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Monitoring the Agricultural Inputs Programme 1985-1986

Annexes
April 1986

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FIELD MONITORING OF THE DEPOSITION AND DRIFT OF AERIALLY APPLIED INSECTICIDES

1.1 INTRODUCTION

Factors affecting downwind drift of insecticide are noted in Chapter 8.1.1. The interaction between drop size and the climatological factors of windstrength, temperature and humidity determine the degree of drift, both as amount (numbers of drops and quantity of chemical) and distance.

Large droplets, defined as those whose sedimentation velocity is at least three times greater than the existing wind eddy velocity are relatively unaffected by turbulence and deposit within a distance that is directly proportional to release height and wind velocity and inversely proportional to their sedimentation velocity i.e.

$$x = \frac{h\bar{u}}{v}$$

where x is the distance travelled downwind by the drop
h is the release height above the ground
ū is the mean windspeed between the ground and release height
v is the drop sedimentation velocity

The behaviour of small drops, that is, drops whose sedimentation velocity is less than one third of the prevailing eddy velocity, is dominated by turbulence and downwind drift is characterised by an asymetric ground deposition pattern (Ref. 47). Under neutral conditions, i.e., when eddy velocity is about one tenth of the associated wind velocity, maximum drop deposition occurs at a distance downwind equal to ten times the spray release height. Further downwind, deposition decreases in inverse proportion to the square of the downwind distance. The peak of the ground deposit is given approximately by:

$$x_m = \frac{h\bar{u}}{u_*}$$

where x_m is the distance downwind of the maximum deposit
h is the release height above the ground
ū is the mean windspeed between the ground and release height
u_* is the wind eddy velocity

The wind eddy velocity is related to windspeed by:

$$u_* \approx 0.4z \frac{du}{dz}$$

where du is the change in wind speed over a height interval dz, centred at height z. Over typical agricultural surfaces the eddy velocity is about 10 per cent of the mean wind speed measured at a height of three metres.

The extent of spray drift is normally increased in conditions which favour drop evaporation although the magnitude of evaporative effects depends on drop size. Firstly, there will be those drops whose diameters will not be significantly reduced by evaporation before deposition takes place. Secondly, there will be drops of a size such that evaporation will change the dominating influence on drift from sedimentation to turbulence and thirdly, there are those drops whose volatile components will evaporate to leave a relatively involatile residue. An approximation for the time taken for a water drop to evaporate completely (t) is given by:

$$t = \frac{d^2}{80\ dt}$$

where d is drop diameter (um)
dt is difference between wet and dry bulb temperature (°C)

Experimental work by Wanner (Ref. 46) has shown that the water evaporation rate from many water-based pesticide formulations is similar to that of pure water and is not significantly reduced until almost all the water has evaporated.

The choice of equipment and its subsequent calibration to produce sprays that maximise deposition and spray cover and reduce drift to a minimum is therefore of particular importance in the Sudan where high temperatures and low relative humidities are common during the cotton spraying season.

1.2 SPRAY DRIFT ASSESSMENT

Spray drift from aerial spraying operations on cotton was monitored on seven occasions in the Gezira and once in the Rahad scheme. Details of the aircraft involved, the type of spray gear employed and the insecticide formulations applied are shown in Table A.A.1.

1.2.1 Sampling methods

The details of the manner in which spray deposition and drift would be monitored were broadly defined in the original proposed methodology document and, with some minor changes, were implemented as such during the monitoring period. The original detailed proposals for sampling spray drop deposition and drift included several alternative methods in order that should one technique prove unfeasible another could be used instead. This report will deal only with those methods actually used during the sampling programme. Due to problems of GLC analysis in the Wad Medani Laboratory (Ref. 1.4.B) it was not possible to analyse insecticide deposits extracted from whole plants in and outside sprayed fields. Quantitative drift assessment was therefore not possible on a directly comparative basis.

Three types of drop sampler were used: strands of acrylic blend knitting wool, rotating rectangular section glass tubes coated with magnesium oxide (Mg0) and spray sensitive paper targets.

(1) Acrylic knitting wool (Amalfi Brand, 65% polyacryl, 30% Mohair, 5% cotton) After extraction with acetone to remove possible contaminants the wool was stored in aluminium foil previously heated to 200°C for two hours until used. In the field three wool strands of just over one metre in length, with knots one metre apart, were stretched vertically between two horizontal cords tied to two wooden or steel rods driven into the ground. The strands were spaced 0.3 m apart with their lower ends 0.5 m above the ground. At the end of each trial the strands were cut at the knot at their lower ends, wound onto aluminium foil strips and stored in foil packages, and placed in a freezer as soon as possible.

TABLE A.A.1. SUMMARY OF AIRCRAFT OPERATING CONDITIONS, TREATMENTS, SPRAY DROPLET SIZE AND COVER[1]

Study No.	Date	Aircraft	Insecticide[2]	Mean windspeed m/sec	Temp. °C	R.H. %	Spraying period	No. drops per sq. cm H	No. drops per sq. cm V	Drop median diameters Volume (um) H	Drop median diameters Volume (um) V	Drop median diameters Number H	Drop median diameters Number V
1	19.10	AG Truck	dimethoate cypermethrin	7-8	35	22	09.33-09.48	8	57	-	-	-	-
2	21.10	Airtractor	amitraz endosulfan	2-3	30	49	08.50-09.05	42	300	-	-	-	-
3	27.10	Antonov 2M	deltamethrin	3-4	30	56	08.25-08.55	13	24	163	215	82	92
4	28.10	Thrush Comm	dimethoate alphamethrin	0-2	31	47	08.10-08.25	14	280	116	86	34	45
5	5.11	Antonov 2M	triazophos endosulfan	3-4	27	32	08.41-09.12	6	193	108	130	28	47
6	11.11	Turbothrush	quinalphos endosulfan	2-3	32	20	14.32-14.47	39	254	176	165	55	64
7	21.11	Antonov 2M	thiometon endosulfan	0-1	23	40	07.30-07.42	28	152	160	270	30	55
8	30.11	Turbothrush	chlorpyrifos endosulfan	2-3	27	42	08.30-08.42	56	226	144	134	35	50

Notes: [1] *All the drop data was obtained from magnesium oxide coated microscope slides placed within the target field.*

[2] *All the insecticides were applied as emulsifiable concentrate mixes at 21.6 litres/ha except on the 19.10 and 28.10 when an ultra low volume formulation was used at 1.0 litre/ha.*

In the Table R.H. denotes relative humidity, H and V horizontally and vertically disposed slides.

(2) Rotating MgO coated tubes
These were prepared in the field by exposing the tubes to the smoke from burning magnesium ribbon. Each sampler consisted of two such tubes (8 x 0.2 x 0.3 cm) mounted on the parallel, vertical arms of a U-shaped frame rotated at 330 rpm by a small, battery powered motor. The two tubes were spaced 8 cm apart, the whole assembly being mounted at the top of a 2 m high wooden post.

(3) Spray sensitive paper targets
Two types were used; white kromokote paper for sprays coloured with dye and oil-sensitive (coated recorder chart) paper for ultra-low volume and emulsifiable concentrate sprays. The papers were used as 2.5 cm wide strips wrapped around wooden crosspieces (1.5 x 1.5 x 15 cm) fixed to wooden posts at whatever height was required.

Water soluble papers proved to be unsatisfactory with EC formulations because they could not detect small drops from which the water component had already evaporated.

The original intention of using dyes to estimate insecticide deposition on cotton plants was attempted but proved to be unsatisfactory due to the presence of whitefly honeydew, dust and plant pigments which prevented the preparation of plant washings sufficiently clear to allow accurate spectrophotometer readings to be made.

1.2.2 Sampling layout

The downwind dispersal of spray droplets was monitored using wool, paper and rotary samplers positioned in fallow land at 25, 50, 100, 250 and 500 m from the downwind edge of the target field. Two sets of samplers were usually set up at the 25 m point, one of which was removed shortly before spraying took place to act as a control.

The battery-powered rotary samplers were switched on as they were erected and normally operated for a period of about 1.5 hrs before their collection within 0.5 hr of the end of spraying. Spray sampling was also carried out within the target field using oil sensitive paper targets mounted on a line of up to forty posts, spaced 4 m apart and perpendicular to the aircraft spray path. Each post carried targets attached to wooden crosspieces fixed at full and half crop height. In addition, the first six posts leading into the field from its downwind edge carried MgO coated glass slides fixed to the upper and windward sides of crosspieces mounted 0.2 m above the top of the crop.

1.2.3 Trial conditions

Details of the windspeeds, temperatures and relative humidities that were experienced during the spray application periods are shown in Table A.A.1.

Spray application during the sampling trials was usually completed before 09.30 am although one mid-afternoon spray took place as the result of delay brought about by high early morning windspeeds. Dry bulb temperatures before 09.30 am varied from 23°C to 35°C with corresponding relative humidities of between 56 and 20 per cent. Windspeeds over the same period generally ranged from 0 to 4 m/sec. On several occasions the target field had been irrigated within a few days prior to the trial. Collection of all the sampling materials was normally completed before 10.45 am.

1.2.4 Assessment methods

The wool samples were kept frozen until their analyses in the UK. The amounts of insecticide deposited on the strands were determined by gas/liquid chromatography and the result expressed in ug/metre (Hunting Research Laboratories Ref. 45).

The stains produced on the sensitive papers by both emulsifiable concentrate and ultra-low volume spray droplets were counted using a hand lens fitted with a 1 cm square grid. Number (Nmd) and volume (Vmd) median diameters could not be determined because of the lack of calibration of stain diameter versus drop diameter for the various insecticides involved.

The spray drops collected by the magnesium oxide coated targets were characterised by counting and sizing their corresponding impressions using a microscope equipped with an appropriate eyepiece graticule. The results were expressed as number of drops per square centimetre (No/sq. cm), and as volume and number median diameters. Some of the Mg0 coated rotary samples could not be assessed because of the presence of large numbers of dust particles which obscured the impressions made by the impacting spray drops.

1.3 RESULTS

1.3.1 Drift of Insecticide

The results of the assessment of the downwind paper and Mg0 coated targets, uncorrected for collection efficiency, are shown in Table A.A.2.

The amounts of insecticide recovered from the wool strand samplers and determined by gas/liquid chromatography are presented in Table A.A.3. The effective collecting area of a single wool strand was 100 cm x 0.25 cm^2 cross-section, or 25 cm^2. The time over which collection took place was from 30 to 45 minutes after spray application, depending on time taken to retrieve the wool samplers. With windspeeds from 1 to 8 mps this time was sufficient for the samplers to collect all drifting chemical.

The relationship between the amount of insecticide applied to the target field and that dispersed downwind was made by comparing the quantities of insecticide recovered from the wool samplers with estimates of deposition on an equivalent target area within the sprayed field. The latter was based on the application rate of active ingredient and spray droplet counts from the Mg0 coated slides. The results are given in Table 8.1 and Figures 8.1 to 8.8 shown in the main report.

This relationship between the theoretical amount of airborne spray that would be collected by a wool strand sampler sited within the target field and that collected on an identical sampler downwind was determined by calculating the infield collection (Q) as:

$$Q = A \times 0.641 \times Nv/_{Nh}$$

where Q = amount of insecticide (μg/m of wool)
A = application rate (g.a.i./ha)
Nv = no. drops/μm^2 deposited on vertical Mg0 target
Nh = no. drops/μm^2 deposited on horizontal Mg0 target

The quantity thus estimated was used to express the amounts deposited downwind as a percentage.

Details of the variation in droplet deposition across the target fields, obtained from spray sensitive paper targets fixed at full and half-crop height on posts, are shown in Figures A.A.1 to A.A.8.

In terms of the amount of insecticide collected by the furthest downwind wool sampler (500 m), relative to that estimated for an identical in-field sampler, the worst drift (Study 7, Table A.A.1) resulted from an early morning spray (07.30-07.42) under light wind conditions (0-1 m/sec) and at a temperature of 23°C. The average Vmd and Nmd of the spray drops sampled on horizontal and vertical targets within the sprayed area was 215 μm and 43 μm respectively, reducing to 42 μm and 21 μm at the 500 m downwind sampling point. Considerable drift also occurred under much harsher conditions when a mid-morning application was made (09.33-09.48) during which the windspeed varied from 7-8 m/sec and the air temperature reached 35°C (Table A.A.2).

TABLE A.A.2 SUMMARY OF SPRAY DROPLET SIZE AND COVER FROM DOWN-WIND Mg0 COATED ROTARY SAMPLERS AND SPRAY SENSITIVE PAPER TARGETS

Study No.	Date		Distance downwind (m) 25	50	100	250	500
			Rotary Mg0 samplers				
5	5.11	N	3383	2476	5360	4231	3940
		Vmd	43	53	56	37	42
		Nmd	23	23	20	20	21
		Vol	51	54	96	44	51
7	21.11	N	5413	2342	1672	1382	1141
		Vmd	60	65	50	47	48
		Nmd	24	22	28	24	28
		Vol	142	46	43	27	26
8	30.11	N	2510	2388	1882	451	0
		Vmd	56	69	52	52	-
		Nmd	23	18	19	21	-
		Vol	59	57	31	9	-
			Paper targets : No. drops/sq. cm				
3	27.10		6	4	1	0	0
4	28.10		420	330	215	118	45
5	5.11		177	111	83	49	30
6	11.11		223	192	164	120	54
7	21.11		135	114	102	78	76
8	30.11		156	101	81	23	2

Note: In the Table, N denotes number of drops/sq. cm; Vmd, volume median diameter; Nmd, number median diameter; Vol, volume of counted drops in nl/sq. cm.

TABLE A.A.3 SUMMARY OF INSECTICIDE COLLECTION BY DOWNWIND WOOL STRAND COLLECTORS (ug/m)

Study No.	Date	Insecticide	Application[1] rate g.ai/feddan	Distance downwind (m) 25	50	100	250	500
1	19.10	dimethoate	180	447.4	375.2	215.2	101.9	58.8
		cypermethrin	25	149.7	140.4	74.7	33.9	15.6
2	21.10	amitraz	200	598.5	642.6	595.2	206.1	58.9
		endosulfan	400	1095.4	1098.4	956.2	318.8	88.6
3	27.10	decamethrin	5.25	4.1	2.9	2.1	0.3	0.05
4	28.10	dimethoate	180	355.6	146.9	127.6	34.3	17.4
		alphamethrin	6.50	31.4	23.7	18.4	6.4	2.4
5	5.11	triazophos	176	585.5	547.4	289.8	179.1	127.3
		endosulfan	325	784.1	719.2	371.1	102.1	124.4
6	11.11	quinalphos	187	439.9	299.2	405.4	134.2	53.2
		endosulfan	375	675.5	444.4	572.4	205.0	78.1
7	21.11	thiometon	200	35.4	30.4	36.9	34.5	45.3
		endosulfan	375	647.9	522.2	549.2	384.4	364.0
8	30.11	chlorpyrifos	360	321.1	552.8	373.9	74.0	7.2
		endosulfan	400	366.6	632.1	423.5	85.1	15.2

Note: [1] *Rate assumed to be the ARC recommended rate. This could vary according to aircraft calibration accuracy and pilot performance.*

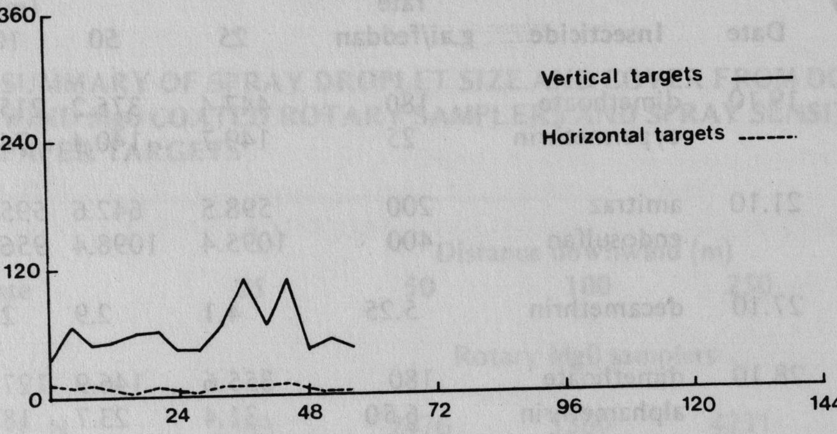
The quantities of insecticide recovered from the downwind wool samplers (Ref. Table 8.1) ranged between 5.1 to 131 per cent of the theoretical collection on an equivalent in-field sampler for the samplers stationed at 25 m, and 0.7 to 28 per cent for those at 500 m. In general, the relative amounts collected as airborne spray declined substantially at distances greater than 100 m from the sprayed area. Details are shown in Table 8.1 and in Figures 8.1 to 8.8.

Very low values were obtained for thiometon, possibly due to loss of material between deposition on the wool strands and their subsequent analysis or to the use of old stock (storage life 2 years at 20°C, Ref. 35).

The majority of the spray applications monitored took place between 08.00 and 09.15 in winds of up to 4 m/sec and at temperatures not exceeding 31°C. Relative humidities recorded downwind of the target fields ranged from 20 per cent to 56 per cent although on several occasions readings were artificially high because of the recent irrigation of the treatment area, although this reflects practical field conditions over much of the season.

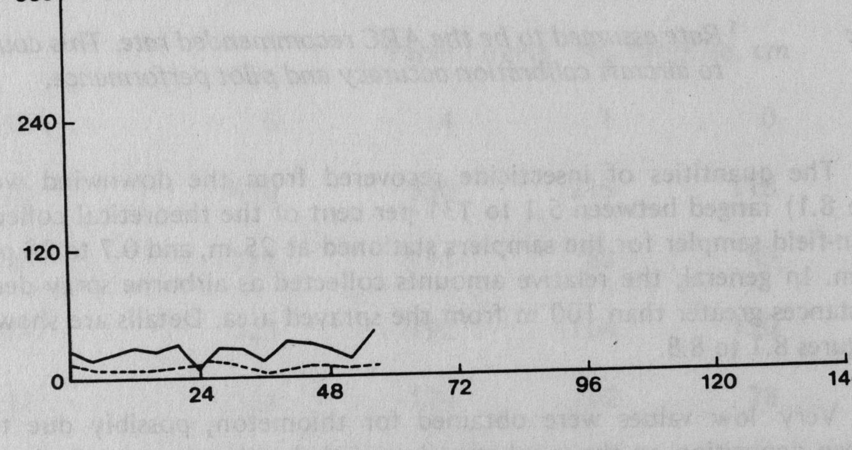
FIGURE A.A.1 TURABI, 19.10.1985 (Droplet deposition on mast mounted targets)

TARGETS AT TOP OF PLANTS
(mean height 45cm)



		Droplet deposition:	Vertical targets	Horizontal targets
Aircraft	Cessna Agwagon	Mean No./cm^2	57	8
Insecticide	Alamos D16 ULV	Coefficient of variation	38%	59%
Windspeed	7-8 m/sec			
Temperature	35°C			
Relative humidity	22%			

TARGETS AT MIDDLE OF PLANTS

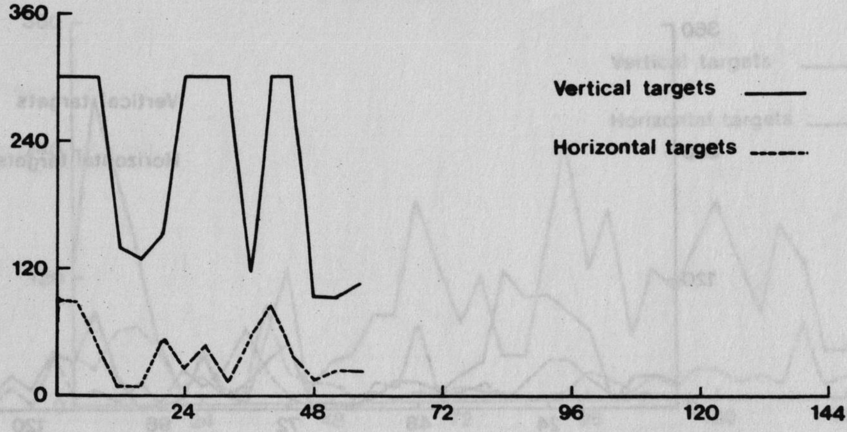


DISTANCE ACROSS COTTON NUMBER (metres)
(one mast each 4 metres)

Droplet deposition	Vertical targets	Horizontal targets
Mean No./cm^2	25	11
Coefficient of variation	39%	50%

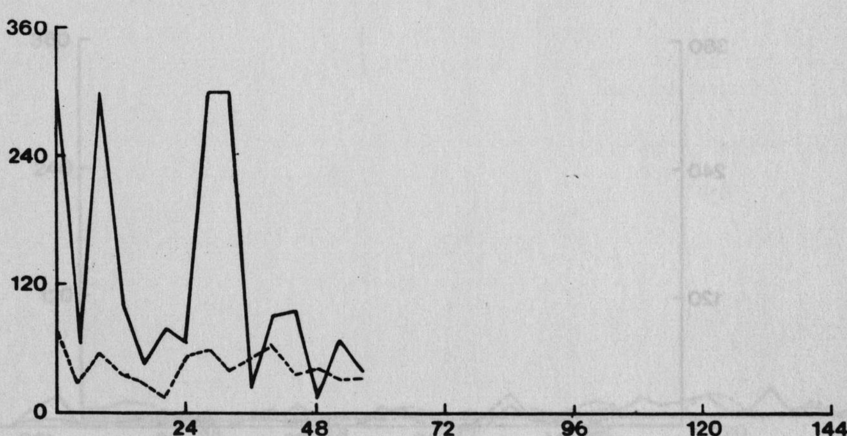
FIGURE A.A.2 VILLAGE 40. 21.10.1985 (Droplet deposition on mast mounted targets)

TARGETS AT TOP OF PLANTS
(mean height 94 cm)



Aircraft	Air Tractor	Droplet deposition:	Vertical targets	Horizontal targets
Insecticide	Thimul + Mitac E.C.	Mean No./cm²	>162	42
Windspeed	2-3 m/sec	Coefficient of variation	66%	27%
Temperature	30°C			
Relative humidity	49%			

TARGETS AT MIDDLE OF PLANTS

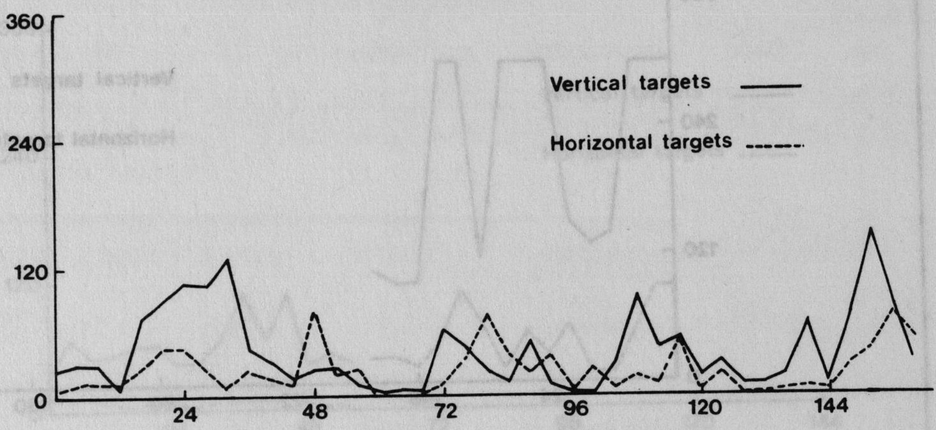


DISTANCE ACROSS COTTON NUMBER (metres)
(one mast each 4 metres)

Droplet deposition	Vertical targets	Horizontal targets
Mean No./cm²	101	44
Coefficient of variation	66%	38%

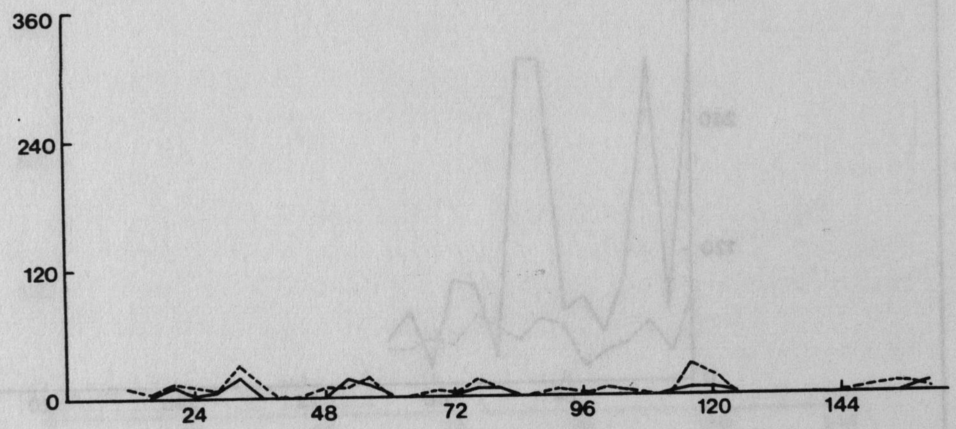
FIGURE A.A.3 WADSHANNAN, 27.10.1985 (Droplet deposition on mast mounted targets)

TARGETS AT TOP OF PLANTS
(mean height 98cm)



Aircraft	Antonov AN-2M	**Droplet deposition:**	**Vertical targets**	**Horizontal targets**
Insecticide	Decis E.C.	Mean No./cm²	41	22
Windspeed	3-4 m/sec	Coefficient of variation	90%	95%
Temperature	30°C	Volume median diameter	215μm	163μm
Relative humidity	56%	Number median diameter	92μm	82μm

TARGETS AT MIDDLE OF PLANTS

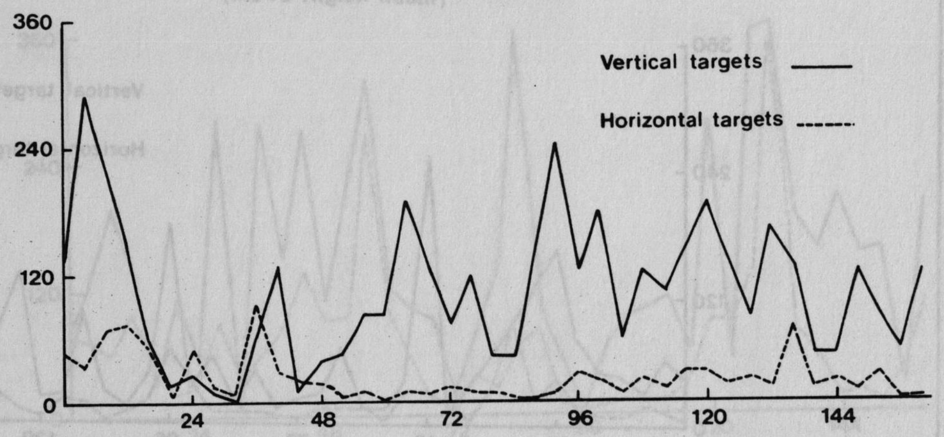


DISTANCE ACROSS COTTON NUMBER (metres)
(one mast each 4 metres)

Droplet deposition	Vertical targets	Horizontal targets
Mean No./cm²	3	7
Coefficient of variation	173%	117%

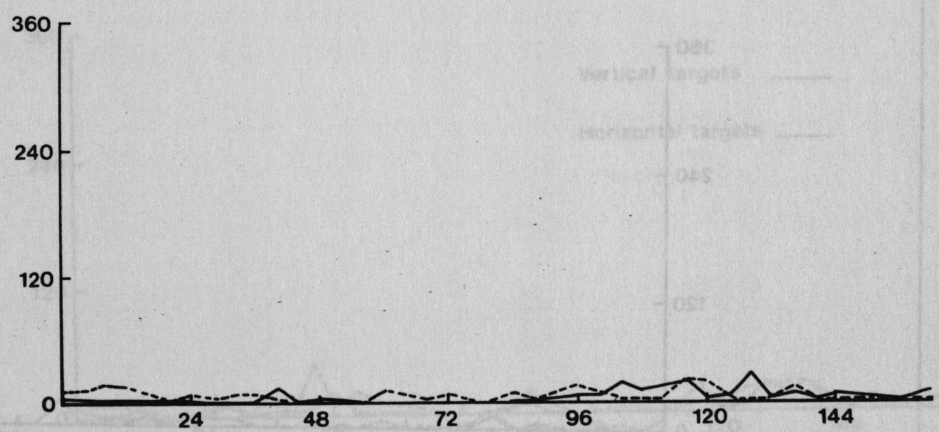
FIGURE A.A.4 MASSELAMIA, 28.10.1985 (Droplet deposition on mast mounted targets)

TARGETS AT TOP OF PLANTS
(mean height 74 cm)



Aircraft	Thrush Commander 600	Droplet deposition:	Vertical targets	Horizontal targets
Insecticide	Fastac + dimethoate ULV	Mean No./cm²	105	25
Windspeed	0-2.0 m/sec	Coefficient of variation	22%	68%
Temperature	31°C	Volume median diameter	86μm	116μm
Relative humidity	47%	Number median diameter	45μm	34μm

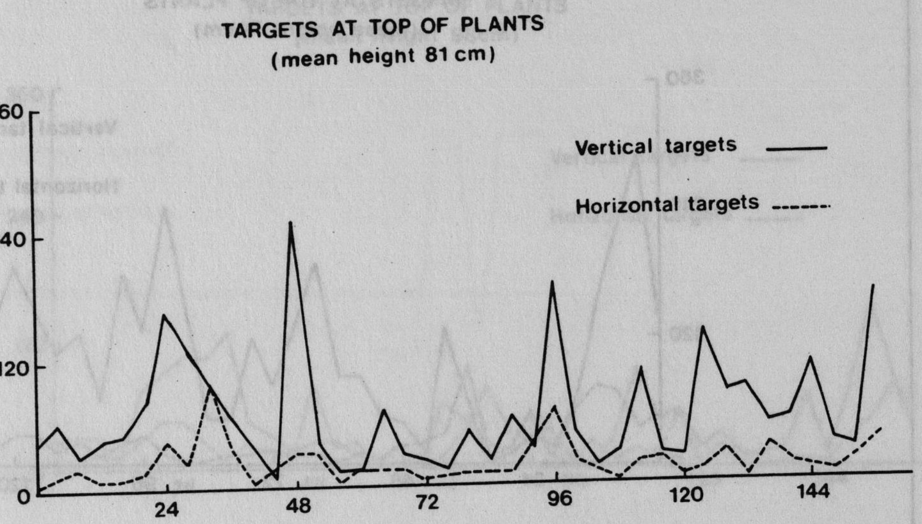
TARGETS AT MIDDLE OF PLANTS



DISTANCE ACROSS COTTON NUMBER (metres)
(one mast each 4 metres)

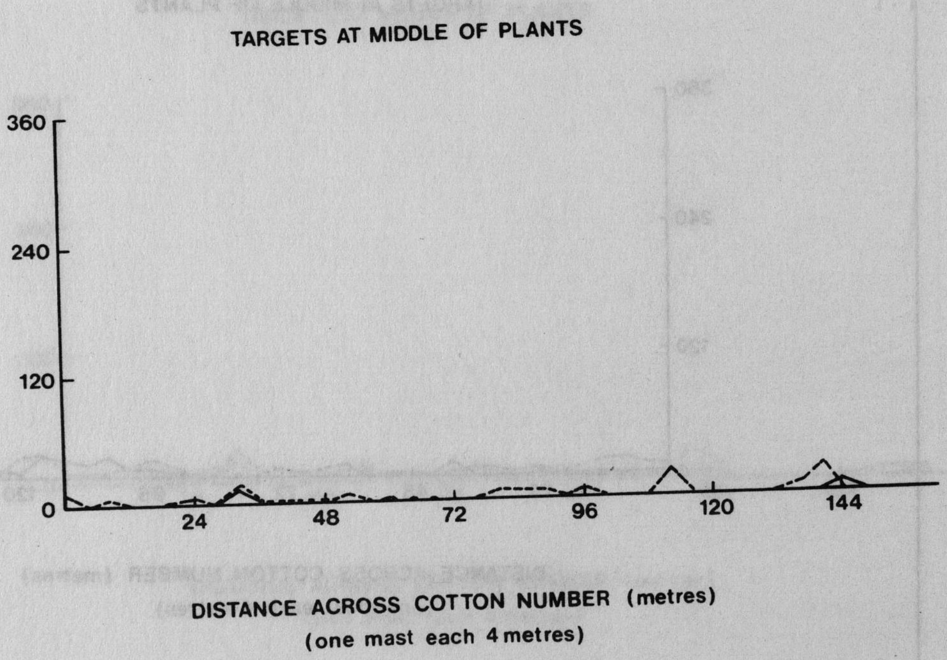
Droplet deposition	Vertical targets	Horizontal targets
Mean No./cm²	6	8
Coefficient of variation	105%	66%
Volume median diameter		
Number median diameter		

FIGURE A.A.5 GANDEEL, 5.11.1985 (Droplet deposition on mast mounted targets)



Aircraft	Antonov AN-2M
Insecticide	Endophos E.C.
Windspeed	3-4 m/sec
Temperature	26,5°C
Relative humidity	32%

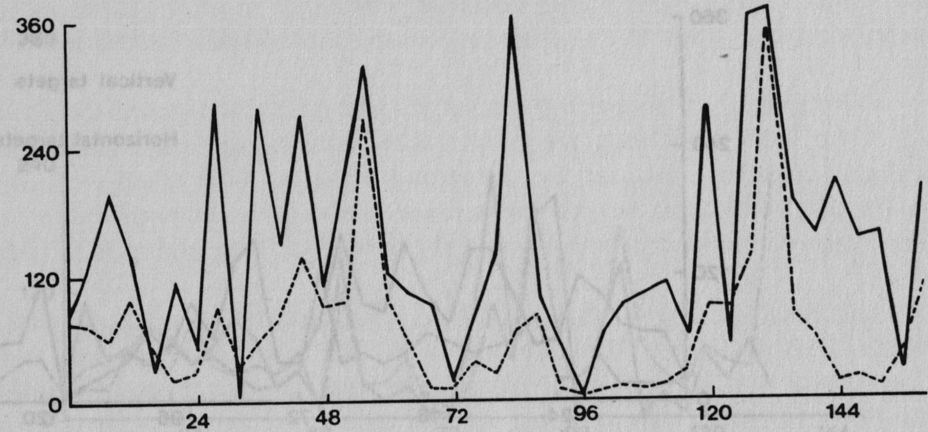
Droplet deposition:	Vertical targets	Horizontal targets
Mean No./cm²	66	22
Coefficient of variation	82%	89%
Volume median diameter	130μm	108μm
Number median diameter	47μm	28μm



Droplet deposition	Vertical targets	Horizontal targets
Mean No./cm²	2	4
Coefficient of variation	171%	145%
Volume median diameter		
Number median diameter		

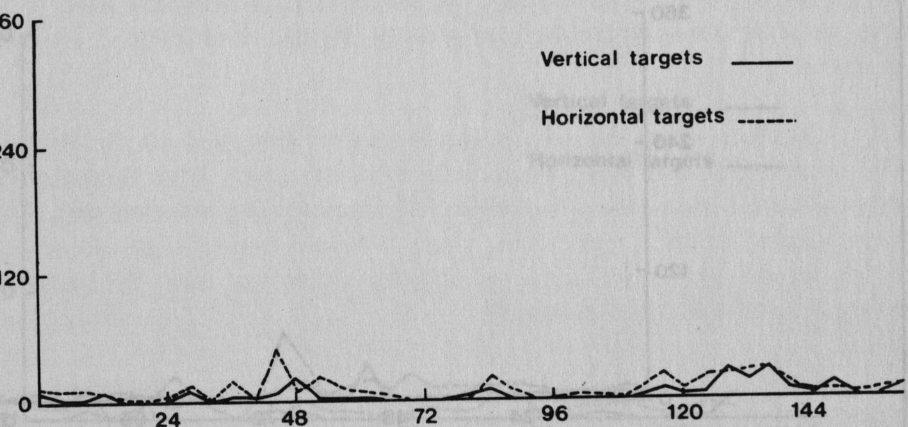
FIGURE A.A.6 EL FAWAIDA, 11.11.1985 (Droplet deposition on mast mounted targets)

TARGETS AT TOP OF PLANTS
(mean height 93 cm)



		Droplet deposition:	Vertical targets	Horizontal targets
Aircraft	Turbo Thrush	Mean No./cm^2	147	67
Insecticide	Thimul + Ekalux	Coefficient of variation	68%	104%
Windspeed	2-3 m/sec	Volume median diameter	165μm	176μm
Temperature	32°C	Number median diameter	64μm	55μm
Relative humidity	20%			

TARGETS AT MIDDLE OF PLANTS

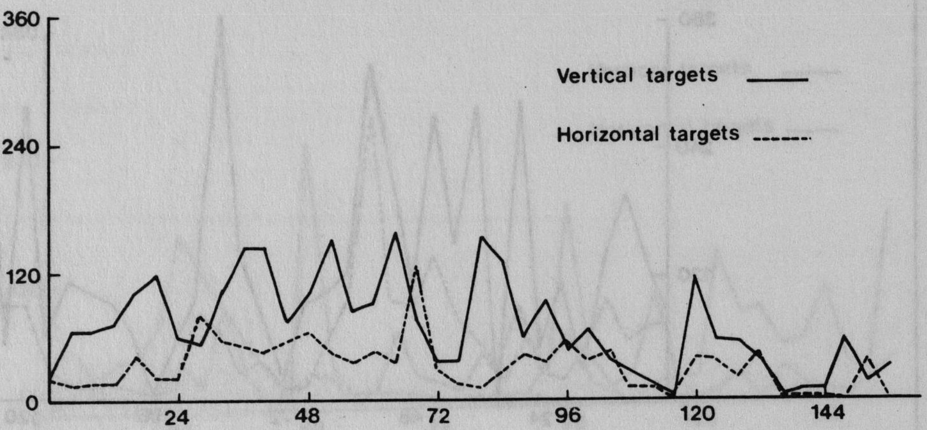


DISTANCE ACROSS COTTON NUMBER (metres)
(one mast each 4 metres)

Droplet deposition	Vertical targets	Horizontal targets
Mean No./cm^2	5	11
Coefficient of variation	139%	93%

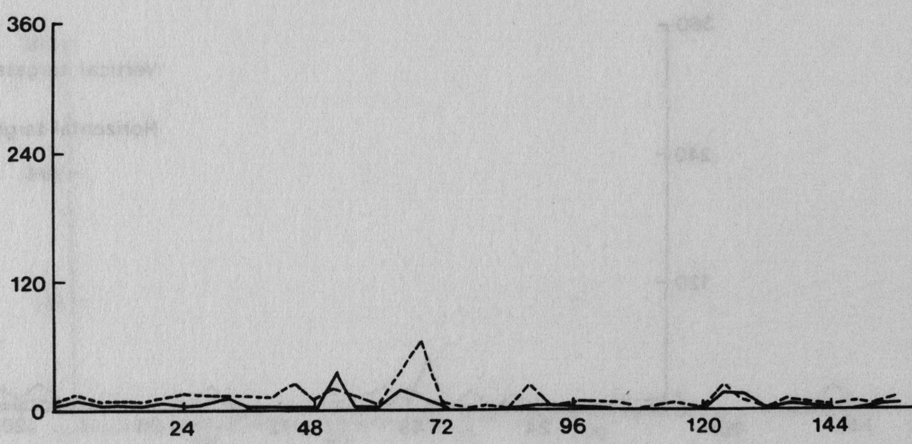
FIGURE A.A.7 NUR HUDA, 21.11.1985 (Droplet deposition on mast mounted targets)

TARGETS AT TOP OF PLANTS
(mean height 67 cm)



Aircraft	Antonov AN-2M	**Droplet deposition:**	**Vertical targets**	**Horizontal targets**
Insecticide	Thimul + Ekatin	Mean No./cm²	70	33
Windspeed	0-1 m/sec	Coefficient of variation	62%	70%
Temperature	23°C	Volume median diameter	270μm	160μm
Relative humidity	40%	Number median diameter	55μm	30μm

TARGETS AT MIDDLE OF PLANTS

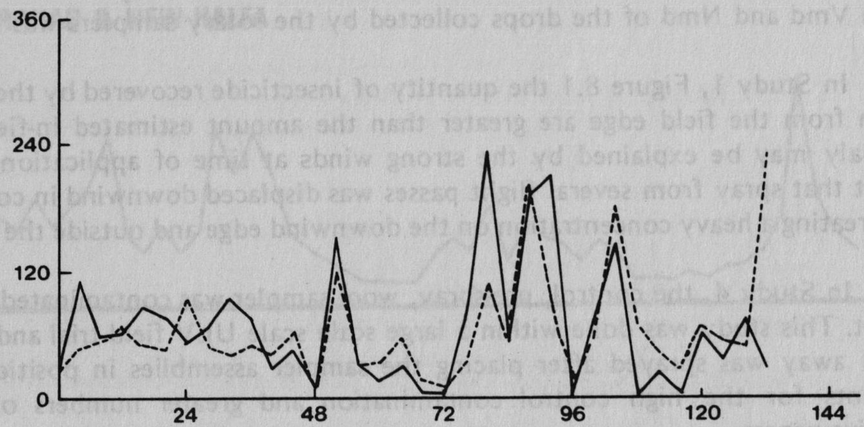


DISTANCE ACROSS COTTON NUMBER (metres)
(one mast each 4 metres)

Droplet deposition	Vertical targets	Horizontal targets
Mean No./cm²	2	12
Coefficient of variation	175%	105%

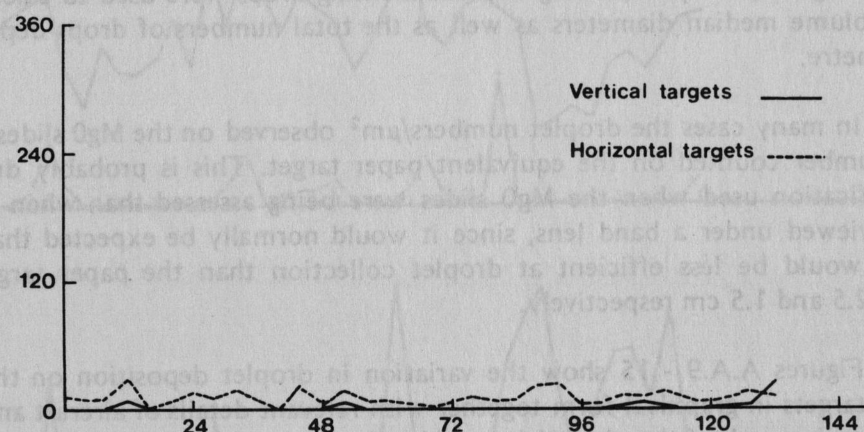
FIGURE A.A.8 WADSHANNAN, 30.11.1985 (Droplet deposition on mast mounted targets)

TARGETS AT TOP OF PLANTS
(mean height 168cm)



		Droplet deposition:	Vertical targets	Horizontal targets
Aircraft	Turbo Thrush			
Insecticide	Thimul + Dursban EC	Mean No./cm²	65	63
Windspeed	2-3 m/sec	Coefficient of variation	90%	79%
Temperature	27°C	Volume median diameter	134μm	144μm
Relative humidity	42%	Number median diameter	50μm	35μm

TARGETS AT MIDDLE OF PLANTS



DISTANCE ACROSS COTTON NUMBER (metres)
(one mast each 4 metres)

Droplet deposition	Vertical targets	Horizontal targets
Mean No./cm²	2	12
Coefficient of variation	175%	59%

The average Vmd and Nmd of the spray drops deposited on the in-field Mg0 coated targets varied from 101 μm to 189 μm and 38 μm to 87 μm, respectively. Analysis of the drops collected by the rotary samplers showed little change in drifting spray drop characteristics beyond 25 m downwind, indicating that maximum loss by evaporation of the drops volatile components occurred within 25 m of the point of release. The overall mean Vmd and Nmd of the drops collected by the rotary samplers was 52 μm and 22 μm.

In Study 1, Figure 8.1 the quantity of insecticide recovered by the collectors 25 and 50 m from the field edge are greater than the amount estimated in-field. This apparent anomaly may be explained by the strong winds at time of application. This could have meant that spray from several flight passes was displaced downwind in considerable quantities creating a heavy concentration on the downwind edge and outside the field.

In Study 4, the control, pre-spray, wool sampler was contaminated to an exceptional extent. This study was done within a large scale scale ULV field trial and one upwind field 1 km away was sprayed after placing the sampler assemblies in position. This probably accounts for the high control contamination and greater numbers of droplets on the sensitive papers.

1.3.2 Droplet Deposition in the Field

The droplet counts obtained from the paper targets have been used to determine the variation in spray deposition across the sprayed trials fields. Similarly the relationship between the droplet counts made on the upper and lower targets placed on the masts within the sprayed field has been used to assess the penetration of the cotton leaf canopy by the aerially applied sprays in terms of relative number of drops.

The magnesium oxide slides obtained from the sprayed fields have been used to determine the characteristics of the range of spray droplets collected by the slide during insecticide application. Mirroscope measurements of the diameters of the impressions made in the Mg0 layer by impacting and sedimenting drops were used to calculate the number and volume median diameters as well as the total numbers of drops deposited per square centimetre.

In many cases the droplet numbers/μm^2 observed on the Mg0 slides was greater than the number counted on the equivalent paper target. This is probably due to the greater magnification used when the Mg0 slides were being assessed than when the paper targets were viewed under a band lens, since it would normally be expected that the larger Mg0 slides would be less efficient at droplet collection than the paper targets, their widths being 2.5 and 1.5 cm respectively.

Figures A.A.9 - 15 show the variation in droplet deposition on the mast mounted paper targets in graphical form together with relevant details of aircraft and meteorological status during each of the nine trials completed.

Spray droplet deposition across the width of the cotton numbers sampled was generally uneven. In almost every case the deposition coefficient of variation (standard deviation ÷ mean), determined from handlers droplet counts of the paper targets, was greater than 50 per cent. The average coefficient for the topmost mast targets was 69 per cent and 63 per cent for horizontally and vertically disposed targets respectively, and 84 per cent and 107 per cent for the lower mast targets. Value of 70 per cent generally held to be the maximum acceptable variation for aerially supplied sprays.

