

ENDOSULFAN (032)

EXPLANATION

Endosulfan has been reviewed many times from 1967 to 1989, at which time a full re-evaluation was carried out. As a result of information that proposed MRLs for endosulfan on several brassica crops did not reflect GAP in the USA, the 1992 CCPR placed the recommendations in step 7B, pending review by the JMPR. Additional GAP and residue data have now become available and are reviewed below.

USE PATTERN

Endosulfan is widely used as an insecticide on fruits, vegetables, cereals and oilseed. GAP information from 21 countries was provided by the main manufacturer, Hoechst AG; this is summarised in Table 1.

Table 1. Endosulfan - registered use rates and patterns

| Country | Crop | EC/WP/DP | Conc | Applic. (kg ai/ha) | No. of app. | PHI (days) | Comments |
|-----------|---|----------|----------|--------------------|-------------|------------|-------------------------|
| Argentina | Vegetables | EC | 35% | 0.60 | 1 | 7 | Post-Flowering |
| | Soya bean | EC | 35% | 0.45 | 1 | 14 | Post-Flowering |
| | Sunflower | EC | 35% | 0.50 | 1 | 14 | Flowering |
| Australia | Pineapple | EC | 35% | [0.56-0.7 g/l] | 1 | - | Post-harvest dip |
| Belgium | Fruits | EC | 35% | 0.35-1.75 | - | 28 | 4 wks pre-harvest |
| | Berries | EC | 35% | | - | 42 | |
| | Strawberry & small fruits | EC | 35% | 0.525 | - | 28 | Before flowering |
| | Mushrooms | EC | 35% | 14 | - | 21 | 3 wks pre-harvest |
| | Potato | EC | 35% | 0.175-0.525 | - | 28 | 4 wks pre-harvest |
| Brazil | Rape | EC | 35% | 0.6-0.7 | - | 28 | |
| | Soya bean | EC | 35% | 0.26 | 1 | 30 | |
| | Cotton | EC | 35% | 0.525 | 1 | 30 | |
| Canada | Coffee | EC | 35% | 0.525 | 1 | 70 | |
| | Apple & Pear | WP | 50% | 1.6-3.4 | Sev. | 15 | |
| | Apricot, Cherry, Peach & Plum | EC/WP | 40/50% | 0.48-0.76 | 2-3 | 15 | Avoid spray on fruit |
| | Grapes | WP | 50% | 1.25-1.5 | 2 | 30 | |
| | Strawberry | EC | 40% | 1.0-5.4 | 1-2 | 7 | Pre-bud & after harvest |
| | | WP | 50% | 1.0-16 | 1-2 | 7 | Pre-bud & after harvest |
| | Broccoli, Brussels sprouts, Cabbage & Cauliflower | EC/WP | 40/50% | 0.55-0.88 | Sev. | 7 | 7 day intervals |
| | | DP | 2% | 0.8-1.0 | Sev. | 7 | 7-10 day intervals |
| | Cucumber, Melon, Pumpkin & Squash | EC/WP | 40/50% | 0.5-0.6 | 1-4 | 2 | 7 day intervals |
| | | DP | 2% | 0.8-1.0 | 4 | 5 | 7-10 day intervals |
| | Egg plant, Peppers & Tomato | EC | 40% | 0.5-0.6 | Sev. | 2 | 7 day intervals |
| | | DP | 2% | 1.0-1.1 | Sev. | 5 | 7-10 day intervals |
| | Sweet Corn | EC/WP | 40/50% | 1.0-1.7 | 1-2 | 50 | |
| Lettuce | EC/WP | 40/50% | 0.8-0.88 | 1-3 | 14 | | |

| Country | Crop | EC/WP/DP | Conc | Applic. (kg ai/ha) | No. of app. | PHI (days) | Comments |
|-----------|----------------|----------|--------|--------------------|-------------|------------|------------------------------|
| | | DP | 2% | 0.8-1.0 | 1-3 | 14 | 7-10 day intervals |
| | Spinach | EC/WP | 40/50% | 0.8-0.88 | 1 | 14 | |
| | Beans | EC | 40% | 0.56-1.0 | Sev. | 2 | Not Lima beans |
| | | WP | 50% | 0.55-0.75 | Sev. | 2 | Not Lima beans |
| | Peas (canning) | EC/WP | 40/50% | 0.55-0.88 | 1-2 | 7 | |
| | (seed) | EC/WP | 40/50% | 0.55-0.88 | Sev. | 7 | |
| | Potato | EC/WP | 40/50% | 0.56-0.84 | Sev. | 1 | As necessary |
| | | DP | 2% | 0.81-1.1 | Sev. | 1 | 7-10 day intervals |
| | Rutabaga | EC/WP | 40/50% | 0.80-0.87 | 1-2 | 45 | |
| | Turnip | EC/WP | 40/50% | 0.80-0.87 | 1-2 | 45 | |
| | Sugar beet | EC | 40% | 0.6-1.1 | 1 | 45 | |
| | Celery | EC/WP | 40/50% | 0.80-0.88 | 1-3 | 14 | |
| | | DP | 2% | 1.0-1.2 | Sev. | 14 | 7-10 day intervals |
| | Maize | EC/WP | 40/50% | 1.0-1.7 | 1-2 | 50 | |
| | Sunflower | EC | 40% | 0.56-0.6 | 1 | 60 | |
| | Alfalfa | EC | 40% | 0.3 | 1 | 30 | |
| | Clover | EC | 40% | 0.3 | 1 | 30 | |
| Colombia | Strawberry | EC | 35% | 0.56-0.7 | - | - | |
| | Beans | EC | 35% | 0.525-0.7 | 1-3 | - | |
| | Cruciferae | EC | 35% | 0.7-1.05 | - | - | |
| | Soya bean | EC | 35% | 0.35-0.7 | 1-2 | - | |
| | Potato | EC | 35% | - | - | - | |
| | Rice | EC | 35% | 1.2-1.4 | - | - | |
| | Cotton | EC | 35% | 0.525 | 2-5 | - | |
| | Sesame | EC | 35% | 1.05-1.4 | - | - | |
| | Coffee | EC | 35% | 0.525-0.7 | - | - | |
| Ecuador | Vegetables | EC | 35% | 0.35 | 1-3 | 10 | |
| | Rice | EC | 35% | 0.525 | 1-2 | - | |
| | Cotton | EC | 35% | 0.17-0.35 | 1 | - | |
| | Palm nut | EC | 35% | 0.43 | 1 | - | |
| | Coffee | EC | 35% | 0.63 | 1-2 | - | |
| Finland | Currant, Black | EC | 35% | 0.375-1.5 | 1-2 | - | Pre-flowering |
| | Strawberry | EC | 35% | 0.75-1.5 | 1 | - | Post-harvest only |
| Greece | Apple | EC/WP | 35/47% | All EC appl. | 1 | 30 | |
| | Pear | EC/WP | 35/47% | are at | 1 | 30 | |
| | Cherry | EC/WP | 35/47% | 0.074-0.098 | 1 | 30 | |
| | Grapes | EC/WP | 35/47% | kg ai/hl. | 1-2 | 30 | |
| | Strawberry | EC/WP | 35/47% | (High vol.) | 1-2 | - | Pre-flower/ after harvest |
| | Olives | EC/WP | 35/47% | | 1 | - | Pre-flowering |
| | Cucumber | EC/WP | 35/47% | | 1-3 | 7 | |
| | Melon | EC/WP | 35/47% | | 1-3 | 7 | |
| | Squash, Summer | EC/WP | 35/47% | All WP appl. | 1-3 | 7 | |
| | Watermelon | EC/WP | 35/47% | are at | 1-3 | 7 | |
| | Egg plant | EC/WP | 35/47% | 0.075-0.094 | 1-3 | - | |
| | Peppers | EC/WP | 35/47% | kg ai/hl | 1-3 | - | |
| | Tomato | EC/WP | 35/47% | (High vol.) | 1-3 | 4 | |
| | Potato | EC/WP | 35/47% | | 1-3 | 21 | |
| | Cotton | EC/WP | 35/47% | | 1-2 | - | |
| | Alfalfa (seed) | EC/WP | 35/47% | | 1 | - | |
| | Clover (seed) | EC/WP | 35/47% | | 1 | - | |
| Guatemala | Cruciferae | EC | 35% | 0.595 | 1 | 40 | |
| | Melon | EC | 35% | 0.525 | 1-2 | 30 | |
| | Tomato | EC | 35% | 0.595 | 3 | 20 | |
| | Coffee | EC | 35% | 0.595 | 1 | 135-165 | |
| Indonesia | Shallot | EC | 35% | 0.25-0.45 | 5 | - | |

