	-	1 5	0.32 0.11
TX	2	0.70	-	3	0.11
TX	3	0.70	-	3	0.06

[1] Corrected for blanks

Tomatoes. Thirteen trials were conducted on tomatoes in Europe from 1970 to 1996 (Table 21). Two trials in Greece were with three applications instead of one, but at the GAP concentration (0.03 kg ai/hl). The residues at the GAP PHI of 14 days were 0.04 and 0.08 mg/kg. Five trials in the UK with 1-7 applications of 0.28 or 0.56 kg ai/ha gave residues of 0.24 to 0.96 mg/kg after 0 to 16 days, but no information on GAP was provided.

In six trials in Portugal and Spain which approximated Portuguese GAP (0.15-0.30 kg ai/ha, 4-day PHI) the residues after 3 days were <0.03 to 0.12 mg/kg.

In three trials in the USA according to GAP (5-10 x 0.28-0.56 kg ai/ha) the residues at the GAP PHI of 1 day were 0.15-0.98 mg/kg. Sixteen other trials which did not conform to GAP gave residues of <0.06 to 2.9 mg/kg after 0 to 14 days.

Table 21. Residues from trials with benomyl on tomatoes in Europe and the USA.

Country Report No. year	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
Greece AMR 3449-95 1995	3	0.279-0.309	0.03	0 1 3 7 14	0.16 0.08 0.13 0.08 0.08
AMR 3939-96	3	0.149-0.233	0.03	0	0.03

Country Report No. year	Application No	kg ai/ha	kg ai/hl	PHI, days	Residues, mg/kg
1996				1	0.06
				3	0.04
				7	0.05
				14	0.04
Portugal AMR 3449-95 1995	3	0.172-0.180	0.03	0	<0.03
				1	<0.03
				3	<0.03
				7	<0.03
				14	<0.03
AMR 3939-96 1996	3	0.197-0.281	0.03	0	0.14
				1	0.08
				3	0.12
				7	0.08
				14	0.08
Spain AMR 3449-95 1995 Barcelona	3	0.334-0.352	0.02-0.03	0	0.15
				1	0.09
				3	0.08
				7	0.06
				14	<0.03
Sevilla	3	0.211-0.219	0.03	0	<0.03, <0.03
				1	0.03
				3	0.03
				7	<0.03
AMR 3939-96 1996 Sevilla	3	0.171-0.181	0.03	0	0.07
				1	0.07
				3	0.03
				8	0.03
				14	0.03
	3	0.177-0.182	0.03	0	0.09
				1	0.10
				3	0.06
				8	0.08
				14	0.07
UK BENO/RES 24 1970 Suffolk	1	0.56	0.56	0	0.96
Lincs[1] 1971-72	6	0.28	0.03	14	0.30
	7	0.28	0.03	16	0.24
	6	0.28	0.03	0	0.76
Essex[1]	6	0.28	0.03	7	0.33
USA [2] TAS000-005 1968 AR[1]	8	0.56	0.060	7	<0.06
TX	9	0.14	-	3	<0.06
				6	<0.06
OH[1] 1969	2	0.56	0.060	2	0.72
1971 FL	3	0.28	-	0	0.06
				6	0.10
	3	0.42	-	0	<0.06

Country Report No. year	Application			PHI, days	Residues, mg/kg
	No	kg ai/ha	kg ai/hl		
				6	0.08
	3	0.28	-	0	<0.06
				6	<0.06
	3	0.42	-	0	<0.06
				6	<0.06
1972 CA	3	0.28	-	0	0.92
				1	0.59
				4	0.46
	3	0.56	-	0	1.2
				1	0.98
				4	0.59
	4	0.28	-	0	0.27
				1	0.15
				4	0.36
	4	0.56	-	0	0.50
				1	0.56
				4	0.52
FL	3	0.28	-	3	0.19
				6	0.06
	3	0.28-0.56	-	3	0.20
				6	0.14
	3	0.28	-	8	0.13
	1	0.41	-	7	0.08
				14	<0.06
	2	0.56	-	7	0.32
IN[1]	3	0.56	0.030	10	<0.06
	3	0.56	0.060	10	<0.06
AMR 1352-89 1989 NY[3]	2	2.8	2.4	5	2.9

[1]Indoor
[2] Residues were corrected for blanks
[3] Also analysed for 2-AB

Legume vegetables

Beans. One trial in France with 2 applications of 0.96 kg ai/ha gave residues of 0.14 and <0.05 mg/kg after 11 and 25 days respectively. No GAP was reported.

Four of twelve trials in the USA on green beans (lima beans) were according to GAP (1-2 x 0.84-1.12 kg ai/ha). The residues in the whole commodity (bean plus pod) ranged from <0.06 to 0.14 mg/kg at PHIs of 20-33 days (Tables 22).

Table 22. Residues in beans plus pods from trials with benomyl on beans.

Country Report No. year	Application No	Application kg ai/ha	Application kg ai/hl	PHI, Days	Residues, mg/kg
France BEA118908-BG 1988 Bouches du Rhone	2	0.96	0.04	11 25	0.14 <0.05
USA TAS000-005 1970	1	0.56	-	14	0.38
OR	1	1.12	-	14	0.91
1971 CA	1	1.12	-	16	0.31
	2	1.12	-	19	<0.03
	2	1.12	-	20	0.14
WA	2	1.12	-	27	<0.06
ID	2	1.12	-	33	<0.06
	2	1.12	-	33	0.03
NY	2	1.12	-	38	0.09
	3	1.12	-	31	0.10
1975	2	1.12	-	14	0.10
NY	2	1.12	-	14	0.58

Dry and snap beans. In seven trials in Canada and the UK samples were taken much later than the recommended PHI (14 and 21 days).

Thirty two trials were carried out in the USA from 1968 to 1972. In six trials according to GAP (1-2 x 0.84-1.12 kg ai/ha, PHI 14 days) the residues in the whole commodity (beans plus pods) ranged from <0.06 to 0.47 mg/kg at PHIs of about 14 days. Residues in the pods from trials carried out at or above the GAP rate varied from <0.06 to 1.2 mg/kg after 2 to 45 days (Table 23).

Table 23. Residues from trials with benomyl on dry and snap beans.

Country Report No. year	Application No	Application kg ai/ha	Application kg ai/hl	PHI, days	Sample	Residues, mg/kg
Canada TAS000-005 1968 Ontario	1	1.68	-	27	pods and beans	<0.06
UK AMR 4014-96	2	0.55	0.30	44	Bean	0.73
1995	2	0.55	0.30	48	Bean	0.75
AMR 3994-96 1996	2	0.563-0.583	0.03	67	Bean	<0.03
	2	0.559-0.577	0.03	54	Bean	<0.03
	2	0.575-0.583	0.03	51	Bean	<0.03
	2	0.577	0.03	56	Bean	<0.03

Country Report No. year	Application			PHI, days	Sample	Residues, mg/kg
	No	kg ai/ha	kg ai/hl			
USA TAS000-005	1	2.24	-	26	Pods Vines	0.46 3.28
1968	1	2.24	-	19	Pods	0.11
OR	1	1.12	-	17	Pods Vines	<0.06 2.7
NY	1	1.12	-	10	Pods	0.14
	1	1.12	-	32	Pods	<0.06
	1	1.12	-	27	Pods	0.12
	2	0.84	-	20	Pods	0.07
	1	1.68	-	13	Pods	0.07
	2	1.68	-	7	Pods	0.12
WA	1	1.12	-	23	Pods	0.06
	1	2.24	-	2	Pods	0.33
	1	1.12	-	22	Pods Vines	0.07 2.5
	1	2.24	-	22	Pods Vines	0.07 5.8
	2	1.12	-	15	Pods Vines	0.28 1.6
	2	2.24	-	15	Pods Vines	0.28 3.3
OR	2	1.12	-	15	Pods	0.61
	2	2.24	-	15	Pods	1.2
1969 FL	1	1.12	-	45	Pods	<0.06
1970	1	1.12	-	22	pods and beans	0.07
WA	1	1.12	-	22	pod s and beans	0.06
	2	0.56[1]	-	15	pods and beans	<0.06
	2	0.56[1]	-	15	pods and beans	<0.06
1971	1	0.56	-	14	pods and beans	0.06
OR	1	0.56	-	14	pods and beans	0.06
	1	1.12	-	14	pods and beans	0.27
	1	1.12	-	26	pods and beans	<0.06
1972	2	1.12	-	15	pods and beans	0.10
OR	2	1.12	-	14	pods and beans	<0.06
	2	1.12	-	16	pods and beans	<0.06
1972	2	1.12[1]	-	19	pods and beans	<0.06
ID	2	1.12	-	42	pods and beans	<0.06
CO	2	0.84	-	15	pods and beans	0.47

[1] Aerial application

Peas. In two trials in the UK at the recommended rate (2 x 0.55 kg ai/ha) the residues were 0.11 and 0.04 mg/kg after 12 and 10 days. No samples were taken at the GAP PHI of 21 days (Table 24).

Table 24. Residues from trials with benomyl on peas in the UK.

Report No. year location	Application			PHI, days	Residues, mg/kg[1]
	No	kg ai/ha	kg ai/hl		
AMR 4013-96 1995	2	0.550	0.30	12	0.11
South Humberside	2	0.550	0.30	10	0.04

[1]In peas without pod

Soya beans. In four trials in the USA according to GAP (1-2 x 0.28-0.56 kg ai/ha, PHI 35 days) the residues in the grain at 35-43 days were <0.03 to 0.04 mg/kg. Three other trials at higher rates and one at the GAP rate but a longer PHI yielded residues from <0.03 to 0.23 mg/kg (Table 25).

Table 25. Residues from trials with benomyl on soya beans in the USA.

Report No. year location	Application			PHI, days	Residues in seed, mg/kg
	No	kg ai/ha	kg ai/hl		
AMR 1378-89 1989 IL	2	4.48	-	30	0.22
AMR 2564-93 1993	2	4.48	2.1	35	0.23
AMR 2894-94 1994	1	0.56	0.12	43	<0.03
MD	1	1.12	0.24	43	0.04
MS	1	0.56	0.62	47	<0.03
IN	1	0.56	0.24	35	0.04
IL	1	0.56	0.27	36	0.03
MN	1	0.56	0.32	35	<0.03

Root vegetables

Carrots. Twenty one trials in the USA on carrots according to GAP (3-12 x 0.14-0.56 kg ai/ha) gave residues of <0.01 to 0.14 mg/kg at the GAP PHI of 4 days. Eight other trials at higher rates or longer PHIs gave similar results (Table 26).

Table 26. Residues from trials with benomyl on carrots in the USA.

Report No. Year Location	Application			PHI, days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
TAS000-005	6	0.14-0.28	0.49	4	<0.03	
1974	9	0.14-0.28	0.49	4	<0.03	
FL	10	0.56	0.49	5	<0.03	
	11	0.56	0.49	5	<0.03	
1975	8	0.14	0.49	5	<0.03	
FL	10	0.56	0.49	10	<0.03	

Report No. Year Location	Application			PHI, days	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl			
AMR 2287-92 1992 CA	3	0.56	1.19	4	0.12	Test 4
	3	0.56	0.0055	4	0.05	Test 5
	3	0.56	0.24	4	<0.01	Test 6
	3	0.56	0.19	4	0.10	Test 7
	3	0.56	0.19	4	0.13	Test 8
	3	0.56	0.0073	4	0.11	Test 9
	3	0.56	0.0041	4	0.06	Test 10
	3	0.56	0.0042	4	0.04	Test 11
	3	0.56	0.24	4	0.01	Test 18
	3	1.12	0.48	4	0.01	
FL	3	0.56	0.12	4	0.02	Test 1
	3	1.12	0.24	4	0.04	
MI	3	0.56	0.25	4	0.04	Test 16
	3	1.12	0.50	4	0.13	
TX	3	0.56	0.24	4	0.14	Test 12
	3	0.56	0.46	4	0.05	Test 13
	3	0.56	1.19	4	0.02	Test 14
	3	0.56	0.30	4	0.04	Test 15
	3	1.12	0.60	4	0.14	
WI	3	0.56	0.22-0.21	4	0.05	Test 3
1993 FL	3	0.56	0.20	4	0.05	Test 2
	3	0.56	0.12	4	0.02	Test 15
	3	1.12	0.24	4	0.07	

Sugar beet. In one trial on sugar beet in France and twelve in the USA at rates from 1 x 0.16 to 6 x 0.42 kg ai/ha, residues in the roots were <0.05 or <0.06 mg/kg and in the tops 0.10 to 11 mg/kg after 21 to 53 days (Table 27). No information on GAP was reported.

Table 27. Residues from trials with benomyl on sugar beet.

Country Report No. year	Application			PHI, days	Sample	Residues, mg/kg
	No	kg ai/ha	kg ai/hl			
France BEA118909-BG Cote d'Or 1988	1	0.16	0.16	21	roots	<0.05
USA TAS000-005 1967 OH	5	0.21	0.022	23	roots tops	<0.06 0.22
IA	3	0.21	0.037	36	roots tops	<0.06 0.20
MN	4	0.21	0.045	23	roots tops	<0.06 11
1968 MN	4	0.28	0.037	31	roots tops	<0.06 0.15
CA	5	0.42	0.045	24	roots tops	<0.06 1.1

Country Report No. year	Application			PHI, days	Sample	Residues, mg/kg
	No	kg ai/ha	kg ai/hl			
MI	6	0.21	0.022	16	roots tops	<0.06 0.27
OH	3	0.42	0.045	53	roots tops	<0.06 0.65
MO	4	0.42	0.045	39	roots tops	<0.06 0.16
IO	3	0.28	0.16	34	roots tops	<0.06 0.10
	3	0.28	0.075	34	tops	0.11
TX	6	0.21	0.049	46	roots tops	<0.06 0.65
	6	0.42	0.049	46	roots tops	<0.06 0.44

Cereal grains

Rice. Of twenty nine trials on rice in the USA from 1969 to 1989, 21 were according to GAP (1-2 x 0.56-1.12 kg ai/ha, 21-day PHI). The residues ranged from <0.03 to 1.6 mg/kg in the husked grain and from 0.25 to 11 mg/kg in the straw (Table 28).

Table 28. Residues in husked grain and straw from trials with benomyl on rice in the USA.

