BENOMYL (069)

[See also CARBENDAZIM (072) and THIOPHANATE-METHYL (077)]

EXPLANATION

Benomyl was first evaluated in 1973 and has been reviewed on five other occasions. The 1988 JMPR initiated a re-evaluation of residues arising from the use of the three related fungicides benomyl, carbendazim and thiophanate-methyl, all to be calculated as carbendazim, in response to concerns expressed at the 1988 CCPR (ALINORM 89/24, paras. 82-84). The 1989 CCPR requested that the recommendation for a group MRL for carbendazim in cereals should be replaced by recommendations for separate MRLs for individual crops, while at the 1992 CCPR (ALINORM 93/24, para. 105) several MRLs were held at step 7B pending further review by the JMPR. Although some information was provided for the 1990 JMPR, that Meeting concluded that it would be premature to review the compounds until all of the required data became available and consideration was deferred to the 1992 JMPR. However, because of the work-load at that Meeting, the re-evaluation was again postponed until 1993. The data submitted for the 1990 and 1992 JMPRs, together with additional data provided in 1993, have now been reviewed with particular attention to the information on GAP and some new residue data.

USE PATTERN

A great deal of information on the uses of benomyl was provided by the manufacturer (Du Pont, 1990, 1992, 1993) and also by the European Commission (EC, 1993) and several countries (Canada, 1993; Netherlands, 1993; New Zealand, 1993; Spain, 1993). This is summarized in Tables 1-4 and clearly shows the extensive applications of this fungicide. Although it is known that post-harvest uses have been withdrawn in several countries, there are still registered post-harvest uses on fruits in many others. The commodities include apricots, cherries, citrus fruits, nectarines, peaches, pineapples, plums, and pome fruits, all of which were held at step 7B by the 1988 CCPR. The post-harvest treatment of carrots (MRL also held at 7B in 1988) is not now registered. The other 7B commodities, bean fodder, berries and other small fruits, cereal grains, head lettuce, mushrooms, peppers, sugar beet leaves or tops and tomatoes, are not subject to post-harvest treatments.

Table 1. Benomyl - registered use rates and patterns on fruits.

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
Citrus fruits	Argentina	WP	50	0.75-1.5	1-2	15	
	Australia	SG	50	[100g/hl]	1	-	Post-harvest
	Indonesia	WP	50	0.12-0.2	-	-	
	Portugal	WP	50	[30-50g/hl]	1	-	Post-harvest
	Spain	WP	50	0.375-0.75	-	15	
	Taiwan	WP	50	0.35-0.75	1-4	-	
	USA	SG	50	0.84-1.68	1-4	1	
				0.56-1.12	1	1	For post-harvest rots
Mandarins	Japan	WP	50	0.417-1.25	1-4	1	
Pome fruits							
Apple	Argentina	WP	50	0.25-0.625	1-2	30	

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
	Australia	SG	50	[50g/hl]	-	-	10-14 day intervals
				[50g/hl]	1	-	Post-harvest
	Belgium	WP	50	0.5	1-2	14	
	Canada	WP	10-50	0.275-0.425	-	1-48	7-14 day intervals
	Denmark	WP	50	0.6	1-2	14	
	Finland	WP	50	0.25	1	-	
	France	WP	50	[30g/hl]	-	-	Post-harvest
	Germany	WP	50	0.225	3	7	
	Greece	WP	50	0.6-1.25	7-8	15	
	Indonesia	WP	50	0.2	-	-	
	Ireland	WP	50	0.55	-	-	
	Italy	WP	50	[30g/hl]	1	15	
				[75-100g/hl]	1	-	Post-harvest
	Japan	WP	50	0.833-1.25	1-6	7	
	Korea	WP	50	0.975	1-6	7	
	Luxembourg	WP	50	0.2-0.375	1-3	14	
	Netherlands	WP	50-75	0.25-0.75	1-2	14	
				0.30-0.45	2	-	Trees after harvest
				[50g/hl]	1	60	Post-harvest spray
	New Zealand	WP	50	max. 0.375	1-2	7	
	Portugal	WP	50	[20-30g/hl]	2-3	7	
		WP	50	[30g/hl]	-	-	Post-harvest
	Spain	WP	50	0.375-0.75	2-4	15	
	Sweden	WP	50	0.6	1-2	28	
	Switzerland	WP	50	[100g/hl]	-	-	
	Taiwan	WP	50	0.15-0.3	1-4	21	
	Uruguay	WP	50	[50g/hl]	1-8	15	
	USA	SG	50	0.21-0.42	1-13	14	7-14 day intervals
Pear	Argentina	WP	50	0.25-0.625	1-2	30	
	Australia	SG	50	[40g/hl]	1-3	-	7 day intervals
				[50g/hl]	1		Post-harvest
	Belgium	WP	50	0.5	1	14	
	Canada	WP	50	0.275	-	48	7-14 day intervals
	Denmark	WP	50	0.6	1	14	
	Finland	WP	50	0.6	2	14	
	France	WP	50	[30g/hl]	-	-	Post-harvest
	Germany	WP	50	0.225	3	7	
	Greece	WP	50	0.6-0.75	5-6	15	
	Ireland	WP	50	0.55	-	-	
	Italy	WP	50	[30g/hl]	1	15	
				[75-100g/hl]	1	-	Post-harvest
	Japan	WP	50	1.25-2.5	1-6	7	
	Korea	WP	50	0.75-0.975	1-6	7	
	Luxembourg	WP	50	0.2-0.375	1-3	14	
	Netherlands	WP	50-75	0.25-0.75	1-2	14	
				0.30-0.45	2	-	Trees after harvest
				[50g/hl]	1	60	Post-harvest spray
	New Zealand	WP	50	max. 0.375	1-2	7	
	Portugal	WP	50	[20-30g/hl]	2-3	7	
		WP	50	[30g/hl]	-	-	Post-harvest
	Spain	WP	50	0.375-0.75	2-4	15	
	Sweden	WP	50	0.6	1-2	28	
	Taiwan	WP	50	0.15-0.3	1-7	-	
	Uruguay	WP	50	[50g/hl]	1-8	15	
	USA	SG	50	0.42-0.84	1-6	14	7-14 day intervals