FIGURE A.A.9 ULV DROPLET DISTRIBUTION

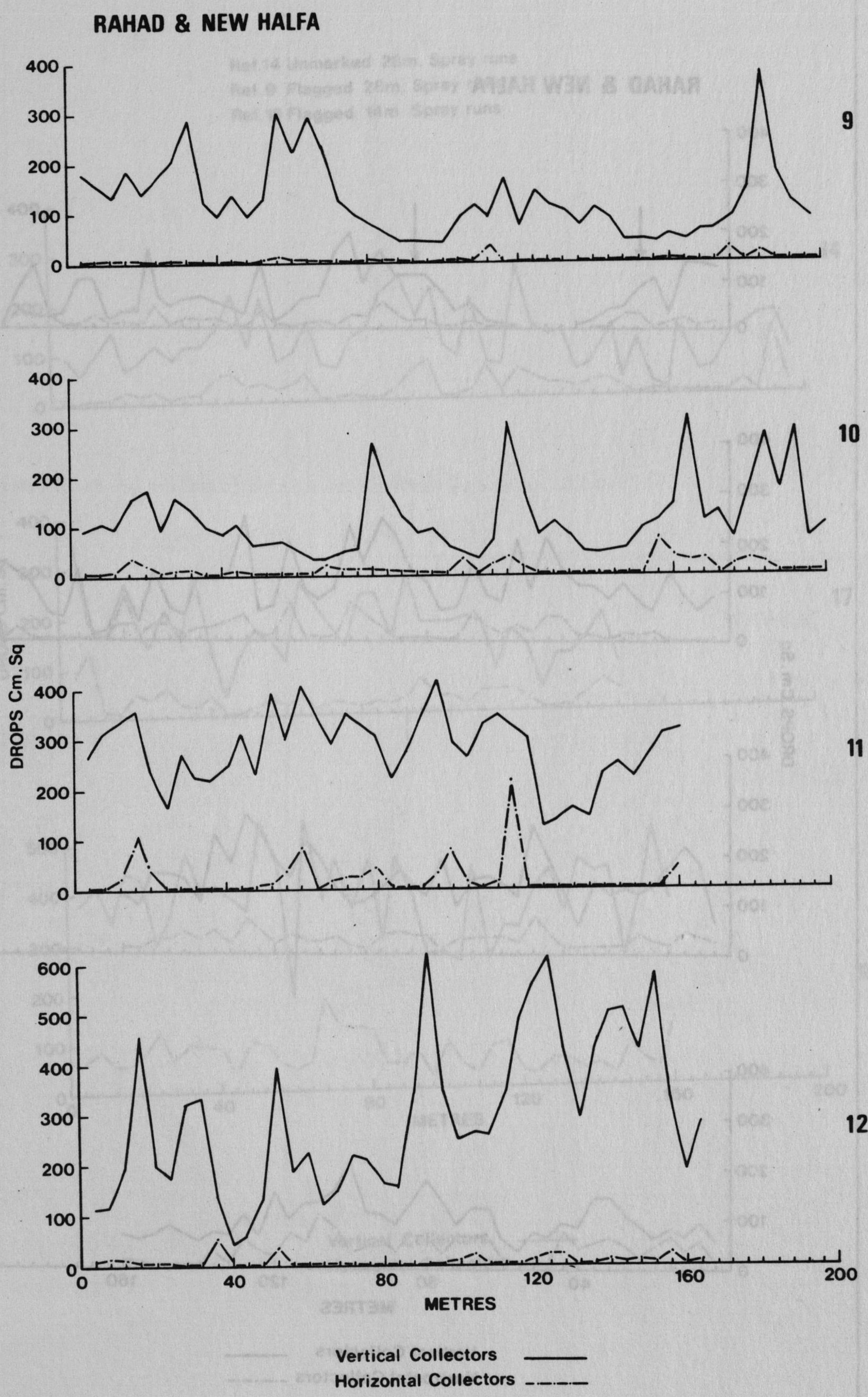


FIGURE A.A.10 CLV DROPLET DISTRIBUTION

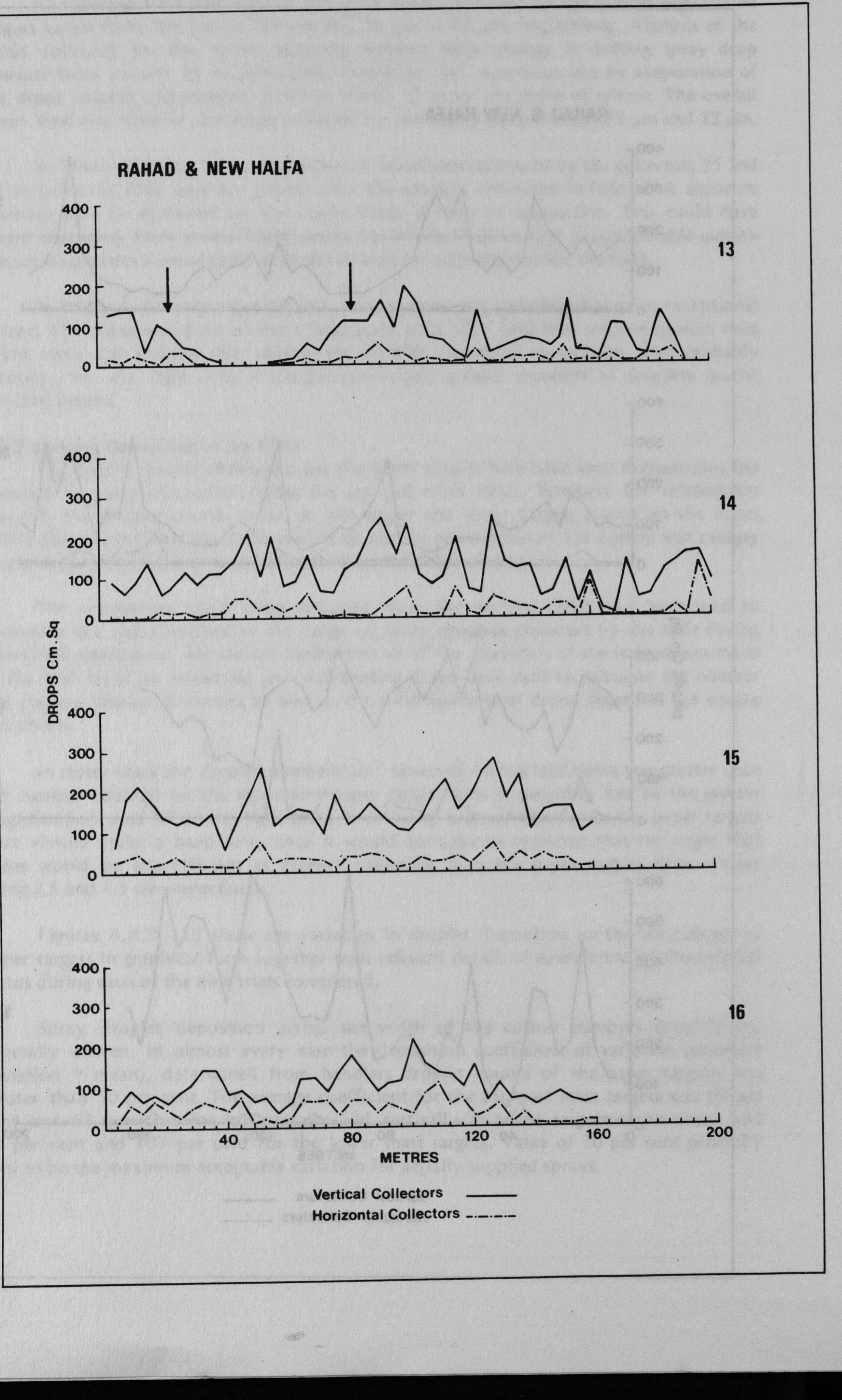


FIGURE A.A.11 DROPLET DISTRIBUTION - MODE OF APPLICATION

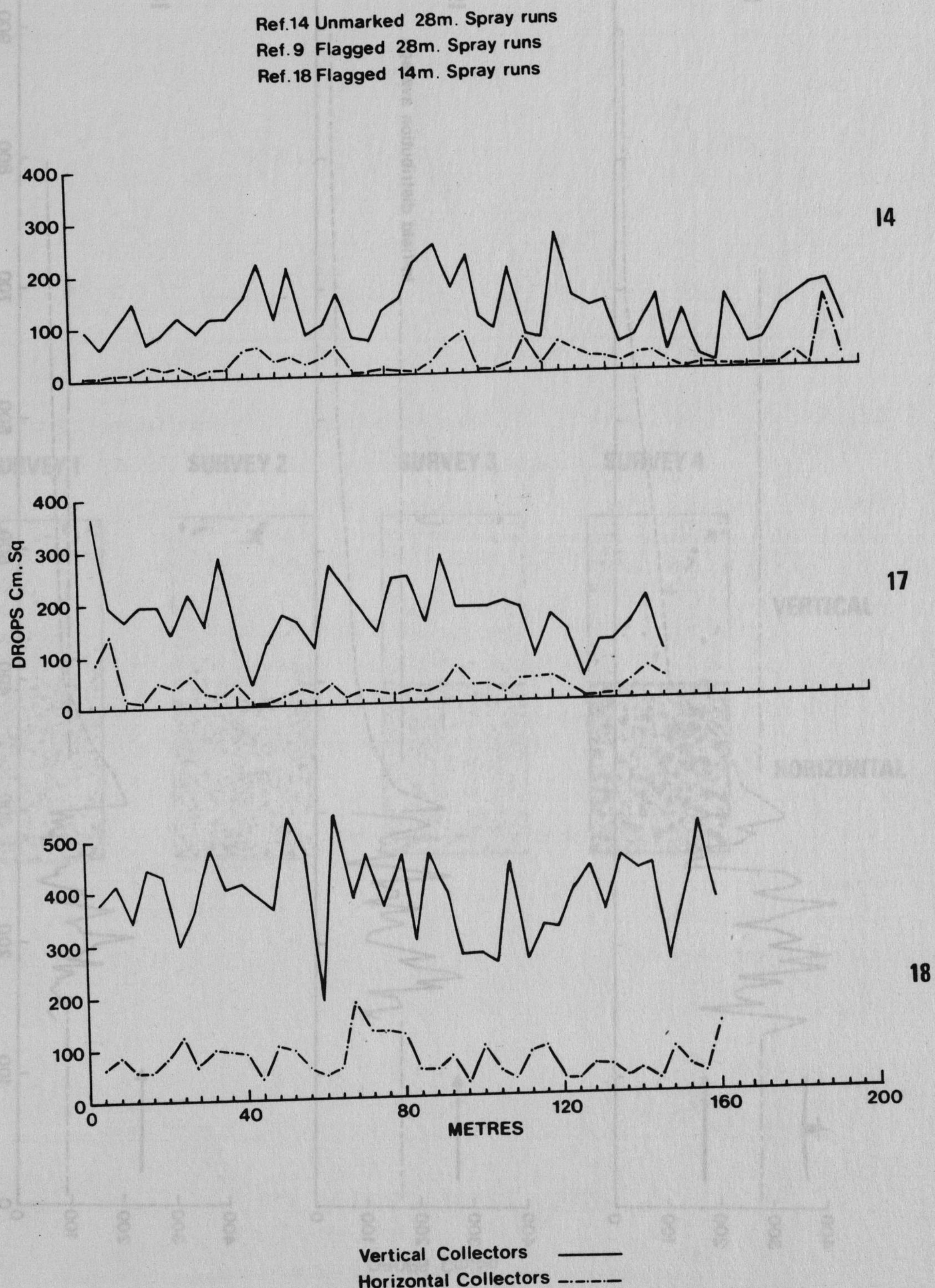


FIGURE A.A.12 IN-FIELD DROPLET DISTRIBUTION AND DOWNWIND DRIFT

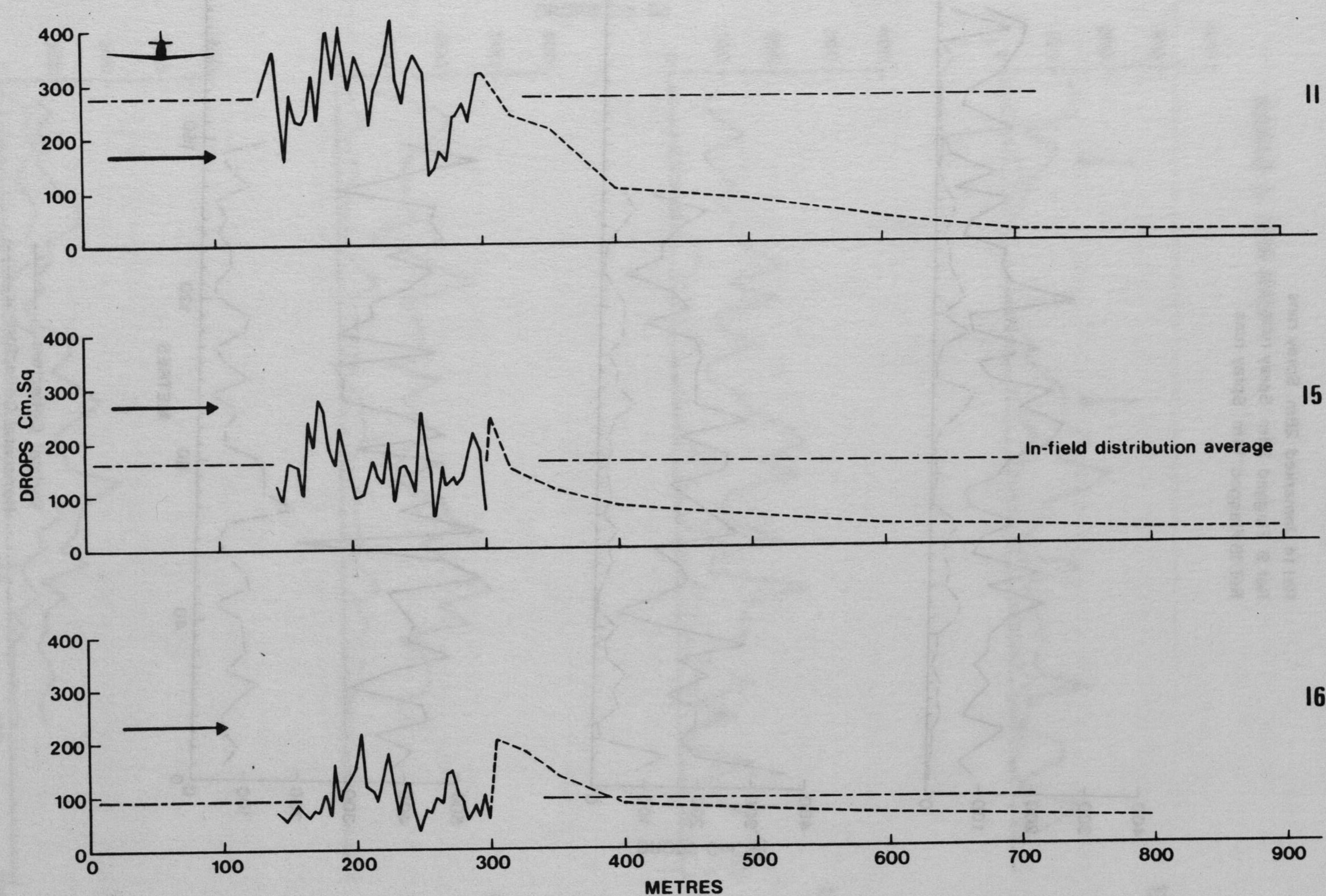


FIGURE A.A.13 SAMPLE DROPLET COLLECTORS OIL SENSITIVE PAPER

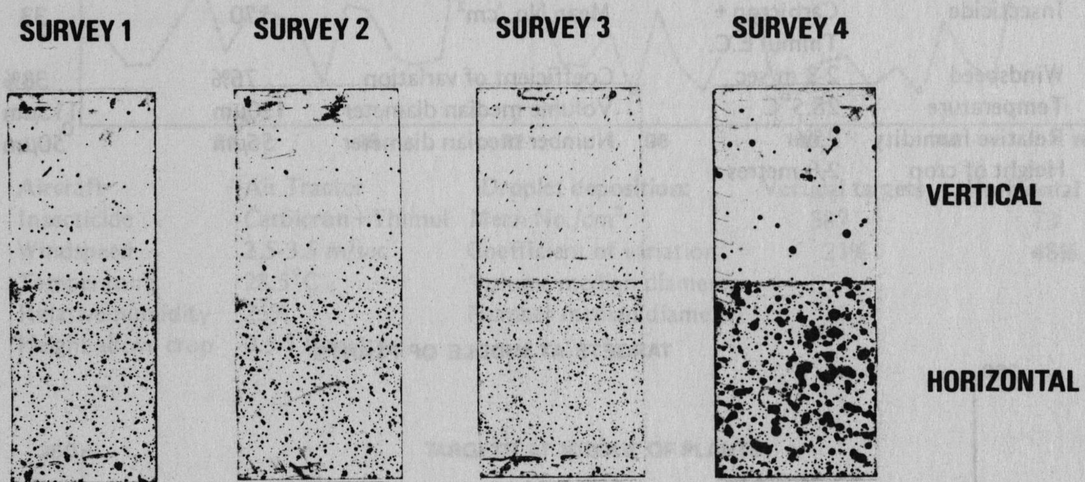
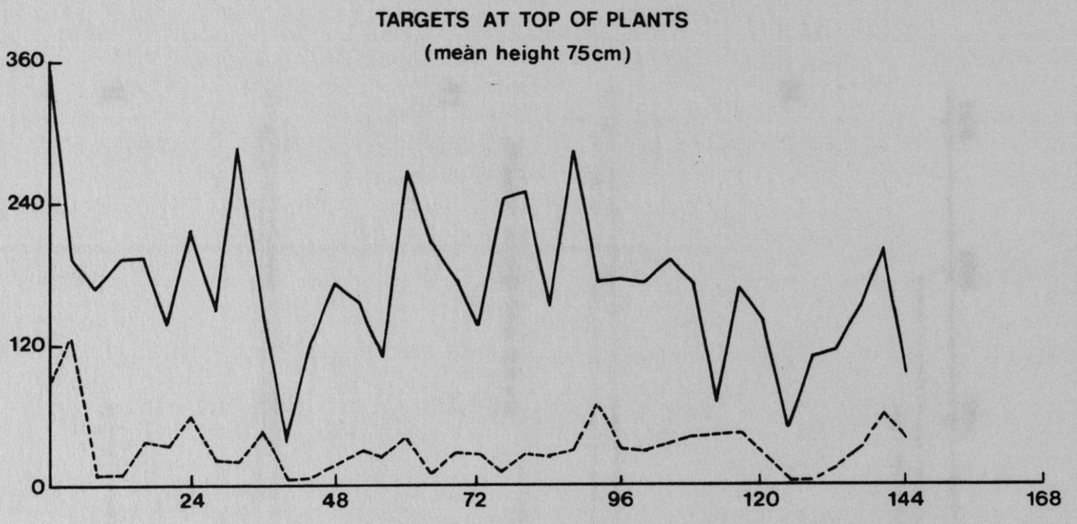
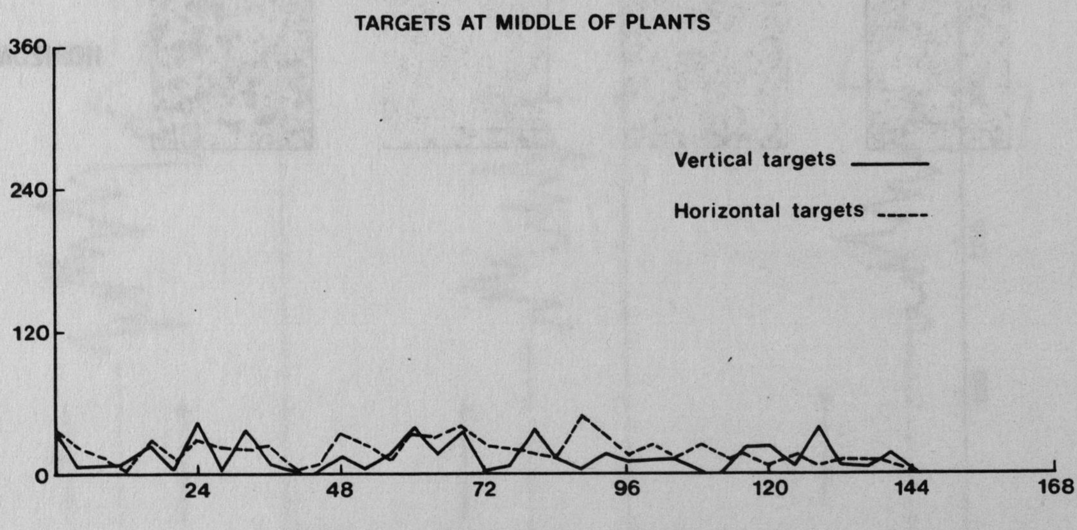


FIGURE A.A.14 STANDARD TREATMENT STUDY 17 (4.11.1985)
(Droplet deposition on mast mounted targets)

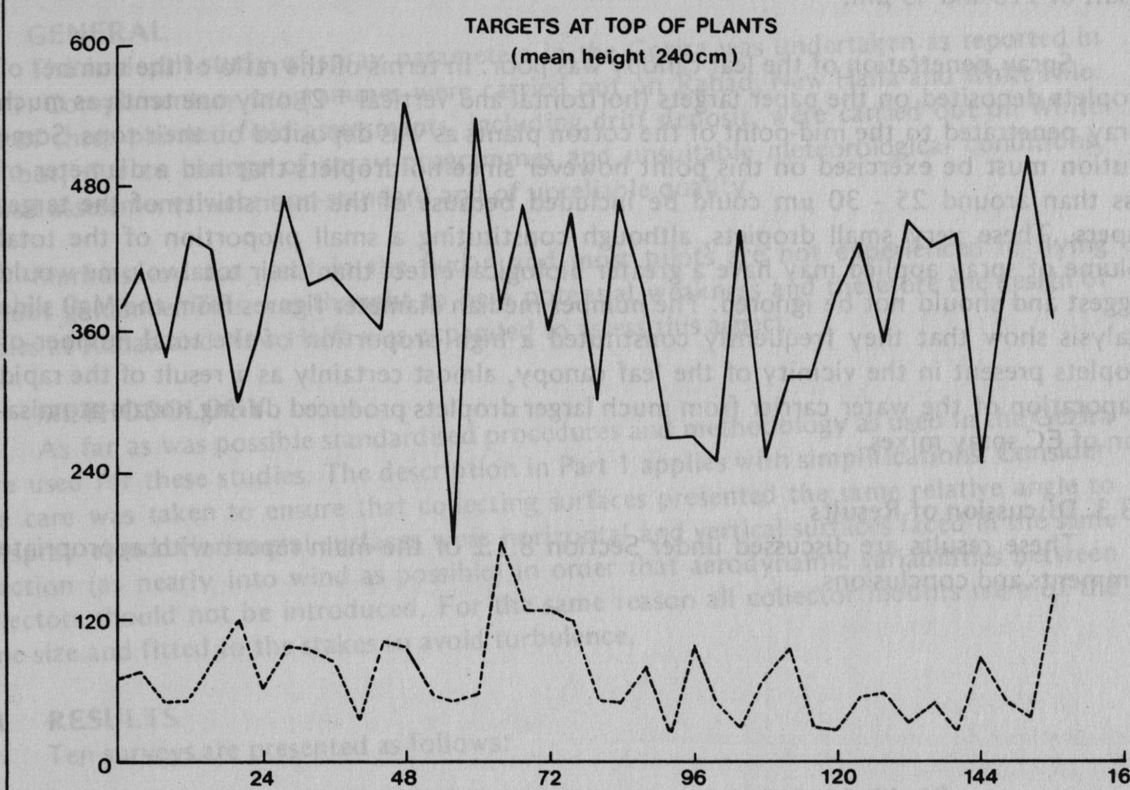


Aircraft	Air Tractor	**Droplet deposition:**	**Vertical targets**	**Horizontal targets**
Insecticide	Carbicron + Thimul E.C.	Mean No./cm²	170	33
Windspeed	2-3 m/sec	Coefficient of variation	76%	38%
Temperature	28.5°C	Volume median diameter	120μm	113μm
Relative humidity	25%	Number median diameter	56μm	50μm
Height of crop	2.0 metres			

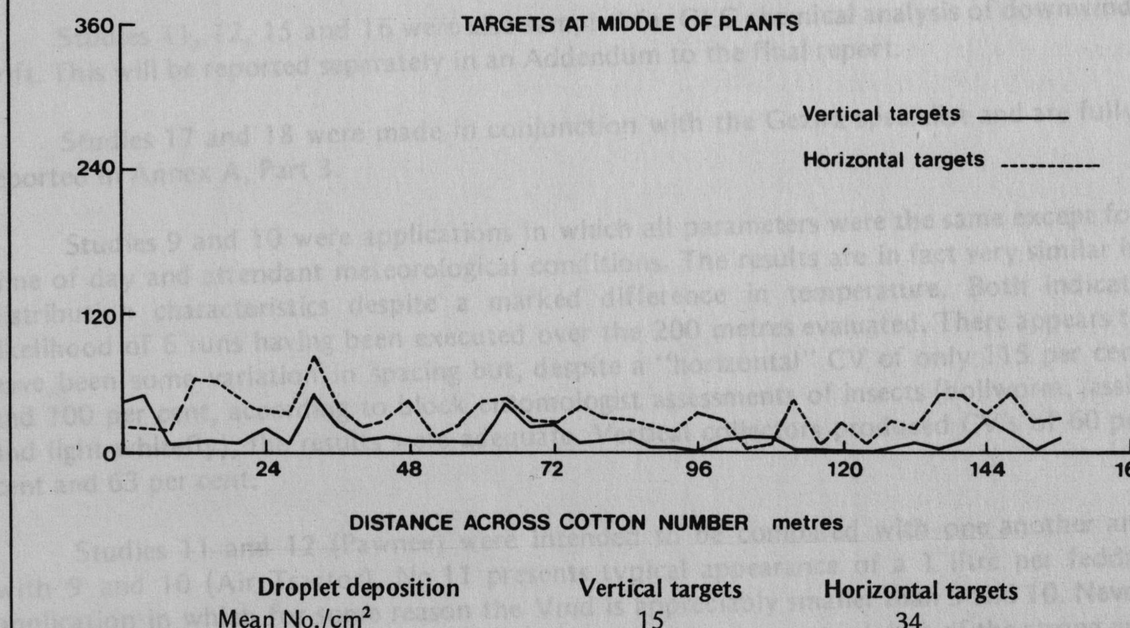


Droplet deposition	**Vertical targets**	**Horizontal targets**
Mean No./cm²	14	19
Coefficient of variation	90%	60%

FIGURE A.A.15 EXPERIMENTAL TREATMENT STUDY 18 (4.11.1985)
(Droplet deposition on mast mounted targets)



Aircraft	Air Tractor	Droplet deposition:	Vertical targets	Horizontal targets
Insecticide	Carbicron + Thimul	Mean No./cm²	387	73
Windspeed	2.5-3.5 m/sec	Coefficient of variation	21%	48%
Temperature	28.5°C	Volume median diameter		
Relative humidity	25%	Number median diameter		
Height above crop	0.5-1.0 metres			



Droplet deposition	Vertical targets	Horizontal targets
Mean No./cm²	15	34
Coefficient of variation	84%	48%

Spray droplet volume and number median diameters varied from 108 - 270 μm and 28 - 92 μm respectively for the EC spray mixes. The single ULV trial gave a comparative result of 116 and 45 μm.

Spray penetration of the leaf canopy was poor. In terms of the ratio of the number of droplets deposited on the paper targets (horizontal and vertical ÷ 2) only one tenth as much spray penetrated to the mid-point of the cotton plants as was deposited on their tops. Some caution must be exercised on this point however since no droplets that had a diameter of less than around 25 - 30 μm could be included because of the insensitivity of the target papers. These very small droplets, although constituting a small proportion of the total volume of spray applied may have a greater biological effect than their total volume would suggest and should not be ignored. The number median diameter figures from the Mg0 slide analysis show that they frequently constituted a high proportion of the total number of droplets present in the vicinity of the leaf canopy, almost certainly as a result of the rapid evaporation of the water carrier from much larger droplets produced during nozzle atomisation of EC spray mixes.

1.3.3 Discussion of Results

These results are discussed under Section 8.1.2 of the main report with appropriate comments and conclusions.

2. MONITORING SPRAY DISTRIBUTION AT RAHAD AND NEW HALFA

2.1 GENERAL

The in-depth study of spray parameters in the Gezira was undertaken as reported in Part 1. Complimentary programmes were carried out on Rahad, New Halfa and White Nile. Two of three planned field assessments, including drift deposit, were carried out on White Nile but, due to change of spray programmes and unsuitable meteorological conditions, deposit assessments were non-standard and of unreliable quality.

Markers are not used in the Sudan and most pilots are not experienced in flying without guidance. This was thought to be a potential weakness and therefore the design of studies at Rahad and New Halfa was expanded to assess this aspect.

2.2 METHODOLOGY

As far as was possible standardised procedures and methodology as used in the Gezira were used for these studies. The description in Part 1 applies with simplifications. Considerable care was taken to ensure that collecting surfaces presented the same relative angle to the spray cloud. Horizontal surfaces were horizontal and vertical surfaces faced in the same direction (as nearly into wind as possible) in order that aerodynamic variabilities between collectors should not be introduced. For the same reason all collector mounts were of the same size and fitted to the stakes to avoid turbulence.

2.3 RESULTS

Ten surveys are presented as follows:

Figure A.A. 9	ULV droplet distribution	Study 9, 10, 11, 12
Figure A.A.10	CLV droplet distribution	Study 13, 14, 15, 16
Figure A.A.11	Droplet distribution and Mode of application	Study 14, 17, 18
Figure A.A.12	In-field droplet distribution and downwind drift	Study 11, 12, 15, 16
Table A.A. 4	Resumé of results	

Studies 11, 12, 15 and 16 were also sampled for GLC chemical analysis of downwind drift. This will be reported separately in an Addendum to the final report.

Studies 17 and 18 were made in conjunction with the Gezira specialist and are fully reported in Annex A, Part 3.

Studies 9 and 10 were applications in which all parameters were the same except for time of day and attendant meteorological conditions. The results are in fact very similar in distribution characteristics despite a marked difference in temperature. Both indicate likelihood of 6 runs having been executed over the 200 metres evaluated. There appears to have been some variation in spacing but, despite a "horizontal" CV of only 115 per cent and 100 per cent, according to block entomologist assessments of insects (bollworm, jassid and light whitefly), the results were adequate. Vertical collectors produced CV's of 60 per cent and 63 per cent.

Studies 11 and 12 (Pawnee) were intended to be compared with one another and with 9 and 10 (Air Tractor). No.11 presents typical appearance of a 1 litre per feddan application in which for some reason the Vmd is appreciably smaller than 9 and 10. Nevertheless the distribution and coverage is quite good when account is taken of the strong and gusty wind and high temperature. The wind strength most probably accounts for the high recovery of droplets on the vertical collectors in comparison with 9 and 10. Block entomologists were satisfied with the results achieved. No.12 was purported to be an application at 1.5 litre per feddan. The deposit is indicative of a far higher application rate or of a formulation of non-standard staining characteristics. It was impossible to do further surveys because this was a trial product donated to the agricultural corporation and had all been used. Under the circumstances prevailing the good results achieved remain somewhat suspect. Spray collectors typical of each of these applications are illustrated in Figure A.A.13.

Studies 13 and 14 were intended to be comparable one with the other, except for time of day and meteorological conditions. On this particular occasion water sensitive papers were being used. In the process of collecting the papers the absence of stains on the collectors between the arrows shown on Figure A.A.10 was quite noticeable yet the crop appeared to have droplets on it. A visit to the landing strip revealed that a drum of ULV had been mistakenly loaded in place of a drum of EC. Presumably the ULV formulation (not soluble in water) had remained separate above the EC mixture in the aircraft tank and had constituted the bulk of the liquid applied during these last two runs. Evaluation calculations have been made on the area outside the two arrows. The fewer droplets recorded in 13 is most probably due to the EC mixture characteristics being disturbed by the inclusion of the ULV product. The number of droplets collected in survey 14 is lower than that collected in 15 and could have resulted from the difference in wind: the Evaporative Index was about the same.

Study 16 is a Pawnee aircraft which shows a similar distribution to 14 and 15. The greater number of droplets on horizontal collectors is most probably due to the larger Vmd produced by the D8-45 nozzles fitted to the aircraft in comparison with the Whirljet No.3 fitted to the faster flying Air Tractor as is discussed in Appendix C.

Studies 14, 17 and 18 are compared together to show an "unmarked" 28 metre swath (well executed) with a "marked" 28 metre swath and a marked 14 metre swath, the latter flown at a lower height than surveys 14 and 17. The difference between numbers of droplets collected is probably related mostly to wind effect, insofar as 14 and 17 are concerned. However, the greater number of droplets collected and the markedly more even distribution in Study 18 is directly related to the narrow "marked" swath and the lower flying height, which can be used if maximum width spray run spacing (maximum productivity) is not the main parameter. This study is fully described under Part 3 as a trial report to Rahad Corporation.

TABLE A.A.4 MONITORING - DROPLET DISTRIBUTION - RESUME OF RESULTS

Study No.	Date	Location	Aircraft	Spray Equipment	Spray Volume per fd	Wind Direction Relative to Spray Run	Wind Strength mps	Meteorology Temp. °C	Meteorology R.H.%	Meteorology I.E.	Collectors Type	Vertical $\tilde{x}$ Drops Cm^2	Vertical CU%	Horizontal $\tilde{x}$ Drops Cm^2	Horizontal CU%
9	20.09	Rahad	Air Tractor	Micronair	ULV 1.0 L	45°	1.0-2.0	27	72	0.37	O/S	126	60	5	115
10	20.09	Rahad	Air Tractor	Micronair	ULV 1.0 L	45°	1.5-2.0	36	36	1.36	O/S	113	63	14	100
11	24.09	Rahad	Pawnee	Micronair	ULV 1.0 L	90°	2.0-6.0	32	56	0.75	O/S	299	52	10	110
12	12.10	New Halfa	Pawnee	Micronair	ULV 1.5 L	70°	3.0-4.0	32	44	0.92	O/S	280	25	20	180
13[1]	05.10	Rahad	Air Tractor	Whirljet 3	CLV 2.0g	0°	0.5-1.0	31	50	0.78	W/S	75	64	20	87
14	05.10	Rahad	Air Tractor	Whirljet 3	CLV 2.0g	45°	1.5-2.5	36	40	1.21	W/S	118	48	25	104
15	14.11	Rahad	Air Tractor	Whirljet 3	CLV 2.0g	45°	2.5-4.0	30	25	1.22	O/S	152	33	29	48
16	20.12	New Halfa	Pawnee	D8-45	CLV 2.0g	60°	1.0-3.0	25	31	0.98	O/S	97	40	42	59
17[2]	04.11	Rahad	Air Tractor	Whirljet 3	CLV 2.0g	90°	2.0-3.0	28.5	25	1.15	O/S	170	76	33	38
18[2]	04.11	Rahad	Air Tractor	Whirljet 3	CLV 2.0g	90°	2.0-3.0	28.5	25	1.15	O/S	387	21	73	48

Notes:

[1] *CV exclusive of sector between arrows on Figure A.A.10.*

[2] *Aerial Application for Whitefly Control Experiment (Annex A, Part 3).*

mps - Metres per second

EI - Evaporative Index

W/S - Water Sensitive Paper

O/S - Oil Sensitive Paper

CV% - Coefficient of Variation %

3. AERIAL APPLICATION FOR WHITEFLY CONTROL (Report on Trial at Rahad 14-11-1985 to Rahad Agricultural Corporation)

3.1 BACKGROUND

Control of whitefly *(Bemisia tabaci)* in irrigated cotton of the Sudan by aerial application of pesticides is seldom completely satisfactory after crop canopy closure. It is generally recognised this is related directly to inadequate coverage in the lower third of the cotton plant. In the course of monitoring studies it was observed at Rahad that with an Airtractor aircraft flying much lower than the recommended height, with wheels within 50 cm of crop height, a markedly stripey application across the field was obtained showing a high coefficient of variation of droplet distribution. Assessment of insect control revealed superior kill of whitefly under the flight paths of the aircraft. This appeared due to better penetration and coverage of the insecticide, perhaps due to the relatively high aspect ratio wings and high operating speeds of the Airtractor, which could give a wider area of greater turbulence than some other aircraft in use. It appeared that modification of aerial application techniques could give better whitefly control, and hence greater value from 1985/86 German aid. A routine monitoring exercise was therefore modified to further investigate those observations.

3.2 TRIAL OUTLINE

3.2.1 Treatments

A. Standard. Airtractor flying at approximately 2 m above crop canopy, swath width of 28 m, giving 10 runs per number (field 280 m wide).

B. Narrow swath. Airtractor flying at approximately 0.5 - 1 m above crop canopy, swath width of 14 m giving 20 runs per number.

The insecticide applied was Thimul/Carbicron at:

A. 2 g/fd to give 0.17 g Thimul + 0.1 g Carbicron per feddan.
B. 2.2 g/fd to give 0.19 g Thimul + 0.11 g Carbicron per feddan.

3.2.2 Methodology

Two fields of cotton approximately half km apart at Rahad Block 4, village 18 were selected having similar stands and growth of mature cotton. Crop development and uniformity varied along the length of the numbers due to uneven irrigation since planting. The east end of both fields was much better grown than the west where the crop was stunted, fully mature with more open but fewer bolls, and with greater leaf shed. The fields were scouted for pest populations by Rahad Crop Protection department using standard procedures before and after application. Pre- and post-spray counts (1 and 3 days) of *Heliothis* egg and larvae and *Bemisia* adults and nymphs were also made by project entomologists. The system used was, per treatment:

Heliothis	Eggs and larvae on 33 plant stands
Bemisia	Adults on 5 leaves (2 top, 1 middle, 2 bottom) from 30 plants. Field count.
	Nymphs from 100 leaves collected randomly in the field from lower third of plant. Number per 4 cm^2 /leaf, counted in laboratory.

Spray droplet drift, and deposition within the crop was assessed using several different techniques.

(a) Mast mounted paper targets

These consisted of one inch wide strips of oil sensitive recorder chart paper wound around 1.5 cm square cross-section wooden blocks, 15 cm long mounted horizontally on upright wooden masts placed 4 m apart along a cotton row. Each mast carried two such paper targets, one positioned level with the top of the crop, the other at half plant height, the latter being the means whereby droplet penetration of the crop could be assessed by comparison with the upper targets. In both cases droplet deposition was determined in terms of number of droplets per square centimetre as counted using a x10 viewing lens fitted with a 1 cm^2 graticule.

(b) Magnesium oxide slides

These were used to determine the characteristics of the spray emitted by the aircraft as received by the slides which were mounted on the first six wooden posts leading into the cotton number from the downwind edge. Two slides were mounted on 3 cm square wooden blocks, one horizontally and one vertically, and held in position by elastic bands. The wooden blocks were positioned 20 cm above the top of the cotton plants. Measurement of the impact craters produced by falling or wind-blown droplets enabled the determination of the number of droplets/cm^2, their volume median and number median diameters. These were employed only in the standard treatment.

(c) Acrylic wool sampling

These consisted of 3 lengths of acrylic wool each 1 metre in length, mounted vertically between two lengths of string fixed horizontally between two vertical steel rods 1 metre apart and driven into the ground. Five such assemblies were used, located at 25, 50, 100, 250 and 500 m from the downwind edge of the sprayed field. A control assembly was set up at the 5 m position, the wool being removed shortly before spraying took place.

The wools were removed from their frames by pushing the three lengths together, wrapping them onto an aluminium strip at their lower ends, cutting them free at the string and winding them onto the aluminium strip before cutting the upper ends. The 1 metre sampling lengths were indicated by knots tied into the wool. After winding the wool samples were placed in aluminium foil packets, sealed by folding the edge and stored in a coolbox for return to eventual storage in a freezer. The wool samplers were only used on the standard treatment field.

(d) Rotary collectors

These consisted of two vertically positioned magnesium oxide coated glass tubes, mounted on a metal V-shaped frame rotated at 330 rev/min. The dimensions of the rectangular section tubes were 8.0 x 0.3 x 0.2 cm. The two tubes were spaced 7.5 cm apart on the U-frame which was fixed to the shaft of a 6 V direct current motor powered by a sealed lead acid battery. The motors and rotating assemblies were mounted at the top of 2 m long upright wooden masts positioned alongside the wool samplers. The period of rotation of each rotary sampling unit was recorded.

A further mast-mounted oil-sensitive paper target was also placed close by each rotary and wool sampler location.

3.3 RESULTS

3.3.1 Droplet Dispersion

The pattern of droplet deposition across the standard and experimental treatment fields together with aircraft data and spray droplet characteristics are shown below in Table A.A.5 and in Figures A.A.14 and A.A.15. Droplet counts are given in

Tables A.A.6, A.A.7. Droplet size distribution in Tables A.A.8, A.A.9, and droplet deposition downwind in Table A.A.10.

TABLE A.A.5 DROPLET DEPOSITION, SPRAY CHARACTERISTICS AND OPERATIONAL DATA

In both the standard and experimental treatments the same aircraft and insecticide was used viz. Air Tractor and Thimul/Carbicron.

Operational Data	Standard	Experimental
Windspeed	2 - 3 m/sec	2.5 - 3.5 m/sec
Temperature	28.5°C	28.5°C
Relative humidity	25%	25%
Spray height above crop	2 metres	0.5 - 1.0 metres
Time of spraying	09.10 - 09.20	08.47 - 09.07
Swath width	28 metres	14 metres
Volume application rate	21.6 litres/ha	23.8 litres/ha

Spray characteristics/ Droplet deposition	Standard: Upper targets Vertical	Standard: Upper targets Horizontal	Experimental: Upper targets Vertical	Experimental: Upper targets Horizontal
Number/cm²	170	33	387	73
Coefficient of variation	76%	38%	21%	48%
Volume median diam.	120 µm	113 µm		
Number median diam.	56 µm	50 µm		

	Standard: Lower targets Vertical	Standard: Lower targets Horizontal	Experimental: Lower targets Vertical	Experimental: Lower targets Horizontal
Number/cm²	14	19	15	·34
Coefficient of variation	90%	60%	84%	48%
Volume median diam.	-	-	-	-
Number median diam.	-	-	-	-

TABLE A.A.6 DROPLET COUNTS ON STANDARD TREATMENT (No/cm^2)

Upper targets						Lower targets					
Mast	Horiz.	Vert.	Mast	Horiz.	Vert.	Mast	Horiz.	Vert.	Mast	Horiz.	Vert.
1	83	360	21	26	246	1	35	35	21	20	38
2	134	194	22	23	154	2	22	7	22	18	11
3	8	166	23	31	280	3	13	8	23	7	3
4	9	192	24	68	170	4	4	9	24	51	16
5	41	194	25	31	174	5	29	26	25	33	11
6	37	138	26	32	172	6	13	2	26	16	10
7	59	214	27	17	190	7	27	43	27	22	13
8	22	150	28	41	170	8	22	2	28	13	2
9	20	285	29	44	72	9	2	17	29	26	4
10	45	140	30	45	166	10	22	8	30	11	21
11	6	38	31	25	138	11	1	3	31	13	22
12	8	120	32	6	49	12	5	0	32	5	5
13	19	172	33	6	111	13	36	16	33	17	39
14	31	156	34	15	114	14	24	7	34	5	6
15	23	108	39	31	146	15	13	18	35	12	4
16	40	265	36	60	195	16	39	39	36	12	17
17	12	215	37	4	98	17	30	16	37	4	0
18	27	176	**Tot.**	**1204**	**6306**	18	39	38	**Tot.**	**716**	**525**
19	24	138	x̄	32.5	170.4	19	11	1	x̄	19.4	14.2
20	15	240	σ	24.9	65.2	20	26	8	σ	11.7	12.7
			cv	76%	389				cv	60%	90%

TABLE A.A.7 DROPLET COUNTS ON EXPERIMENTAL TREATMENT (No/cm^2)

Upper targets						Lower targets					
Mast	Horiz.	Vert.	Mast	Horiz.	Vert.	Mast	Horiz.	Vert.	Mast	Horiz.	Vert.
1	66	382	23	79	390	1	51	48	23	24	6
2	77	415	24	27	270	2	33	51	24	19	3
3	53	341	25	99	277	3	15	4	25	37	14
4	56	445	26	47	251	4	62	12	26	30	16
5	83	430	27	30	444	5	62	12	27	7	12
6	122	300	28	73	257	6	46	9	28	9	2
7	61	370	29	96	323	7	37	21	29	44	0
8	97	480	30	29	320	8	35	9	30	5	1
9	94	400	31	28	393	9	84	50	31	28	5
10	86	412	32	56	436	10	23	25	32	9	10
11	37	389	33	58	350	11	28	12	33	30	3
12	101	363	34	34	453	12	30	18	34	23	10
13	96	540	35	49	429	13	46	12	35	53	29
14	57	470	36	28	440	14	17	11	36	53	18
15	49	185	37	85	250	15	26	11	37	36	12
16	57	543	38	55	386	16	47	43	38	52	20
17	182	380	39	39	516	17	48	21	39	27	2
18	125	470	40	137	370	18	30	22	40	32	11
19	128	361	Tot.	2905	15464	19	28	9	Tot.	1367	609
20	120	463	$\bar{x}$	72.6	387	20	40	12	$\bar{x}$	34.2	15.2
21	53	300	σ	35.0	82.3	21	31	18	σ	16.3	12.8
22	56	470	cfv	48%	21%	22	30	5	cfv	48%	84%

The magnesium oxide slides exposed on the standard treatment field enabled the volume and median diameters of the collected droplets to be estimated. These are shown in Table A.A.8.

TABLE A.A.8 DROPLET SIZE DISTRIBUTION OF DROPLETS COLLECTED ON HORIZONTAL SLIDES

Droplet size class	Mean diameter^3	No. (N)	$\frac{\text{No. x 100}}{\Sigma N}$	Cum.	N.d^3	$\frac{\text{Nd}^3\text{ x 100}}{\Sigma \text{Nd}^3}$	Cum.
7-10μm	0.01 x 10^{-5}	0	-	-	-	-	-
10-14	0.02	2	0.21	0.21	0.04	-	-
14-20	0.05	41	4.24	4.45	2.05	0.05	0.05
20-28	0.13	103	10.7	15.2	13.4	0.31	0.36
28-40	0.37	171	17.7	32.9	63.3	1.47	1.83
40-56	1.10	243	25.1	58.0	267	6.21	8.04
56-79	3.00	225	23.3	81.3	675	15.7	23.7
79-112	8.30	126	13.0	94.3	1046	24.3	48.0
112-158	23.5	46	4.76	99.0	1081	25.1	73.1
158-224	66.6	6	0.62	99.6	400	9.3	82.4
224-316	188	4	0.41	100	752	17.5	99.9

VMD = 113 μ m NMD = 50 μm $\frac{VMD}{NMD}$ = 2.26

TABLE A.A.9 DROPLET SIZE DISTRIBUTION OF DROPLETS COLLECTED ON VERTICAL SLIDES

Droplet size class	Mean diameter^3	No. (N)	No. x 100 / ΣN	Cum.	N.d^3	Nd^3 x 100 / ΣNd^3	Cum.
10- 14 μm	0.02 x 10^{-5}	23	5.87	5.87	0.46	0.03	0.03
14- 20	0.05	73	18.6	24.5	3.65	0.21	0.24
20- 28	0.13	54	13.8	38.3	7.02	0.41	0.65
28- 40	0.37	46	11.7	50.0	17.0	0.99	1.64
40- 56	1.10	50	12.8	62.8	55.0	3.21	4.85
56- 80	3.00	54	13.8	76.6	162	9.46	14.3
80- 112	8.30	57	14.5	91.1	473	27.6	41.9
112-160	23.5	31	7.91	99.0	729	42.6	84.5
160-224	66.6	4	1.02	100	266	15.5	100.

VMD = 120 μm NMD = 40 μm $\frac{VMD}{NMD} = 2.14$

Results of glc analysis for the accounts of insecticide collected by the downwind wool samplers will be reported in a later Addendum. The number of droplets counted by handlens on the paper targets stationed alongside the wool samplers are shown in Table A.A.10.

TABLE A.A.10 NUMBER OF DROPLETS COLLECTED BY DOWNWIND OIL-SENSITIVE PAPER TARGETS

Distance downwind (N)	25	50	100	250	500
No. droplets/cm^2	425	560	352	260	55

The collection efficiency of the 1.5 cm wide targets is approximately 50 per cent for 50 μm droplets moving at 2.0 m/sec, falling to less than 10 per cent for a 20 μm droplet under the same conditions.

At a velocity of 5.0 m/sec the targets collect 50 μm droplets at 70 per cent efficiency, 20 μm droplets at 21 per cent efficiency. Of the droplets collected in the cotton field 50 per cent had diameters less than 40-50 μm.

The volume application rate was kept constant for both treatments by reducing the pump pressure sufficiently to halve the volume output rate during application to the narrow swath field, where 14 m swaths were employed instead at the 28 m swaths in the standard treatment. No Mg0 slides were placed in the experimental field so no assessment of the effect of reduced pressure on nozzle performance in terms of droplet characteristics can be made.

3.3.2 Discussion - Droplet Dispersion

The variation in droplet deposition across the cotton fields used in the trial as determined from droplet counts made on the oil sensitive paper targets was markedly greater on the upper targets of the standard treatment than on the experimental treatments. This can be attributed to two possible causes, (1) the lower flying height and increased number of swaths used in the experimental treatment, and (2) a possible increase in droplet volume median diameter due to the lower operating pressure used in the experimental treatment.

In the latter case a moderate increase in the number of larger drops would increase the number of countable droplet stains on the oil sensitive paper leading to a higher figure for the No/cm^2. The minimum stain size visible and clearly attributable to spray droplets on the oil sensitive paper is about 40-50 μm equivalent to a droplet diameter of around 20-30 μm. In the standard treatment 50 per cent of the droplets collected on the MgO slides were less than 50-56 μm so it would be expected that an increase in the range of droplet diameters produced at a lower nozzle operating pressure would result in a larger number of countable droplets. Only a droplet size analysis of the two sets of oil sensitive papers using an appropriate droplet diameter/stain diameter calibration will show whether this was the case. If not, then the greater number droplets/cm^2 and lower deposition variability across the swath can be directly attributed to the lower flying height and narrow swath width since all other factors were equal.

The variation in droplet deposition across the field was less marked on the targets placed at half plant height (Table A.A.5) and were in the ratio of 84/90 and 48/60 for the vertical and horizontal paper targets in the experimental and standard treatments respectively. This illustrates the inability of aerially applied sprays to penetrate the cotton canopy of the crop as currently cultivated.

The number of droplets deposited downwind at the standard treatment field was higher per unit area than those collected on the targets in the field (Table A.A.10) although of much smaller size. This may be due to the action of aircraft turbulence causing a proportion of spray to rise above the crop which then drifts and falls downwind, evaporating as it does and thus leading to the deposition of the high numbers of small droplets collected. Since the collection efficiency of the targets used is about 50 per cent for 50 μm droplets in a wind of 2 m/sec this gives an indication of the true number, although in terms of volume recovery they constitute no more than an estimated 2 per cent of the total spray volume, possibly less.

3.3.2 Biological Effect

The effect of treatments on pest populations is summarised in Table A.A.11. The numbers of *Heliothis* larvae were low in the narrow swath field. In the standard field with 27 larvae per 100 plants before application, reduction to 6 per 100 was satisfactory. It is worth nothing that, at this stage of the crop cycle, populations of small larvae of this level do not cause economic damage as the bolls are hard, and spraying is not considered necessary in most cotton producing countries.

The variation between fields in adult whitefly numbers before application was high on the top leaves, but this was confined to the east, well-grown, part of the fields (original data not presented), in which the standard field supported far higher numbers than the narrow swath field (1103 cf 374 adults per 100 plants, each 2 leaves).

TABLE A.A.11 EFFECT ON INSECT PESTS

			Standard	Narrow Swath
Pre-Spray 3-11-1985			**Standard**	**Narrow Swath**
Heliothis[1]	egg		6	6
	larvae		27	6
Whiteflyadults[2]				
	2 top leaves	60 leaves	1807 (3012)	1119 (1865)
	1 mid-leaf	30 leaves	1661 (5536)	1551 (5170)
	2 bot.leaves	60 leaves	2873 (4788)	2693 (4488)
	Total	**150 leaves**	**6341**	**5063**
	No. per 100 leaves		(4227)	(3375)
Whitefly nymphs[3]				
	Empty		3.9	3.0
	Live		14.0	5.5
	Brown		0.3	0.1
Post-Spray 1 Day 5-11-85			**Standard**	**Narrow Swath**
Heliothis[1]	egg		0	0
	larvae		9	9
Whitefly adults[2]				
	2 top leaves	60 leaves	145 (242)	139 (232)
	1 mid-leaf	30 leaves	221 (737)	73 (122)
	2 bot.leaves	60 leaves	405 (675)	529 (882)
	Total	**150 leaves**	**771**	**741**
	No. per 100 leaves		(514)	(494)
% reduction of Pre-Spray			**87.8**	**85.4**
Post-Spray 3 days 7-11-85				
Heliothis[1]	egg		0	0
	larvae		6	3
Whitefly adults[2]				
	2 top leaves	60 leaves	240 (400)	94 (157)
	1 mid-leaf	30 leaves	267 (890)	86 (287)
	2 bot. leaves	60 leaves	715 (1192)	237 (395)
	Total	**150 leaves**	**1222**	**417**
	No. per 100 leaves		(817)	(278)
% reduction of Pre-Spray			**80.7**	**93.4**
Whitefly nymphs[3]				
	Empty		3.6	4.3
	Live		6.9	7.5
	Brown		0.2	0.2

Notes: [1] *Number per 100 stands (apparently unthinned)*
[2] *Numbers in brackets are per 100 leaves*
[3] *Mean per square cm*

The reduction in total numbers of adult whitefly (Table A.A.11) by both methods of air-spraying was very good, however at these extremely high populations overall reductions above 95 per cent would be needed to bring the level down below the recommended spray action threshold of 200/100 leaves. This was not achieved although it was approached by the narrow swath spray 3 days after application, which at 93.4 per cent reduction was better than the standard system, with 80.7 reduction. However it is unlikely that this difference would be statistically significant considering the variation in pest population levels.

TABLE A.A.12 % REDUCTION WHITEFLY (Numbers/100 leaves)

		Top	Middle	Bottom	Total
Standard	1 day	92	86.7	85.9	87.8
	3 days	86.7	83.9	75.1	80.7
Narrow Swath	1 day	87.6	97.4	80.3	85.4
	3 days	94.8	94.8	91.7	93.4

Reduction in the upper parts of the plants was higher than in the lower (Table A.A.12), however differences were not great. Control levels in the lower crop were within 10 per cent of the upper part except for the standard treatment after 3 days.