Report No. year location	Application			PHI, days	Portion analysed	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl				
BENO/RES 23 1969	2	0.56	0.2	32	grain straw	<0.07 1.6	
LA	2	2.24	0.86	32	grain straw	0.12 4.8	
1970	2	0.672	0.748	25	grain	0.08	
TX	2	0.672	0.748	20	grain	0.36	
1972	2	1.12	1.12	29	grain straw	0.07 2.5	
TX	2	0.672	0.187	23	grain straw	0.26 8.5	
	2	1.12	-	24	grain straw	<0.03 0.25	
	2	1.12	1.03	26	grain straw	0.20 5.9	
	2	1.12	1.03	29	grain straw	<0.03 1.4	
1973	3	0.56	0.28	40	grain straw	0.07 0.29	
LA	2	0.56	0.28	21	grain straw	<0.03 0.65	

Report No. year location	Application			PHI, days	Portion analysed	Residues, mg/kg	Reference
	No	kg ai/ha	kg ai/hl				
	2	0.56	0.28	15	grain	0.70	
					straw	2.5	
TX	2	0.28	0.17	24	grain	<0.05	
	2	0.56	0.17	24	grain	0.05	
	2	0.56	0.448	21	grain	<0.03	
	2	0.56	0.448	21	grain	<0.03	
	2	0.56	0.448	21	grain	<0.03	
1974	2	0.56	0.093	7	grain	<0.03	
				14	grain	<0.03	
				14	straw	2.5	
				21	grain	<0.03	
				21	straw	0.41	
				30	grain	<0.03	
LA	2	0.56	0.280	7	grain	1.8	
				14	grain	1.8	
				14	straw	3.7	
				21	grain	1.6	
				21	straw	5.9	
				33	grain	<0.03	
				33	straw	2.4	
	2	0.56	0.093	7	grain	0.5	
				14	grain	0.11	
				14	straw	1.3	
				21	grain	0.04	
				21	straw	0.98	
				30	grain	<0.03	
AR	2	0.56	0.093	10	grain	0.67	
				10	straw	1.5	
				19	grain	0.16	
				19	straw	0.65	
				33	grain	<0.03	
				33	straw	<0.03	
AMR 1433-89	2	1.12	1.3	21	straw	11	Test 1
MS	2	2.24	2.5	21	straw	29	
AK	2	1.12	1.2	21	straw	4.3	Test 2
	2	2.24	2.4	21	straw	14	
	2	1.12	1.2	21	straw	4.3	Test 3
	2	2.24	2.4	21	straw	12	
LA	2	1.12	0.7	21	straw	1.3	Test 4
	2	2.24	1.4	21	straw	7.5	

Wheat. Two trials in the Netherlands according to GAP (1 x 0.25 kg ai/ha, 35 days PHI) gave residues of <0.04 mg/kg in the grain and 0.05 and 0.18 mg/kg in the straw at 34 or 35 days. In two other trials at twice this rate, the residues were <0.07 mg/kg in the grain and 0.50 and 0.44 mg/kg in the straw after 63 or 64 days (Table 29).

In four trials in the USA according to GAP (1-2 x 0.28-1.12 kg ai/ha) the residues at PHIs close to GAP (21 days) were <0.03 mg/kg in the grain and <0.1 and 0.72 mg/kg in the straw. In three trials at shorter PHIs they were 0.09 to 0.15 mg/kg in the grain and 1.6 to 2.7 mg/kg in the straw.

Table29. Residues from trials with benomyl on wheat.

Country Report No. year	Application No	Application kg ai/ha	Application kg ai/hl	PHI, days	Sample	Residues, mg/kg	Reference
Netherlands R4278 1973	1	0.25	0.050	35	grain straw	<0.04 0.05	
	1	0.25	0.050	34	grain grain	<0.04 0.18	
1972	1	0.50	-	63	grain straw	<0.07 0.50	
	1	0.50	-	64	grain straw	<0.07 0.44	
USA TAS000-005 1974/1975 MD	2	0.28	0.067	28	grain straw	<0.03 <0.1	
	2	0.56	0.133	28	grain straw	<0.03 <0.1	
DE	2	0.28	-	19	grain straw	<0.03 0.72	
IL	2	0.28	0.15	26	grain	<0.03	
	2	0.28	0.15	30	grain	<0.03	
	8	0.56	0.05	9	grain straw	0.09 2.2	
	4	0.56	0.05	9	grain straw	0.15 2.7	
	2	0.56	0.05	9	grain straw	0.10 1.6	

Nuts

Fourteen trials in the USA on almonds at or above the GAP rate (2-3 x 0.56-0.84 kg ai/ha) gave residues of <0.06-0.08 mg/kg in the kernels, but all the samples were taken much later than the recommended PHI of 50 days.

Seven trials on macadamia nuts, five of them above the recommended rate (3 x 0.98 kg ai/ha), gave residues of <0.06 mg/kg in the kernels after 95-151 days.

Six trials on pecans gave the same residues but no GAP was reported to evaluate the results (Table 30).

Table 30. Residues from trials with benomyl on tree nuts in the USA (Report No. TAS 000-005).

Commodity, location year	Application No	Application kg ai/ha	Application kg ai/hl	PHI, days	Sample	Residues, mg/kg	Reference
Almonds, California							
1969	2	0.448	0.019	162	kernels hulls	<0.06 <0.13	
	2	0.896	0.038	162	kernels hulls	<0.06 <0.13	
	2	0.448	0.03	204	kernels hulls	<0.06 <0.13	
	2	0.896	0.03	204	kernels hulls	<0.06 <0.13	
	2	0.448	0.03	204	kernels hulls	<0.06 <0.13	
	2	0.896	0.03	204	kernels hulls	<0.06 <0.13	
1970	1	1.4	0.030	233	kernels hulls	<0.06 0.27	
1971	1	1.4	0.12	204	kernels hulls	<0.06 <0.06	
	1	1.4	0.03	201	kernels hulls	<0.06 <0.06	
	1	1.12	0.17	177	kernels hulls	0.06 0.08	
	1	0.56	0.023	175	kernels hulls	<0.06 <0.06	
	1	1.12	0.046	175	kernels hulls	0.08 0.48	
	1	1.12	0.046	175	kernels hulls	<0.06 <0.06	
	3	0.784	0.0335	175	kernels hulls	<0.06 0.06	
Macadamia nuts, Hawaii, 1970							
	5	1.4	0.30	102	kernels	<0.06	
	10	1.4	0.30	95	kernels	<0.06	
	10	2.8	0.60	95	kernels	<0.06	
	4	1.0	0.31	144	kernels	<0.06	
	7	1.0	0.31	144	kernels	<0.06	
	7	2.0	0.62	144	kernels	<0.06	
	4	1.4	0.30	151	kernels	<0.06	
Pecans, 1967/1968							
GA	6	0.84	0.029	69	kernels	<0.06	
	6	0.56	0.019	86	kernels	<0.06	
FL	6	0.56	0.039	70	kernels	<0.06	
MS	4	0.56	0.029	64	kernels	<0.06	
	5	0.84	0.029	64	kernels	<0.06	
AR	3	0.56	0.059	98	kernels	<0.06	

Peanuts. Ten trials in the USA above the GAP rate (12 x 0.14 kg ai/ha) gave residues in the kernels of <0.06 mg/kg after 11 to 86 days. The recommended PHI is 14 days (Table 31).

Table 31. Residues from trials with benomyl on peanuts in the USA (Report No. TAS 000-005).

Location	Application			PHI, days	Residues in kernels, mg/kg
	No	kg ai/ha	kg ai/hl		
GA	7	0.21	-	20	<0.06
FL	6	0.21	-	25	<0.06
AL	13	0.21	-	11	<0.06
TX	4	0.21	-	18	<0.06
	3	0.44	-	14	<0.06
	4	0.33	-	32	<0.06
	6	0.33	-	33	<0.06
OK	4	0.44	-	37	<0.06
NC	1	4.48	-	86	<0.06
	2	0.56	-	14	<0.06

FATE OF RESIDUES IN STORAGE AND PROCESSING

In storage

No information.

In processing

Oranges. In a study in the USA (McNally and Hay, 1991a) a WG formulation of benomyl was applied at more than seven times the GAP rate. On the day of the last application the harvested oranges were dipped in a water solution of 240 g ai/hl of benomyl. In two studies in Brazil (Galhiane, 1994a,b) 0.025-0.1 kg ai/ha of a WP formulation of benomyl was applied 3 or 4 times. The oranges and the processed fractions were analysed for benomyl, carbendazim and 2-aminobenzimidazole (2-AB). The results are shown in Table 32. In all the studies the processing procedures simulated commercial practice.

In the US study the residues increased only in orange oil (by a factor of 1.36). The other processing factors varied from 0.012 in finisher pulp to 0.88 in dried peel. The processing factors for juice were 0.016 in the USA and 0.23-0.83 in Brazil.

Table 32. Effects of processing on residues in oranges.

Sample	PHI, days	Residues as carbendazim, mg/kg	Processing factor
USA			
Unwashed fruit	0	6.0	1.0
Washed fruit	0	0.74	0.12
Juice	0	0.10	0.016
Finisher pulp	0	0.07	0.012
Oil emulsion water	0	0.93	0.15
Press liquor	0	1.0	0.16
Peel frits	0	2.6	0.43
Orange oil	0	8.2	1.36
Chopped peel	0	1.5	0.25
Dried peel	0	5.3	0.88
Molasses	0	3.6	0.60

Sample	PHI, days	Residues as carbendazim, mg/kg	Processing factor
BRAZIL			
Fruit Juice	1	0.13; 0.14 0.03; 0.05	0.23; 0.36
Fruit Juice	1	0.36; 0.24 0.10; 0.20	0.28; 0.83

Apples. In simulated household and industrial processing studies in the USA a benomyl WG formulation was applied to apple trees according to US GAP (6 x 0.0238-0.09 kg ai/hl). In the household preparation study, in New York and Ohio (Sharp, 1993a), freshly harvested apples were washed and packed at commercial packing facilities to produce fruit for supermarket shelves and samples were collected throughout the packing line process. Typical household preparation was used to produce consumer-prepared washed, peeled and cooked apples. In the industrial study (North Carolina and Pennsylvania, Sharp, 1993b) apples were conventionally harvested and commercially processed at industrial food processing facilities to produce puréed apples, canned apple slices, apple sauce and apple juice using state-of-the-art food processing technology. The results are shown in Table 33.

Table 33. Effects of household and industrial processing on residues in apples, USA.

Sample	PHI, days	Residue, mg/kg as carbendazim	Processing factors	
			From line start	From raw fruit
New York Trial				
Unwashed fruit	14	0.20		1.0
Packing line start apples	64	0.18	1.0	0.9
Washed & brushed	64	0.14	0.81	0.73
Consumer washed	92	0.14	0.74	0.66
Consumer cooked with peel	92	0.16	0.89	0.80
Consumer peeled and cooked	92	0.05	0.27	0.24
Ohio Trial				
Unwashed fruit	14	0.16	--- 1.0	1.0
Early pack-out				
Packing line start apples	33	0.07	1.0[b]	0.46
Washed & brushed	33	0.05	0.71	0.33
Consumer washed	40	0.05	0.68	0.31
Consumer cored and sliced	40	0.05	0.74	0.34
Late pack-out				
Packing line start apples	194	0.06	1.0	0.42
Washed & brushed	194	0.06	1.0	0.42
Consumer washed	229	0.05	0.70	0.29
Consumer cored and sliced	229	0.06	0.92	0.38
Consumer peeled and sliced	229	0.03	0.49	0.20
North Carolina Trial				
Unwashed fruit	14	0.19	---	
Processing lines 1, 2, 3				
RAC line start apples (mean of sample means)	62/6 4	0.22, 0.17, 0.18 (0.19 ± 0.03)*	1.0, 1.0, 1.0	
Water-washed apples (mean of sample means)	62/6 4	0.18, 0.20, 0.17 (0.18 ± 0.02)*	0.82, 1.2, 0.93 (0.98 ± 0.20)*	
Final puréed apple (H_2O) (mean of sample means)	62/6 4	0.12, 0.11, 0.14 (0.12 ± 0.02)*	0.58, 0.65, 0.75 (0.66 ± 0.08)*	
Lye-washed apples	62	0.13	0.61	
Final puréed apple (lye)	62	0.12	0.58	
Pennsylvania Trial				
Unwashed fruit	14	0.27	---	1.0
Canned slice line				

Sample	PHI, days	Residue, mg/kg as carbendazim	Processing factors	
			From line start	From raw fruit
Packing line start apples	31	0.17	1.0	0.62
Washed apples	31	0.12	0.69	0.43
Peeled & cored slices	31	0.06	0.38	0.23
Canned apple slices	31	0.04	0.23	0.14
Apple sauce line				
Packing line start apples	73	0.10	1.0	0.36
Washed apples	73	0.07	0.73	0.26
Peeled & cored apples	73	0.04	0.41	0.15
Applesauce	73	0.04	0.37	0.13
Apple juice line				
Packing line start apples	73	0.10	1.0	0.36
Gradeout fruit	73	0.16	1.6	0.57
Pressed raw juice	73	0.07	0.73	0.26
Clarified & filtered juice	74	0.07	0.67	0.23

* Mean of two or more values

Washing and packing generally decreased the residues in the apples: the factors ranged from 0.26 to 1.2 (0.55 ± 0.28) and from 0.36 to 1.0 (0.68 ± 0.29) respectively. Residues in cooked peeled and unpeeled apples were 0.80 and 0.24 times those in the raw fruit respectively, while the processing factors for peeled and cored apple slices were 0.23-0.38 (0.24 ± 0.10). The factors for canned apple slices, apple sauce and gradeout fruit were 0.14, 0.13 and 0.57 respectively, and apple purée showed an average factor of 0.47 (0.58-0.75). Residues in the juice were decreased by factors of 0.26 and 0.23.

Peaches and plums. Two studies were conducted on peaches in the USA with 2 applications of 0.096 to 0.12 kg ai/hl (Sharp 1992, 1993c). Washing decreased the residues by factors of 0.18 and 0.37, and washing and peeling by factors of 0.02 and 0.12. Sliced and puréed peaches showed processing factors of <0.01 and 0.06 respectively (Table 34).