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
				0.42-1.05	1	1	For post-harvest rots
Stone fruits	Argentina	WP	50	0.75-0.9	1-3	30	
	Australia	SG	50	[10-50g/hl]	1-5	-	Post-harvest
	France	WP	50	[30g/hl]	-	-	
	Greece	WP	50	0.6-0.75	3-4	15	
	New Zealand	WP	50	max. 0.5	3	-	Up to shuck fall
	Italy	WP	50	[30g/hl]	>4	15	
				[50g/hl]	1	15	Post-harvest
	Spain	WP	50	0.375-0.75	2-4	15	
	USA	SG	50	0.56-1.12	1-6	3	
Apricot	Canada	WP	50	0.425	1-3	2	
Cherries	Belgium	WP	50	[25g/hl]	1	14	
	Canada	WP	50	0.55	2	2	Sweet cherries
				0.425	1-2	5	Sour cherries
	Denmark	WP	50	0.6	3-4	14	
	Japan	WP	50	0.833	1-2	14	
	Netherlands	WP	50-75	0.25-0.375	1-2	14	
	Portugal	WP	50	[30-50g/hl]	2	7	
Peach	Canada	WP	10-50	0.425	1-3	2	
	Japan	WP	50	0.833-1.25	1-3	3	
	Portugal	WP	50	[30-50g/hl]	2	7	
Plums	Canada	WP	50	0.425	1-3	2	
	Denmark	WP	50	0.6	3-4	14	
	Japan	WP	50	0.833-1.25	1-3	60	
	Netherlands	WP	50-75	0.25-0.375	1-2	14	
Berries and other small fruits							
Blackberries	Canada	WP	50	0.55	-	2	7-14 day intervals
	Ireland	WP	50	0.55	-	-	
	USA	SG	50	0.42	2-5	3	
Blueberries	USA	SG	50	0.56	1-8	21	
Boysenberries	USA	SG	50	0.42	1-5	3	
Currants, Black, Red, White	Ireland	WP	50	0.55	-	-	
Dewberries	USA	SG	50	0.42	1-5	3	
Gooseberries	Ireland	WP	50	0.55	-	-	
Grapes	Argentina	WP	50	0.24	1-2	15	
	Australia	SG	50	1	1-3	3	
				[40-100g/hl]	1-4	3	Monthly
	Canada	WP	50	0.425-0.75	1-3	7	
	France	WP	50	0.25	-	-	
	Greece	WP	50	0.15-0.6	5-6	15	
	Italy	WP	50	0.45	5-6	15	
	Japan	WP	50	0.33-0.5	1-3	60	
	Korea	WP	50	0.975	-	7	
	Luxembourg	WP	50	0.25-0.375	-	-	
	Portugal	WP	50	[30/g/hl]	3	7	
	Spain	WP	50	0.25-0.5	2-4	15	
		WP	50	0.25-0.5	2-4	21	Wine grapes
	Taiwan	WP	50	0.15-0.2	1-3	-	
	Thailand	WP	50	0.11-0.34	-	7	
	Uruguay	WP	50	[100g/hl]	1-6	15	
	USA	SG	50	0.42-0.84	1-8	7	
Loganberries	USA	SG	50	0.42	1-5	3	
Raspberries	Australia	SG	50	[50g/hl]	-	4	7-14 day intervals
	Canada	WP	50	0.55	-	2	7-14 day intervals
	Ireland	WP	50	0.55	-	-	

