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REPORT TITLE

Endosulfan (Hoe 002671)
Worldwide Monitoring of Soil Dissipation

DATA REQUIREMENT

EPA Guideline No.: None

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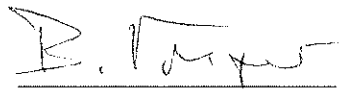
Volume 1 of 3

STATEMENT OF NO DATA CONFIDENTIALITY CLAIMS

No Claim of confidentiality is made for any information contained in this study on the basis of its falling within the scope of FIFRA §10(d)(1)(A)(B) or (C).

Company/Submitter: Endosulfan Task Force

Representative: 

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Date: 6/2/01

STATEMENT OF GOOD LABORATORY PRACTICE

The information contained in this report was from studies initiated/conducted before October 16, 1989. Therefore, no Good Laboratory Practice Statement is required for this volume according to 40CFR Part 160, Good Laboratory Practice Standards as promulgated in Federal Register 54, No. 158, 34067-34704, August 17, 1989.

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Date: 6/2/01

Endosulfan - Worldwide Monitoring of Soil Dissipation

1. Objective

The objective of this worldwide monitoring program was to investigate the dissipation of endosulfan in soil under various climates at locations with a known history of intensive endosulfan use over several years.

2. Monitoring Performance

Out of the many countries and crops where endosulfan is used frequently the following sites were chosen:

Australia	-	Cotton (2 locations)
Ethiopia	-	Cotton
Brazil	-	Soybeans / Coffee
Italy	-	Hazelnuts (2 locations)
West-Germany	-	Plums
South Africa	-	Cotton
Netherlands	-	Pears

2.1 Description of the monitoring sites

2.1.1 Australia - Cotton Site A

Trial No : AUS 85 I 100
Crop : Cotton/Wheat rotation
Location : Moree, New South Wales
Size : 250 ha
Height above sea level: 200 m

Soil characteristics:

	soil depth (cm) 0-10	10-20	20-30
Clay %	48.6	45.9	46.9
Silt %	36.7	40.5	37.6
Sand %	14.7	13.6	15.5
pH-Value	7.2	7.5	6.8
org. matter %	1.12	1.82	1.86

The endosulfan use is documented since 1980 (see Table 1.).
Respective weather data are attached in Table 11.

2.1.2 Australia - Cotton Site B

Trial No : AUS 85 I 200
Crop : Cotton/Wheat rotation
Location : Narrabri, New South Wales
Size : 200 ha
Height above sea level: 212 m

Soil characteristics:

	soil depth (cm) 0-10	10-20	20-30
Clay %	64.8	53.4	53.4
Silt %	31.8	30.0	30.3
Sand %	3.4	16.6	16.3
pH-Value	6.9	7.4	7.5
org. matter %	1.34	1.27	1.39

The endosulfan use is documented since 1978 (see Table 2).
Respective weather data are attached in Table 12.

2.1.3 Ethiopia - Cotton

Trial No : ETH 85 I 001
Crop : Cotton
Location :) Details on the
Size :) location could
Height above sea level:) not be obtained

Soil characteristics:

	soil depth (cm) 0-20	20-50
Clay %	67.8	64.8
Silt %	25.3	29.1
Sand %	6.9	6.1
pH-Value	6.9	7.2
org. matter %	1.22	1.12

Use of endosulfan has been recorded for 20 years. Unfortunately it was not possible to obtain details of application rates and timing per year. The total amount of endosulfan applied and the residues formed can be seen in Table 3. Weather data were not recorded.

2.1.4 Brazil - Soybeans

Trial No : BRA 85 I 200
Crop : Soybean/Wheat rotation
Location : Assis - Sao Paulo State
Size : 150 ha
Height above sea level: 400 m

Soil characteristics:

	soil depth (cm) 0-10	10-20	20-30
Clay %	38.4	46.5	54.5
Silt %	30.0	29.0	25.0
Sand %	31.6	24.5	20.5
pH-Value	4.65	4.3	4.4
org. matter %	2.71	2.28	1.30
biomass (mg C/100 g soil)	20.7	2.0	2.7

The endosulfan use is documented since 1981 (see Table 4). Respective weather data are attached in Table 13.

2.1.5 Brazil - Coffee

Trial No : BRA 85 I 300
Crop : Coffee
Location : Galia - Sao Paulo State
Size : 200 ha
Height above sea level: 650 m

Soil characteristics:

	soil depth (cm) 0-20	20-40	40-60
Clay %	3.8	15.6	24.6
Silt %	20.4	20.6	18.6
Sand %	75.8	63.8	56.8
pH-Value	4.5	4.05	4.05
org. matter %	1.33	0.58	0.83
biomass (mg C/100 g soil)	3.67	4.60	1.04

The use of endosulfan is recorded since 1981. Details can be seen in Table 5. Respective weather data are attached in Table 14.

2.1.6 Italy - Hazelnuts Site A

Trial No : ITA 85 I 100
Crop : Hazelnuts
Location : Cuneo - Cravanzana
Size : 0.5 ha
Height above sea level: 580 m
Soil characteristic:

	soil depth (cm) 0-30
Clay %	23.4
Silt %	49.6
Sand %	27.0
pH-Value	3.7
org. matter %	1.71
biomass (mg C/100 g soil)	18.87

2.1.7 Italy - Hazelnuts Site B

Trial No : ITA 85 I 200
Crop : Hazelnuts
Location : Cuneo - Cravanzana
Size : 0.5 ha
Height avobe sea level: 600 m
Soil characteristics:

	soil depth (cm) 0-30
Clay %	8.5
Silt %	28.7
Sand %	62.8
pH-Value	6.8
org. matter %	1.41
biomass (mg C/100 g soil)	34.09

The endosulfan use at both locations is documented since 1980 (see Table 6 and 7). Respective weather data are attached in Table 15.

2.1.8 West-Germany - Plums

Trial No : DEU 86 I 100
Crop : Plums
Location : St. Augustin - Niederpleis
Size : 0.2 ha
Height above sea level: 150 m
Soil characteristics:

	soil depth (cm) 0-20	20-40	40-60
Clay %	11.8	9.3	16.3
Silt %	30.6	32.5	25.5
Sand %	87.4	58.2	58.2
pH-Value	6.4	5.65	4.75
org. matter %	2.86	2.32	1.22
biomass (mg C/100 g soil)	34.5	16.3	11.4

The endosulfan use is documented since 1983 (see Table 8). Respective weather data are attached in Table 16.

2.1.9 South Africa - Cotton

Trial No : ZAF 85 I 100
Crop : Cotton
Location : Marble Hall
Size : not recorded
Height above sea level: 1500 m

Soil characteristics:

	soil depth (cm) 0-20	20-50
Clay %	25.2	24.3
Silt %	12.9	17.0
Sand %	61.9	58.7
pH-Value	5.9	6.0
org. matter %	1.14	1.14
biomass (mg C / 100 g soil)	5.38	5.48

Use of endosulfan is documented since 1981 (see Table 9). Respective weather data are attached in Table 17.

2.1.10 Netherlands - Pears

Trial No : NLD 86 I 100
Crop : Pear
Location : Wtenweerde
Size : not recorded
Height above sea level: not recorded

Soil characteristics:

	soil depth (cm) 0-10	10-20	20-30	30-40	40-50
Clay %	22.8	24.0	23.4	21.6	22.4
Silt %	45.2	44.4	45.6	47.0	49.9
Sand %	32.0	31.6	31.0	31.4	27.7
pH-Value	5.0	5.5	5.5	5.5	5.4
org. matter %	1.48	1.07	1.06	1.15	0.96
biomass (mg C g / 100 g soil)	24.6	17.5	18.3	16.4	15.2

Use of endosulfan is recorded since 1980. Details can be found in Table 10. Weather data were not recorded.

2.2 Sampling procedure

Soil samples were taken with a probe in 10 cm increments. Depending on the physical feasability in the different countries the sampling depth varied from 30 cm to 60 cm. Each sample consisted of approximately 10 cores. The sample size was 1 kg. The soil samples were packed in plastic containers lined with aluminium foil, deepfrozen and sent the the Analytical Laboratory of Hoechst AG, Frankfurt.

2.3 Sampling schedule

Due to the widespread geographical distribution of the various locations, difficulties in obtaining samples and transportation to Frankfurt, it was not possible to keep a unique sampling schedule for all sites.

In any case the first set of samples taken at each site consisted of two kinds:

- one for residue analysis
- one for determination of the soil characteristics
  The individual sampling periods per site are described below:

2.3.1 Australia Cotton Site A AUS 85 I 100

Soil samples were taken 23 months after continuous use of endosulfan for five years. At the first sampling, not only regular soil samples down to 30 cm were taken but also sediment samples at the outlet of the field after irrigation.

2.3.2 Australia Cotton Site B AUS 85 I 200

At this site endosulfan use was recorded for 6 years continuosly before the first samples were taken. Sampling of soil 0-30 cm and sediment (0-10 cm at the outlet) was performed 1 year after last application.

Regular soil samples were taken again 6 months after the last application in 1986 in 10 cm increments down to 50 cm depth.

2.3.3 Ethiopia Cotton ETH 85 I 001

Soil sampling at this site was carried out after continuous use of endosulfan for 20 years. Soil samples were taken 6 months after an endosulfan application in June 1985 in 10 cm increments down to 50 cm depth. Although details of timing and amount of endosulfan used per year were not recorded this site was found worth wile the investigation since it is the location with the longest use of endosulfan in the entire monitoring program.