Narrow swath and low flying gave a difference through the crop of only 3 per cent for the 3 day post-spray count and penetration of chemical was clearly better than for the standard application, where the difference was 11.5 per cent.

TABLE A.A.13 CROP PROTECTION UNIT (RAHAD) COUNTS

		Heliothis Egg	Heliothis Larvae	Whitefly[1] Adults
Standard	Pre-Spray	7	1.5	1091
	Post-Spray	2.5	0	448
	% Reduction	65	100	58.9
Narrow Swath	Pre-Spray	6	1	982
	Post-Spray	0	0	114
	% Reduction	100	100	88.4

Note: [1] Counts of 5 leaves on 20 plants

Data from the Crop Protection Department routine pest counts on the two fields is given in Table A.A.13. Pre-Spray counts of adult whitefly were well below those by project staff, but post-spray were of the same order. This difference could be associated with CPD pre-spray count being at 4.00 pm in the afternoon. The % reduction with narrow swath spraying shown by these counts was considerably greater than that obtained by standard spraying.

Table A.A.11 gives counts under the microscope of whitefly nymphs on leaves. Application of Thimul/Carbicron appears to have little effect on nymphs, assessed three days after application. The apparent increase in numbers of nymphs in the narrow swath treatment over the trial period emphasises the problems of accurate sampling of a variably distributed population. Clearly these counts do not reflect the true populations and unfortunately leaf samples over the whole field were bulked so that distributions were not obtained.

3.4 CONCLUSIONS

Narrow swaths and low flying clearly give much more uniform droplet dispersion and superior cover than the standard system. Penetration to the lower part of the crop canopy onto horizontal targets is also better.

This superior droplet dispersion is reflected by improved kill of whitefly adults over a period of several days particularly in the lower third of the plant.

It is recommended that the results of this preliminary investigation are sufficiently promising to warrant further investigation to:

(a) Confirm results on a wider scale and range of temperature conditions.

(b) Ascertain the possibilities of substantially reducing the rate of chemical applied, and possibly the volume, if superior cover and penetration is confirmed.

(c) Evaluate the economics of the two application system, taking account of possible reduction in rates of chemical applied.

3.5 CULTURAL PRACTICES RELATING TO WHITEFLY CONTROL

Cultural practices directly affect pest population dynamics, and control of pests. In the trial field three practices in particular were noted to contribute to poor pest control. The Consultants feel it necessary to comment on these.

(i) The crop was not thinned, having 5 to 10 plants per hole. This results in extremely high plant populations and competition between plants, which were leafy, stemmy and carried fewer bolls than if the crop were thinned to 1 or 2 plants per hole. The resulting vegetative growth habit increases numbers of whitefly and reduces spray penetration.

(ii) Irrigation was variable down the number, being excessive to the east and inadequate to the west as shown by crop growth.

(iii) Irrigation was still continuing late in the crop cycle, thus maintaining vegetative growth and moist humid conditions favourable for whitefly at a time when the crop was mature. In field A a count at the east end gave an average of 4.3 open bolls per plant stand. In field B it was 2.1. All other bolls were hard and there were no young bolls forming. Yet irrigation was **still** proceeding on November 7th in a mature crop that could have been harvested by November 15th had water been cut off at the appropriate time (perhaps October 20th).

The practice of extended irrigation in short season, determinate, medium staple Acala type cotton must be condemned for the following reasons:

- by maintaining a leafy crop it increases whitefly populations

- this increases contamination of open bolls

- it delays picking of open bolls and thus increases contamination by honeydew

- the number of late season insecticide sprays are increased and costs of pest control rise

- the efficacy of late sprays is reduced by the vegetative nature of the crop

- the cost of late-season irrigation at Rahad is high. This water must be pumped from Blue Nile, as opposed to the Rahad river

- no increase in yield can be obtained by extending the crop season since the variety is determinate and once its potential for boll production is reached no further production is possible, particularly under the cool temperatures that follow onset of northerly winds in early November.

There can be no doubt that irrigation cut-off will result in a better quality crop, with no effect on yield unless the early season bolls have been lost for some reason. There may even be possibilities for use of a defoliant to hasten loss of leaf, thus enhancing whitefly control.

The reasons for extended irrigation and alternatives will be considered in the Consultants final report. They affect the efficient and effective use of the German-aid programme, and any future aid programmes.

ANNEX B

MONITORING OF AGRICULTURAL INPUTS PROJECT IN SUDAN

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MONITORING OF AGRICULTURAL INPUTS PROJECT IN SUDAN

1. Environmental Monitoring Studies
(With acknowledgements to the USAID funded monitoring project of 1983 by the Consortium for International Crop Protection).

2. Technical Information on Temik
(Union Carbide Co.).

3. Determination of Concentrations of Aldicarb in Soil
March 27th, 1986.
(Huntingdon Research Centre).

Consortium for International Crop Protection

ENVIRONMENTAL MONITORING STUDIES ON TEMIK ALDICARB PESTICIDE TREATED COTTON FIELDS IN THE SUDAN

II. Experimental Procedures

A. Soil Degradation Study

Two locations in the Gezira scheme were selected for the soil dissipation studies and were identified as follows: South Group Block No. (7) and Center Group Block No. (9). (Refer to map Appendix I, II and III, Area map and description of irrigation and land administration.) Both locations were treated with TEMIK 15G at the rate of 2.5 kilograms active ingredient (ai)/hectare (17 lbs. of 15G/feddan) when the cotton was in the pinhead square stage approximately 40 days after planting. The field was flood irrigated within 5 days after treatment. Normal irrigation schedules were maintained (at approximately two week intervals until mid-December).

Soil samples were taken at regular intervals to study aldicarb residue disappearance in Sudanese soil. Samples were taken prior to application of TEMIK and at approximately one, two and four months after treatment in each location. Pre-treatment sampling consisted of four replications. Samples were taken between cotton rows where the TEMIK was applied. Soil cores were obtained by bucket auger to a depth of 180 cm. Cores were separated into increments of 0-30, 30-60, 60-120, and 120-180 cm. The auger was washed with clean water and scrubbed to prevent contamination between strata. Each auger of soil from a stratum was placed in a plastic bag and mixed thoroughly. A 200 gram aliquot was removed and placed in a plastic bag which was then placed into a pre-labeled cloth bag. Soil samples were kept cool until the end of the day then frozen until analyzed.

Additional sampling was conducted to determine the level of aldicarb present in previously treated fields (1982-83 season). Two locations were selected from fields treated the previous year, from Center Group Block No.

(9). At each location, four cores were taken as previously described. Sampling techniques and handling procedures were the same as previously described.

B. Irrigation Water Samples

Water samples were obtained at regular intervals in an attempt to detect any aldicarb residues in irrigation water and consequently, to determine their persistence under Sudanese conditions. Two locations were selected for the study: Center Group - Block No. (9) and South Group - Block No. (7). Both locations received 2.5 kg ai/ha of aldicarb and were flood irrigated within 5 days of application. Water samples were taken from the flooded field at 24 and 48 hours after irrigation. Six replicates were taken at each sampling period. Each replicate consisted of a 2000 milliliter (ml) sample taken randomly from the treated area. Two aliquots of 200 ml each were removed and placed into labeled plastic bottles. Water samples were taken during the first three irrigations in the Center Group and the first four irrigations in the South Group. Additional water samples were taken from the main canal, secondary canal and the irrigation ditch from both locations. Water samples from these locations consisted of two 200 ml aliquots taken from a 1000 ml random sample. These were taken prior to irrigation and 48 hours post-irrigation. Sampling intervals coincided with the first three irrigations after treatment. All samples were kept cool until the end of the day, then frozen until analyzed.

C. Village Water Source Sampling

Water samples were taken from representative village water supply sources prior to, and at regular intervals following application of TEMIK in an effort to determine the potential for appearance of aldicarb residues in village water sources.

A survey of villages in the Sudan Gezira and Rahad agricultural schemes indicated three types of water sources were regularly used by villagers. Water for personal consumption was obtained from: 1) a village well installed by the SGB (well depth averaged 30-40 meters), 2) canal water that is pumped through a filtering system into the village (filters were installed for removal of particulate matter from the water), and 3) canals adjacent to villages that have no filtration system.

Five villages representing each of the three types of water sources were chosen for monitoring. Established criteria dictated that a village had to be within a block in which cotton was treated and was also to be bordered on at least one side by a TEMIK treated cotton field. Filtered canal water supplies were sampled from five villages in the Rahad agricultural scheme. In the Gezira scheme, five villages each were chosen from South and Center Groups for monitoring. In the South group, samples were taken in three villages with wells and two villages that obtained unfiltered water directly from canals. In the Center Group samples were taken from two well sources and three unfiltered canal sources.

The designated villages in both schemes were sampled one and two months following TEMIK application. One thousand ml samples were collected from each well and divided into smaller 200 ml subsamples for analysis by Union Carbide and USAID. These 200 ml samples were then placed into a cooled container until frozen for analysis. The late arrival of the sample bottles shipped from the U.S. and, the unavailability of similar containers locally made sampling of village water supply sources prior to the TEMIK application impossible. Therefore, similar water source villages outside the treated area were used as untreated controls.

D. Cotton Foliage and Seed Residue Study

Foliage samples were taken at regular intervals to monitor the level of aldicarb residues in cotton treated with 2.5 kg ai/ha of aldicarb. The field was irrigated within 5 days of treatment. A site was selected in the South Group Block No. (7) and divided into three replicates for the study. A control site was selected adjacent to the treated areas. Foliage samples were taken from the same location (20 meter section of 2 rows) throughout the season. One kilogram whole plant samples were taken at each sampling interval. Sampling intervals were 1, 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20 weeks following application. Additionally, twenty randomly selected seed cotton samples were taken during harvest in the Gezira and Rahad agricultural schemes to determine aldicarb residues. The samples were kept cool until the end of the day, then frozen until analyzed.

III. Discussion of Results

A. Soil Degradation Study

Soil in the Gezira agricultural schemes are classified as vertisols. These soils contain large amounts of montmorillonite clay which expand and contract with wetting and drying. Vertisols are characterized by large cracks which develop during the dry season or between irrigations. Loose materials fall from the edges to the bottom of the cracks, which is conducive to good soil tilth.

A typical soil profile in the Gezira has an average of 59% clay to a depth of 1.8m deep. The average organic content ranges from 0.1% to 0.4%. Soil pH values are highly alkaline with values ranging from 8.5 to 9.5 in the upper profile. Field capacity is high at 38.5% with a permanent wilting point of 20%.

Irrigation begins with planting (Aug - Sept) and continues through the season until maturity (Dec. - Jan.). Irrigation intervals average every two weeks with approximately 0.1m of water applied at each irrigation by the flood/basin method. The application of TEMIK is timed to occur just prior to irrigation.

The mean concentration of aldicarb residues in soil at both locations (summarized in Table I and II with detailed data presented in Appendix IV) indicates that detectable residues did not move below 60 centimeters (cm). In the South group location, maximum observed mean aldicarb residues of 0.023 parts per million (ppm) were present in samples from the 0-30 cm stratum taken 30 days after treatment. Only trace aldicarb residues were observed in the 30-60 cm stratum. Data from the 2 and 4 month (post application) sampling periods indicate that aldicarb residues had degraded to non-detectable levels (Table I).

The maximum observed mean residue level for the Center group (Table II) was 0.045 ppm and occurred in the 0-30 cm stratum, taken 30 days after treatment. Data from the 2 and 4 month (post) sampling periods indicate the presence of low level concentrations of aldicarb residues (0.040 ppm maximum). Most of the residues present occurred in the 30 to 60 cm stratum four months after treatment.

Data from two soil degradation studies taken one year post treatment (82-83 season) are found in Table III. The data indicate that no aldicarb residues were found in any of the stratum one year post treatment at either location.

In summary, environmental conditions and irrigation practices in the Gezira agricultural scheme promote the degradation of aldicarb and consequently, retards movement of residues in the soil profile so that detectable levels of aldicarb will not be found below approximately 60 cm. Degradation is so rapid that less than 10 percent of the applied aldicarb remains in the soil one month after application and, remaining residues completely degrade in the soil profile by the following growing season.

B. Irrigation Water Sampling

Irrigation in the Gezira and Rahad agricultural schemes is a gravity flow system. Water is diverted from the Blue Nile and carried by major canals to the agricultural growing areas. Secondary canals distribute the water to the fields where irrigation ditches deliver the water to the individual blocks (howshat) (Appendix III). The basin method of irrigation is utilized with fields normally flooded to a depth of 0.1m at each irrigation. This method is highly efficient with virtually 100% water utilization.

No detectable aldicarb residues were reported in any major canals, secondary canals or irrigation ditches at either test location (Table IV). Since water flows from major canals through secondary canals and irrigation ditches directly to the fields the chance of irrigation canal contamination is nil. (See Appendix V for analytical details.)

Results of irrigation water sampling from the South and Center group locations are found in Table V. Measurable residues were found in the irrigation water at both locations. Data from the South group indicate that flood water residues at the first irrigation were higher than in the subsequent three irrigations. The maximum residue in any sample from the first irrigation was 0.157 ppm, 24 hrs. post-treatment. (See Appendix V for detailed analytical data on replicate water samples.) The average residues taken from water samples 24 hrs. post-treatment were 0.043 ppm. The 48 hr. post-treatment average was 0.030 ppm with a maximum value of 0.055 ppm. The 2nd, 3rd, and 4th irrigation water samples contained only trace residues (0.002 ppm maximum).

Aldicarb residues found in the Center group were higher in the 1st and 2nd irrigation water samples than in the 3rd. Only trace residues were found in the 3rd irrigation (0.008 ppm maximum). The average residues, 24 hr. and 48 hr. after the 1st irrigation were 0.015 and non-detect[1] respectively. Values for the 2nd irrigation, 24 hr. and 48 hr. post-treatment were 0.066 and 0.089 ppm respectively. The highest residue found in any replicate sample of

[1]level of sensitivity is 0.001 ppm.

irrigation water was in the 2nd irrigation at 48 hrs. post-treatment at 0.209 ppm. (See Appendix V.)

An estimate has been made of the potential exposure to aldicarb that a worker might receive during flood irrigation of fields in the Sudan:

Workers would be walking in approximately 0.1 m of water containing aldicarb residues of a maximum of 0.2 ppm (worse case). Due to aldicarb's water solubility characteristics, little dermal absorption would take place while the worker remained in the water. Once out of the water, it has been estimated by Union Carbide toxicologists that a 0.01 cm layer of water would remain on 10% of the body surface area. Once the water has evaporated, 100% dermal penetration of the remaining aldicarb residue was assumed. This would have resulted in the worker being exposed to a total body burden of approximately 4 milligrams of aldicarb. No clinical symptoms would be expected to result from this level of exposure in a human weighing more than 60 kgs. Average aldicarb levels were shown not to be above 0.089 ppm which is approximately 2.4 X less than the highest level of residues observed. The likelihood of a person becoming ill from exposure to irrigation water containing low level aldicarb residues is remote.

C. <u>Village Water Sources</u>

There were no detectable aldicarb residues in any of the samples taken from village water supply sources in the Gezira or Rahad locations (Tables VI, VII and VIII). These well and canal sources were monitored for 1 month after TEMIK was applied in the area, and again 2 months after the material had been applied. Sample analyses indicated that residues did not leach into the water table supplying the wells. This agrees with previously described soil analyses which showed that aldicarb degraded rapidly in Sudanese soil and did not move below the 30-60 cm stratum in the 4 months following TEMIK application. The total absence of residues in adjacent canals used for village water supplies is very important. It shows that flood irrigation water, which does contain residues while pooled in the treated field, will not "run-off" and enter nearby water sources. Any residue in the irrigation water will remain in the field as irrigation water is absorbed or evaporated. Flood irrigation in these areas is dependent on gravity flow of water from the main canals through secondary canals and then, irrigation ditches to the fields. Because canals and ditches are all up gradient from fields, it is understandable that no residues were found in these sources nor would any be expected at similar sites.

D. Cottonseed and Foliage

Cottonseed from the Gezira and Rahad agricultural schemes was harvested from twenty separate fields each of which had been treated with 2.5 kg ai/ha TEMIK 15G. Nineteen of twenty seed samples contained trace levels of aldicarb residues between 0.01 and 0.03 ppm (Table IX). These residues are consistent with extensive data for aldicarb residues in cotton seed and are less than the established U.S. Environmental Protection Agency tolerance of 0.1 ppm. A single sample of cottonseed was determined to have 0.15 ppm residue, remarkably different from all other fields. Because this level exceeds the mean of seed residue by more than four standard deviations, it is reasonable to conclude that this value is aberrant as a result of misapplication or unintentional post-harvest contamination in the field or laboratory.

Cotton foliage residues seem to remain relatively constant from the first sampling one week after treatment through the seventh sampling twelve weeks after treatment (Table X). After twelve weeks, residues have degraded or growth dilution has reduced levels to less than 0.1 ppm. Replicate results are consistant, indicating an even application of pesticide to the field. This level of systemic plant residue is not hazardous to field workers which may come in contact with the plants.

See Appendix VI for detailed seed and foliage analytical data.

VI. Conclusions

The likelihood of aldicarb residues reaching subsurface or groundwater is remote under Su danese conditions because the environmental conditions favors slow downward movement and rapid degradation. Such environmental conditions include the presence of soil microorganisms, alkaline pH, warm soil temperatures and high field capacity soils. The 1983-84, USAID/Union Carbide monitoring program has confirmed that these conditions exist in the Gezira and result in slow downward movement and rapid degradation of aldicarb residues.

The data from the soil dissipation studies have indicated that aldicarb residues are present in the top 60 cm of soil for approximately 4 months following treatment. However, additional soil samples taken one year after initial treatment indicated that aldicarb residues had degraded completely during this time.

The likelihood of aldicarb residues reaching village water sources is remote because of the gravity flow irrigation system. All aldicarb residues can be expected to remain in treated areas. Monitoring of village water sources, major canals, secondary canals and irrigation ditches indicated that no aldicarb residues reached water sources that may be used for human consumption.

The only aldicarb residues found during the course of this study were in the irrigation water present in treated fields. These residues were relatively low and were non-detectable by the third irrigation. Furthermore, these residues have been determined not to pose an undue hazard to the human population.

Aldicarb residues found in cotton foliage and seed are within expected levels. Foliage residues were found to degrade as expected, to levels less than the sensitivity of the analytical method (0.01 ppm). Likewise, seed residues taken at harvest were found to be well within the tolerance of 0.1 ppm established by the U.S. Environmental Protection Agency.

In summary, TEMIK aldicarb pesticide has provided effective pest control in the Sudan without persisting in the environment for long periods of time. Rapid degradation and reduced soil movement resulted in minimal residue concentrations in irrigation water, the upper 60 cm of soil and in cotton foliage. Therefore when used as directed, TEMIK presents no threat to either drinking water sources or agricultural workers in the Sudan.

TABLE I
ALDICARB RESIDUES REMAINING IN SOIL AFTER TREATMENT WITH
2.5 KG AI/HA IN THE GEZIRA AGRICULTURAL SCHEME, SUDAN
LOCATION: SOUTH GROUP, BLOCK 7

DATE OF SAMPLING	SAMPLING INTERVAL[a/]	STRATA (CM)	MEAN ALDICARB RESIDUES PPM[b/,c/]
9/24/83	Pre-treatment	0-30	<0.010
	Pre-treatment	30-60	<0.010
	Pre-treatment	60-120	<0.010
	Pre-treatment	120-180	<0.010
11/5/83	1 month (post)	0-30	0.023
	1 month (post)	30-60	<0.010
	1 month (post)	60-120	<0.010
	1 month (post)	120-180	<0.010
12/5/83	2 months (post)	0-30	<0.010
	2 months (post)	30-60	<0.010
	2 months (post)	60-120	<0.010
	2 months (post)	120-180	<0.010
2/5/84	4 months (post)	0-30	<0.010
	4 months (post)	30-60	<0.010
	4 months (post)	60-120	<0.010
	4 months (post)	120-180	<0.010

Footnotes:

[a/] Months after initial pesticide application.

[b/] Each number represents the mean residue concentration of 4 replications.

[c/] Level of sensitivity: 0.01 ppm.

TABLE II
ALDICARB RESIDUES REMAINING IN SOIL AFTER TREATMENT WITH
2.5 KG AI/HA IN THE GEZIRA AGRICULTURAL SCHEME, SUDAN
LOCATION: CENTER GROUP, BLOCK 9

DATE OF SAMPLING	SAMPLING INTERVAL[a]	STRATA (CM)	MEAN ALDICARB RESIDUES PPM[b,c]
9/26/83	Pre-treatment	0-30	<0.010
	Pre-treatment	30-60	<0.010
	Pre-treatment	60-120	<0.010
	Pre-treatment	120-180	<0.010
11/7/83	1 month (post)	0-30	0.045
	1 month (post)	30-60	0.015
	1 month (post)	60-120	<0.010
	1 month (post)	120-180	<0.010
12/5/83	2 months (post)	0-30	0.040
	2 months (post)	30-60	0.010
	2 months (post)	60-120	<0.010
	2 months (post)	120-180	<0.010
2/5/84	4 months (post)	0-30	0.010
	4 months (post)	30-60	0.040
	4 months (post)	60-120	<0.010
	4 months (post)	120-180	<0.010

Footnotes:

a/ Months after initial pesticide application.

b/ Each number represents the mean residue concentration of 4 replications.

c/ Level of sensitivity: 0.01 ppm.

TABLE III

ALDICARB RESIDUES REMAINING IN SOIL ONE YEAR AFTER TREATMENT WITH 2.5 KG AI/HA IN THE GEZIRA AGRICULTURAL SCHEME, SUDAN

LOCATION: CENTER GROUP, BLOCK NO. (9)

DATE OF SAMPLING	SAMPLING INTERVAL[a]	STRATA (CM)	MEAN ALDICARB RESIDUES PPM[b,c]
Field A			
10/26/83	1 year (post)	0-30	<0.010
	1 year (post)	30-60	<0.010
	1 year (post)	60-120	<0.010
	1 year (post)	120-180	<0.010
Field B			
10/26/83	1 year (post)	0-30	<0.010
	1 year (post)	30-60	<0.010
	1 year (post)	60-120	<0.010
	1 year (post)	120-180	<0.010

Footnotes:

a/ Interval from initial application.

b/ Each number represents the mean residue concentration of 4 replications.

c/ Level of sensitivity: 0.01 ppm.

TABLE VI
SURVEY OF DRINKING WATER SOURCES FOR ALDICARB RESIDUES
IN THE GEZIRA AGRICULTURAL SCHEME[a/]

LOCATION	DATE OF SAMPLING	SAMPLING INTERVAL FROM APPLICATION	WATER SOURCE	ALDICARB CONCENTRATION (PPM)[b/]
South Group				
W. Shaeir Hqs.	10/30/83	Untreated	Well	<0.001
W. Shaeir Village	10/30/83	Untreated	Well	<0.001
El Dabab	10/30/83	Untreated	Canal	<0.001
Tanous Village	10/30/83	Untreated	Well	<0.001
Goz Ahmed Nur	10/30/83	Untreated	Well	<0.001
Wad El Ahaya	10/13/83	1 month (post)	Well	<0.001
Umtraibat	10/13/83	1 month (post)	Well	<0.001
Village #15 (Block 5)	10/13/83	1 month (post)	Canal (UF)[c/]	<0.001
Roeina	10/13/83	1 month (post)	Well	<0.001
Small Roaf	10/13/83	1 month (post)	Canal (UF)	<0.001
Wad El Ahaya	11/15/83	2 months (post)	Well	<0.001
Umtraibat	11/15/83	2 months (post)	Well	<0.001
Village #15 (Block 5)	11/15/83	2 months (post)	Canal (UF)	<0.001
Roeina	11/15/83	2 months (post)	Well	<0.001
Small Roaf	11/15/83	2 months (post)	Canal (UF)	<0.001

Footnotes:

a/ Criteria dictates that a village had to be with a block whose cotton was treated and be bordered on at least one side by a TEMIK treated cotton field.

b/ Level of sensitivity: 0.001 ppm.

c/ Unfiltered water source.

TABLE VII
SURVEY OF DRINKING WATER SOURCES FOR ALDICARB RESIDUES
IN THE GEZIRA AGRICULTURAL SCHEME[a/]

LOCATION	DATE OF SAMPLING	SAMPLING INTERVAL FROM APPLICATION	WATER SOURCE	ALDICARB CONCENTRATION (PPM)[c/]
Center Group				
16 Maryoud	10/30/83	Untreated	Canal (F)[b/]	<0.001
Kilo 51 Bridge	10/30/83	Untreated	Canal (F)	<0.001
Amara Kasir	10/30/83	Untreated	Canal (F)	<0.001
Village 40	10/30/83	Untreated	Canal (F)	<0.001
Bahyla	10/30/83	Untreated	Canal (F)	<0.001
Wad El Khahala	10/13/83	1 month (post)	Well	<0.001
Hamidel Nil	10/13/83	1 month (post)	Well	<0.001
Um Jukain	10/13/83	1 month (post)	Canal (UF)[d/]	<0.001
Omer	10/13/83	1 month (post)	Canal (UF)	<0.001
El Shareif	10/13/83	1 month (post)	Canal (UF)	<0.001
Wad El Khahala	11/15/83	2 months (post)	Well	<0.001
Hamidel Nil	11/15/83	2 months (post)	Well	<0.001
Um Jukain	11/15/83	2 months (post)	Canal (UF)	<0.001
Omer	11/15/83	2 months (post)	Canal (UF)	<0.001
El Shareif	11/15/83	2 months (post)	Canal (UF)	<0.001

Footnotes:

a/ Criteria dictates that a village well had to be within a block whose cotton was treated or a canal be bordered on at least one side by a TEMIK treated cotton field.

b/ Filtered water source.

c/ Level of sensitivity: 0.001 ppm.

d/ UF - Unfiltered water source.

TABLE VIII
SURVEY OF DRINKING WATER SOURCES FOR ALDICARB RESIDUES IN THE RAHAD AGRICULTURAL SCHEME[a]

LOCATION	DATE OF SAMPLING	SAMPLING INTERVAL FROM APPLICATION	WATER SOURCE	ALDICARB CONCENTRATION (PPM)[c]
Rahad				
Major 4	10/24/83	Untreated	Canal (F)[b]	<0.001
Village 17	10/24/83	Untreated	Canal (F)	<0.001
Village 27	10/24/83	Untreated	Well	<0.001
Village 23	10/24/83	Untreated	Canal (F)	<0.001
Village 40	10/24/83	Untreated	Canal (F)	<0.001
Village 12	10/25/83	1 month (post)	Canal (F)	<0.001
Village 10	10/25/83	1 month (post)	Canal (F)	<0.001
Village 8	10/25/83	1 month (post)	Canal (F)	<0.001
Village 7	10/25/83	1 month (post)	Canal (F)	<0.001
Village 6	10/25/83	1 month (post)	Canal (F)	<0.001
Village 12	11/23/83	2 months (post)	Canal (F)	<0.001
Village 10	11/23/83	2 months (post)	Canal (F)	<0.001
Village 8	11/23/83	2 months (post)	Canal (F)	<0.001
Village 7	11/23/83	2 months (post)	Canal (F)	<0.001
Village 6	11/23/83	2 months (post)	Canal (F)	<0.001

Footnotes:

a/ Criteria dictates that a village well had to be within a block whose cotton was treated or a canal be bordered on at least one side by a TEMIK treated cotton field.

b/ (F) - Filtered water source.

c/ Level of sensitivity: 0.001 ppm.

TABLE X

DEGRADATION OF ALDICARB RESIDUES IN COTTON FOLIAGE TREATED WITH 2.5 KG AI/HA IN THE GEZIRA AGRICULTURAL SCHEME, SUDAN[a/]

DATE OF SAMPLING	TREATMENTS	SAMPLING INTERVAL FROM APPLICATION	ALDICARB CONCENTRATION (PPM)[b/]
10/11/83	Untreated	1 week	0.01[c/]
	Treated		3.20[d/]
10/18/83	Untreated	2 weeks	0.02
	Treated		2.29
11/1/83	Untreated	4 weeks	0.03
	Treated		2.10
11/15/83	Untreated	6 weeks	0.01
	Treated		0.65
11/29/83	Untreated	8 weeks	0.01
	Treated		1.70
12/13/83	Untreated	10 weeks	0.01
	Treated		1.37
12/30/83	Untreated	12 weeks	0.01
	Treated		1.10
1/15/84	Untreated	14 weeks	0.01
	Treated		0.20
1/30/84	Untreated	16 weeks	0.01
	Treated		0.09
2/14/84	Untreated	18 weeks	<0.01
	Treated		0.08
3/1/84	Untreated	20 weeks	<0.01
	Treated		0.07

Footnotes:

[a/]Location: South Group (Block No. 7).

[b/]Level of sensitivity: 0.01 ppm.

[c/]Number represents the residue concentrations of 1 replication.

[d/]Number represents the mean residue concentration of 3 replications.

ANNEX B

TECHNICAL INFORMATION ON TEMIK
(UNION CARBIDE CO.)

TABLE 5. ALDICARB METABOLITES, TOXICOLOGICAL PROPERTIES AND RELATIVE PROPORTIONS IN COTTON PLANTS.

Compound	Occurance (1)	Acute Oral LD50 mg./kg.(rat)	NIEL (2)	% Recovered in Cotton Foliage 14 days	30 days	60 days
Aldicarb	P,A,S	0.93	0.1	1.0	1.7	--
Aldicarb Sulfoxide	P,A,S	0.88	0.5	66.5	30.2	12.3
Aldicarb Sulfone	P,A,S	25.0	5.4	5.0	5.7	5.4
Aldicarb Oxime	A	2,580	--	--	--	--
Sulfoxide Oxime	P,A,S	8,000	>125	3.3	4.1	1.0
Sulfone Oxime	P,A	1,590	>50	--	0.5	4.6
Sulfoxide Nitrile	P,A,S	4,000	~100	7.7	15.3	1.3
Sulfone Nitrile	P,A,S	350	>72.5	--	--	--
Sulfoxide Amide	P	16,000	--	0.4	3.7	2.1
Sulfoxide Acid	P	7,500	--	1.1	6.0	7.5
Sulfone Acid	P	5,700	--			2.3
Sulfoxide Alcohol	P	11,300	1,000	7.2	20.1	28.5
Sulfone Alcohol	P	11,300	--	--	0.9	0.7

(1) P = Plant, A = Animal, S = Soil

(2) Chronic "no ill effect" level - mg./kg./day.

Figure 1.

Metabolic Pathways of TEMIK in Cotton Plants

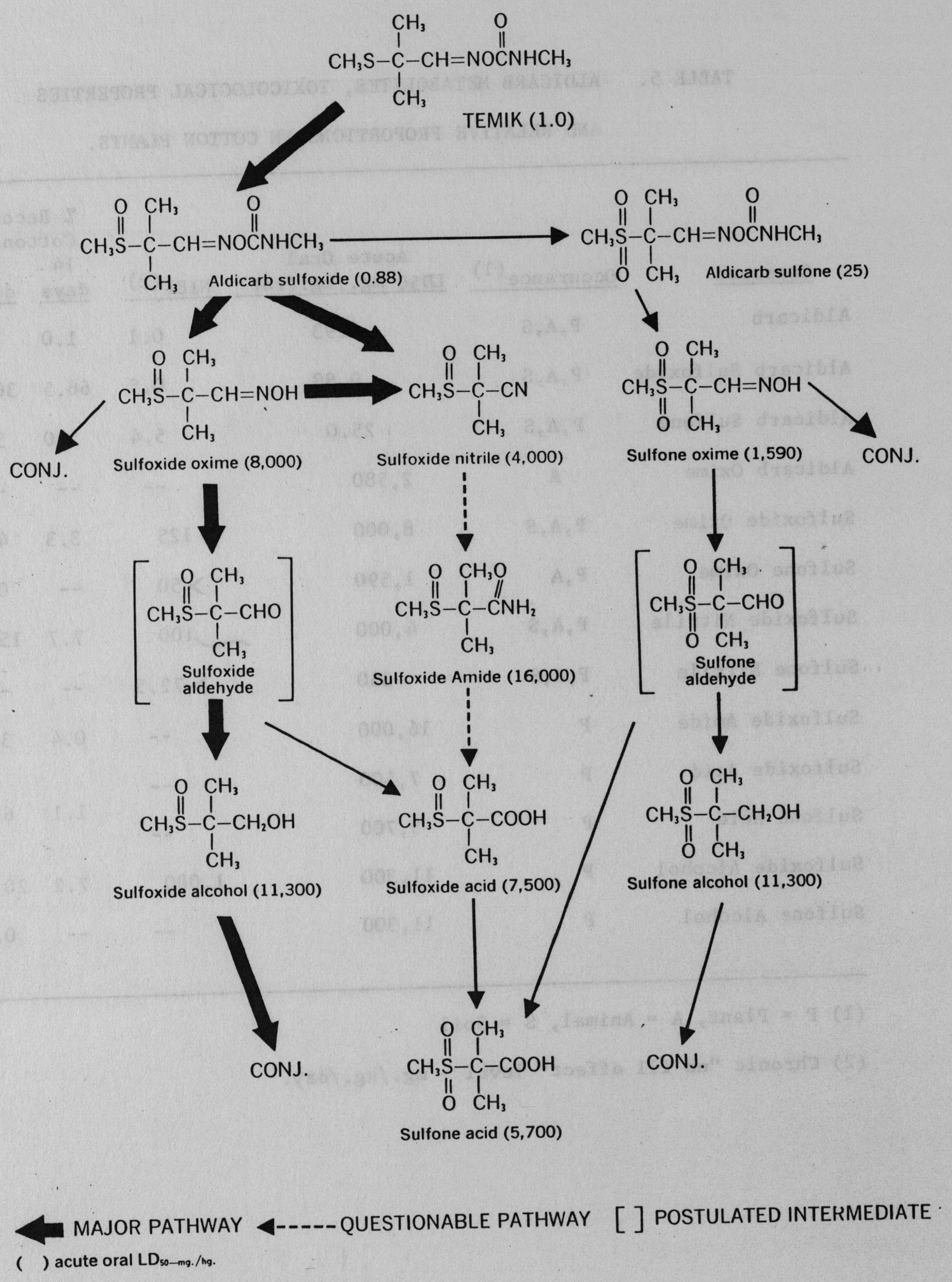
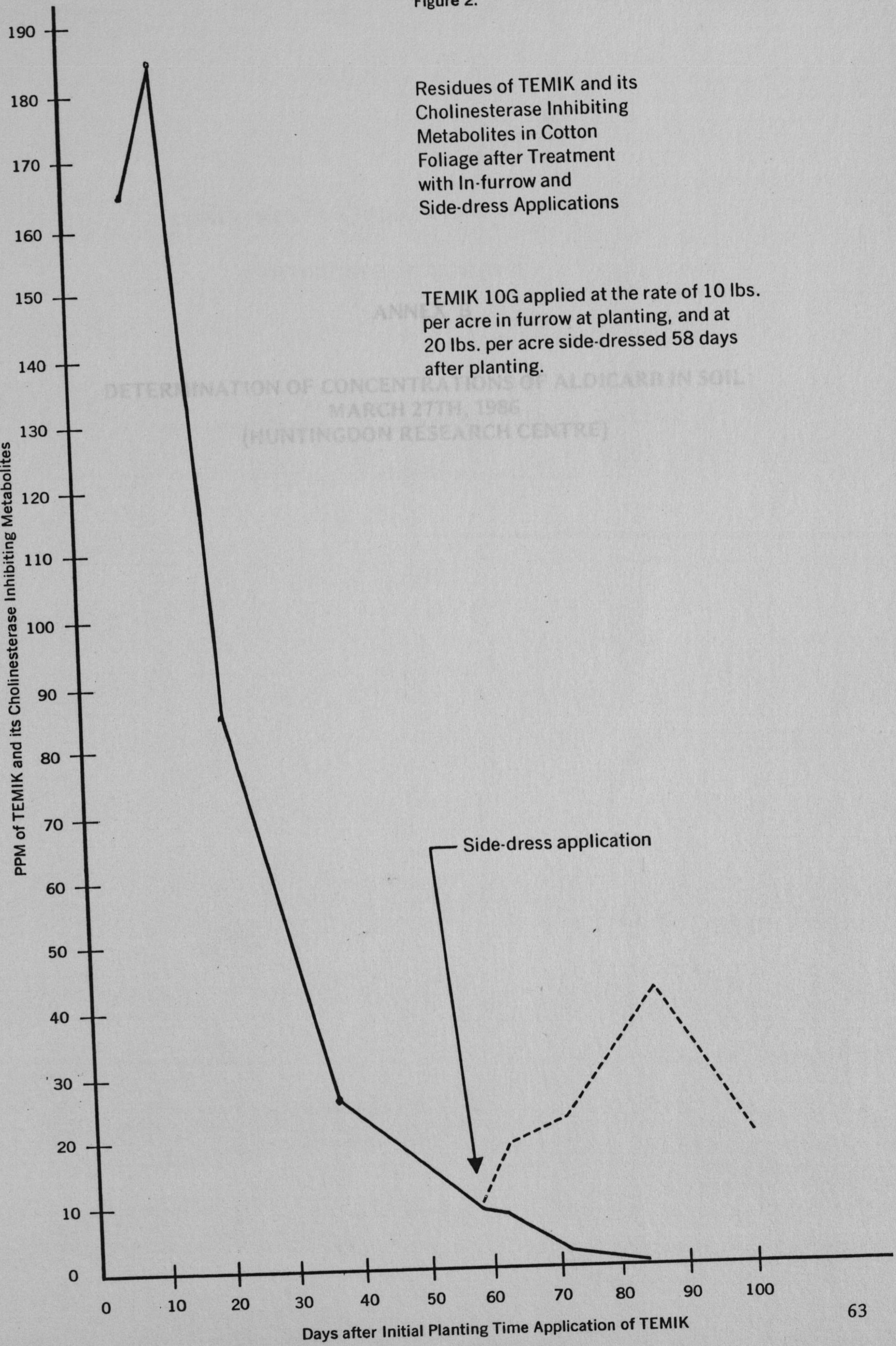


Figure 2.



Residues of TEMIK and its Cholinesterase Inhibiting Metabolites in Cotton Foliage after Treatment with In-furrow and Side-dress Applications
TEMIK 10G applied at the rate of 10 lbs. per acre in furrow at planting, and at 20 lbs. per acre side-dressed 58 days after planting.
Side-dress application
PPM of TEMIK and its Cholinesterase Inhibiting Metabolites
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
Days after Initial Planting Time Application of TEMIK

ANNEX B

DETERMINATION OF CONCENTRATIONS OF ALDICARB IN SOIL
MARCH 27TH, 1986
(HUNTINGDON RESEARCH CENTRE)

HRC

HUNTINGDON RESEARCH CENTRE Ltd

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DEPARTMENT OF ANALYTICAL CHEMISTRY

CERTIFICATE OF ANALYSIS

The Determination of Concentrations of Aldicarb in Soil

HTS/1

27th March 1986

HRC

Ian A. Macdonald, L.R.S.C.,
Head of Pesticide and Environmental Analysis,
Department of Analytical Chemistry.

G A Taylor

Graham A. Taylor, B.Sc.,
Study Analyst,
Department of Analytical Chemistry.

HRC

HRC Project number: HTS/1.

Date of commission: This work was commissioned by Mr. C. Whetnall on 10th November 1985.

Samples: Samples were received from Sudan between 19th November 1985 and 1st March 1986 in a good condition and stored at -20°C prior to analysis.

Study: Pesticide Residue analysis, Aldicarb.

Method: Samples were analysed by extraction with acetone/water, evaporation, oxidation with peracetic acid, neutralisation with sodium bicarbonate solution followed by liquid partition from aqueous phase into chloroform. The extract was further purified by Florisil column chromatography eluting with 25% acetone in diethyl ether. Quantitation was by gas-liquid chromatography using conditions detailed in Appendix 1.

Results: The results obtained, uncorrected for control or procedural recovery values, are shown in Table 1. Procedural recovery values corrected for appropriate control residues are shown in Table 2.

Typical analytical chromatograms are shown in Figure 1.

The reliable limit of detection for aldicarb in soil was 0.02 ppm.

Chemistry Laboratory Notebook Reference: 2421/86/06

HRC

TABLE 1

Concentrations of Aldicarb found in soil

HRC Reference	Sample Reference	Aldicarb ppm
85/8681	1	ND
85/8682	2	ND
85/8683	3	ND
85/8684	4	ND
85/8685	5	ND
85/8686	6	ND
85/8687	7	ND
85/8688	8	ND
85/8689	9	ND,ND
85/8690	10	0.04,0.03
85/8691	11	0.03,0.02
85/8692	12	0.20,0.10
85/9160	25 Control	ND
85/9161	26 Control	ND
85/9434	27 Control	ND
86/1467	51	0.04
86/1468	52	ND
86/1469	53	ND

TABLE 2

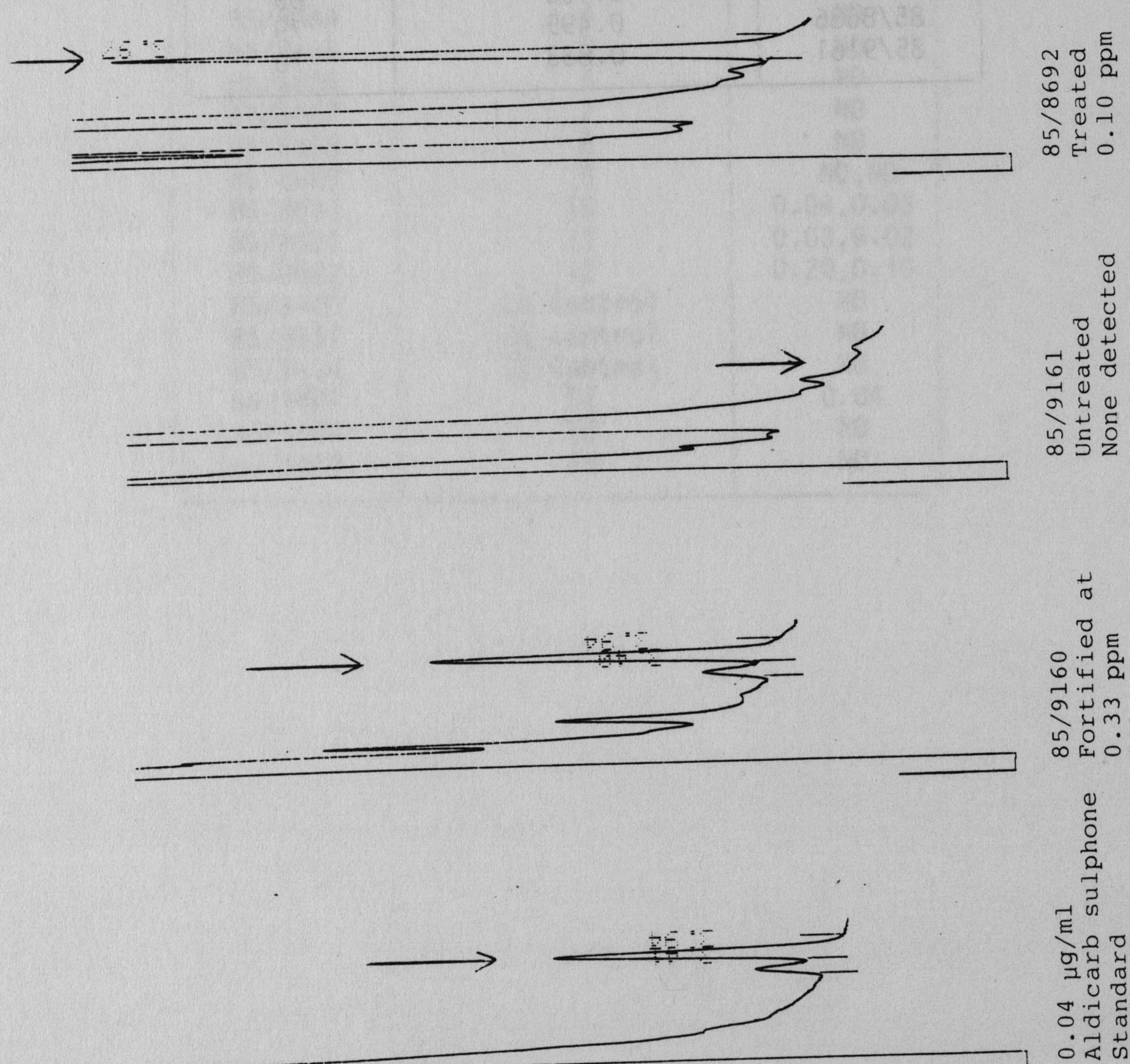
Procedural Recovery Data

HRC Reference	Level of fortification, ppm	Per cent recovery
85/8686	0.066	80
85/8686	0.166	77
85/9161	0.166	69
85/8686	0.499	79
85/9161	0.833	70

HRC

FIGURE 1

Typical analytical chromatography of Aldicarb sulphone in soil



APPENDIX 1

Gas chromatographic conditions used for the determination of Aldicarb as Aldicarb sulphone

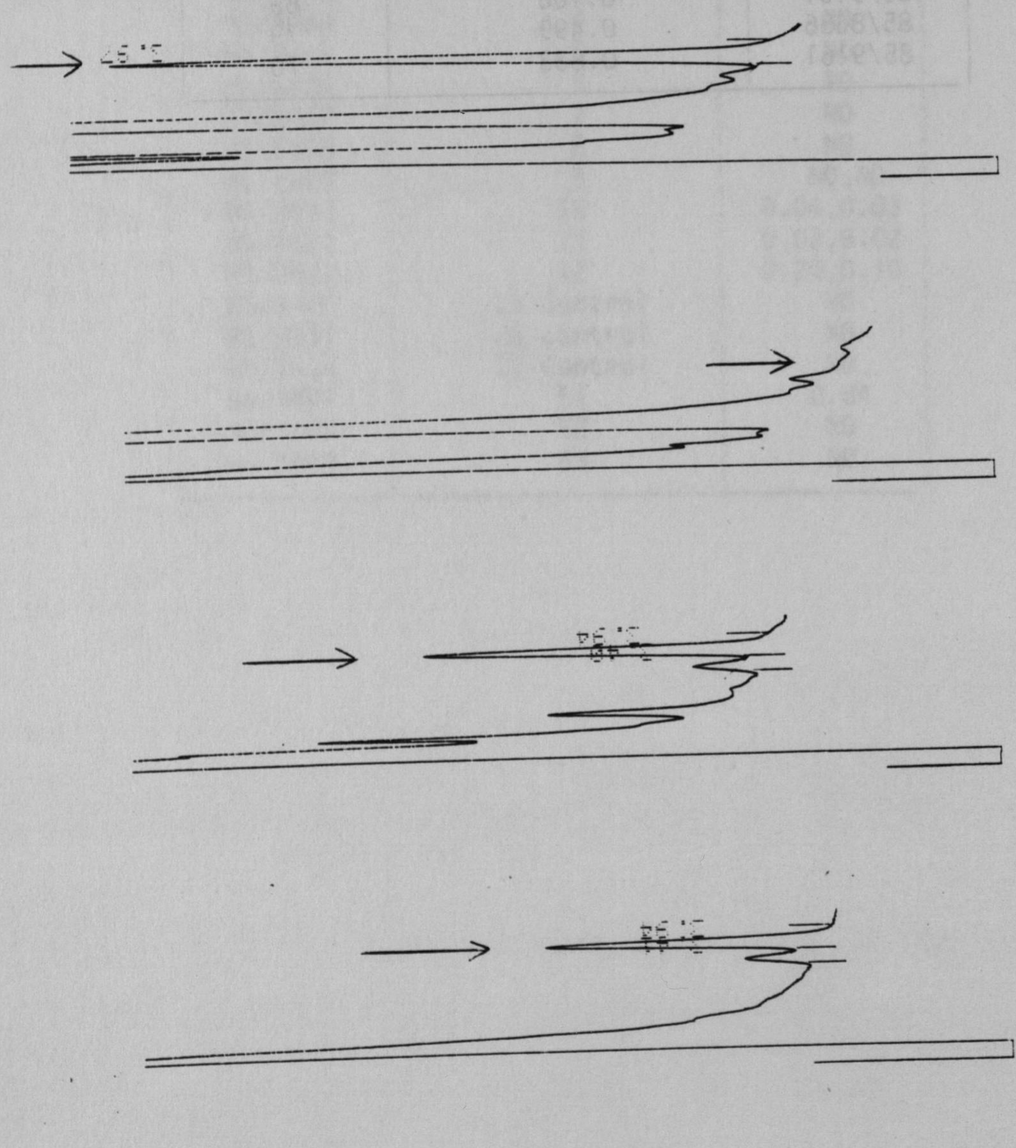
Instrument:	Hewlett Packard 5710A gas chromatograph fitted with a nitrogen phosphorous thermionic specific detector and HP 7671A automatic sampler.
Column:	2 m x 4 mm i.d. glass packed with 5% DC 200 + 2% Carbowax on DCLQ (80-100 mesh).
Temperatures:	
Injector	250°C
Column	190°C
Detector	300°C
Gases:	
Carrier	
Helium	30 ml/minute
Flame	
Hydrogen	3 ml/minute
Air	80 ml/minute.
Injection volume:	10 µl.

Under these conditions Aldicarb sulphone had an approximate retention time of 3.9 minutes.

HRC

FIGURE 1

Typical analytical chromatography of Aldicarb sulphone in soil



APPENDIX 1

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Instrument:	Hewlett Packard 5710A gas chromatograph fitted with a nitrogen phosphorous thermionic specific detector and HP 7671A automatic sampler.
Column:	2 m x 4 mm i.d. glass packed with 5% DC 200 + 2% Carbowax on DCLQ (80-100 mesh).
Temperatures:	
Injector	250°C
Column	190°C
Detector	300°C
Gases:	
Carrier	
Helium	30 ml/minute
Flame	
Hydrogen	3 ml/minute
Air	80 ml/minute.
Injection volume:	10 µl.

Under these conditions Aldicarb sulphone had an approximate retention time of 3.9 minutes.

ANNEX C

PESTICIDE SAFETY

SUDAN COTTON SPRAYING CAMPAIGN 1985-1986

INTRODUCTION

A structured evaluation (by checklist/questionnaire) of pesticide safety in pesticide stores, at airstrips, and among farmers and field workers was conducted, with the help of other team members, in the Gezira, Managil, Rahad and White Nile cotton growing regions of the Sudan.