| Country | Crop | EC/WP/DP | Conc | Applic. (kg ai/ha) | No. of app. | PHI (days) | Comments |
|-------------------|------------------------------|----------|-------|--------------------|-------------|------------|----------------------|
| | Peppers, Chili | EC | 35% | 0.25-0.45 | 8 | - | |
| | Rice | EC | 35% | 0.28-0.42 | 2 | - | |
| | Soya bean | EC | 35% | 0.21-0.31 | 4 | - | |
| Ireland | Apple & Pear | WP | 50% | 0.625-0.85 | - | 7-21 | |
| | Currants, Red, Black & White | WP | 50% | 0.625-0.85 | - | 7-21 | |
| | Brassicas | WP | 50% | 0.625-0.85 | - | 7-21 | |
| | Beans (dwarf) | WP | 50% | 0.625-0.85 | - | 7-21 | |
| | Cucumber | WP | 50% | 0.625-0.85 | - | 7-21 | |
| | Tomato & Peppers | WP | 50% | 0.625-0.85 | - | 7-21 | |
| | Carrot, Potato & Sugar beet | WP | 50% | 0.625-0.85 | - | 7-21 | |
| | Celery | WP | 50% | 0.625-0.85 | - | 7-21 | |
| | Rape | WP | 50% | 0.625-0.85 | - | 7-21 | |
| Italy | Citrus fruits | EC | 32.9% | 1.0 | 1 | 25 | |
| | Peach | EC | 32.9% | 0.75 | 1 | 25 | |
| | Grapes | EC | 32.9% | 0.5 | 1-2 | 25 | |
| | Vegetables | EC | 32.9% | 0.5 | 1-2 | 25 | |
| | Tomato | EC | 32.9% | 0.5 | 1-2 | 25 | |
| | Potato | EC/WP | 32.9% | 0.5 | 1-2 | 25 | |
| | Sugar beet | EC/WP | 32.9% | 0.5 | 1-2 | 25 | |
| | Tree nuts | EC | 32.9% | 0.5 | 1-2 | 25 | |
| Republic of Korea | Mulberry | DP | 3% | 1.2 | 1 | - | After summer logging |
| | Chinese cabbage | DP | 3% | 0.9-1.8 | 4 | 30 | |
| Philippines | Citrus fruits | EC | 35% | 1-3 | - | 7 | |
| | Perennial fruits | EC | 35% | 1-3 | - | 7 | |
| | Mango | EC | 35% | 1-3 | - | 7 | |
| | Pineapple | EC | 35% | 1-3 | - | 7 | |
| | Cruciferae | EC | 35% | 1-3 | - | 7-14 | |
| | Egg plant | EC | 35% | 1-3 | - | 7-14 | |
| | Tomato | EC | 35% | 1-3 | - | 1 | |
| | Legumes | EC | 35% | 1-3 | - | 3 | |
| | Maize | EC | 35% | 1.5-3 | - | 10 | |
| | Rice | EC | 35% | 1.5-2 | - | 10 | |
| | Cotton | EC | 35% | 1.5-4 | - | - | |
| Portugal | Apple & Pear | WP | 35% | 1.2-2.45 | - | 28 | |
| | Brassicas | EC | 38% | 1.2-2.45 | 1-3 | 28 | |
| | | WP | 35% | 1.2-2.45 | 1-3 | 28 | |
| | | WP | 80% | 1.2-2.45 | 1-3 | 28 | |
| | Cabbage | WP | 35% | 1.2-2.45 | 1-3 | 28 | |
| | Tomato | WP | 35% | 1.2-2.45 | - | 28 | |
| | Tomato | DP | 3% | 0.75 | - | 3-28 | |
| | Maize | WP | 35% | 1.2-2.45 | - | 28 | |
| | Sugar cane | WP | 35% | 1.2-2.45 | - | 28 | |
| Spain | Citrus fruits | EC | 35% | 2.1-6.3 | 1-3 | 15 | |
| | Stone fruits | EC | 30% | 0.675-1.35 | - | 15 | |
| | Grapes | EC | 35% | 0.32-0.63 | 1-3 | 15 | |
| | Olives | EC | 35% | 0.53-1.05 | - | 15 | |
| | Brassicas | EC | 35% | 0.53-1.58 | - | 15 | |
| | Cucurbits | EC | 35% | 0.53-1.58 | - | 7 | |
| | Egg Plant | EC | 35% | 0.53-1.58 | - | 7 | |
| | Peppers | EC | 35% | 0.53-1.58 | - | 7 | |
| | Tomato | EC | 35% | 0.53-1.58 | - | 7 | |
| | Potato | EC | 35% | 0.53-1.58 | - | 15 | |
| | Asparagus | EC | 35% | 0.53-1.58 | - | 15 | |
| | Hazelnuts | EC | 35% | 0.8-1.6 | 1-3 | 15 | |
| | Cotton | EC | 35% | 0.53-1.05 | 1-3 | 15 | |

| Country | Crop | EC/WP/DP | Conc | Applic. (kg ai/ha) | No. of app. | PHI (days) | Comments |
|---------------------------|---|----------|----------|--------------------|-------------|-------------------------------------|--|
| Sweden | Currants, Black | EC | 35% | 0.35-0.7 | 1 | - | |
| | Strawberry | EC | 35% | 0.35-1.05 | 1-2 | - | |
| Thailand | Citrus fruits | EC | 35% | - | 10 | 7-14 | |
| | Grapes | EC | 35% | - | 3 | 7-14 | |
| | Rambutan | EC | 35% | - | 5 | 7-14 | |
| | Vegetables | EC | 35% | 0.26-0.35 | 5 | 7-14 | |
| | Onion | EC | 35% | 0.52-0.7 | 8 | 7-14 | |
| | Tomato | EC | 35% | 0.26-0.35 | 5 | 7-14 | |
| | Beans | EC | 35% | 0.35-0.44 | 3 | 7-14 | |
| | Rice | EC | 35% | 0.26-0.35 | 4 | 7-14 | |
| | Cotton | EC | 35% | 0.35-0.7 | 5 | 7-14 | |
| | Coffee | EC | 35% | 0.88-1.3 | 5 | 7-14 | |
| UK | Blackberries | EC | 20% | 0.5 | 3 | - | |
| | Curants, Black | EC | 20% | 0.6 | 3 | - | First flower |
| | Curants, Black | EC | 20% | 0.9 | 3 | - | Fruit set |
| | Strawberry | EC | 20% | 0.5 | 1 | - | |
| USA | Citrus fruits | EC/WP | 35/50% | 0.55-2.75 | 1-2 | 365 | Max. 3.3 kg/ha/year (Non-bearing trees) |
| | Apple | EC/WP | 35/50% | 0.55-2.75 | 1-3 | 21 | Max. 3.3 kg/ha/year |
| | Pear | EC/WP | 35/50% | 0.28-2.75 | 1-2 | 7 | Max. 3.3 kg/ha/year |
| | Apricot | EC/WP | 35/50% | 0.55-2.75 | 1-2 | 21 | Max. 3.3 kg/ha/year |
| | Cherry | EC/WP | 35/50% | 0.55-2.75 | 1-2 | 21 | |
| | Nectarine | EC/WP | 35/50% | 0.55-2.75 | 1-2 | 21 | Max. 3.3 kg/ha/year |
| | Peach | EC/WP | 35/50% | 0.55-2.75 | 1-2 | 21 | Max. 3.3 kg/ha/year |
| | Plum & Prune | EC/WP | 35/50% | 0.55-2.75 | 1-2 | 7 | Max. 3.3 kg/ha/year |
| | Blueberries | EC/WP | 35/50% | 1.6 | 1-2 | - | Max. 3.3 kg/ha/year After harvest 4+6-8weeks |
| | Grapes | EC/WP | 35/50% | 0.55-1.6 | 1-3 | 7 | Max. 3.3 kg/ha/year |
| | Strawberry | EC/WP | 35/50% | 1.1-2.2 | 1-3 | 4 | Max. 3.3 kg/ha/year |
| | Pineapple | EC | 35% | 1.6-2.1 | 1-2 | 7 | Max. 3.3 kg/ha/year |
| | Broccoli | EC/WP | 35/50% | 0.8-1.1 | 1-4 | 7 | Max. 3.3 kg/ha/year |
| | Brussels sprouts | EC/WP | 35/50% | 0.8-1.1 | 1-4 | 14 | Max. 3.3 kg/ha/year |
| | Cabbage, Head | EC/WP | 35/50% | 0.8-1.1 | 1-4 | 7 | Max. 3.3 kg/ha/year |
| | Cauliflower | EC/WP | 35/50% | 0.8-1.1 | 1-4 | 14 | Max. 3.3 kg/ha/year |
| | Cucumber, Melon, Pumpkin & Squash (Summer & Winter) | EC/WP | 35/50% | 0.55-1.1 | 1-6 | 2 | Max. 3.3 kg/ha/year |
| | Peppers | EC/WP | 35/50% | 0.8-1.1 | 1-2 | 1-4 | Max. 2.2 kg/ha/year |
| | Egg plant | EC/WP | 35/50% | 1.1 | 1-2 | 1 | Max. 1.1 kg/ha/year |
| | Sweet corn | EC/WP | 35/50% | 1.1-2.2 | 1-3 | 1 | Max. 3.3 kg/ha/year |
| | Tomato | EC/WP | 35/50% | 0.55-1.1 | 1-6 | 2 | Max. 3.3 kg/ha/year |
| | Collards | EC/WP | 35/50% | 0.8-1.1 | 1 | 21 | Max. 1.1 kg/ha/year |
| | Kale | EC/WP | 35/50% | 0.8 | 1 | 21 | Max. 0.8 kg/ha/year |
| | Lettuce, Head | EC/WP | 35/50% | 0.8-1.1 | 1-3 | 14 | Max. 3 app. post-thinning |
| | Lettuce, Leaf | EC/WP | 35/50% | 0.8-1.1 | 1-2 | 14 | Max. 2 app./year |
| | Mustard greens | EC/WP | 35/50% | 0.8-1.1 | 1 | 21 | Max. 1.1 kg/ha/year |
| | Spinach | EC/WP | 35/50% | 0.8-1.1 | 1 | 21 | Max. 1.1 kg/ha/year |
| | Beans | EC/WP | 35/50% | 0.55-1.1 | 1-2 | 3 | Max. 1.1 kg/ha/year Pre-bud forming |
| | Peas (seed crop) | EC/WP | 35/50% | 0.55-1.1 | 1-2 | 1 | Max. 1.6 kg/ha/year |
| | Carrot | EC/WP | 35/50% | 0.55-1.1 | 1 | 7 | Max. 1.1 kg/ha/year |
| | Potato | EC/WP | 35/50% | 0.55-1.1 | 1-6 | 1 | Max. 3.3 kg/ha/year |
| | Sugar beet | EC/WP | 35/50% | 0.55-1.1 | 1-2 | 30 | Max. 2.2 kg/ha/year |
| Sweet potato | EC/WP | 35/50% | 0.55-2.2 | 1-3 | 1 | Max. 3.3 kg/ha/year | |
| Artichoke | EC/WP | 35/50% | 0.8-1.1 | 1-2 | 7 | Max. 2.2 kg/ha/year | |
| Celery | EC/WP | 35/50% | 0.55-1.1 | 1 | 4-7 | Max. 1.1 kg/ha/year | |
| Barley, Oats, Rye & Wheat | EC/WP | 35/50% | 0.28-0.8 | 1-2 | - | Max. 1.1 kg/ha/year | |
| Pecan | EC/WP | 35/50% | 0.55-0.8 | 1-2 | - | Max. 3.3 kg/ha/year Pre shuck split | |