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
	USA	SG	50	0.42	1-5	3	
Strawberries	Argentina	WP	50	0.06-0.09	1	15	
	Australia	SG	50	0.5-1	-	4	7-14 day intervals
	Belgium	WP	50	0.3-0.5	1	14	
	Canada	WP	50	0.55-0.875	-	2	7-14 day intervals
	Denmark	WP	50	0.5-0.6	-	14	
	Greece	WP	50	0.18-0.6	3	15	Field or Greenhouse
	Ireland	WP	50	0.55	-	-	
	Japan	WP	50	3	1-3	-	
	Netherlands	WP	50-75	0.22-0.37	2-3	14	Field
				0.24-0.3	4-6	14	Greenhouse
	Portugal	WP	50	[30g/hl]	3	7	
	Spain	WP	50	0.375-0.75	2-4	7	Field or Greenhouse
	Uruguay	WP	50	[75g/hl]	1-6	15	
	USA	SG	50	0.28-0.6	1-8	-	7-14 day intervals
Tropical and sub-tropical fruits - edible peel							
Olives	Spain	WP	50	0.25-0.5	-	15	
Persimmon	Japan	WP	50	0.833-1.25	1-6	7	
	Korea	WP	50	0.975	1-6	7	
Tropical and sub-tropical fruits - inedible peel							
Avocado	Australia	SG	50	[600g/hl]	1	21	
	El Salvador	WP	50	0.225-0.25	-	-	
	Guatemala	WP	50	0.225-0.25	-	-	
	Honduras	WP	50	0.225-0.25	-	-	
	New Zealand	WP	50	max. 0.875	3	14	
	Panama	WP	50	0.225-0.25	-	-	
	USA	SG	50	0.56-1.12	1-14	30	3-4 week intervals
Banana	Australia	SG	50	[40g/hl]	1	-	Post-harvest dip
	El Salvador	WP	50	0.075-0.125	1	-	
	Guatemala	WP	50	0.075-0.125	-	-	
	Honduras	WP	50	0.075-0.125	-	-	
	Nicaragua	WP	50	0.075-0.125	-	-	
	Panama	WP	50	0.075-0.125	-	-	
	Philippines	WP	50	0.28	-	7	
	Portugal	WP	50	-	-	-	Post-harvest
	Spain	WP	50	[1-2.5g/sq m]	-	15	
	Taiwan	WP	50	0.3	1-2	-	
Kiwifruit	Japan	WP	50	1.25	1-5	-	
Litchi	Australia	SG	50	[100g/hl]	1	-	Post-harvest
Mango	Australia	SG	50	[100-200g/hl]	1	-	Post-harvest
	El Salvador	WP	50	0.25-0.4	-	-	
	Guatemala	WP	50	0.25-0.4	1	-	
	Honduras	WP	50	0.25-0.4	1	-	
	Nicaragua	WP	50	0.25-0.4	-	-	
	Panama	WP	50	0.25-0.4	-	-	
	Thailand	WP	50	0.11-0.34	-	14	
	USA	SG	50	0.56-1.12	1-12	14	
Papaya	Taiwan	WP	50	0.15-0.25	1-2	-	
Pineapple	Australia	SG	50	[480g/hl]	1	-	Post-harvest
	USA	SG	50	[124g/hl]	1	-	Pre-plant dip

Table 2. Benomyl - registered use rates and patterns on vegetables.

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
Vegetables							
Vegetables (except fruiting and legume)	Spain	WP	50	0.375-0.75	2-4	15	
Bulb vegetables							
Leek	Belgium	WP	50	[250g/hl]	1	-	Plant dipping
	Netherlands	WP	50-75	[100g/hl]	1	-	Plant dipping
Onion, Bulb	Denmark	WP	50	0.25-0.5	-	14	
	Ireland	WP	50	[100g/100kg]	1	-	Seed dressing
	Netherlands	WP	50-75	0.25	1-2	28	On crop
				[100g/hl]	1	28	Plant dipping
				[100g/100kg]	1	-	Seed dressing
	Portugal	WP	50	[15-30g/hl]	2	7	
Brassica vegetables							
Brussels sprouts	Australia	SG	50	[50-100g/hl]	-	5	10-14 day intervals
	Ireland	WP	50	0.55	1-2	21	
	Netherlands	WP	50-70	0.5	2	21	
Cauliflower	Australia	SG	50	[50-100g/hl]	-	5	10-14 day intervals
	Netherlands	WP	50-70	0.5	2	21	
Cabbages, Head	Australia	SG	50	[50-100g/hl]	-	5	10-14 day intervals
	Ireland	WP	50	0.55	1-2	21	
	Netherlands	WP	50-70	0.5	2	21	
Fruiting vegetables	Spain	WP	50	0.375-0.75	2-4	3	Field or Greenhouse
Cucurbits	Australia	SG	50	[50-100g/hl]	-	5	7-10 day intervals
	USA	SG	50	0.14-0.28	1-8	14	7-14 day intervals
Cucumber	Belgium	WP	50	0.5	1	3	
	Canada	WP	50	1.125-1.625	-	14	7-14 day intervals
	Greece	WP	50	0.18-0.45	3	7	Field or Greenhouse
	Netherlands	WP	50-75	0.25-0.75	-	3	10-14 day intervals
	Portugal	WP	50	[20g/hl]	3	20	
Gherkin	Belgium	WP	50	0.5	1	3	
	Greece	WP	50	0.18-0.45	3	7	Field or greenhouse
	Netherlands	WP	50-75	0.25-0.75	-	3	10-14 day intervals
				[0.25g/plant]	4	3	Soil drench, after planting
Melons	Australia	SG	50	[100g/hl]	1	-	Post-harvest
	Belgium	WP	50	0.5	1	3	
	Canada	WP	50	1.125-1.625	-	14	7-14 day intervals
	El Salvador	WP	50	0.075-0.125	1-3	-	
	France	WP	50	0.3	-	-	
	Guatemala	WP	50	0.075-0.125	2	-	
	Honduras	WP	50	0.075-0.125	2	-	
	Netherlands	WP	50-75	0.25-0.75	-	3	10-14 day intervals
				[0.25g/plant]	1-3	3	Soil drench, after planting
	Nicaragua	WP	50	0.075-0.125	1-3	-	
	Panama	WP	50	0.075-0.125	1-3	-	
	Portugal	WP	50	[20g/hl]	3	7	
Squash, Summer	Canada	WP	50	1.125-1.625	-	14	7-14 day intervals
	Netherlands	WP	50-75	0.25-0.75	-	3	10-14 day intervals
Squash, Winter	Canada	WP	50	1.125-1.625	-	14	7-14 day intervals
Watermelon	El Salvador	WP	50	0.075-0.125	1-3	-	