2.3.4 Brazil Soybeans BRA 85 I 200

Soil samples were taken in 10 cm increments down to 60 cm after endosulfan had been used five years from 1981 to 1985. The first set of samples was taken 210 days after last application. A further application was made in February 1986 followed by samplings on day 2, 60, 120 and 185 after application.

2.3.5 Brazil Coffee BRA 85 I 300

At this site endosulfan had been used for 5 years before the first set of samples was taken. Again the increments were 10 cm down to 60 cm soil depth. The first samples were taken 330 days after the last application in 1985. After a further endosulfan application in January 1986, soil samples were taken 46, 98, 154 and 221 days later.

2.3.6 Italy Hazelnuts Site A ITA 85 I 100

Soil samples in 10 cm increments down to 30 cm depth were taken after endosulfan use for 5 years. Sampling was performed 7 months after the last application in 1985.

2.3.7 Italy Hazelnuts Site B ITA 85 I 200

At this site endosulfan was applied for 6 consecutive years before soil samples were taken. The sampling pattern was identical to Site A.

2.3.8 West Germany Plums DEU 86 I 100

Several endosulfan applications were made over three years before soil samples were taken down to 50 cm depth (10 cm increments). Sampling was performed 232 days after last application.

2.3.9 South Africa Cotton ZAF 85 I 100

Endosulfan was used at this site in 1981, '82, '84 and '85 up to 6 times a year. Soil samples were taken 21 days after the last application in 10 cm increments down to 40 cm depth.

2.3.10 Netherlands Pears NDL 86 I 100

This pear orchard was sprayed with endosulfan from 1980 to 1986 before soil samples were taken. Going down to 50 cm soil depth samples were taken on day 4, 61, 120, 195 and 257 after last application.

3. Residue analysis

The analytical procedure applied to all of the samples is described in the Analytical method AL 60/86 of the Analytical Laboratory, Hoechst AG, Frankfurt (M): "Hoe 002671 (Endosulfan), Residue determination in biological materials. (H.J. Werner et. al., 1986).

Principle of the method:

The two isomeres of the active ingredient (alpha- and beta-Endosulfan) as well as its metabolites E-sulfate, E-lacton and E-diol are included in the applied method.

50 g of the laboratory soil sample were homogenized and extracted after the addition of 70 ml of acetone by mixing and agitating in a separation funnel for 30 min. During filtration of the mixture the filtrate was directly poured into 600 ml saline (40 g NaCl/l water). This extraction step with acetone was repeated twice.

The resulting solution was extracted with 100 ml dichloromethane by agitating for 1 min. After phase separation the lower organic phase was poured into a filtration funnel which was filled with anhydrous sodium sulfate. The extraction of the aqueous phase was repeated twice with 50 ml of dichloromethane each. The solvent CH_2Cl_2 was evaporated to dryness, the residue was redissolved in a mixture of ethyl acetate/cylohexane (1 + 1) and again evaporated to the commencement of dryness. This step was repeated until complete dissolved in the ethyl acetate/cyclohexane mixture and the volume was adjusted to 25 ml.

Purification of the extracts:

A small chromatography column was filled with glass wool, 1 g of silica gel suspended in hexane followed by a 1 cm layer of sodium sulfate and washed with hexane.

The 5 ml aliquot of the sample extract is applied to the top of the column followed by the addition of hexane up to a total volume of 10 ml. Parent compounds and metabolites were eluted with a 20 ml mixture (95 % toluene + 5 % acetone, v + v). The eluates were concentrated to dryness and redissolved in 2 ml of toluene.

Gaschromatographic quantification

Derivatization of the E-diol:

0.02 ml of the final extract (2 ml) were filled into a reaction flask and adjusted to 0.1 ml with toluene. This solution was subjected to silylation at 70 - 80° C for 15 min. after addition of 0.04 ml MSTA (N-Methyl-N-trimethylsilyl-trifluroroacetamide) in the sealed flask. After completion of the reaction the solution was adjusted to a final volume of 1 ml.

GC-conditions:

Capillary column (Length: 30 m; i. d.: 0.32 mm; Stat. phase: 0.25 um DB-5)

On-column-injector : 45° C
Detector : electron capture detector (280° C)
Temperature program: Starting at 85° C (1 min.)

Temperature increase with maximal rate (ballistically) up to 200° C immediately followed by.

Temperature increase 20° C/min. up to 220° C (remaining for 15 min.).

Temperature increase with maximal rate (ballistically) up to 250° C (remaining for 5 min.).

Evaluation of GC-peaks:

Peak heights of actual samples were compared with peak heights of spiked extracts from control samples (obtained from non-treated plots). The lower limits of determination are for:

α -Endosulfan	= 0.02 mg/kg
β -Endosulfan	= 0.02 mg/kg
Endosulfan-sulfate	= 0.02 mg/kg
Endosulfan-lacton	= 0.02 mg/kg
Endosulfan-diol	= 0.02 mg/kg

Recovery of the spiked control samples: between 70 % and 100%.

4. Results and Discussion

Details of the history of endosulfan use, sampling dates and analytical results of the various locations can be seen in tables 1 to 10.

Samples of all monitoring sites were analyzed for alpha, beta and endosulfan sulfate. At five sites the further degradation products of endosulfan, endosulfan-lacton and endosulfan-diol were analyzed.

A summary of residues of all monitoring sites is attached in table 18.

Looking at the results of this summary it can be seen that at none of the locations an accumulation of endosulfan residues has taken place even after use of endosulfan over several years. None of the sites showed any α-Endosulfan in the first 10 cm soil layer. β-Endosulfan was found in trace levels just above the limit of determination (0.02 mg/kg) up to 0,06 mg/kg in the Netherlands. Endosulfan sulfate was found up to 0.1 mg/kg at the locations in tropical climates. The locations under moderate climatic conditions showed levels up to 0.4 mg/kg. None of the samples analyzed for endosulfan-lacton and endosulfan-diol showed any detectable residues of these substances.

Although the level of endosulfan residues found was fairly low at all locations, the tendency of a faster degradation under warm climatic conditions is obvious. In general no leaching of endosulfan down to deeper soil layers could be found. Only one location in Australia (AUS85I200) showed levels of 0.1 mg/kg of α-Endosulfan, 0,07 mg/kg of β-Endosulfan and 0.04 mg/kg of Endosulfan sulfate in the soil layer of 30-40 cm. At the two locations in Australia where additional sediment samples at the irrigation outlet of the fields were taken the endosulfan levels found in the sediment were higher than those determined in the regular soil samples.

5. Conclusion

From the results of this study it can be concluded that Endosulfan dissipates rapidly under tropical climatic conditions. Even in areas where Endosulfan is used intensively over several years there is no persistence of the active ingredient nor its metabolites. The sites were investigated down to 60 cm soil depth. There was no evidence for leaching. The crop or growing conditions do not seem to influence the dissipation of Endosulfan.

The two sites chosen for further investigation will be monitored and soil samples will be taken until termination of the monitoring program.

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Table 1

History of Endosulfan use and residue results

Trial-No. : AUS 85 I 100
Crop : Cotton/Wheat rotation
Product used : Thiodan 35 EC, Thiodan 25 ULV, Endosan
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
20.11.80	0.73								
09.12.80	0.73								
17.12.80	0.73								
25.12.80	0.73								
04.01.81	0.73								
15.01.81	0.73								
09.12.82	0.52								
17.12.82	0.52								
24.12.82	0.73								
09.01.83	0.73								
18.01.83	0.73								
20.12.83	0.73								
29.12.83	0.73								
10.01.84	0.73								
23.01.84	0.52								
		16.12.85	23 month	0 - 10	< 0.02	< 0.02	< 0.02		
				10 - 20	< 0.02	< 0.02	0.02		
				20 - 30	< 0.02	< 0.02	< 0.02		
		Sediment at outlet		0 - 5	< 0.02	0.02	0.04		
				5 - 10	< 0.02	0.02	0.05		

Table 1 cont.

History of Endosulfan use and residue results

Trial-No. : AUS 85 I 100
Crop : Cotton/Wheat rotation
Product used : Thiodan 35 EC, Thiodan 25 ULV, Endosan
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
16.12.85	0.73								
23.12.85	0.73								
10.01.86	0.73								
		27.07.86	6 months	0 - 10	< 0.02	< 0.02	0.03	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.03	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	0.04	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 2

History of Endosulfan use and residue results

Trial-No. : AUS 85 I 200
Crop : Cotton/Wheat rotation
Product used : Thiodan 35 EC, Thiodan 25 ULV
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
18.12.78	0.73								
29.12.78	0.73								
06.01.79	0.73								
27.10.80	0.49								
21.11.80	0.49								
06.12.80	0.49								
17.12.80	0.73								
02.01.81	0.73								
01.01.83	0.72								
20.01.83	0.72								
07.02.83	0.72								
11.12.84	0.72								
		12.12.85	1 year	0 - 10	0.09	0.12	0.41	-	-
				10 - 20	0.03	0.10	0.15	-	-
				20 - 30	0.02	0.10	0.20	-	-
		Sediment at outlet		0 - 5	0.15	0.73	0.62		
				5 - 10	0.06	0.38	0.39		

Annotation: no endosulfan application in 1982

Table 2 cont.