Safety criteria for pesticide stores included the siting of stores, store design and construction, storage systems, store management and staff training. For airstrips, criteria included transport (from pesticide store to airstrip) handling and mixing of pesticides, loading aircraft, and other aspects including training. Farmers and field workers were assessed in terms of general awareness of pesticide hazard, and incidence of pesticide poisoning. Observations were also made on the return of empty pesticide containers to stores, and their subsequent re-use, sale or disposal. Checklists/questionnaires used in these investigations for stores, airstrips, farmers/field workers, and pesticide container use are given in Appendices A, B, C and D, respectively.

During the period 21st September - 19th October 1985 the Safety Specialist inspected eleven pesticide stores on three cotton corporations, evaluated procedures at five airstrips, and interviewed a small number of farmers and field workers. Aspects of the sale and re-use of empty pesticide containers were also monitored. In addition, other team members made, over a longer period, independent assessments in these areas using identical check lists/questionnaires. Their findings are incorporated in the report. In total, 43 pesticide stores and 56 airstrips were inspected; 235 interviews were held with farmers and field workers, and 13 independent observations made on pesticide container use.

The results, though not giving a complete picture of the status of pesticide safety in the cotton growing regions of the Sudan, provide a sound basis on which to make recommendations for improvement. It is recognised that, in many instances, there are severely limited resources in the Sudan and that, under such conditions, pesticide management practices may be far from ideal. Given these constraints it was very encouraging to see, in some instances, good use of available resources and sensible pesticide management. The Sudanese authorities are congratulated on these aspects and should be encouraged to continue improvements. There is, however, little room for complacency as the overall picture is one of poor pesticide safety which could, in many instances, be much improved at very little (or at no) additional cost. Some improvements (for example, the safe disposal of large stocks of -date pesticide) will incur high costs, but many of these will be avoided in future with better pesticide management, which is already being implemented in some areas.

METHOD AND RESULTS

The full results of checklists/questionnaires are given in Appendices E-1, in which summaries (including calculations) and the raw data (individual answers) are tabulated. To assist collation and analysis of data, each answer or entry was given a numeric score as follows:

ANSWER	SCORE
Yes	4
Yes (qualified)	3
No (qualified)	2
No	1
Don't know	No score

Provision was made in checklists/questionnaires for supplementary questions and additional observations to be included, when appropriate to local condtions. These results are also included in Appendices E-1, and discussed in the text.

The most important findings of the survey are summarised in Tables 1-6 indicating the relative frequency of occurrence of undesirable criteria or "problems". For ease of comparison an approximate, three-point scale is used:

+++ indicates found in more than 50 per cent of observations
++ indicates found in 25-50 per cent of observations
+ indicates found in less than 25 per cent of observations

The mathematical relationship between this three-point scale and the mean values of numeric scores in Appendices E-I is approximately (lower mean score limits in each scale category occur as the proportion of "qualified YES" to "YES" answers increases):

SCALE VALUE	MEAN SCORE
+++	>2.5
++	1.75 - 2.5
+	<1.75

In some instances, to better identify problems of pesticide safety, the "polarity" of a question in questionnaires was changed. For example, in the questionnaire on pesticide stores (Appendix A), in answer to the first question - "Is the store easily approached..?", 93 per cent of respondents replied "YES" or "qualified "YES" (see attribute "access" in Appendix E). This is equivalent to 7 per cent replying "YES/qualified YES" to the "opposite" question - "Is the store not easily approached..?" (i.e. is access a problem?). In comparing Tables 1-6 with the results in Appendices E-I, consideration must be given in each case to the "polarity" of the original question.

Though the number of questionnaires completed in the survey was large, the sample size relating to a given question or criterion varied according to the number of blank returns, or "don't know" entries, for that question. Consequently, in tables identifying problems of pesticide safety, it is important to remember that sample sizes (given as "No. " or "N" in Appendices E-I) may differ.

1. PESTICIDE STORES

Pesticide stores were of three basic types (Appendix E): fully enclosed (37 per cent of stores); open-sided (roof and uprights, but no walls) (2 per cent); and fully open (open storage area, no roof, no sides) (33 per cent). Most stores were a combination of two or more of these types with many changing over the season as chemical was delivered or used. Many stores, particularly the "open" type, had sandy soil or dirt floors. These may in one way represent a benefit, because the sand/dirt will absorb pesticide leaks and spills. But if leaks/spills are not immediately collected and safely disposed, the soil may represent a hazard, especially if strong winds disperse contaminated particles, or if people walk through contaminated soil wearing inadequate footwear. Problems associated with the siting, design and construction of pesticide stores are identified in Table AC. 1.

TABLE AC.1 FREQUENCY OF OCCURRENCE OF PROBLEMS IN THE SITING, DESIGN AND CONSTRUCTION OF PESTICIDE STORES.

Siting	Relative Freq.
Store not easily reached by delivery vehicles/road poor	+
Store too near other buildings (houses, offices etc.)	+++
Store too near public water supply (canal, pond etc.)	+++
Danger of pesticide spills entering water courses	++
Store too near fuel supplies (petrol, diesel etc.)	+++
Insecure site (lacks security fence/fence broken etc.)	+++
Site in area of possible flooding (e.g. in heavy rain)	+++
DESIGN/CONSTRUCTION	
Store not built for purpose of storing pesticides	+++
Store too small for storage requirements	++
Floor of store cracked/porous (or of dirt/soil)[1]	+++
Walls of store cracked/porous (if applicable)	++
No means of retaining spills (excludes soil/dirt floors)	+++
Roof leaks	++
Roof will not collapse in event of fire (retain pesticide fumes)	++
Inadequate ventilation	++
Inadequate lighting (excludes open stores)	+++
Store gets uncomfortably hot during the day	+++
Storekeepers office/desk inside store	++
Store built of combustible material	+
Store has faulty electrical fittings	+
Store weak/likely to collapse in severe weather	+
Store not locked or sufficiently guarded	+
Store has inadequate washing facilities	+++

[1] In some instances may be regarded as a benefit (e.g. soil absorbs spills), but only when spills are immediately collected and disposed.

Nearly all stores (95 per cent) had direct access to the outside - a good safety feature. Though most stores were rated as being easily approached by vehicles, this assessment was particularly subjective because roads were often very bumpy (hazardous when transporting pesticides) and, under Sudanese conditions, many would become impassable when wet.

Table AC.2 summarises problems associated with storage systems and store management practices. In most instances (87 per cent) reliable, up-to-date records were kept of pesticides in store (occasionally, it was not possible to see records because only the watchman was on site - information from senior local staff (e.g. area Entomologist) that good records were kept was accepted as reliable). Pesticides were generally issued on a "first-in, first-out" basis; the exception being usually in relation to old stock, no longer approved for use on cotton, which was awaiting eventual disposal.

Very little pesticide was seen in food or drinks containers in pesticide stores (on one occasion at an airstrip, a Coca-Cola container was used to hold pesticide for priming the pump used to load aircraft). In none of the stores was food and drink, or clothing for retail, among the products stored, though other items were kept in store (Table 2). In 24 per cent of stores, storemen reported that staff had suffered symptoms of pesticide poisoning; of these, 33 per cent (represents 8 per cent of the total sample of stores) had required professional medical attention.

In a sample of 30 stores, working conditions in them were thought to be generally hazardous (see attribute "hazard" in Appendix E) for a variety of reasons, including pesticide disposal (very old stock) problems. A list of some of the old/unusable pesticide requiring safe disposal is included in Appendix E (refer to last page of Appendix E for raw data from individual stores, and end of "attribute" column in summary sheets).

In four stores watchmen used the outer packaging (cardboard)of pesticide containers to construct their shelter, or to make a bed/mattress on top of full pesticide drums (attribute "packinuse" in Appendix E). In at least six stores "empty" pesticide containers were used to contain other items such as fuel or water ("continuse" in Appendix E), and at five stores domestic animals were kept in the store enclosure or immediate store vicinity.

DISCUSSION AND RECOMMENDATIONS - PESTICIDE STORES

Many of the stores inspected were fully open storeage areas, or stores with open areas, offering no shade or protection from rain. Essentially, the very minimum requirement for all but the most temporary storage (i.e. one-day storage, prior to use in the field) is security from theft/unofficial use, and dry, cool, well-ventilated conditions. A number of open stores offered two of these conditions - good ventilation and adequate security (they were fenced and guarded by watchmen); other open stores offered only good ventilation.

Considering the value of pesticide currently in open stores it would be worthwhile, in economic terms, to convert all open stores to open-sided stores offering at least some shade from direct sunlight. Ambient temperatures in the field reached about 40°C when the Safety Specialist was in the Sudan, and the metal surfaces of pesticide drums in direct sunlight must have been at considerably higher temperatures than this. It is understood that SGB officials have recently measured temperatures exceeding 60°C on the surface of drums in direct sun. It is highly probable that under these conditions much active ingredient is degraded (effectively, lost) while pesticide is in open storage. It is therefore recommended that serious consideration be given to the conversion of open stores to at least open-sided stores, as a matter of some priority. The minimum requirement is the provision of a roof over pesticide containers, to shade them from the sun. Better would be the provision of

TABLE AC.2 FREQUENCY OF OCCURRENCE OF PROBLEMS IN STORAGE SYSTEMS AND STORE MANAGEMENT PRACTICES

Storage System	Relative Freq.
Pesticide stored directly on floor (no dunnage)	+++
Insufficient shelving (or dunnage)	+++
In adequate gangways between stacks	+++
Different types of pesticide together (e.g. insecticide & herbicide)	++
Seed or fertiliser also in store	++
Flammable liquids (e.g. fuel, kerosene) also in store	++
Tools/miscellaneous equipment also in store	++
Repacking of pesticide (other than emergency) done in store	++
STORE MANAGEMENT	
No date of receipt/delivery on pesticide container	+++
In adequate labelling of pesticide containers	+++
Pesticide stored "wrong way" up[1]	++
Unsafe stacking heights	+
Damaged/broken pesticide packages left in store	+++
Pesticide not issued on FIRST-IN, FIRST-OUT basis	++
Store inspection too infrequent	+
Out-of-date stock (sometimes unusable) seen	+++
Inadequate protective clothing available	+++
Eating/drinking allowed (or seen) in store	++
Smoking allowed (or seen) in store	+
Store generally untidy (unnecessarily so)	++
Badly corroded pesticide containers seen	+++
Undisposed spills observed	++
Insufficient/no hazard warning signs in store	+++
Inadequate/no fire fighting equipment	+++
Inadequate/no first-aid facilities	+++
Storekeeper/staff inadequately trained (safety aspects)	+++

[1] Large metal drums are often stored on their sides, this procedure is acceptable provided drums carry no markings to indicate otherwise.

surrounding "half-walls" (say 1-2 metres high, but not reaching fully up to the roof) to afford greater protection from sun and rain, yet allow adequate ventilation. These walls should have wide openings, probably on each side, to allow easy access to the pesticides in store. No doors are necessary.

Present "open-sided" stores comprise roof and vertical supports, but no side walls. These are useful designs for pesticide storage, especially for large drums of pesticide, but they still allow strong sunlight to reach many of the drums in store, raising their temperature to very high levels; and do not prevent rain penetrating the store in windy weather. On balance it would be appropriate to erect, as indicated earlier, low walls (1-2 metres high) around the store, to offer more protection from sun and rain, yet allow adequate ventilation. Again, there should be wide openings on each side, for easy access.

The results summarised in Tables AC.1 and AC.2 indicate that some of the main problems of pesticide storage could easily be avoided with better planning and better day-to-day management. A number of remedies, particularly those related to operational procedures, could be made at very little (or no) additional cost. Other problems (for example, structural modifications and large-scale pesticide disposal) will require financial commitment to alleviate them. It is recommended that immediate attention be given to low-cost improvements (better store husbandry etc), and that serious consideration be given to providing the necessary resources to make longer-term improvements (structural modifications to stores, better training of staff etc). Safe disposal of old/unwanted pesticide should be regarded as an urgent requirement.

On the siting of stores the most frequent problems (or potential problems, if a large-scale emergency occurred) were that the store was situated too near domestic houses or offices; too near an additional source of fire risk (e.g.petrol/diesel tanks); too near a source of "public" water supply which might become contaminated; that the store was insecure (lacking a good security fence); and that the site was liable to flooding in heavy rain. Less common, though still an important problem (which, as indicated earlier, might be underrated due to seasonal effects of weather) was poor road access.

Problems were identified in store design and construction, the most frequent being that the store was not designed for the purpose of storing pesticides (the "open" pesticide store is also included in this category); thatthe store became excessively hot during the day; and that no or inadequate washing facilities were provided for storemen. Comment has been made on the safety implications of dirt/soil floors in pesticide stores. Problems of inadequate ventilation (especially in enclosed stores), often associated with high temperatures in the store, may be reduced by opening store doors for at least seven hours a week. This simple procedure helps to vent the store of toxic vapours which may accumulate, thus making the store safer for the workmen within, and also minimises the danger of flammable vapours (e.g. from formulation solvents) building up, which might cause fire if their flash points are reached.

A number of "avoidable" problems, easily remedied at low cost, were identified (Table AC.2). These were largely "operational" problems not normally seen in good store management practice. Because of the vast quantity of pesticide involved, it is not surprising to find drums stored on the ground, rather than on dunnage. This practice is acceptable for relatively short-term storage (1 or 2 years) of pesticide in metal drums which are in rapid turnover, but unacceptable fo older stock (which will corrode rapidly if the drums are allowed to stand on damp/wet surfaces) and for the storage of cardboard cartons. Insufficient dunnage (and virtually no shelving) in stores was a very common occurrence.

Inadequate gangways between pesticide stacks were common, making it necessary (and dangerous) to climb over containers to inspect the stock. Different types of pesticide (for example, insecticide and herbicide) were often found stored close together. This practice is not recommended because of the risk of possible cross-contamination. In a number of instances pesticide was stored in the same store as, and often very close to, seeds and fertilisers, fuel, or miscellaneous tools and agricultural machinery. Pesticides must be kept separate from other items.

Very often there was no indication on the container of the date of manufacture (or delivery/receipt) of pesticide, though records of dates were kept in log books. Sometimes it was difficult to discern the name of the product, or its formulation, from the markings on the container. It is recommended that all pesticide containers be stamped or otherwise marked with the date of manufacture, the name of the product (preferably the approved common name, as well as the trade name), the formulation (one instance of ULV and e.c. formulations being inadvertently mixed and sprayed together cccurred), and the concentration of active ingredient. In addition, appropriate hazard warning should be indicated, using "signal" words or recognised symbols (conventionally, the signal words "DANGER: POISON", together with a skull and crossbones, are used to denote highly hazardous pesticide forumulations; "WARNING" is used to denote moderatly hazardous material; and "CAUTION" is used to denote slightly hazardous products). It is the content of the container, whether it be active ingredient or formulated product (usually the content is a formulated product), that should be classified. All markings on containers should be in English and Arabic.

Damaged or split pesticide containers were a common occurrence in stores, often associated with pesticide spills. All damaged containers should be replaced by good ones, and split pesticide cleaned up and safely disposed. Protective clothing should be provided for storekeepers handling concentrates together with facilities for repacking and adequate washing facilities soap and running water). Eating, drinking or smoking must not be permitted in or near the storage area.

General untidiness was common in the stores inspected. The importance of tidy storekeeping cannot be overemphasised, not only on grounds of safety, but also because it saves store inspection time and minimises wastage. It is appropriate here to congratulate the staff of the White Nile Agricultural Corporation pesticide store, at Kosti, who had very limited resources (the store was completely open), yet maintained a very tidy store.

Hazard warning signs,simple fire-fighting equipment (buckets, or small drums of soil or sand are useful to put out small fires), and basic first-aid facilities were generally lacking in stores. Very few storemen had received any training in basic principles of pesticide store management.

Most stores had some out-of-date pesticide awaiting disposal. In some instances the quantity of out-of-date material was substantial, and represented a major problem, both financially (proper disposal by incineration is a costly process) and in terms of safety. It is possible that some of the unwanted stock could be given to others for use in an official capacity (for example, the 1,464 drums of DDT at Gorashi store was of interest to Public Health Department officials, who indicated that the DDT could be analysed by them (to determine concentration of remaining active ingredient, and to test formulation properties), and, if suitable, used in mosquito control programmes). The remainder of the stock, particularly the most hazardous chemicals,should be suitably disposed as a matter of some urgency. Proper adherence to the basic rule "FIRST-IN FIRST-OUT" in the movement of pesticide stock should minimise the need to dispose of large stocks of pesticide in the future, particularly if care is taken to avoid the procurement of more pesticide than is needed for a given programme of pest control.

2. PESTICIDE TRANSPORT

Limited opportunities were found to evaluate pesticide transportation procedures (loading, transit, off-loading) from stores to airstrips. Results of observations (which relate to the first part of the questionnaire in Appendix B) are summarised in Appendix F. From observations, problems associated with transportation were identified (Table AC.3).

DISSCUSSION AND RECOMMENDATIONS - PESTICIDE TRANSPORT

Loading procedures were generally acceptable. Typically, a team of men lifted pesticide drums from ground level onto the backs of trucks, using one upright drum as an intermediate platform. The procedure was usually coordinated by singing or chanting, and the process seemed efficient. Pesticide drums were generally in reasonable condition when loaded; no additional damage to them was observed during this procedure. Trucks were often loaded to the maximum, with drums stacked high. Considering the bumpiness of the roads to be negotiated, the drums were probably stacked too high for optimum safety.

Except in Rahad, other items were often transported with pesticide. Items included food and water for labourers, bedding and camping gear, labourers and their baggage, fuel for aircraft, and miscellaneous supplies including cooking utensials. Rahad observations (Appendix F) may indicate better transportation practice in that area than elsewhere, though the data received from Rahad were combined observations of 3 visits to 8 airstrips, rather than 24 independent assessments, and could not therefore be included for analysis in the main body of results. It is recommended that, wherever possible, pesticides should not be transported with other items, especially food and water, or bedding and clothing. Where vehicles which have been used to transport pesticide are later used to transport other items, special attention must be given to the decontamination of pesticide spills on these vehicles.

TABLE AC.3 FREQUENCY OF OCCURRENCE OF PROBLEMS ASSOCIATED WITH THE TRANSPORT OF PESTICIDES

Transport	Relative Freq.
Pesticides not loaded carefully	+
Pesticide containers in poor condition when loaded	+
Other items transportedwith pesticide	+++
Condition of vehicle not checked before loading pesticide	+++
No documentation identifying pesticide	+++
No documentation on hazardous nature of pesticide	+++
No documentation on safety procedures to be followed	+++
No documentation giving name and address of supplier	+++
No fire extinguisher	+++
Inadequate protective clothing	+++
No clean-up equipment/materials for spills	+++
No training in accident/safety procedures	+++
Accident occurred during loading/transport/off-loading	+
Pesticide containers in poor condition on delivery	+
Pesticide not off-loaded carefully	++
Consignment delivered disagrees with that loaded	+
Pesticide storage facilities at point of delivery inadequate	+++

All vehicles possessed a safety barrier (cabin or tractor/trailer combination) between driver and load, but few drivers carried documents identifying the pesticide being transported, the hazardous nature of the load, or safety procedures to be followed in the event of accident. Fire extinguishers, simple protective clothing for drivers, or equipment for mopping up spills were rarely if ever carried on vehicles transporting pesticide. Sensibly, soil was generally used to absorb spills, but contaminated soil was then usually left in situ, rather than safely disposed. In most instances, drivers had received no training in pesticide safety and were unaware of proper procedures in the event of accidental pesticide spillage. It is recommended that drivers, or their assistants, be given basic training in pesticide safety procedures. Very few accidents ("accid" in Appendix F) relating to transportation of pesticides were reported.

Off-loading of drums at airstrips highlighted poor safety considerations. In most instances observed, drums were simply pushed off the backs of the vehicles and allowed to fall to the ground, sometimes denting them markedly. On other occasions an old truck tyre was used to help break the fall of drums. These procedures are unsatisfactory because, even with the cushioning effect of a vehicle tyre, there remains a risk of drums bursting open, particularly those which may be corroded. It is recommended that simple ramps made of wooden planks be used for off-loading drums using ropes to roll down the drums. Mechanical hoists would be a better, though more costly, solution to this problem, and transportation to the spray strips could present problems.

Pesticide was normally delivered to the spray strips on the day of spraying operations, and sometimes a day or two earlier. It is recommended that whenever pesticide is delivered early, a guard should be present at all times to ensure pesticide is not used for unofficial purposes.

3. AIRSTRIPS

Observations at airstrips (relating to the second part of the questionnaire in Appendix B) are summarised in Appendix B. From these observations, problems associated with airstrip procedures were identified (Table AC.4).

TABLE AC.4 FREQUENCY OF OCCURRENCE OF PROBLEMS AT AIRSTRIPS

Handling/Mising Pesticides	Relative Freq.
Inadequate labelling on pesticide containers	+++
Insufficient pesticide hazard/warning notices	+++
Safety instructions not read/obeyed	+++
Insufficient care when handling/mixing pesticides	++
Unauthorised persons/animals present	+++
Pesticides mixed improperly	+
Insufficient protective clothing - overalls	++
Insufficient protective clothing - gloves, boots, face mask etc.	+++
Protective clothing not worn	+++
Soap and water unavailable	++
Eating/drinking/smoking allowed near pesticide	++
Staff mixing/handling inadequately trained	+++
Staff mixing/handling inadequately supervised	+

TABLE AC.4 FREQUENCY OF OCCURRENCE OF PROBLEMS AT AIRSTRIPS (Continued)

Loading Aircraft	Relative Freq.
Insufficient care when loading	+++
Inaccurate monitoring of pesticide loading	+
No checks on secure tanks/contamination of aircraft	++
No empty containers available for pesticide spills	++
Pesticide spills not cleaned up	+++
No trained/experienced general supervisor	+
No trained/experienced foreman i/c pesticide management	++
Insufficient trained support staff	++
ADDITIONAL SAFETY ASPECTS AT AIRSTRIPS	
Local inhabitants not told about spraying/advised to stay clear	++
Local inhabitants not told safety period	++
Little effort to avoid spraying foodcrops/humans/livestock/water	+
Inadequate first-aid facilities	+++
Empty containers not returned to pesticide store	+
Unused pesticide not returned to pesticide store	+
Aircraft not properly calibrated before spraying	+
Accidents involving pesticide occurred at airstrip	+
Application equipment improperly cleaned	++
Inaccurate/insufficient record kept of aerial application	+
Accident during aerial spraying	+++

DISCUSSION AND RECOMMENDATIONS - AIRSTRIPS

Pesticide handling and loading procedures, generally, gave cause for concern (Table AC.4). In some instances pilots did not know what product was being loaded (only that it was, for example, a ULV formulation) and had little idea of its mammalian toxicity (some pilots wore only shorts and sandals when flying aircraft). Loaders knew what product was being loaded, but knew little about its toxic hazard. Consequently, in most instances observed, too little attention was given to pesticide safety procedures. The result of this was evident from the blood cholinesterase tests carried out by the project (Ref. Chaper 5 and Annex D).

Overalls were worn by many loading staff, but were not washed at regular intervals (it is generally recommended that protective clothing be washed at the end of each day, unless grossly contaminated, in which case is should be washed immediately). Occasionally, rubber gloves were available for persons emptying pesticide drums and those connecting the feed hoses to aircraft. Several gloves inspected by the Safety Specialist appeared to be contaminated on the inside (they had the odour of pesticide in them, and an "oily" feel). Clearly, it is not sensible to waear gloves contamined in this way - it would be safer to wear no gloves at all, particularly if hands were washed at regular intervals! Other types of protective clothing (boots, face shields, etc) were lacking or, if available, not worn. This was no surprise because to wear full protective clothing (rubber suit, face mask, gloves, boots etc.) in the tropics soon becomes extremely uncomfortable, and can lead to additional hazards though tiredness or exhaustion. Nevertheless, it is recommended that at least adequate protective clothing be provided for all personnel handling pesticide concentrates AND (most important)that, for them, training be given in the proper use of this protective clothing.

Evidence from the Sudan (including results of blood tests of acetyl cholinesterase inhibition obtained by other members of the team) suggests that, without adequate training, the provision of protective clothing such as rubber gloves and boots could well lead to greater risk of pesticide contamination among airstrip personnel. Provision of protective clothing without training in its proper use cannot, therefore, be recommended. In general, for most airstrip workers, it seems more important to change (through better supervision and training) dangerous handling and loading practice than to provide full protective clothing, which might not be worn.

Soap and water for washing was available at some, but not all, airstrips. It is recommended that a large tank of water, preferably fitted with a top, and plenty of soap should be provided at all airstrips not adjacent to canals. Ideally a mobile shower is needed. On occasions staff were soused completely with insecticide when hoses under pressure burst.

Eating, drinking and smoking near pesticides was a common sight at airstrips (in one instance, food was being prepared within 15 metres of the pesticide drums and, in another, a person was smoking a cigarette while sitting on a pesticide drum). Such activities must be kept well away from pesticides. The rules forbidding them are often ignored and should be enforced.

Generally, pilots did not handle pesticide; all loading was done by the loading teams. Loaders were mostly inexperienced, and had received no special training in safety aspects of their work being instructed by experienced workers. Mistakes were made during loading. For example, on several occasions much pesticide was spilled, unnecessarily, when the feed hose was disconnected from the aircraft. The spillage was left on the runway (it should have been collected and safely disposed by burial).

At several airstrips, halved 44 gallon drums were used to collect surplus pesticide draining from feed hoses after disconnection from aircraft, but these containers represented a potential hazard. One type (a drum cut in half across the longest dimension to form a U-shaped container) was particularly hazardous because it was unstable. On a number of occasions the container was seen to rock when the filler hose was dumped in it, and spillage occurred. A simple anser to this problem would be to provide wedge-shaped blocks to prevent rocking. The other type of container (a drum cut in half across the middle, leaving a flat base) was also unsatisfactory because, like the U-shaped container, it was difficult to reposition, particularly when full. Containers mounted on stable trolleys, which can be wheeled to and from aircraft when necessary, would minimise this problem.

Usually there were inadequate first aid facilities at airstrips, and airstrip staff (including pilots and mechanics) were unaware of action to be taken in the event of an emergency involving pesticide contamination.

Supervision of the type and quantity of pesticide off-loaded from vehicles and loaded onto aircraft was usually good. Supervision of handling and loading procedures was poor (ratings in Table AC 4. for these criteria are probably underestimates because additional data from Rahad and New Halfa (see "Super" and "Genboss" in Appendix 6) indicate a higher frequency of occurence of inadequate supervision) due, probably, to the lack of proper training of supervisors. Often, there was no clear differentiation of areas of responsibility of staff at airstrips. On one occasion, for example, a loader busy at pesticide drums had to warn village people walking across the airstrip that the plane was about to take off. The presence of "unauthorised" people (and domestic animals) at airstrips was a common observation in most regions, except Rahad and New Halfa.

Problems of calibration/operation of spray gear were observed (for example, some rotary atomisers had siezed up; other apparatus dripped pesticide excessively) but these aspects, described elsewhere, were investigated more closely by the Application Specialist (Ref. Section 3.1.3).

In a sample of 14 airstrips, most were assessed as "generally hazardous" ("Genhaz" in Appendix G), usually because of improper pesticide handling (including much spillage), inadequate training of staff, and limited resources affecting safety. At eight airstrips better first-aid facilities and protective clothing were specifically requested; at five airstrips more tents were requested to protect labourers from excessive sun (some airstrips had no tents/ shade at all); and at four airstrips unauthorised access by villagers and livestock was considered a serious problem.

Reports of airborne accidents were relatively frequent (Table AC.4), and during the season four were reported. In one instance, when the Safety Specialist was in the Sudan, an aircraft carrying Decis/dimethoate mixture "crash" landed in an irrigated field immediately after take-off and was unable to get airborne again. The engineer/assistant attempting to help the pilot became heavily contaminated with pesticide (which had been dumped, in an attempt to lighten the plane when the pilot tried to move out under engine power)and later suffered moderate to severe symptoms of pesticide poisoning. Though inadequate first-aid facilities (and no antidotes) were available, the patient and pilot failed to follow even the most elementary safety procedures (such as washing immediately in the nearest canal), presumably through lack of understanding of pesticide hazard and consequences of pesticide poisoning.

In general, safety procedures at airstrips were unacceptable (Table AC.4) due, largely, to lack of awareness, lack of training, and inadequate supervision. Much could be improved, at relatively little cost, with better day-to-day airstrip management, and with basic training in pesticide safety for all airstrip staff. Recommendations for improvement, therefore, are to concentrate first on basic needs. These are also discussed under Section 3.1.3.

4. FARMERS AND FIELD WORKERS

Awareness of pesticide hazard among farmers and field workers was assessed by questionnaire (Appendix C), with the help of local staff acting as interpreters. Results are summarised in Appendix H. Because of the large number of farmers and field workers interviewed, results are considered reliable even though, on occasion, communication was difficult. From the results, problems associated with farmer/field worker awareness were identified (Table AC.5).

DISCUSSION AND RECOMMENDATIONS - FARMERS AND FIELD WORKERS

In many areas farmers (the term "farmers" includes field workers for the rest of this report) were not told, in advance, when aerial spraying was to be done, nor what type of pesticide was to be used. Most (60-70 per cent) were advised to stay clear of crops at the time of spraying but, on average, only about 50 per cent were advised to keep out of crops for a somewhat arbitrary safety period (usually 24h). Additional data from Rahad and New Halfa (Appendix H) indicate that, in these areas, the proportion may have been much lower. Almost universally, no protective clothing was worn by farmers entering treated crops during, or soon after, aerial spraying.

Very few farmers used pesticides themselves at work or at home ("workuse" and "homeuse" in Appendix H), consequently few had received training in pesticide safety.

TABLE AC.5 FREQUENCY OF OCCURRENCE OF PROBLEMS AT FIELD WORKER/ FARMER LEVEL

Field Worker/Farmer	Relative Freq.
Not told in advance when spraying to be done	+++
Not told what type of pesticide used	+++
Not advised to stay clear of crops at time of spraying	++
Not advised to keep out of crops for safety period	++
No protective clothing worn when entering treated crops	+++
No trainning in pesticides/pesticide safety	+++
Not aware that pesticides may be hazardous to man	+
Not aware of oral route of poisoning	++
Not aware of dermal route of poisoning	+++
Not aware of inhalation route of poisoning	++
Would not recognise symptoms of pesticide poisoning	+++
Human poisoning symptoms related to aerial spraying	+
Farmer offered empty containers	+
General public in area not notified of spraying	+++
General public in area not warned to stay clear	+++
General public in area not advised of safety period	+++
Aircraft observed spraying people	+
Aircraft observed spraying livestock	+
Aircraft observed spraying foodcrops	+
Aircraft observed spraying water courses	++
SUPPLEMENTARY QUESTIONS	
Dead fish seen in canals after aerial spraying	+++
People eat dead fish	+++
People swim, wash, drink in canal	+++
Aerial spraying said to kill domestic animals	++

Generally, farmers were aware that pesticides were hazardous to man, but few recognised all of the routes of entry of pesticides into the human body. Most recognised the oral and inhalation routes, but only 30-40 per cent of farmers were aware of the dermal route of entry. With the possibe exception of Rahad and New Halfa (Appendix H), few farmers would recognise many of the symptoms of pesticide poisoning if they occurred, though a greater number said they would recognise some of the symptoms, particularly if they occurred in domestic animals.

It is recommended that farmers be made more aware, through all possible extension media, of the possible dangers of dermal contamination by pesticides (perhaps the most likely route of entry in sprayed cotton fields), and informed of general symptoms of pesticide poisoning.

Occurrence of pesticide poisoning among farmers during, or soon after, aerial spraying was rare (none in Rahad or New Halfa). Observations of dead fish in canals at such times were very common. In a sample of 78 farmers, 75 per cent said that local villagers ate the dead fish seen in canals, though no evidence of villagers becoming sick as a result was obtained (Ref. Section 8.2.1). Most villagers swam and washed in canals, and drank canal water when in the fields.

Farmers opinion on whether aircraft sprayed (accidentally or otherwise) "non-targets" such as people, livestock, foodcrops or water courses varied (Appendix H). In relatively small samples from Rahad and New Halfa, the majority of farmers had seen aircraft spraying all of these non-targets (though relatively few had seen dead fish in canals!); in a larger sample from other regions, fewer farmers (Table AC.5) had observed such occurrences.

It is the responsibility of the production Corporation to notify villagers and farmers when and where airspraying will take place. In general, villagers/local public were not told in advance when aerial spraying was to be done in their area, nor warned to stay clear of fields during spraying or to keep out of them for a given safety period after spraying. It is recommended that farmers and local villagers be advised in good time about aerial spraying operations in their area, and that appropriate safety warnings be given. The present system was found to be ineffective.

Results of supplementary questions about causes of death among domestic animals are detailed in Section 3.2.6.

5. PESTICIDE CONTAINERS

Results of the survey on pesticide containers (which relate to the questionnaire in Appendix D) are summarised in Appendix I. From these results, a number of potential hazards and problems were identified (Table AC.6), even though the sample size was small.

DISCUSSION AND RECOMMENDATIONS - PESTICIDE CONTAINERS

Mostly "empty" containers had been returned from airstrips or other field sites; to Block or Group stores prior to disposal. i.e. Pesticide stores are also container depots. The majority of containers were large (200 litre) metal drums, though medium-sized drums (20-100 litre) were also present in 69 per cent of depots. Plastic containers were less common, occurring in less than 20 per cent of depots (Appendix I).

All block and group stores sold (or gave) metal containers to others for re-use ("otherus/m" in Appendix I), and most of those with plastic containers also offered them for re-use. In the majority of instances (92 per cent) "empty" containers were not cleaned or decontaminated before sale; only two exceptions were noted, one being containers from the Shell Chemical Co. formulation plant which were reported (Appendix I. raw data) to be rinsed with water and detergent and, in some instances, caustic soda. The second was the Duiem Store on White Nile were decontamination is by washing and then burning off residue with petrol.

Empty containers were used for a variety of purposes (Table AC.6), some of which (for example, the storing of food or water) were potentially highly hazardous - especially as most containers were sold uncleaned. Recognising this (and that, in view of the intrinsic usefulness of empty pesticide containers in the Sudan any recommendation that pesticide containers be destroyed would be ignored), it is strongly recommended that all "empty" pesticide containers be cleaned (preferably by thorough rinsing and soaking) by the seller, before sale. The producing corporations should assume this responsibility not pass it to the buyer. The Government of the Sudan is urged to consider introducing legislation to this effect, even though the current view of the Corporations is that responsibility for washing out containers lies with the purchaser.

Empty pesticide containers were sold to a number of merchants (unit purchasing price typically £10-£20 Sudanese) for conversion into other items (Fig AC.1). One merchant converted containers into a range of cooking utensils, including concave pans similar to

FIGURE A.C.1 RE-USE OF EMPTY PESTICIDE CONTAINERS (conversion of metal drums)

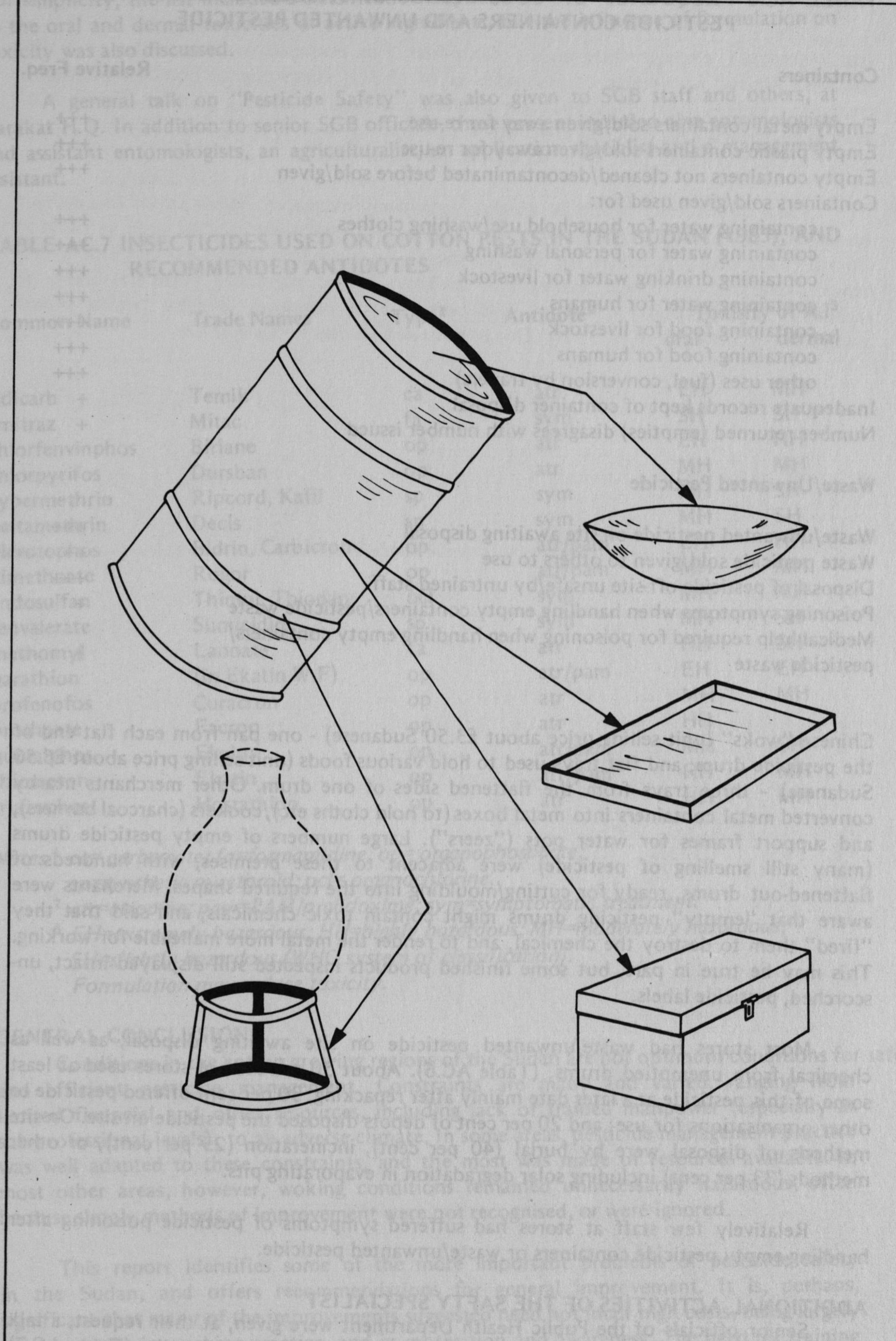

TABLE AC.6 FREQUENCY OF OCCURRENCE OF PROBLEMS ASSOCIATED WITH PESTICIDE CONTAINERS AND UNWANTED PESTICIDE

Containers	Relative Freq.
Empty metal containers sold/given away for re-use	+++
Empty plastic containers sold/given away for re-use	+++
Empty containers not cleaned/decontaminated before sold/given	+++
Containers sold/given used for:	
containing water for household use/washing clothes	+++
containing water for personal washing	+++
containing drinking water for livestock	+++
containing water for humans	+++
containing food for livestock	+++
containing food for humans	+++
other uses (fuel, conversion by traders)	+++
Inadequate records kept of container disposal	+
Number returned (empties) disagrees with number issued	+
Waste/Unwanted Pesticide	
Waste/unwanted pesticide on site awaiting disposal	+++
Waste pesticide sold/given to others to use	++
Disposal of pesticide off-site unsafe/by untrained staff	+++
Poisoning symptoms when handling empty containers/pesticide waste	+
Medical help required for poisoning when handling empty containers/ pesticide waste	+

Chinese "woks" (unit selling price about £3.50 Sudanese) - one pan from each flat end of the pesticide drum; and flat trays used to hold various foods (unit selling price about £6.50 Sudanese) - three trays from the flattened sides of one drum. Other merchants nearby converted metal containers into metal boxes (to hold cloths etc), cookers (charcoal burners), and support frames for water pots ("zeers"). Large numbers of empty pesticide drums (many still smelling of pesticide) were adjacent to these premises, with hundreds of flattened-out drums, ready for cutting/moulding into the required shapes. Merchants were aware that "empty" pesticide drums might contain toxic chemicals, and said that they "fired" them to destroy the chemical, and to render the metal more malleable for working. This may be true in part, but some finished products inspected still displayed intact, unscorched, pesticide labels.

Most stores had waste/unwanted pesticide on site awaiting disposal, as well as chemical from unemptied drums. (Table AC.6). About 50 per cent of stores used at least some of this pesticide at a later date mainly after repacking; 30 per cent offered pesticide to other organisations for use; and 20 per cent of depots disposed the pesticide on site. On-site methods of disposal were by burial (40 per cent), incineration (25 per cent), or other methods (33 per cent) including solar degradation in evaporating pits.

Relatively few staff at stores had suffered symptoms of pesticide poisoning after handling empty pesticide containers or waste/unwanted pesticide.

ADDITIONAL ACTIVITIES OF THE SAFTY SPECIALIST

Senior officials of the Public Health Department were given, at their request, a talk on "Symptoms and treatment of pesticide poisoning", together with a list (Table AC.7) of insecticides used in 1985 against cotton pests in the Sudan, and recommended antidotes.

For simplicity, the list included a classification of pesticide hazard (WHO system) according to the oral and dermal toxicities of active ingredients, but the influence of formulation on toxicity was also discussed.

A general talk on "Pesticide Safety" was also given to SGB staff and others, at Barakat H.Q. In addition to senior SGB officials, those present included nine entomologists and assistant entomologists, an agriculturalist, an application specialist and a management assistant.

TABLE AC.7 INSECTICIDES USED ON COTTON PESTS IN THE SUDAN (1985), AND RECOMMENDED ANTIDOTES

Common Name	Trade Names	Type[1]	Antidote[2]	Toxicity of A.I[3] oral	Toxicity of A.I[3] dermal
aldicarb	Temik	ca	atr	EH	MH
amitraz	Mitac	fa	sym	SH	SH
chlorfenvinphos	Birlane	op	atr	EH	HH
chlorpyrifos	Dursban	op	atr	MH	MH
cypermethrin	Ripcord, Kafil	sp	sym	MH	SH
deltamethrin	Decis	sp	sym	MH	SH
dicrotophos	Bidrin, Carbicron	op	atr/pam	EH	HH
dimethoate	Rogor	op	atr/pam	MH	MH
endosulfan	Thimul, Thiodan	ocl	sym	MH	MH
fenvalerate	Sumicidin	sp	sym	MH	SH
methomyl	Lannate	ca	atr	HH	SH
parathion	(in Ekatin W.F)	op	atr/pam	EH	EH
profenofos	Curacron	op	atr	MH	MH
prothoate	Facron	op	atr	HH	
quinalphos	Ekalux	op	atr/pam	MH	SH
thiometon	Ekatin	op	atr/pam	HH	MH
triazophos	Hostathion	op	atr	HH	MH

Notes [1] *ca= carbamate; fo=formamidine; op= organophosphate; sp=synthetic pyrethroid; ocl= organochlorine.*

[2] *atr=atropine; pam=PAM/pralidoxime; sym=symptomatic treatment.*

[3] *EH=extremely hazardous; HH=highly hazardous; MH=moderately hazardous; SH=slightly hazardous (WHO system of classification). Formulation may reduce toxicity.*

GENERAL CONCLUSIONS

Conditions in the cotton growing regions of the Sudan are not optimum conditions for safe and efficient pesticide management. Constraints are many and varied, ranging from limited financial and other resources, including lack of trained manpower (especially at sub-professional levels), to an adverse climate. In some areas, pesticide management practice was well adapted to these constraints, and the most was made of resources available. In most other areas, however, woking conditions remained unnecessarily hazardous, often because simple methods of improvement were not recognised, or were ignored.

This report identifies some of the more important problems of pesticide safety in the Sudan, and offers recommendations for general improvement. It is, perhaps, significant that many of the improvements suggested need not incur high costs, being largely improvements in working practice, and in motivation and awareness. The need for training was widespread, encompassing several disciplines. For example, many local hospital staff had very limited knowledge of pesticides or of clinical symptoms of pesticide poisoning; pesticide handlers loading packs (some of them damaged) of Temik granules (Temik is an extremely hazardous pesticide) were observed climbing over the packs and throwing them onto transport vehicles, with little regard for their own safety.

Some improvements will be costly, particularly extensive modifications to pesticide stores, and the safe disposal of very large stocks of unwanted pesticide such as those at Gorashi Main Store. Priorities for disposal should be those pesticides (and pesticide breakdown products) of highest mammalian toxicity; highly persistent pesticides likely to represent an environmental hazard; and pesticides of unknown identity (which should always be regarded as highly toxic). This is discussed further in Section 4.6.

ANNEX C

APPENDICES

APPENDIX A

QUESTIONNAIRE: PESTICIDE STORES

QUESTIONNAIRE: PESTICIDE STORES REF.NO. SUD/__________

NAME/LOCATION OF STORE:

ORGANISATION RESPONSIBLE:

CONTACT PERSON:

Please answer each question by putting a tick (✔) in the appropriate space, and give further details where indicated.

QUESTIONS	ANSWERS YES	NO	DONT KNOW	
SITING OF STORE				
1. Is the store easily approached by delivery vehicles etc?				1
2. Is the store near other buildings (houses, shops, farms, factories, etc)?				2
3. Is the store near a public water supply (river, well standpipe, pond etc)?				3
4. Is there a danger of pesticide spills entering drainage channels and water courses?				4
5. Is the store near fuel supplies (petrol pumps, fuel dumps etc)?				5
6. Is there a security fence (or other barrier) around the site?				6
7. Is the site in an area where there is danger of flooding?				7
BUILDING DESIGN AND CONSTRUCTION				
8. Is the store designed especially for the purpose of storing pesticides?				8
9. Is the store large enough for your storage requirements?				9
10. Is the floor free from cracks and non-porous (leak-proof) to pesticide spills?				10
11. Are the walls free from cracks and non-porous (leak-proof) to pesticide spills?				11
12. Does the store have a means of preventing spills reaching public drains and water supplies (trench, bund, sump etc)?				12
13. Does the roof leak?				13
14. Will the roof (by collapsing, or otherwise) allow fumes to escape in the event of fire?				14
15. Is there adequate ventilation in the store?				15
16. Is there adequate lighting in the store?				16

Question	YES	NO	DONT KNOW	
17. Does the store get uncomfortably hot during the day?				17
18. Is the storekeeper's office/desk inside the store?				18
19. Is the store built of combustible material (eg wood)?				19
20. Are electrical fittings (wires, switches etc) faulty or likely to cause sparks?				20
21. Does the store have a direct exit to the outside (ie <u>not</u> through another store or building)?				21
22. Is the store of weak construction, likely to collapse in severe weather?				22
23. Is the store normally locked (or guarded) to prevent unauthorised entry?				23
24. Does the store have washing/decontamination facilities for staff?				24

STORAGE SYSTEM

Question				
25. Which of the following types of <u>pesticides</u> are normally kept in the store:				25
insecticides....................................				
herbicides (weedkillers)........................				
fungicides......................................				
others (eg rodenticides)(state which.......... ....)				
26. Which types of pesticide do you stock in <u>large</u> quantity (100 or more drums or cases):				26
insecticides....................................				
herbicides (weedkillers)........................				
fungicides......................................				
other (eg rodenticides)(state which........... ....)				
27. Which of the following formulations of <u>insecticide</u> do you keep in store:				27
emulsifiable concentrate (e.c.)...............				
wettable powder (w.p.).........................				
soluble powder (s.p.)..........................				
dust..				
granule...				
ulv...				
other (state which.............................)				
28. Are pesticides normally stored:				28
on the floor....................................				
off the floor using dunnage (timber, bricks etc)...				
on shelves......................................				
29. Is there enough shelving or dunnage in the store (answer "NO" if there is none at all)?				29
30. Are there adequate gangways (at least 1 metre/3 feet) between shelves or stacks?				30

	YES	NO	DONT KNOW	
31. Are different types of pesticide (eg insecticides and herbicides) stored close together?				31
32. Are any of the following products also kept in the store:				32
seeds/fertilizer....................................				
fuel (eg petrol, kerosene)...........................				
food/drink/animal feed...............................				
tools/equipment......................................				
clothing for retail..................................				
other goods (state which.....................)				
33. Is repacking of pesticides (<u>other</u> than in emergencies) carried out in the store?				33

STORE MANAGEMENT

	YES	NO	DONT KNOW	
34. Are reliable (accurate and up-to-date) records kept of the pesticides in store?				34
35. Is the date of receipt/delivery written on each pesticide carton or container?				35
36. Are <u>all</u> pesticide cartons and containers properly labelled (in local language if most appropriate) and in good condition?				36
37. Are any pesticides stored in food or drinks containers?				37
38. Are all pesticide cartons and containers stored the right way up?				38
39. Are sensible/safe stacking heights strictly observed?				39
40. Are damaged or broken pesticide packages:				40
left in store until the next inspection/audit.......				
repacked (or disposed) as soon as possible..........				
41. Are <u>empty</u> pesticide containers kept:				41
in the store				
nearby, but not actually in the store...............				
42. Are pesticides issued/sold on a FIRST-IN, FIRST-OUT basis?				42
43. Are store inspections by the storekeeper held regularly (at least once a month)?				43
44. Are out-of-date stocks of pesticide:				44
kept in the store until sold/distributed............				
returned to the supplier............................				
otherwise disposed (if YES give details............ ....)				
45. Is there much out-of-date pesticide stock?				45
46. Is protective clothing available/normally kept:				46
in the pesticide store..............................				
nearby, but not actually in the store...............				
47. Is eating or drinking allowed in the store?				47

Question	YES	NO	DONT KNOW	
48. Is smoking (cigarettes etc.) allowed in the store?				48
49. Is the store generally tidy?				49
50. Are there any badly corroded/broken containers (drums, cartons etc) in the store (exclude empty containers)?				50
51. Are any undisposed pesticide spills observed?				51
52. Are there pesticide hazard signs or other relevant warning signs in the store?				52
53. Is there adequate fire-fighting equipment in the store?				53
54. Are adequate first-aid facilities available nearby?				54
55. Has anyone working at the store ever had symptoms of pesticide poisoning? (if YES give details................. ....)				55
56. Has anyone working at the store ever needed professional medical attention for pesticide poisoning? (if YES give details.. ....)				56

TRAINING

Question				
57. Has the storekeeper/store manager received:				57
adequate training				
inadequate/no training............................				
58. Have junior/support staff received:				58
adequate training.................................				
inadequate/no training............................				
59. Is the storekeeper/store manager trained to give basic advice on pesticide safety and use?				59

SPACE FOR SUPPLEMENTARY QUESTIONS:

Question				
60. ____________________				60
61. ____________________				61
62. ____________________				62

SPACE FOR COMMENTS/ADDITIONAL INFORMATION:

1. ____________________

2. ____________________

3. ____________________

4. ____________________

THANK YOU

APPENDIX B

QUESTIONNAIRE: PESTICIDE TRANSPORT/AIRSTRIP

QUESTIONNAIRE: PESTICIDE TRANSPORT/AIRSTRIP REF.NO. SUD/---------/TA

NAME/LOCATION:

ORGANISATION RESPONSIBLE:

CONTACT PERSON:

Please answer each question by putting a tick (✓) in the appropriate space, and give further details where indicated.