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
	Guatemala	WP	50	0.075-0.125	2	-	
	Honduras	WP	50	0.075-0.125	2	-	
	Japan	WP	50	0.333-0.5	1-5	1	
	Korea	WP	50	0.75-0.975	1-5	2	
	Taiwan	WP	50	0.35-0.5	1-3	-	
Fruiting vegetables, other than Cucurbits							
Peppers	Australia	SG	50	0.55-1.1	-	5	10-14 day intervals
	Greece	WP	50	0.18-0.3	4-5	7	Foliar spray
		WP	50	[0.5l/plant]	1	7	Indiv. plants, 2-3 leaves
	Netherlands	WP	50-75	0.25-0.75	-	3	10-14 day intervals
Egg plant	Greece	WP	50	0.18-0.3	4-5	7	Foliar spray
				[0.5l/plant]	1	-	Indiv. plants, 2-3 leaves
	Netherlands	WP	50-75	0.25-0.75	-	3	10-14 day intervals
Mushrooms	Australia	SG	50	[200g/1.7cu m]	1	21	On peat moss
	Canada	WP	50	[30g/100 sq m]	1-2	2	After casing
	Denmark	WP	50	[0.5g/sq m]	-	-	
	France	WP	50	[1g/sq m]	-	-	
	Ireland	WP	50	[1.2g/sq m]	-	-	
	Netherlands	WP	50-75	0.25-0.75	1-2	5	
	USA	SG	50	[5g/sq m]	1-2	2	
Tomato	Argentina	WP	50	0.09-0.18	1-2	20	
	Australia	SG	50	0.55-1.1	-	5	10-14 day intervals
	Canada	WP	50	0.84-1.1	-	7	4-13 day intervals
	Denmark	WP	50	[60g/hl]	1-2	14	
	El Salvador	WP	50	0.175-0.225	1-2	-	
	France	WP	50	0.3-0.4	-	-	
	Greece	WP	50	0.18-0.3	3	7	Foliar spray
		WP	50	[0.5l/ plant]	1	7	Indiv. plants, 2-3 leaves
	Guatemala	WP	50	0.175-0.225	-	-	
	Honduras	WP	50	0.175-0.225	-	-	
	Indonesia	WP	50	0.075-0.125	2	-	
	Ireland	WP	50	[50g/hl]	-	-	10-14 day intervals
	Japan	WP	50	0.333-1	1-5	-	
	Netherlands	WP	50-75	0.3-0.6	-	3	10-14 day intervals
	Nicaragua	WP	50	0.175-0.225	-	-	
	Panama	WP	50	0.175-0.225	1	-	
	Portugal	WP	50	[15.30g/hl]	2	4	
	Switzerland	WP	50	[60g/hl]	-	3	
	Thailand	WP	50	0.11-0.34	-	7	
	Uruguay	WP	50	[50g/hl]	1-8	7	
	USA	SG	50	0.28-0.56	1-10	-	Field or greenhouse
Leafy vegetables							
Brassicas, leafy	Ireland	WP	50	0.55	1-2	21	
Lettuce	Australia	SG	50	[50-100g/hl]	-	5	10-14 day intervals
	Greece	WP	50	0.18-0.3	3-4	7	Foliar spray
				[15g/hl]	1	-	Drench
	Ireland	WP	50	[25g/hl]	-	-	10-14 day intervals
	Portugal	WP	50	[15-30g/hl]	2	7	
Legume vegetables	Spain	WP	50	0.375-0.75	2-4	3	Field or Greenhouse
Common bean	Australia	SG	50	1-2	2	5	
	Belgium	WP	50	0.4	2	6	
	Canada	WP	50	0.875-1.125	1	14	Snap and dry beans

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
	France	WP	50	0.3-0.4	-	-	
	Ireland	WP	50	0.5-0.55	1-2	-	
				[1.9g/kg seed]	1	-	Seed dressing
	Netherlands	WP	50-75	1.0	2	14	Crop treatment
				[0.5g/kg seed]	1	-	Seed dressing
	USA	SG	50	1.7-2.2	2	14	
Lima bean	Canada	WP	50	0.875-1.125	1	14	
	USA	SG	50	1.7-2.2	2	28	
Garden pea	Belgium	WP	50	0.4	-	7	
	France	WP	50	0.3-0.4	-	-	
	Netherlands	WP	50-75	[4g/kg seed]	1	-	Seed dressing
Soya bean	Australia	SG	50	2	-	5	14 day intervals
	USA	SG	50	0.56-1.1	2	35	
Root and tuber vegetables							
Carrot	Canada	WP	50	0.125-0.55	3	15	
	Greece	WP	50	0.18-0.3	3-4	7	
Celeriac	Netherlands	WP	50-75	0.3	1-2	28	10-14 day intervals
Potato	Australia	SG	50	1.1	-	5	14 day intervals
	Denmark	WP	50	[37.5g/t]	1	-	Seed dressing
	Netherlands	WP	50-75	[25g/t]	1	-	Seed dressing
Scorzonera	Netherlands	WP	50-75	0.25	2-3	14	
Sugar beet	France	WP	50	0.15	-	-	
	Portugal	WP	50	[0.3g/hl]	3	21	3 week intervals
	Spain	WP	50	0.075-0.15	-	15	
	USA	SG	50	0.42-0.56	-	21	14-21 day intervals
Swede	Ireland	WP	50	0.55	-	-	
	Netherlands	WP	50-75	0.5	1	28	
Stalk and stem vegetables							
Asparagus	Netherlands	WP	50-75	[100g/hl]	-	-	Plant dipping
Celery	Australia	SG	50	[50-100g/hl]	-	5	10-14 day intervals
	France	WP	50	-	-	-	
	Ireland	WP	50	0.55	2	-	Crop spraying
	USA	SG	50	0.28-0.56	-	7	7-10 day intervals

Table 3. Benomyl - registered use rates and patterns on cereals and other grasses.