History of Endosulfan use and residue results

Trial-No. : AUS 85 1 200
Crop : Cotton/Wheat rotation
Product used : Thiodan 35 EC, Thiodan 25 ULV
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
28.12.85	0.72								
19.01.86	0.72								
		03.08.86	6 months	0 - 10	< 0.02	0.03	0.08	< 0.02	< 0.02
				10 - 20	< 0.02	0.02	0.05	< 0.02	< 0.02
				20 - 30	0.10	0.08	0.05	< 0.02	< 0.02
				30 - 40	0.10	0.07	0.04	< 0.02	< 0.02
				40 - 50	0.09	0.07	0.03	< 0.02	< 0.02

Table 3

History of Endosulfan use and residue results

Trial-No. : ETH 85 I 001
Crop : Cotton
Product used :
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Endosulfan has been used for 20 years at this location. Total Dosage approx. 25-35 kg									
Last Appl. June 1985		04.11.85	6 months	0 - 10	< 0.02	< 0.02	0.1		
				10 - 20	< 0.02	< 0.02	< 0.02		
				20 - 30	< 0.02	< 0.02	0.03		
				30 - 40	< 0.02	< 0.02	0.1		
				40 - 50	< 0.02	< 0.02	0.03		

Table 4

History of Endosulfan use and residue results

Trial-No. : BRA 85 I 200
Crop : Soybean / Wheat rotation
Product used : Thiodan 35 EC
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Dec.1981	0.175								
Dec.1982	0.350								
Dec.1983	0.350								
Dec.1984	0.175								
Jan.1985	0.350								
May 1985	0.280								
		31.12.85	210	0 - 10	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
24.02.86	0.525	26.02.86	2	0 - 10	< 0.02	0.02	0.04	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.02	< 0.02	< 0.02
Application				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Details : 300 l/ha water				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Equipment: Stationary Bar Sprayer				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
tractor mounted				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Total soil coverage by the soybeans									
		25.04.86	60	0 - 10	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 4 cont.

History of Endosulfan use and residue results

Trial-No. : BRA 85 I 200
Crop : Soybean / Wheat rotation
Product used : Thiodan 35 EC
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
24.02.86	0.525	24.06.86	120	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
		28.08.86	185	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

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Table 5

History of Endosulfan use and residue results

Trial-No. : BRA 85 I 300
Crop : Coffee
Product used : Thiodan 35 EC
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Jan.1981 Jan.1982 Feb.1982 Dec.1982 Jan.1983 Dec.1983 Feb.1984 Dec.1984 Jan.1985	0.525 0.525 0.525 0.525 0.525 0.525 0.525 0.525 0.525	30.12.85	330	0 - 10	< 0.02	< 0.02	0.10	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
20.01.86	0.525	07.03.86	46	0 - 10	< 0.02	< 0.02	0.05	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Application Details : 300 l/ha water Equipment: Atomized Turbo IT400 tractor mounted Soil covered 50 % by coffee tree tops Tree spacing 4 m x 2 m									
		28.04.86	98	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 5 cont.

History of Endosulfen use and residue results

Trial-No. : BRA 85 I 300
Crop : Coffee
Product used : Thiodan 35 EC
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
20.01.86	0.525	23.06.86	154	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
		29.08.86	221	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

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Table 6: History of Endosulfan Use and Residue Results

Trial No. : ITA 85 I 100
Crop : Hazelnut
Product used : Thiodan 35 EC
Endosulfan use:

Date	Rate l/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg				
					α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Apr. 1980	1.6								
May 1980	1.6								
Apr. 1981	1.6								
May 1981	1.6								
Apr. 1982	1.6								
May 1982	1.6								
Apr. 1983	1.6								
May 1983	1.6								
Apr. 1985	1.6								
May 1985	1.6								
		04.12.85	7 months	0 - 10	<0.02	0.04	0.4	-	-
				10 - 20	<0.02	0.02	0.09	-	-
				20 - 30	<0.02	<0.02	<0.02	-	-

Annotation: No endosulfan application in 1984

Table 7: History of Endosulfan Use and Residue Results

Trial No. : ITA 85 I 200
Crop : Hazelnut
Product used : Thiodan 35 EC
Endosulfan use:

Date	Rate l/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg				
					α -Endos.	β -Endos.	E-Sulfate	E-Lacton	E-Diol
Apr. 1980	1.6								
May 1980	1.6								
Apr. 1981	1.6								
May 1981	1.6								
Apr. 1982	1.6								
May 1982	1.6								
Apr. 1983	1.6								
May 1983	1.6								
Apr. 1984	1.6								
May 1984	1.6								
Apr. 1985	1.6								
May 1985	1.6								
		04.12.85	7 months	0 - 10	<0.02	<0.02	0.05	-	-
				10 - 20	<0.02	<0.02	0.02	-	-
				20 - 30	<0.02	0.02	<0.02	-	-

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Table 8

History of Endosulfan use and residue results

Trial-No. : DEU 86 I 100
Crop : Plums
Product used : Thiodan 35 EC
Endosulfan use :

Appl. Date	Rate (%)	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
05.05.83	0.1								
10.05.83	0.15								
31.05.83	0.15								
13.06.83	0.1								
01.07.83	0.1								
07.05.84	0.1								
16.05.84	0.1								
23.06.84	0.1								
03.05.85	0.1								
15.05.85	0.1								
30.05.85	0.1								
11.06.85	0.1	29.01.86	232	0 - 10	< 0.02	0.02	0.27	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.09	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Applications were made with a spraying pistole wet to run off

Table 9

History of Endosulfan use and residue results

Trial-No. : ZAF 85 I 100
Crop : Cotton, Green Beans, Peas rotation
Product used : Thiodan 35 MO
Endosulfan use :

Date	Rate l/ha.	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
23.12.81	1.0								
09.01.82	1.0								
16.01.82	1.0								
26.01.82	1.0								
08.02.82	1.0								
18.02.82	1.0								
27.02.82	1.0								
28.01.84	1.0								
04.02.84	1.0								
18.02.84	1.5								
25.02.84	1.5								
03.03.84	1.5								
10.03.84	1.5								
08.01.85	1.0								
19.01.85	1.0								
26.01.85	1.5								
14.02.85	1.5								
02.03.85	1.5								
21.11.85	0.75								
		12.12.85	21 Days	0 - 10	< 0.02	< 0.02	0.03	-	-
				10 - 20	< 0.02	< 0.02	0.03	-	-
				20 - 30	< 0.02	< 0.02	0.03	-	-
				30 - 40	< 0.02	< 0.02	0.02		

Table 10

History of Endosulfan use and residue results

Trial-No. : NDL 85 1 100
Crop : Pears
Product used : Thiodan 50 WP, thiodan MO (incl. Mineraloil), Thioate
Endosulfan use :

Appl. Date	Rate (%)	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Apr.1980	0.15								
Apr.1981	0.15								
Apr.1982	0.15								
Apr.1983	0.15								
Aug.1983	0.15								
Apr.1984	0.15								
Apr.1985	1.5								
Apr.1985	0.1								
May 1985	0.1								
July 1985	0.1								
June 1986	0.15								
		29.06.86	4	0 - 10	0.08	0.15	0.45	0.03	< 0.02
				10 - 20	0.02	0.03	0.09	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	0.04	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 10 cont.

History of Endosulfan use and residue results

Trial-No. : NDL 86 I 100
Crop : Pears
Product used : Thiodan 50 WP, Thiodan MO (incl. Mineraloil), Thioate
Endosulfan use :

Appl. Date	Rate (%)	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg				
					α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
		29.08.86	61	0 - 10	< 0.02	0.08	0.33	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.03	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
		22.10.86	120	0 - 10	< 0.02	0.13	0.59	0.02	< 0.02
				10 - 20	< 0.02	0.04	0.11	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	0.03	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	0.02	< 0.02	< 0.02
		05.01.87	195	0 - 10	< 0.02	< 0.02	0.04	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 10 cont.

History of Endosulfan use and residue results

Trial-No. : NDL 86 I 100
Crop : Pears
Product used : Thiodan 50 WP, Thiodan MO (incl. Mineraloil), Thioate
Endosulfan use :

Appl. Date	Rate (%)	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
		07.03.87	257	0 - 10	< 0.02	0.06	0.22	not	< 0.02
				10 - 20	< 0.02	0.03	0.05	analyzed	< 0.02
				20 - 30	< 0.02	< 0.02	0.02		< 0.02
				30 - 40	< 0.02	0.07	0.29		< 0.02
				40 - 50	< 0.02	< 0.02	0.02		< 0.02

Table 11

History of Endosulfan use and residue results

Weather Data for Location Moree - Trial No AUS 85 I 100

Month	1980 Rainfall mm	1981 Rainfall mm	1982 Rainfall mm	1983 Rainfall mm	1984 Rainfall mm	1985 Rainfall mm
January	41.6	50	113.5	69	139.5	0.0
February	24.6	73	58	0.0	49.5	48
March	5.6	0.0	120	14	18	51
April	3.6	0.0	0.0	108	0.0	29
May	39.5	88	14	102.5	103	0.0
June	4.2	26	3	52.5	53	0.0
July	16.2	73	0.5	31	31	89
August	14.6	1.5	0.0	33.5	34	80
Sept.	0.8	8.5	31	66.5	67	14
October	54.0	29	16.5	104	104	47
November	25.0	60	0.0	95.5	94	46
December	125.8	78	49	44	44	173
Average/ Total	355.5	487.0	405.5	720.5	737.0	577.0

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Landwirtschaftliche Entwicklungsabteilung