QUESTIONS	ANSWERS			
	YES	NO	DONT KNOW	
TRANSPORT				
1. Are pesticides loaded carefully onto transport vehicles, with due regard given to the stability of the load?				1
2. Are pesticide packages/containers etc in good condition, with labels intact, when loaded? (if NO give details..... ....)				2
3. Are any *other* items (goods/equipment/materials) also loaded onto vehicles carrying pesticide? (if YES give details... ....)				3
4. For what purposes are the vehicles used when *not* carrying pesticide:				4
carrying pesticide-related equipment/materials......				
carrying foodstuffs/drinks/animal feed............				
carrying passengers/livestock.........................				
other/general purpose..................................				
5. Is the general condition of vehicles checked (against unsound floors, protruding nails, etc, likely to damage pesticide containers) before loading pesticide?				5
6. Is there a safety barrier (cabin, partition etc) between driver and load on vehicles used to transport pesticides?				6
7. Does the driver/vehicle carry appropriate documentation to identify, in the event of accident, the:				7
pesticide/product being transported.................				
hazardous nature (toxic etc) of load carried........				
safety procedures to be followed.....................				
name and address of supplier/place of despatch......				
8. Are the following items available for use (if necessary) on vehicles transporting pesticides:				8
suitable fire extinguisher..............................				
suitable protective clothing............................				
clean-up equipment/materials for spills, leaks etc.. (if YES describe general cleaning-up procedure.... ....)				
9. Have drivers who transport pesticides received proper instruction in safety procedures in the event of accident?				9

	YES	NO	DONT KNOW

10. Have any accidents occurred locally during loading, 10
transporting, or unloading pesticides? (if YES give brief
details of how the accidents occurred..................
....
....
and details of any casualties...........................
....
....)

AIRSTRIP/SPRAYING SITE

11. Are pesticide packages/containers etc in good condition, 11
with labels intact, on arrival at the airstrip/site?

12. Are pesticides off-loaded carefully from the delivery 12
vehicles at the site?

13. Does the consignment of pesticide delivered to the site 13
agree in quantity and quality with that which left the
supply depot/main store?

14. Are storage facilities at the site at least adequate 14
(secure, dry, relatively cool, well ventilated) for the
proper temporary storage of pesticides? (if NO what are
the main problems.......................................
....)

HANDLING/MIXING PESTICIDES

15. Are clear labels/instructions for the safe handling and 15
mixing of pesticides available:
- on each pesticide container...........................
- on some, but not all, pesticide containers............
- on none of the pesticide containers ....
- nearby, but not actually on containers................

16. Are general pesticide hazard/warning notices displayed at 16
the site where pesticide handling/mixing is done?

17. Are safety instructions always read and obeyed? (if NO 17
explain why not...
....)

18. Is handling/mixing of pesticides done carefully, without 18
unnecessary splashing or spillage?

19. Are unauthorised persons and animals kept away from the 19
site when handling/mixing of pesticides is in progress?

20. Are pesticides mixed properly, in the correct quantities, 20
as instructed on the label (or other Official Order)?

21. Is the following protective clothing available at the 21
site for use (if necessary) by all those handling/mixing
pesticides:
- overalls/boiler suit (or suitable equivalent).......
- gloves (eg rubber/PVC/neoprene).....................
- boots (eg rubber)...................................
- face shield/goggles.................................
- head/neck protection (eg hood, cape)................
- respirator/face mask................................

	YES	NO	DONT KNOW	
22. When handling/mixing pesticides, is the appropriate protective clothing worn? (if NO explain why not......... ....)				22
23. Is soap and water available for washing, and a clean change of clothing, in the event of contamination by pesticide?				23
24. Is eating, drinking and smoking prohibited when handling/ mixing pesticide?				24
25. Are persons handling/mixing pesticides: properly trained..				25
properly supervised				
LOADING AIRCRAFT				
26. Is loading pesticide onto aircraft done carefully, without unnecessary splashing or spillage?				26
27. Is the type and quantity of pesticide/mixture loaded onto the aircraft carefully and accurately checked/measured?				27
28. Are aircraft pilots allowed to handle/mix/load pesticides?				28
29. After loading with pesticide, are checks made to ensure that aircraft tanks are securely closed, and that there is no spillage/contamination in the aircraft cockpit?				29
30. Are <u>empty</u> containers for the <u>temporary</u> retention of surplus pesticide/mixture (after filling aircraft spraytanks etc) available at the airstrip?				30
31. Are pesticide spills or leaks which may occur during handling, mixing, or loading cleaned up as quickly as possible (if YES describe general procedure............... ....)				31
32. Is there an appropriately trained/experienced general supervisor (or equivalent), at the airstrip/site?				32
33. Is there a trained/experienced foreman (or equivalent) in charge of pesticide management (handling/mixing/loading etc) at the airstrip/site?				33
34. Are there sufficient trained support staff (ground crew etc) at the airstrip/site to ensure safe and efficient pesticide handling?				34
ADDITIONAL SAFETY ASPECTS				
35. Are local inhabitants told in advance about spraying operations, and advised to <u>stay clear</u> of treatment areas during spraying?				35
36. Are local inhabitants advised to stay out of treated areas for an appropriate <u>safety period</u> after spraying?				36
37. Is every effort made to avoid spraying foodcrops, humans livestock and water courses during aerial application of pesticides?				37

	YES	NO	DONT KNOW	
38. Is there adequate first-aid/emergency equipment available at the airstrip/site?				38
39. Are all <u>empty</u> <u>pesticide</u> <u>containers</u> returned to the main pesticide store after aerial spraying is completed? (if NO describe what happens to them.......................... ....)				39
40. Is all <u>unused</u> <u>pesticide</u> returned to the main pesticide store after aerial spraying is completed? (if NO describe what happens to it.. ....)				40
41. Is all aircraft spray equipment properly <u>calibrated</u> before spraying operations begin?				41
42. Have any accidents occurred locally during handling/mixing/loading pesticides onto aircraft? (if YES give brief details of <u>how</u> the accidents occurred............. .... and details of any <u>casualties</u>............................ ....)				42
43. Is all pesticide application equipment (spray gear etc), and related items (mixing/measuring equipment etc), properly cleaned/washed after use? (if YES <u>how</u> is equipment cleaned... .... and what happens to the <u>washings/rinsings</u>............... ....)				43
44. Are detailed and accurate records kept of aerial applications of pesticide in the locality?				44
45. Have any accidents occurred in the locality <u>during</u> aerial spraying? (if YES give brief details of <u>how</u> the accident occurred... .... and details of any <u>casualties</u>............................ ....)				45
SPACE FOR SUPPLEMENTARY QUESTIONS:				
46. --				
47. --				
48. --				

SPACE FOR COMMENTS/ADDITIONAL INFORMATION:

1. --

2. --

3. --

4. --

-- THANK YOU

APPENDIX C

QUESTIONNAIRE: PESTICIDE FIELD/FARM WORKER

QUESTIONNAIRE: PESTICIDE FIELD/FARM WORKER REF.NO. SUD/_________/FF

LOCATION:

ORGANISATION RESPONSIBLE:

CONTACT PERSON:

JOB TITLE:

Please answer each question by putting a tick (✓) in the appropriate space, and give further details where indicated.

QUESTIONS	ANSWERS YES	NO	DONT KNOW	
1. Are you told, in advance, when aerial spraying of pesticide is to be done in your area?				1
2. Are you told what type of pesticide is to be used?				2
3. Are you advised to keep clear of crops/target areas during actual spraying operations? (if NO explain why not...)				3
4. After spraying is completed, are you advised to keep out of treated areas for a given safety period? (if NO explain why not...)				4
5. If you do enter treated areas at the time of spraying, or soon after, do you wear any protective clothing? (if YES what clothing...)				5
6. Have you been given any training on pesticides, or on pesticide safety? (if YES give brief details...)				6
7. Are you aware that pesticides are poisonous, and that they can be hazardous to humans?				7
8. By which of these routes do you think pesticides may enter the human body:				8
through the mouth..............................				
through the skin..............................				
through breathing..............................				
9. Would you recognise general/typical symptoms of pesticide poisoning if they occurred? (if YES give some examples of symptoms...)				9

YES	NO	DONT KNOW

10. Have you, or any of your colleagues, ever had symptoms of pesticide poisoning during (or soon after) aerial spraying operations? (if YES give details of <u>how</u> poisoning occurred 10
....
details of any <u>casualties</u>..................................
....
and <u>name of pesticide</u> (if known)........................)

11. During (or after) aerial spraying operations in your area, have you ever been given (or been sold) <u>empty pesticide containers</u> for your own use,? (if YES for what purpose are the containers used.. 11
....)

12. Do you use, or handle, pesticides in any way at work? (if YES give brief details.. 12
....)

13. Do you use, or handle, pesticides at home? (if YES give brief details.. 13
....)

14. Is the general public in your area : 14
    notified when aerial spraying is to be done.........
    warned to stay clear during spraying................
    advised to keep out of crops etc after spraying.....

15. Have you ever observed aircraft spraying (accidentally or otherwise) <u>pesticide intended for cotton</u> crops onto: 15
    people...
    livestock/domestic animals...........................
    foodcrops..
    water courses (streams, rivers, ponds etc)..........
    (if YES to any part of this question give brief details of observations..
....)

SPACE FOR SUPPLEMENTARY QUESTIONS:

16. ____

17. ____

18. ____

19. ____

20. ____

SPACE FOR COMMENTS/ADDITIONAL INFORMATION:

1. ____

2. ____

3. ____

4. ____

____ THANK YOU

APPENDIX D

QUESTIONNAIRE: PESTICIDE CONTAINERS

QUESTIONNAIRE: PESTICIDE CONTAINERS   REF.NO. SUD/________/C

NAME/LOCATION OF STORE:

ORGANISATION RESPONSIBLE:

CONTACT PERSON:

Please answer each question by putting a tick (✓) in the appropriate space, and give further details where indicated.

QUESTIONS	ANSWERS YES	NO	DONT KNOW	
1. Do you at any time have <u>empty (used) pesticide containers</u> on your site? (if NO, go to question 14).				1
2. From where do your <u>empty</u> pesticide containers come:				2
airstrip/field sites (eg after spraying operations)..				
from within store (eg after repacking/dispensing)....				
from other sources (if YES give details............. ....)				
3. Which of the following <u>types</u> of empty pesticide containers do you, at some time, have on your site:				3
METAL large (greater than 22 gal/100 litre).........				
medium (4.5 gal/20 litre - 22 gal/100 litre)..				
small (less than 4.5 gal/20 litre)...........				
PLASTIC large (greater than 22 gal/100 litre).........				
medium (4.5 gal/20 litre - 22 gal/100 litre)..				
small (less than 4.5 gal/20 litre)...........				
PAPER/CARDBOARD (any size, excluding outer packaging)..				
OTHER types (state which............................ ....)				
4. (Where applicable) How are empty <u>metal</u> containers disposed:				4
re-used on site.....................................				
sold/given to others for re-use.....................				
disposed on the site (if YES outline method......... ....)				
taken away for disposal by others...................				
other (give details................................. ....)				
5. (Where applicable) How are empty <u>plastic</u> containers disposed:				5
re-used on site.....................................				
sold/given to others for re-use.....................				
disposed on the site (if YES give details........... ....)				
taken away for disposal by others...................				
other (give details................................. ....)				

	YES	NO	DONT KNOW	
6. (Where applicable) How are empty paper/cardboard containers (exclude outer packaging) disposed:				6
re-used on site........				
sold/given to others for re-use........				
disposed on the site (if YES give details........ ....)				
taken away for disposal by others........				
other (give details........ ....)				
7. (Where applicable) If empty containers are re-used on site:- Are they used to contain:				7
- same pesticide as original (eg malathion container re-used for malathion)........				
- same kind/group of pesticide as original (eg insecticide container re-used for insecticide)...				
- different kind/group of pesticide from original (eg insecticide container re-used for herbicide).....				
- other material/used for other purpose (if YES give details........ ....)				
Are they properly re-labelled?........				
8. (Where applicable) If empty containers are sold/given to others for re-use:				8
- Are they first cleaned/decontaminated?........ (if YES, outline cleaning/decontamination procedures for each type of container involved: METAL containers........ .... PLASTIC containers........ .... PAPER/CARDBOARD containers........ ....) (if NO what advice, if any, on cleaning/decontamination do you give to recipients?........ ....)				
- To whom are they given/sold?........				
9. (Where applicable) If empty containers are sold/given to others for re-use, are they used to contain:				9
water for household washing (clothes/utensils etc.)..				
water for personal washing/bathing........				
drinking water for livestock........				
drinking water for humans........				
food for livestock........				
food for humans........				
other items (if YES give examples........ ....)				
10. (Where applicable) If empty containers are disposed on site, are accurate and reliable records kept (numbers of containers, method of disposal etc.) of all disposals?				10
11. (Where applicable) If empty containers are taken away for disposal, is disposal done by trained staff following safe/proper disposal procedures?				11

Question	MORE THAN 100	UP TO 100	NONE	
12. Approximately, how many of each type of empty container do you have on site at present (where possible indicate number, otherwise tick the most appropriate column):				12
METAL large (greater than 22 gal/100 litre).........				
medium (4.5 gal/20 litre - 22 gal/100 litre)..				
small (less than 4.5 gal/20 litre)............				
PLASTIC large (greater than 22 gal/100 litre).........				
medium (4.5 gal/20 litre - 22 gal/100 litre)..				
small (less than 4.5 gal/20 litre)............				
PAPER/CARDBOARD (any size)...........................				
OTHER types (state which.............................. ....)				

Question	YES	NO	DONT KNOW	
13. (Where applicable) Does the number of empty containers returned from airstrip sites always agree with the number of full containers originally issued? (if NO, what happens to the remainder?.............................. ....)				13
14. Do you at any time have waste/unwanted pesticide (unused pesticide returned from airstrip sites, unused pesticide spray mixture, out-of-date stock awaiting disposal, etc) on the site? (if NO go to question 19).				14
15. From which of the following sources does your waste/unwanted pesticide come:				15
returned from airstrip/field sites................				
from within store.................................				
from other sources (if YES give details............ ....)				
16. How is waste/unwanted pesticide disposed:				16
re-used by staff at a later date..................				
sold/given to others to use.......................				
disposed on (or near) the site....................				
taken away for disposal by others.................				
other (give details............................... ....)				
17. (Where applicable) If waste/unwanted pesticide is disposed on (or near) the site, what are the disposal procedures used:				17
ground burial.....................................				
burial in special landfill sites..................				
open burning (eg on wood/paper fires).............				
high temperature incineration.....................				
chemical decomposition (eg hydrolysis)............				
other (if YES give details........................ ....)				

	YES	NO	DONT KNOW	
18. (Where applicable) If waste/unwanted pesticide is <u>taken away for disposal</u>, is disposal done by trained staff following safe/proper disposal procedures?				18
19. Have you, or anyone for whom you are responsible, ever suffered symptoms of pesticide poisoning as a result of handling empty pesticide containers, or handling pesticide waste/unwanted material? (if YES give details... ....)				19
20. Have you, or anyone for whom you are responsible, ever required professional medical attention as a result of handling empty pesticide containers, or handling pesticide waste/unwanted material? (if YES give details... ....)				20

SPACE FOR SUPPLEMENTARY QUESTIONS:

	YES	NO	DONT KNOW
21. ____			
22. ____			
23. ____			
24. ____			
25. ____			

SPACE FOR COMMENTS/ADDITIONAL INFORMATION:

1. ____
2. ____
3. ____
4. ____
5. ____

THANK YOU

APPENDIX E

PESTICIDE STORES (SUMMARY)

APPENDIX E PESTICIDE STORES (SUMMARY).

SUDAN QUESTIONNAIRE SUMMARY: PESTICIDE STORES (REF: SUDSTORE.CAL)

ATTRIBUTE	TOTAL	MEAN	NO.	COUNT(4)	COUNT(3)	COUNT(2)	COUNT(1)	%(4)	%(3)	%(2)	%(1)	ALL YES	ALL NO
OPEN ONLY	85	1.98	43	14			29	32.56	.00	.00	67.44	32.56	67.44
CLOS ONLY	91	2.12	43	16			27	37.21	.00	.00	62.79	37.21	62.79
OPSI ONLY	46	1.07	43	1			42	2.33	.00	.00	97.67	2.33	97.67
OP+CLOS	71	1.65	43	9		1	33	20.93	.00	2.33	76.74	20.93	79.07
OP+OPSI	43	1.00	43				42	.00	.00	.00	97.67	.00	97.67
CL+OPSI	43	1.00	43				42	.00	.00	.00	97.67	.00	97.67
ALL TYPES	52	1.21	43	3			40	6.98	.00	.00	93.02	6.98	93.02
ACCESS	161	3.83	42	38	1	3		90.48	2.38	7.14	.00	92.86	7.14
NEAROTHER	132	3.07	43	29	1		13	67.44	2.33	.00	30.23	69.77	30.23
NEARWATER	111	2.58	43	19	4	3	17	44.19	9.30	6.98	39.53	53.49	46.51
SPILLS	98	2.28	43	15	5		23	34.88	11.63	.00	53.49	46.51	53.49
NEARFUEL	123	2.86	43	26	1		16	60.47	2.33	.00	37.21	62.79	37.21
SECURITY	98	2.28	43	15	4	2	22	34.88	9.30	4.65	51.16	44.19	55.81
FLOODS	120	2.86	42	16	14	2	10	38.10	33.33	4.76	23.81	71.43	28.57
DESIGN	69	1.64	42	7	3		32	16.67	7.14	.00	76.19	23.81	76.19
LARGE	117	2.85	41	24	1	2	14	58.54	2.44	4.88	34.15	60.98	39.02
FLOORS	91	2.17	42	9	1	20	12	21.43	2.38	47.62	28.57	23.81	76.19
WALLS	81	2.89	28	16	2	1	9	57.14	7.14	3.57	32.14	64.29	35.71
SPILLAGE	53	1.29	41	2	1	4	34	4.88	2.44	9.76	82.93	7.32	92.68
ROOFLEAK	67	2.23	30	11		4	15	36.67	.00	13.33	50.00	36.67	63.33
ROOFCOLL	76	2.71	28	13	3	3	9	46.43	10.71	10.71	32.14	57.14	42.86
VENTS	110	2.62	42	21	2	1	18	50.00	4.76	2.38	42.86	54.76	45.24
LIGHTING	97	2.31	42	17		4	21	40.48	.00	9.52	50.00	40.48	59.52
HOT	142	3.46	41	30	5	1	5	73.17	12.20	2.44	12.20	85.37	14.63
OFFICE	92	2.36	39	16	2	1	20	41.03	5.13	2.56	51.28	46.15	53.85
COMBUST	42	1.17	36	2			34	5.56	.00	.00	94.44	5.56	94.44
ELECTRICS	31	1.29	24	1	1	2	20	4.17	4.17	8.33	83.33	8.33	91.67
EXIT	166	3.86	43	41			2	95.35	.00	.00	4.65	95.35	4.65
WEAK	51	1.59	32	5	2		25	15.63	6.25	.00	78.13	21.88	78.13
LOCKED	139	3.56	39	29	6	1	3	74.36	15.38	2.56	7.69	89.74	10.26
WASHING	48	1.33	36	2	3		31	5.56	8.33	.00	86.11	13.89	86.11
INSECTI	161	3.74	43	39		1	3	90.70	.00	2.33	6.98	90.70	9.30
HERBI	132	3.30	40	29	1		10	72.50	2.50	.00	25.00	75.00	25.00
FUNGI	49	1.69	29	6	1		22	20.69	3.45	.00	75.86	24.14	75.86
ROD/OTHER	81	2.38	34	14	2	1	17	41.18	5.88	2.94	50.00	47.06	52.94
LARGINS	116	2.90	40	24	1	2	13	60.00	2.50	5.00	32.50	62.50	37.50
LARGHERB	82	2.22	37	13	2	2	20	35.14	5.41	5.41	54.05	40.54	59.46
LARGFUNG	39	1.34	29	3		1	25	10.34	.00	3.45	86.21	10.34	89.66
LARGOTHER	49	1.58	31	5	1	1	24	16.13	3.23	3.23	77.42	19.35	80.65
INS.EC	128	3.37	38	29			9	76.32	.00	.00	23.68	76.32	23.68
INS.WP	81	2.53	32	16		1	15	50.00	.00	3.13	46.88	50.00	50.00
INS.SP	51	1.89	27	8			19	29.63	.00	.00	70.37	29.63	70.37
INS.DUST	56	2.07	27	9	1		17	33.33	3.70	.00	62.96	37.04	62.96
INS.GRAN	57	1.90	30	9			21	30.00	.00	.00	70.00	30.00	70.00
INS.ULV	131	3.45	38	31			7	81.58	.00	.00	18.42	81.58	18.42
INS.OTHER	20	1.18	17	1			16	5.88	.00	.00	94.12	5.88	94.12
ON FLOOR	166	3.95	42	40	2			95.24	4.76	.00	.00	100.00	.00
DUNNAGE	45	1.07	42		1	1	40	.00	2.38	2.38	95.24	2.38	97.62
SHELVES	42	1.00	42				42	.00	.00	.00	100.00	.00	100.00
ENOUGH SD	43	1.00	43				43	.00	.00	.00	100.00	.00	100.00
GANGWAYS	91	2.28	40	15	2	2	21	37.50	5.00	5.00	52.50	42.50	57.50
DIFFTYPE	107	2.68	40	12		1	27	30.00	.00	2.50	67.50	30.00	70.00
SEED/FERT	94	2.29	41	16	2	1	22	39.02	4.88	2.44	53.66	43.90	56.10
FUEL	84	2.05	41	14		1	26	34.15	.00	2.44	63.41	34.15	65.85
FOOD/DR	37	1.00	37				37	.00	.00	.00	100.00	.00	100.00
TOOLS/EQ	94	2.35	40	18			22	45.00	.00	.00	55.00	45.00	55.00
CLOTHING	37	1.00	37				37	.00	.00	.00	100.00	.00	100.00
OTHER	55	1.62	34	7			27	20.59	.00	.00	79.41	20.59	79.41

APPENDIX E PESTICIDE STORES (SUMMARY)/CONTINUED.

ATTRIBUTE	TOTAL	MEAN	NO.	COUNT(4)	COUNT(3)	COUNT(2)	COUNT(1)	%(4)	%(3)	%(2)	%(1)	ALL YES	ALL NO
REPACKING	77	1.93	40	12		1	27	30.00	.00	2.50	67.50	30.00	70.00
RECORDS	134	3.53	38	30	3		5	78.95	7.89	.00	13.16	86.84	13.16
DATE	75	1.74	43	9	2	1	31	20.93	4.65	2.33	72.09	25.58	74.42
LABELLED	88	2.05	43	11	5	2	25	25.58	11.63	4.65	58.14	37.21	62.79
FOODCONT	47	1.09	43	1		1	41	2.33	.00	2.33	95.35	2.33	97.67
UPRIGHT	122	3.13	39	23	6	2	8	58.97	15.38	5.13	20.51	74.36	25.64
STACKING	140	3.50	40	30	5		5	75.00	12.50	.00	12.50	87.50	12.50
AUDIT	98	2.58	38	16	6		17	42.11	15.79	.00	44.74	57.89	44.74
REPACKED	96	2.59	37	17	4		16	45.95	10.81	.00	43.24	56.76	43.24
IN STORE	128	3.05	42	28	1		13	66.67	2.38	.00	30.95	69.05	30.95
NEARBY	67	1.86	36	10		1	25	27.78	.00	2.78	69.44	27.78	72.22
FIRST I/O	85	2.93	29	14	7		8	48.28	24.14	.00	27.59	72.41	27.59
INSPECT	120	3.43	35	27	2		6	77.14	5.71	.00	17.14	82.86	17.14
IN STORE	140	3.50	40	28	8		4	70.00	20.00	.00	10.00	90.00	10.00
RETURNED	43	1.26	34	3			31	8.82	.00	.00	91.18	8.82	91.18
OTHERDISP	47	1.38	34	1	5		28	2.94	14.71	.00	82.35	17.65	82.35
OUT-DATE	115	2.88	40	20	6	3	11	50.00	15.00	7.50	27.50	65.00	35.00
CLOTH-IN	46	1.15	40	1	1	1	37	2.50	2.50	2.50	92.50	5.00	95.00
CLOTH-OUT	49	1.23	40	2	1	1	36	5.00	2.50	2.50	90.00	7.50	92.50
EAT/DRINK	67	1.76	38	9	1		28	23.68	2.63	.00	73.68	26.32	73.68
SMOKING	62	1.68	37	7	1	2	27	18.92	2.70	5.41	72.97	21.62	78.38
TIDY	126	2.93	43	26	2	1	14	60.47	4.65	2.33	32.56	65.12	34.88
CORR.CONT	113	2.76	41	22	2	2	15	53.66	4.88	4.88	36.59	58.54	41.46
UNDISP	99	2.36	42	18	1	1	22	42.86	2.38	2.38	52.38	45.24	54.76
SIGNS	48	1.14	42		2	2	38	.00	4.76	4.76	90.48	4.76	95.24
FIRE	49	1.14	43	1	1	1	40	2.33	2.33	2.33	93.02	4.65	95.35
FIRST-AID	53	1.26	42	2	2	1	37	4.76	4.76	2.38	88.10	9.52	90.48
SYMPTOMS	68	1.84	37	9		4	24	24.32	.00	10.81	64.86	24.32	75.68
MEDHELP	49	1.29	38	3		2	33	7.89	.00	5.26	86.84	7.89	92.11
BOSSAD	53	1.36	39	1	3	5	30	2.56	7.69	12.82	76.92	10.26	89.74
STAFFAD	46	1.31	35	1	1	6	27	2.86	2.86	17.14	77.14	5.71	94.29
ADVICE	70	1.84	38	10		2	26	26.32	.00	5.26	68.42	26.32	73.68
HAZARD	110	3.67	30	22	7		1	73.33	23.33	.00	3.33	96.67	3.33
PACKINUSE	15	3.75	4	3	1			75.00	25.00	.00	.00	100.00	.00
CONTINUSE	24	4.00	6	6				100.00	.00	.00	.00	100.00	.00
ANIMALSIN	17	3.40	5	2	3			40.00	60.00	.00	.00	100.00	.00
ALDRIN	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
CHLORPYR	8	4.00	2	2				100.00	.00	.00	.00	100.00	.00
CURACRON	8	4.00	2	2				100.00	.00	.00	.00	100.00	.00
DIMETH	16	4.00	4	4				100.00	.00	.00	.00	100.00	.00
DDT	28	4.00	7	7				100.00	.00	.00	.00	100.00	.00
DELTAM	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
ENDOSUL	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
FORMOTHI	8	4.00	2	2				100.00	.00	.00	.00	100.00	.00
HERCULES	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
OXYD.METH	12	4.00	3	3				100.00	.00	.00	.00	100.00	.00
TEMIC	8	4.00	2	2				100.00	.00	.00	.00	100.00	.00
THIOMETON	20	4.00	5	5				100.00	.00	.00	.00	100.00	.00
TOXAPHENE	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
TORBIDAN	12	4.00	3	3				100.00	.00	.00	.00	100.00	.00
TRIAZOPH	8	4.00	2	2				100.00	.00	.00	.00	100.00	.00
ZINC.PH	14	3.50	4	2	2			50.00	50.00	.00	.00	100.00	.00
BASUGRAN	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
COT.MULTI	7	3.50	2	1	1			50.00	50.00	.00	.00	100.00	.00
MIKANTOP	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
NITROFEN	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
PROPANIL	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
PROPANIL	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
RONSTAR	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
SATURN	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
ZORIAL	4	4.00	1	1				100.00	.00	.00	.00	100.00	.00
GEN.PEST	50	3.57	14	9	4	1		64.29	28.57	7.14	.00	92.86	7.14
? PESTIC	13	3.25	4	3			1	75.00	.00	.00	25.00	75.00	25.00

APPENDIX E PESTICIDE STORES (RAW DATA).

SUDAN QUESTIONNAIRE DATA: PESTICIDE STORES (REF: SUDSTORE.CAL)

NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
REF.	B.9	KABGID	MES.AMIR	SG.4	DUL B.26	GMS.30	BAR.C.10	GOR.C.HAS	KG.NWG	SG.B7	NG.B.TUR	SG.B1	SG.B13	CG.B9	MIK.GS	MIK.B49	SGM.B4*	SG.B3	SG.B5	TONSA.B85	B.96	B.84	B.97	B.47
OPEN ONLY	1	4	1	1	4	1	1	1	1	1	4	1	1	1	4	1	1	1	1	1	1	1	1	4
CLOS ONLY	1	1	4	1	1	1	1	1	4	4	1	4	4	4	1	1	1	4	4	1	1	1	1	1
OPSI ONLY	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
OP+CLOS	1	1	1	4	2	4	1	1	1	1	1	1	1	1	1	4	4	1	1	4	4	4	4	1
OP+OPSI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CL+OPSI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ALL TYPES	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ACCESS	2	4	3	2	4	2	4	4		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
NEAROTHER	4	1	3	1	4	1	1	4	4	4	4	4	4	4	4	1	4	4	4	4	4	4	4	4
NEARWATER	1	4	2	1	3	1	1	1	4	1	3	4	3	1	1	4	1	4	4	4	4	4	4	4
SPILLS	1	1	1	1	3	1	1	4	4	1	3	3	3	1	4	4	1	4	4	4	4	4	4	4
NEARFUEL	4	1	3	4	4	1	1	1	4	4	1	4	4	4	4	4	4	4	4	4	4	4	4	4
SECURITY	1	4	4	4	1	1	4	4	1	1	4	1	1	1	1	3	4	1	1	1	1	1	1	1
FLOODS	3	3		2	3	3	3	3	4	3	2	4	4	4	4	1	1	4	4	3	1	4	4	4
DESIGN	1	1	3	4	1	1	3	1	4	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1
LARGE	4	4	4	1	2	1	4	1	1	4		3	4	1	1	4	2	1	4	4	4	4	1	4
FLOORS	2	2	4	2	2	2	3	2	2	1	2	1	1	1	2	2	1	1	2	4	4	1	4	4
WALLS			2	4		4	3		4	1		1	1	1		4	1	1	4	4	4	1	4	4
SPILLAGE	2	2	2	1	2	1	1	1	1	1	1	1	1	1		1	3	1	1	4	1	1	1	1
ROOFLEAK	2		1	1		1	2	2	1	1		4	4	4		1	1	4	4	1	1	4	4	4
ROOFCOLL	2		1	4		1	2	2		4		4	4	4			4	1	4	1	1	4	4	4
VENTS	3	4	4	4	4	2	4	4	1	4	4	1	1	1	4	1	4	1	1	1	1	1	1	1
LIGHTING	4	4	1	1	4	2	2	4	1	1	4	1	1	1	4	2	1	1	1	1	1	1	1	1
HOT	1	4		1	4	4	2	3	4	3	4	4	4	4	4	3	1	4	4	4	4	4	4	4
OFFICE	1	1	4	1		4	2	1	1	4		4	4	4		4	1	4	4	4	4	4	4	4
COMBUST	1		1	1		1	1	1	1	1		1	1	1		1	1	1	4	1	1	1	1	1
ELECTRICS	3		1				2		1	2		1	1				1		4	1	1	1	1	1
EXIT	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
WEAK	1		1	1		1	1	1	1	1		1	1	1		1	1	3	4	1	1	4	1	4
LOCKED	1	4	3		3	4	4	1	4	4		4	4	4		4	4	4	3	4	4	3	3	3
WASHING	1	4			1	3	4	3	1	1			1	1	1	1	1	1	1	1	1	1	1	1
INSECTI	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
HERBI	1	4		4	3	4	4	4	4	4	1			4	4	4	4	4	4	4	4	4	4	4
FUNGI	1	1			4	1			4		1			3				1	1	1	1			
ROD/OTHER	1	1		4	3	4	4		4		1	4						4	4	3	2	4	1	4
LARGINS	4	4	3	4	4	4	4	4	4		1	1	1		2	2	4	4	1	1	1	1	1	
LARGHERB	1	1		3	3	1	4	4	4		1	1			2	2		4	1	1	1	1	1	
LARGFUNG	1	1			4	1					1	1						1	1	1	1	1	1	
LARGOTHER	1	1		1	2	4	4				1	1						4	1	1	1	1	1	
INS.EC	4	4	4	4	4	4	4	4	4		4		1		4	4	4		1	4		4	4	4
INS.WP	1	1		1	2	1					1	4	4			4		4	4	4		4	4	4
INS.SP	1	1		1	1	1					1							4	4	4		4		4
INS.DUST	1	1		1	1	3					1							4	4	4	4		4	4
INS.GRAN	1	1		4	1	1		4			1				4	4		4	1	1	4			4
INS.ULV	4	4	4	4	4	4	4	4	4		4				4	4	4	1	1	4	4		4	4
INS.OTHER	1	1									1							1		1				
ON FLOOR	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4	4	4	4	4
DUNNAGE	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
SHELVES	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
ENOUGH SD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
GANGWAYS	4	3	4	2	1	4	3	4	1	1		1	4	4			1	1	1	4	1	1	1	1
DIFFTYPE	1	4		4	2	4	4	4	4	4	4	4	1		1	4	4	4	4	1	1	1	4	4
SEED/FERT	1	1	1	1	3	1	1	4		4	1	4	4	4		4	1	4	3	4	4	4	4	4
FUEL	1	1	1	1	1	1	1	1	4	4	1	4	4	4			1	4	4	4	4	4	4	4
FOOD/DR	1	1	1	1	1	1	1	1	1	1	1	1					1	1		1	1	1		1

APPENDIX E   PESTICIDE STORES (RAW DATA)/CONTINUED

NO.	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
REF.	RAB.WN.NB	GEI.WN.GB	WN.ELG.M	NH.AR	NH.UM	NH.TS	NH.CS	RAHAD.CS	WN.KO.64	WN.KO.65	WN.KO.CMS	SEN.MS	HG.B93	GG.B78	MG.B68	TAH.GP	MG.MS	ELS.WN	DEU.WN
OPEN ONLY	4	4	4	4	4	1	4	1	1	1	4	4	1	1	1	1	4	1	1
CLOS ONLY	1	1	1	1	1	4	1	1	4	4	1	1	1	4	4	4	1	4	4
OPSI ONLY	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
OP+CLOS	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1
OP+OPSI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CL+OPSI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ALL TYPES	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
ACCESS	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
NEAROTHER	4	4	4	1	1	1	1	1	4	4	1	4	4	4	4	4	1	4	1
NEARWATER	4	4	4	1	1	1	1	3	2	2	1	1	4	1	4	4	1	4	4
SPILLS	1	1	1	1	1	1	1	3	1	1	1	1	4	4	4	4	1	1	1
NEARFUEL	1	1	1	1	1	1	1	1	4	4	1	4	4	4	4	4	1	1	4
SECURITY	4	1	1	3	3	4	4	4	2	2	3	4	1	1	1	4	1	4	4
FLOODS	1	1	3	1	1	1	3	3	3	3	3	4	4	4	4	4	1	1	4
DESIGN	4	4	1	1	1	1	1	1	1	1	1		1	3	1	1	1	1	4
LARGE	4	4	1	4	4	4	4	1	4	4	4		1	4	4	1	4	1	1
FLOORS	2	2	2	2	2	4	2	2	1	1	2		1	4	4	1	2	4	1
WALLS						4		3	1	1			4	4	4	4		4	4
SPILLAGE	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	4
ROOFLEAK						1		1	1	2			1	4	4	4		1	1
ROOFCOLL						4		3	1	1			3	4	3	1		1	4
VENTS	4	4	4	4	4	4	4	4	1	1	4		1	1	1	3	4	1	4
LIGHTING	4	4	4	4	4	4	4	2	1	1	4		1	1	1	4	4	1	4
HOT	4	4	4	4	4	4	4	3	4	4	4		4	4	4	4	3	1	1
OFFICE	1	1	1	1	1	1		1	1	1	3	3	4	1	4	1	1	1	1
COMBUST	1	1	1			1		1	1	1	1	1	1	1	1	1	1	1	4
ELECTRICS		1	1			1					1		1	1	1	1		1	1
EXIT	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1	4	4	1	4
WEAK	3	1				1		1	1	1			4	1	1	1		1	4
LOCKED	4	4	4	4	4	4		2	4	4	4	4	4	4	4	4	1	4	4
WASHING	1	1	1			1		3	1	1	1	1	1	1	1	1	1	1	1
INSECTI	4	4	4	4	4	4	4	4	1	1	4	4	2	4	1	4	4	4	4
HERBI	1	1	4	4	4	4	4	4	4	1	4	4	4	4	4	1	1	1	1
FUNGI	1	1	1	1	1		1	4	1	1	1	1	4	4	4	1	1	1	1
ROD/OTHER	1	1	1	1	1		1	4	1	4	1	1	1	4	4	1	1	1	4
LARGINS	4	4	4	4	4	4	4	4	1	1	4	4	1	4	1	1	4	4	4
LARGHERB	1	1	1	4	4	4	4	4	4	1	1	4	1	4	4	1	1	1	1
LARGFUNG	1	1	1	1	1		1	2	1	1		1	1	4	4	1	1	1	1
LARGOTHER	1	1	1	1	1		1	4	1	3		1	1	4	1	1	1	1	1
INS.EC	4	4	4	4	4	4	4	4	1	1	4	4	1	1	1	1	4	4	4
INS.WP	4	4	4	1	1		1	4	1	1		1	4	4	4	1	1	1	1
INS.SP	4	4	4	1	1		1		1	1		1	1	1	1	1	1	1	1
INS.DUST	4	4	4	1	1		1		1	1		1	1	1		1	1	1	1
INS.GRAN	4	4	1	1	1		1		1	1		1	1	1	1	1	1	1	1
INS.ULV	4	4	4	4	4	4	4	4	1	1	4	4	1	4	1	4	4	1	4
INS.OTHER		1	1				1		1	1		1	1	4	1	1	1	1	
ON FLOOR	4	4	4	4	4	4	4	3	4	4	4	4	4	4	3	4	4	4	4
DUNNAGE	1	1	1	1	1	1	1	2	1	1	1	1	1	1	3	1	1	1	1
SHELVES	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ENOUGH SD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
GANGWAYS	1	1	1	4	4	4	4	2	4	1	4	4	1	1	1	1	1	1	4
DIFFTYPE	1	4	4	1	1	1		4	1	1	1	4	4	4	4	1	1	1	1
SEED/FERT	1	1	1	1	1	1	1	2	4	1	1	1	4	4	4	1	1	1	1
FUEL	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	4	1	4	1
FOOD/DR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

APPENDIX E PESTICIDE STORES (RAW DATA)/CONTINUED

NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
REF.	B.9	KABGID	MES.AMIR	SG.4	DUL B.26	GMS.30	BAR.C.106	OR.C.HAS	KG.NWG	SG.B7	NG.B.TUR	SG.B1	SG.B13	CG.B9	MIK.GS	MIK.B49	SGM.B4*	SG.B3	SG.B5	TONSA.B85	B.96	B.84	B.97	B.47
TOOLS/EQ	1	1	1	1	1	1	4	1	1	4	1	4	4	4			1	4		4	4	4	4	4
CLOTHING	1	1	1	1	1	1	1	1	1	1	1						1	1		1	1	1	1	1
OTHER	1	1	1	1	1	1	1	4	1	1	1						1			1	1	1		1
REPACKING	1	1		4	1	1	1	1	1	1	1	1	1	1	4	1	1		1	4	1	4	1	4
RECORDS	3			4	3	4	1	3		4	4	4	4	4	4		4	4	4	4	4	4	4	4
DATE	1	1	2	1	1	1	1	1	1	3	1	4	1	1	1	1	3	4	4	4	1	1	1	1
LABELLED	2	1	1	2	1	3	1	1	1	3	1	3	3	1	1	1	3	4	4	4	4	4	4	4
FOODCONT	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
UPRIGHT	2	3	3	4		1	3	3	1		1	4	4	1			3	4	4	4	4	4	4	4
STACKING	4	4	4	3	4	4	3	4			1	4	4		4	4	3	4	4	4	4	4	4	4
AUDIT	3	4			3	1	1	3		4	3			4	4	1	4	4	1	1	4	4	1	4
REPACKED	1	1			3	4	3	3		1	1			1	1	4	1	4	4	4	4		4	1
IN STORE	4	4	3	4	4	4	4	4		1	4	4	1	4	4	4	4	4	4	1	4	4	4	1
NEARBY	1	1			1	1	1	4		1				1	1	1	1	2	1	4	4	1	4	4
FIRST I/O	3			4	4	4	3	3					4		4	4		4	1					
INSPECT		1		4	4	4	3	4		4	1				1		4	4	4	4	4	4	4	4
IN STORE	3	3		3	4	4	4	4		4	4	4	1		4	4	4	4	4	4	4	1	3	4
RETURNED	1	1			1	1	1	1		1	1	1	4		1		1	1	4	1	1	4		1
OTHERDISP					1	1	1	1		1	1	1	1		1		1	1		1	1		3	1
OUT-DATE	4	3			4	3	3	4		1	1	1	1	4	4	1	1	4	1	4	4	2	4	2
CLOTH-IN	3	1		1	1	1	1	1		1	1	1	1		1	1	1	4	1	1	1	1	1	1
CLOTH-OUT	1		1	1	1	1	3	1		1	1	1	1		4	4	1	1	1	1	1	1	1	1
EAT/DRINK	1			1	1	4	1	1		1		1	1	1	1	1	1	1	1	1	1	1	4	4
SMOKING	2			1	3	1	1	1	4			1	1	1	1	1		1	1	1	1	1	1	1
TIDY	1	3	4	1	2	1	3	4	1	4	1	4	4	1	1	4	4	4	4	4	4	4	4	4
CORR.CONT	4	4		4	4	4	4	4		4	1	1	2	4	1	4	3	1	2	1	1	1	4	1
UNDISP	4	4	2	4	4	4	4	4		1	1	1	1	4	4	1	1	1	1	1	1	1	1	1
SIGNS	1	1	1	1	1	1	1	1		3	1	1	1	1	1	1	3	1	1	1	1	1	1	1
FIRE	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1
FIRST-AID	1	1		1	1	1	3	3	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1
SYMPTOMS	1			1	2	1	1	4	1			4	1	1	1	1	2		4	1	1	4	4	2
MEDHELP	1			1	2	1	1	4	1			1	1	1	1	1	2	1	4	1	1	1	1	1
BOSSAD	1				1	1	3	1	1	3	1	1	1	1	1	1	1	1	4	3	1	1	1	1
STAFFAD	1				1	4	1	1	1			1	1		1	1		1	2	3	1	1	1	1
ADVICE	1				1	1	2	1	1	1	4	1	1	1	1	1	1	4	4	4	4	4	4	4
HAZARD	4	3	1		4	3	4	4							4		3	4	4	4	4	4	4	4
PACKINUSE		4	4								3													
CONTINUSE		4	4																	4	4	4		
ANIMALSIN			4					3	4															

APPENDIX E PESTICIDE STORES (RAW DATA)/CONTINUED

NO.	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
REF.	RAB.WN.NB	GEI.WN.GB	WN.ELG.M	NH.AR	NH.UM	NH.TS	NH.CS	RAHAD.CS	WN.KO.64	WN.KO.65	WN.KO.CMS	SEN.MS	HG.B93	GG.B78	MG.B68	TAH.GP	MG.MS	ELS.WN	DEU.WN
TOOLS/EQ	1	1	1	1	1	1	1	4	4	4	4	1	4	4	4	1	1	1	1
CLOTHING	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
OTHER	1	1	1	1	1	1		1	4	4	1	1	4	4	4	1	1	1	4
REPACKING	4	4	4	1	1	1	1	2	1	1	1	1		4	4	4	1	1	4
RECORDS	1	1	4	4	4	4	4		4	1	4	4	4	4	4	4	4	1	4
DATE	1	1	1	1	1	1	1	1	1	1	1	1	4	4	4	4	4	1	1
LABELLED	1	1	1	1	1	1	1	1	1	1	1	1	4	4	4	1	4	1	1
FOODCONT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1
UPRIGHT	1	1	1	4	4	4	4	1	4	2	4	4	4	4	4	3	4	4	4
STACKING	1	1	1	4	4	4	4	3	4	3	4	4	4	4	4	1	4	4	4
AUDIT	4	4	4	1	1	1	1	3	4	4	4	1	1	1	1	3	1	1	4
REPACKED	1	1	1	4	4	4	4	1	1	1	1	4	4	4	4	3	4	4	1
IN STORE	4	4	4	4	4	1	4	4	1	1	4	4	1	1	1	1	4	1	1
NEARBY	1	1	1	1	1	1	1	1		1	1	1	4	4	4	4	1	1	4
FIRST I/O	1	1	1	3	3	4	4	3	1	1	3		4	4	4	1	4	1	4
INSPECT	1	1	4	4	4	4	4		3	1	4	4	4	4	4	4	4	4	4
IN STORE	4	4	4	3	3	1	3	4	4	4	4	1	3	4	4	4	4	4	4
RETURNED	1	1	1			1		1	1	1	1	1	1	1	1	1	1	1	1
OTHERDISP	1	1	1	3	3	4	3	1	1	1	1	3	1	1	1	1	1	1	1
OUT-DATE	4	4	4	4	4	3	4	3	1	3	4	2	4	4	1	4	1	1	4
CLOTH-IN	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
CLOTH-OUT	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
EAT/DRINK	4	4	4	1	1	1	1		1	1	3	4	1	1	1	1	4	1	4
SMOKING	4	1	4	1	1	1	1		1	1	1	4	1	1	1	2	4	4	4
TIDY	1	1	1	4	4	4	4	1	4	1	4	4	4	4	1	4	1	4	4
CORR.CONT	4	4	4	4	4	1	4	4	4	4	3	4	1	1	1	4	1	1	1
UNDISP	4	4	4	1	1	1	1	4	4	4	3	4	1	1	1	4	1	1	4
SIGNS	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	1
FIRE	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1
FIRST-AID	1	1	1	1	1	1	4	1	1	1	1	4	1	1	1	1	1	1	1
SYMPTOMS	1	1	4	1	1	1	1	4	1		2	1	1	4	1	1	1	1	4
MEDHELP	1	1	1	1	1	1	1	4	1		1	1	1	1	1	1	1	1	1
BOSSAD	1	1	1	2	2	2	2	2	1	1	1		1	1	1	1	1	1	1
STAFFAD	1	1	1	2	2	2	2	2	1	1	1		1	1	1	1	1	1	1
ADVICE	1	1	1	1	1	1	1		1	1	1		1	4	1	2	1	1	4
HAZARD	4	4	4	3	3			4	3	4	4	4	4	4		3			4
PACKINUSE								4											
CONTINUSE											4								
ANIMALSIN													3			3			

APPENDIX E PESTICIDE STORES (RAW DATA)/CONTINUED:

(OLD STOCK/UNUSABLE PESTICIDE AWAITING SAFE DISPOSAL)

SUDAN QUESTIONNAIRE DATA: PESTICIDE STORES (REF: SUDSTORE.CAL)

NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
REF.	B.9	KABGID	MES.AMIR	SG.4	DUL B.26	GMS.30	BAR.C.106	GOR.C.HAS	KG.NWG	SG.B7	NG.B.TUR	SG.B1	SG.B13	CG.B9	MIK.G5	MIK.B49	SGM.B44	SG.B3	SG.B5	TONSA.B85
ALDRIN								4												
CHLORPYR	4																			
CURACRON	4																			
DIMETH	4							4												
DDT					4			4			4									
DELTAM																				
ENDOSUL																				
FORMOTHI								4												
HERCULES											4									
OXYD.METH	4				4			4												
TEMIC			4				4													
THIOMETON																				4
TOXAPHENE																				
TORBIDAN					4			4												
TRIAZOPH					4			4												
ZINC.PH			4				4													
BASUGRAN								4												
COT.MULTI																			4	3
MIKANTOP								4												
NITROFEN								4												
PROPANIL								4												
PROPANIL								4												
RONSTAR																				4
SATURN								4												
ZORIAL																			4	
GEN.PEST						4									4		2	3	4	
? PESTIC		4			1		4													

NO.	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
REF.	RAB.WN.NB	GEI.WN.GB	WN.ELG.M	WN.AR	WN.UM	WN.TS	WN.CS	RAHAD.CS	WN.KO.G4	WN.KO.G5	WN.KO.CMS	SEN.MS	HG.B93	GG.B78	MG.B68	TAH.GP	MG.MS	ELS.WN	DEU.WN
ALDRIN																			
CHLORPYR																4			
CURACRON																4			
DIMETH												4				4			
DDT				4	4						4		4						
DELTAM																4			
ENDOSUL												4							
FORMOTHI											4								
HERCULES																			
OXYD.METH																			
TEMIC																			
THIOMETON											4								
TOXAPHENE											4								
TORBIDAN											4								
TRIAZOPH																			
ZINC.PH										3				3					
BASUGRAN																			
COT.MULTI																			
MIKANTOP																			
NITROFEN																			
PROPANIL																			
PROPANIL																			
RONSTAR																			
SATURN																			
ZORIAL																			
GEN.PEST	4	4	3	3	3			4			4								
? PESTIC												4							

APPENDIX F PESTICIDE TRANSPORT (SUMMARY AND RAW DATA).