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
Cereals	Spain	WP	50	0.25	-	15	
Barley	Australia	SG	50	0.5	1	120	
	Belgium	WP/SC	6.5-20	0.1-0.25	1-2	28-42	
	Denmark	WP	50	0.25	1	-	Apply in May
				0.25-0.5	1	-	Apply in Nov/Dec
	Germany	WP	52.4	0.131	1	56	Winter barley
	Ireland	WP	50	0.25	1-2	-	
	UK	WP	50	0.25	2	-	Spring or winter barley
Oats	Belgium	WP/SC	6.5-20	0.1-0.25	1-2	28-42	
	UK	WP	50	0.25	2	-	
Rice	USA	SG	50	1.1-2.2	2	21	
Rye	Germany	WP	52.4	0.131	1	56	Winter rye
	Ireland	WP	50	0.25	1-2	-	
	UK	WP	50	0.25	2	-	Spring or winter rye
Triticale	Belgium	WP/SC	6.5-20	0.1-0.25	1-2	28-42	
	UK	WP	50	0.25	2	-	

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
Wheat	Australia	SG	50	0.5	1	120	
	Belgium	WP/SC	6.5-20	0.1-0.25	1-2	28-42	
	Germany	WP	52.4	0.131	1	56	Winter wheat
	Ireland	WP	50	0.25	1-2	-	
	Italy	WP	50	0.2-0.25	2	30	
	Netherlands	WP	50-75	0.25	1	35	
	UK	WP	50	0.25	2	-	Winter wheat
Grasses for sugar or syrup production							
Sugar cane	Australia	SG	50	[300g/hl]	1	-	Seedpieces dip
	Philippines	WP	50	[25-50g/hl]	1	-	Seedpieces dip
	USA	SG	50	[25-50g/hl]	1	-	Seedpieces dip

Table 4. Benomyl - registered use rates and patterns on nuts, oilseed and herbs.

Crop	Country	Application				PHI, days	Comments
		Form	Conc %	kg ai/ha	No.		
Tree nuts							
Almonds	USA	SG	50	1.1-1.7	1-2	-	
Macadamia nuts	USA	SG	50	2	-	-	7-14 day intervals
Pecan	USA	SG	50	0.56-1.1	1-5	-	Before shuck split
Oilseed							
Peanut	Australia	SG	50	0.3	1	-	
	USA	SG	50	0.28	-	14	7-14 day intervals
Rape seed	Canada	WP	50	0.5-0.75	1	-	
	Ireland	WP	50	0.55	2	-	Spring application
Herbs							
Dill	Canada	WP	50	0.55	2	-	
Information was also supplied that benomyl was registered on many crops in Austria, Bulgaria, Hungary, Poland, and South Africa but no data on GAP were given.							

RESIDUES RESULTING FROM SUPERVISED TRIALS

Fruits - See Table 5.

Apple. Data were provided from several supervised trials carried out in France and the USA in 1988 and 1990; two trials involved the use of a post-harvest dip. Residues from the field trials reached 1.8 mg/kg at 7 days and 1.6 mg/kg at 14 days PHI; 1.0 mg/kg was seen at 21 days. From the post-harvest dip treatment, a maximum of 1.4 mg/kg was found at day 0.

Pear. From 3 trials in the USA in 1990, residues reached a maximum of 2.6 mg/kg at 14 days PHI.

Apricot. Little difference in residue levels was observed in trials in France and the USA at PHIs from 14 to 109 days; the highest was 0.08 mg/kg.

Nectarine. A maximum of 0.01 mg/kg was found at PHIs up to 113 days.

Peach. Trials in France (3) and the USA (16) gave residues up to about 2 mg/kg at 7 or 14 days but less than 0.01 mg/kg at PHIs from 104 to 151 days.

Grapes. A residue of 0.1 mg/kg was found in one trial in France.

Strawberry. Residues from two trials in Spain in 1990 were very variable, up to 0.75 mg/kg at 3 days, 0.58 mg/kg at 7 days and <0.01 mg/kg at 14 days in one trial, although all results at similar intervals were below 0.01 mg/kg in the other.

Kiwifruit. Data were provided from 4 trials in New Zealand in 1988. A maximum of 0.25 mg/kg was found at 60 days PHI.

Table 5. Residues of benomyl in fruit from supervised trials.