Analytisches Laboratorium

Date : 08.11.1988
Report-No.: LEA/R88/008

Table 12

Weather Data for Location Narrabri - Trial No AUS 85 I 200

Month	1981		1982		1983		1984		1985	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	25.9	2.2	27.7	94.0	25.9	111.4	23.1	218.8	27	17.6
February	27.7	72.6	26.7	35.4	27.3	39.4	23.9	120.4	26.1	105.2
March	23.6	0	22.9	126.4	24.4	14.4	22.2	26.6	23.9	18.9
April	20.7	12.8	19.6	3.4	17.6	99.6	18.3	61.2	18.9	20.8
May	15.3	68.8	14.6	15.6	15.9	191.0	14.1	0.6	16	9.5
June	10.5	58.2	10.2	1.6	10.9	26.8	12.6	6.6	10.4	12.4
July	7.4	54.2	9.7	7.8	10.3	38.4	9.8	133.2	-	-
August	9.8	5.2	14.1	0	11.3	52.6	11.4	11.6	11.7	82.8
Sept.	16.3	19.8	15.6	26.4	15.7	45.2	12.8	30.0	13.8	18.4
October	19.3	39.4	18.9	33.4	18.6	93.0	18.5	53.8	18.1	58.4
November	20.6	89.6	25.3	1.6	20.4	89.8	22.2	54.7	21.9	27.4
December	26.9	22.6	26.9	72.3	23.7	47.8	25.0	18.7	-	-
Average/ Total	18.6	445.4	19.4	417.9	18.5	849.4	17.8	736.2		

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Landwirtschaftliche Entwicklungsabteilung

Analytisches Laboratorium

Date : 08.11.1988
Report-No.: LEA/R88/008

Table 13

Weather Data for Thiodan No.: BRA851200, Location Assis - Sao Paulo State

Month	1981		1982		1983		1984		1985		1986	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	24.4	152.9	25.3	202.9	26.4	342.5	28.1	193.5	24.3	139.6	28.8	257.0
February	24.6	60.5	26.9	98.8	26.9	133.6	28.2	121.4	26.6	134.7	27.0	216.0
March	24.3	58.6	24.5	126.0	25.3	175.7	28.0	170.5	24.7	154.9	26.9	388.9
April	20.9	135.5	23.0	52.6	24.5	98.3	22.5	90.5	23.5	180.1	24.7	115.5
May	20.4	1.9	20.3	85.3	22.2	219.1	22.3	74.1	20.4	88.7	20.0	151.4
June	17.2	109.0	19.7	224.5	17.5	201.2	20.8	0.0	19.4	24.5	18.4	0.0
July	15.7	13.8	20.6	75.8	21.3	7.0	21.2	5.5	20.0	22.5	17.8	28.4
August	18.3	6.2	21.5	66.6	22.2	0.0	18.6	63.5	23.4	5.5	14.4	166.0
September	20.2	14.4	22.8	37.0	19.6	232.8	20.4	83.4	23.0	37.3	21.2	54.5
October	19.9	204.9	24.3	166.9	23.5	121.2	25.8	42.0	27.1	12.6	22.2	53.5
November	22.8	176.7	26.1	188.5	25.4	168.3	26.1	60.5	28.0	103.8		
December	21.9	189.3	24.2	388.7	25.9	275.2	24.2	249.0	22.9	16.0		
Average/ Total	20.9	1124.0	23.3	1713.6	23.4	1975.2	23.9	1153.9	21.5	912.2		

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Landwirtschaftliche Entwicklungsabteilung

Analytisches Laboratorium

Date : 08.11.1988
Report-No.: LEA/R88/008

Table 14

Weather Data for Thiodan No.: BRA851300, Location Galia - Sao Paulo State

Month	1981		1982		1983		1984		1985		1986	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	22.6	281.5	23.1	188.0	-	415.0	27.4	200.0	25.0	288.0	26.8	181.5
February	23.7	57.5	24.0	285.0	-	250.0	27.9	92.0	27.2	104.0	25.3	164.5
March	21.9	63.5	23.0	316.0	-	103.0	25.6	80.0	25.2	116.0	25.1	415.5
April	19.3	116.5	21.0	33.0	-	141.0	22.5	92.5	24.1	207.0	25.6	82.0
May	19.7	0.0	20.4	84.0	20.3	320.0	23.1	74.0	21.1	75.0	22.2	118.5
June	15.7	100.0	19.4	168.0	12.5	201.0	21.6	0.0	18.3	14.0	20.9	0.0
July	14.8	5.0	19.2	67.0	21.4	16.0	21.4	10.0	18.6	17.5	19.8	28.0
August	19.2	7.0	23.2	23.0	21.4	0.0	20.8	93.0	22.7	12.0	16.9	166.0
September	22.0	10.0	21.3	24.0	15.6	287.0	22.1	131.0	23.3	46.5	21.9	52.5
October	20.8	184.5	21.8	392.0	22.8	99.0	26.0	80.0	25.5	70.0	24.8	48.0
November	23.9	116.0	-	126.0	25.4	239.5	26.5	109.0	25.2	180.0		
December	23.2	186.0	-	239.0	24.4	274.5	25.6	207.0	-	130.5		
Average/ Total	20.6	1127.0	-	1945.0	-	2346.0	24.2	1168.5	-	1260.5		

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Table 15

Weather Data for Location Cuneo - Trial No ITA 85 I 100 and Trial No ITA 85 I 200

Month	1981		1982		1983		1984		1985	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	-	-	0.7	38.0	4.1	0.0	1.4	54.0	- 2.0	12.0
February	-	-	4.9	192.6	2.1	0.0	1.5	116.4	2.3	1.0
March	13.1	78.4	8.2	41.0	7.9	117.2	5.9	9.6	6.4	83.0
April	11.4	174.8	12.6	58.6	12.2	85.6	10.8	39.8	12.5	8.8
May	11.3	95.5	18.4	23.0	16.9	47.4	12.4	240.2	15.5	105.2
June	-	-	23.7	9.9	21.5	108.6	19.5	30.4	20.1	9.8
July	-	-	26.7	1.2	27.0	6.6	21.8	0.0	24.8	0.0
August	-	-	20.5	18.2	22.9	51.0	21.3	23.8	22.9	8.0
Sept.	-	-	20.6	0.0	18.6	10.8	16.5	36.8	20.8	25.0
October	13.3	54.4	12.4	106.4	13.2	24.4	12.2	0.0	13.6	26.0
November	3.4	-	7.8	95.3	5.1	0.0	6.6	23.6	-	-
December	1.5	57.0	3.3	6.4	0.5	51.0	2.1	27.6	-	-
Average/ Total	-	-	13.3	485.8	12.7	502.6	11.0	602.2		

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Table 16

Weather Data for Location St. Augustin - Trial No.: DEU 86 I 100

Month	1982		1983		1984		1985		1986	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	- 0.6	86.7	6.2	58.2	5.1	77.7	- 3.3	61.2	2.3	41.8
February	3.3	5.7	1.8	35.5	2.5	91.7	- 1.1	26.3	1.3	69.0
March	6.3	26.1	6.9	66.5	3.2	11.1	0.8	48.6	- 2.2	18.1
April	7.7	29.0	10.4	46.7	7.2	44.4	8.7	42.1	5.9	55.3
May	14.1	49.8	13.1	90.6	11.7	78.8	10.2	31.4	10.4	55.4
June	18.3	58.5	18.4	26.5	14.0	40.6	16.1	64.6	13.9	70.1
July	20.3	23.9	21.7	39.9	17.1	52.2	16.8	14.8	19.5	29.8
August	19.9	54.6	22.0	12.5	19.0	42.8	18.1	46.7	19.5	28.5
Sept.	16.4	54.6	17.8	42.4	17.8	29.6	16.6	43.4	15.2	57.7
October	11.9	29.8	13.8	13.7	13.3	78.7	16.0	16.6	11.6	34.0
November	8.4	33.1	5.5	15.3	9.0	30.1	6.6	13.9	8.3	93.7
December	3.9	73.5	3.1	49.5	5.9	55.4	2.5	26.4	3.5	57.6
Average/ Total	10.8	525.3	11.7	497.3	10.5	633.1	9.0	436.0	9.1	611.0

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Table 17

Weather Data for Location Marble Hall - Trial No.: ZAF 85 I 100

Month	1981		1982		1983		1984		1985	
	Average Temp. °C	Rainfall mm	Average Temp. °C	Rainfall mm	Average Temp. °C	Rainfall mm	Average Temp. °C	Rainfall mm	Average Temp. °C	Rainfall mm
January				82		143		39		111
February				38		0		0		155
March				49		0		70		56
April				0		0		0		0
May				0		0		0		58
June				0		0		0		
July				0		0		0		
August				0		36		0		
Sept.		35		0		0		20		
October		41		94		30		84		
November		11		44		174		52		
December		74				55		42		
Average/ Total				380		438		307		

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Table 18: Summary of Endosulfan Residues of all Monitoring Sites

Country	Crop	No. of years of Endosulfan use	Total Dosage (kg ai/ha)	Time lapsed after last application (months)	Residues in mg/kg in the 0-10 cm soil layer*				
					α -E	β -E	E-Sulfat	E-Lacton	E-Diol
AUS85I100	Cotton	6	12.5	6	<0.02	<0.02	0.03	<0.02	<0.02
AUS85I200	Cotton	7	9.4	6	<0.02	0.03	0.08	<0.02	<0.02
ETH85I001	Cotton	20	24 - 35	6	<0.02	<0.02	0.10		
BRA85I200	Soybeans	6	2.2	6	<0.02	<0.02	<0.02	<0.02	<0.02
BRA85I300	Coffee	6	5.3	7	<0.02	<0.02	<0.02	<0.02	<0.02
ZAF85I100	Cotton	5	7.5	1	<0.02	<0.02	0.03		
ITA85I100	Hazelnuts	5	5.5	7	<0.02	0.04	0.40		
ITA85I200	Hazelnuts	6	6.6	7	<0.02	<0.02	0.05		
DEU86I100	Plums	3	6.3	7	<0.02	0.02	0.27	<0.02	<0.02
NLD86I100	Pears	6	8.8	9	<0.02	0.06	0.22		<0.02

* All deeper soil layers analyzed showed no residues or lower values.