| Country | Crop | EC/WP/DP | Conc | Applic. (kg ai/ha) | No. of app. | PHI (days) | Comments |
|---------|-----------|----------|--------|--------------------|-------------|------------|---|
| | Walnuts | EC/WP | 35/50% | 1.6-2.75 | 1-2 | - | Max. 3.3 kg/ha/year |
| | Cotton | EC/WP | 35/50% | 0.4-1.6 | - | - | Max. 3.3 kg/ha/year Pre boll opening |
| | Safflower | EC/WP | 35/50% | 1.1 | 1-2 | 1 | Max. 2.2 kg/ha/year Pre bud opening |
| | Sunflower | EC/WP | 35/50% | 1.1 | 1-3 | 1 | Max. 3.3 kg/ha/year |
| | Alfalfa | EC/WP | 35/50% | 0.28 | 1-3 | 21 | Max. 0.82 kg/ha/year |

RESIDUES RESULTING FROM SUPERVISED TRIALS

Fruits - see Table 2.

Citrus fruits

Clementine. In one trial in Spain in 1992, residues were below 0.1 mg/kg 14 days after application.

Lemon. Residues in lemons were up to 0.16 mg/kg at 7 days and 0.12 mg/kg at 14 days after treatment.

Oranges. Residues from three trials in Spain at GAP rates did not exceed 0.35 mg/kg at 15 days PHI. In five other trials at a slightly excessive application rate, one residue of 0.54 mg/kg was observed at 14 days; all other determinations were below 0.4 mg/kg.

Pome fruits

Apple. From five trials on apples in Germany, a maximum residue of 0.63 mg/kg was found at 21 days PHI. The current CXL for pome fruits is 1 mg/kg.

Stone fruits

Cherry, Sour. In four trials on Morello cherries in Germany in 1983 the maximum residue found at 21 days PHI was 0.03 mg/kg, well within the current CXL of 1 mg/kg.

Peach. Use of a 2.8% dusting powder in five trials on peaches in Germany resulted in residues up to 0.5 mg/kg at 14 or 21 days. Two trials in Spain using 35% EC gave a maximum residue of 0.73 mg/kg at 15 days. None of the trials was within current GAP in these countries.

Plums. In seven trials in Germany, from 1983 to 1989, a maximum residue of 0.38 mg/kg was found at 21 days PHI.

Grapes. Data were provided on 15 trials on grapes in Germany from 1974 to 1987. At a PHI of 60 to 62 days, residues were in the range 0.49-0.6 mg/kg.

Strawberry. Three trials on strawberries in Spain in 1985 showed residues up to 4 mg/kg at 3 days, 2.5 mg/kg at 4 days and 0.84 mg/kg at 13 days after application. This treatment is not GAP in Spain.

Pineapple. Endosulfan is used in Australia for quarantine purposes as a post-harvest dip. Residues up to 2 mg/kg can be expected from this procedure which would be within the existing CXL of 2 mg/kg for "Fruits".

Table 2. Residues of endosulfan in fruit from supervised trials.

| Crop/Country/Year | EC/WP/DP/% | Appl. | | No. of trials | Residues (mg/kg) at intervals (days) after last appl. | Ref. |
|-------------------|------------|-----------|-----|---------------|--|--------------|
| | | kg/ha | no. | | | |
| Clementine | | | | | | |
| Spain '92 | EC 35 | 2.1 | 1 | 1 | 0.03-0.22 (7), 0.05-0.10 (14), 0.05-0.09 (28) | Spain 1993 |
| Lemon | | | | | | |
| Spain '86 | EC 35 | 4.55 | 1 | 1 | 0.15-0.16 (7), 0.11-0.12 (14), 0.04 (30) | Spain 1993 |
| Orange | | | | | | |
| Spain '91 | EC 35 | 7.7 | 1 | 5 | 0.52-0.92 (7), 0.24-0.54 (14), 0.12-0.44 (21) | A49713-7 |
| '92 | | 3.7 | 1 | 1 | 0.21-0.29 (7), 0.03-0.06 (14), 0.02-0.05 (28) | Spain 1993 |
| | | 5.93 | 1 | 1 | 0.78 (3), 0.65 (7), 0.33 (15) | A49712 |
| | | 6.3 | 1 | 2 | 0.82, 0.88 (3), 0.55, 0.64 (7), 0.27, 0.35 (15) | A49710-1 |
| Apple | | | | | | |
| Germany '85 | EC 35 | 0.53 | 4 | 3 | 0.46-0.77 (7), 0.48-0.77 (14), 0.44-0.63 (21) | A33345-7 |
| '89 | | 0.4-0.47 | 4 | 1 | 0.42 (0), 0.55 (21) | A47390 |
| | | 0.53 | 4 | 1 | 0.76 (0), 0.11 (21) | A47389 |
| UK '80 | SC 43 | 0.85 | 2 | 4 | 0.045, 0.19 (20), 0.015, 0.095 (21) | A21279-82 |
| Cherry, sour | | | | | | |
| Germany '83 | DP 2.8 | 0.71 | 3 | 4 | 0.015-0.21 (7), 0.015-0.02 (14), 0.015-0.03 (21) | A28378-81 |
| Peach | | | | | | |
| Germany '83 | DP 2.8 | 0.71 | 3 | 5 | 0.2-1.5 (70), 0.1-0.51 (14), 0.06-0.49 (21) | A28382-6 |
| Spain '92 | EC 35 | 1.68 | 1 | 1 | 1.0 (3), 0.98 (7), 0.73 (15) | A49700 |
| | | 1.94 | 1 | 1 | 0.88 (3), 0.5 (7), 0.31 (15) | A49001 |
| Plums | | | | | | |
| Germany '83 | DP 2.8 | 0.71 | 5 | 3 | 0.15-0.26 (7), 0.05-0.15 (14), 0.07-0.09 (21) | A28391-3 |
| '84 | | 0.71 | 5 | 2 | 0.1-0.3 (7), 0.12-0.28 (14), 0.1-0.38 (21) | A30124-5 |
| '89 | EC 35 | 0.26-0.29 | 5 | 1 | 0.22 (0), 0.10 (21) | A46682 |
| | | 0.53 | 5 | 1 | 0.52 (0), 0.16 (21) | A46681 |
| Grapes | | | | | | |
| Germany '74 | EC 35 | 2.8 | 1 | 2 | 0.7, 0.9 (7), 0.24, 0.3 (14), 0.20, 0.25 (21), 0.16, 0.18 (28) | A02889, 2893 |
| | | 2.8 | 2 | 2 | 0.6, 1.2 (7), 0.4, 0.6 (14), 0.26, 0.39 (21), 0.16, 0.28 (28), 0.14 (42) | A02887, 2891 |
| | WP 35 | 2.8 | 1 | 1 | 0.4 (7), 0.3 (14), 0.26 (21), 0.18 (28) | A02894 |