Crop	Country 'Year	Application			No.of trials	Residues (mg/kg as carbendazim) at PHI (days)	Ref.
		Form	kg/ha	No			
Apple	France '88	DG 50	0.3	1	3	<0.01,0.6,1.8 (8); <0.01,0.31,0.47 (15)	Du Pont, 1990
			[50g/hl]	1	2	0.39,1.42 (0) [Post-harvest dip]	
	France '90	DG 50	0.21	1	1	0.19 (1); 0.16 (7)	Du Pont, 1993
			0.318	1	1	<0.05 (2, 8)	
			0.345	1	1	0.12 (1); 0.15 (7)	
	USA '90	DG 50	0.4	7	8	0.19-1.8 (7); 0.16-1.6 (14); 0.14-0.98 (21)	Du Pont, 1993
			0.8	7	4	0.98-1.6 (7); 0.2-1.2 (14); 0.17-1.0 (21)	
Pear	USA '90	DG 50	0.7	4	2	1.4 (7); 1.4 (10); 1.0-2.0 (14); 2.0 (21)	Du Pont, 1993
			1.0	4	1	2.6 (14)	
Apricot	France '88	DG 50	0.3	4	2	<0.05 (109); 0.08 (106)	Du Pont, 1990
	USA '90	DG 50	1.1	2	2	<0.01 (88; 109)	Du Pont, 1993
			2.2	2	2	0.03 (88); <0.01 (109)	
Nectarine	USA '90	DG 50	1.1	2	3	<0.01 (105-116)	Du Pont, 1993
			2.2	2	3	<0.01-0.01 (105-113)	
Peach	France '88	DG 50	0.3	1	2	0.54 (4); 0.24 (11); 0.12 (5); <0.05 (10)	Du Pont, 1990
	USA '90	DG 50	0.3	2	1	0.07 (7)	Du Pont, 1993
			1.2	2	8	0.38-1.7 (7); 0.29-1.6 (14); <0.01 (104-151)	
			2.2	2	8	0.31-2.0 (7);0.43-1.8 (14); <0.01 (104-151)	
Grapes	France '88	DG 50	0.125	4	1	0.1 (92)	Du Pont, 1990
Strawberry	Spain '90	EC 45	0.75	1	2	<0.01,0.75 (3); <0.01,0.58 (7); <0.01 (14)	Spain, 1993
Kiwifruit	New Zealand '88	WP 50	[50g/hl]	1	2	0.12,0.2 (60); 0.12, 0.19 (90); <0.01,0.11 (120)	Du Pont, 1990
			[100g/hl]	1	2	0.22,0.25 (60); 0.09, 0.1 (90); 0.15,0.19 (120)	

Other crops - See Table 6.

Brussels sprouts. Less than 0.01 mg/kg was found in a trial in The Netherlands in 1975.

Melons. Two trials in France in 1988 gave residues up to 0.33 mg/kg at 3 days, 0.19 mg/kg at 7 days and 0.08 mg/kg after 14 days.

Mushrooms. At a PHI of 12 days, residues in three trials in France were up to 1.4 mg/kg.

Common bean. Green beans contained 0.14 mg/kg at 11 days PHI. Residues in dry beans were below 0.01 mg/kg at 37 days although the pods contained 0.18 mg/kg.

Potato. In two trials using post-harvest spray treatments of potatoes at rates of 25 and 40 g per tonne, most of the residues remained in the peel (up to 14 mg/kg). The flesh of the peeled potatoes contained between 0.11 and 0.20 mg/kg.

Sugar beet. Residues were below the limit of determination (0.05 mg/kg) in the roots and tops of sugar beet treated in France in 1988.

Turnip. Residues up to 0.81 mg/kg were found in the greens of treated turnips in the USA but were below 0.1 mg/kg in the roots.

Wheat. In trials in France, residues in treated grain were below 0.05 mg/kg but one sample of straw contained 0.77 mg/kg.

Rape seed. Residues were at or below 0.05 mg/kg in one trial in France.

Sunflower seed. A maximum residue of 0.07 mg/kg was found in one trial in France.

Rice. Residues ranging from 1.2 to 30 mg/kg were found in samples of rice straw during 6 trials in the USA in 1989.

Table 6. Residues of benomyl in other crops from supervised trials.

Crop	Country 'Year	Application			No of trials	Residues (mg/kg as carbendazim) at PHI (days)	Ref.
		Form.	kg/ha	No.			
Brussels sprouts	Nthlnds '75	WP 50	0.5	1	1	<0.01 (14, 21, 28)	Nthlnds 1993
Melon	France '88	DG 50	0.375	4	1	0.1 (3), <0.05 (7), <0.05 (14)	Du Pont 1990
			0.39	4	1	0.33 (3), 0.19 (7), 0.08 (14)	
Mushrooms	France '88	DG 50	5	1	2	0.76, 0.9 (12)	Du Pont 1990
			10	1	1	1.4 (12)	
Common bean, green	France '88	DG 50	0.48	2	2	0.14 (11), <0.05 (22), <0.05 (53)	Du Pont 1990
Beans, dry	France '88	DG 50	0.48	2	1	<0.05 (37) seed; 0.18 (37) pod	Du Pont 1990
Potato	Nthlnds '76	WP 50	[25g/t]	1	1	8.5-9.3, mean 8.7 (171) peel	Nthlnds 1993 [Post-harvest]
						0.12-0.20, mean 0.15 (171) peeled tubers	
	Nthlnds '77	WP 50	[40g/t]	1	1	12-14, mean 13 (90) peel	
						0.11-0.16 mean 0.14 (90) peeled tubers	
Sugar beet	France '88	DG 50	0.25	2	1	<0.05 (21) root and top+leaves	Du Pont 1990
Turnip	USA '90	WP 50	0.28	3	1	<0.1 (14) root; 0.81,0.64 (14) greens	Du Pont 1992
Wheat	France '88	DG 50	0.2	1	1	<0.05 (92) grain and straw	Du Pont 1990
			0.25	1	1	<0.05 (88) grain; 0.77 (88) straw	
Rape seed	France '88	DG 50	0.25	2	2	<0.05 (75), 0.05 (90)	Du Pont 1990
Sunflower seed	France '88	DG 50	0.25	2	2	<0.05 (61), 0.07 (63)	Du Pont 1990
Rice straw	USA '89	DG 50	1.12	2	3	1.2-12, mean 3.7 (21)	Du Pont 1990
			2.24	2	3	6.5-30, mean 15 (21)	

Tea. Tea plants were treated with 50% wettable powder in Taiwan in 1986 at dilutions of 1 to 1500 and 2000, both treatments being at 0.7 kg/ha. Leaves were sampled at three-day intervals and prepared as tea water solution for analysis. The table below shows the rate of decline of residues (as carbendazim) with time.