A40218

Study Title

Endosulfan (Hoe 002671)
Worldwide monitoring of soil Dissipation

Author(s)

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Performing Laboratory

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Laboratory Project D

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Endosulfan - Worldwide Monitoring of Soil Dissipation

1. Objective

The objective of this worldwide monitoring program was to investigate the dissipation of endosulfan in soil under various climates at locations with a known history of intensive endosulfan use over several years.

2. Monitoring Performance

Out of the many countries and crops where endosulfan is used frequently the following sites were chosen:

Australia	-	Cotton (2 locations)
Ethiopia	-	Cotton
Brazil	-	Soybeans / Coffee
Italy	-	Hazelnuts (2 locations)
West-Germany	-	Plums
South Africa	-	Cotton
Netherlands	-	Pears

2.1 Description of the monitoring sites

2.1.1 Australia - Cotton Site A

Trial No : AUS 85 I 100
Crop : Cotton/Wheat rotation
Location : Moree, New South Wales
Size : 250 ha
Height above sea level: 200 m

Soil characteristics:

	soil depth (cm) 0-10	10-20	20-30
Clay %	48.6	45.9	46.9
Silt %	36.7	40.5	37.6
Sand %	14.7	13.6	15.5
pH-Value	7.2	7.5	6.8
org. matter %	1.12	1.82	1.86

The endosulfan use is documented since 1980 (see Table 1.).
Respective weather data are attached in Table 11.

2.1.2 Australia - Cotton Site B

Trial No : AUS 85 I 200
Crop : Cotton/Wheat rotation
Location : Narrabri, New South Wales
Size : 200 ha
Height above sea level: 212 m

Soil characteristics:

	soil depth (cm) 0-10	10-20	20-30
Clay %	64.8	53.4	53.4
Silt %	31.8	30.0	30.3
Sand %	3.4	16.6	16.3
pH-Value	6.9	7.4	7.5
org. matter %	1.34	1.27	1.39

The endosulfan use is documented since 1978 (see Table 2).
Respective weather data are attached in Table 12.

2.1.3 Ethiopia - Cotton

Trial No : ETH 85 I 001
Crop : Cotton
Location :) Details on the
Size :) location could
Height above sea level:) not be obtained

Soil characteristics:

	soil depth (cm) 0-20	20-50
Clay %	67.8	64.8
Silt %	25.3	29.1
Sand %	6.9	6.1
pH-Value	6.9	7.2
org. matter %	1.22	1.12

Use of endosulfan has been recorded for 20 years. Unfortunately it was not possible to obtain details of application rates and timing per year. The total amount of endosulfan applied and the residues formed can be seen in Table 3. Weather data were not recorded.

2.1.4 Brazil - Soybeans

Trial No : BRA 85 I 200
Crop : Soybean/Wheat rotation
Location : Assis - Sao Paulo State
Size : 150 ha
Height above sea level: 400 m

Soil characteristics:

	soil depth (cm) 0-10	10-20	20-30
Clay %	38.4	46.5	54.5
Silt %	30.0	29.0	25.0
Sand %	31.6	24.5	20.5
pH-Value	4.65	4.3	4.4
org. matter %	2.71	2.28	1.30
biomass (mg C/100 g soil)	20.7	2.0	2.7

The endosulfan use is documented since 1981 (see Table 4). Respective weather data are attached in Table 13.

2.1.5 Brazil - Coffee

Trial No : BRA 85 I 300
Crop : Coffee
Location : Galia - Sao Paulo State
Size : 200 ha
Height above sea level: 650 m

Soil characteristics:

	soil depth (cm) 0-20	20-40	40-60
Clay %	3.8	15.6	24.6
Silt %	20.4	20.6	18.6
Sand %	75.8	63.8	56.8
pH-Value	4.5	4.05	4.05
org. matter %	1.33	0.58	0.83
biomass (mg C/100 g soil)	3.67	4.60	1.04

The use of endosulfan is recorded since 1981. Details can be seen in Table 5. Respective weather data are attached in Table 14.

2.1.6 Italy - Hazelnuts Site A

Trial No : ITA 85 I 100
Crop : Hazelnuts
Location : Cuneo - Cravanzana
Size : 0.5 ha
Height above sea level: 580 m
Soil characteristic:

	soil depth (cm) 0-30
Clay %	23.4
Silt %	49.6
Sand %	27.0
pH-Value	3.7
org. matter %	1.71
biomass (mg C/100 g soil)	18.87

2.1.7 Italy - Hazelnuts Site B

Trial No : ITA 85 I 200
Crop : Hazelnuts
Location : Cuneo - Cravanzana
Size : 0.5 ha
Height avobe sea level: 600 m
Soil characteristics:

	soil depth (cm) 0-30
Clay %	8.5
Silt %	28.7
Sand %	62.8
pH-Value	6.8
org. matter %	1.41
biomass (mg C/100 g soil)	34.09

The endosulfan use at both locations is documented since 1980 (see Table 6 and 7). Respective weather data are attached in Table 15.

2.1.8 West-Germany - Plums

Trial No : DEU 86 I 100
Crop : Plums
Location : St. Augustin - Niederpleis
Size : 0.2 ha
Height above sea level: 150 m
Soil characteristics:

	soil depth (cm) 0-20	20-40	40-60
Clay %	11.8	9.3	16.3
Silt %	30.6	32.5	25.5
Sand %	87.4	58.2	58.2
pH-Value	6.4	5.65	4.75
org. matter %	2.86	2.32	1.22
biomass (mg C/100 g soil)	34.5	16.3	11.4

The endosulfan use is documented since 1983 (see Table 8). Respective weather data are attached in Table 16.

2.1.9 South Africa - Cotton

Trial No : ZAF 85 I 100
Crop : Cotton
Location : Marble Hall
Size : not recorded
Height above sea level: 1500 m

Soil characteristics:

	soil depth (cm) 0-20	20-50
Clay %	25.2	24.3
Silt %	12.9	17.0
Sand %	61.9	58.7
pH-Value	5.9	6.0
org. matter %	1.14	1.14
biomass (mg C / 100 g soil)	5.38	5.48

Use of endosulfan is documented since 1981 (see Table 9). Respective weather data are attached in Table 17.

2.1.10 Netherlands - Pears

Trial No : NLD 86 I 100
Crop : Pear
Location : Wtenweerde
Size : not recorded
Height above sea level: not recorded

Soil characteristics:

	soil depth (cm) 0-10	10-20	20-30	30-40	40-50
Clay %	22.8	24.0	23.4	21.6	22.4
Silt %	45.2	44.4	45.6	47.0	49.9
Sand %	32.0	31.6	31.0	31.4	27.7
pH-Value	5.0	5.5	5.5	5.5	5.4
org. matter %	1.48	1.07	1.06	1.15	0.96
biomass (mg C g / 100 g soil)	24.6	17.5	18.3	16.4	15.2

Use of endosulfan is recorded since 1980. Details can be found in Table 10. Weather data were not recorded.

2.2 Sampling procedure

Soil samples were taken with a probe in 10 cm increments. Depending on the physical feasability in the different countries the sampling depth varied from 30 cm to 60 cm. Each sample consisted of approximately 10 cores. The sample size was 1 kg. The soil samples were packed in plastic containers lined with aluminium foil, deepfrozen and sent the the Analytical Laboratory of Hoechst AG, Frankfurt.

2.3 Sampling schedule

Due to the widespread geographical distribution of the various locations, difficulties in obtaining samples and transportation to Frankfurt, it was not possible to keep a unique sampling schedule for all sites.

In any case the first set of samples taken at each site consisted of two kinds:

- one for residue analysis
- one for determination of the soil characteristics
  The individual sampling periods per site are described below:

2.3.1 Australia Cotton Site A AUS 85 I 100

Soil samples were taken 23 months after continuous use of endosulfan for five years. At the first sampling, not only regular soil samples down to 30 cm were taken but also sediment samples at the outlet of the field after irrigation.

2.3.2 Australia Cotton Site B AUS 85 I 200

At this site endosulfan use was recorded for 6 years continuosly before the first samples were taken. Sampling of soil 0-30 cm and sediment (0-10 cm at the outlet) was performed 1 year after last application.

Regular soil samples were taken again 6 months after the last application in 1986 in 10 cm increments down to 50 cm depth.

2.3.3 Ethiopia Cotton ETH 85 I 001

Soil sampling at this site was carried out after continuous use of endosulfan for 20 years. Soil samples were taken 6 months after an endosulfan application in June 1985 in 10 cm increments down to 50 cm depth. Although details of timing and amount of endosulfan used per year were not recorded this site was found worth wile the investigation since it is the location with the longest use of endosulfan in the entire monitoring program.

2.3.4 Brazil Soybeans BRA 85 I 200

Soil samples were taken in 10 cm increments down to 60 cm after endosulfan had been used five years from 1981 to 1985. The first set of samples was taken 210 days after last application. A further application was made in February 1986 followed by samplings on day 2, 60, 120 and 185 after application.

2.3.5 Brazil Coffee BRA 85 I 300

At this site endosulfan had been used for 5 years before the first set of samples was taken. Again the increments were 10 cm down to 60 cm soil depth. The first samples were taken 330 days after the last application in 1985. After a further endosulfan application in January 1986, soil samples were taken 46, 98, 154 and 221 days later.

2.3.6 Italy Hazelnuts Site A ITA 85 I 100

Soil samples in 10 cm increments down to 30 cm depth were taken after endosulfan use for 5 years. Sampling was performed 7 months after the last application in 1985.