Plums treated with 4 applications of 0.99 or 1.96 kg ai/ha were processed into prunes in California (Goldberg, 1989a) with processing factors of 0.12 and 0.48. Plums from some of the residue trials in California were processed to prunes. The residues in the prunes are shown in Table 9 and the processing factors are listed in Table 34. The processing factors for prunes from all the trials ranged from 0.08 to 0.83, with an average of 0.24 ± 0.27 (n = 24)

Table 34. Effects of processing on residues in peaches and plums.

Peaches			Plums		
Sample	mg/kg as carbendazim	Processing factor	Sample	mg/kg as carbendazim	Processing factor
Whole	1.0		plum	1.2; 3.3	
Rinsed	0.37	0.37	prune	0.12; 0.48	0.1, 0.14
Peeled	0.12	0.12	Results from Table 9		0.83, 0.56, 0.09, 1.0,
Purée	0.06	0.06	6 trials, PHIs 0-14 days		0.026, 0.08, 0.018,
Whole	0.71				0.18, 0.15, 0.13, 0.10,
Flume washed	0.18	0.13			0.83, 0.56, 0.10, 0.24,
Lye peeled	0.02	0.01			0.027, 0.087, 0.18, 0.19,
Halves	<0.01	<0.01			0.15, 0.13, 0.10
Slices	0.01	<0.01	Average ± SD		0.24 ± 0.27

Grapes. The results of four processing studies on grapes in Switzerland (1971) after 3 to 6 applications of 0.6-3.0 kg ai/ha and PHIs from 15 to 56 days (Hornshuh, 1994c) and two in the USA in 1986 after 2 applications of 0.84 kg ai/ha and a PHI of 7 days (Goldberg, 1989b) are shown in Table 35. Processing factors for grapes to wine averaged 0.53, to raisins 1.3 and to raisin waste 4.1.

Table 35. Effects of processing on residues in grapes.

Country	Commodity	mg/kg as carbendazim	Processing factor
Switzerland	Grapes	2.3; 1.2 ; 5.3; 1.8	
	Wine	1.7; 0.40; 3.6; 0.65	0.74; 0.33; 0.68; 0.36
USA	Grapes	3.1; 1.2	
	Raisins	3.1; 1.9	1.0; 1.6
	Raisin waste	11; 5.6	3.5; 4.7

Tomatoes. A single processing study was conducted in the USA (Vincent and Tomic, 1989) after two applications of benomyl WG formulation at 5.6 kg ai/ha and a PHI of 5 days (GAP is 0.90 kg ai/ha with a PHI of 14 days). The pilot-scale plant differed from normal commercial practice only in having shorter start-up and shut-down intervals, leading to lower yields than would be expected in a commercial process. Processing factors varied from 0.27 for juice to 0.66 for purée (Table 36).

Table 36. Effects of processing on residues in tomatoes.

Commodity	mg/kg carbendazim	Processing factor
Whole fruit	2.9	
Wet tomato pomace	0.85	0.29
Dry tomato pomace	1.4	0.48
Juice	0.78	0.27
Purée	1.9	0.66
Ketchup	1.8	0.62

Soya beans. Two processing trials were conducted in the USA. In the first (McNally and Tomic, 1992) application was at 8 times the recommended rate and the processing closely simulated commercial procedures. The second (Adams, 1994), with four times the maximum label rate, was designed to determine the residues in aspirated grain fractions, comprising an assortment of seeds, stems, leaves, straw, hay, hulls, millings, sand and dirt. The results of both trials are shown in Table 37.

Table 37. The effects of processing on residues in tomatoes.

Sample	Benomyl as carbendazim, mg/kg	Processing factor
Whole soya beans	0.33	
Meal	0.24	0.71
Hulls	0.65	1.9
Refined oil	<0.03	<0.1
Crude oil	0.08	0.23
Soap stock	1.1	3.3
Whole soya beans	0.59	
Aspirated fractions	11	19.2

Rice. In two processing studies in the USA (McNally and Hay, 1991b) two applications of a WG benomyl formulation were made at 2.24 kg ai/ha (twice the GAP rate) with PHIs of 22 and 30 days. The pilot-scale plant differed from normal commercial practice only in having shorter start-up and shut-down intervals, giving lower yields. The results are shown in Table 38.

Table 38. The effect of processing on residues in rice.

Commodity	mg/kg as carbendazim	Processing factor
Whole grain	4.0	
Processed white rice	0.04	0.01
Whole grain	5.3	
Bran	1.6	0.31
Hulls	12	2.3

Milk. Benomyl was added to whole milk at a level of 1 mg/kg, and the treated milk was processed into common milk fractions (Chin *et al*., 1986). Although benomyl was lost in the production of sterile evaporated canned milk (processing factors of 0.64 and 0.43 for whole and skimmed milk respectively) pasteurisation did not affect the residue levels. The residues tended to concentrate in cream and other high-fat fractions (Table39).

Table39. The effect of processing on residues in milk.

Sample	mg/kg as carbendazim	Processing factor
Whole milk	0.47	
Heated at 140 °F	0.03	0.06
Skimmed milk	0.32	0.68
Pasteurized skimmed milk	0.32	0.68
Standardized whole milk	0.31	0.67
Canned evaporated whole milk	0.30	0.64
Canned evaporated skimmed milk	0.20	0.43
Spray-dried lactose	0.72	1.5
Anhydrous butter oil	0.72	1.5
Casein	0.54	1.1
Crude lactose	0.24	0.45
Whey	0.21	0.44
Mother liquor	2.5	5.2
Cream	0.78	1.7
Pasteurized cream	0.72	1.5
Residual cream solids	1.6	3.5

APPRAISAL

Benomyl, carbendazim and thiophanate-methyl are benzimidazole fungicides with extensive use on fruit, vegetables and cereals in many countries. Carbendazim and benomyl were first evaluated in 1973 and most recently in 1994 (residues) and 1995 (toxicology). They were proposed for re-evaluation within the Periodic Review Programme in 1998 by the 1995 CCPR. The 1996 CCPR postponed discussion on individual MRLs not recommended for deletion, awaiting the evaluation by the 1998 JMPR. It noted that the residue definition would be reconsidered on the basis of information provided by the UK and that a risk assessment would be required in relation to any new definition (ALINORM 97/24, para 51). Information on use patterns, national MRLs and analytical methods was provided by the main manufacturers and the governments of The Netherlands, Poland and Australia. This section discusses data on metabolism, environmental fate and analytical methods for benomyl and carbendazim, and residue trials on all three compounds. The metabolism, environmental fate and methods of determination thiophanate-methyl are dealt with in the separate item on that compound (4.25).

The metabolism of benomyl and carbendazim was studied in rats, mice, ruminants, hens and plants. In rats, benomyl and carbendazim are rapidly absorbed after oral administration; the bioavailability is up to 85% and is dependent to a great extent on the route of administration (less after incorporation in the diet than after administration by gavage). Excretion is rapid and takes place almost entirely in the urine. After the oral administration of 3 mg/kg bw of labelled carbendazim, the maximum blood level of 1.0 µg/ml was reached after 15 to 40 minutes, and up to 63% of the administered radioactivity was found in the urine after 6 hours. Excretion in the faeces accounted for a maximum of 1%. At higher doses (300 mg/kg bw) peak blood levels were less than proportionately higher and were reached later (after 0.4 to 4 hours). Repeated doses showed no indications of a cumulative effect. Minor amounts of the labelled substance or its metabolites were found for a short time in the excretory organs, liver and kidney, but with no accumulation.

The metabolic conversion of carbendazim in rats and mice occurs mainly by hydroxylation and hydrolysis. The main metabolite in rats is methyl 5-hydroxybenzimidazol-2-ylcarbamate (5-HBC), and other hydroxylated metabolites are also found to a minor extent. They are usually excreted as sulfates or glucuronides. Metabolites may also be present in the faeces after higher doses.

Benomyl and carbendazim are metabolized in a similar manner in both ruminants (cows and goats) and laying hens. Reported data indicate that the initial metabolism of benomyl occurs by loss of the butylcarbamoyl group to form carbendazim. It is hyphothesized that carbendazim is oxidized to an epoxide, which can undergo a number of transformations to the identified compounds. These include hydrolysis to a dihydrodiol, reduction to methyl 4-hydroxybenzimidazol-2-ylcarbamate (4-HBC) and 5-HBC, and sulfide conjugation. Sulfide conjugation is proposed as the source of the unextractable residues in the livers of goats, cows, and poultry, which can only be released by reductive cleavage using Raney nickel as a catalyst. In two cow and two goat metabolism studies, with either [2-^{14}C]benomyl or [2-^{14}C]carbendazim, the majority of the dosed ^{14}C was excreted in the urine (57-85%) and faeces (14-18%), with only a small fraction in the tissues (0.09 to 0.45% in the kidneys and 2.6 to 4.1% in the liver) or milk (0.37 to 2.2%). In the carbendazim-dosed cows 4,5-DDBC (methyl 4,5-dihydro-4,5-dihydroxybenzimidazol-2-ylcarbamate), ADDB (2-amino-4,5-dihydro-4,5-dihydroxy-benzimidazole), DHBC-G (the monoglucuronide of 5,6-dihydroxy-cabenazim), 4-HBC and 5-HBC occurred in urine, while 4-HBC (3%), 5-HBC (41%), 4,5-DDBC, and DHBC-G were the major residues in the kidneys. In the liver, 4,5-DHHBC-G (*S*-[4,5-dihydro-5-hydroxy-2-(methoxycarbonylamino)-1*H*-benzimidazol-4-yl]glutathione) and other sulfur-linked dihydrohydroxy-carbendazim conjugates (15.2%) predominated, with smaller amounts of 4,5-DDBC and ADDB (0.8%), and 5-HBC (2.7%). 4,5-DDBC (<0.06 mg/kg, <25%) was found in the milk in addition to 4-HBC (0.05 mg/kg, 21%) and 5-HBC (0.11 mg/kg, 42%). The metabolites seen in benomyl-treated cows were similar, indicating the loss of the butylcarbamoyl group before further metabolism occurs.

Benomyl is metabolized in plants mainly to carbendazim. Benomyl itself accounted for 48, 60, 77, 53 and 62% of the total benomyl plus carbendazim residue on the leaves of apple, cucumber, banana, orange and grape plants respectively, 21-23 days after treatment. In orange and apple peel the proportions of benomyl were 61 and 34% respectively after 15-16 days, and in rice and peaches 19.8 and 33% respectively. To determine the amount of benomyl remaining in or on plant tissues, the sample was subjected to reflux under caustic conditions to convert any remaining benomyl to the stable derivative BUB (*N*-(1*H*-benzimidazol-2-yl)-*N'*-butylurea); carbendazim under these conditions is converted to 2-aminobenzimidazole (2-AB).

In soya beans treated with benomyl, 2-AB was found to be a major metabolite in addition to carbendazim. After the plants were treated twice at the early pod stage, the major residues in the mature beans after 35 days were 2-AB (0.42 mg/kg), benomyl (0.05 mg/kg) and carbendazim (0.14 mg/kg). Unextractable residues accounted for 13% of the total radioactivity. In all the other plants tested, 2-AB was always below 10%.

Crop rotation studies with lettuce, radishes, beet, cabbage, barley, beans, maize, carrots, tomatoes, alfalfa and ryegrass showed little or no uptake of benomyl or its major soil degradation product carbendazim into succeeding crops. The residues in plants grown in soil treated with carbendazim or benomyl at 1 to 3.4 kg ai/ha and aged for 30 to 224 days were <0.1 mg/kg.

Studies of environmental fate with carbendazim and benomyl were conducted in soil, water and air. Benomyl is rapidly converted to carbendazim in the environment, with half-lives of 2 and 19 hours in water and soil respectively. Carbendazim decomposes in the environment with half-lives of 6 to 12 months on bare soil, 3 to 6 months on turf, and 2 and 25 months in water under aerobic and anaerobic conditions respectively. In degradation studies with [*phenyl*-^{14}C]benomyl, [2-^{14}C]benomyl or [2-^{14}C]carbendazim, incubated with soil or sediment under aerobic or anaerobic conditions, carbendazim was the major compound (34 to 57% of the applied radioactivity), followed by STB (3-butyl-1,3,5-perhydrotriazino[1,2-*a*]benzimidazole-2-4-dione) or BUB (up to 7.6%) and 2-AB (up to 1.5%). No formation of CO_2 (<0.1%) from benomyl was observed in sterilized aerobic soil or under strictly anaerobic conditions, but, 9.2% of the applied ^{14}C was evolved as CO_2 after 1 year of incubation under non-sterile aerobic conditions.

Adsorption/desorption experiments showed carbendazim desorption coefficients higher than adsorption coefficients (9 to 51 and 1.6 to 6.6 respectively), and a K_{oc} between 200 and 246. Column and container leaching studies showed that the leachate contained <2% of the applied radioactivity. In leaching experiments with benomyl in water-saturated silty clay loam soils, 94% of the applied radioactivity was found in the top soil segment (0-0.5 cm). Benomyl was well adsorbed to soils (K_a 6.1-90) but desorption occurred slowly (K_d 2.4-2.5), and the compound did not move significantly from the site of application (0.1-0.7% of the TRR was detected in the run-off water).

The hydrolytic, photochemical and biological degradation of carbendazim in aquatic systems at pH 5 to 9, under aerobic or anaerobic conditions and temperatures of 20-70°C, showed that 2-AB was the main degradation product, accounting for <3 to 30% of the total radioactivity. The half-life ranged from <0.125 days (aerobic, 20°C) to 457 days (pH 5, 22°C). There is little or no photolysis of benomyl. In an aerobic degradation study of [*phenyl*-^{14}C]benomyl in pond water and sediment the carbendazim formed had a half-life of 61 days under non-sterile conditions. After 30 days, 22% of the applied radioactivity was bound to the sediments and <1% was evolved as carbon dioxide.

The volatilization of carbendazim from bare soil and bean leaves was tested under outdoor conditions. After 6 hours from 76 to 117% of the applied compound remained in the soil and 83-100% on the leaves.