Day	0	3	6	9	12	15	18	21
1:1500	19.4	9.7	4.8	0.99	1.5	0.76	0.56	0.20
1:2000	4.7	2.2	1.0	0.99	0.6	1.49	0.57	0.40

As a result of this study a PHI of 21 days was proposed.

FATE OF RESIDUES

In storage and processing

Prunes. Prune plums were treated with benomyl (WP 50) at two sites in the USA in 1986. Both fresh plums and the resulting dried prunes were analysed and the results are given below (Table 7).

Table 7. Effect on residue levels of drying plums treated with benomyl.

Application		PHI, days	Residue (carbendazim, mg/kg)		Ratio, prunes/plums
Rate, kg ai/ha	No.		Fresh plums	Dried prunes	
70	3	7	0.65	0.54	0.83
62	4	0	0.23	0.13	0.57
		1	1.4	0.14	0.10
		3	0.65	0.16	0.25
		7	3.0	0.08	0.027
		14	0.91	0.08	0.088
122	4	0	2.8	0.50	0.18
		1	3.3	0.61	0.18
		3	4.0	0.60	0.15
		7	3.1	0.40	0.13
		14	3.1	0.32	0.10

It is clear that the drying process reduces the residue considerably.

Grapes. Grapes at two sites in California, USA, were treated with benomyl in 1986. Mature grapes were harvested, some were analysed for benomyl residues and the rest were dried. The raisins and the raisin waste (stems and pieces) were analysed separately. The results obtained, residues expressed as carbendazim, are given below.

Appl. rate, kg/ha	No. appl.	PHI, days	Carbendazim mg/kg		
			Grapes	Raisins	Raisin waste
0.84	2	7	3.1	3.1	11
0.84	2	7	1.2	1.9	5.6

Thus, residues in fresh grapes and raisins were similar, despite the loss of weight on drying, while residues in the raisin waste were some 3 to 4 times greater.

Pineapples. Residues of benomyl in pineapples and their processed products were studied in 1988 in the USA (Du Pont, 1990). Ripe fruits were dipped at twice the then recommended concentration of 480 g/hl and processed normally. The results of residue analyses of the various fractions are given below.

Sample	Residue, mg/kg as carbendazim
Unwashed fruits	7.8
Washed fruits	4.0, 4.2, 4.2

Feed pulp	1.0
Pineapple slices	0.37, 0.40
Beverage juice	1.2
Mill juice	12, 15
Juice concentrate	4.2, 5.0

In general, less than 20% of the total residues were found in the feed pulp, beverage juice, and fruit slices; the concentrated juice also showed a reduction in residues in that only 60% of the level in the raw agricultural commodity was found. Concentration of residues (about 1.8 times) was only found in the mill juice fraction. This is obtained through extraction of the pineapple skins which could be expected to have higher levels of residues.

Tomatoes. In 1989 tomatoes were treated with benomyl, 50% dispersible granules, at 10 to 20 times the recommended rate in order to ensure that measurable residue levels would ensue in the fruits and their processed products. The results obtained are shown below.

Fraction	Residue, mg/kg as carbendazim	Reduction factor
Tomato	2.8, 2.8, 2.9	1
Wet pomace	0.77, 0.81, 0.79	0.30
Dry pomace	0.41, 0.48, 0.40	0.47
Juice	0.67, 0.72, 0.64	0.25
Puree	1.8, 1.6, 1.7	0.66
Ketchup	1.6, 1.6, 1.5	0.64

Hence, residues from the treatment of tomatoes with benomyl are reduced during the processing of the fruit to juice, puree or ketchup.

RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

Stored apples from the 1989 harvest were collected from four different packing houses in Kent, UK, immediately before grading. All samples, apart from the controls, had been treated with benomyl at full or half the recommended rate (i.e. 0.5 or 0.25 kg ai/1000 l) applied by commercial dip or drench equipment. All of the treated fruit contained residues of benomyl, with a maximum of 0.67 mg/kg as carbendazim (1.0 mg/kg as benomyl), and the average of the 25 samples was 0.25 mg/kg as carbendazim (0.38 mg/kg as benomyl).

In monitoring and selective studies in Hungary in 1990 to 1992 (Hungary, 1993), residues of benomyl were found in 4 of 63 samples of strawberries examined, with a mean of 0.3 mg/kg. Three of 36 samples of raspberries contained a mean residue of 0.22 mg/kg, while 4 of 65 lettuces gave a maximum content of 1.2 mg/kg, the other residues being below 0.5 mg/kg. Of only 6 samples of tomatoes tested, 1 showed a residue of 0.2 mg/kg. All other results were below the limit of determination.

In the USA in 1991, a study was made of residues arising from the use of benomyl or its allied compounds, determined as carbendazim, in foods for which there were post-harvest uses or established food additive tolerances in the USA (US FDA, 1992). The results obtained are shown below.