| Crop/Country/Year | EC/WP/DP/% | Appl. | | No. of trials | Residues (mg/kg) at intervals (days) after last appl. | Ref. |
|-------------------|------------|----------------|-----|---------------|---|-----------------|
| | | kg/ha | no. | | | |
| | | | 2 | 2 | 1.1, 1.2 (7), 0.6, 0.7 (14), 0.4, 0.4 (21), | A02888,2892 |
| | | | | | 0.26, 0.37 (28), 0.15, 0.19 (42) | |
| '84 | WP 33 | 0.6+1.2 | 2 | 1 | 1.9 (14), 0.68 (35), 0.55 (60) | A030914 |
| | | 1.2 | 2 | 1 | 1.3 (19), 0.7 (35), 0.49 (62) | A030915 |
| | CS 35* | 1.26 | 2 | 1 | 2.5 (19), 1.4 (35), 0.59 (62) | A30909 |
| | | 0.6+1.3 | 2 | 1 | 1.8 (14), 0.82 (35), 0.6 (60) | A30910 |
| '87 | EC 35 | 0.56 | 1 | 4 | <0.015 (77-162) | A38806-9 |
| Strawberry | | | | | | |
| Spain '85 | EC 35 | 2.1 | 1 | 1 | 0.77, 0.9 (2), 0.42, 0.72 (5), 0.36, 0.65 (8), | Spain 1993 |
| | | | | | 0.22, 0.36 (13) | |
| | | | 1 | 1 | 2.5, 4.0 (3), 0.8, 1.7 (7), 0.16, 0.52 (14), | Spain 1993 |
| | | | | | 0.13, 0.14 (21) | |
| | | | 1 | 1 | 2.5, 2.5 (4), 1.8, 1.8 (7), 0.84, 0.84 (13), | Spain 1993 |
| | | | | | 0.25, 0.25 (21) | |
| Pineapple | | | | | | |
| Australia'90 | EC 35 | Dip [0.56 g/l] | 1 | 1 | 1.9 (0), 1.7 (3), 1.4 (7) | Australia, 1993 |

* CS = Suspension of Microcapsules

Brassica vegetables - see Table 3.

The only residue data from the USA that were presented were from two trials on Brussels sprouts carried out in 1964. At 14 days PHI, residues reached 1.2 mg/kg. From one trial on Brussels sprouts in the UK in 1976, residues reached 0.1 mg/kg at 14 days and 0.06 mg/kg at 21 days PHI. One trial on broccoli at the GAP rate in Portugal gave 0.44 mg/kg at 28 days PHI, just in concordance with the existing CXL of 0.5 mg/kg.

Residues from six trials on head cabbage in Germany and Portugal showed maximum residues of 0.73 mg/kg at 27 days; the current CXL is 1 mg/kg. Data from 26 trials on Savoy cabbage in Germany showed no residues above 0.42 mg/kg at 14 days; the current CXL is 2 mg/kg. On cauliflower, four trials in Germany showed residues below 0.2 mg/kg at 10 days and 0.1 mg/kg at 14 days PHI.

Information from Canada on Chinese broccoli and mustard cabbage showed residues up to 1.3 mg/kg at 7 days.

Table 3. Residues of endosulfan in brassica vegetables from supervised trials.

| Crop/Country/Year | EC/WP/DP/% | Appl. | | No. of trials | Residues (mg/kg) at intervals (days) after last application | Ref. |
|-------------------|------------|-------|-----|---------------|---|------|
| | | kg/ha | No. | | | |
| Broccoli | | | | | | |

| Crop/Country/Year | EC/WP/DP/% | Appl. | | No. of trials | Residues (mg/kg) at intervals (days) after last application | Ref. |
|-----------------------------|------------|---------|-----|---------------|---|------------------|
| | | kg/ha | No. | | | |
| Portugal '86 | EC 38 | 0.95 | 1 | 1 | 3 (7), 1.7 (14), 0.71 (21), 0.44 (28) | Portugal, 1993 |
| | | 3.7 | 1 | 1 | 22 (7), 11 (14), 2.6 (21), 2.0 (28) | Portugal, 1993 |
| Brussels sprouts | | | | | | |
| UK '76 | EC 35 | 0.3 | 1 | 1 | 0.80 (7), 0.10 (14), 0.06 (21) | A10195 |
| USA '64 | EC 24 | 0.84 | 14 | 2 | 0.68, 2.8 (7), 0.45, 1.8 (10), 1.2 (14) | A48555 |
| Cabbage, Head (White & Red) | | | | | | |
| Germany '88 | EC 35 | 0.21 | 1 | 4 | <0.015 (42-94) | A40703-6 |
| Portugal '85 | EC 38 | 2.5 | 1 | 1 | 3.1 (6), 1.8 (13), 0.9 (20), 0.73 (27) | Portugal, 1993 |
| '90 | EC 38 | 1.1+0.9 | 2 | 1 | 4.3 (7), 2.7 (14), 1.3 (21), 0.62 (28) | Portugal, 1993 |
| Cabbage, Savoy | | | | | | |
| Germany '74 | EC 35 | 0.21 | 1 | 2 | <0.02 (54, 112) | A40701-2 |
| | | | 3 | 2 | 0.1, 0.2 (7), 0.1, 0.2 (14), 0.01, 0.03 (21) | A08860-1 |
| | | 0.35 | 1 | 5 | 0.07-2.2 (7), <0.02-0.4 (14), | A02452, 2456, |
| | | | | | <0.08-0.28 (21), <0.08-0.14 (28) | 2463, 3350, 3352 |
| | | 0.53 | 1 | 4 | 0.05-1.2 (7), <0.08-0.13 (14), | A02460, 2464, |
| | | | | | <0.08 (21), <0.18-0.14 (28) | 3351, 3353 |
| | WP 35 | 0.35 | 1 | 2 | 0.04, 0.7 (7), <0.08 (14-28) | A02465, 3315 |
| | | 0.53 | 1 | 5 | 0.06-0.7 (7), <0.05-0.18 (14), | A02454, 2462, |
| | | | | | <0.08-0.07 (21), <0.08-0.06 (28) | 2466, 3316-7 |
| '83 | WP 33 | 0.2 | 3 | 3 | 0.1-1.2 (5), 0.25-0.09 (10), 0.02-0.34 (14) | A028372-4 |
| | DP 2.8 | 0.71 | 3 | 3 | 0.19-1.9 (5), 0.02-0.15 (10), 0.02-0.42 (14) | A028919-21 |
| Cauliflower | | | | | | |
| Germany '83 | DP 2.8 | 0.71 | 3 | 4 | 0.02-0.54 (5), 0.02-0.16 (10), 0.02-0.06 (14) | A28593-6 |
| Chinese broccoli (Guy Lon) | | | | | | |
| Canada '91 | EC 40 | 0.8 | 1 | 1 | 3.5 (0), 0.8 (3), 0.35 (7), 0.05 (13) | Canada, 1993 |
| Mustard cabbage (Bok Choi) | | | | | | |
| Canada '91 | EC 40 | 0.8 | 1 | 1 | 5.9 (0), 2.4 (3), 1.3 (7), 0.55 (15), 0.07 (21) | Canada, 1993 |

Other vegetables - see Table 4.

Cucurbits. At a PHI of 7 days, five trials on cucumbers in Canada showed a maximum residue of 0.17 mg/kg from treatments at slightly above the current GAP rate. Greenhouse cucumbers treated in Spain in 1992 showed a residue of about 0.1 mg/kg at 7 days PHI.

Greenhouse-grown melons in Spain showed residues up to 0.5 mg/kg after 7 days. Residues from trials on squash in Canada and Spain were up to 0.23 mg/kg at 7 days PHI.

Peppers. Two trials on greenhouse peppers in Spain showed residues up to about 0.5 mg/kg at 7 days.