In the residue analysis for benomyl and carbendazim in plants, soil and water, the samples are homogenized with ethyl acetate or acetone under acidic condition to convert any benomyl present to carbendazim. The extracts are cleaned up by liquid-liquid partition and/or solid-phase extraction and carbendazim is determined by HPLC with UV, fluorescence or mass spectrometric detection, or by GLC with an ECD. In one study on pineapples, recoveries were 67-120% for benomyl (as carbendazim), 68-114% for carbendazim and 73-124% for 2-AB. The limit of determination ranged from 0.01 to 0.1 mg/kg. An ELISA immunoassay was developed for benomyl, as carbendazim, in water, with a linear range from 0.1 to 5 μg/l, a recovery of 100% and limit of determination of 0.65 μg/l.

Carbendazim and the metabolites 5-HBC and 4-HBC can be determined in animal products after hydrolysis and liquid-liquid extraction by HPLC with UV detection, with limits of determination of 0.01- 0.02 mg/kg in milk, 0.05-0.1 mg/kg in tissues and faeces, 0.1 mg/kg in urine and 0.05 mg/kg in eggs. Recoveries ranged from 50 to 100%.

Carbendazim residues in analytical samples were shown to be stable at -20°C for 18 months in apples and processed fractions, 26 months in peaches and processed fractions, 30 months in tomatoes and green beans, 24 months in wheat grain, wheat straw and soya beans and 9 months in soil, with the remaining residue ranging from 79 to 107% of the initial residue. 2-AB was shown to be stable for 24 months in tomatoes and for 9 months in soya beans.

Definition of the residue

The current residue definition to be used for enforcement for benomyl, carbendazim and thiophanate-methyl is "carbendazim". The Meeting noted however that an appreciable proportion of the residue in crops arising from the use of benomyl was likely to be benomyl (which would be determined as carbendazim), and concluded that the definition of residues of benomyl for compliance with MRLs should be “the sum of benomyl and carbendazim expressed as carbendazim”. Since the ADI of benomyl is five times that of carbendazim, the same definition would avoid under-estimating the dietary risk from benomyl and would therefore be appropriate for the estimation of STMRS.

The definition of residues arising from the use of carbendazim should continue to be “carbendazim” (both for compliance with MRLs and for the estimation of dietary intake), with the addition of a note that maximum residue levels and STMRs cover carbendazim residues arising as a result of the use of benomyl or thiophanate-methyl (occurring as a metabolite and/or hydrolysis product during analysis) or from the direct use of carbendazim.

Residues resulting from supervised trials

All the residues are expressed as carbendazim. Trials with benomyl, carbendazim and thiophanate-methyl are evaluated together for each crop. STMRs for benomyl, carbendazim or thiophanate-methyl have been estimated when there were enough trials according to GAP with each compound.

Citrus fruit, Oranges. Two trials with benomyl in the USA according to GAP yielded residues in the fruit, as carbendazim, of 0.29 and 0.43 mg/kg at a PHI of 2 days. Eleven other trials were at higher rates and/or longer PHIs. Four trials in Brazil at the GAP rate gave residues of 0.13, 0.14, 0.36 and 0.63 mg/kg at a 1-day PHI. Two other trials were at twice the GAP rate. The residues from treatments according to GAP were, in rank order, 0.13, 0.14, 0.29, 0.36, 0.43 and 0.63 mg/kg.

Two post-harvest trials were conducted with carbendazim in France, where no GAP was reported. One pre-harvest trial in South Africa at the GAP rate gave residues of 0.07 and 1.6 mg/kg in the pulp and fruit respectively, at 15 days. Another trial was at twice the GAP rate.

Two trials with thiophanate-methyl in Japan were according to GAP, giving residues in the pulp of 0.11 and 0.16 mg/kg at a 1-day PHI. The residues in the fruit, calculated from the peel/pulp ratio, were 0.16 and 0.23 mg/kg.

On the basis of the benomyl data the Meeting estimated a maximum residue level of 1 mg/kg, as carbendazim, in oranges. As there were not enough data on residues in the pulp from trials according to GAP, the Meeting estimated an STMR from the residues in the fruit of 0.325 mg/kg for benomyl, as carbendazim.

Other citrus fruit. Two trials were conducted with benomyl on grapefruit in the USA, according to GAP for citrus, giving residues in the fruit at a PHI of 2 days of 0.08 and 0.09 mg/kg. Four other trials on grapefruit and one trial on limes were at higher or lower rates or PHIs.

Two trials with thiophanate-methyl on Chinese citron were at a higher rate than the recommended GAP.

There were insufficient data from trials according to GAP to estimate a maximum residue level for grapefruit, Chinese citron or limes.

Pome fruit, Apples. Eleven trials with benomyl in France according to GAP gave residues in the fruit, as carbendazim, at PHIs of about 7 days of <0.05 (2), 0.11, 0.15, 0.19 (2), 0.28, 0.49, 0.60, 0.81 and 1.75 mg/kg. Three other trials were carried out in France at shorter PHIs and three in Germany at a higher rate than the recommended GAP. Nine trials in the UK (where there is no GAP) did not comply with any GAP in the northern part of Europe. Of 39 trials carried out in the USA 23 were according to GAP, giving residues at 14 days PHI of <0.01, 0.16, 0.18, 0.20, 0.27, 0.28, 0.36, 0.37, 0.38, 0.51, 0.54, 0.60, 0.65, 0.72, 0.78 (2), 0.98, 1.0 (2), 1.2, 1.4 and 1.6 (2) mg/kg.

Eight trials with carbendazim in Germany according to UK GAP gave residues at 7 days PHI of 0.30, 0.35, 0.36, 0.42, 0.49, 0.70, 0.84 and 0.90 mg/kg.

Two trials with thiophanate-methyl in France according to GAP gave residues as carbendazim at a 1-day PHI of 0.57 and 0.31 mg/kg. Sixteen post-harvest trials could not be evaluated as there was no GAP. Two trials in Japan at the GAP rate gave residues at a 1-day PHI of 0.25 and 1.0 mg/kg. Sixteen other trials in the UK and one in Denmark were at higher rates or longer or shorter PHIs than the recommended GAP.

Pears. Three trials with benomyl in the UK did not match any reported GAP. In eight trials in the USA according to GAP the residues at a PHI of 14 days were 0.52, 0.65, 0.72 (2), 0.85, 1.1, 1.3 and 2.4 mg/kg. Another trial was at a higher rate.

Two trials with thiophanate-methyl in Japan at the GAP rate gave residues at a 1-day PHI of 0.54 and 0.94 mg/kg. Four trials in the UK were at longer or shorter PHIs than the recommended GAP.

As the residue populations and the recommended uses on apples and pears are similar, the Meeting agreed to combine the residues in the two commodities and estimate a maximum residue level for pome fruits. The combined results are listed below.

Benomyl (as carbendazim): <0.01, <0.05 (2), 0.11, 0.15, 0.16, 0.18, 0.19 (2), 0.20, 0.27, 0.28 (2), 0.36, 0.37, 0.38, 0.46, 0.51, 0.52, 0.54, 0.60 (2), 0.65 (2), 0.72 (3), 0.78 (2), 0.81, 0.85, 0.98, 1.0 (2), 1.1, 1.2, 1.3, 1.4, 1.6 (2) 1.8 and 2.4 mg/kg.

Carbendazim: 0.30, 0.35, 0.36, 0.42, 0.49, 0.70, 0.84 and 0.90 mg/kg.

Thiophanate-methyl (as carbendazim): 0.31, 0.54, 0.57 and 0.94 mg/kg.

On the basis of the benomyl data the Meeting estimated a maximum residue level of 3 mg/kg as carbendazim in pome fruit, and STMRs for benomyl, carbendazim and thiophanate-methyl of 0.60, 0.455 and 0.555 mg/kg respectively.

Apricots and nectarines. One trial was conducted with benomyl on apricots in Switzerland, but no GAP was reported. Two trials in the USA on apricots and four on nectarines were at lower rates than the recommended GAP.

Eight trials were conducted with thiophanate-methyl on apricots in Italy, but the spray concentration was not reported.

As there were no data which could be related to approved GAP the Meeting could not estimate maximum residue levels and recommended the withdrawal of the existing draft MRLs for apricot and nectarine.

Cherries. Two trials with benomyl in Italy according to French GAP gave residues, as carbendazim, at a PHI of 7 days of 0.24 and 0.65 mg/kg. Forty one trials in the USA were at lower or higher rates than the recommended GAP.

Six residue trials with carbendazim in Germany did not match any reported GAP.

The treatment in one trial with thiophanate-methyl in France was below the recommended rate. One trial in the UK according to French GAP and another in France according to Belgian GAP gave residues, as carbendazim, of 0.17 mg/kg at day 0 and 0.22 mg/kg at 13 days respectively.

The Meeting concluded that there were insufficient data from trials according to GAP to estimate a maximum residue level for cherries, and recommended the withdrawal of the draft MRL.

Peaches. Four trials with benomyl in France according to GAP gave residues in fruit, as carbendazim, of 0.07, 0.09, 0.12 and 0.15 mg/kg at a PHI of 7 days. Trials in Portugal and Spain according to Portuguese GAP gave residues at a PHI of 7 days of 0.08, 0.09 and 0.56 mg/kg. Seven trials in the USA according to GAP gave residues at a PHI of 3 days of 0.21, 0.30, 0.51, 0.61, 0.72, 1.0 (2) mg/kg. Three other trials in the USA were at twice the GAP rate. The trials according to GAP gave residues, in rank order, of 0.07, 0.08, 0.09 (2), 0.12, 0.15, 0.21, 0.30, 0.51, 0.56, 0.61, 0.72 and 1.0 (2) mg/kg.

In 12 trials with carbendazim in Europe, where recommended PHIs are 14-15 days, the samples were harvested after 40 days or more.

In three trials with thiophanate-methyl in France at the GAP rate (no PHI specified) samples were harvested after 12 or 19 days. Two other trials were at a lower rate. Thirteen trials in Italy did not match GAP in Italy or a neighbouring country. In two trials in Japan at the GAP rate the residues in the pulp, as carbendazim, at a PHI of 1 day were 0.41 and 0.22 mg/kg.

On the basis of the benomyl data, the Meeting confirmed the draft MRL of 2 mg/kg for peach and estimated an STMR of 0.255 mg/kg for benomyl, as carbendazim.

Plums. In seven trials in France and Italy with benomyl according to French GAP, the residues in the fruit at a PHI of 7 days were <0.05(2), 0.05, 0.06, 0.08, 0.10 and 0.34 mg/kg. Two trials in Spain according to Portuguese GAP gave residues of 0.07 and 0.05 mg/kg after 7 days. In four trials in the USA according to GAP the residues at a PHI of 3 days were 0.02, 0.06, 0.21 and 0.24 mg/kg in the fruit. Another eight trials in the USA were at lower or higher rates. In rank order, the trials according to GAP gave residue of <0.05(2), 0.02, 0.05 (2), 0.06 (2), 0.07, 0.08, 0.10, 0.21, 0.24 and 0.34 mg/kg.

In three trials with thiophanate-methyl in France according to GAP (no PHI specified) none of the samples were taken at day 0. Four other trials were at a lower rate. In five trials in Italy the application concentration was not reported.

The Meeting confirmed the draft MRL of 0.5 mg/kg for plums and estimated an STMR of 0.06 mg/kg for benomyl as carbendazim.

Berries and small fruits, Grapes. In four trials with benomyl in France and Italy according to French GAP and two in Greece, one in Portugal and two in Spain according to the national GAP, the residues as carbendazim were 0.30, 0.36, 0.45, 0.46, 0.84, 0.86 and 1.0 (3) mg/kg at a PHI of 14 days. Two trials in Germany (no GAP) were at higher rates than reported European GAP.

Ten trials carried out with carbendazim on grapes in France and two in Spain did not match any reported GAP. Nine trials in Germany and two in Italy were at higher rates than the recommended GAP.

Of twenty trials with thiophanate-methyl in Italy, five which complied with Portuguese or Spanish GAP gave residues as carbendazim after 22 or 28 days of 0.21, 0.36, 0.56, 0.87 and 1.9 mg/kg. Two trials in Portugal according to GAP gave residues of 1.1 and 1.3 mg/kg at the GAP PHI of 28 days. Two trials in Japan were at the GAP rate, but at a longer PHI. The trials according to GAP gave residues of 0.21, 0.36, 0.56, 0.87, 1.1, 1.3 and 1.9 mg/kg.

On the basis of the trials with benomyl and thiophanate-methyl the Meeting estimated a maximum residue level of 3 mg/kg as carbendazim, and STMRs for benomyl and thiophanate-methyl, as carbendazim, of 0.84 and 0.87 mg/kg respectively.

Strawberries. One trial with benomyl in Canada and eighteen in the USA were at lower or higher rates or PHIs than the recommended GAP.

Two trials with carbendazim in the UK and one in Finland according to GAP in The Netherlands gave residues at a PHI of 15 days of 0.30, 1.2 and 2.0 mg/kg. Six other trials in Germany and one in Italy could not be evaluated because no GAP was reported.

One trial with thiophanate-methyl in Denmark was at a higher rate than the recommended GAP and two trials in The Netherlands and 7 in the UK did not comply with any reported GAP.

The Meeting concluded that there were insufficient data from trials according to GAP to recommend an MRL or estimate an STMR for strawberries.

Other berries. Three trials with benomyl on blackberries and blueberries in the USA according to GAP gave residues at PHIs of 3 days (blackberries) or 21 days (blueberries) of 0.42, 1.6 and 1.7 mg/kg. Ten other trials were at lower or higher rates.

Twenty one trials in the UK with thiophanate-methyl did not match any reported GAP.

The Meeting concluded that there were insufficient data from trials according to GAP and recommended the withdrawal of the draft MRL for berries and other small fruits.

Avocados. In two trials with benomyl in the USA according to GAP, the residues were 0.22 and <0.06 mg/kg at 30 days PHI. Eight other trials were carried out at higher rates.

There were too few trials according to GAP. The Meeting recommended the withdrawal of the CXL for avocado.

Bananas. Fourteen trials were conducted with benomyl in Central America (no PHI) and Brazil (3 days PHI) according to GAP, with residues of <0.03 (7), 0.05, 0.06 (3) and 0.11 mg/kg in whole fruit and <0.03 (10), <0.06 (2), 0.10 and 0.44 mg/kg in the pulp.

The Meeting estimated a maximum residue level of 0.2 mg/kg to replace the existing CXL of 1 mg/kg. On the basis of the residues in pulp the Meeting estimated an STMR of 0.03 mg/kg for benomyl, as carbendazim.