SUDAN QUESTIONNAIRE SUMMARY: TRANSPORT/AIRSTRIP (REF: SUDTA.CAL)

TRANSPORT

NO.	REF:	LOADED	GOOD C	OTHERIT	EQUIP	FOODRI	PASSLIV	GENERAL	VEHICLE	SAFBAR
1	GEDAL.B27	4	1	1	4	1	1	4	4	4
2	RAHAD									
3	SG.B4		1	1	4	1	1	4		4
4	SG.B4(2)	4	4	1	4	4	4	4	4	4
5	KM.88	4	3	1	4	1	1	4	1	4
6	KM.88(2)									
7	TURABI	4	4	4	4	1	3	4	4	4
8	TURABI(2)									
9	NG.KAB									
10	MES.WM									
11	SG.B2	4	4	4	4	1	1	1	4	4
12	B.7	1	4	1	4	4	4	4	1	4
13	B.7(2)	1	4	1			4	4	1	4
14	B.3	1	4	4			4	4	1	4
15	MA.SAAD		4							
16	SG.B6									
17	B.UMHANI		4	4						4
18	B.GODA	4	4	4	4	1	4		1	4
19	B.GODA(2)	4	4	4	4	1	1	1	1	4
20	MAT.77	4	4	1	4	1	1	1	1	4
21	GAM.80	4	4	1	4	1	1	4	4	4
22	MAN.53	4	4	4	4	4	4	4	4	4
23	UM DAG.BN	4	4	4						4
24	B.95									
25	NW.SEID									
26	ELS.WN	4	1	4	4	1	1	1	1	4
	SUM	51	62	44	52	22	35	44	32	68
	MEAN	3.40	3.44	2.59	4.00	1.69	2.33	3.14	2.29	4.00
	NO.	15	18	17	13	13	15	14	14	17
	SUM(4)	12	14	9	13	3	6	10	6	17
	SUM(3)	0	1	0	0	0	1	0	0	0
	SUM(2)	0	0	0	0	0	0	0	0	0
	SUM(1)	3	3	8	0	10	8	4	8	0
	%(4)	80.00	77.78	52.94	100.00	23.08	40.00	71.43	42.86	100.00
	%(3)	.00	5.56	.00	.00	.00	6.67	.00	.00	.00
	%(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00
	%(1)	20.00	16.67	47.06	.00	76.92	53.33	28.57	57.14	.00
	TOTAL	100	100	100	100	100	100	100	100	100
ADDITIONAL DATA FROM RAHAD										
	N	24	24	24	24	24	24	24	24	24
	SUM(4)	24	0	0	0	0	24	24	24	24
	SUM(1)	0	24	24	24	24	0	0	0	0
	%(4)	100	0	0	0	0	100	100	100	100
	%(1)	0	100	100	100	100	0	0	0	0
	TOTAL	100	100	100	100	100	100	100	100	100
ADDITIONAL DATA FROM NEW HALFA										
	N	6	6	6	6	6	6	6	6	6
	SUM(4)	6	0	6	0	0	6	6	6	6
	SUM(1)	0	6	0	6	6	0	0	0	0
	%(4)	100	0	100	0	0	100	100	100	100
	%(1)	0	100	0	100	100	0	0	0	0
	TOTAL	100	100	100	100	100	100	100	100	100

NO.	REF:	PESTIC	HAZARD	SAFETY	NAME	EXTIN	PROTECT	CLEANUP	TRAINING	ACCID	GOOD C	OFFL	AGREE	STORAGE
1	GEDAL.B27	1	1	1	4	1	1	1	1	1	1		4	3
2	RAHAD										4		4	3
3	SG.B4	2	2	2	2	1	1	1	2	1	3	1	4	3
4	SG.B4(2)	2	2	2	2	1	1	1	4	1	4	3	4	2
5	KM.88	4	1	1	4	1	4	1	1	4	4	2	4	2
6	KM.88(2)										4			2
7	TURABI	1	1	1	4	1	1	1	1	1	3		4	3
8	TURABI(2)										1			2
9	NG.KAB									1	4	3		2
10	MES.WM										4	1		2
11	SG.B2	1	1	1	4	4	1		1	1	4	4	4	2
12	B.7	4	4	4	4	4	4	4	4	1	4	4	4	2
13	B.7(2)	1	1	1	1	1	1	1	1	1	3	1	4	1
14	B.3	1	1	1	1	1	1	1	1	1	4	1	1	2
15	MA.SAAD										4	4		
16	SG.B6										4			2
17	B.UMHANI					1	1	1	1	1	4	4		2
18	B.GODA	1	1	1	1	1	4	1	1	1	4	4	4	2
19	B.GODA(2)	1	1	1	1	1	1	1	1	1	4	4	4	2
20	MAT.77	4	4	4	4	1	1	1		1	4	1	4	1
21	GAM.80	4	4	4	4	1	4	1	4	1	4	4	4	4
22	MAN.53	4	1	1	4	1	1	1	1	1	4	1	4	1
23	UM DAG.BN	1	1	1	1	1	1	1	1	1	4	4	4	1
24	B.95									1	1	1	4	1
25	NW.SEID										1			2
26	ELS.WN	1	1	1	1	1	1	1	1	4	1	4	4	1
	SUM	33	27	27	42	23	29	19	26	25	86	51	69	50
	MEAN	2.06	1.69	1.69	2.63	1.35	1.71	1.19	1.63	1.32	3.31	2.68	3.83	2.00
	NO.	16	16	16	16	17	17	16	16	19	26	19	18	25
	SUM(4)	5	3	3	8	2	4	1	3	2	18	9	17	1
	SUM(3)	0	0	0	0	0	0	0	0	0	3	2	0	4
	SUM(2)	2	2	2	2	0	0	0	1	0	0	1	0	14
	SUM(1)	9	11	11	6	15	13	15	12	17	5	7	1	6
	%(4)	31.25	18.75	18.75	50.00	11.76	23.53	6.25	18.75	10.53	69.23	47.37	94.44	4.00
	%(3)	.00	.00	.00	.00	.00	.00	.00	.00	.00	11.54	10.53	.00	16.00
	%(2)	12.50	12.50	12.50	12.50	.00	.00	.00	6.25	.00	.00	5.26	.00	56.00
	%(1)	56.25	68.75	68.75	37.50	88.24	76.47	93.75	75.00	89.47	19.23	36.84	5.56	24.00
	TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100
ADDITIONAL DATA FROM RAHAD														
	N	24	24	24	24	24	24	24	24	24	24	24	24	24
	SUM(4)	0	0	0	0	0	0	0	0	0	0	0	24	0
	SUM(1)	24	24	24	24	24	24	24	24	24	24	24	0	24
	%(4)	0	0	0	0	0	0	0	0	0	0	0	100	0
	%(1)	100	100	100	100	100	100	100	100	100	100	100	0	100
	TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100
ADDITIONAL DATA FROM NEW HALFA														
	N	6	6	6	6	6	6	6	6	6	6	6	6	6
	SUM(4)	0	0	0	0	0	0	0	0	0	0	0	6	0
	SUM(1)	6	6	6	6	6	6	6	6	6	6	6	0	6
	%(4)	0	0	0	0	0	0	0	0	0	0	0	100	0
	%(1)	100	100	100	100	100	100	100	100	100	100	100	0	100
	TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100

APPENDIX G AIRSTRIPS (SUMMARY AND RAW DATA).

SUDAN QUESTIONNAIRE SUMMARY: AIRSTRIP HANDLING AND LOADING (B:SUDAIR.CAL)

NO.	REF.	EACH	SOME	NONE	NEAR	NOTICE	SAFETY	CARE	UNAUTH	MIX	OVERALL	GLOVE	BOOT	FACE	HEAD	RESP	WORN	SOAP	EAT	TRAINED	SUPER	LOAD	TYPE	PILOT
1	GEDAL.27	1				1	1		1		4	1	1	1	1	1	1	1	1	1	1	1	4	1
2	RAHAD	1				1	2	1	3		4	4	1	3	1	1	3	3	1	2	2	1	4	1
3	B.4	3				1	2		1		1	4	1	1	1	1	1	4	1	3	3	4	4	1
4	SG.4(2)	4				4	1	4	4	4	4	1	4	4	4	4	1	4	4	2	4	1	4	1
5	KM.88	3				2	3		1	4	4	4	1	1	1	1	3	3	1	1	4	2	4	1
6	KM.88(2)					1		1	1		4	1	1	1	1	1	2	1			4		1	1
7	TURABI	1				1	1		1		1	1	1	1	1	3	1	4	1	1		2	4	2
8	TURABI(2)	1	1	4		1	1	4		4	1	1	1	1	1	1	1	1	3	1	4	4	4	
9	NG.KAB	1	4	1	1	1	1	1	1	4	1	1	1	2	1	1	1	1	4	1	1	1		1
10	MES.WM	1	4	1	1	1	1	4	4	4	1	1	1	1	1	1	1	4	4	4	4	4	4	1
11	SG.2	4	1	1	1	4	4	4	4	4	3	3	3	3	3	3	4	4	4	1	4	1	4	1
12	B.7	1	2	2	1	1	1	2	4	3	4	4	1	1	1	1	1	4	1	1	4	4	3	1
13	B.7(2)	4	1	1	1	1	1	1	1	1	4	3	1	1	1	3	3	3	4	1	3	1	1	1
14	B.3	4	1	1	1	1	1	1	1	1	4	3	1	1	1	1	2	3	4	1	4	1	1	1
15	MA.SAAD	4	1	1	1	1	1	4	4	4	4	4	1	1	1	1	4	1	1	3	3	4	4	
16	SG.6	4	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	4	1	3	1	1	1
17	B.UMHANI	1	4	1	1	1	1		1		4	1	1	1	1	1	1	4	2	1	1	1	4	1
18	B.GODA	1	4	1	4	4	4	1	4	4	4	1	1	1	1	1	1	1	1	1	4	1	4	1
19	B.GODA(2)	1	4	1	4	1	4	1	1	4	4	1	1	1	1	1	3	3	4	1	1	1	4	1
20	MAT.77	4	1	1	1	4	4	4	4	4	4	4	4	4	1	4	1	1	4	1	3	4	4	1
21	GAM.80	4	1	1	1	4	4	4	4	4	4	4	4	4	1	4	4	4	1	4	4	4	4	1
22	MAN.53	4	1	1	1	1	4	4	4	4	1	3	1	1	1	1	1	1	1	1	4	4	4	1
23	UM DAG.BN	1	1	4	1	1	1	4	1		1	1	1	1	1	1	1	2	4	1	4	4	4	1
24	B.95	1	4	1	1	1	1	4	1	1	4	1	1	1	1	2	1	4	4	1	1	4	4	1
25	NW.SEID	1	4	1	1	1	1	4	1	4	4	1	1	1	1	1	1	4	4	4	4	4	4	1
26	ELS.WN	1	1	4	1	1	4	1	1	4	4	1	1	1	1	1	3	3	4	1	4	1	4	1

	EACH	SOME	NONE	NEAR	NOTICE	SAFETY	CARE	UNAUTH	MIX	OVERALL	GLOVE	BOOT	FACE	HEAD	RESP	WORN	SOAP	EAT	TRAINED	SUPER	LOAD	TYPE	PILOT
SUM	56	41	29	24	42	50	55	54	66	82	55	37	40	31	42	47	69	67	40	78	60	87	25
MEAN	2.24	2.16	1.53	1.33	1.62	2.00	2.62	2.16	3.47	3.15	2.12	1.42	1.54	1.19	1.62	1.81	2.65	2.68	1.60	3.12	2.40	3.48	1.04
N	25	19	19	18	26	25	21	25	19	26	26	26	26	26	26	26	26	25	25	25	25	25	24
SUM(4)	9	7	3	2	5	7	11	9	15	18	7	3	3	1	3	3	10	13	3	14	11	20	0
SUM(3)	2	0	0	0	0	1	0	1	1	1	4	1	2	1	3	5	6	1	2	5	0	1	0
SUM(2)	0	1	1	0	1	2	1	0	0	0	0	0	1	0	1	2	1	1	2	1	2	0	1
SUM(1)	14	11	15	16	20	15	9	15	3	7	15	22	20	24	19	16	9	10	18	5	12	4	23
%(4)	36.00	36.84	15.79	11.11	19.23	28.00	52.38	36.00	78.95	69.23	26.92	11.54	11.54	3.85	11.54	11.54	38.46	52.00	12.00	56.00	44.00	80.00	.00
%(3)	8.00	.00	.00	.00	.00	4.00	.00	4.00	5.26	3.85	15.38	3.85	7.69	3.85	11.54	19.23	23.08	4.00	8.00	20.00	.00	4.00	.00
%(2)	.00	5.26	5.26	.00	3.85	8.00	4.76	.00	.00	.00	.00	.00	3.85	.00	3.85	7.69	3.85	4.00	8.00	4.00	8.00	.00	4.17
%(1)	56.00	57.89	78.95	88.89	76.92	60.00	42.86	60.00	15.79	26.92	57.69	84.62	76.92	92.31	73.08	61.54	34.62	40.00	72.00	20.00	48.00	16.00	95.83
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
ADDITIONAL DATA FROM RAHAD																							
N	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
SUM(4)	0	24	0	0	0	0	0	24	24	24	24	0	0	0	0	0	0	24	0	0	0	24	0
SUM(1)	24	0	24	24	24	24	24	0	0	0	0	24	24	24	24	24	24	0	24	24	24	0	24
%(4)	0	100	0	0	0	0	0	100	100	100	100	0	0	0	0	0	0	100	0	0	0	100	0
%(1)	100	0	100	100	100	100	100	0	0	0	0	100	100	100	100	100	100	0	100	100	100	0	100
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
ADDITIONAL DATA FROM NEW HALFA																							
N	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SUM(4)	0	6	0	0	0	0	0	6	6	6	0	0	0	0	0	0	0	6	0	0	0	6	0
SUM(1)	6	0	6	6	6	6	6	0	0	0	6	6	6	6	6	6	6	0	6	6	6	0	6
%(4)	0	100	0	0	0	0	0	100	100	100	0	0	0	0	0	0	0	100	0	0	0	100	0
%(1)	100	0	100	100	100	100	100	0	0	0	100	100	100	100	100	100	100	0	100	100	100	0	100
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

APPENDIX G AIRSTRIPS (SUMMARY AND RAW DATA).

SUDAN QUESTIONNAIRE SUMMARY: AIRSTRIP HANDLING AND LOADING (B:SUDAIR.CAL)

NO.	REF.	EACH	SOME	NONE	NEAR	NOTICE	SAFETY	CARE	UNAUTH	MIX	OVERALL	GLOVE	BOOT	FACE	HEAD	RESP	WORM	SOAP	EAT	TRAINED	SUPER	LOAD	TYPE	PILOT
1	GEDAL.27	1				1	1		1		4	1	1	1	1	1	1	1	1	1	1	1	4	1
2	RAHAD	1				1	2	1	3		4	4	1	3	1	1	3	3	1	2	2	1	4	1
3	B.4	3				1	2		1		1	4	1	1	1	1	1	4	1	3	3	4	4	1
4	SG.4(2)	4				4	1	4	4	4	4	1	4	4	4	4	1	4	4	2	4	1	4	1
5	KM.88	3				2	3		1	4	4	4	1	1	1	1	3	3	1	1	4	2	4	1
6	KM.88(2)					1		1	1		4	1	1	1	1	1	2	1			4		1	1
7	TURABI	1				1	1		1		1	1	1	1	1	3	1	4	1	1		2	4	2
8	TURABI(2)	1	1	4		1	1	4		4	1	1	1	1	1	1	1	1	3	1	4	4	4	
9	NG.KAB	1	4	1	1	1	1	1	1	4	1	1	1	2	1	1	1	1	4	1	1	1		1
10	MES.WM	1	4	1	1	1	1	4	4	4	1	1	1	1	1	1	1	4	4	4	4	4	4	1
11	SG.2	4	1	1	1	4	4	4	4	4	3	3	3	3	3	3	4	4	4	1	4	1	4	1
12	B.7	1	2	2	1	1	1	2	4	3	4	4	1	1	1	1	1	4	1	1	4	4	3	1
13	B.7(2)	4	1	1	1	1	1	1	1	1	4	3	1	1	1	3	3	3	4	1	3	1	1	1
14	B.3	4	1	1	1	1	1	1	1	1	4	3	1	1	1	1	2	3	4	1	4	1	1	1
15	MA.SAAD	4	1	1	1	1	1	4	4	4	4	4	1	1	1	1	4	1	1	3	3	4	4	
16	SG.6	4	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	4	1	3	1	1	1
17	B.UMHANI	1	4	1	1	1	1		1		4	1	1	1	1	1	1	4	2	1	1	1	4	1
18	B.GODA	1	4	1	4	4	4	1	4	4	4	1	1	1	1	1	1	1	1	1	4	1	4	1
19	B.GODA(2)	1	4	1	4	1	4	1	1	4	4	1	1	1	1	1	3	3	4	1	1	1	4	1
20	MAT.77	4	1	1	1	4	4	4	4	4	4	4	4	4	1	4	1	1	4	1	3	4	4	1
21	GAM.80	4	1	1	1	4	4	4	4	4	4	4	4	4	1	4	4	4	1	4	4	4	4	1
22	MAN.53	4	1	1	1	1	4	4	4	4	1	3	1	1	1	1	1	1	1	1	4	4	4	1
23	UM DAG.BN	1	1	4	1	1	1	4	1		1	1	1	1	1	1	1	2	4	1	4	4	4	1
24	B.95	1	4	1	1	1	1	4	1	1	4	1	1	1	1	2	1	4	4	1	1	4	4	1
25	NW.SEID	1	4	1	1	1	1	4	1	4	4	1	1	1	1	1	1	4	4	4	4	4	4	1
26	ELS.WN	1	1	4	1	1	4	1	1	4	4	1	1	1	1	1	3	3	4	1	4	1	4	1

	EACH	SOME	NONE	NEAR	NOTICE	SAFETY	CARE	UNAUTH	MIX	OVERALL	GLOVE	BOOT	FACE	HEAD	RESP	WORM	SOAP	EAT	TRAINED	SUPER	LOAD	TYPE	PILOT
SUM	56	41	29	24	42	50	55	54	66	82	55	37	40	31	42	47	69	67	40	78	60	87	25
MEAN	2.24	2.16	1.53	1.33	1.62	2.00	2.62	2.16	3.47	3.15	2.12	1.42	1.54	1.19	1.62	1.81	2.65	2.68	1.60	3.12	2.40	3.48	1.04
N	25	19	19	18	26	25	21	25	19	26	26	26	26	26	26	26	26	25	25	25	25	25	24
SUM(4)	9	7	3	2	5	7	11	9	15	18	7	3	3	1	3	3	10	13	3	14	11	20	0
SUM(3)	2	0	0	0	0	1	0	1	1	1	4	1	2	1	3	5	6	1	2	5	0	1	0
SUM(2)	0	1	1	0	1	2	1	0	0	0	0	0	1	0	1	2	1	1	2	1	2	0	1
SUM(1)	14	11	15	16	20	15	9	15	3	7	15	22	20	24	19	16	9	10	18	5	12	4	23
%(4)	36.00	36.84	15.79	11.11	19.23	28.00	52.38	36.00	78.95	69.23	26.92	11.54	11.54	3.85	11.54	11.54	38.46	52.00	12.00	56.00	44.00	80.00	.00
%(3)	8.00	.00	.00	.00	.00	4.00	.00	4.00	5.26	3.85	15.38	3.85	7.69	3.85	11.54	19.23	23.08	4.00	8.00	20.00	.00	4.00	.00
%(2)	.00	5.26	5.26	.00	3.85	8.00	4.76	.00	.00	.00	.00	.00	3.85	.00	3.85	7.69	3.85	4.00	8.00	4.00	8.00	.00	4.17
%(1)	56.00	57.89	78.95	88.89	76.92	60.00	42.86	60.00	15.79	26.92	57.69	84.62	76.92	92.31	73.08	61.54	34.62	40.00	72.00	20.00	48.00	16.00	95.83
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

ADDITIONAL DATA FROM RAHAD

	EACH	SOME	NONE	NEAR	NOTICE	SAFETY	CARE	UNAUTH	MIX	OVERALL	GLOVE	BOOT	FACE	HEAD	RESP	WORM	SOAP	EAT	TRAINED	SUPER	LOAD	TYPE	PILOT
N	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
SUM(4)	0	24	0	0	0	0	0	24	24	24	24	0	0	0	0	0	0	24	0	0	0	24	0
SUM(1)	24	0	24	24	24	24	24	0	0	0	0	24	24	24	24	24	24	0	24	24	24	0	24
%(4)	0	100	0	0	0	0	0	100	100	100	100	0	0	0	0	0	0	100	0	0	0	100	0
%(1)	100	0	100	100	100	100	100	0	0	0	0	100	100	100	100	100	100	0	100	100	100	0	100
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

ADDITIONAL DATA FROM NEW HALFA

	EACH	SOME	NONE	NEAR	NOTICE	SAFETY	CARE	UNAUTH	MIX	OVERALL	GLOVE	BOOT	FACE	HEAD	RESP	WORM	SOAP	EAT	TRAINED	SUPER	LOAD	TYPE	PILOT
N	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SUM(4)	0	6	0	0	0	0	0	6	6	6	0	0	0	0	0	0	0	6	0	0	0	6	0
SUM(1)	6	0	6	6	6	6	6	0	0	0	6	6	6	6	6	6	6	0	6	6	6	0	6
%(4)	0	100	0	0	0	0	0	100	100	100	0	0	0	0	0	0	0	100	0	0	0	100	0
%(1)	100	0	100	100	100	100	100	0	0	0	100	100	100	100	100	100	100	0	100	100	100	0	100
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

NO.	CHECKS	EMPTY	SPILLS	GENBOSS	FORE	SUPPORT	CLEAR	OUT	AVOID	FIRSTAID	EMPTY	UNUSED	CALIB	ACCID/H	CLEANED	RECORDS	ACCID/S	CONT	SPILLS	GENHAZ	NEED F/A	NEED P/C	NEEDTENT	UNAUTH
1		1	1	3	2	3	4	4	4	1	1	4	4	1	3	4	2		4	4	4	4	3	
2	4	4	1	3	3	3	4	4	4	3	4	3	3	3	1	4	1	4	4	4	4	4		
3	4	4	1	4	3	3	4	4	3	2	4	3	4	1	3	4	1		3	3	4	4	3	
4	4	4	1	4	1	1	4	1	4	1	4	4	4	1	4	4	1				4	4	4	
5	4	4	1	3	4	3	4	4	4	1	4	4	4	1	3	4	4				4	4	4	
6	1	4	1	4					1	1	4	4		1		4	1							
7	3	1	1	1	1	1	4	1	4	1	4	4	4	1	4	4	4		4	4		4		4
8		4	1	4	1	1	3		1	1				1					4	4				
9				4		1				1	3	4		3		4	1							
10	1	4		4	4	4	4			1	4	4	1	1	1	4	1			3				4
11	4	4	2	4	4	1	4	4	4	1	4	4	3	1	4	4	1				2	4	4	
12	4	4	1	4	4	4	1	1	4	1	4	4		4		4	1			3				
13	1	1	1	3	1	1	1	1	4	1	4	4	1	1	1	4	1			3				
14	1	1	1	4	2	1	2	1	4	1	4		1	1	1	4	1			3				
15		1	1	3	4	4	4	4	4	1	4	1	1			4	1							
16	4	3	1	4	4	1	1	3	4	1	4			1	1	4				3				
17	1	1	1	3	3	3	4	4	4	1	4	1	4	4	3	4	4		4	4				
18	4	1	2	4	1	4	4	4	1	1	4	4	4	1	4	1	1							
19	4	4	3	4	4	1	4	4	1	1	4	4	4	1	4	1	1							
20	4	4	1	4	2	2	4	3	4	1	4	4	4	1	4	4	1		4	4				
21	4	4	1	4	4	4	4	4	4	1	4	4	4	1	4	4	1		4	4	4			
22	4	4	1	4	3	3	1	4	4	1	4	4	4	4	4	4	4		4	4	4	4		4
23	4	1	1	3	3	3	1	1	4	1	4	4		4	4	4	4							4
24	1	4	1	4	4	4	4		4	1	4		4	1	4	4	1							
25	4	4	1	4	4	4	1	1	4	1	4	4	4	1	1	4	1							
26	4	4	1	4	4	4	4	4	4	1	4	4	4	1	4	1	4							

CHECKS	EMPTY	SPILLS	GENBOSS	FORE	SUPPORT	CLEAR	OUT	AVOID	FIRSTAID	EMPTY	UNUSED	CALIB	ACCID/H	CLEANED	RECORDS	ACCID/S	CONT	SPILLS	GENHAZ	NEED F/A	NEED P/C	NEEDTENT	UNAUTH
69	75	28	94	70	63	75	61	80	29	96	80	66	41	62	91	43	4	35	50	30	32	18	16
3.14	3.00	1.17	3.62	2.92	2.52	3.13	2.90	3.33	1.12	3.84	3.64	3.30	1.64	2.95	3.64	1.79	4.00	3.89	3.57	3.75	4.00	3.60	4.00
22	25	24	26	24	25	24	21	24	26	25	22	20	25	21	25	24	1	9	14	8	8	5	4
15	16	0	18	11	7	16	12	18	0	23	18	14	4	11	22	6	1	8	8	7	8	3	4
1	1	1	7	5	8	1	2	1	1	1	2	2	2	4	0	0	0	1	6	0	0	2	0
0	0	2	0	3	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0
6	8	21	1	5	9	6	7	5	24	1	2	4	19	6	3	17	0	0	0	0	0	0	0
68.18	64.00	.00	69.23	45.83	28.00	66.67	57.14	75.00	.00	92.00	81.82	70.00	16.00	52.38	88.00	25.00	100.00	88.89	57.14	87.50	100.00	60.00	100.00
4.55	4.00	4.17	26.92	20.83	32.00	4.17	9.52	4.17	3.85	4.00	9.09	10.00	8.00	19.05	.00	.00	.00	11.11	42.86	.00	.00	40.00	.00
.00	.00	8.33	.00	12.50	4.00	4.17	.00	.00	3.85	.00	.00	.00	.00	.00	.00	4.17	.00	.00	.00	12.50	.00	.00	.00
27.27	32.00	87.50	3.85	20.83	36.00	25.00	33.33	20.83	92.31	4.00	9.09	20.00	76.00	28.57	12.00	70.83	.00	.00	.00	.00	.00	.00	.00
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
24	24	24	24	24	24			24	24	24	24	24	24		24	24							
24	24	0	0	24	0			24	0	24	24	24	0		24	0							
0	0	24	24	0	24			0	24	0	0	0	24		0	24							
100	100	0	0	100	0			100	0	100	100	100	0		100	0							
0	0	100	100	0	100			0	100	0	0	0	100		0	100							
100	100	100	100	100	100			100	100	100	100	100	100		100	100							
6	6	6	6	6	6			6	6	6	6	6	6		6	6							
6	6	0	0	6	0			6	0	6	6	6	0		6	6							
0	0	6	6	0	6			0	6	0	0	0	6		0	0							
100	100	0	0	100	0			100	0	100	100	100	0		100	100							
0	0	100	100	0	100			0	100	0	0	0	100		0	0							
100	100	100	100	100	100			100	100	100	100	100	100		100	100							

APPENDIX H FIELD AND FARM WORKERS (SUMMARY).

SUDAN QUESTIONNAIRE SUMMARY: FIELD AND FARM WORKERS (B:SUDFIELD.CAL)

	WHEN	WHAT	AVOID	RE-ENTRY	CLOTHING	TRAINED	HAZARD	MOUTH	SKIN	INHALE	SYMPTOMS	POISONED	CONTAINER	WORKUSE	HOMEUSE	NOTIFIED	WARNED	ADVISED	PEOPLE	LIVESTOCK	FOOD	WATER	DEAD FISH	PESTIC	EAT FISH	CANAL	SPRAYMORT	MORTEMIC
SUM	396	185	468	446	178	173	546	448	315	419	292	221	169	224	208	353	371	371	232	225	223	337	557	12	255	190	100	292
MEAN	2.39	1.11	2.82	2.69	1.07	1.04	3.43	2.97	2.13	2.81	1.76	1.33	1.02	1.36	1.25	2.22	2.33	2.33	1.42	1.36	1.34	2.03	3.84	2.00	3.27	3.80	2.38	3.36
N	166	166	166	166	166	167	159	151	148	149	166	166	165	165	166	159	159	159	163	165	166	166	145	6	78	50	42	87
SUM(4)	76	4	97	88	2	2	128	99	55	90	38	16	1	19	14	64	70	70	23	20	19	57	136	2	59	44	16	60
SUM(3)	1	3	5	5	3	0	0	0	1	0	3	3	0	1	0	1	1	1	0	0	0	0	2	0	0	4	4	6
SUM(2)	0	1	1	6	0	0	3	0	0	0	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13
SUM(1)	89	158	63	67	161	165	28	52	92	59	119	146	163	145	152	94	88	88	140	145	147	109	7	4	19	2	20	8
%(4)	45.78	2.41	58.43	53.01	1.20	1.20	80.50	65.56	37.16	60.40	22.89	9.64	.61	11.52	8.43	40.25	44.03	44.03	14.11	12.12	11.45	34.34	93.79	33.33	75.64	88.00	38.10	68.97
%(3)	.60	1.81	3.01	3.01	1.81	.00	.00	.00	.68	.00	1.81	1.81	.00	.61	.00	.63	.63	.63	.00	.00	.00	.00	1.38	.00	.00	8.00	9.52	6.90
%(2)	.00	.60	.60	3.61	.00	.00	1.89	.00	.00	.00	3.61	.60	.61	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4.76	14.94
%(1)	53.61	95.18	37.95	40.36	96.99	98.80	17.61	34.44	62.16	39.60	71.69	87.95	98.79	87.88	91.57	59.12	55.35	55.35	85.89	87.88	88.55	65.66	4.83	66.67	24.36	4.00	47.62	9.20
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

ADDITIONAL DATA FROM NEW HALFA

N	30	30	30	30	30	30	30	30	20	24	26	29	30	30	30	29	27	27	30	30	30	30	30
SUM(4)	20	3	21	8	0	3	29	30	8	20	20	0	2	3	3	18	11	9	26	25	20	26	14
SUM(1)	10	27	9	22	30	27	1	0	12	4	6	29	28	27	27	11	16	18	4	5	10	4	16
%(4)	66.67	10.00	70.00	26.67	.00	10.00	96.67	100.00	40.00	83.33	76.92	.00	6.67	10.00	10.00	62.07	40.74	33.33	86.67	83.33	66.67	86.67	46.67
%(1)	33.33	90.00	30.00	73.33	100.00	90.00	3.33	.00	60.00	16.67	23.08	100.00	93.33	90.00	90.00	37.93	59.26	66.67	13.33	16.67	33.33	13.33	53.33
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

ADDITIONAL DATA FROM RAHAD

N	38	39	40	38	40	40	40	33	25	30	36	38	39	40	40	39	39	29	40	40	39	40	40
SUM(4)	29	1	25	12	0	15	38	29	7	25	30	0	3	2	0	21	21	10	31	27	25	25	12
SUM(1)	9	38	15	26	40	25	2	4	18	5	6	38	36	38	40	18	18	19	9	13	14	15	28
%(4)	76.32	2.56	62.50	31.58	.00	37.50	95.00	87.88	28.00	83.33	83.33	.00	7.69	5.00	.00	53.85	53.85	34.48	77.50	67.50	64.10	62.50	30.00
%(1)	23.68	97.44	37.50	68.42	100.00	62.50	5.00	12.12	72.00	16.67	16.67	100.00	92.31	95.00	100.00	46.15	46.15	65.52	22.50	32.50	35.90	37.50	70.00
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

APPENDIX H FIELD AND FARM WORKERS (RAW DATA).

SUDAN QUESTIONNAIRE DATA: FIELD AND FARM WORKERS (B:SUDFIELD.CAL)

NO.	REF:	WHEN	WHAT	AVOID	RE-ENTRY	CLOTHING	TRAINED	HAZARD	MOUTH	SKIN	INHALE	SYMPTOMS	POISONED	CONTAINER	WORKUSE	HOMEUSE	NOTIFIED	WARNED	ADVISED	PEOPLE	LIVESTOCK	FOOD	WATER	DEAD FISH	PESTIC	EAT FISH	CANAL	SPRAYMORT	MORTENIC
1	WS.31	4	1	4	4	1	1	4	4	4	4	4	1	2	4	4	4	4	4	1	1	1	4	4	4				
2	AK.31	4	1	3	4	1	1	4	4	4	4	4	3	1	4	4	4	4	4	1	1	1	1	4	1	4			2
3	SORIBA	1	1	4	3	1	1	1				3	1		1	1				1	1	1	4	4	1	1			
4	GEZ.AB	1	1	3	1	3	1	4	4	4	4	4	4	1	1	4	1	1	1	1	1	1	1	4		1			
5	N.DEB	1	1	1	4	1	1	4	4	4	4	4	1	1	4	1	1	4	4	4	4	4	1	4					
6	N.DEB	1	1	1	4	1	1	4	4	4	4	2	1	1	1	1	1	1	1	4	4	1	4	4		4			
7	N.DEB	1	1	4	4	1	1	4	4	1	4	2	1	1	4	4	1	1	1	1	1	1	1						
8	S.7						1	4	4		4		1																
9	S.7	4	2	4	4	1	1	4	4	3	4	1	1	1	1	1	4	4	4	4	4	4	4	4					
10	S.7	4	4	4	4	1	1	4		4	4	1	1	1	1	4	4	4	4	1	1	1	1	4		4			
11	S.6	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
12	S.6	1	1	1	1	1	1	4	4			4	1	1	4	1	1	1	1	4	4	4	4	4		4			
13	S.6	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1				1	1	1	1	4		1			4
14	S.6	1	1	1	1	1	1	4	1	1	1	1	3	1	1	1				1	1	1	1	4		1			4
15	BL.95	4	1	4	4	1	1	4	4	4		4	1	1	1	1	4	4	4	1	1	1	1	4					4
16	C.8	1	1	4	4	1	1	1	4	4	4	1	4	1	1	4	4	4	4	1	1	1	1	4					3
17	M.85	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1		1	1	1	1					4
18	S.7	1	1	1	1	1	1	4	4	4	4	4	3	1	1	1	1	1	1	1	1	1	1	4					4
19	S.5	4	1	4	4	3	1	4	4	4	4	4	1	1	3	1	1	1	1	1	1	1	1						2
20	S.3	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1				2
21	S.6	4	1	4	1	1	1	2	4	1	4	4	1	1	1	1	1	1	1	1	1	1	1	4					2
22	S.6	4	3	4	4	1	1	4	4	4	4	4	1	1	4	4	4	4	4	4	4	4	4	4					4
23	C.12	4	1	4	4	3	1	1	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4					4
24	C.14	4	1	1	1	4	1	4	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4					
25	S.6	4	1	4	4	1	1	4	4	4	4	4	1	1	1	1	4	4	4	1	1	1	1	4					2
26	S.7	4	1	4	2	1	1	4	4	4	4	4	1	1	1	4	4	4	4	1	1	1	1	4					2
27	S.7	1	1	1	1	1	1	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1	1	4					2
28	C.8	1	1	3	4	1	1	4	4	4	4	1	1	1	1	1	4	4	4	4	4	4	4	4					4
29	C.8	1	1	4	4	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4					4
30	C.9	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4					3
31	C.9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4					3
32	C.10	1	1	4	4	1	1	1	4	4	4	1	1	1	1	1	1	1	1	1	1	1	1	4		4			4
33	C.10	4	1	4	4	1	1	4	4	4	4	1	1	1	1	1	4	4	4	1	1	1	1	4					4
34	C.11	4	1	4	4	1	1	4	4	4	4	4	4	1	1	1	4	4	4	1	1	1	1	4					2
35	C.11	1	1	4	1	1	1	4	4	4	4	1	1	1	1	1	4	4	4	4	4	4	4	4	1	4			4
36	WH.26	4	1	4	4	1	1	4	4	4	4	2	1	1	4	1	4	4	4	1	1	1	1						
37	WH.26	4	4	4	1	1	1		4	1	1	2	1	1	1	1	1	4	4	4	4	4	4						
38	WH.26	1	1	1	1	1	1		4	4	4	1	4	1	4	1	1	1	1	1	1	1	1						
39	N.TUR	4	1	4	4	1	1	4	4	4	4	2	1	1	4	1	4	4	4	1	1	1	1						
40	N.DEB	4	1	4	4	1	1	4	4	4	4	2	1	1	1	1	4	4	4	1	1	1	1						
41	N.DEB	1	1	1	4	4	1	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1	1						4
42	S.1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					4
43	S.6	1	1	1	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	1	4					
44	C.12	1	1	4	4	1	1	1	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4					2
45	C.15	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		4	4		
46	C.15	4	1	4	4	1	1	4	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4			4		
47	C.15	4	1	4	3	1	1	4				1	1	1	1	1	1	1	1	1	1	1	1	4			4		
48	C.15	4	4	4	4	1	1	4	4	4	4	4	1	1	1	1	4	4	4	1	1	1	1	4					
49	C.14	4	3	4	4	1	1	4	4	4	4	4	1	1	1	1	1	1	1	4	4	4	4	4					
50	B.7	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			4
51	S.5	4	1	4	4	1	1	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1	1	4					4
52	S.95	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4					
53	S.3	1	1	4	4	1	1	4	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	4					4
54	C.GP	1	1	4	4	1	1	4	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1	4		4	4		
55	C.11	4	1	4	1	1	1	4	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4			4		

APPENDIX H FIELD AND FARM WORKERS (RAW DATA)/CONTINUED

SUDAN QUESTIONNAIRE DATA: FIELD AND FARM WORKERS (B:SUDFIELD.CAL)

NO.	REF:	WHEN	WHAT	AVOID	RE-ENTRY	CLOTHING	TRAINED	HAZARD	MOUTH	SKIN	INHALE	SYMPTOMS	POISONED	CONTAINER	WORKUSE	HOMEUSE	NOTIFIED	WARNED	ADVISED	PEOPLE	LIVESTOCK	FOOD	WATER	DEAD FISH	PESTIC	EAT FISH	CANAL	SPRAYMORT	HORTEMIC
56	C.7	4	1	4	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4					4
57	S.5	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	4					
58	S.3	1	1	3	2	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4					4
59	S.2	4	1	4	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4					4
60	S.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4					2
61	S.3	4	1	4	4	1	1	4	4	4	4	1	1	1	1	1	4	4	4	1	1	1	1	4					2
62	C.13	1	1	1	2	1	1	4	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	4					2
63	C.13	1	1	1	2	1	1	4	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	4					4
64	C.14	4	1	4	4	1	1	4	4	4	4	1	1	1	4	4	4	4	4	1	1	1	1	4	4				4
65	C.15	1	1	1	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	1	4					4
66	C.15	1	1	1	1	1	1	1	1	1	1	4	1	1	4	1	1	1	1	1	1	1	1	4		4			4
67	C.14	1	1	4	4	1	1	4	4	4	4	1	1	1	1	1	4	4	4	1	1	1	1	4					4
68	C.GP	1	1	1	1	1	1	4	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1	4		4	4		4
69	G.10	4	1	4	4	1	1	4	4	4	4	1	1	1	1	1	4	4	4	1	1	1	1	4		4	4		
70	C.8	1	1	2	2	1	1	1	1			1	1	1	1	1				1	1	1	1	4		1	4		4
71	B.8	4	1	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		4	4	4	4
72	B.8	1	1	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		4	4	4	4
73	B.8	4	1	4	1	1	1		1	1	1	1	1	1	1	1	3	3	3	1	1	1	1	1			4	4	1
74	C.12	4	1	4	3	1	1	4	1	1	1	1	4	1	1	1	4	4	4	1	1	1	1	4		1	4	2	4
75	C.8	4	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	4		4	4	4	4
76	B.8	1	1	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		1	4	1	4
77	B.7	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	4	1	1
78	SG.7	1	1	1	1	1	1	4	1	4	1	1	1	1	1	1	4	4	4	1	1	1	1				4	4	4
79	SG.7	4	1	4	4	1	1					1	1	1	1	1	4	4	4	1	1	1	1	4		1	1	1	1
80	B.7	4	1	4	4	1	1	2	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4		1	3	1	4
81	C.8	4	1	4	4	1	1	4	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4		4	4	4	4
82	C.8	1	1	4	4	1	1	4	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4		4	4		4
83	C.9	1	1	3	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	4		4	4	3	3
84	S.95	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		4	3	1	1
85	S.2	4	1	4	1	1	1	4	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4		1	4	3	
86	S.2	4	1	4	4	1	1	1	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4		1	3	1	4
87	S.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		4	4	1	4
88	S.5	4	1	4	4	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		4	4	1	4
89	C.9	4	1	4	1	1	1	4				4	1	1	1	1	1	1	1	1	1	1	1	4		4	4	1	4
90	C.9	4	1	4	1	1	1	4				1	1	1	1	1	1	1	1	1	1	1	1	4		4	4	1	4
91	S.1	4	1	4	4	1	1	1	1	1	1	1	1	1	1	1	4	4	4	1	1	1	1	4		4		1	4
92	S.1	1	1	1	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	1	4					
93	S.5	3	1	4	4	1	1	4	4	4	4	4	1	1	1	1	4	4	4	1	1	1	1	4					4
94	C.8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	4				1	
95	C.8	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		4	4		4
96	S.7	1	1	4	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		4		1	4
97	C.8	4	1	4	4	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		1	4	1	4
98	HUD.93	4	1	4	4	1	1	4	4	4	4	1	4	1	1	1	4	4	4	1	1	1	1	4		4	4	1	4
99	HUD.90	1	1	1	4	1	1	4				1	1	1	1	1	4	4	4	1	1	1	1	4		4	3	1	4
100	HUD.90	4	1	4	4	1	1	4	1	1	1	4	1	1	1	1	4	4	4	4	4	4	4	4		1	4	1	4
101	MAN.53	1	1	4	1	1	1	4				1	1	1	1	1	4	4	4	1	1	1	1	4		4	4	2	4
102	TAN.78	4	1	4	4	1	1	4	4	4	4	1	1	1	1	1	4	4	4	1	1	1	1	4		4	4	4	4
103	MAT.B	4	1	1	1	1	1	4				4	1	1	1	1	1	1	1	1	1	1	1	4		4	4	4	
104	MAT.68	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4		4	4	1	
105	MAT.74	4	1	4	1	1	1	4				1	1	1	1	1	4	4	4	1	1	1	1	4		4	4		
106	B.77	1	1	1	1	1	1	4				1	1	1	1	1	1	1	1	1	1	1	1	4		4	4	1	1
107	GAN.80	4	1	4	1	1	1					1	1	1	1	1	4	4	4	1	1	1	1	1		4	4	3	2
108	GAN.78	4	3	4	4	1	1	4	4	4	4	1	1	1	1	1	4	4	4	1	1	1	1	4		4	4	4	4
109	MAK.84	1	1	1	1	1	1					1	1	1	1	1	1	1	1	1	1	1	1	4		4	4	4	1
110	HUD.90	1	1	4	1	1	1	4				1	1	1	1	1	4	4	4	1	1	1	1	4		4	4	4	4

APPENDIX H FIELD AND FARM WORKERS (RAW DATA)/CONTINUED

SUDAN QUESTIONNAIRE DATA: FIELD AND FARM WORKERS (B:SUDFIELD.CAL)

NO.	REF:	WHEN	WHAT	AVOID	RE-ENTRY	CLOTHING	TRAINED	HAZARD	MOUTH	SKIN	INHALE	SYMPTOMS	POISONED	CONTAINER	WORKUSE	HOMEUSE	NOTIFIED	WARNED	ADVISED	PEOPLE	LIVESTOCK	FOOD	WATER	DEAD FISH	PESTIC EAT FISH	CANAL	SPRAYMORT	MORTEMIC
111	N.DEB	4	1	4	4	1	1	4	4	4	4	4	1	1	1	1	1	1	1	1	1	1	4	4	4			
112	N.DEB	1	1	1	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	4	4	1			
113	N.DEB	1	1	1	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	4	4				
114	N.DEB	1	1	1	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	4	4				
115	N.DEB	4	1	4	4	1	1	4	4	4	4	1	4	1	1	1	1	1	1	4	4	4	1	4	4			
116	N.DEB	4	1	4	4	1	1	4	4	1	4	1	1	1	1	1	4	4	4	1	1	1	4	4	4			
117	N.DEB	4	1	4	4	1	1	4	4	1	4	1	1	1	1	1	4	4	4	1	1	1	4	4				4
118	N.DEB	4	1	4	4	1	1	4	4	1	4	1	1	1	1	1	4	4	4	1	1	1	4	4	4			
119	(N.DEB)	4	1	4	4	1	1	4	4	1	4	4	4	1	1	1	4	4	4	1	1	1	4	4				
120	C.8	4	1	4	4	1	1	4	4	1	4	4	1	1	1	1	1	1	1		1	1	4	4	4			3
121	MES.21	4	1	4	4	1	1	4	4	1	4	1	4	1	1	1	.1	1	1	1	1	1	4	4				
122	MES.4	1	1	1	4	1	1	4	4	1	4	1	1	1	1	1	4	4	4	1	1	1	4					
123	MES.BL	1	1	4	4	1	1	4	4	1	4	4	1	1	1	1	1	1	1	1	1	1	4	4				
124	C.BAR	4	1	4	4	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	4	4	4			
125	C.11	4	1	4	4	1	1	4	4	4	4	1	1	1	4	1	4	4	4	1	1	1	4	4				
126	C.11	4	1	4	4	1	1	4	4	4	4	1	1	1	4	1	4	4	4	1	1	1	4	4				
127	C.BAR	4	1	4	4	1	1	4	4	1	4	1	1	1	1	1	4	4	4	1	1	1	4	4				
128	C.BAR	1	1	1	1	1	1	4	4	1	4	4	1	1	1	1	1	1	1	1	1	1	4	4				
129	WN.26	4	1	4	4	1	1	4	4	4	4	4	1	1	1	1	4	4	4	1	1	1	4	4				
130	WN.26	4	1	4	4	1	1	4	4	4	4	4	1	1	4	1	4	4	4	1	1	1	4					
131	WN.26	4	1	4	4	1	1	4	4	1	4	1	1	1	1	1	4	4	4	1	1	1	4					
132	WN.26	1	1	1	4	1	1	4	4	1	4	1	1	1	1	1	4	4	4	1	1	1	4					
133	NW.43	4	1	4	4	1	1	4	4	1	4	1	1	1	4	1	1	1	1	1	1	1	4	3	4			
134	N.DEB	4	1	4	4	1	1	4	4	-1	4	4	1	1	1	1	4	4	4	1	1	1	4					
135	MAS.SCH	1	1	4	4	1	4	4	4	4	4	1	1	1	1	1	1	4	4	1	1	1	4	4				
136	MAS.SCH	1	1	4	4	1	4	4	4	4	4	1	1	1	4	1	1	4	4	1	1	1	1	1	1			
137	GEIGER	4	1	4	1	1	1	4	4	1	1	1	1	1	1	4	1	1	1	1	1	1	4	4	4			
138	GEIGER	1	1	1	1	1	1	4	4	4	4	1	1	4	1	4	4	4	1	4	4	4	4	4				
139	GEIGER	4	1	4	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1	4	4	4	4					
140	RABAK	4	1	4	4	1	1	4	4	4	4	4	4	1	1	1	1	1	1	4	4	4	4					
141	RABAK	1	1	4	4	1	1	4	4	4	4	4	4	1	1	1	1	1	1	4	4	4	4					
142	C.10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					
143	C.10(2)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	4	4	4	4
144	C.10	1	1	1	1	1	1	4				4	1	1	1	1	1	1	1	1	1	1	1	4	4	4	4	4
145	C.10	1	1	4	4	1	1	4	4	4	4	1	2	1	1	1	1	4	4	4	4	1	1	4	4	4		
146	C.9	1	1	1	1	1	1	4	4	4	4	1	1	1	1	1	1	4	4	4	4	1	1	4	4	4	4	4
147	C.9	1	1	1	1	1	1					1	1	1	1	1	1	1	1	1	1	1	1	4	4	4	4	1
148	C.7	4	4	1	1	1	1					1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1
149	DEU.WN	1	1	4	4	1	1	4	4	4	4	1	1	1	1	1	1	4	4	1	1	1	1	4	4	4	4	4
150	KOSTI.WN	1	1	4	4	1	1	4	4	1	4	3	4	1	1	1	1	4	4	4	4	1	4	4				
151	MAL.WN	1	1	4	1	1	1	4	4	4	4	4	1	1	4	1	1-	4	4	4	4	4	4	4	1		3	
152	ELS.WN	1	1	4	4	1	1	4	4	4	4	1	4	1	4	4	1	4	4	4	4	1	4					
153	N.KABEL	1	1	1	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	4	4				
154	RAHAD	1	1	1	4	1	1	4	4	1	4	3	1	1	1	1	1	1	1	1	1	4	4	4				
155	HAB.28	4	1	4	4	1	1	4	4	1	4	1	1	1	1	1	1	4	4	1	1	4	4	4	4			
156	HAB.28	1	1	4	4	1	1	4	4	1	4	1	1	1	1	1	1	4	4	4	4	4	4	4	4			4
157	N.DEB	1	1	1	3	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	4	4	4	4			4
158	MES.TED	1	1	4	4	1	1	4	4	1	4	1	1	1	1	1	1	4	4	4	4	4	4	4	4			
159	N.DEB	1	1	1	4	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	4	4	4	4			
160	NW.SEID	4	1	4	4	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	4	4	4				3
161	N.DEB	1	1	4	4	1	1	4	4	1	4	1	1	1	1	1	4	4	4	1	1	4	4	4	4			
162	N.TUR	1	1	1	4	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	4	4	4	4			
163	N.DEB	1	1	L	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	4	4	4				
164	MES.TEI	1	1	1	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	4	4	4				
165	HEI.ASB	1	1	1	4	;	;	4	4	;	4	1	1	1	1	1	1	1	1	1	1	1	4	4				
166	N.DEB	1	1	1	3	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	4	4				
167	NW.SEID	4	1	4	4	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	4	4	4			

APPENDIX I PESTICIDE CONTAINERS (SUMMARY).