Tomato. Data were available from 28 field trials in Germany and one in Canada. At a PHI of 7 days residues were generally below 0.2 mg/kg, although in one trial a level of 1 mg/kg was found.

Tomatoes treated in greenhouses in Spain showed residues up to 1 mg/kg at 7 and 15 days PHI, but at rates of application that were above the quoted GAP.

Lettuce. Two trials in Canada gave residues up to 0.15 mg/kg at 14 days, well within the current CXL of 1 mg/kg.

Common bean. From 20 trials on common beans in Canada, Germany and Spain, the maximum residue observed at a PHI of 14 days was 0.59 mg/kg. At 3 days PHI, up to 0.97 mg/kg was found.

Broad beans. Twelve trials on broad beans in Germany gave residues up to 1.9 mg/kg at 7 days and 0.04 mg/kg at 21 days. No data were provided at the GAP PHI of 14 days.

Soya beans. Data were supplied from Australia, 2 trials, and Brazil, 42 trials. At the recommended PHI of 30 days, the maximum residue was 0.6 mg/kg; all of the other findings were below this at PHIs ranging from 13 to 101 days.

Potato. Residues from seven trials in Germany were all below 0.015 mg/kg at PHIs from 0 to 28 days.

Celery. Two trials in Canada showed residues well below the existing CXL of 2 mg/kg at 0 to 35 days after treatment.

Table 4. Residues of endosulfan in other vegetables from supervised trials.

| Crop Country/Year | EC/WP/ DP/% | Appl. | | | Residues (mg/kg) at intervals (days) after last application | Ref. |
|---------------------------------|----------------|-------|-----|-----------------|--|--------------|
| | | kg/ha | No. | No of trials | | |
| Cucumber | | | | | | |
| Canada '89 | EC 40 | 0.6 | 1 | 1 | 0.08 (1), 0.03 (3), 0.09 (7), 0.037 (14), 0.013 (21) | Canada, 1993 |
| Germany '83 | EC 35 | 0.21 | 3 | 1 | 0.16 (0), 0.11 (3), 0.07 (5), 0.08 (7) | A28059 |
| | | 0.32 | 3 | 3 | 0.12-0.2 (0), 0.08-0.11 (3), 0.08-0.17 (5), 0.06-0.17 (7) | A28056-8 |
| Cucumber (greenhouse) | | | | | | |
| Spain '92 | EC 35 | 1.58 | 1 | 1 | 0.18-0.25 (2), 0.07-0.11 (7), 0.05-0.09 (10), 0.03-0.09 (15) | Spain 1993 |
| Melon (Greenhouse) | | | | | | |
| Spain '92 | EC 35 | 0.71 | 1 | 1 | 0.38 (0), 0.05 (3), 0.02 (7), 0.02 (15) | A49703 |
| | | 0.76 | 1 | 1 | 0.97 (0), 0.63 (3), 0.50 (7), 0.22 (15) | A49704 |
| | | 0.82 | 1 | 1 | 0.81 (0), 0.28 (3), 0.23 (7), 0.11 (15) | A49702 |
| | | 0.87 | 1 | 1 | 0.09 (0), <0.01 (3), <0.01 (7), 0.04 (15) | A49705 |
| Squash, Summer ('fuzzy') | | | | | | |
| Canada '91 | EC 40 | 0.8 | 1 | 1 | 0.18 (0), 0.09 (3), 0.08 (7), 0.049 (13) | Canada, 1993 |

| Crop Country/Year | EC/WP/ DP/% | Appl. | | | Residues (mg/kg) at intervals (days) after last application | Ref. |
|----------------------|----------------|-----------|-----|-----------------|--|--------------|
| | | kg/ha | No. | No of trials | | |
| Squash (Greenhouse) | | | | | | |
| Spain '92 | EC 35 | 1.02 | 1 | 1 | 0.32 (0), 0.13 (3), 0.02 (7), 0.02 (15) | A49709 |
| | | 1.09 | 1 | 1 | 1.1 (0), 0.46 (3), 0.23 (7), 0.03 (15) | A49706 |
| | | 1.21 | 1 | 1 | 1.0 (0), 0.53 (3), 0.05 (7), 0.04 (15) | A49702 |
| | | 1.37 | 1 | 1 | 0.11 (0), <0.01 (3), 0.05 (7), 0.02 (15) | A49705 |
| Peppers (Greenhouse) | | | | | | |
| Spain '88 | EC 35 | 0.962 | 1 | 1 | 0.54-1.46 (2), 0.08-0.45 (7), 0.03-0.22 (11), 0.03-0.09 (15) | Spain 1993 |
| '89 | EC 35 | 0.962 | 1 | 1 | 0.73-0.93, 0.36-0.54 (7), 0.04-0.57 (10), 0.20-0.48 (15) | Spain 1993 |
| Tomato | | | | | | |
| Canada '89 | EC 40 | 0.56 | 1 | 1 | 0.07 (1), 0.03 (3), 0.03 (7), 0.01 (14), <0.01 (21) | Canada, 1993 |
| Germany '74 | EC 35 | 0.21 | 1 | 3 | 0.6-0.9 (0), 0.4-0.5 (1), 0.2-1 (2), 0.03-0.7 (4) | A02392,4,6 |
| | | | 3 | 1 | 0.4 (0), 0.2 (1), 0.07 (2), 0.03 (4) | A08854 |
| | | 0.53 | 1 | 2 | 0.04 (0), 0.02-0.03 (1), 0.03-0.05 (2), 0.03 (4) | A02605,7 |
| | | 0.70 | 1 | 1 | 1 (0), 0.24 (1), 0.12 (2), 0.11 (4) | A03081 |
| | WP 35 | 0.21 | 1 | 3 | 0.6 (0), 0.3-0.41 (1), 0.09-0.2 (2), 0.05-0.1 (4) | A02393,5,7 |
| | | | 3 | 1 | 0.5 (0), 0.2 (7), 0.06 (10), 0.03 (14) | A08853 |
| | | 0.53 | 1 | 2 | 0.04-0.1 (0), 0.03-0.04 (1), 0.01-0.03 (2), 0.012-0.15 (4) | A02604,6 |
| | | 0.70 | 1 | 1 | 0.36 (0), 0.12 (1), 0.09 (2), 0.08 (4) | A03082 |
| '76 | EC 35 | 0.21/0.28 | 3 | 1 | 0.1 (0), 0.09 (1), 0.05 (2), 0.02 (4) | A08855 |
| | WP 35 | 0.21 | 3 | 1 | 0.5 (0), 0.2 (1), 0.06 (2), 0.03 (4) | A08853 |
| | | 0.21/0.28 | 3 | 1 | 0.05 (0), 0.04 (1), 0.015 (2), 0.015 (4) | A08852 |
| '82 | EC 35 | 0.85 | 1 | 1 | 0.2 (0), 0.055 (3), 0.045 (5), 0.035 (7), 0.045 (10) | A24861 |
| '83 | EC 35 | 0.21 | 3 | 1 | 0.19 (0), 0.085 (3), 0.045 (5), 0.085 (7) | A28257 |
| | | 0.35 | 3 | 1 | 0.50 (0), 0.92 (3), 0.72 (5), 1.0 (7) | A28256 |
| | DP 2.8 | 0.71 | 3 | 3 | 0.3-0.3 (0), 0.21 (5), 0.1-0.12 (10), 0.075-0.13 (14) | A28922-4 |
| '85 | EC 35 | 0.32 | 3 | 3 | 0.24-0.46 (0), 0.07-0.15 (30), 0.06-0.16 (5), 0.06-0.21 (7) | A33348-50 |
| '89 | EC 35 | 0.21-0.42 | 4 | 2 | 0.6,0.72 (0), 0.035, 0.095 (7) | A43307-8 |
| Tomato (Greenhouse) | | | | | | |
| Spain '92 | EC 35 | 2.10 | 1 | 1 | 1.4 (0), 1.3 (3), 0.43 (7), 0.36 (15) | A49690 |
| | | 2.26 | 1 | 1 | 2.2 (0), 1.8 (3), 1.0 (7), 1.0 (15) | A49688 |
| | | 2.31 | 1 | 1 | 1.5 (0), 1.3 (3), 0.43 (7), 0.36 (15) | A49691 |
| | | 2.63 | 1 | 1 | 0.92 (0), 1.1 (3), 0.42 (7), 0.18 (15) | A49689 |
| Lettuce 1 | | | | | | |
| Canada '89 | EC 40 | 0.6 | | 2 | 0.4 (3),0.06 (7),0.12,0.15 (14),0.01,0.1 (21) | Canada, 1993 |
| Common bean | | | | | | |