Commodity	No. sampled	No. with residues	Range (mg/kg)
Apples	152	3	0.05-0.07
Mushrooms	90	25	0.06-0.84
Pears	49	4	0.05-0.33
Pineapples	62	10	0.05-7.5
Stone fruits	247	79	0.05-1.9

In a similar study in 1991, of 1286 samples examined, 236 were of domestic US produce and 1050 were imported goods. This study put emphasis on leaf/stem vegetables (210), berries including grapes (121), peppers (116), stone fruit (110), tropical fruits (104) and vine fruits (103). Residues were found in only 35 of these samples: peas (8), cherries (7), pears (4), nectarines (3), bananas, cantaloupes, peaches, and plums (2 of each) and cucumbers, green beans, oranges, raspberries and watermelon (1 of each). Apart from the 8 samples of peas, for which no benomyl MRL was established, all results were within the limits allowed in the USA (US FDA, 1992).

NATIONAL MAXIMUM RESIDUE LIMITS

Information on the following national MRLs was provided to the Meeting.

Crop	Country and MRL, mg/kg														
	AU	AT	BE	BR	BG	CA	DK	FR	HU	JP	NL	PL	SA	US	VE
Apple						5							0.5		
Apricot	5					5								15	
Avocado													0.5		
Banana								1							
Berries		1.5	2		5				2		3				
Blackberry						6								7	
Blueberry														7	
Brussels sprouts													0.5		
Carrot	5					5	5							0.2	5
Cauliflower											3				
Celeriac											3				
Cereal grains	0.5		0.1	0.5			0.1		0.5		0.1	1		0.2	
Cherries	5					5				0.7				15	
Citrus fruits	10	7	4	10		10		1.5		0.7	4		0.5	10	
Common bean			2												
Cucumber			0.5												
Cucurbits													0.5		
Fruits												1			
Garden pea			2						2						
Gherkins			0.5												
Grapes		3			10								0.5		
Kiwifruit										0.7					
Lettuce	3		2						2	0.8					5
Litchi	10														
Mango													0.5		
Melons			0.5						1						
Mushrooms	10		0.5			5	1				0.5	1		10	5
Nectarine	5					10								15	
Other crops			0.1								0.1				
Other vegetables			2								3				
Peach	5			10		10				0.7			0.5	15	15
Pear													0.5		
Pepper, sweet	3		0.5						2						5
Pineapple		2		35		1								35	
Plums	5					5				0.7				15	
Pome fruit	5	2	2	5	5			6	2	0.7	3			7	
Potato					3						3				
Raspberry	5					6								7	
Stone fruit					10										
Strawberry	5			5		5				0.7				5	
Sugar beet					0.1						0.1				
Tomato	3			5	5	2.5				0.8				5	5
Vegetables							2					1			
Wheat					0.5										
Key to Countries	AU = Australia, AT = Austria, BE = Belgium, BR = Brazil, BG = Bulgaria, CA = Canada, DK = Denmark, FR = France, HU = Hungary, JP = Japan, NL = Netherlands, PL = Poland,														

Crop	Country and MRL, mg/kg														
	AU	AT	BE	BR	BG	CA	DK	FR	HU	JP	NL	PL	SA	US	VE
	SA = South Africa, US = USA, VE = Venezuela.														

APPRAISAL

Benomyl was first evaluated in 1973 and has been reviewed on five other occasions. The 1988 JMPR initiated a re-evaluation of residues arising from the use of the three related fungicides benomyl, carbendazim and thiophanate-methyl, all to be calculated as carbendazim, in response to concerns expressed at the 1988 CCPR (ALINORM 89/24, paras. 82-84). The 1989 CCPR requested that the recommendations for a group MRL for carbendazim in cereals should be replaced by separate recommendations for MRLs for individual crops, while at the 1992 CCPR (ALINORM 93/24, para. 105) several other MRLs were held at step 7B pending further review by the JMPR. Although some information was provided for the 1990 JMPR, that Meeting concluded that it would be premature to review the compounds until all of the required data became available and consideration was deferred to the 1992 JMPR. However, because of the work-load at that Meeting, the re-evaluation was again postponed until 1993. The data submitted for the 1990 and 1992 Meetings, together with additional data provided in 1993, have now been reviewed with particular attention to the information on GAP and some new residue data.

The information on GAP illustrated the extensive applications of this fungicide world-wide. Although post-harvest uses have been withdrawn in several countries, they are still registered for fruits in others. However, apart from two trials on apples in France in 1988, no data on residues arising from such treatments were made available.

Data were available from field trials on pome and stone fruits, and limited data on residues in grapes, strawberries, wheat, and a range of vegetables. Of the commodities with MRLs currently held at Step 7B, residue data from the use of benomyl were available only for apricot, grapes, strawberry, mushrooms, nectarine, peach, pome fruits, sugar beet leaves, and wheat.

Some data were presented on residues occurring in commercially treated apples and also on the effects of processing on treated prune plums, grapes, pineapples and tomatoes. Results of monitoring studies carried out in Hungary and the USA were also provided.

Any assessment of the residues from the use of benomyl must take into account those arising from uses of carbendazim and/or thiophanate-methyl, since all three pesticides yield carbendazim as the residue of prime importance. Recommendations are therefore dealt with under "carbendazim".

FURTHER WORK OR INFORMATION

Desirable

1. Residue data from supervised trials of benomyl using currently registered post-harvest treatments of fruits and vegetables.

2. Residue data from supervised trials of benomyl on rice to enable a recommendation for an MRL to be made.

3. Residue data from supervised trials of benomyl at the currently registered rates of use on lettuce, peppers, tomatoes and sugar beet.

4. Supporting residue data from supervised trials of benomyl at the currently registered rates of use on all other crops for which CXLs are listed.

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