2.3.7 Italy Hazelnuts Site B ITA 85 I 200

At this site endosulfan was applied for 6 consecutive years before soil samples were taken. The sampling pattern was identical to Site A.

2.3.8 West Germany Plums DEU 86 I 100

Several endosulfan applications were made over three years before soil samples were taken down to 50 cm depth (10 cm increments). Sampling was performed 232 days after last application.

2.3.9 South Africa Cotton ZAF 85 I 100

Endosulfan was used at this site in 1981, '82, '84 and '85 up to 6 times a year. Soil samples were taken 21 days after the last application in 10 cm increments down to 40 cm depth.

2.3.10 Netherlands Pears NDL 86 I 100

This pear orchard was sprayed with endosulfan from 1980 to 1986 before soil samples were taken. Going down to 50 cm soil depth samples were taken on day 4, 61, 120, 195 and 257 after last application.

3. Residue analysis

The analytical procedure applied to all of the samples is described in the Analytical method AL 60/86 of the Analytical Laboratory, Hoechst AG, Frankfurt (M): "Hoe 002671 (Endosulfan), Residue determination in biological materials. (H.J. Werner et. al., 1986).

Principle of the method:

The two isomeres of the active ingredient (alpha- and beta-Endosulfan) as well as its metabolites E-sulfate, E-lacton and E-diol are included in the applied method.

50 g of the laboratory soil sample were homogenized and extracted after the addition of 70 ml of acetone by mixing and agitating in a separation funnel for 30 min. During filtration of the mixture the filtrate was directly poured into 600 ml saline (40 g NaCl/l water). This extraction step with acetone was repeated twice.

The resulting solution was extracted with 100 ml dichloromethane by agitating for 1 min. After phase separation the lower organic phase was poured into a filtration funnel which was filled with anhydrous sodium sulfate. The extraction of the aqueous phase was repeated twice with 50 ml of dichloromethane each. The solvent CH_2Cl_2 was evaporated to dryness, the residue was redissolved in a mixture of ethyl acetate/cylohexane (1 + 1) and again evaporated to the commencement of dryness. This step was repeated until complete dissolved in the ethyl acetate/cyclohexane mixture and the volume was adjusted to 25 ml.

Purification of the extracts:

A small chromatography column was filled with glass wool, 1 g of silica gel suspended in hexane followed by a 1 cm layer of sodium sulfate and washed with hexane.

The 5 ml aliquot of the sample extract is applied to the top of the column followed by the addition of hexane up to a total volume of 10 ml. Parent compounds and metabolites were eluted with a 20 ml mixture (95 % toluene + 5 % acetone, v + v). The eluates were concentrated to dryness and redissolved in 2 ml of toluene.

Gaschromatographic quantification

Derivatization of the E-diol:

0.02 ml of the final extract (2 ml) were filled into a reaction flask and adjusted to 0.1 ml with toluene. This solution was subjected to silylation at 70 - 80° C for 15 min. after addition of 0.04 ml MSTA (N-Methyl-N-trimethylsilyl-trifluroroacetamide) in the sealed flask. After completion of the reaction the solution was adjusted to a final volume of 1 ml.

GC-conditions:

Capillary column (Length: 30 m; i. d.: 0.32 mm; Stat. phase: 0.25 um DB-5)

On-column-injector : 45° C
Detector : electron capture detector (280° C)
Temperature program: Starting at 85° C (1 min.)

Temperature increase with maximal rate (ballistically) up to 200° C immediately followed by.

Temperature increase 20° C/min. up to 220° C (remaining for 15 min.).

Temperature increase with maximal rate (ballistically) up to 250° C (remaining for 5 min.).

Evaluation of GC-peaks:

Peak heights of actual samples were compared with peak heights of spiked extracts from control samples (obtained from non-treated plots). The lower limits of determination are for:

α -Endosulfan	= 0.02 mg/kg
β -Endosulfan	= 0.02 mg/kg
Endosulfan-sulfate	= 0.02 mg/kg
Endosulfan-lacton	= 0.02 mg/kg
Endosulfan-diol	= 0.02 mg/kg

Recovery of the spiked control samples: between 70 % and 100%.

4. Results and Discussion

Details of the history of endosulfan use, sampling dates and analytical results of the various locations can be seen in tables 1 to 10.

Samples of all monitoring sites were analyzed for alpha, beta and endosulfan sulfate. At five sites the further degradation products of endosulfan, endosulfan-lacton and endosulfan-diol were analyzed.

A summary of residues of all monitoring sites is attached in table 18.

Looking at the results of this summary it can be seen that at none of the locations an accumulation of endosulfan residues has taken place even after use of endosulfan over several years. None of the sites showed any α-Endosulfan in the first 10 cm soil layer. β-Endosulfan was found in trace levels just above the limit of determination (0.02 mg/kg) up to 0,06 mg/kg in the Netherlands. Endosulfan sulfate was found up to 0.1 mg/kg at the locations in tropical climates. The locations under moderate climatic conditions showed levels up to 0.4 mg/kg. None of the samples analyzed for endosulfan-lacton and endosulfan-diol showed any detectable residues of these substances.

Although the level of endosulfan residues found was fairly low at all locations, the tendency of a faster degradation under warm climatic conditions is obvious. In general no leaching of endosulfan down to deeper soil layers could be found. Only one location in Australia (AUS85I200) showed levels of 0.1 mg/kg of α-Endosulfan, 0,07 mg/kg of β-Endosulfan and 0.04 mg/kg of Endosulfan sulfate in the soil layer of 30-40 cm. At the two locations in Australia where additional sediment samples at the irrigation outlet of the fields were taken the endosulfan levels found in the sediment were higher than those determined in the regular soil samples.

5. Conclusion

From the results of this study it can be concluded that Endosulfan dissipates rapidly under tropical climatic conditions. Even in areas where Endosulfan is used intensively over several years there is no persistence of the active ingredient nor its metabolites. The sites were investigated down to 60 cm soil depth. There was no evidence for leaching. The crop or growing conditions do not seem to influence the dissipation of Endosulfan.

The two sites chosen for further investigation will be monitored and soil samples will be taken until termination of the monitoring program.

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Table 1

History of Endosulfan use and residue results

Trial-No. : AUS 85 1 100
Crop : Cotton/Wheat rotation
Product used : Thiodan 35 EC, Thiodan 25 ULV, Endosan
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
20.11.80	0.73								
09.12.80	0.73								
17.12.80	0.73								
25.12.80	0.73								
04.01.81	0.73								
15.01.81	0.73								
09.12.82	0.52								
17.12.82	0.52								
24.12.82	0.73								
09.01.83	0.73								
18.01.83	0.73								
20.12.83	0.73								
29.12.83	0.73								
10.01.84	0.73								
23.01.84	0.52								
		16.12.85	23 month	0 - 10	< 0.02	< 0.02	< 0.02		
				10 - 20	< 0.02	< 0.02	0.02		
				20 - 30	< 0.02	< 0.02	< 0.02		
		Sediment at outlet		0 - 5	< 0.02	0.02	0.04		
				5 - 10	< 0.02	0.02	0.05		

Table 1 cont.

History of Endosulfan use and residue results

Trial-No. : AUS 85 I 100
Crop : Cotton/Wheat rotation
Product used : Thiodan 35 EC, Thiodan 25 ULV, Endosan
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
16.12.85 23.12.85 10.01.86	0.73 0.73 0.73	27.07.86	6 months	0 - 10	< 0.02	< 0.02	0.03	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.03	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	0.04	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 2

History of Endosulfan use and residue results

Trial-No. : AUS 85 I 200
Crop : Cotton/Wheat rotation
Product used : Thiodan 35 EC, Thiodan 25 ULV
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
18.12.78	0.73								
29.12.78	0.73								
06.01.79	0.73								
27.10.80	0.49								
21.11.80	0.49								
06.12.80	0.49								
17.12.80	0.73								
02.01.81	0.73								
01.01.83	0.72								
20.01.83	0.72								
07.02.83	0.72								
11.12.84	0.72								
		12.12.85	1 year	0 - 10	0.09	0.12	0.41	-	-
				10 - 20	0.03	0.10	0.15	-	-
				20 - 30	0.02	0.10	0.20	-	-
		Sediment at outlet		0 - 5	0.15	0.73	0.62		
				5 - 10	0.06	0.38	0.39		

Annotation: no endosulfan application in 1982

Table 2 cont.

History of Endosulfan use and residue results

Trial-No. : AUS 85 I 200
Crop : Cotton/Wheat rotation
Product used : Thiodan 35 EC, Thiodan 25 ULV
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
28.12.85	0.72								
19.01.86	0.72								
		03.08.86	6 months	0 - 10	< 0.02	0.03	0.08	< 0.02	< 0.02
				10 - 20	< 0.02	0.02	0.05	< 0.02	< 0.02
				20 - 30	0.10	0.08	0.05	< 0.02	< 0.02
				30 - 40	0.10	0.07	0.04	< 0.02	< 0.02
				40 - 50	0.09	0.07	0.03	< 0.02	< 0.02

Landwirtschaftliche Entwicklungsabteilung

Analytisches Laboratorium

Date : 08.11.1988
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Table 3

History of Endosulfan use and residue results

Trial-No. : ETH 85 I 001
Crop : Cotton
Product used :
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Endosulfan has been used for 20 years at this location. Total Dosage approx. 25-35 kg									
Last Appl. June 1985		04.11.85	6 months	0 - 10	< 0.02	< 0.02	0.1		
				10 - 20	< 0.02	< 0.02	< 0.02		
				20 - 30	< 0.02	< 0.02	0.03		
				30 - 40	< 0.02	< 0.02	0.1		
				40 - 50	< 0.02	< 0.02	0.03		

Table 4

History of Endosulfan use and residue results

Trial-No. : BRA 85 I 200
Crop : Soybean / Wheat rotation
Product used : Thiodan 35 EC
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Dec.1981	0.175								
Dec.1982	0.350								
Dec.1983	0.350								
Dec.1984	0.175								
Jan.1985	0.350								
May 1985	0.280								
		31.12.85	210	0 - 10	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
24.02.86	0.525	26.02.86	2	0 - 10	< 0.02	0.02	0.04	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Application Details : 300 l/ha water Equipment: Stationary Bar Sprayer tractor mounted Total soil coverage by the soybeans									
		25.04.86	60	0 - 10	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 4 cont.