Kiwifruit. Two trials in Japan with thiophanate-methyl according to GAP gave residues of 0.20 and 0.61 mg/kg in the pulp.

There were too few trials to estimate a maximum residue level.

Mangoes. Nineteen trials with benomyl in the USA were at lower or higher rates than the recommended GAP. The Meeting recommended the withdrawal of the CXL for mango.

Persimmons. One trial was conducted with thiophanate-methyl in Italy, but no GAP was reported. The Meeting could not estimate a maximum residue level.

Pineapples. Eight trials with benomyl in Costa Rica complied with Mexican GAP, giving residues at a 0-day PHI of 1.9, 2.0, 2.1, 2.3, 2.5, 2.7, 2.9 and 3.3 mg/kg in the whole fruit and <0.03 mg/kg in all trials in the pulp.

The Meeting estimated a maximum residue level of 5 mg/kg for pineapple and an STMR of 0.03 mg/kg for benomyl, as carbendazim, in pineapples.

Onions. Two trials with thiophanate-methyl in Japan at the GAP rate gave residues of <0.02 and 0.04 mg/kg at a PHI of 1 day. One trial in The Netherlands and 7 trials in the UK with a seed dressing and/or foliar treatment could not be evaluated as there was no information on GAP.

The Meeting concluded that there were insufficient data from trials according to GAP and recommended the withdrawal of the CXL for bulb onion.

Brussels sprouts. Six trials with benomyl in the UK which complied with GAP (21 days PHI) gave residues, as carbendazim, of 0.04, <0.05, 0.05, 0.08, 0.16 and 0.27 mg/kg, and two in the USA according to GAP gave residues of 2.4 and 2.9 mg/kg (7 days PHI).

Two trials with thiophanate-methyl in The Netherlands could not be evaluated as there was no reported GAP.

The Meeting concluded that the benomyl residues were from two different populations and on the basis of the UK data confirmed the CXL of 0.5 mg/kg for Brussels sprouts. It estimated an STMR of 0.065 mg/kg for benomyl as carbendazim.

Fruiting vegetables, Cucumbers and gherkins. Two trials with benomyl in Canada and six in the USA were at a lower or higher rate than the recommended GAP. Two trials in Germany with a soil drench and three indoor trials in the UK could not be evaluated in the absence of information on GAP. One trial in the USA in 1967 according to GAP gave a residue, as carbendazim, of <0.06 mg/kg. In two trials in Portugal, two in Greece and four in Spain, according to the recommended rate in Spain, where the PHI is 14 days, the residues after 7 days were <0.03 (7) and 0.05 mg/kg.

In four trials with carbendazim in Belgium and The Netherlands above the GAP rate only the peel and washed commodities were analysed. In ten trials on gherkins in Germany according to GAP in Belgium or The Netherlands the residues were <0.05 mg/kg at 3 days.

In one trial with thiophanate-methyl in Denmark and 3 trials in The Netherlands the treatments were below or above recommended rate in The Netherlands. Five trials in the UK were below the GAP rate or with drench treatments for which no GAP was reported.

On the basis of the carbendazim trials with support from the benomyl trials at 7 days PHI, the Meeting estimated maximum residue levels at the limit of determination of 0.05* mg/kg for cucumbers and gherkins to replace the previous recommendations of 0.5 mg/kg for cucumber and 2 mg/kg for gherkins. The Meeting estimated STMRs of 0.03 and 0.05 mg/kg for benomyl and carbendazim respectively in both cucumbers and gherkins.

Melons. Two trials with benomyl in Canada were at shorter PHIs than the recommended GAP. In two trials in France according to GAP for cucurbits, the residues at a PHI of 7 days were <0.05 and 0.19 mg/kg.

One trial with thiophanate-methyl in Italy according to Spanish GAP gave a residue of 0.11 mg/kg at a PHI of 21 days.

The Meeting concluded that there were insufficient data from trials according to GAP and recommended the withdrawal of the CXL for melons, except watermelon.

Tomatoes. Two trials with benomyl in Greece were at a higher rate than the recommended GAP, and five in the UK did not match any reported GAP. In six trials in Portugal and Spain according to Portuguese GAP the residues at 3 days PHI were <0.03, 0.03(2), 0.06, 0.08 and 0.12 mg/kg. In three trials in the USA according to GAP the residues at 1 day were 0.15, 0.56 and 0.98 mg/kg. Sixteen other trials in the USA were at lower or higher rates. The European and US trials represent two different populations and the results cannot be combined.

A total of ten trials were carried out with carbendazim in Finland, France, Italy and Spain, but no relevant GAP was reported. Seven of 10 trials in The Netherlands were according to GAP and yielded residues at a PHI of 3 days of <0.1 mg/kg in the pulp and of 0.08, 0.11, 0.12, 0.16, 0.17, 0.18 and 0.22 mg/kg in the whole fruit. The other trials at higher rates gave similar results.

Two trials with thiophanate-methyl in Italy and eight trials with drench or foliar treatments in the UK could not be evaluated because no relevant GAP was reported. Two trials in Japan according to GAP gave residues at 1 day of 0.59 and 0.73 mg/kg. Two other trials at a higher spray concentration gave residues of 0.69 and 0.31 mg/kg.

On the basis of the carbendazim data, the Meeting estimated a maximum residue level of 0.5 mg/kg for tomato to replace the draft MRL of 0.1 mg/kg, and an STMR of 0.16 mg/kg for carbendazim. The Meeting estimated an STMR of 0.045 mg/kg for benomyl, as carbendazim, on the basis of the European trials with benomyl.

Other fruiting vegetables. In the USA, four trials were conducted with benomyl on watermelons (no GAP reported) and four trials on summer squash at a higher rate than the recommended GAP.

One trial with thiophanate-methyl on egg plants and two on peppers in Italy, and ten trials on mushrooms in The Netherlands, could not be evaluated because information was incomplete or no GAP was reported.

As there were no data from trials according to GAP, the Meeting could not estimate a maximum residue level for watermelon and recommended the withdrawal of the draft MRLs for carbendazim in mushrooms and peppers, and the CXLs for egg plant and summer squash. No trials on winter squash were reported so the Meeting recommended the withdrawal of the CXL.

Lettuce. Seven trials were conducted with thiophanate-methyl in the UK in the field and in glasshouses, but no relevant GAP was reported. The Meeting recommended the withdrawal of the draft MRL for carbendazim in head lettuce.

Common beans. One trial was conducted with benomyl in France, but no GAP was reported. In four trials on green beans in the USA according to GAP, residues in the whole commodity were <0.06 (2), 0.03 and 0.14 mg/kg at a PHI of 28 days.

In three trials with carbendazim on dwarf beans in the UK according to GAP, residues at 22 days were all <0.1 mg/kg. Another three trials were at higher or lower rates or PHIs.

In one trial on dwarf beans and one on runner beans with thiophanate-methyl in the UK according to GAP and seven other trials on dwarf, broad and French beans at higher rates or PHIs, only the beans were analysed.

The Meeting concluded that there were insufficient data from trials according to GAP and recommended the withdrawal of the CXLs for common bean and broad bean.

Dry beans. Seven trials with benomyl in Canada and the UK and 32 trials in the USA did not comply with GAP.

Seven trials with carbendazim on field beans in the UK were at the GAP rate or higher, but there was not enough information to decide whether the trials were according to GAP.

Two trials with thiophanate-methyl in Japan on kidney beans according to the GAP rate for adzuki beans gave residues of 0.09 and 0.39 mg/kg in the beans. Four other trials on adzuki and kidney beans were at higher rates. In six trials with field beans in the UK at the GAP rate, the residues in the beans were 0.06, 0.09, 0.13, <0.2 (2) and 0.21 mg/kg after 6 to 19 days. The eight trials according to GAP gave residues in the beans of 0.06, 0.09 (2), 0.13, <0.2 (2), 0.21 and 0.39 mg/kg.

The Meeting estimated a maximum residue level of 0.5 mg/kg in dry beans, on the basis of the thiophanate-methyl data, to replace the CXL of 2 mg/kg, and an STMR of 0.165 mg/kg for thiophanate-methyl.

Peas. Two trials were conducted with benomyl in the UK at the recommended rate but with a shorter PHI.

Two trials with thiophanate-methyl in Japan were at a longer PHI, and nine in France were at a lower rate than recommended GAP. In four trials in the UK at GAP rates the residues in shelled peas, as carbendazim, were <0.01 (2) and 0.01 (2) mg/kg at 21 days PHI. Two other trials at shorter PHIs and two at longer PHIs gave similar results.

On the basis of the thiophanate-methyl trials according to GAP supported by two other trials at a shorter PHI, the Meeting estimated a maximum residue level of 0.02 mg/kg and an STMR of 0.01 mg/kg for thiophanate-methyl, as carbendazim, in garden pea, shelled.

Soya beans. In four trials with benomyl in the USA according to GAP, residues in the beans at a PHI of 35 days were <0.03 (2), 0.03 and 0.04 mg/kg. Four other trials were at higher rates or longer PHIs.

The Meeting concluded that there were insufficient data from trials according to GAP and recommended the withdrawal of the existing CXLs for soya bean (dry) and soya bean fodder.

Carrots. Twenty one trials with benomyl on carrots in the USA according to GAP yielded residues of <0.01, 0.01, 0.02 (3), <0.03 (3), 0.04 (3), 0.05 (4), 0.06, 0.10, 0.11, 0.12, 0.13 and 0.14 mg/kg at a PHI of 4 days. Eight other trials carried out at higher rates or a longer PHI gave similar results.

The Meeting estimated a maximum residue level of 0.2 mg/kg for carrot and an STMR of 0.05 mg/kg for benomyl, as carbendazim, in carrots.

Sugar beet. No GAP was reported to evaluate one trial in France and twelve in the USA with benomyl or six trials in France and nine in Germany with carbendazim. In one trial in Germany according to Belgian GAP, the residue at a PHI of 28 days was <0.05 mg/kg. Residues were similar in five other trials at higher or lower rates, and in all but one trial at a 0-day PHI.

Two trials with thiophanate-methyl in Japan according to GAP gave residues of <0.04 mg/kg at a PHI of 7 days.

The Meeting concluded that there were insufficient data from trials according to GAP to estimate a maximum residue level for sugar beet or sugar beet leaves or tops, and recommended the withdrawal of the existing CXL and draft MRL.

Celery. Two trials were conducted with thiophanate-methyl in The Netherlands, but no GAP was reported.

As no data from trials according to approved GAP were submitted, the Meeting recommended the withdrawal of the CXL.

Cereals, Barley grain. In three trials with carbendazim in Germany according to GAP, residues in the grain at a PHI of 56 days were <0.02, 0.03 and 0.05 mg/kg. In five other trials at higher rates and/or shorter PHIs the residues were in the same range. Fourteen other trials in Germany, France, Italy and Spain were at lower rates or longer PHIs than the recommended GAP. In the UK, two trials according to GAP (the PHI is “up to and including grain watery ripe”) yielded residues at 42-45 days PHI of <0.05 and 0.29 mg/kg. In rank order, the residues in the grain were <0.02, 0.03, <0.05, 0.05 and 0.29 mg/kg.

In fourteen trials with thiophanate-methyl in the UK (1973-1974) at up to 3 times the GAP rate (no PHI specified), the residues in the grain were <0.1 (13) and <0.2 mg/kg after 72 to 121 days. Fourteen trials with a seed dressing treatment (no GAP reported) gave similar results.

On the basis of the carbendazim trials complying with GAP (5 results), supported by the trials at a higher rate and/or shorter PHI (5 results), the Meeting estimated a maximum residue level of 0.5 mg/kg and an STMR of 0.05 mg/kg for carbendazim in barley grain.

Barley straw. In six trials with carbendazim in Germany and two in the UK according to GAP, the residues in rank order were <0.05, 0.20 (2), 0.49, 0.77 and 0.98 mg/kg.

The Meeting estimated a maximum residue level of 2 mg/kg (the existing CXL) and an STMR of 0.345 mg/kg for carbendazim in barley straw and fodder, dry.

Maize. In three trials with carbendazim in France in 1988 at the GAP rate and three at a lower rate the residues in the kernels after 10-31 days were <0.05 mg/kg.

The Meeting concluded that the data from trials according to GAP were insufficient to estimate a maximum residue level for maize.

Rice, grain. In seventeen trials with benomyl in the USA according to GAP, residues at 21 days, as carbendazim, were <0.03 (7), 0.04, 0.05, <0.07, <0.08, 0.16, 0.20, 0.26, 0.36, 0.70 and 1.6 mg/kg in the grain.

Three trials with thiophanate-methyl in Japan were at a higher rate than the recommended GAP.

The Meeting estimated a maximum residue level of 2 mg/kg and an STMR of 0.05 mg/kg for benomyl as carbendazim in rice, husked

Straw. In fifteen trials with benomyl in the USA according to GAP the residues, as carbendazim, were 0.25, 0.41, 0.65 (2), 0.98, 1.3, 1.4, 2.5 (2), 4.3 (2), 5.9 (2), 8.5 and 11 mg/kg in straw at a 21-day PHI.

The Meeting confirmed the CXL of 15 mg/kg for rice straw and fodder, dry, and estimated an STMR of 2.5 mg/kg for benomyl as carbendazim.

Wheat, grain. In two trials with benomyl in The Netherlands according to GAP the residues, as carbendazim, were <0.04 mg/kg at a PHI of 34/35 days. Two other trials at twice the rate and PHI gave similar results. In four trials in the USA according to GAP the residues at a PHI of 21 days were <0.03 mg/kg. Three other trials were at shorter PHIs than the recommended GAP. The residues in rank order from the trials according to GAP were <0.03 (4) and <0.04 (2) mg/kg.

In 30 trials with carbendazim in Germany the rates were higher than the recommended GAP and/or samples were not taken at the recommended PHI. In the UK, one trial according to GAP showed residues at a PHI of 42 days of <0.05 mg/kg. Seven trials in France, three in Italy, one in Spain and one in the UK were at higher or lower rates than allowed by GAP.

In two trials with thiophanate-methyl in Japan at the GAP rate the residues in husked grain after 14 or 30 days were <0.02 or 0.03 mg/kg. Seven trials in the UK which complied with GAP gave residues in the grain after 46 to 83 days of <0.01 (3), 0.01 and <0.03 (3) mg/kg. Another 15 trials at higher rates gave similar results. Four trials in The Netherlands with treatments up to four times the German GAP rate showed similar residues in the grain.