| Crop Country/Year | EC/WP/ DP/% | Appl. | | | Residues (mg/kg) at intervals (days) after last application | Ref. |
|----------------------|----------------|-------|-----|-----------------|--|----------------------------|
| | | kg/ha | No. | No of trials | | |
| Canada '81 | EC 40 | 0.5 | 2 | 1 | 0.65 (3), 0.43 (7), 0.41 (14) | Canada, 1993 |
| | | | 2 | 1 | 0.46 (3), 0.33 (7), 0.24 (14) | Canada, 1993 |
| Germany '74 | DP 3.0 | 0.9 | 1 | 6 | 0.04-2.3 (7), 0.02-0.59 (14), 0.02-0.22 (21), 0.016-0.08 (28) | A05393-8 |
| '83 | DP 2.8 | 0.71 | 3 | 4 | 0.18-1.1 (0), 0.06-0.19 (5), 0.03-0.12 (11), 0.025-0.055 (14) | A28387-90 |
| Spain '92 | EC 35 | 1.21 | 1 | 1 | 2.7 (0), 0.25 (3), 0.04 (7), 0.01 (14) | A49694 |
| | | 1.34 | 1 | 1 | 2.7 (0), 0.16 (3), 0.04 (7), 0.01 (14) | A49695 |
| | | 1.79 | 1 | 1 | 2.0 (0), 0.42 (3), 0.05 (7), 0.03 (14) | A49693 |
| | | 1.89 | 1 | 1 | 2.8 (0), 0.97 (3), 0.10 (7), 0.01 (14) | A49692 |
| | | 2.00 | 1 | 1 | 2.7 (0), 0.33 (3), 0.08 (7), 0.02 (14) | A49697 |
| | | 2.10 | 1 | 3 | 1.7-2.2 (0), 0.09-0.28 (4), 0.03-0.23 (7), 0.01-0.05 (14) | A49696, 98,99 |
| Broad beans | | | | | | |
| Germany '75 | DP 3.0 | 0.75 | 1 | 6 | 0.01-0.02 (0), 0.02-0.09 (7), 0.015-0.038 (21), 0.015-0.023 (28) | A04910-1, 06758, 06760,2,4 |
| | | | 2 | 4 | 0.083 (0), 0.028-0.13 (7), 0.018-0.021 (21), 0.018 (28) | A06759,61,63, 65 |
| '76 | WP 35 | 0.32 | 3 | 1 | 9.3 (0), 1.9 (7), 0.3 (21) | A10200 |
| | DP 3.0 | 0.75 | 3 | 1 | 11 (0), 1.9 (7), 0.2 (21) | A10199 |
| Soya beans | | | | | | |
| Australia '81 | EC 35 | 0.74 | 1 | 1 | 0.015 (21), 0.03 (28) | A30088 |
| | | 1.47 | 1 | 1 | 0.04 (21), 0.16 (28) | A30088 |
| Brazil '74 | EC 35 | 0.42 | 3 | 1 | 0.22 (62) | A01813 |
| | | | 4 | 1 | 0.17 (13) | A01812 |
| '75 | | 0.53 | 1 | 1 | 0.23 (21) | A07560 |
| '77 | | | 1 | 4 | 0.09 (22), 0.15 (36), 0.33 (66), 0.09 (103) | A13738,0,4,2 |
| | | | 2 | 3 | 0.25 (22), 0.42 (36), 0.33 (66) | A13736,1,3 |
| | | | 3 | 2 | 0.31 (22), 0.45 (36) | A13737,5 |
| '78 | | | 1 | 6 | 0.08 (29), 0.1 (31), 0.2 (61,62), 0.03,0.05 (90) | A06115-7,0612 2-4 |
| | | | 2 | 6 | 0.2,0.2 (29), 0.1,0.2,0.3 (31), 0.2 (61) | A16112-4,6119 -21 |
| | | | 3 | 2 | 0.3 (29), 0.4 (31) | A016111,6118 |
| '79 | | | 1 | 6 | 0.06 (30), 0.27 (41), 0.11 (62), 0.31 (71), 0.015 (91), 0.11 (101) | A017983-5,91-93 |
| | | | 2 | 6 | 0.015,0.3 (30), 0.28,0.56 (42), 0.26 (62), 0.35 (71) | A017980-2,88-90 |
| | | | 2 | 4 | 0.60 (30), 0.34 (41) | A017979,17986 |
| Potato | | | | | | |
| Germany '76 | WP 35 | 0.21 | 2 | 4 | 0.01-0.015 (13-28) | A08862-5 |
| | DP 2.8 | 0.71 | 2 | 3 | 0.015 (0-14) | A28588-90 |
| Celery | | | | | | |
| Canada '89 | EC 40 | 0.8 | 1 | 1 | 0.38 (0), 0.18 (7), 0.14 (14), 0.11,0.24 (21) | Canada, 1993 |
| | | | 1 | 1 | 0.82 (0), 0.24 (21), 0.15 (28), 0.09 (35) | Canada, 1993 |

Cereals - see Table 5.

Maize. Seventeen trials were carried out in France and Germany. The maximum residue was 0.085 mg/kg after 91 days.

Wheat. Trials on wheat in France (3) and Germany (9) gave residues under 0.11 mg/kg at 14 to 57 days after application.

Table 5. Residues of endosulfan in cereals from supervised trials.

| Crop/Country /Year | EC/WP/ DP/% | Appl. | | No. of trials | Residues (mg/kg) at intervals (days) after last application | Ref. |
|---------------------|-------------|-------|-----|---------------|---|------------------|
| | | kg/ha | No. | | | |
| Maize (grain) | | | | | | |
| France '74 | EC 35 | 1.23 | 1 | 2 | 0.015 (91) | A04510,5767 |
| | FG 5 | 1.0 | 1 | 2 | 0.015, 0.085 (91) | A04509,5766 |
| Germany'75 | EC 35 | 1.05 | 1 | 1 | 0.05 (36) | A06757 |
| '76 | | 0.70 | 2 | 4 | 0.015 (63), 0.010-0.015 (70) | A10205-6,10211-2 |
| | | 1.05 | 1 | 4 | 0.02 (70), 0.01 (83) | A10201.3,7,9 |
| '83 | | 0.70 | 2 | 2 | 0.015 (54,70) | A28765-6 |
| | WP 33 | 0.66 | 2 | 2 | 0.015 (54,70) | A28763-4 |
| (FG = Fine Granule) | | | | | | |
| Wheat | | | | | | |
| France '76 | EC 35 | 0.53 | 1 | 3 | 0.03 (34), 0.10 (36), 0.09 (53) | A08496-8 |
| Germany'80 | EC 35 | 0.21 | 3 | 5 | 0.015 (28-29) | A21772,4,6,8,80 |
| | WP 35 | 0.18 | 2 | 2 | 0.015 (19) | A24253,5 |
| '82 | | 0.18 | 2 | 2 | 0.06,0.11 (14) | A26338-9 |

Oilseed - see Table 6.

Cotton seed. From eight trials in Spain the maximum residue at a PHI of 15 days was 0.25 mg/kg.

Rape seed. Results from 24 trials on rape seed in Germany showed residues up to 0.30 mg/kg at 56 days PHI when GAP application rates were used. A level of 0.57 mg/kg was found when over twice the recommended rate was applied.

Sunflower seed. In 5 trials in the USA in 1965 residues up to 0.6 mg/kg were found 63 to 69 days after treatment. ULV application in the Sudan in 1985 gave residues of 0.008-0.036 mg/kg after 109 days.

Table 6. Residues of endosulfan in oilseed from supervised trials.