History of Endosulfan use and residue results

Trial-No. : BRA 85 I 200
Crop : Soybean / Wheat rotation
Product used : Thiodan 35 EC
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
24.02.86	0.525	24.06.86	120	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
		28.08.86	185	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 5

History of Endosulfan use and residue results

Trial-No. : BRA 85 I 300
Crop : Coffee
Product used : Thiodan 35 EC
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Jan.1981	0.525								
Jan.1982	0.525								
Feb.1982	0.525								
Dec.1982	0.525								
Jan.1983	0.525								
Dec.1983	0.525								
Feb.1984	0.525								
Dec.1984	0.525								
Jan.1985	0.525								
		30.12.85	330	0 - 10	< 0.02	< 0.02	0.10	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
20.01.86	0.525	07.03.86	46	0 - 10	< 0.02	< 0.02	0.05	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Application Details : 300 l/ha water Equipment: Atomized Turbo IT400 tractor mounted Soil covered 50 % by coffee tree tops Tree spacing 4 m x 2 m									
		28.04.86	98	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

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Table 5 cont.

History of Endosulfan use and residue results

Trial-No. : BRA 85 I 300
Crop : Coffee
Product used : Thiodan 35 EC
Endosulfan use :

Date	Rate (kg ai/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
20.01.86	0.525	23.06.86	154	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
		29.08.86	221	0 - 10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				50 - 60	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

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Table 6: History of Endosulfan Use and Residue Results

Trial No. : ITA 85 I 100
Crop : Hazelnut
Product used : Thiodan 35 EC
Endosulfan use:

Date	Rate l/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg				
					α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Apr. 1980	1.6								
May 1980	1.6								
Apr. 1981	1.6								
May 1981	1.6								
Apr. 1982	1.6								
May 1982	1.6								
Apr. 1983	1.6								
May 1983	1.6								
Apr. 1985	1.6								
May 1985	1.6								
		04.12.85	7 months	0 - 10	<0.02	0.04	0.4	-	-
				10 - 20	<0.02	0.02	0.09	-	-
				20 - 30	<0.02	<0.02	<0.02	-	-

Annotation: No endosulfan application in 1984

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Table 7: History of Endosulfan Use and Residue Results

Trial No. : ITA 85 I 200
Crop : Hazelnut
Product used : Thiodan 35 EC
Endosulfan use:

Date	Rate l/ha	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg				
					α -Endos.	β -Endos.	E-Sulfate	E-Lacton	E-Diol
Apr. 1980	1.6								
May 1980	1.6								
Apr. 1981	1.6								
May 1981	1.6								
Apr. 1982	1.6								
May 1982	1.6								
Apr. 1983	1.6								
May 1983	1.6								
Apr. 1984	1.6								
May 1984	1.6								
Apr. 1985	1.6								
May 1985	1.6								
		04.12.85	7 months	0 - 10	<0.02	<0.02	0.05	-	-
				10 - 20	<0.02	<0.02	0.02	-	-
				20 - 30	<0.02	0.02	<0.02	-	-

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Table 8

History of Endosulfan use and residue results

Trial-No. : DEU 86 I 100
Crop : Plums
Product used : Thiodan 35 EC
Endosulfan use :

Appl. Date	Rate (%)	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
05.05.83	0.1								
10.05.83	0.15								
31.05.83	0.15								
13.06.83	0.1								
01.07.83	0.1								
07.05.84	0.1								
16.05.84	0.1								
23.06.84	0.1								
03.05.85	0.1								
15.05.85	0.1								
30.05.85	0.1								
11.06.85	0.1								
Applications were made with a spraying pistole wet to run off		29.01.86	232	0 - 10	< 0.02	0.02	0.27	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.09	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 9

History of Endosulfan use and residue results

Trial-No. : ZAF 85 I 100
Crop : Cotton, Green Beans, Peas rotation
Product used : Thiodan 35 MO
Endosulfan use :

Date	Rate l/ha.	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg				
					α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
23.12.81	1.0								
09.01.82	1.0								
16.01.82	1.0								
26.01.82	1.0								
08.02.82	1.0								
18.02.82	1.0								
27.02.82	1.0								
28.01.84	1.0								
04.02.84	1.0								
18.02.84	1.5								
25.02.84	1.5								
03.03.84	1.5								
10.03.84	1.5								
08.01.85	1.0								
19.01.85	1.0								
26.01.85	1.5								
14.02.85	1.5								
02.03.85	1.5								
21.11.85	0.75								
		12.12.85	21 Days	0 - 10	< 0.02	< 0.02	0.03	-	-
				10 - 20	< 0.02	< 0.02	0.03	-	-
				20 - 30	< 0.02	< 0.02	0.03	-	-
				30 - 40	< 0.02	< 0.02	0.02		

Table 10

History of Endosulfan use and residue results

Trial-No. : NDL 85 I 100
Crop : Pears
Product used : Thiodan 50 WP, thiodan MO (incl. Mineraloil), Thioate
Endosulfan use :

Appl. Date	Rate (%)	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
Apr.1980	0.15								
Apr.1981	0.15								
Apr.1982	0.15								
Apr.1983	0.15								
Aug.1983	0.15								
Apr.1984	0.15								
Apr.1985	1.5								
Apr.1985	0.1								
May 1985	0.1								
July 1985	0.1								
June 1986	0.15								
		29.06.86	4	0 - 10	0.08	0.15	0.45	0.03	< 0.02
				10 - 20	0.02	0.03	0.09	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	0.04	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 10 cont.

History of Endosulfan use and residue results

Trial-No. : NDL 86 I 100
Crop : Pears
Product used : Thiodan 50 WP, Thiodan MO (incl. Mineraloil), Thioate
Endosulfan use :

Appl. Date	Rate (%)	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg				
					α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
		29.08.86	61	0 - 10	< 0.02	0.08	0.33	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.03	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
		22.10.86	120	0 - 10	< 0.02	0.13	0.59	0.02	< 0.02
				10 - 20	< 0.02	0.04	0.11	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	0.03	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	0.02	< 0.02	< 0.02
		05.01.87	195	0 - 10	< 0.02	< 0.02	0.04	< 0.02	< 0.02
				10 - 20	< 0.02	< 0.02	0.02	< 0.02	< 0.02
				20 - 30	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				30 - 40	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
				40 - 50	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

Table 10 cont.

History of Endosulfan use and residue results

Trial-No. : NDL 86 I 100
Crop : Pears
Product used : Thiodan 50 WP, Thiodan MO (incl. Mineraloil), Thioate
Endosulfan use :

Appl. Date	Rate (%)	Sampling (Date)	Days after last appl.	Soil depth (cm)	Residues in mg/kg α-Endos.	β-Endos.	E-Sulfate	E-Lacton	E-Diol
		07.03.87	257	0 - 10	< 0.02	0.06	0.22	not	< 0.02
				10 - 20	< 0.02	0.03	0.05	analyzed	< 0.02
				20 - 30	< 0.02	< 0.02	0.02		< 0.02
				30 - 40	< 0.02	0.07	0.29		< 0.02
				40 - 50	< 0.02	< 0.02	0.02		< 0.02

Table 11

History of Endosulfan use and residue results

Weather Data for Location Moree - Trial No AUS 85 I 100

Month	1980 Rainfall mm	1981 Rainfall mm	1982 Rainfall mm	1983 Rainfall mm	1984 Rainfall mm	1985 Rainfall mm
January	41.6	50	113.5	69	139.5	0.0
February	24.6	73	58	0.0	49.5	48
March	5.6	0.0	120	14	18	51
April	3.6	0.0	0.0	108	0.0	29
May	39.5	88	14	102.5	103	0.0
June	4.2	26	3	52.5	53	0.0
July	16.2	73	0.5	31	31	89
August	14.6	1.5	0.0	33.5	34	80
Sept.	0.8	8.5	31	66.5	67	14
October	54.0	29	16.5	104	104	47
November	25.0	60	0.0	95.5	94	46
December	125.8	78	49	44	44	173
Average/ Total	355.5	487.0	405.5	720.5	737.0	577.0

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Table 12

Weather Data for Location Narrabri - Trial No AUS 85 I 200

Month	1981		1982		1983		1984		1985	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	25.9	2.2	27.7	94.0	25.9	111.4	23.1	218.8	27	17.6
February	27.7	72.6	26.7	35.4	27.3	39.4	23.9	120.4	26.1	105.2
March	23.6	0	22.9	126.4	24.4	14.4	22.2	26.6	23.9	18.9
April	20.7	12.8	19.6	3.4	17.6	99.6	18.3	61.2	18.9	20.8
May	15.3	68.8	14.6	15.6	15.9	191.0	14.1	0.6	16	9.5
June	10.5	58.2	10.2	1.6	10.9	26.8	12.6	6.6	10.4	12.4
July	7.4	54.2	9.7	7.8	10.3	38.4	9.8	133.2	-	-
August	9.8	5.2	14.1	0	11.3	52.6	11.4	11.6	11.7	82.8
Sept.	16.3	19.8	15.6	26.4	15.7	45.2	12.8	30.0	13.8	18.4
October	19.3	39.4	18.9	33.4	18.6	93.0	18.5	53.8	18.1	58.4
November	20.6	89.6	25.3	1.6	20.4	89.8	22.2	54.7	21.9	27.4
December	26.9	22.6	26.9	72.3	23.7	47.8	25.0	18.7	-	-
Average/ Total	18.6	445.4	19.4	417.9	18.5	849.4	17.8	736.2		