SUDAN QUESTIONNAIRE SUMMARY: PESTICIDE CONTAINERS (B:SUDCONT.CAL)

	TOTAL	MEAN	N	SUM(4)	SUM(3)	SUM(2)	SUM(1)	%(4)	%(3)	%(2)	%(1)	TOTAL
EMPTIES	52	4.00	13	13	0	0	0	100.00	.00	.00	.00	100
AIR/FIELD	46	3.54	13	11	0	0	2	84.62	.00	.00	15.38	100
STORE	16	1.60	10	2	0	0	8	20.00	.00	.00	80.00	100
OTHER	19	1.90	10	3	0	0	7	30.00	.00	.00	70.00	100
METAL/L	52	4.00	13	13	0	0	0	100.00	.00	.00	.00	100
METAL/M	40	3.08	13	9	0	0	4	69.23	.00	.00	30.77	100
METAL/S	13	1.08	12	0	0	1	11	.00	.00	8.33	91.67	100
PLASTIC/L	12	1.00	12	0	0	0	12	.00	.00	.00	100.00	100
PLASTIC/M	14	1.27	11	1	0	0	10	9.09	.00	.00	90.91	100
PLASTIC/S	17	1.70	10	2	0	1	7	20.00	.00	10.00	70.00	100
PAPER/CD	22	1.83	12	3	0	1	8	25.00	.00	8.33	66.67	100
OTHER	9	1.00	9	0	0	0	9	.00	.00	.00	100.00	100
RE-USED/M	23	2.09	11	4	0	0	7	36.36	.00	.00	63.64	100
OTHERUS/M	48	4.00	12	12	0	0	0	100.00	.00	.00	.00	100
DISPSIT/M	13	1.30	10	1	0	0	9	10.00	.00	.00	90.00	100
AWAYDIS/M	10	1.00	10	0	0	0	10	.00	.00	.00	100.00	100
OTHER/M	6	1.00	6	0	0	0	6	.00	.00	.00	100.00	100
RE-USED/P	6	2.00	3	1	0	0	2	33.33	.00	.00	66.67	100
OTHERUS/P	9	3.00	3	2	0	0	1	66.67	.00	.00	33.33	100
DISPSIT/P	6	2.00	3	1	0	0	2	33.33	.00	.00	66.67	100
AWAYDIS/P	3	1.00	3	0	0	0	3	.00	.00	.00	100.00	100
OTHER/P	6	2.00	3	1	0	0	2	33.33	.00	.00	66.67	100
RE-USED/C	2	1.00	2	0	0	0	2	.00	.00	.00	100.00	100
OTHERUS/C	2	1.00	2	0	0	0	2	.00	.00	.00	100.00	100
DISPSIT/C	12	3.00	4	2	1	0	1	50.00	25.00	.00	25.00	100
AWAYDIS/C	5	2.50	2	1	0	0	1	50.00	.00	.00	50.00	100
OTHER/C	5	2.50	2	1	0	0	1	50.00	.00	.00	50.00	100
SAMEPEST	46	3.54	13	12	0	0	1	92.31	.00	.00	7.69	100
SAMEGROUP	27	2.25	12	5	0	0	7	41.67	.00	.00	58.33	100
DIFFGROUP	12	1.00	12	0	0	0	12	.00	.00	.00	100.00	100
OTHERMAT	19	1.90	10	3	0	0	7	30.00	.00	.00	70.00	100
RELABEL	44	3.38	13	9	2	0	2	69.23	15.38	.00	15.38	100
DECONTAM	15	1.25	12	1	0	0	11	8.33	.00	.00	91.67	100
HOUSEWASH	12	4.00	3	3	0	0	0	100.00	.00	.00	.00	100
PERSWASH	9	3.00	3	2	0	0	1	66.67	.00	.00	33.33	100
WATERLIV	9	3.00	3	2	0	0	1	66.67	.00	.00	33.33	100
WATERHUM	9	3.00	3	2	0	0	1	66.67	.00	.00	33.33	100
FOODLIV	9	3.00	3	2	0	0	1	66.67	.00	.00	33.33	100
FOODHUM	9	3.00	3	2	0	0	1	66.67	.00	.00	33.33	100
OTHER	28	4.00	7	7	0	0	0	100.00	.00	.00	.00	100
RECORDS	37	3.36	11	8	1	0	2	72.73	9.09	.00	18.18	100
PROPERDIS	25	3.57	7	6	0	0	1	85.71	.00	.00	14.29	100
METAL/L	SEE DATA SHEET FOR DETAILS											
METAL/M												
METAL/S												
PLASTIC/L												
PLASTIC/M												
PLASTIC/S												
PAPER/CD												
OTHERTYPE												
AGREE	41	3.73	11	10	0	0	1	90.91	.00	.00	9.09	100
WASTE	52	4.00	13	13	0	0	0	100.00	.00	.00	.00	100
AIR/FIELD	43	3.31	13	10	0	0	3	76.92	.00	.00	23.08	100
STORE	24	2.00	12	4	0	0	8	33.33	.00	.00	66.67	100
OTHER	25	2.50	10	5	0	0	5	50.00	.00	.00	50.00	100
RE-USE	20	2.50	8	4	0	0	4	50.00	.00	.00	50.00	100
OTHERUSER	19	1.90	10	3	0	0	7	30.00	.00	.00	70.00	100
DISPSITE	16	1.60	10	2	0	0	8	20.00	.00	.00	80.00	100
AWAYDISP	12	1.33	9	1	0	0	8	11.11	.00	.00	88.89	100
OTHER	13	2.17	6	1	2	0	3	16.67	33.33	.00	50.00	100
BURIAL	13	2.60	5	2	0	2	1	40.00	.00	40.00	20.00	100
LANDFILL	4	1.00	4	0	0	0	4	.00	.00	.00	100.00	100
BURNING	4	1.00	4	0	0	0	4	.00	.00	.00	100.00	100
INCINER	12	3.00	4	1	2	1	0	25.00	50.00	25.00	.00	100
CHEM	3	1.00	3	0	0	0	3	.00	.00	.00	100.00	100
OTHER	6	2.00	3	1	0	0	2	33.33	.00	.00	66.67	100
SAFEDISP	2	1.00	2	0	0	0	2	.00	.00	.00	100.00	100
SYMPTOMS	18	1.38	13	1	1	0	11	7.69	7.69	.00	84.62	100
MEDHELP	15	1.15	13	0	1	0	12	.00	7.69	.00	92.31	100

ANNEX D

MONITORING OF CHOLINESTERASE INHIBITION
SUDAN COTTON SPRAYING CAMPAIGN 1985 - 1986

D.1 COLLECTION, TREATMENT AND INTERPRETATION OF DATA

1. In any colorimetric process there is the possibility of variation due to subjectivity. It will be seen from the list of persons and functions (Table D.1) that Rahad and New Halfa should be directly comparable one with the other, likewise the North with the South Gezira. White Nile stands on its own. Comparisons between these groupings can only be made where the variation is considerable and certainly greater than 12.5 per cent.

2. Individual normal variation in cholinesterase levels arising from age, sex, race, diet, diurnal, menopausal, seasonal and other causes are mostly too small to be measured on the 12.5 per cent scale used on the Lovibond system. No valid classifications can therefore be made on this basis. Thus, taking the preceding paragraphs 1 and 2 into account, no attempt has been made to differentiate between Groups I and II interms of Contact hazard. Results from Group III are however significantly different from Groups I and II, as also are differences between trade groups within Group III.

3. A few results were excluded for the following reasons:

   (a) ambiguity or uncertainty regarding occupation (8 cases).

   (b) Low cholinesterase level apparently or possibly attributable to causes other than chemical contamination (3 cases).

   Excluded cases were:

   (i) N. Gezira
   50 per cent 17-18.12.85; uncertain whether landing strip worker or farmer.

   - 25 per cent 3.12.85, 62.5 per cent 18.12.85, 75 per cent 31.12.85; landing strip worker transferred to cook because of contamination.

   - 2 x 75 per cent 31.12.85; mess servants who should not be in contact with chemicals but found to be washing contaminated clothes.

   - 2 x 37.5 per cent 31.12.85; grouping not clearly identified.

   S. Gezira
   - 37.5 per cent 12.12.85; villager in fact an ARC worker possibly employed with pesticides, sent home because of illness.

   New Halfa
   - 62.5 per cent 22.11.85; villager actually working part time on landing strip.

   (ii) S. Gezira
   - 25 per cent 1.12.85; village boy, no known or traceable contacts with chemicals, later hospitalised (hepatitis?)

   N. Gezira
   - 50 per cent villager; old man, previously hospitalised for 3 months, no known or traceable contacts with chemicals.

   The only real anomalies were 2 x 37.5 per cent recorded in the Indirect Contact Group North Gezira on 31.12.85 in which the only common factor was old age.

4. During first evaluations in Rahad particular attention was paid to persons living in villages in close proximity to sprayed fields. No sifnificance was noted from this factor though it cannot be ruled out as contributory to the somewhat lower figures recorded for Groups I and II in the Gezira where habitations may be closer to treatments than in the test areas in Rahad. The consultants conclude that, in relation to Group III, contamination in Groups I and II is insignificant regardless of proximity to treated fields.

5. It will be especially noted from Table AD3 Summary of all Tests for Northern Gezira that Groups I and II show a marked downturn in cholinesterase levels on 31.12.85 in comparison with the other dates. The persons analysed were taken from a village in much closer proximity to both landing strip and treated cotton fields than had been the case with other samples. While this proximity is thought to be the cause for the downturn, no firm conclusion can be drawn from one isolated case.

6. Figures 5.2, 5.3, and 5.4 trace the development of contamination through the season. There is a definite tendency to greater contamination as the season becomes more intense, with recovery at the end. This emerged during the survey. Sampling had not been specifically planned with this in mind but the observations are logical and should be considered valid.

7. Groups I and II were not surveyed in White Nile. Pilots and engineers in the region were too small a sample group to provide valid data.

TABLE A D.1 RELATIONSHIP OF OPERATORS, SCHEMES AND FUNCTION

Region	Function	Person
H.Q.	Training	A
H.Q.	Interpretation and Reporting	A
Rahad	Supervisor	A
Rahad	Technician	A or Y
New Halfa	Supervisor	A
New Halfa	Technician	A or Z
South Gezira	Supervisor	B or V
South Gezira	Technician	X
North Gezira	Supervisor	C or U
North Gezira	Technician	X
Hosti	Supervisor	D
Hosti	Technician	W

A, B, C, D = Expatriate staff

U,V,W,X,Y,Z = Sudanese staff

TABLE A D.2 SOUTH GEZIRA - SPRAYED AREA

SUMMARY OF ALL TESTS

Date	Group	100	87.5	75	62.5	50	37.5	25	12.5	Total	
22.10	I	5	3							8	
28.10		8								8	
4.11	No	8								8	Accumulated
11.11		1	3							4	
16.11	Contact	2	3							5	Group I
25.11		6	5	1						12	
01.12		10	4	7						21	Average 91%
08.12		1	2	3						6	
12.12		3	7	2						12	
16.12		6	9	5						20	
19.12		7	1							8	
22.12		-	5	5						10	
		57	42	23						122	
% Total Tests		47	34	19						100	
22.10	II	8	2							10	
28.10		8	1	1						10	
4.11	Indirect	5	2							7	Accumulated
11.11		1	5	1						7	
18.11	Contact	7	4	4						15	Group II
25.11		10	16	3	-	1				30	
2.12		15	12	9						36	Average 88.9%
8.12		3	4	5						12	
12.12		15	2	6	2					25	
16.12		7	5	6						18	
19.12		7	2	2						11	
23.12		18	15	14	6	3				56	
29.12		5	5	1	1					12	
		109	75	52	9	4				249	
% Total Tests		44	30	21	4	1					
22.10	III	1	1	4	-	1	1			8	
28.10		1	3	2	2					8	
14.11	Direct	1	-	1	2	2				6	Accumulated
11.11		-	3	-	2	1				6	
18.11	Contact	2	-	1	1	5	4	3		16	Group III
2.12		1	3	1						5	
19.12		4	5	4	2	1	1			17	Average 71.7%
29.12		3	2	2	2	1				10	
		13	17	15	11	11	6	3		76	
% Total Tests		18	22	20	14	14	8	4		100	

TABLE A D.3 NORTHERN GEZIRA - SPRAYED AREA

SUMMARY OF ALL TESTS

Date	Group	100	87.5	75	62.5	50	37.5	25	12.5	Total	
23.10	I	2								2	Accumulated
27.10		2								2	
06.11	No Contact	2	2	1						5	Group I
13.11		3	2	1						6	Average 94.4%
30.11		5								5	
4.12		8	4	1	1	1				15	
18.12		22	4	1						27	
31.12		13	12							25	
		57	24	4	1	1				87	
% Total Tests		65	28	5	1	1				100	
23.10	II	14								14	Accumulated
27.10		4								4	
06.11	Indirect	4	1							5	Group II
13.11		4	3	2	1					10	
30.11	Contact	7								7	Average 92%
04.12		5	4	-	2					11	
18.12		31	4	-	1					36	
31.12		9	15	12	3	-	1			40	
		78	27	14	7	-	1			127	
%Total Tests		61	21	11	6		1			100	
23.10	III	-	1	2	2					5	Accumulated
27.10		-	1	2	4	1				8	
06.11	Direct	5	2	1	4	2	1	1		16	Group III
13.11		1	1	2	1	1				6	
19.11	Contact	-	-	1	1	7	4			13	Average 65.2%
30.11		-	-	-	3	2				5	
4.12		1	1	5	6	2	5			21	
18.12		3	-	1	4	3	-	1		12	
31.12		3	2							5	
		13	8	14	25	18	10	2		91	
% Total Tests		14	10	15	28	20	11	2		100	

TABLE A D.4 NORTHERN GEZIRA - SPRAYED AREA

SUMMARY OF GROUP III

Date	Group	100	87.5	75	62.5	50	37.5	25	12.5	Total	
23.10	Pilots	5								5	Accumulated
27.10		5	1	1						7	
06.11		2	1	-	1					4	
13.11		-	5	1	-	1				7	Pilot Average
19.11		-	-	2						2	85.7%
04.12		2	1	2						5	
18.12		4	1							5	
		18	9	6	1	1				35	
% Total Tests		51	26	17	3	3				100	
23.10	Engineers	2	-	-	-	1				3	Accumulated
27.10		3	-	-	1	2				6	
06.11		4	-	-	1					5	Engineer
13.11		-	-	3	1					4	Average
19.11		-	1	-	1					2	
04.12		7	3	2	3					15	84.1%
18.12		2	2							4	
31.12		-	-	1						1	
		18	6	6	7	3				40	
% Total Tests		45	15	15	18	7				100	
23.10	Loader	-	1	2	2					5	Accumulated
27.10		-	1	2	4	1				8	
6.11	Crews	5	2	1	4	2	1	1		16	Loader Crews
13.11		1	1	2	1	1				6	
19.11		-	-	1	1	7	4			13	Average 65.4%
30.11		-	-	-	3	2				5	
4.12		1	1	5	6	2	5	-	1	21	
18.12		3	-	1	4	3	-	1		12	
31.12		3	2							5	
		13	8	14	25	18	10	2	1	91	
% Total Tests		15	9	15	27	20	11	2	1	100	

TABLE A D.5 RAHAD - SPRAYED AREA

SUMMARY OF ALL TESTS

Date	Group	100	87.5	75	62.5	50	37.5	25	12.5	Total	
24.9	I	6	2							8	Accumulated
1.10	No	2	1							3	
8.10	Contact	4	1							5	Group I
14.10		4								4	
15.10		4								4	Average
29.10		7	1							8	
12.11		1								1	98.1%
		28	5							33	
% Total Tests		84	16							100	
18.9	II	6								6	Accumulated
24.9		9	1							10	Group II
1.10	Indirect	12	2	1						15	
8.10	Contact	12	1							13	Average
15.10		13	2							15	
29.10		13	2							15	98.1%
5.11		13	2	1						16	
		78	10	2						90	
% Total Tests		86	11	3						100	
9.9	III	1	1	1						3	
13.9		3	1	3						7	
20.9	Direct	12	3	2	1					18	Accumulated
1.10		7	6	7	3	3				26	
8.10	Contact	4	4	7	2					17	Group III
14.10		2	1	4	3	2				12	
15.10		4	-	1	5	1	3			14	Average 79%
29.10		9	5	3	6	4	3	2	1	33	
5.11		8	1	-	1	3	1	1		15	
12.11		13	5	5	2	2	2			29	
		63	27	33	23	15	9	3	1	174	
% Total Tests		36	16	19	13	9	5	2		100	

TABLE A D.6 RAHAD - SPRAYED AREA

SUMMARY OF GROUP III

Date	Group	100	87.5	75	62.5	50	37.5	25	12.5	Total	
13.09	Pilots	3	-	2						5	Accumulated
20.09		8								8	
01.10		6	2							8	Pilot
08.10		2	1	2						5	Average
14.10		5	1	3						9	94.8%
29.10		4	2							6	
12.11		10	2							12	
		38	8	7						53	
% Total Tests		72	15	13						100	
09.09	Engineers	1	1	1						3	
13.09		1	-	1						2	
20.09		2	-	1	1					4	Accumulated
01.10		-	3	4	1	1				9	Engineer
08.10		1	1	1	1					4	Average
14.10		-	-	1	2					3	78.9%
29.10		1	-	1	-	1				3	
12.11		-	1							1	
		6	6	10	5	2				29	
% Total Tests		21	21	34	17	7				100	
20.09	Loader	1	3	1						5	Accumulated
01.10	Crews	-	-	3	1	2				6	
08.10		1	1	4	1					7	Loader Crew
14.10		-	-	1	4	1	3			9	
29.10		3	3	2	6	3	1	2	1	21	Average 69.5%
05.11		7	1	-	1	3	1	1		14	
12.11		3	1	5	3	2	1			15	
		15	9	16	16	11	6	3	1	77	
% Total Tests		19	12	21	21	14	8	4	1	100	

TABLE A D.7 NEW HALFA - SPRAYED AREA

SUMMARY OF ALL TESTS

Date	Group	100	87.5	75	62.5	50	37.5	25	12.5	Total	
28.09	I	7								7	Accumulated
07.11		11	1							12	
06.12	No Contact	6								6	Group I
24.12		9	2							11	
		33	3							36	Average 99%
% Total Tests		92	8							100	
28.09	II	10	1							11	Accumulated
24.10		38	3							41	
22.11	Indirect	42	2	1						45	Group II
6.12		9	1							10	
24.12	Contact	6	1							7	Average 98.1%
		105	8	1						114	
% Total Tests		92	7	1						100	
28.9	III	18								18	
24.10		6	3	6	1	1				17	Accumulated
07.11		5	4	5	-	1				15	
22.11	Direct	-	2	4	4	1				11	Group III
06.12	Contact	7	1	-	5	4	1			18	
24.12		2	3	1	5	1	1			13	Average 81.6%
28.12		1	-	1	1	1				4	
		39	13	17	16	9	2			96	
% Total Tests		40	14	18	17	9	2			100	

TABLE A D.8 WHITE NILE SPRAYED AREA

SUMMARY OF GROUP III
Note No Group I or II tested in Kosti

Date	Group	100	87.5	75	62.5	50	37.5	25	12.5	Total	
26.10	Pilots	-	1	1						2	Accumulated
6.11		-	-	1						1	Pilot
14.12		-	1							1	Average 81.3%
		-	2	2						4	
% Total Tests		-	50	50						100	
26.10	Engineers	-	-	-	1					1	Accumulated
6.11		-	-	-	-	-	-	-	1	1	Engineer
14.12		-	-	-	-	1	-	1	-	2	Average 37.5%
					1	1	-	1	1	4	
% Total Tests		-	-	-	25	25	-	25	25	100	
26.10	Loader	1	-	1	3	1	1			7	Accumulated
31.10		1	-	1	2	1				5	
6.11	Crews	-	-	1						1	Loader Crews
14.12		-	-	3	4	2				9	
16.12		1	2	1	2	1	1			8	Average 67.1%
		3	2	7	11	5	2			30	
% Total Tests		10	7	23	36	17	7			100	

TABLE A D.9 CHOLINESTERASE TEST TOTALS

	Group I	Group II	Group III	Misc. Additional
Sprayed Area				
North Gezira	87	127	165	
South Gezira	121	250	76	
Rahad	33	90	174	
New Halfa	36	114	96	
White Nile	-	-	38	
TOTAL	**277**	**581**	**549**	**1956**
Temik Treatments				
Rahad	16	60	31	
South Gezira		17	17	
	16	**77**	**48**	**141** **2081**
Additional/Miscellaneous				
Kosti storeman, family and neighbours				9
Rahad Public Health Spray Team				9
Fau Refugee Camp Spray Team				5
Annex D Exclusions				11
GRAND TOTAL				**2121**

TABLE A D.10 CHOLINESTERASE ANALYSIS : SAMPLE SHEET OF SOME INDIVIDUAL RESULTS

Location	Occupation	Name	September 08	13	20	28	October 01	08	14	15	24	29	30	November 05	07	09	12	24	December 06	24
Rahad	Pilots	Ross Harvey	-	-	100	100	-	75	75	-	-	100	-	-	-	-	100	-	-	-
		Lars Bressman	-	-	100	100	-	100	-	-	-	-	-	-	-	-	100	-	-	-
		Tim Breeze	-	100	100	87.5	-	75	75	-	-	100	-	-	-	-	87.5	-	-	-
		Mark Kleynhans	-	-	-	-	-	87.5	87.5	-	-	-	-	-	-	-	100	-	-	-
		Tony Sims	-	100	100	-	-	100	100	-	-	87.5	-	-	-	-	100	-	-	-
		Robin Metcalfe	-	75	100	100	-	-	75	-	-	-	-	-	-	-	100	-	-	-
		Roger Witt	-	100	-	87.5	-	-	100	-	-	-	-	-	-	-	100	-	-	-
		John Benyon	-	-	100	100	-	-	100	-	-	-	-	-	-	-	100	-	-	-
		R. Petersen	-	75	100	100	-	-	100	-	-	-	-	-	-	-	100	-	-	-
	Engineers	Ula Magnusson	-	100	100	75	-	62.5	75	-	-	75	-	-	-	-	-	-	-	-
		? Patel	-	75	100	75	-	75	62.5	-	-	-	-	-	-	-	87.5	-	-	-
	A/C Cleaners	Ahmed Abdulla	-	-	87.5	-	62.5	-	-	-	-	-	-	50	-	-	-	-	-	-
		Mayzub Saleh	-	-	75	-	50	-	50	-	-	-	-	25	-	-	-	-	-	-
		Yussif Hussein	-	-	87.5	-	50	-	-	-	-	37.5	-	-	-	-	50	-	-	-
		Faisal Abdullahi	75	-	62.5	-	62.5	-	-	-	-	-	-	100	-	-	-	-	-	-
		Mohd Idris	-	-	-	-	50	-	-	-	-	50	50	-	-	-	62	-	-	-
		Hassan Mohd Nabir	-	-	-	-	87.5	-	62.5	-	-	-	-	75	-	-	-	-	-	-
	Loading Crews	Raschid Ahmed	-	-	-	-	62.5	-	62.5	-	-	62.5	-	50	-	-	-	-	-	-
		Khalid Ahmed	-	-	-	-	75	75	-	-	-	-	-	-	-	-	75	-	-	-
		Hassan Musa	-	-	-	-	75	87.5	-	-	-	12;5	-	37.5	-	-	37.5	-	-	-
		Nazir Nomi	-	-	-	-	-	75	-	62.5	-	-	-	62.5	-	-	62.5	-	-	-
New Halfa	A/C Cleaner	Ismael Yacoub Ishag	-	-	100	100	-	-	75	-	-	-	-	-	-	100	-	-	62.5	62.5
		Osman Ibraham Osman	-	-	100	-	-	-	100	-	-	-	-	-	-	-	-	50	-	62.5
	Loading Crews	Abdulla Draffala	-	-	-	-	-	-	-	-	75	-	-	-	75	75	-	-	62.5	75
		Adam Abahir	-	-	-	-	-	-	-	-	75	-	-	-	-	-	-	50	32.5	50
		Hussein Idris	-	-	-	100	-	-	-	-	50	-	-	-	75	-	-	-	-	-

Location	Occupation	Name	October 22	28	November 04	11	18	25	December 02	16	19	23	29
S. Gezira	Villager	Adam Gesid Al Sid	100	-	100	87.5	100	100	100	100	-	100	-
		Kabashi Yacoub	100	100	100	-	87.5	87.5	-	-	-	-	-
		Suleiman Mustapha O'alla	87.5	100	-	87.5	100		-	-	-	-	-
	Farmer	Adam Aboullani Bashir	100	100	100	-	-	-	-	87.5	-	-	100
		Ibrahim Abder Wahab	100	75	87.5	75	-	87.5	-	-	-	-	-
		Atayeb Ali	-	100	100	100	100	100	-	-	-	-	-
		Al Fader Mohd Ali	-	100	100	87.5	-	-	100	-	-	75	-
	Loading Crew	Mohd Al Seal	87.5	87.5	-	-	75	-	100	-	-	-	100
		Adam Narein	100	75	75	-	62.5	-	-	-	-	-	87.5
		Obeid Gelei	87.5	87.5	62.5	-	50	-	87.5	-	-	-	-

TABLE A D.11 CHOLINESTERASE ANALYSIS: NEW HALFA - GERIA 18 (Village) - 08.11.85

Name	T. Tube	Occupation	Last contact with chemicals	Level	Comment
L. Hewitt	2	Control (Hunting)	None	87.5	
Mohd Abdulla Sidin	3	Farmer	Indirect	100	
Abdel Aziz Ibrahim	4	Farmer	Indirect	100	
Saleh Ali Geneid	5	farmer	Indirect	100	
Saleh Dafaalla	6	Schoolboy	None	100	
Babinr Ibrahim Geneid	8	Shopkeeper	None	75	Chemicals in shop
Al Awad Babinr	7	Farmer	Indirect	87.5	
Hassan Mohd Ali	9	Farmer	Indirect	100	
Ibrahim Ahmed Ibrahim	10	Schoolboy	None	100	
Mohd Al Hassan Ali	11	Schoolboy	None	100	
Ahmed Ibraham Geneid	12	Schoolboy	None	100	
Hassan Ali Hassan	13	Schoolboy	None	87.5	
Bashir Babinr	14	Schoolboy	None	100	
Mohd Fasa	15	Schoolboy	None	100	
Babinr Abdulla	16	Schoolboy	None	100	
Mohd Ali Bashir	17	Farm Boy	Indirect	87.5	
Osman Abdulla Sidin	18	Driver	None	100	
Abdulla Sidin	19	Farmer	Indirect	100	
Medawi Ibrahim	20	Farmer	Indirect	100	
L. Hewitt[1] Repeat		Control (Hunting)		87.5	

Blood samples taken	10.30 - 11.00
Analysis begins	11.05 - 12.05
Temp	32°C
Reaction time	21 mins

Note: [1] *Normally 100. No known reason for drop. No other known control available.*

TABLE A D.12 CHOLINESTERASE ANALYSIS: RAHAD BASE AIRSTRIP - 12.11.85

Name	T. Tube	Occupation	Last contact with chemicals	Level	Comment
Mohd Al Amin	2	Hosp Attendant (Control)	None	100	
Lars Bressman	3	Pilot	11.11	100	
Digby Goss	4	Pilot	11.11	100	
Francisco Fialho	5	Pilot	11.11	87.5	
Sagay	6	Houseboy	11.11	100	
Tim Breeze	7	Pilot	11.11	87.5	
Ross Harvey	8	Pilot	11.11	100	
Enrico Lopez	9	Pilot	11.11	100	
Yussif Hussein	10	Loader	11.11	50	No Clinical symptons
Hassan Musa	11	Loader	11.11	37.5	Warned, included in
Nazir Nomi	12	Loader	11.11	62.5	report to company and
Hassan Mohd	13	Loader	11.11	75	Corporation.
Osman Mohd Ahmed	14	Loader	11.11	100	
Suleiman Mohd	15	Loader	11.11	100	
Mohd Idris	16	Loader	11.11	62.5	As above
John Nodi	17	Loader	11.11	100	
Santino Gurang	18	Mechanic	11.11	87.5	
Hadi Abdel Narim	19	Loader	11.11	75	
Khalid Ahmed	20	Loader	11.11	75	

Blood samples taken	11.25 - 12.05
Analysis	12.10 - 12.40
Reaction time	21 mins
Temp.	34°C

D.2 COLORIMETRIC CHEMICAL ANALYTICAL METHODS

THE RAPID FIELD DETERMINATION OF CHOLINESTERASE

INTRODUCTION

Farmers, spray operators, and research workers using organic phosphorus insecticides may run some risk of significant absorption of these toxic chemicals despite the adoption of protective measures. Over-absorption, and unsafe working methods are detectable by depression of the normal cholinesterase enzyme activity of the blood. See also Note 11. Several methods exist for the accurate measurement in the laboratory of cholinesterase activity, but a rapid 'field' method is frequently needed for use in emergencies or away from the laboratory. The method of Limperos and Ranta[1] has been modified by Edson[2] to give a combination of speed, convenience and reasonable precision for emergency or routine cholinesterase determination with simple equipment.

The cholinesterase activity in the blood from the subject under test is expressed as a percentage of the activity in normal blood. Depending on the result obtained, the following action is recommended.

100% - 75% of normal	No action, but retest in near future.
75% - 50% of normal	Over-exposure probable; repeat test. If confirmed, suspend from further work with organic phosphorus insecticides for 2 weeks; then retest to assess recovery.
50% - 25% of normal	Serious over-exposure: repeat test. If confirmed, suspend from all work with insecticides. If indisposed or ill arrange medical examination.
25% - 0% of normal	Very serious, a dangerous over-exposure. Repeat test; if confirmed, suspend from all work pending medical examination.

PRINCIPLE OF THE METHOD

Blood contains an enzyme, cholinesterase, which liberates acetic acid from acetylcholine thereby changing the PH. A mixture of blood, indicator and acetylcholine perchlorate is prepared and allowed to stand for a fixed time. The change of PH in this time is a measure of the cholinesterase activity.

It has been established by Watson and Edson[10] that, as suggested by Davies and Nicholls[7], it is possible to dispense with a timed control sample and to substitute a temperature/time relationship provided that the temperature range involved is not excessive and that the modified instructions are followed exactly.

REAGENTS REQUIRED

1. **Indicator Solution**
   Sodium salt of bromo-thymol blue (BDH Ltd. water soluble) 0.112 g.
   Distilled water (CO_2 free) 250 ml.

   This solution is stable for several months and should be kept tightly stoppered to prevent absorption of CO_2. The concentration is critical, the permissible limits being ± 0.01 g.

Note: Re Reagent 1 (Indicator solution)
The concentration of Bromo-thymol blue indicator solution is critical, the permissible limits being 107 - 117 mg/250 ml distilled water (CO_2 free). Outside these limits colour matching becomes unreliable. While every attempt is made to ensure the ampoules are precisely filled, it is recommended that accurate weighing be carried out where a very critical study is proposed. Accurate weighing is of course necessary where the indicator has been obtained in bulk.

2. Substrate Solution
Acetylcholine perchlorate 0.5 ± 0.2 g
Distilled water (CO_2 free) 100 ml.

This substrate solution should be freshly prepared each day. The exact concentration is not critical, and slight turbidity can be ignored.

THE STANDARD LOVIBOND COMPARATOR DISC 5/30

The disc covers the range 0 - 100 per cent normal activity in steps of 12½ per cent, and is calibrated for use with 2.5 mm cells (see note 12).

TECHNIQUE

(a) Determination of blood cholinesterase in human beings

1. Test the reagents by mixing 0.5 ml of indicator, 0.01 ml of finger-prick blood from a normal "control" subject, and 05. ml of substrate solution. Mix well and place in a 2.5 mm cell in the right-hand compartment of the comparator. Hold the comparator facing a source of uniform white light, such as the north sky in the northern hemisphere, and revolve the disc until a close colour match with the test solution is obtained. It should be no more yellow (acid) than the 12.5 per cent activity colour. If the indicator solution is too acid, due to the absorption, of carbon dioxide, it can be restored to normality by bringing it momentarily to the boil. If this does not reduce acidity to the 12.5 per cent colour the substrate is at fault and it must be discarded, and a fresh solution prepared.

2. Make a blood "blank" by adding 0.01 ml of finger-prick blood to 1 ml distilled water in a 2.5 mm cell and place in the left hand compartment of the comparator.

3. Set up a reaction tube for each patient, and pipette 0.5 ml of indicator solution into each tube. Up to 15 - 20 tests can be carried out at the same time.

4. From each patient pipette 0.01 ml blood, obtained by finger or thumb prick, into a reaction tube, rinsing the pipette two or three times with the indicator in the tube. A "control" blood sample (i.e. that of a normally healthy person unexposed to organic phosphorus insecticided) should be put into tube No.1.

5. Pipette 0.5 ml substrate solution into tube No.1 ("controll" tube). Note the time ("zero time"), immediately transfer the reaction mixture to a 2.5 mm cell and note its colour in the comparator. It should be no more acid than the 12½ per cent colour.

6. Add 0.5 ml substrate solution to the other reaction tubes at 1 minute intervals from zero time, stopper them and shake to mix.

7. Wait for the contents of the control sample cell to reach 100 per cent activity colour (which will take 20 - 30 minutes, depending largely on temperature) decant control sample and at 1 minute intervals from this time transfer the contents of the other tubes in turn to the cell. Match each sample against the disc, by placing the cell in the right hand compartment of the comparator and revolving the disc until the nearest match is found, and record the activity. The discs are graduated in per cent of normal (i.e. of control) activity.

(b) Simplified Technique

Test the reagents, make up a blood blank, and set up the reaction tubes as directed in paragraphs 1 - 3 of the original instruction. From each patient pipette into a reaction tube 0.01 ml of blood, obtained by finger or thumb prick, rinsing the pipette two or three times with the indicator in the tube. Note the shade temperature. Add 0.5 ml of substrate to the reaction tubes at 1 minute intervals, stopper the tubes and shake to mix. Allow each tube to stand for exactly the time corresponding to the shade temperature shown in the Table. Immediately this time has expired transfer the contents of the tube to the 2.5 mm sample cell, place this in the right hand compartment of the comparator and match against the standards in the disc.

TIME TEMPERATURE TABLE

Use time column corresponding most closely to colour value in reagent test

Shade Temp. °C	Time Minutes Reagent = 0%	Time Minutes Reagent = 12½%
10	41	36
15	33	29
20	27	24
25	24	21
30	21	18.5
35	18	16
40	16.5	14.5
45	16	14

For temperatures above 45°C the original procedure must be used.

(c) Determination of Blood Cholinesterase in Animals[6]

Blood is collected from the ear, except in the case of mice when the tail is used, 0.01 ml being used for guinea pigs and mice, 0.02 ml for other animals. The blood is immediately transferred to a tube, and mixed with 0.5 ml of indicator solution, (reagent 1). 0.5 ml of substrate solution (reagent 2) is added and the time noted. After the elapse of the appropriate time, given in the table below, the mixture is transferred to a 2.5 mm comparator cell and the percentage determined.

Cattle	80 minutes
Dogs	40 minutes
Sheep	120 minutes
Mice	20 minutes
Guinea pigs	80 minutes

A conversion of 75 per cent or more within the stated time	- blood normal
50 - 75 per cent	- moderate depression
35 - 50 per cent	- no clinical symptoms but caution required
below 35 per cent	- severe exposure requiring palliative measures

It has not been possible to obtain satisfactory result using this method with goats and rats.

Notes:

1. Good agreement has been found with result obtained by the electrometric method of Michel[4].

2. Acid, alkali or insecticide contamination should be avoided by carefully cleaning the skin before taking the blood sample, first with soap and water, then with surgical spirit, and drying the area with clean cotton wool, the needle must also be carefully cleaned each time.

3. The control blood sample must be obtained from a normally healthy person, who has had no probability of exposure to organic phosphorus insecticides in the past three months. Alternatively, a 'stock' sample of normal blood may be used, but only heparin is suitable for use as the anticoagulant. Citrate or oxalate cause interfering PH changes and should not be used.

4. The reaction tubes and bungs must be carefully washed with distilled water between tests, because, as this test depends on a change of PH, there must be no contamination from any acid or alkali.

5. All pipetting must be done with teats to avoid producing acidity and false results due to contamination with CO_2 in the breath.

6. The 100 per cent normal cholinesterase value of the cholinesterase disc is based on average values for healthy European males. Non Europeans of tropical countries may show lower normal values, in the range of 75 - 87 per cent. Females normally have slightly lower ChE activity than males.

7. As there is considerable personal variation in normal blood ChE activity, it is very desirable wherever possible, to determine the normal activity of all workers before they begin a campaign with organic phosphorus insecticides.

8. The indicator blood dilution is stable only for up to four hours in cool climates and two hours in hot climates. Individual 0.01 ml blood samples from isolated workers may thus be collected and retained in stoppered reaction tubes, as dilutions in 0.5 ml indicator solution, but should be analysed within the above times.

9. An almost immediate colour change from green blue to orange suggests acid contamination. Repeat the test after washing out tubes with distilled water.

   Failure to develop any colour change in the reaction tube may be due to a complete absence of cholinesterase in the blood sample from a grossly over exposed worker, but may also be due to failure to add the blood or substrate, or to alkaline contamination. All such instances therefore necessitate a repeat test for confirmation.

10. A portable field set is available for use with this test, details of which may be obtained from The Tintometer Limited, Salisbury.

11. Cholinesterase is involved in the metabolism of the muscle relaxant succinylcholine. Deficiency of the enzyme results in prolonged action of this normally short acting relaxant, leading to prolonged apnoea. Apart from low enzyme levels that are sometimes found following liver disease and exposure to organophosphorus insecticides, a small number of people are found to have a genetically deficiency. The finding of a prolonged apnoea following succinylcholine administration, due to cholinesterase deficiency, is a strong indication for screening the remaining members of the family for the presence of a similar defect.

12. A special 2.5 mm comparator cell, W727, is made for this test.

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5. J.H. Wolfsie and G.D. Winter, Arch. Ind. Hyg., 1954, 9, 396.
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8. E.F. Edson, World Crops, 1956, 8, 240.
9. E.F. Edson, World Crops, 1958, 10, 49.
10. W.A. Watson and E.F. Edson, personal communication, 1964.
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D.3 CHOLINESTERASE TESTS HOLDING OF BLOOD SAMPLES

A maximum of 20 persons can be analysed in one run when using Lovibond Kit AF 267. This number may not always be assembled at one site. This required that, on occasion, samples be taken from 2 or 3 locations before beginning analysis if best use was to be made of time available. Facilities for cool storage in transit were not available.

A test was therefore undertaken in which three samples were taken from the same donors and substrate was added 5 minutes, 23 minutes and 76 minutes after adding the sample to the bromethyl blue in the test tubes. There was no difference in results.

On rare occasions blood samples were held up to 2 hours without any illogical final figures. On these occasions control samples were taken twice, once with the test cases and again immedieatly before analysis. Reaction time tended to be longer when blood samples were held beyond an hour.

D.4 CONTAMINATION OF STOREMEN

In White Nile area one store appeared especially hazardous. A test was made and the following cholinesterase results noted:

Storeman	100 per cent
Storeman's wife	87.5 per cent
Storeman's daughter (17 yrs)	100 per cent
Storeman's son (10 rrs)	100 per cent
Watchman	87.5 per cent
Watchman's grandson (21 yrs)	100 per cent
Next door gardener	87.5 per cent
Labourer in store	75 per cent
Store administrator (also pest scout)	100 per cent

A report was made to the Corporation as follows, requesting urgent action to ameliorate the hazard:

"Although these results indicate that there is negligible cholinesterase depression, except for one labourer, it does not mean that there is no risk. Gross contamination hazard is ever present and a serious accident could occur at any time.

Furthermore it is possible that contamination is taking place from DDT, Endosulphan, Dieldrin, which, being organochlorines do not show in these tests."

The same comments are equally true of Rahad chemical stores where 6 storemen were tested on 18.9.85 and returned 100 per cent level. It is noteworthy that the above tests occurred early in the spray campaign.

In North Gezira where pesticide storekeepers were tested during the season, the following results were obtained:

23.10.85	1-75 per cent	
26.10.85	1-87 per cent	2-62.5 per cent
5.11.85	1-87.5 per cent	1 - 50 per cent
13.11.85	1-62.5 per cent	
4.12.85	1-75 per cent	1-62.5 per cent
18.12.85	2-100 per cent	

These results emphasise the dangers commented on for the White Nile and suggest that storemen as a group should be studied more deeply in the future than has been possible this season, although in no case was reduction of cholinesterase levels sufficient to give cause for alarm.

D.5 WARNING NOTICES

Since monitoring at airstrips showed a regretably large number of ground-crew, notably loaders and cleaners, with blood cholinesterase levels of 12.5 to 37.5 per cent normal consultants therefore introduced a warning notice system (sample sheet, herewith) whereby airspray contractors were advised of employees exhibiting levels below 62.5 per cent. Reservations were expressed about this on the grounds that the contractors would simply dismiss these workers, thus evading responsibility. Advice from the Department of Occupational Health, Wad Medani, was sought. It appears that dismissal of any workers with chemicals, involving matters of ill health, should be brought to a Medical Committee by the air spray contractor for assessment, and if necessary award of compensation. A dismissed worker has the right of appear against dismissal through this committee. In fact no such dismissals are known to have resulted from the warning notices.

A further question arises however in that where workers are provided with protective clothing, in particular gloves, they often decline to use them or use them in an incorrect way. Low cholinesterase percentages may thus arise through a combination of circumstances and consideration of justification for dismissal may be complex.

CONSULTANTS TO GOVERNMENT OF SUDAN THROUGH AGRICULTURAL CORPORATIONS

CHOLINESTERASE INHIBITION

Dear

In course of monitoring the inhibition of cholinesterase due to organo-phosphorous or carbamate poisoning following contact with insecticides we have found following results.

Name of person	Date	% of normal	Job
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

(Results above 75% are not noted)

Recommendations

Official recommendations by medical authorities are:

100-75%	No action but retest in near future.
75-50%	Over - exposure probable. Repeat test. If confirmed suspend from work with organo-phosphorus insecticides for 2 weeks. Retest to assess recovery. (NB in Sudan this effectively means suspend from all insecticide work).
50-25%	Serious over-exposure. Repeat test. If confirmed suspend from all work with insecticides. If ill, arrange to see doctor.
25- 0%	Very serious and dangerous over-exposure, suspend from all work pending compulsory medical examination.

Comment. It is not impossible that persons in the 25-0% category who continue work will die, either directly from chemical poisoning, or by accident induced by slow reaction, tiredness and carelessness. For safety of the worker and as a matter of employer's responsibility we believe the recommendations should be considered mandatory. We hope this notification will assist in enhancing safety aspects of insecticide useage and reduce possible accidents.

Yours faithfully,

ANNEX E

PEST POPULATION FLUCTUATIONS

ANNEX E

PEST POPULATION FLUCTUATIONS

INTRODUCTION

The figures presented in this Annex show fluctuations in the pest populations assessed by twice weekly scouting as described in Chapter 7. The weekly counts figured are means of two, occasionally three counts made. In every figure the top graph shows numbers of *Heliothis armigera* eggs and larvae per 100 plants; the middle graph shows numbers of jassid nymphs per 100 leaves; the lower graph shows numbers of whitefly adults per 100 leaves.

For most groups one block only is given. For North group two blocks' data is shown, one of which having been partially treated with Temik (Block 36). On this graph Figure A.E.1 the numbers of whitefly and jassid in treated and untreated fields are shown as separate lines after the time of treatment. It should be noted that differences in numbers between treated and untreated fields should not be mathematically compared since there were considerable differences in cultural, irrigation and other factors between fields, and the pest counts were not made by the same scouts using the same techniques.

For South group four blocks of data are presented. These should be examined with reference to the comments on Temik and non-Temik effects in Section 3.2.3.

Legend

↑		day of spray application
P	=	partial spray (margins of fields)
S	=	selective spray (early or late season to infested areas)
NT	=	spray to non-Temik field, Figure A.E.1
T	=	Spray to Temik field, Figure A.E.1
✸	=	Action Threshold level

The month name is placed across Week one of the respective month.