| Crop/Country /Year | EC/WP/ DP/% | Appl. | | No. of trials | Residues (mg/kg) at intervals (days) after last application | Ref. |
|--------------------|-------------|-------|-----|---------------|---|------|
| | | kg/ha | No. | | | |
| Cotton seed | | | | | | |

| Crop/Country/Year | EC/WP/DP/% | Appl. | | No. of trials | Residues (mg/kg) at intervals (days) after last application | Ref. |
|-------------------|------------|-----------|-----|---------------|---|------------------|
| | | kg/ha | No. | | | |
| Australia '74 | EC 35 | 0.74 | 13 | 1 | 0.01 (44) | A02015 |
| | | | 15 | 1 | 0.035 (25) | A02016 |
| Spain '92 | EC 35 | 0.63 | 1 | 2 | 0.35,0.78 (3), 0.27,0.3 (7), 0.05 (15) | A49593-4 |
| | | 1.0 | 1 | 4 | 0.1-0.62 (3), 0.1-0.25 (7), 0.005-0.25 (15) | A49545-8 |
| | | 1.11 | 1 | 2 | 0.4,0.4 (3), 0.11,0.11 (7), 0.07,0.10 (15) | A49599-60 |
| Rape seed | | | | | | |
| Germany '74 | DP 3.0 | 0.9 | 1 | 9 | 0.24-0.4 (7), 0.09-0.67 (14), 0.14-0.34 (21), | A02610-1,2467, |
| | | | | | 0.09-0.33 (28), 0.03-0.07 (53-70) | A024670,73-77 |
| | | | 2 | 5 | 0.07 (42), 0.03,0.09 (47), 0.50,0.57 (54) | A02469,72, |
| | | | | | | A02616,2895-6 |
| | | | 4 | 2 | 0.06 (55), 0.09 (56) | A013208-9 |
| '84 | EC 35 | 0.42 | 2 | 3 | 0.03 (55), 0.30 (39), 0.30 (56) | A12344,13206-7 |
| | | 0.21+0.42 | 2 | 5 | 0.015 (56,70), 0.02 (76), 0.06 (67), 0.11 (56) | A30122-3,31482-4 |
| Sunflower seed | | | | | | |
| Sudan '88 | ULV 52 | 0.84 | 1 | 2 | 0.008-0.036 (109) | A41153-4 |
| USA '65 | EC 24 | 1.12 | 1 | 1 | 0.09 (88) | A38684 |
| | | | 2 | 2 | 0.43-0.61 (69), 0.04 (81) | A38683-4 |
| | | | 3 | 2 | 0.44-0.60 (63), 0.39 (74) | A38683-4 |

Beverage seeds - see Table 7.

Cacao. Trials were carried out in Brazil (4) and the Ivory Coast (3). All residues were below 0.02 mg/kg at 28 to 45 days after treatment.

Coffee. Trials on coffee were carried out in Brazil (6), Cameroon (60) and Guatemala (4). Results were all expressed separately as on the surface and in the interior of the green beans. All residues were below 0.05 mg/kg at PHIs ranging from 30 to 205 days.

Table 7. Residues of endosulfan in seeds for beverages from supervised trials.

| Crop/Country/Year | EC/WP/DP/% | Appl. | | No. of trials | Residues (mg/kg) at intervals (days) after last application | Ref. |
|-------------------|------------|-------|-----|---------------|---|-----------|
| | | kg/ha | No. | | | |
| Cacao | | | | | | |
| Brazil '82 | EC 35 | 0.35 | 2 | 1 | 0.015 (30, 45) | A025749 |
| | | | 3 | 1 | 0.015 (30), 0.02 (45) | A025747 |
| | | 0.7 | 2 | 1 | 0.015 (30, 45) | A025748 |
| | | | 3 | 1 | 0.015 (30, 45) | A025746 |
| Ivory Coast '83 | EC 35 | 0.25 | 2 | 3 | 0.02, 0.15 (2), 0.015, 0.02 (10), 0.015 (28) | A028024-6 |
| Coffee | | | | | | |
| Brazil '74 | EC 35 | 0.53 | 2 | 1 | 0.05, 0.07 (45-140) | A04394 |

| Crop/ Country/Year | EC/WP/ DP/% | Appl. | | No. of trials | Residues (mg/kg) at intervals (days) after last application | Ref. |
|-----------------------|----------------|-------|-----|------------------|---|-----------|
| | | kg/ha | No. | | | |
| | | 0.70 | 1 | 1 | 0.025,0.035(65) | A04396 |
| | | | 2 | 1 | 0.025,0.04(100-200) | A04391 |
| | | | 3 | 1 | 0.035,0.017(90-180) | A04395 |
| | | 1.05 | 1 | 1 | 0.035,0.05(135-165) | A04392 |
| | | | 4 | 1 | 0.025,0.035(60-90) | A04393 |
| Cameroon '74 | EC 35 | 0.88 | 1 | 3 | 0.028-0.12(180-205) | A05785-7 |
| | | 1.05 | 1 | 2 | 0.028-0.044(180) | A04383-4 |
| | | | 2 | 1 | 0.028-0.044(150) | A05788 |
| Guatemala '74 | EC 35 | 0.76 | 2 | 2 | 0.028,0.041(36,39) | A04381-2 |
| | | 0.81 | 1 | 2 | 0.028,0.041(30,34) | A04379-80 |

FATE OF RESIDUES

In storage and processing

Apples. In two trials on apples in Germany in 1989, fruit with residue levels of 0.055 and 0.11 mg/kg gave apple juice containing less than 0.006 mg/kg, while the respective pomaces held 0.08 and 0.18 mg/kg. (Hoechst, A47389-90).

Grapes. Grapes treated in Germany in 1984 which contained residues of endosulfan at levels of 0.49 and 0.55 mg/kg were used to make wines. These contained less than 0.006 mg/kg, while the musts yielded 0.03 and 0.04 mg/kg respectively (Hoechst, A30914-5).

Common beans. In Canada, in 1988, a study was made of the effect of various culinary procedures on residues in beans. The measures used included trimming, water rinsing, boiling, blanching, microwave cooking and freezing. The results obtained are summarized below and show that boiling and trimming off the ends are the major causes of residue loss (Canada, 1993).

| | | |
|-------------------------|----------------|----------------|
| Fresh beans (untrimmed) | (a) 0.63 mg/kg | (b) 0.24 mg/kg |
| Trimmed ends | (a) 2.1 mg/kg | (b) 0.92 mg/kg |

| Treatment | % Endosulfan removed | |
|----------------------------------|----------------------|------|
| | (a) | (b) |
| None | 0.0 | 0.0 |
| Water rinse, 30 sec | 0.0 | 17.7 |
| Boiling 10 min | 49.1 | 34.4 |
| Boiling 10 min (French style) | 28.5 | 66.1 |
| Microwave | 0.0 | 1.0 |
| Frozen, 2 months | 0.0 | 0.0 |
| Blanched, frozen | 14.3 | 0.0 |
| Trimmed | 13.9 | 3.1 |

Wheat. Bread was made from wheat containing residues of endosulfan at 0.19 mg/kg. Residues in wholemeal bread were 0.13 mg/kg, in refined meal bread 0.049 mg/kg and in the bran 0.28 mg/kg.

NATIONAL MAXIMUM RESIDUE LIMITS

The Meeting received information on the following national MRLs.

| Commodity | MRL, mg/kg | | | | | |
|----------------------------|--------------------|-------------------|------------------|------------------|------------------|-------|
| | Austr ¹ | Belg ² | Can ³ | Den ⁴ | Ger ⁵ | Spain |
| Alfalfa | | | 0.1 | | | |
| Apple | | | 2 | | | |
| Asparagus | | | | | | 1 |
| Barley | | | | | 0.1 | |
| Berries, etc. | | 1 | | 2 | | |
| Blackberry | | | | | 1 | |
| Brassicacae | | | | | | 1 |
| Broccoli | | | 2 | | | |
| Brussels sprouts | | | 2 | | | |
| Cabbages | | | 2 | | 1 | |
| Carrot | 0.2 | | | | | |
| Cauliflower | | | 1 | | 1 | |
| Celery | | | 1 | | | |
| Cereals | 0.2 | | | | | |
| Citrus fruits | | | | | | 1 |
| Clover | | | 0.1 | | | |
| Common bean | | | 1 | | 1 | |
| Cotton | | | | | 1 | |
| Cotton seed oil (crude) | 0.5 | | | | | |
| Cucumbers | | | 1 | | | |
| Cucurbits | | | | | | 1 |
| Currants, Black | | | | 2 | | |
| Currants, Red & White | | | | | 1 | |
| Dairy products | | | 0.1 | | | |
| Egg plant | | | 1 | | | 1 |
| Eggs | 0.05 | | | | | |
| Fat of meat of cattle | 0.2 | | | | | |

| Commodity | MRL, mg/kg | | | | | |
|---------------------------|--------------------|-------------------|------------------|------------------|------------------|-------|
| | Austr ¹ | Belg ² | Can ³ | Den ⁴ | Ger ⁵ | Spain |
| Fat of meat of goats | 0.2 | | | | | |
| Fat of meat of sheep | 0.2 | | | | | |
| Fruit | 2 | | | | | |
| Goat milk (fat basis) | 0.5 | | | | | |
| Grapes | | | 1 | | | 1 |
| Hazlenut | | | | | | 1 |
| Hops | | | | | 10 | |
| Lettuce, Head | | | 2 | | | |
| Lupins | 1 | | | | | |
| Meat | | | 0.1 | | | |
| Melon | | | 1 | | | |
| Milk (fat basis) | 0.5 | | | | | |
| Milk products (fat basis) | 0.5 | | | | | |
| Mung beans | 1 | | | | | |
| Mushrooms | | 0.05 | | | | |
| Navy beans | 1 | | | | | |
| Nuts | 0.2 | | | | | |
| Oats | | | | | 0.1 | |
| Oil seeds | 1 | | | | | |
| Olive | | | | | | 1 |
| Onion | 0.2 | | | | | |
| Other vegetables | 2 | | | | | |
| Parsley | | | 0.1 | | | |
| Peanuts | 1 | | | | | |
| Pear | | | 2 | | | |
| Peas | | | | | 1 | |
| Pepper | | | 1 | | | 1 |
| Pome fruit | | | | 2 | 1 | |
| Potato | | | 0.1 | | 0.1 | 0.1 |