On the basis of the trials with thiophanate-methyl supported by those with benomyl, the Meeting estimated a maximum residue level in wheat grain 0.05* mg/kg as a practical limit of determination, and estimated STMRs of 0.03 and 0.01 mg/kg for benomyl and thiophanate-methyl, as carbendazim respectively.

Straw. In two trials with benomyl in The Netherlands and three in the USA according to GAP, residues, as carbendazim, were 0.05, <0.1 (2), 0.18 and 0.72 mg/kg.

In six trials with carbendazim in Germany and one in the UK according to GAP the residues were <0.03 (4), <0.05, 0.2 and 0.66 mg/kg, at PHIs of 42 or 56 days.

On the basis of the benomyl and carbendazim data, the Meeting estimated a maximum residue level of 1 mg/kg to replace the CXL of 5 mg/kg and STMRs of 0.1 mg/kg for benomyl as carbendazim and 0.03 mg/kg for carbendazim in wheat straw and fodder, dry.

Rye. Six trials with carbendazim in Germany at the GAP rate or higher gave residues in the grain below the LOD (0.01 or 0.05 mg/kg) at a longer PHI than the recommended GAP (56 days). In two trials the residues in stalks at 56 days were 0.33 and <0.05 mg/kg.

In the UK there is no GAP for the use of thiophanate-methyl on rye, so the estimated maximum residue level for wheat cannot be extended to rye.

As there were no data from trials according to GAP were submitted, the Meeting could not estimate a maximum residue level for rye, and recommended the withdrawal of the existing draft MRL.

Tree nuts. Fourteen trials with benomyl in the USA in almonds or macadamia nuts were at the GAP rate or higher, but the samples were taken much later than the recommended PHI. Six trials were conducted on pecans, but no GAP was reported.

As there were no data from trials according to GAP, the Meeting could not estimate a maximum residue level in tree nuts and recommended the withdrawal of the existing CXL.

Rape seed. Residues in ten trials with carbendazim in Germany according to GAP were <0.02 mg/kg in the pods and seeds at about 56 days PHI. In three other trials at higher rates and in five trials in France at or below the GAP rate and longer PHIs than recommended, residues in the seeds and pods were again below the LOD (0.05 or 0.02 mg/kg).

Four trials were carried out with thiophanate-methyl in France, but no GAP was reported.

On the basis of the carbendazim trials, the Meeting estimated a maximum residue level of 0.05* mg/kg to replace the existing CXL of 0.1 mg/kg. As trials with applications above the recommended rate also yielded residues below the LOD, the Meeting estimated an STMR of 0 for carbendazim in rape seed.

Hops. Four trials with carbendazim on hops in Germany were with 2 applications of 0.225 or 0.38 kg ai/ha. The residues at PHIs of 17 or 26 days were 16, 18, 29 and 49 mg/kg. As no GAP was reported, the Meeting recommended the withdrawal of the existing CXL.

Peanuts. Ten trials with benomyl in the USA with applications above the recommended GAP rate gave residues in the kernels of <0.06 mg/kg 11 to 86 days after the last application.

As no data from trials according to GAP were submitted, the Meeting recommended the withdrawal of the CXLs for carbendazim in peanut and peanut fodder.

Coffee. In one trial with carbendazim in Brazil with a higher application rate than the recommended GAP and in six trials in Kenya (no GAP) the residues in the beans after 44-81 days were <0.1 mg/kg.

As no data from trials according to GAP were reported, the Meeting recommended the withdrawal of the CXL for carbendazim in coffee beans.

Tea. In six trials with thiophanate-methyl in Japan at a lower rate than the recommended GAP, the residues were 1.1-1.8 mg/kg after 7-21 days.

As there were no data from trials according to GAP, the Meeting could not recommend an MRL.

Processing studies

In two processing studies with benomyl on oranges in Brazil and one in the USA which simulated commercial practices, the processing factors (PF) for juice were 0.016, 0.36 and 0.83, with an average of 0.40. In the US study the PF was 1.36 in orange oil and ranged from 0.012 in finisher pulp to 0.88 in dried peel.

On the basis of an STMR for benomyl in oranges of 0.325 mg/kg and the calculated processing factors, the Meeting estimated STMRs of 0.13 and 0.442 mg/kg for benomyl, as carbendazim, in orange juice and orange oil respectively.

Two processing studies were carried out in the USA with benomyl on apples, one simulating household and commercial preparation and the other industrial processing. Washing and packing normally decreased the residues on apples, with PFs ranging from 0.26 to 1.2 (mean 0.55 ± 0.28) and from 0.36 to 1.0 (0.68 ± 0.29) respectively. Residues in peeled and unpeeled apples decreased after cooking, with PFs of 0.80 and 0.24 respectively. Residues in peeled and cored apple slices were decreased by factors of 0.23-0.38 (0.24 ± 0.10). Canned apple slices, apple sauce and gradeout fruit had PFs of 0.14, 0.13 and 0.57 respectively, and the average PF for apple purée was 0.47. Residues in juice decreased by factors of 0.26 and 0.23.

On the basis of an STMR for benomyl in pome fruits of 0.60 mg/kg and the calculated processing factors, the Meeting estimated STMRs of 0.147, 0.282 and 0.078 mg/kg for benomyl, as carbendazim, in apple juice, apple purée and apple sauce respectively.

In two separate studies on peaches in the USA, washing and peeling processing factors were 0.18 and 0.37, and 0.02 and 0.12 respectively. The PFs for sliced and puréed peaches were <0.01 and 0.06 respectively. In seven studies on plums in California, the processing factors for prunes ranged from 0.08 to 0.83, with an average of 0.24 ± 0.27 (n = 25).

In four processing studies on grapes in Switzerland and two in the USA, the processing factors for wine averaged 0.53 (n = 4), for raisins 1.3 (n = 2) and for raisin waste 4.1 (n = 2).

On the basis of an STMR for benomyl in grapes of 0.84 mg/kg and the calculated processing factors, the Meeting estimated STMRs of 0.445, 1.09 and 3.44 mg/kg for benomyl, as carbendazim, in wine, raisins and raisin waste respectively.

A single processing study on tomatoes treated with benomyl was conducted in the USA in a pilot-scale plant, with processing factors of 0.29, 0.48, 0.27, 0.66, and 0.62 for wet tomato pomace, dry tomato pomace, juice, purée and ketchup respectively. The Meeting estimated corresponding STMRs of 0.013, 0.022, 0.012, 0.023, 0.030 and 0.028 mg/kg from the STMR of 0.045 mg/kg for benomyl in tomatoes.

In two processing studies in the USA with soya beans, the processing factors were 0.71, 1.9, <0.1, 0.23, 3.3 and 19.2 in meal, hulls, refined oil, crude oil, soap stock and aspirated fractions (assortment of seeds, stems, leaves, straw, hay, hulls, mill, sand and dirt) respectively, but there was no STMR for soya beans.

Two processing studies on rice in the USA in a pilot-scale plant closely simulated commercial practice. Processing factors from whole grain were 0.01, 0.31 and 2.3 in white rice, rice bran and rice hulls.

When benomyl was added to whole milk at a level of 1 mg/kg it appeared to be degraded during the production of commercial sterile evaporated canned milk (PFs of 0.64 and 0.43 for whole and skimmed milk respectively), but pasteurization did not affect residue levels. Residues tended to concentrate in mother liquor (PF=5.2) and cream (PF = 1.5 and 1.7).

As the STMR for benomyl in milk is 0, the STMR for cream is also 0.

Food of animal origin

Livestock feeding studies were conducted with benomyl or carbendazim at concentrations (in benomyl equivalents) ranging from 5 to 450 ppm in poultry and from 2 to 75 ppm in cattle. In two studies with cows at feeding levels above 10 ppm, residues in the milk of 4-HBC and 5-HBC ranged from <0.007 mg/kg after 7 days depuration to 0.09 mg/kg after 28 days of exposure. In four studies on poultry the residues of carbendazim, 4-HBC and 5HBC in the tissues and eggs were at or below the LOD (0.02 to 0.05 mg/kg) from levels of 5 ppm in the diet. A separate study showed that benomyl residues in liver reached a plateau within two weeks.

The STMRs for raisin waste and dry tomato pomace were equivalent to 5.2 and 0.033 mg/kg benomyl respectively, and the STMRs in barley, rice and wheat grain corresponded to 0.076, 0.076 and 0.045 mg/kg benomyl. On the basis of these estimates of the STMRs for animal feed items, the

Meeting concluded that the levels used in the feeding studies were adequate to estimate maximum residue levels in animal commodities.

The Meeting recommended the withdrawal of the CXLs for milks, cattle meat, chicken fat, poultry meat and eggs and estimated maximum residue levels of 0.05* mg/kg to replace them. As the lowest feeding levels used in the animal studies were much higher than the estimated dietary burdens, the Meeting estimated STMRs of 0 for cattle and poultry commodities (meat, milks, edible offal, chicken fat and eggs).

Residues in food in commerce or at consumption

Monitoring or surveillance data for carbendazim residues generated in the UK during 1995 and 1996 from samples of fruits, vegetables, cereals and processed products of UK or imported origin were submitted. In 1995, 1135 samples were analysed, of which 62 samples (55%) of apples, apple juice, fruit-based infant food, plums, strawberries, lettuce and blackcurrants had detectable levels of carbendazim (0.1 to 0.9 mg/kg). Of the 1375 samples analysed in 1996, 16 samples or 1.2% (apples, celery, dessert grapes and pears) had levels above the limit of determination, ranging from 0.1 to 1.1 mg/kg.

Monitoring data generated by the food industry in the UK were also reported. Residues of carbendazim were above the limit of determination in 36 samples. It was not clear from the report how many samples were analysed. Bananas had the highest frequency of positive samples (20%). Residues in bananas, apples, grapes, fruit conserve, oranges, pineapples and cabbages ranged from 0.2 to 1.5 mg/kg.

RECOMMENDATIONS

The maximum residue levels estimated to arise from the use of benomyl are covered by the MRLs recommended for carbendazim listed in the carbendazim monograph. The list also includes the STMRs estimated for benomyl, carbendazim and thiophanate-methyl.

Definition of the residue for compliance with MRLs and for the estimation of dietary intake: sum of benomyl and carbendazim, expressed as carbendazim.

DIETARY RISK ASSESSMENT

The residues of benomyl, carbendazim and thiophanate-methyl are all expressed as carbendazim, which has the lowest ADI of the three compounds. A total of 34 STMRs were estimated for benomyl, 8 for carbendazim and 5 for thiophanate-methyl. If STMRs were estimated for more than one compound in a commodity, the highest STMR was used for the calculation. No MRLs were used.

International Estimated Daily Intakes of benomyl, carbendazim and thiophanate-methyl for the five GEMS/Food regional diets were in the range of 1 to 6% of the carbendazim ADI.

The Meeting concluded that the intake of residues of benomyl, carbendazim and/or thiophanate-methyl resulting from their uses that have been considered by the JMPR is unlikely to present a public health concern.

REFERENCES

Adams, G.R. 1994. Magnitude of residues of benomyl in soya beans (RAC) and soya bean aspirated grain fractions (RAC) following field application of Benlate® fungicide. E.I. du Pont de Nemours and Company, Du Pont Agricultural Products, Global Technology Division, Experimental Station, Wilmington, DE 19880-0402, USA and Food Protein Research and Development Center, Texas A and M University, Faculty Mail Box 183, College Station, TX 77843-2476, USA. Du Pont Report No. AMR 2564-93. Unpublished.

Barefoot, A.C. 1988. Vapor Pressure of Benomyl. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware 19880-0402, U.S.A. Du Pont Agricultural Products Report No. AMR 1078-88. Unpublished.

BASF. 1974a. Pflanzenschutzmittel-Rueckstaende. BASF Landwirtschaftliche Versuchsstation Limburgerhof-Rueckstandsanalytik-, Germany. Report no. BASF 72/10483. Unpublished.

BASF. 1974b. Pflanzenschutzmittel-Rueckstaende. BASF Landwirtschaftliche Versuchsstation Limburgerhof-Rueckstandsanalytik-, Germany. Report no. BASF 72/10484. Unpublished.

BASF. 1974c. Pflanzenschutzmittel-Rueckstaende. BASF Landwirtschaftliche Versuchsstation Limburgerhof-Rueckstandsanalytik-, Germany. Report no. BASF 72/10485. Unpublished.

BASF. 1974d. Pflanzenschutzmittel-Rueckstaende. BASF Landwirtschaftliche Versuchsstation Limburgerhof-Rueckstandsanalytik-, Germany. Report no. BASF 72/10486. Unpublished.

Blanchfield, T. F., Pease, H. L. and Gardiner, J. A. 1973. Benomyl: Feeding and Residue Studies with Laying Hens. Du Pont Report HLR 346-72. Unpublished.

Bramble, F.Q. Jr., Trubey, R.K., Norwood, G.I. and Sund, R.W. 1996. Magnitue of residues of benomyl in soya beans following application of Benlate® fungicide at maximum label rates. E.I. du Pont de Nemours and Company, Du Pont Agricultural Products, Global Technology Division, Experimental Station, Wilmington, DE 19880-0402, USA. Du Pont Report No. AMR 2894-94. Unpublished.

Bramble, F.Q., Trubey, R.K., Norwood, G.I. and Sund, R.W. 1997. Magnitude of Residues of Benomyl in Pome fruits Following Application of Benlate® Fungicide at Maximum Label Rates. E.I. du Pont de Nemours and Company, Du Pont Agricultural Products, Global Technology Division, Experimental Station, Wilmington, DE 19880-0402, USA. Du Pont Report No. AMR 3742-96. Unpublished.

Burnden, A.N. and Benwell, L. 1997a. Magnitude of residues of benomyl fungicide in/on head brassica vegetables (Brussels sprouts) grown in Europe-Season 1996. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 4050-96 (269/74-1016). Unpublished.