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Landwirtschaftliche Entwicklungsabteilung

Analytisches Laboratorium

Date : 08.11.1988
Report-No.: LEA/R88/008

Table 13

Weather Data for Thiodan No.: BRA851200, Location Assis - Sao Paulo State

Month	1981		1982		1983		1984		1985		1986	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	24.4	152.9	25.3	202.9	26.4	342.5	28.1	193.5	24.3	139.6	28.8	257.0
February	24.6	60.5	26.9	98.8	26.9	133.6	28.2	121.4	26.6	134.7	27.0	216.0
March	24.3	58.6	24.5	126.0	25.3	175.7	28.0	170.5	24.7	154.9	26.9	388.9
April	20.9	135.5	23.0	52.6	24.5	98.3	22.5	90.5	23.5	180.1	24.7	115.5
May	20.4	1.9	20.3	85.3	22.2	219.1	22.3	74.1	20.4	88.7	20.0	151.4
June	17.2	109.0	19.7	224.5	17.5	201.2	20.8	0.0	19.4	24.5	18.4	0.0
July	15.7	13.8	20.6	75.8	21.3	7.0	21.2	5.5	20.0	22.5	17.8	28.4
August	18.3	6.2	21.5	66.6	22.2	0.0	18.6	63.5	23.4	5.5	14.4	166.0
September	20.2	14.4	22.8	37.0	19.6	232.8	20.4	83.4	23.0	37.3	21.2	54.5
October	19.9	204.9	24.3	166.9	23.5	121.2	25.8	42.0	27.1	12.6	22.2	53.5
November	22.8	176.7	26.1	188.5	25.4	168.3	26.1	60.5	28.0	103.8		
December	21.9	189.3	24.2	388.7	25.9	275.2	24.2	249.0	22.9	16.0		
Average/ Total	20.9	1124.0	23.3	1713.6	23.4	1975.2	23.9	1153.9	21.5	912.2		

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Landwirtschaftliche Entwicklungsabteilung

Analytisches Laboratorium

Date : 08.11.1988
Report-No.: LEA/R88/008

Table 14

Weather Data for Thiodan No.: BRA851300, Location Galia - Sao Paulo State

Month	1981		1982		1983		1984		1985		1986	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	22.6	281.5	23.1	188.0	-	415.0	27.4	200.0	25.0	288.0	26.8	181.5
February	23.7	57.5	24.0	285.0	-	250.0	27.9	92.0	27.2	104.0	25.3	164.5
March	21.9	63.5	23.0	316.0	-	103.0	25.6	80.0	25.2	116.0	25.1	415.5
April	19.3	116.5	21.0	33.0	-	141.0	22.5	92.5	24.1	207.0	25.6	82.0
May	19.7	0.0	20.4	84.0	20.3	320.0	23.1	74.0	21.1	75.0	22.2	118.5
June	15.7	100.0	19.4	168.0	12.5	201.0	21.6	0.0	18.3	14.0	20.9	0.0
July	14.8	5.0	19.2	67.0	21.4	16.0	21.4	10.0	18.6	17.5	19.8	28.0
August	19.2	7.0	23.2	23.0	21.4	0.0	20.8	93.0	22.7	12.0	16.9	166.0
September	22.0	10.0	21.3	24.0	15.6	287.0	22.1	131.0	23.3	46.5	21.9	52.5
October	20.8	184.5	21.8	392.0	22.8	99.0	26.0	80.0	25.5	70.0	24.8	48.0
November	23.9	116.0	-	126.0	25.4	239.5	26.5	109.0	25.2	180.0		
December	23.2	186.0	-	239.0	24.4	274.5	25.6	207.0	-	130.5		
Average/ Total	20.6	1127.0	-	1945.0	-	2346.0	24.2	1168.5	-	1260.5		

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Table 15

Weather Data for Location Cuneo - Trial No ITA 85 I 100 and Trial No ITA 85 I 200

Month	1981		1982		1983		1984		1985	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	-	-	0.7	38.0	4.1	0.0	1.4	54.0	- 2.0	12.0
February	-	-	4.9	192.6	2.1	0.0	1.5	116.4	2.3	1.0
March	13.1	78.4	8.2	41.0	7.9	117.2	5.9	9.6	6.4	83.0
April	11.4	174.8	12.6	58.6	12.2	85.6	10.8	39.8	12.5	8.8
May	11.3	95.5	18.4	23.0	16.9	47.4	12.4	240.2	15.5	105.2
June	-	-	23.7	9.9	21.5	108.6	19.5	30.4	20.1	9.8
July	-	-	26.7	1.2	27.0	6.6	21.8	0.0	24.8	0.0
August	-	-	20.5	18.2	22.9	51.0	21.3	23.8	22.9	8.0
Sept.	-	-	20.6	0.0	18.6	10.8	16.5	36.8	20.8	25.0
October	13.3	54.4	12.4	106.4	13.2	24.4	12.2	0.0	13.6	26.0
November	3.4	-	7.8	95.3	5.1	0.0	6.6	23.6	-	-
December	1.5	57.0	3.3	6.4	0.5	51.0	2.1	27.6	-	-
Average/ Total	-	-	13.3	485.8	12.7	502.6	11.0	602.2		

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Landwirtschaftliche Entwicklungsabteilung

Analytisches Laboratorium

Date : 08.11.1988
Report-No.: LEA/R88/008

Table 16

Weather Data for Location St. Augustin - Trial No.: DEU 86 I 100

Month	1982		1983		1984		1985		1986	
	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm	Average Temp. °C	Rain-fall mm
January	- 0.6	86.7	6.2	58.2	5.1	77.7	- 3.3	61.2	2.3	41.8
February	3.3	5.7	1.8	35.5	2.5	91.7	- 1.1	26.3	1.3	69.0
March	6.3	26.1	6.9	66.5	3.2	11.1	0.8	48.6	- 2.2	18.1
April	7.7	29.0	10.4	46.7	7.2	44.4	8.7	42.1	5.9	55.3
May	14.1	49.8	13.1	90.6	11.7	78.8	10.2	31.4	10.4	55.4
June	18.3	58.5	18.4	26.5	14.0	40.6	16.1	64.6	13.9	70.1
July	20.3	23.9	21.7	39.9	17.1	52.2	16.8	14.8	19.5	29.8
August	19.9	54.6	22.0	12.5	19.0	42.8	18.1	46.7	19.5	28.5
Sept.	16.4	54.6	17.8	42.4	17.8	29.6	16.6	43.4	15.2	57.7
October	11.9	29.8	13.8	13.7	13.3	78.7	16.0	16.6	11.6	34.0
November	8.4	33.1	5.5	15.3	9.0	30.1	6.6	13.9	8.3	93.7
December	3.9	73.5	3.1	49.5	5.9	55.4	2.5	26.4	3.5	57.6
Average/ Total	10.8	525.3	11.7	497.3	10.5	633.1	9.0	436.0	9.1	611.0

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Landwirtschaftliche Entwicklungsabteilung

Analytisches Laboratorium

Date : 08.11.1988
Report-No.: LEA/R88/008

Table 17

Weather Data for Location Marble Hall - Trial No.: ZAF 85 I 100

Month	1981		1982		1983		1984		1985	
	Average Temp. °C	Rainfall mm	Average Temp. °C	Rainfall mm	Average Temp. °C	Rainfall mm	Average Temp. °C	Rainfall mm	Average Temp. °C	Rainfall mm
January				82		143		39		111
February				38		0		0		155
March				49		0		70		56
April				0		0		0		0
May				0		0		0		58
June				0		0		0		
July				0		0		0		
August				0		36		0		
Sept.		35		0		0		20		
October		41		94		30		84		
November		11		44		174		52		
December		74				55		42		
Average/ Total				380		438		307		

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Table 18: Summary of Endosulfan Residues of all Monitoring Sites

Country	Crop	No. of years of Endosulfan use	Total Dosage (kg ai/ha)	Time lapsed after last application (months)	Residues in mg/kg in the 0-10 cm soil layer*				
					α -E	β -E	E-Sulfat	E-Lacton	E-Diol
AUS85I100	Cotton	6	12.5	6	<0.02	<0.02	0.03	<0.02	<0.02
AUS85I200	Cotton	7	9.4	6	<0.02	0.03	0.08	<0.02	<0.02
ETH85I001	Cotton	20	24 - 35	6	<0.02	<0.02	0.10		
BRA85I200	Soybeans	6	2.2	6	<0.02	<0.02	<0.02	<0.02	<0.02
BRA85I300	Coffee	6	5.3	7	<0.02	<0.02	<0.02	<0.02	<0.02
ZAF85I100	Cotton	5	7.5	1	<0.02	<0.02	0.03		
ITA85I100	Hazelnuts	5	5.5	7	<0.02	0.04	0.40		
ITA85I200	Hazelnuts	6	6.6	7	<0.02	<0.02	0.05		
DEU86I100	Plums	3	6.3	7	<0.02	0.02	0.27	<0.02	<0.02
NLD86I100	Pears	6	8.8	9	<0.02	0.06	0.22		<0.02

* All deeper soil layers analyzed showed no residues or lower values.

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