| Commodity | MRL, mg/kg | | | | | |
|------------------------|--------------------|-------------------|------------------|------------------|------------------|-------|
| | Austr ¹ | Belg ² | Can ³ | Den ⁴ | Ger ⁵ | Spain |
| Poultry meat | 0.2 | | | | | |
| Pumpkin | | | 1 | | | |
| Rape | | 0.05 | | | 0.5 | |
| Raspberry | | | | | 1 | |
| Rice (in husk) | 0.1 | | | | | |
| Rutabaga | | | 0.1 | | | |
| Rye | | | | | 0.1 | |
| Soya bean | 1 | | | | | |
| Spinach | | | 2 | | | |
| Squash | | | 1 | | | |
| Stone fruit | | | 2 | 2 | 1 | 1 |
| Strawberry | | | 1 | | | |
| Sugar beet | | | 0.1 | | | |
| Sunflower | | | 0.1 | | | |
| Sweet corn | | | 0.1 | | | |
| Sweet potato | 0.2 | | | | | |
| Tea (dry manufactured) | 30 | | | | | |
| Tomato | | | 1 | | 1 | 1 |
| Turnip | | | 0.1 | | | |
| Water | 0.04 | | | | | |
| Watercress | | | 0.1 | | | |
| Wheat | | | | | 0.1 | |

¹ Australia ² Belgium ³ Canada ⁴ Denmark ⁵ Germany

APPRAISAL

Endosulfan has been reviewed by the JMPR eight times since 1967, including a major re-evaluation in 1989. At the 24th (1992) Session of the CCPR it was pointed out (ALINORM 93/24, paras 81-86) that the MRLs for head cabbages, Savoy cabbage and cauliflower did not reflect the residues expected from GAP in the USA. MRLs for broccoli, Brussels sprouts, head cabbage and Savoy cabbage were therefore held at Step 7B pending review by the present Meeting. The proposed deletion of the general MRLs for "Fruit" and "Vegetables, except as otherwise listed", as recommended by the 1989 JMPR, was also delayed until after this review.

Information on the current GAP of 21 countries was made available to the Meeting by the manufacturer, including full details from the USA. A large quantity of residue data that had not previously been submitted for review was also provided.

Residue data from supervised trials on many fruits, vegetables, cereals, oilseed and beverage seeds which had not been reviewed previously were also provided and are recorded in the monograph on this compound. The Meeting confirmed that the data emphasised the desirability of withdrawing the current general MRLs for fruit and vegetables and replacing them with MRLs for individual commodities, usually at a lower level. It was also possible to make recommendations for MRLs on some additional crops.

The residue data on oranges were adequate to allow an MRL of 0.5 mg/kg to be recommended but the data on clementines and lemons were only in summary form and thus not sufficient to extend the MRL to the citrus fruit group.

Residues from trials on apples, cherries and plums were within the current MRLs of 1 mg/kg. Data for peach residues supported a similar MRL of 1 mg/kg. Residue data on grapes also allowed an MRL of 1 mg/kg to be recommended but the strawberry data were only summaries and were thus inadequate.

A dip treatment of pineapples with endosulfan is required in Australia for export quarantine purposes. The resultant residues are up to 2 mg/kg, within the CXL for "Fruits", and so an MRL of 2 mg/kg was recommended to cover this post-harvest use.

Unfortunately, the only residue data on brassica crops treated in the USA concerned two trials on Brussels sprouts that were carried out in 1964 and had been reported previously; at a 14-day PHI a maximum residue of 1.2 mg/kg was observed. In one trial on Brussels sprouts in the UK in 1976, 0.1 mg/kg was found after 14 days and 0.06 mg/kg after 21 days but the data were not adequate to support an MRL recommendation. Data from other countries under their GAP conditions were available for broccoli, head cabbage, Savoy cabbage and cauliflower; these results were consistent with the existing draft MRLs of 0.5, 1, 2 and 0.5 mg/kg, respectively.

For some other vegetables, currently covered by the CXL for "Vegetables, except as otherwise listed", the data presented

were sufficient to allow recommendations to be made for broad bean, cucumber, melons except watermelon, summer squash and tomato, all at 0.5 mg/kg, and for soya bean at 1 mg/kg. Data for sweet peppers were inadequate.

Residues on celery (2 mg/kg), common bean (0.5 mg/kg), head lettuce (1 mg/kg) and potato (0.2 mg/kg) were within the respective CXLs.

For cereals, residue data were presented for maize and wheat, allowing recommendations of 0.1 mg/kg and 0.2 mg/kg, respectively, to be made.

Trials on some oilseeds gave sufficient residue data for MRLs to be recommended for cotton seed (1 mg/kg), rape seed (0.5 mg/kg) and sunflower seed (1 mg/kg).

New residue data were also available which allowed recommendations to be made for MRLs on cacao beans and coffee beans, both at 0.1 mg/kg.

Processing data were available for apples (juice and pomace), grapes (wine and must) and common beans (washing and cooking).

RECOMMENDATIONS

On the basis of the data on residues resulting from supervised trials the Meeting concluded that the residue levels listed below are suitable for establishing maximum residue limits.

Definition of the residue: sum of alpha- and beta-endosulfan and endosulfan sulphate (fat-soluble).

| Commodity | | Recommended MRL (mg/kg) | | PHI on which based, days |
|-----------|----------------|-------------------------|----------------|--------------------------|
| CCN | Name | New | Previous | |
| VP 0522 | Broad bean | 0.5 | 2 ¹ | 21 |
| VB 0400 | Broccoli | 0.5 | 0.5 | 28 |
| VB 0403 | Cabbage, Savoy | 2 | 2 | 14 |
| VB 0041 | Cabbages, Head | 1 | 1 | 27 |
| SB 0715 | Cacao beans | 0.1 | --- | 28 |
| VB 0404 | Cauliflower | 0.5 | 0.5 | 7 |
| VS 0624 | Celery | 2 | 2 | 14 |
| FS 0013 | Cherries | 1 | 1 | 21 |
| SB 0716 | Coffee beans | 0.1 | --- | 30 |

| Commodity | | Recommended MRL (mg/kg) | | PHI on which based, days |
|-------------|---|----------------------------|----------------|-----------------------------------|
| CCN | Name | New | Previous | |
| VP 0526 | Common bean | 0.5 | 0.5 | 14 |
| SO 0691 | Cotton seed | 1 | 1 | 15 |
| VC 0424 | Cucumber | 0.5 | 2 ¹ | 7 |
| AO2 0001 | Fruits | W | 2 | -- |
| FB 0269 | Grapes | 1 | 2 ² | 60 |
| VL 0482 | Lettuce, Head | 1 | 1 | 14 |
| GC 0645 | Maize | 0.1 | --- | 54 |
| VC 0046 | Melons, except Watermelon | 0.5 | 2 ¹ | 7 |
| FC 0004 | Oranges, sweet, sour | 0.5 | 2 ² | 14 |
| FS 0247 | Peach | 1 | 2 ² | 15 |
| FI 0353 | Pineapple | 2 Po | 2 ² | -- |
| FS 0014 | Plums (including Prunes) | 1 | 1 | 21 |
| FP 0009 | Pome fruits | 1 | 1 | 21 |
| VR 0589 | Potato | 0.2 | 0.2 | 28 |
| SO 0495 | Rape seed | 0.5 | --- | 56 |
| VD 0541 | Soya bean | 1 | 2 ¹ | 30 |
| VC 0431 | Squash, Summer | 0.5 | 2 ¹ | 7 |
| SO 0702 | Sunflower seed | 1 | --- | 63 |
| VO 0448 | Tomato | 0.5 | 2 ¹ | 7 |
| AO1 0002 | Vegetables, except as otherwise listed | W | 2 | -- |
| GC 0654 | Wheat | 0.2 | --- | 14 |

¹ Previously "Vegetables, except as otherwise listed", 2 mg/kg.

² Previously "Fruits", 2 mg/kg.

FURTHER WORK OR INFORMATION

Required (by 1996)

Residue data from supervised trials on brassica crops carried out in the USA under their current GAP.

REFERENCES

(all references are unpublished)

Australia, 1993. Data on GAP and residues supplied by Australia for JMPR.

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Hoechst AG, 1993. A large number of residue reports in the A..... series, as indicated in the Tables or text as appropriate.

Portugal, 1993. Data on GAP and residues supplied by Portugal for JMPR.

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