Burnden, A.N. and Benwell, L. 1997b. Magnitude of residues of benomyl fungicide in/on legume vegetables (Vicia field beans) grown in Europe-Season 1996. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3994-96 (269/73-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997a. Residue decline curve of benomyl fungicide in/on stone fruits (peaches, plums and cherries) grown in Europe-Season 1996. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3830-96 (269/68-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997b. Magnitude of residues of benomyl fungicide in/on stone fruits (peaches, plums and cherries) grown in Europe-Season 1996. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3831-96 (269/69-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997c. Residue decline curve of benomyl fungicide in/on peaches and plums grown in Europe-Season 1995. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3425-95 (269/59-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997d. Magnitude of residues of benomyl fungicide in/on peaches and plums grown in Europe-Season 1995. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3426-95 (269/60-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997e. Magnitude of residues of benomyl fungicide in/on grapes grown in Europe-Season 1995. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3450-95 (269/63-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997f. Residue decline curve of benomyl fungicide in/on grapes grown in Europe-Season 1995. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3451-95 (269/64-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997g. Combined decline and magnitude of residues of benomyl fungicide in/on grapes grown in Europe-Season 1996. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3938-96 (269/71-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997h. Combined decline and magnitude of residues of benomyl fungicide in/on cucumbers grown in Europe-Season 1995. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3427-95 (269/61-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997i. Combined decline and magnitude of residues of benomyl fungicide in/on cucurbits (cucumbers and courgettes) grown in Europe-Season 1996. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3889-96 (269/70-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997j. Combined decline and magnitude of residues of benomyl fungicide in/on tomatoes grown in Europe-Season 1995. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3449-95 (269/62-1016). Unpublished.

Burnden, A.N. and Dunn, L. 1997k. Combined decline and magnitude of residues of benomyl fungicide in/on tomatoes grown in Europe-Season 1996. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 3939-96 (269/72-1016). Unpublished.

Chin, H. B., Katsuyama, A. and McIntosh, C. L. 1986. Benomyl Food Processing Studies-Milk. E.I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, DE, U.S.A. Du Pont Report AMR 471-86 #7. Unpublished.

Cicotti, M. 1987. Determination of DPX-H6573, its two phenyl metabolites and MBC in sugar beet (France-Season 1986). Battelle-Europe, Geneva Division, 7, route de Drize, 1227 Carouge-Geneva, Switzerland. Report no. A52965 (results also included in A53862). Unpublished.

Cicotti, M. 1988. Determination of DPX-H6573, its two phenyl metabolites and MBC in sweet corn (from France) treated with Punch C (Season 1988). Battelle-Europe, Geneva Division, 7, route de Drize, 1227 Carouge-Geneva, Switzerland. Report no. A52966. Unpublished.

Cicotti, M. 1989a. Determination of residues of benomyl in Apricots, Peaches, Apples and Grapes Treated with Benlate 50DF (Season 1988, France). Battelle-Europe, Geneva Division, Biological and Environmental Sciences, 7, route de Drize, 1227 Carouge/Geneva, Switzerland. Report No. BE-A-11-89-10-BG. Unpublished.

Cicotti, M. 1989b. Determination of Residues of Benomyl in Beans, Celery, Melons and Mushrooms Treated with Benlate 50DF (Season 1988, France). Battelle-Europe, Geneva Division, Biological and Environmental Sciences, 7, route de Drize, 1227 Carouge/Geneva, Switzerland. Report No. BE-A-11-89-08-BG. Unpublished.

Cicotti, M. 1989c. Determination of Residues of Benomyl in Sugar Beets, Wheat, Sunflowers and Rape Treated with Benlate 50DF (Season 1988, France). Batelle-Europe, Geneva Division, Biological and Environmental Sciences, 7, route de Drize, 1227 Carouge/Geneva, Switzerland. Report No. BE-A-11-89-09-BG. Unpublished.

Cicotti, M. 1992. Determination of Residues of Benomyl in Apples by HPLC/UV Following Treatment with Benlate DF (France-Season 1990). Battelle-Europe, Geneva Division, Centre for Toxicology and Biosciences, 7, route de Drize, 1227 Carouge-Geneva, Switzerland. Report No. BE-A-11-91-22-BG. Unpublished.

Cicotti, M. 1993. Determination of Residues of Benomyl in Apples by HPLC/UV Following Treatment with Benlate 50 DF (France-Season 1991). Battelle-Europe, Geneva Research Centres, Product Registration and Evaluation, 7, route de Drize, 1227 Carouge/Geneva, Switzerland. Sponsored by: Du Pont Conoco Technologies (France) SA, 137, rue de l' Université, 75334 Paris Cédex 07, France. Battelle-Europe Study No. BE-A-11-92-13-BG. Unpublished.

Du Pont. 1987. Determination of the Octanol/Water Partition Coefficient for Benomyl. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware 19880-0402, U.S.A. Du Pont Agricultural Products Report No. B/PC-55-CA. Unpublished.

Du Pont. Date issued unknown. Physical and Chemical Properties of Technical Benomyl. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware 19880-0402, U.S.A. Du Pont Agricultural Products Report No. PC 1991-85. Unpublished.

Dunn, L. and Burnden, A.N. 1997a. Magnitude of residues of benomyl fungicide in/on head brassica vegetables (Brussels sprouts) grown in Europe-Season 1995. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 4015-96 (269/67-1016). Unpublished.

Dunn, L. and Burnden, A.N. 1997b. Magnitude of residues of benomyl fungicide in/on legume vegetables (vining peas without pods) grown in Europe-Season 1995. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 4013-96 (269/65-1016). Unpublished.

Dunn, L. and Burnden, A.N. 1997c. Magnitude of residues of benomyl fungicide in/on legume vegetables (Vicia field beans) grown in Europe-Season 1995. Covance Laboratories, Otley Road, Harrogate, North Yorkshire, HG3 1PY, U.K. and Du Pont de Nemours (France) S.A., ERDC Nambsheim, Rue du Moulin, 24, F-68740, Nambsheim, France. Du Pont Report No. AMR 4014-96 (269/66-1016). Unpublished.

Eickhoff, J.C., Petersen, B.J. and Chaisson, C.F. 1989. Anticipated residues of benomyl in food crops and potential dietary exposure and risk assessment. Technical Assessment Systems, Inc., 1000 Potomac St., N.W., Washington, D.C. 20007 and EI Du Pont De Nemours and Co. (Inc.), Agricultural Products Department, Research and Development Division, Wilmington, D.D. 19880-0038, USA. Du Pont Report No. TAS-000-005. Unpublished.

Freeman, C. J. 1995a. IN T1991-479 Characterization File. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware 19880-0402, U.S.A. Du Pont Agricultural Products Report No. BENO/PRO 3. Unpublished.

Freeman, C.J. 1995c. Test on one chemical substance [flammability]. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware 19880-0402, U.S.A. Du Pont Agricultural Products Document No. BENO/PRO 7. Unpublished.

Galhiane, M. S. 1994a. Study of Benomyl Residues in Citrus (Orange-*Citrus sinensis*) After Treatment with Benlate 500 PM in Brazil. Du Pont do Brazil S.A., Alameda Itapecuru, 506--Alphaville, 06454-080, Barueri, SP, Brazil. Du Pont Report No. RE-040/94. Unpublished.

Galhiane, M. S. 1994b. Study of Benomyl Residues in Citrus (Orange-*Citrus sinensis*) After Treatment with Benlate 500 PM in Brazil. Du Pont do Brazil S.A., Alameda Itapecuru, 506--Alphaville, 06454-080, Barueri, SP, Brazil. Du Pont Report No. RE-041/94. Unpublished.

Gleisberg. 1991. Abschaetzung der Reaktivitaet organischer Molekuele mit OH-Radikalen der Troposphaere nach Atkinson (1988). Hoechst Ressortgruppe Umwelt UCV, Frankfurt, Germany. Report no. A46060. Unpublished.

Goldberg, S. S. 1989a. Benlate® Fungicide: Magnitude of the Residue in Prunes (Dried Plums) Processed from Plums. E.I du Pont de Nemours and Company, Wilmington, Delaware, U.S.A. Du Pont Study No. AMR 1418-89. Unpublished.

Goldberg, S. S. 1989b. Benlate Fungicide: Magnitude of the Residue in Raisin Waste Processed from Grapes. Agricultural Products Department, Research and Development Division, Experimental Station, E. I. du Pont de Nemours and Company, Wilmington, Delaware, USA Du Pont Study No. AMR 1419-89. Unpublished.

Goseco, C., Mangini, S., Sauter, H.and Morales, J.L. 1997. Magnitude of Residues of Benomyl in Pineapple Following Application of Benlate® Fungicide at Maximum Label Rates-Season 1995/1996. Del Monte Foods-Research Center, 205 North Wiget Lane, Walnut Creek, California 94598, USA. Du Pont Report No. AMR 3300-95. Unpublished.

Hoffman, R.M. 1988. The Henry's Law Constant For Benomyl. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware 19880-0402, U.S.A. Du Pont Agricultural Products Report No. T1991.A. Unpublished.

Hornshuh, M. J. 1994a. Magnitude of Residues of Benomyl on Apples Treated with Benlate® Fungicide and Collected from Field Trials from 1968-1972 and Benomyl on Apples Treated with Benlate® 50 DF and Collected from Field Trials in Southern France During 1988 Growing Season to Support Registration in Europe. Du Pont Agricultural Products, E. I. du Pont de Nemours and Company, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 10. Unpublished.

Hornshuh, M. J. 1994b. Magnitude of Residues of Benomyl on Pears; Benlate® Trials Performed in the UK, During Growing Seasons 1969 and 1971. Du Pont Agricultural Products, E. I. du Pont de Nemours and Company, Wilmington, Delaware, 19880-0402 and Du Pont (UK) Limited, Wedgwood Way, Stevenage, Hertfordshire, UK, SG1 4QN. Du Pont Report No. BENO/RES 8. Unpublished.

Hornshuh, M. J. 1994c. Magnitude of Residues of Benomyl on Grapes Treated with Benlate® Fungicide and Collected from Field Trials from 1967-1972 and Benomyl on Grapes Treated with Benlate® 50DF and Collected from Field Trials in Northern France During 1988 Growing Season to Support Registration in Europe. Du Pont Agricultural Products, E. I. du Pont de Nemours and Company, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 20. Unpublished.

Hornshuh, M. J. 1994d. Magnitude of Residues of Benomyl on Cucumbers Treated with Benlate® Fungicide and Collected from Field Trials from 1967-1972 to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 22. Unpublished.

Hornshuh, M. J. 1994e. Magnitude of Residues of Benomyl on Tomatoes Treated with Benlate® Fungicide and Collected from Trials from 1970-1972 to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 24. Unpublished.

Hornshuh, M. J. 1994f. Magnitude of Residues of Benomyl on Rice Treated with Benlate® Fungicide and Collected from Trials from 1969-1974 to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 23. Unpublished.

Hornshuh, M. J. 1995a. Magnitude of Residues of Benomyl on Citrus Treated with Benlate® Fungicide and Collected From Field Trials in The United Sates From 1967-1974 to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 16. Unpublished.

Hornshuh, M. J. 1995b. Magnitude of Residues of Benomyl on Cherries Treated with Benlate® Fungicide and Collected From Trials From 1967-1969 to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 15. Unpublished.

Hornshuh, M. J. 1995c. Magnitude Of Residues Of Benomyl On Plums/Prunes Treated with Benlate®

Fungicide And Collected From Trials From 1967-1969 to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 19. Unpublished.

Hornshuh, M. J. 1995e. Magnitude of Residues of Benomyl on Nectarines Treated with Benlate® Fungicide and Collected From Trials From 1967-1969 to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 17. Unpublished.

Hornshuh, M. J. 1995f. Magnitude of Residues of Benomyl on Peaches Treated with Benlate® Fungicide and Collected From Trials From 1967-1971 and Benomyl on Peaches Treated with Benlate® 50 DF and Collected from Field Trials in France During 1988 Growing Season to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 18. Unpublished.

Hornshuh, M. J. 1995g. Magnitude Of Residues Of Benomyl On Bananas Treated With Benlate® Fungicide and Collected From Field Trials in Costa Rica, Honduras, Jamaica, Brazil, Colombia and The United States from 1968 to 1985 to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 21. Unpublished.

Hornshuh, M.J. 1995d. Magnitude of Residues of Benomyl on Apricots Treated with Benlate® Fungicide And Collected From Trials From 1967-1971 and Benomyl on Apricots Treated with Benlate® 50 DF and Collected from Field Trials in France During 1988 Growing Season to Support Registration in Europe. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. Du Pont Report No. BENO/RES 14. Unpublished.

Kennedy, C.M. and Devine, P.G. 1992a. Magnitude of Residues of Benlate® Fungicide in Apple Fruit when Applied at the Maximum Use Pattern and Sampled over Time. E.I. du Pont de Nemours and Company, Du Pont Agricultural Products, Global Technology Division, Experimental Station, Wilmington, DE 19880-0402, USA and Morse Laboratories, 1525 Fulton Avenue, Sacramento, CA 95825, USA. Du Pont Report No. AMR 1594-90. Unpublished.

Kennedy, C.M. and Devine, P.G. 1992b. Magnitude of Residues of Benlate® Fungicide in Pear Fruit when Applied at the Maximum Use Pattern and Sampled over Time. E.I. du Pont de Nemours and Company, Du Pont Agricultural Products, Research and Development Division, Experimental Station, Wilmington, DE 19880-0402, USA. Du Pont Report No. AMR 1595-90. Unpublished.

Kirkland, J. J. and Pease, H. L. 1970. Benomyl Livestock Feeding Study: Milk and Meat. Du Pont Report No. B/ME 37. (Additional study details are presented in Du Pont Report No. B/ME 45 entitled Residue Data-Benomyl Livestock Feeding Study. Report B/ME 45 was apparently reformatted to produce Du Pont Report No. MBC/ME 6 entitled Section II: Milk-Meat). Unpublished.

Kivimäe, A. 1971. Feeding Experiment with Benlate Benomyl Fungicide to Laying Hens. Du Pont Report B/ME 64. [includes Blanchfield, T. F. (1972) Benlate®-Chicken and Egg Study, Du Pont Report BENO/RES 1 and Blanchfield, T. F. (1972) Benomyl-Swedish Chicken and Egg Study, Du Pont Report BENO/RES 2]. Unpublished.

Klemens, A. S. and Devine, P. G. 1993. Magnitude of Residues of Benlate® Fungicide in Plums/Prunes When Applied at the Maximum Use Pattern and Sampled Over Time. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, U.S.A. and McKenzie Laboratories, 3725 East Atlanta Avenue, Phoenix, Arizona 85040 U.S.A. Du Pont Report No. AMR 1613-90. Unpublished.

Klemens, A.S. and Tomic, D.M. 1992. Magnitude of Residues of Benlate® Fungicide in Peaches When Applied at the Maximum Use Pattern and Sampled Over Time. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, 19880-0402, U.S.A. and McKenzie Laboratories, 3725 East Atlanta Avenue, Phoenix, Arizona 85040 U.S.A. Du Pont Report No. AMR 1599-90. Unpublished.

Kuenzler, K. 1972a. Residues of Plant Protection Chemicals. Hoechst, Analyt. Labor., Germany. Report no. A06691. Unpublished.

Kuenzler, K. 1972b. Residues of Plant Protection Chemicals. Hoechst, Analyt. Labor., Germany. Report no. A06692. Unpublished.

Kuenzler, K. 1973a. Residues of Plant Protection Chemicals. Hoechst, Analyt. Labor., Germany. Report no. A02025. Unpublished.

Kuenzler, K. 1973b. Pflanzenschutzmittel-Rueckstaende. Hoechst, Analyt. Labor., Germany. Report no. A01028. Unpublished.

Kuenzler, K. 1973c. Pflanzenschutzmittel-Rueckstaende. Hoechst, Analyt. Labor., Germany. Report no. A01029. Unpublished.

Kuenzler, K. 1973d. Pflanzenschutzmittel-Rueckstaende. Hoechst, Analyt. Labor., Germany. Report no. A01030. Unpublished.

Kuenzler, K. 1973e. Pflanzenschutzmittel-Rueckstaende. Hoechst, Analyt. Labor., Germany. Report no. A01031. Unpublished.

Kuenzler, K. 1973f. Pflanzenschutzmittel-Rueckstaende. Hoechst, Analyt. Labor., Germany. Report no. A01032. Unpublished.

Lundehn, J. R. 1993. Guidelines for the Establishment of Community Maximum Residue Levels (MRLs) of Plant Protection Products in Food and Feedstuffs of Plant and Animal Origin. Final Report. Commission of the European Communities, Directorate-General for Agriculture.

McNally, M. E. 1989. Magnitude of Residues of Benomyl in Pineapples and Their Processed Fractions after Applications of Du Pont Benlate® DF Fungicide. Du Pont Report No. AMR 3300-95. Unpublished.

McNally, M.E. 1990. Magnitude of Residues of Benlate® 50 DF Fungicide in Rice Straw. McKenzie Laboratories, Inc., 734A East Southern Pacific Drive, Phoenix, Arizona 85034, USA. Du Pont Report No. AMR-1433-89. Unpublished.

McNally, M.E. 1991. Magnitude of Residues of Benlate® 50 DF Fungicide in Rice Straw. McKenzie Laboratories, Inc., 734A East Southern Pacific Drive, Phoenix, Arizona 85034, USA. Du Pont Report No. AMR-1433-89. Supplement No. 1. Unpublished.

McNally M. E. and Hay R. J. 1991a. Magnitude of Residues of Benlate® Fungicide in Oranges and Its Processed Fractions. Du Pont Study No. AMR 1353-89. E. I. du Pont de Nemours and Company, Inc., Du Pont Agricultural Products, Wilmington, Delaware, USA Du Pont Study No. AMR 1353-89. Unpublished.

McNally, M. E. and Hay, R. J. 1991b. Magnitude of Residues of Benlate® Fungicide in Rice and Its Processed Fractions. E. I. du Pont de Nemours and Company, Inc., Du Pont Agricultural Products, Wilmington, Delaware, USA. Du Pont Study No. AMR 1351-89. Unpublished.

McNally, M.E. and Tomic, D.M. 1992. The Magnitude of Residues of Benlate® in Soya beans and their Processed Fractions. E.I. du Pont de Nemours and Company, Du Pont Agricultural Products, Research and Development Division, Experimental Station, Wilmington, DE 19880-0402, USA and Food Protein Research and Development Center, The Texas A and M University System, College Station, TX 77843-2476, USA. Du Pont Report No. AMR 1378-89. Unpublished.

Monson, K. D. 1985a. Metabolism of [2-^{14}C]Benomyl in the Lactating Dairy Cow. Du Pont Agricultural Products. E. I. du Pont de Nemours and Co., Wilmington, DE, USA. Du Pont Report AMR 247-84. Unpublished.

Monson, K. D. 1985b. Metabolism of [2-^{14}C]Carbendazim in the Lactating Dairy Cow. Du Pont Agricultural Products. E. I. du Pont de Nemours and Co., Wilmington, DE, USA. Du Pont Report No. AMR 248-84. Unpublished.

Monson, K. D. 1986a. Metabolism of [2-^{14}C]Benomyl and [Phenyl(U)-^{14}C]Benomyl in Laying Hens. Du Pont Agricultural Products. E. I. du Pont de Nemours and Co., Wilmington, DE, USA. Du Pont Document No. AMR 391-85. Unpublished.

Monson, K. D. 1986b. Metabolism of [2-^{14}C]Carbendazim in Laying Hens. Du Pont Agricultural Products. E. I. du Pont de Nemours and Co., Wilmington, DE, USA. Du Pont Document No. AMR 264-84. Unpublished.

Mulcahey, L.J., Stanley, B.H. and Tomic, D.M. 1993. Magnitude of Residues of Benomyl in Carrots Following Application of Benlate® Fungicide. E.I. du Pont de Nemours and Company, Du Pont Agricultural Products, Global Technology Division, Experimental Station, Wilmington, DE 19880-0402, USA and McKenzie Laboratories, 3725 E. Atlanta Avenue, Suite One, Phoenix, AZ 85040-2960, USA. Du Pont Report No. AMR 2287-92. Unpublished.

Powley, C.R. 1985. Aqueous Photolysis of [Phenyl-^{14}C(U)] Benomyl. Du Pont Agricultural Products, E. I. du Pont de Nemours and Co., Wilmington, DE, U.S.A. Du Pont Report No. AMR 420-85. Unpublished.

Purser, D. 1988. Benomyl: Behaviour in Water. Du Pont Agricultural Products, E. I. du Pont de Nemours and Co., Wilmington, DE, U.S.A. Du Pont Report No. HUK 269/13. Unpublished.

Rosen, D. E. 1971. Benlate. Benomyl Fungicide (Photodecomposition Studies in Water under Natural Sunlight Conditions). Du Pont Agricultural Products, E. I. du Pont de Nemours and Co., Wilmington, DE, U.S.A. Du Pont Report No. B/ME 30. Unpublished.

Saito, E. and Zager, E. 1994a. Guidance Procedure for Calculating Livestock Dietary Exposure. United States Environmental Protection Agency.

Saito, E. and Zager, E. 1994b. Updated Livestock Feeds Tables for Subdivision O (Residue Chemistry) of the Pesticide Assessment Guidelines. United States Environmental Protection Agency.

Schmuckler, M.E. 1993. Impact Explodability of Technical Benomyl. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware 19880-0402, U.S.A. Du Pont Agricultural Products Report No. AMR 2675-93. Unpublished.

Schollmeier, M. and Petersen, J.W. 1995a. Residue data summary from supervised trials in Pome fruits (Apples). Hoechst Schering AgrEvo GmbH, Germany. Report no. A53860. Unpublished.

Schollmeier, M. and Petersen, J.W. 1995b. Residue data summary from supervised trials in Stone fruits (Cherries). Hoechst Schering AgrEvo GmbH, Germany. Report no. A53867. Unpublished.

Schollmeier, M. and Petersen, J.W. 1995c. Residue data summary from supervised trials in Grapes. Hoechst Schering AgrEvo GmbH, Germany. Report no. A53870. Unpublished.

Schollmeier, M. and Petersen, J.W. 1995d. Residue data summary from supervised trials in Strawberries. Hoechst Schering AgrEvo GmbH, Germany. Report no. A53868. Unpublished.

Schollmeier, M. and Petersen, J.W. 1995e. Residue data summary from supervised trials in Cucurbits. Hoechst Schering AgrEvo GmbH, Germany. Report no. A53865. Unpublished.

Schollmeier, M. and Petersen, J.W. 1995f. Residue data summary from supervised trials in Solanacae (Tomatoes). Hoechst Schering AgrEvo GmbH, Germany. Report no. A53869. Unpublished.

Schollmeier, M. and Petersen, J.W. 1995g. Residue data summary from supervised trials in Beans. Hoechst Schering AgrEvo GmbH, Germany. Report no. A53861. Unpublished.

Schollmeier, M. and Petersen, J.W. 1995h. Residue data summary from supervised trials in Sugar Beets. Hoechst Schering AgrEvo GmbH, Germany. Report no. A53862.

(Includes results described in Cicotti, M. 1987, Report No. A52965). Unpublished.

Schollmeier, M. and Petersen, J.W. 1995i. Residue data summary from supervised trials in Cereals. Hoechst Schering AgrEvo GmbH, Germany. Report no. A53863. Unpublished.

Schollmeier, M. and Petersen, J.W. 1995j. Residue data summary from supervised trials in Rape seeds. Hoechst Schering AgrEvo GmbH, Germany. Report no. A53866. Unpublished.

Sharp, J.K. 1992. Dissipation of Residues on Fresh Peaches Treated with Benlate® Fungicide: A Focused Degradation Study from the Field to Consumer Product. E. I. du Pont de Nemours & Company, Inc., Du Pont Agricultural Products, Wilmington, Delaware, USA. Du Pont Study No. AMR 1691-90. Unpublished.

Sharp, J. K. 1993a. Dissipation of Residues on Fresh Apples Treated with Benlate® Fungicide: A Focused Degradation Study from the Field to Consumer Product. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, USA Du Pont Report No. AMR 1702-90. Unpublished.

Sharp, J. K. 1993b. Dissipation of Residues on Processed Fractions of Apples Treated with Benlate® Fungicide: A Focused Degradation Study From the Field to Consumer Product. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Wilmington, Delaware, USA Du Pont Report No. AMR 1703-90. Unpublished.

Sharp, J.K. 1993c. Dissipation of Residues on Processed Fractions of Peaches Treated with Benlate® Fungicide: A Focused Degradation Study from the Field to Consumer Product. E. I. du Pont de Nemours & Company, Inc., Du Pont Agricultural Products, Wilmington, Delaware, USA. Du Pont Study No. AMR 1692-90. Unpublished.

Singh, R.P. and Chiba, M. 1985. Solubility of Benomyl in Water at Different pHs and Its Conversion to Methyl 2-Benzimidazolecarbamate, 3-Butyl-2,4-dioxo[1,2-a]-s-triazinobenzimidazole, and 1-(2-Benzimidazolyl)-3-n-butylurea. *J. Agric. Food Chem.*, 33, 63-67.

Steurbaut, W., Dejonckheere, W. and Kips, R.H. 1973. Fate of benomyl on early autumn and spring lettuce. *Mededelingen Fakulteit Landbouwwetenschappen Gent*, 38, (3), 917-928. Report no. A58765.

Thier, W. 1973a. Residues of Plant Protection Chemicals. Hoechst, Analyt. Labor., Germany. Report no. A06406. Unpublished.

Thier, W. 1973b. Residues of Plant Protection Chemicals. Hoechst, Analyt. Labor., Germany. Report no. A06407. Unpublished.

Thier, W. 1973c. Residues of Plant Protection Chemicals. Hoechst, Analyt. Labor., Germany. Report no. A06408. Unpublished.

Thier, W. 1973d. Residues of Plant Protection Chemicals. Hoechst, Analyt. Labor., Germany. Report no. A06409. Unpublished.

Tomic, D.M. 1992. Magnitude of Residues of Benlate® Fungicide in Apricots when Applied at the Maximum Use Pattern. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Global Technology Division, Experimental Station, Wilmington, Delaware 19880-0402, U.S.A and McKenzie Laboratories, Inc., 3725 E. Atlanta Avenue, Suite One, Phoenix, AZ 85040, USA. Du Pont Report No. AMR 1611-90. Unpublished.

Tomic, D.M. and Fillipone, P.C. 1992. Magnitude of Residues of Benlate® Fungicide in Nectarines when Applied at the Maximum Use Pattern. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Global Technology Division, Experimental Station, Wilmington, Delaware DE 19880-0402, U.S.A. and McKenzie Laboratories, 3725 East Atlanta Avenue, Phoenix, AZ 85040, U.S.A. Du Pont Report No. AMR 1612-90. Unpublished.

Vincent, D.R. and Orescan, D.B. 1996. Magnitude of Residues of Benomyl in Grapes and Raisins Following Applications of Benlate® Fungicide at Maximum Label Rates. E. I. du Pont de Nemours and Company, Du Pont Agricultural Products, Global Technology Division, Experimental Station, Wilmington, Delaware DE 19880-0402, U.S.A. Du Pont Report No. AMR 2703-93. Unpublished.

Vincent, D.R. and Tomic, D.M. 1989. Magnitude of Residues of Benlate in Tomatoes and Their Processed Fractions. E. I. du Pont de Nemours & Company, Inc., Agricultural Products Department, Wilmington, Delaware, U.S.A. Du Pont Study No. AMR 1352-89. Unpublished.

Wink, O. 1984a. H-NMR/Spectrum. Hoechst Analyt.Labor., Germany. Report no. A30158. Unpublished.

Wink, O. 1984b. UV-VIS-Spectrum. Hoechst Analyt.Labor., Germany. Report no. A30160. Unpublished.

Wink, O. and Voigt, J. 1984. Infrared (IF)-Absorption-Spectrum. Hoechst Analyt.Labor., Germany. Report no. A30161. Unpublished.

Wink, O. and Wintersheidt, G. 1984. Mass-Spectrum. Hoechst Analyt.Labor., Germany. Report no. A30159. Unpublished.

Zenide, D. 1995. Determination of Residues of Benomyl in Apple and Apple Processed Product (Purée) by HPLC-UV Following Treatment with Benlate® WP (France-Season 1993). Battelle, Geneva Research Centres, Agrochemical Product Development, 7, route de Drize, 1227 Carouge/Geneva, Switzerland. Report No. A-11-94-12. Unpublished.