FIGURE A.E.1 NORTH GROUP, BLOCK 36 - DEBEIBA

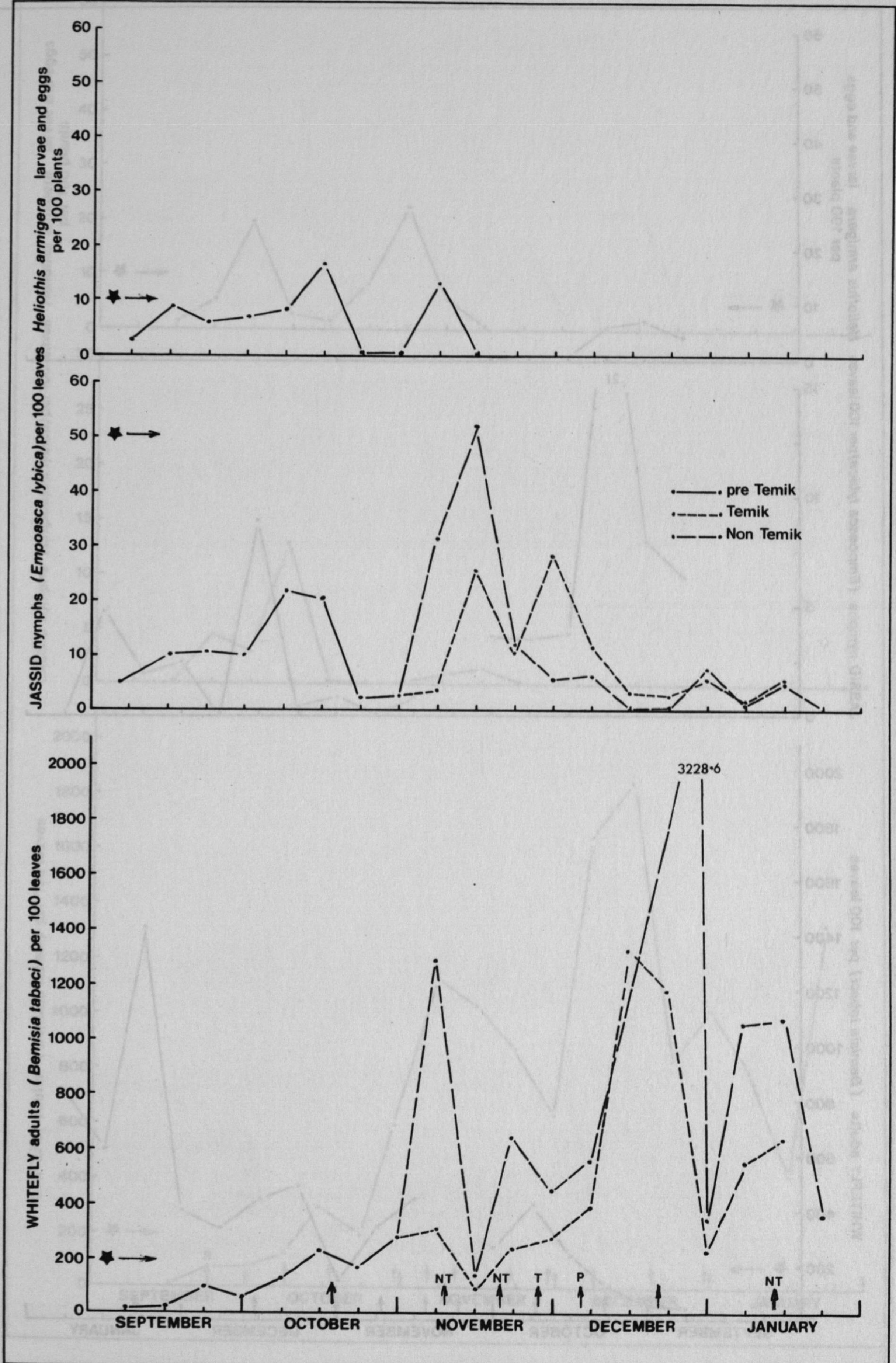

FIGURE A.E.2 NORTH GROUP, BLOCK 37 - TURABI

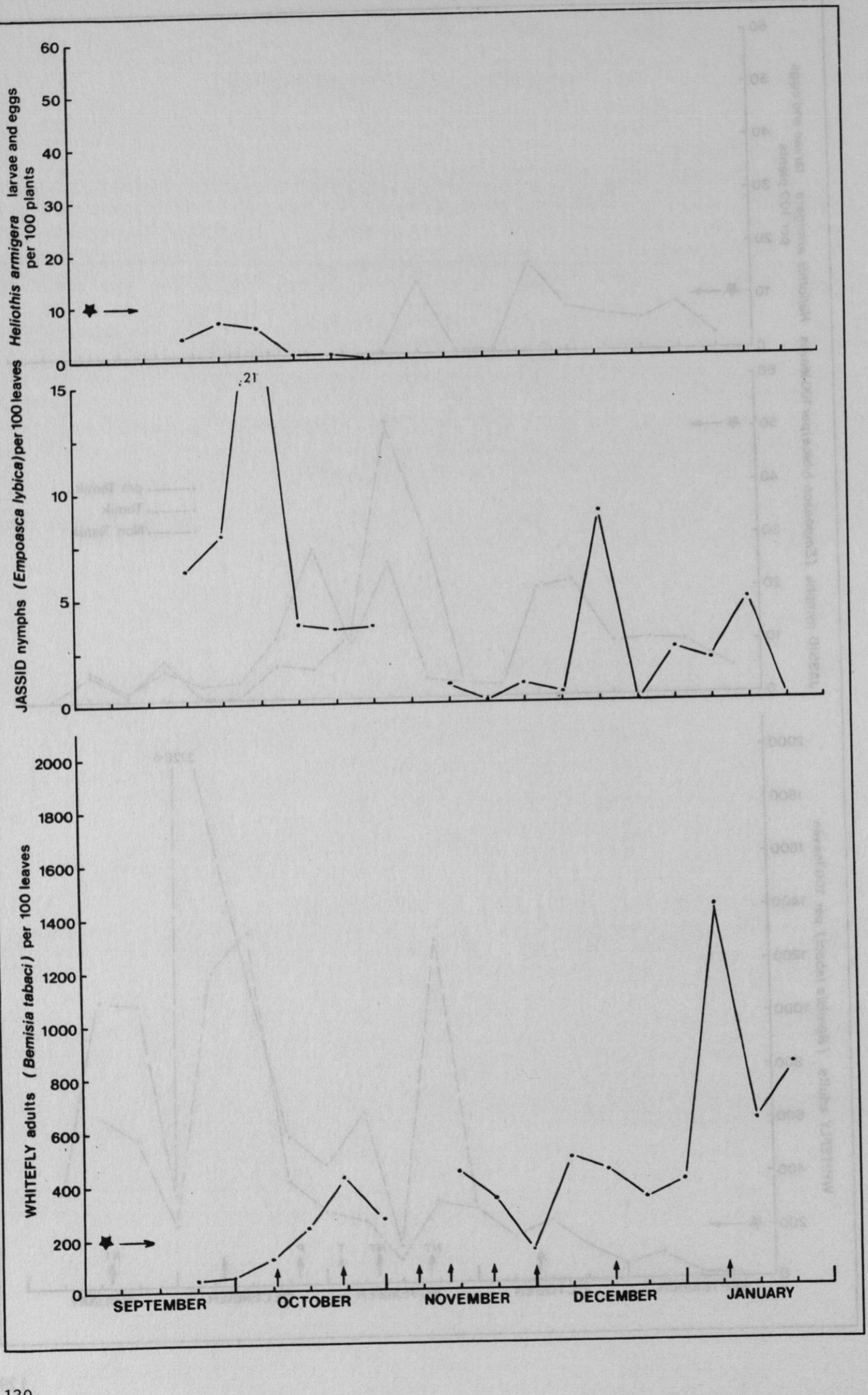

FIGURE A.E.3 SOUTH GROUP, BLOCK 1

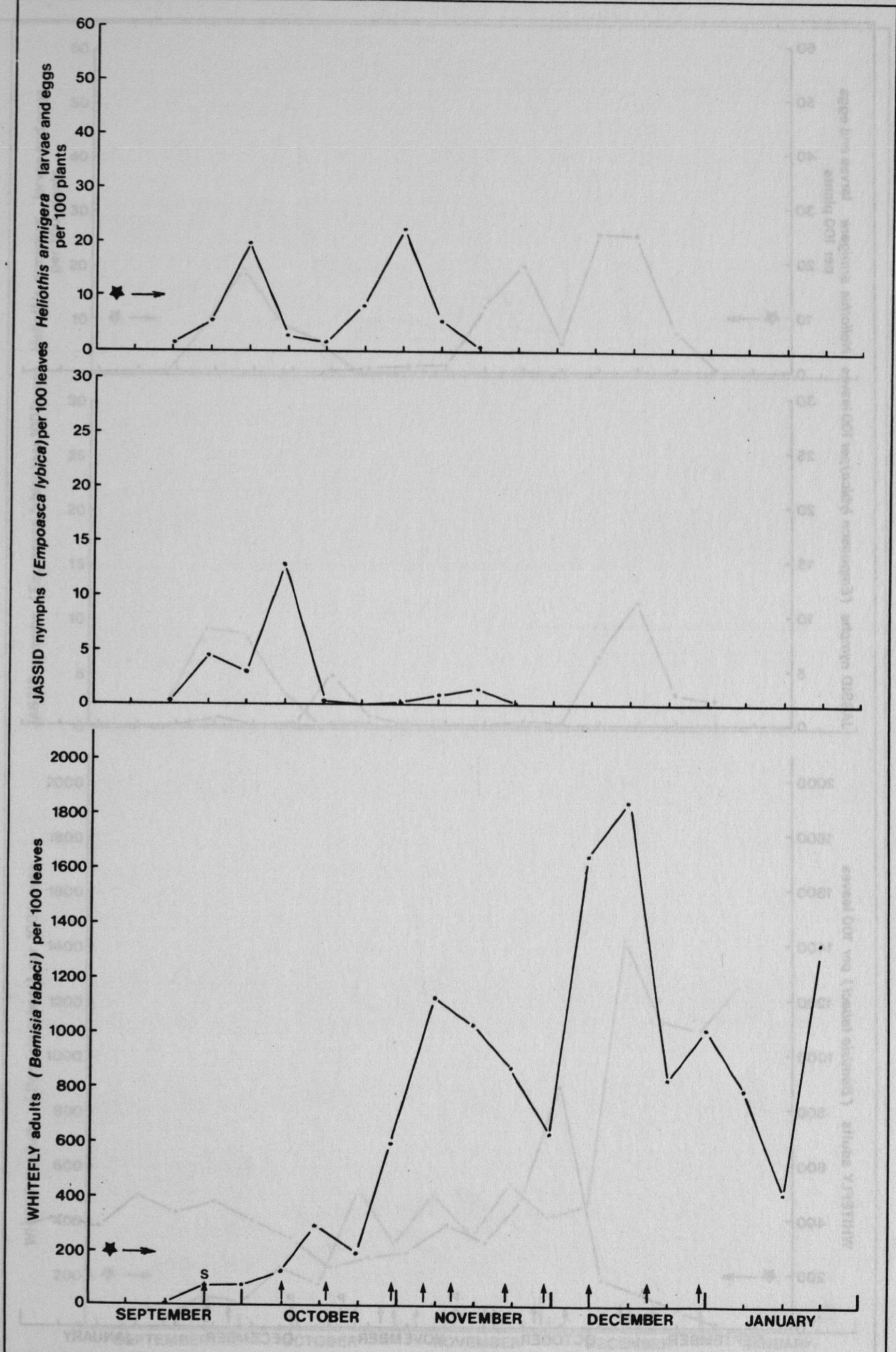

FIGURE A.E.4 SOUTH GROUP, BLOCK 3

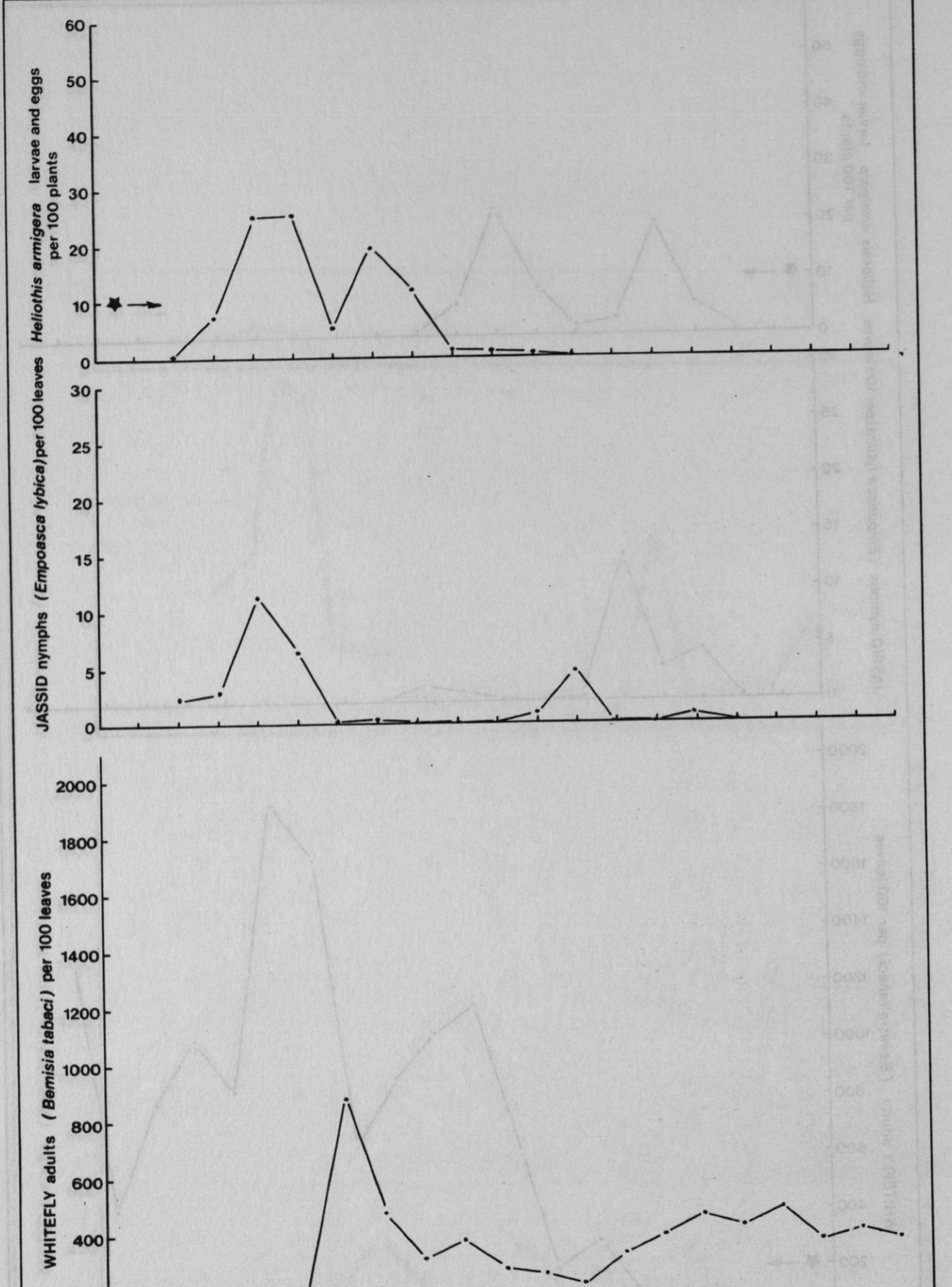

FIGURE A.E.5 SOUTH GROUP, BLOCK 5

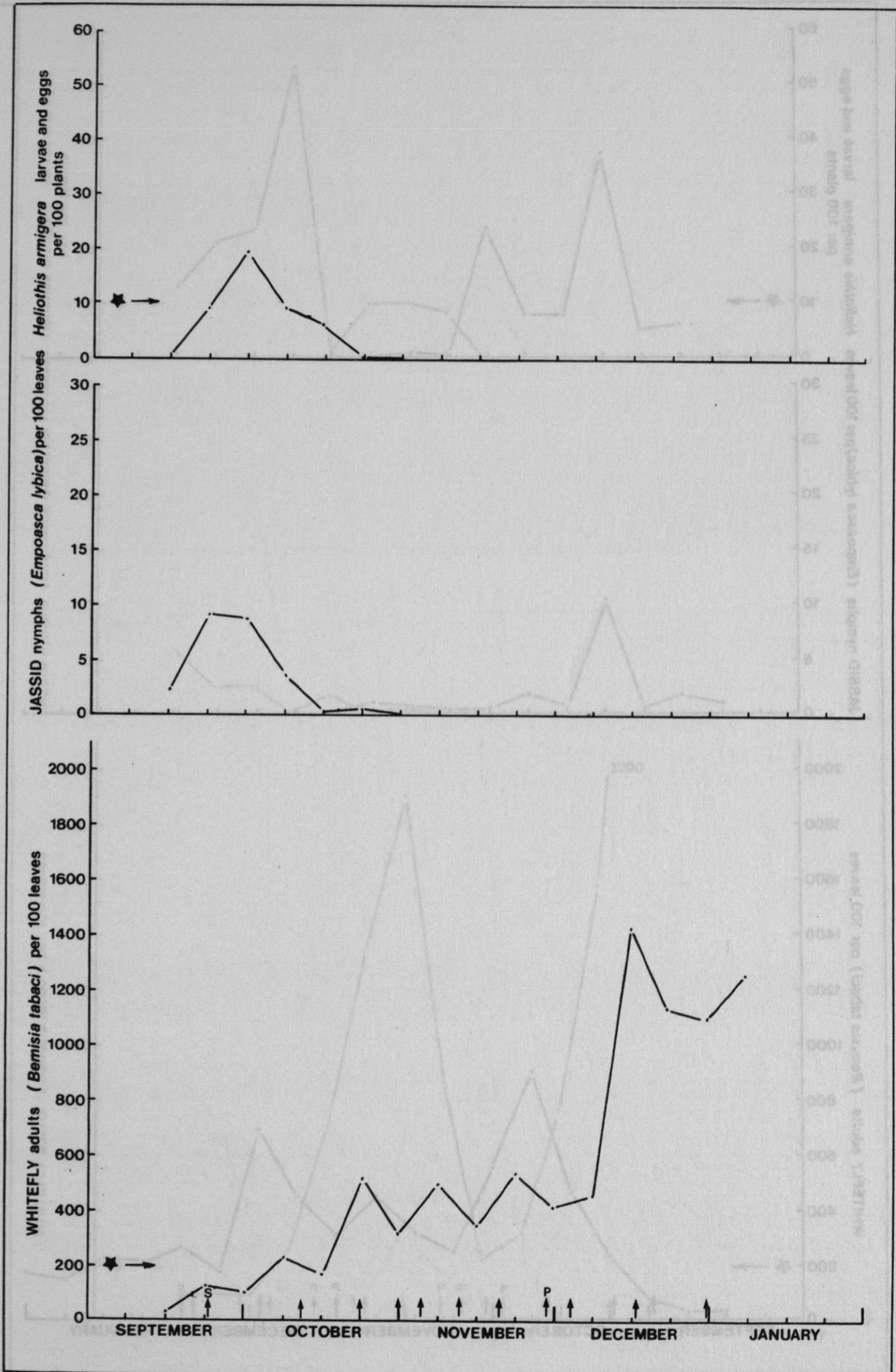

FIGURE A.E.6 SOUTH GROUP, BLOCK 95

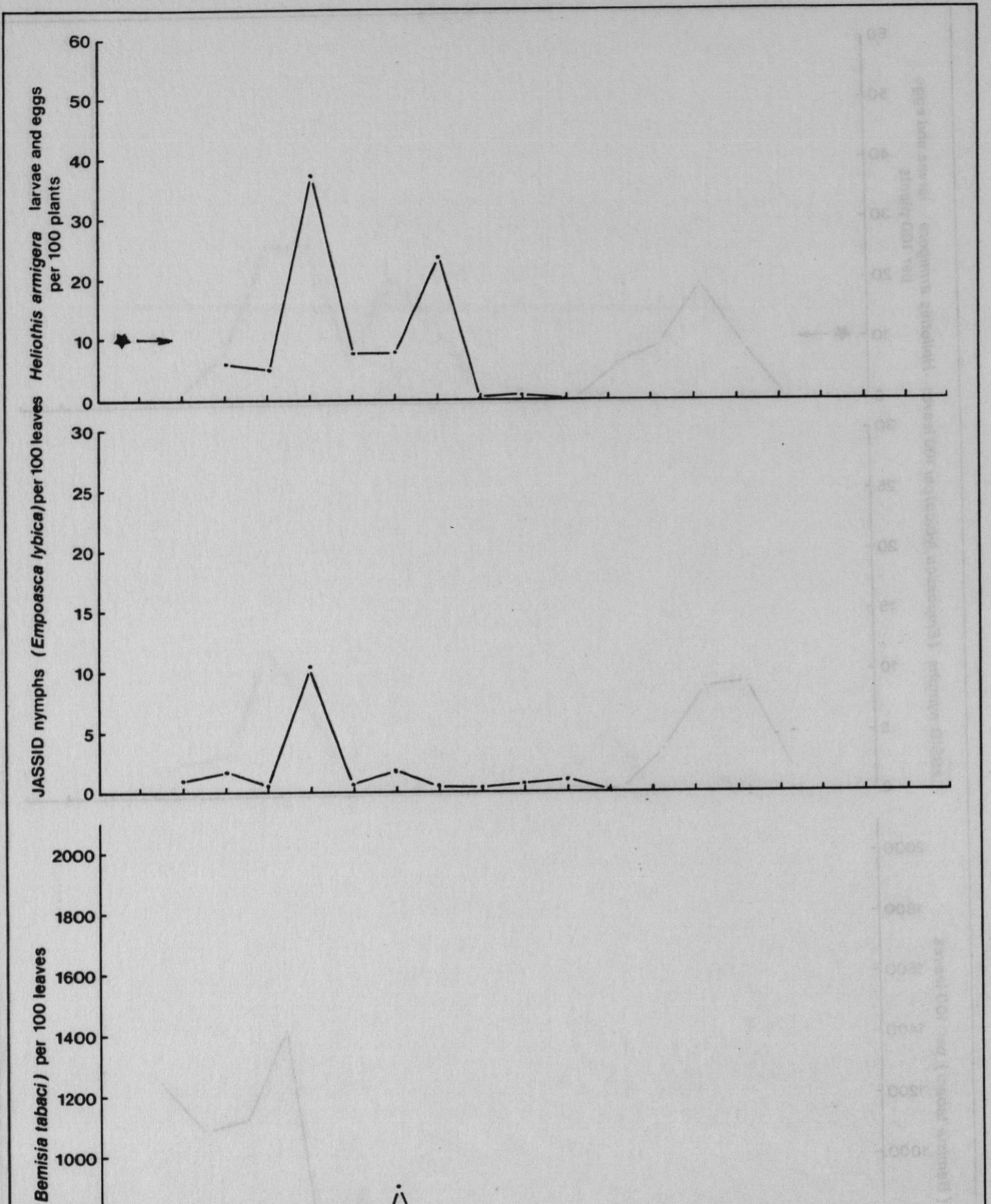

FIGURE A.E.7 CENTRE GROUP, BLOCK 8

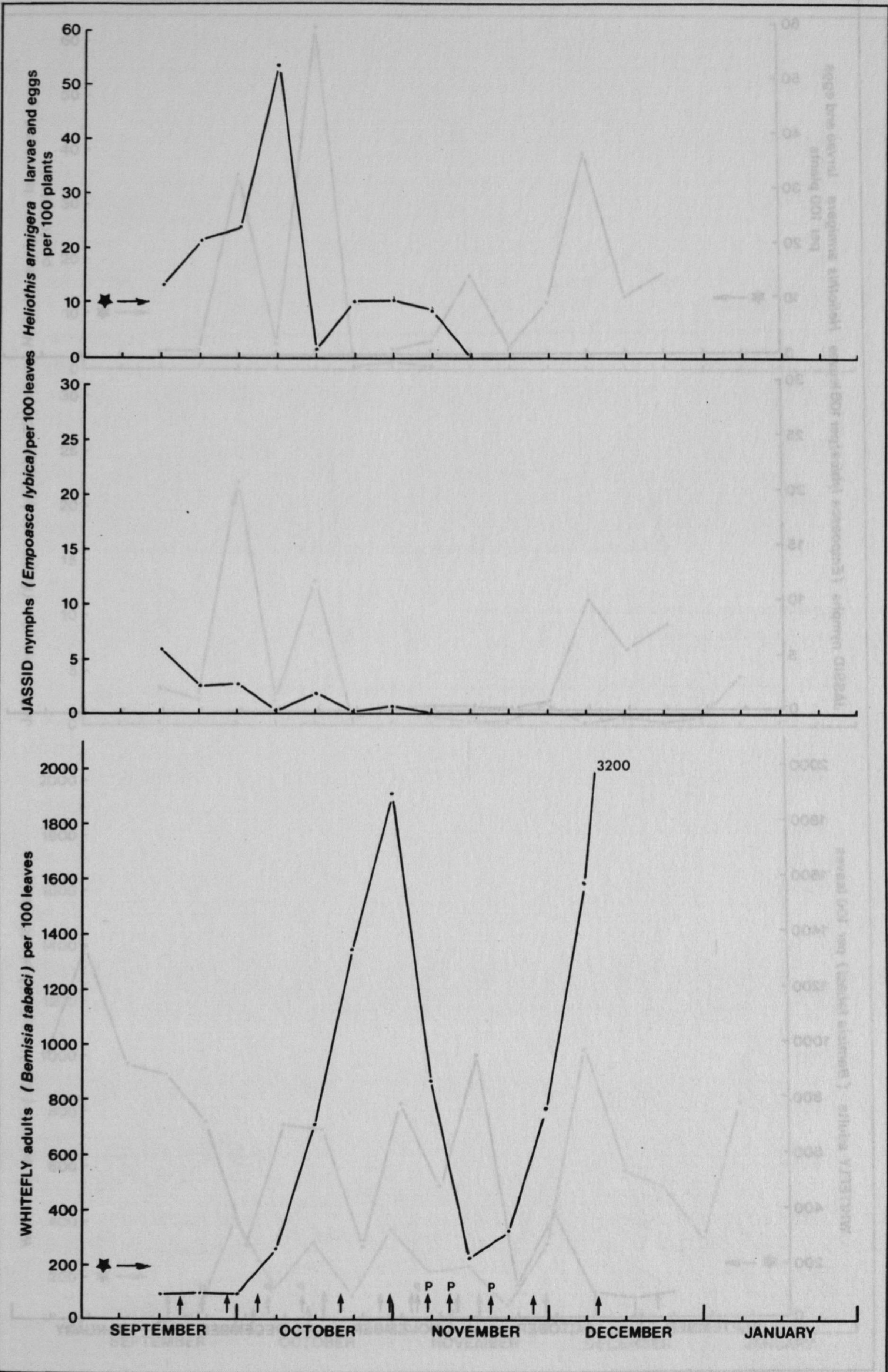

FIGURE A.E.8 MESSELLAMIA GROUP, BLOCK 20 - ABU GALIL

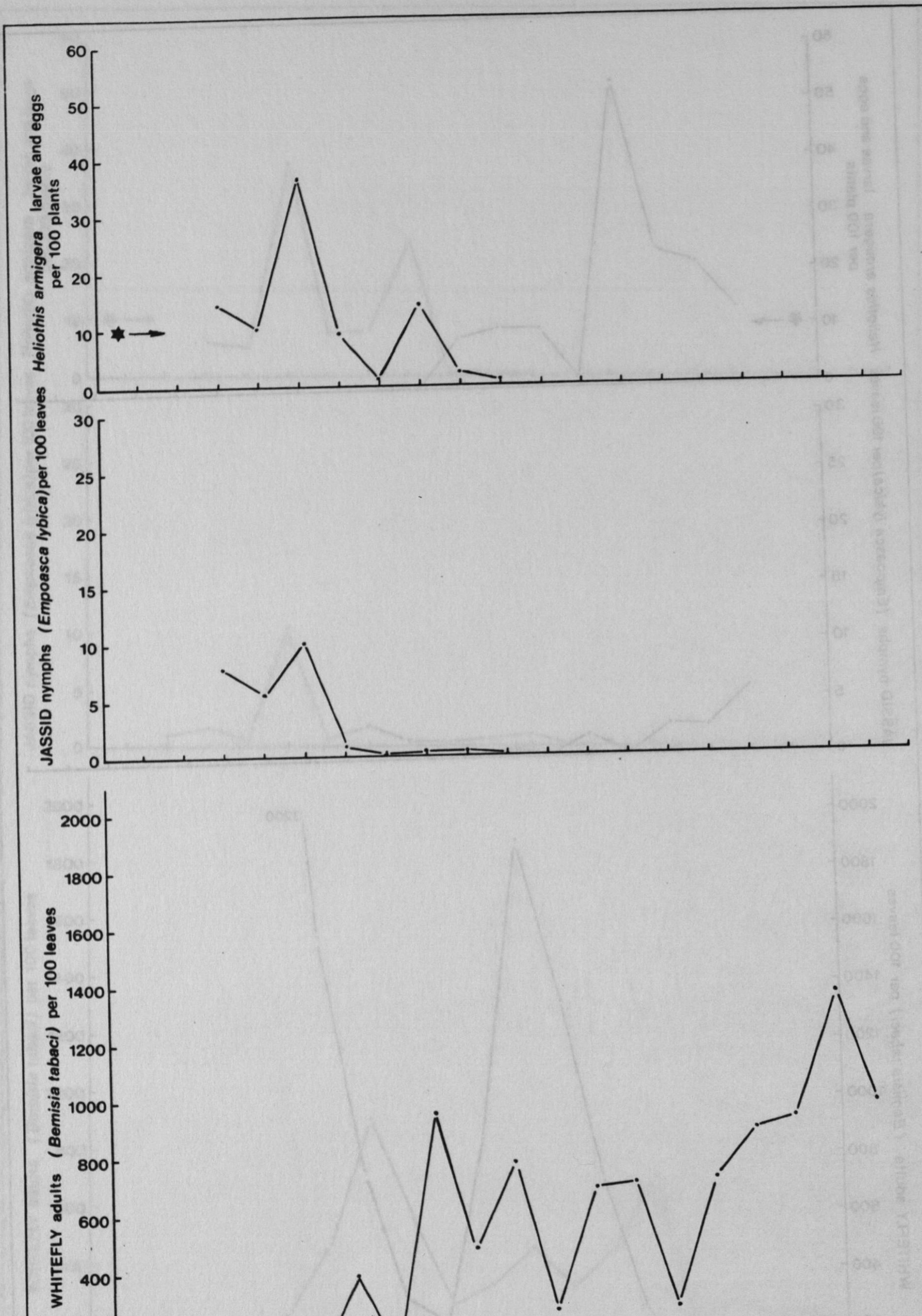

FIGURE A.E.9 WAD HABOUBA GROUP, BLOCK 26 - DOLGA

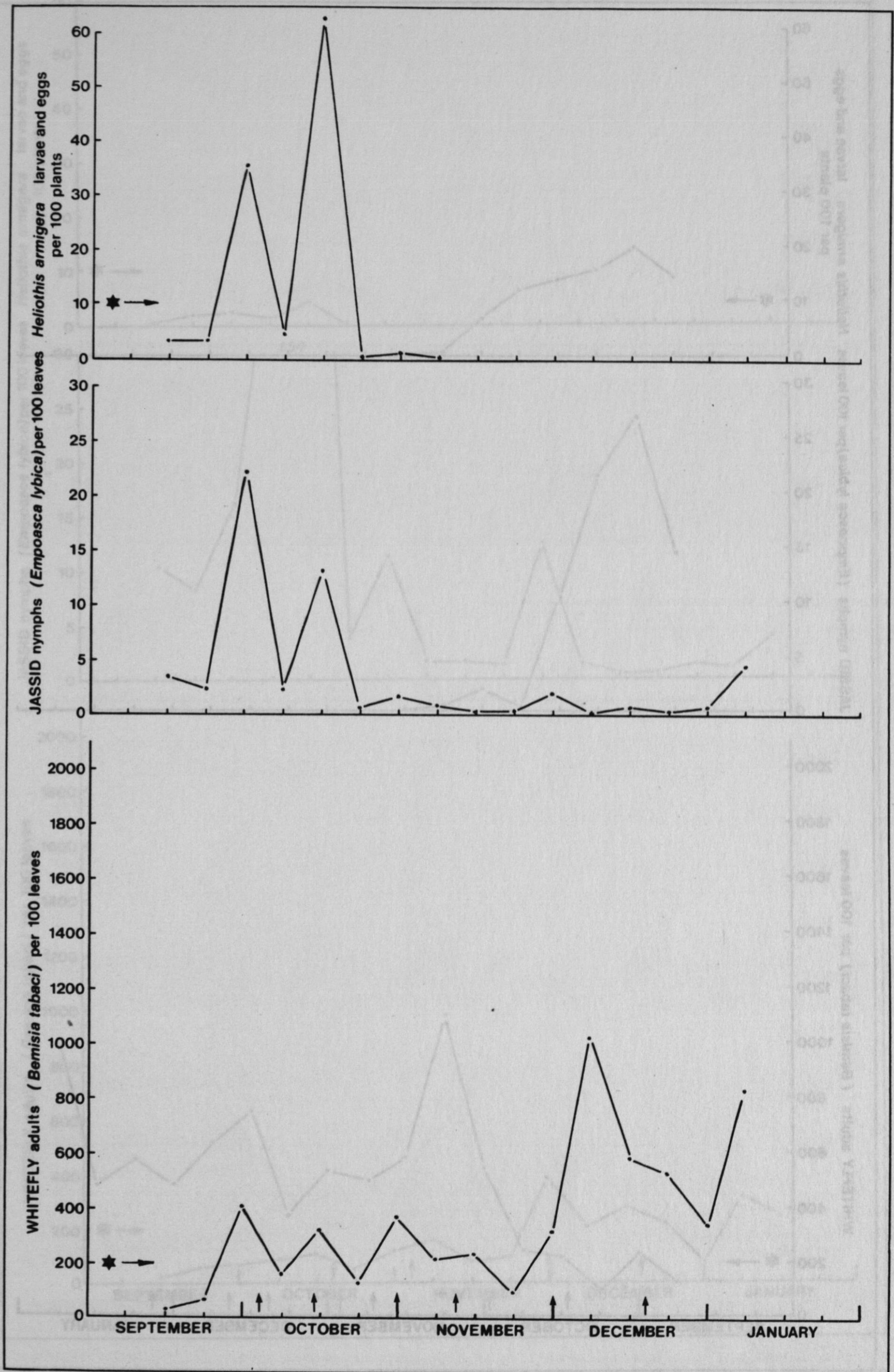

FIGURE A.E.10 WAD SHAIR GROUP, BLOCK 30 - FETEIS

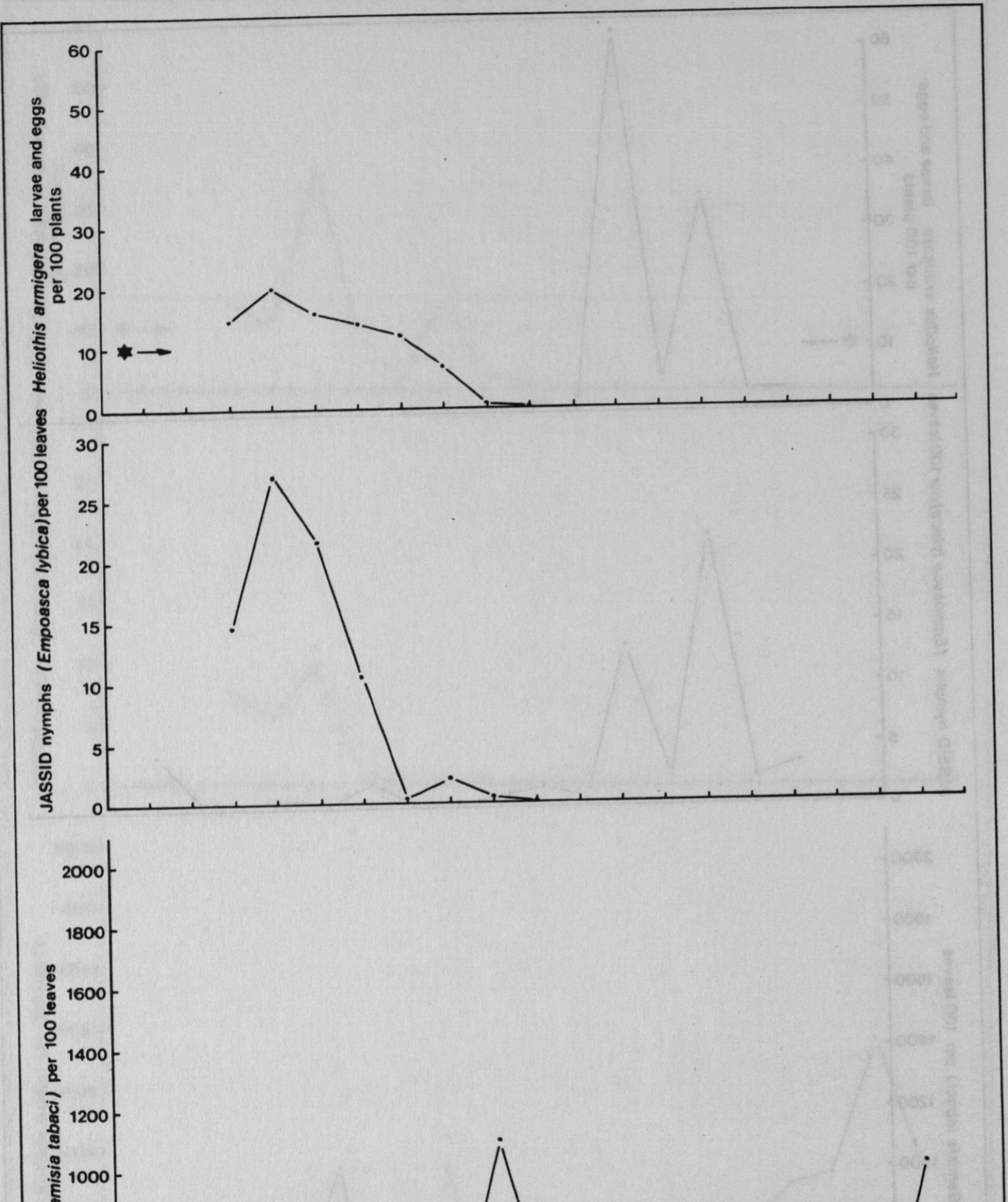

FIGURE A.E.11 NORTH WEST GROUP, BLOCK 44 - ELFRAGEON

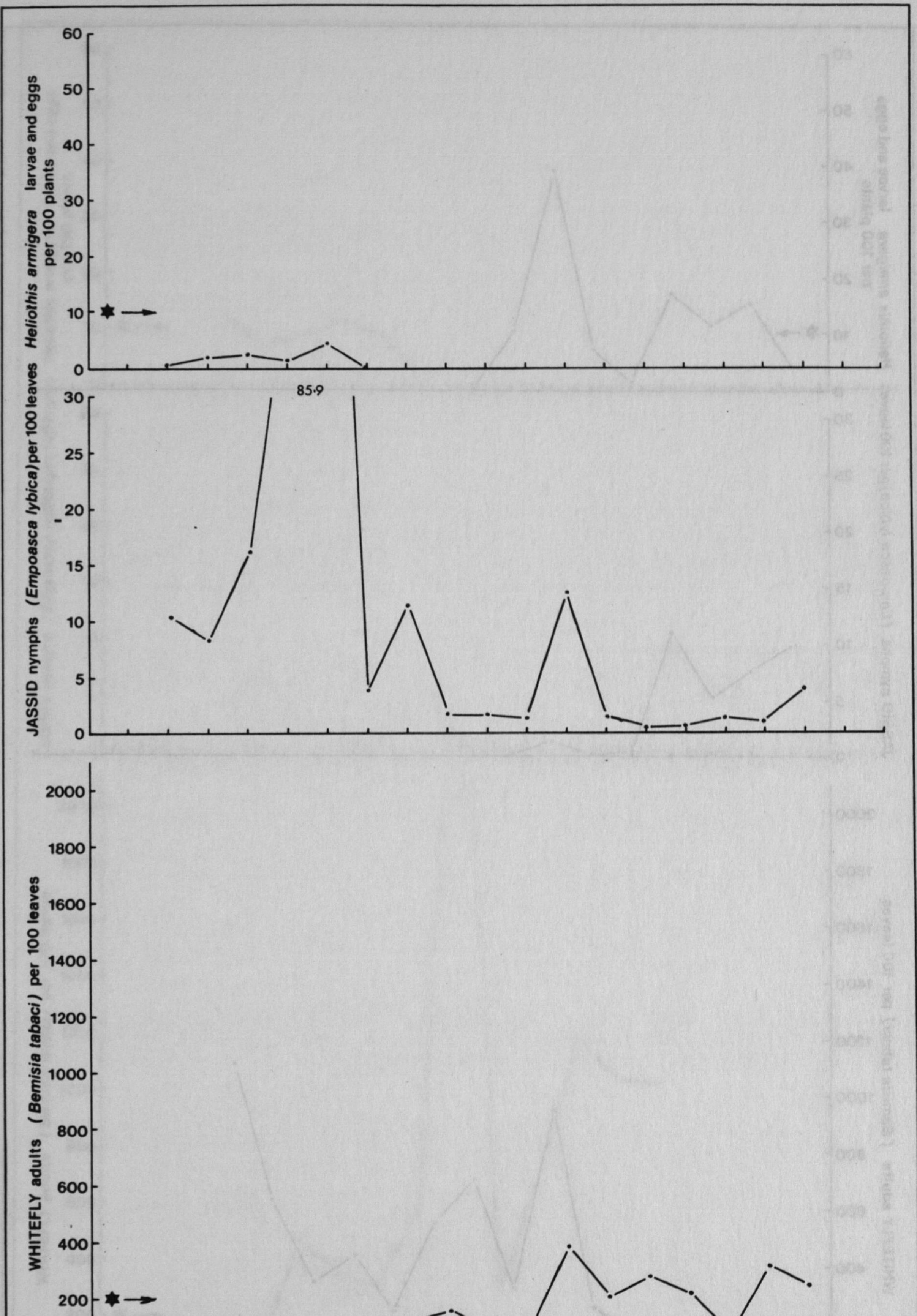

FIGURE A.E.12 MIKASHFI GROUP, BLOCK 47

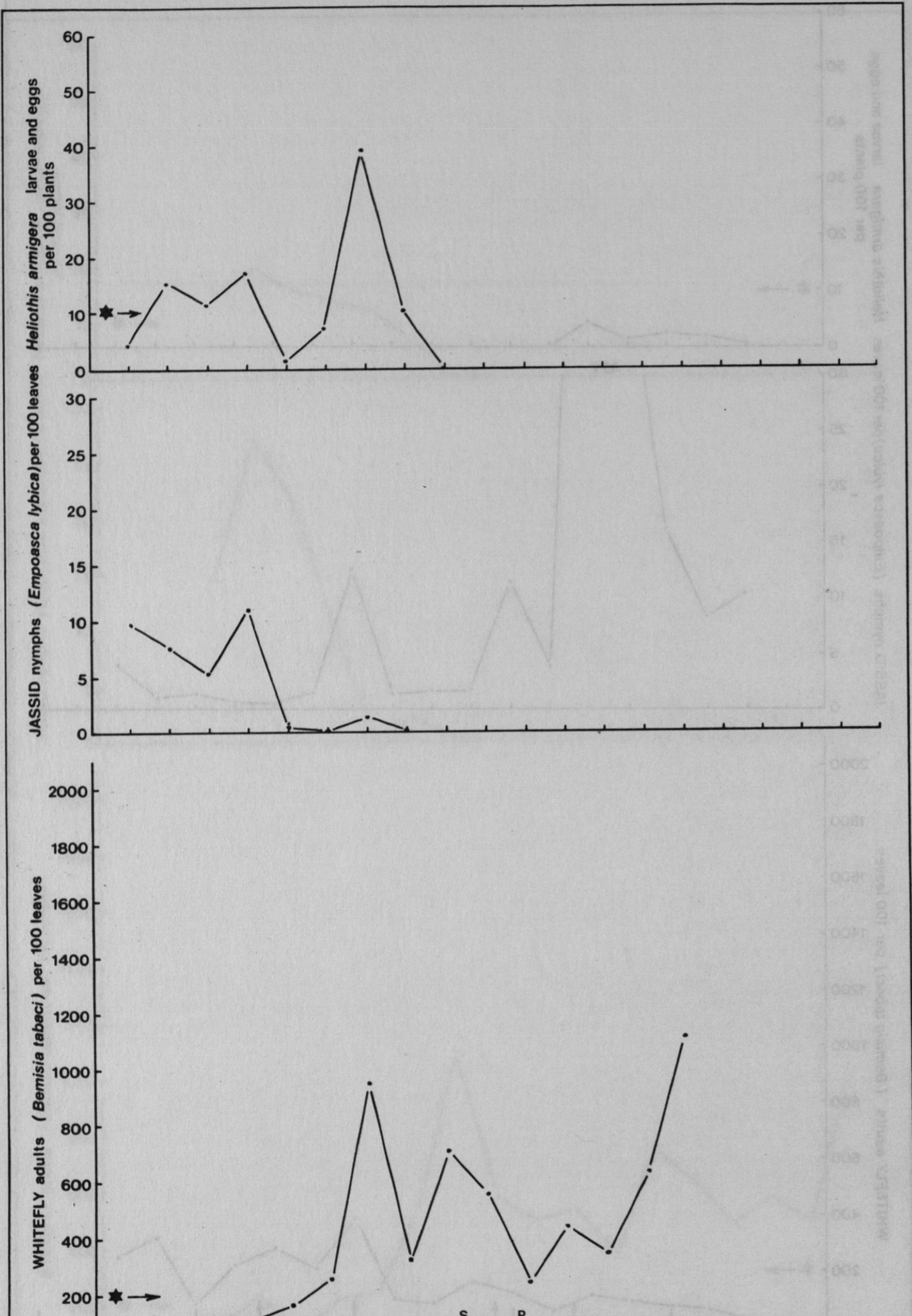

FIGURE A.E.13 HUDA GROUP, BLOCK 50

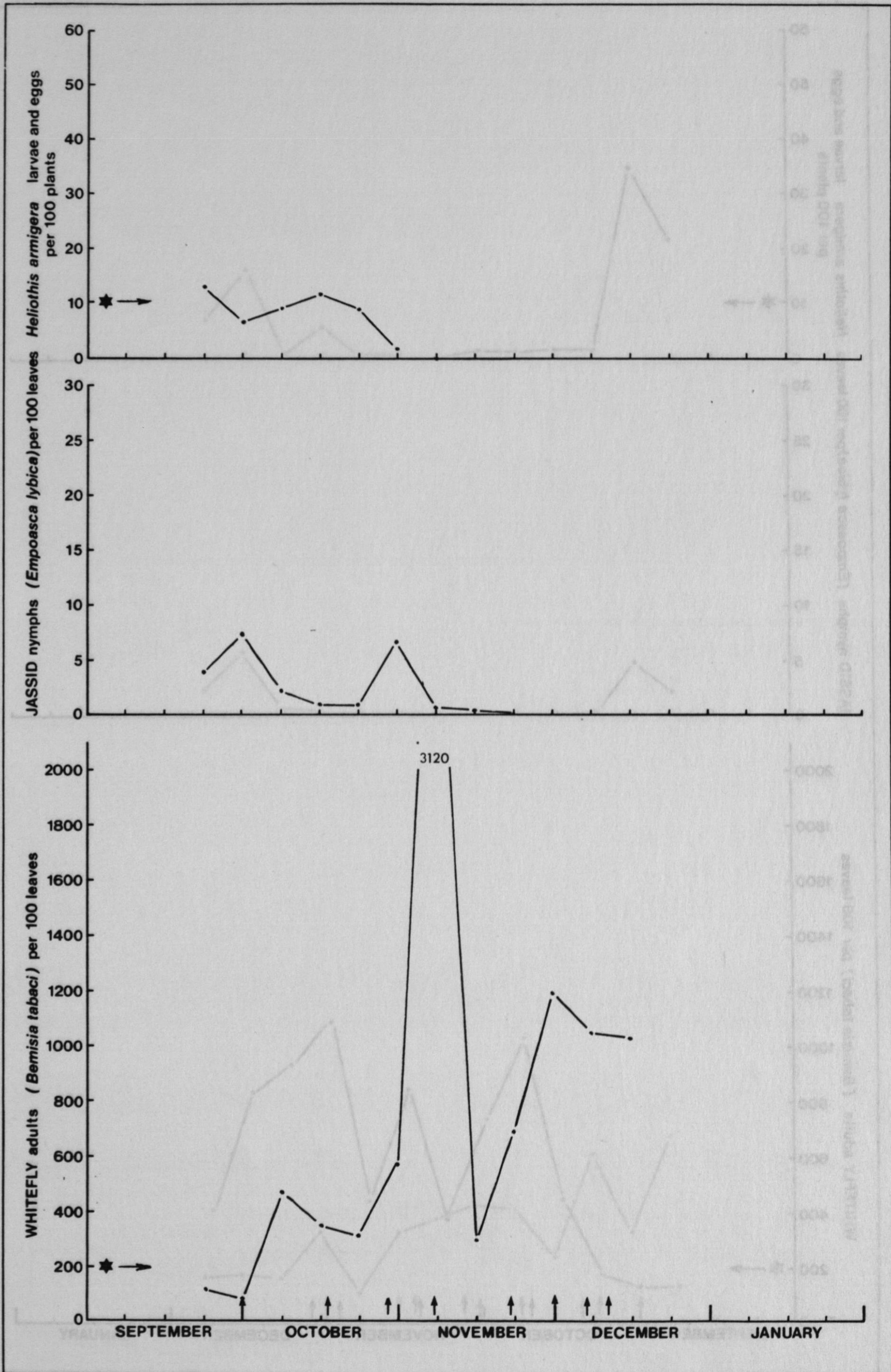

FIGURE A.E.14 MANSI GROUP, BLOCK 53

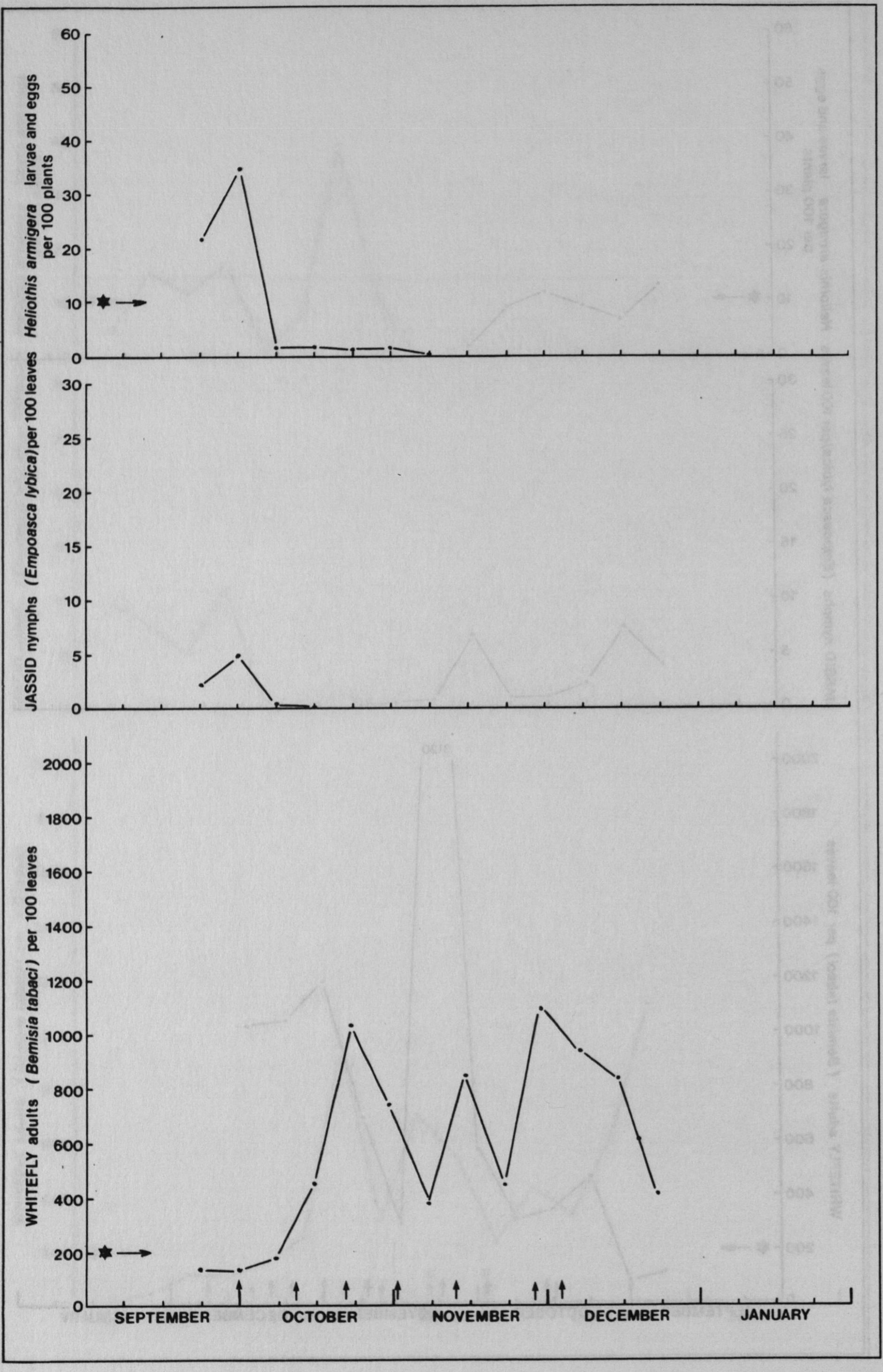

FIGURE A.E.15 MATURI GROUP, BLOCK 69

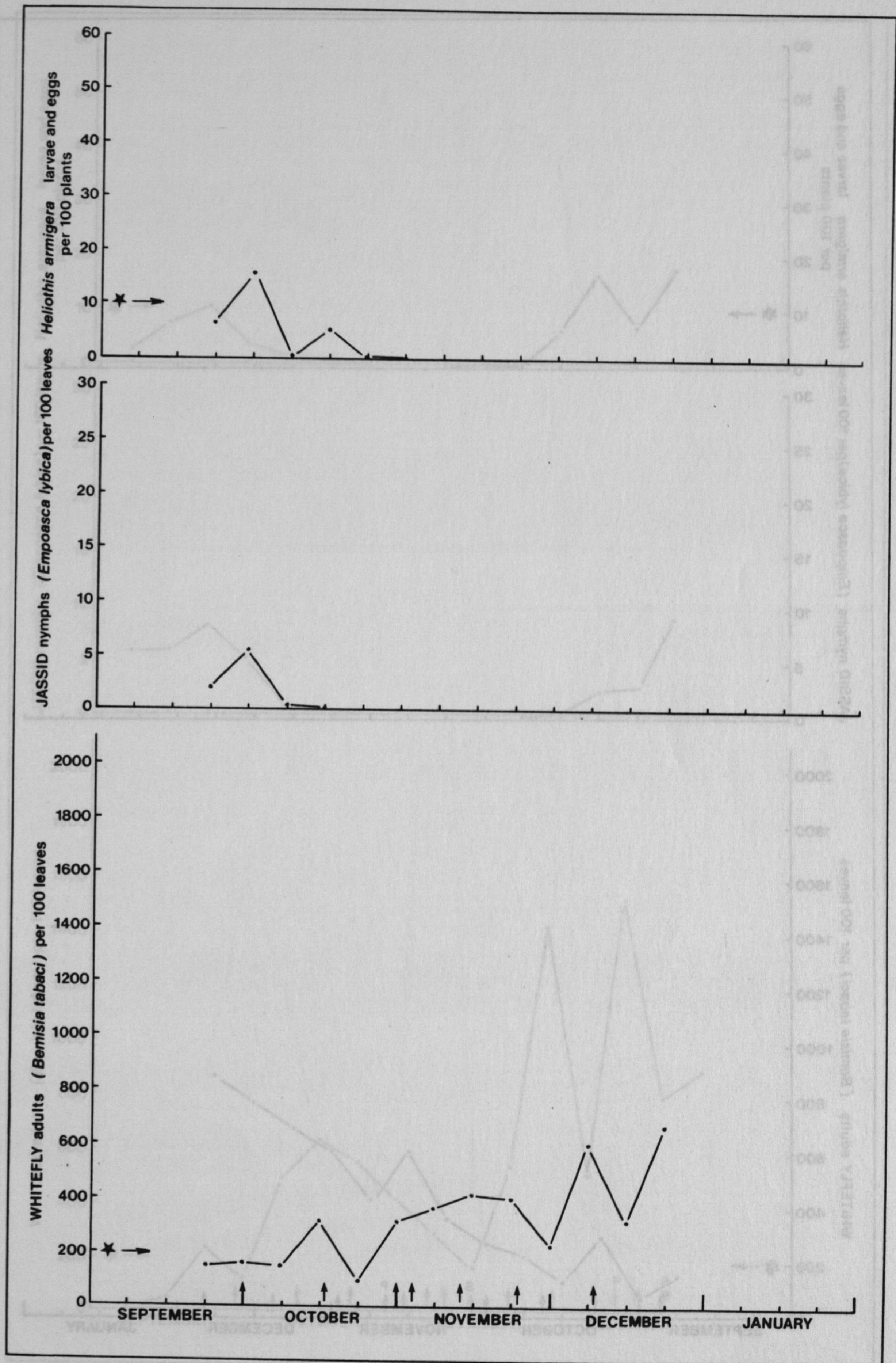

FIGURE A.E.16 MATOUG GROUP, BLOCK 71

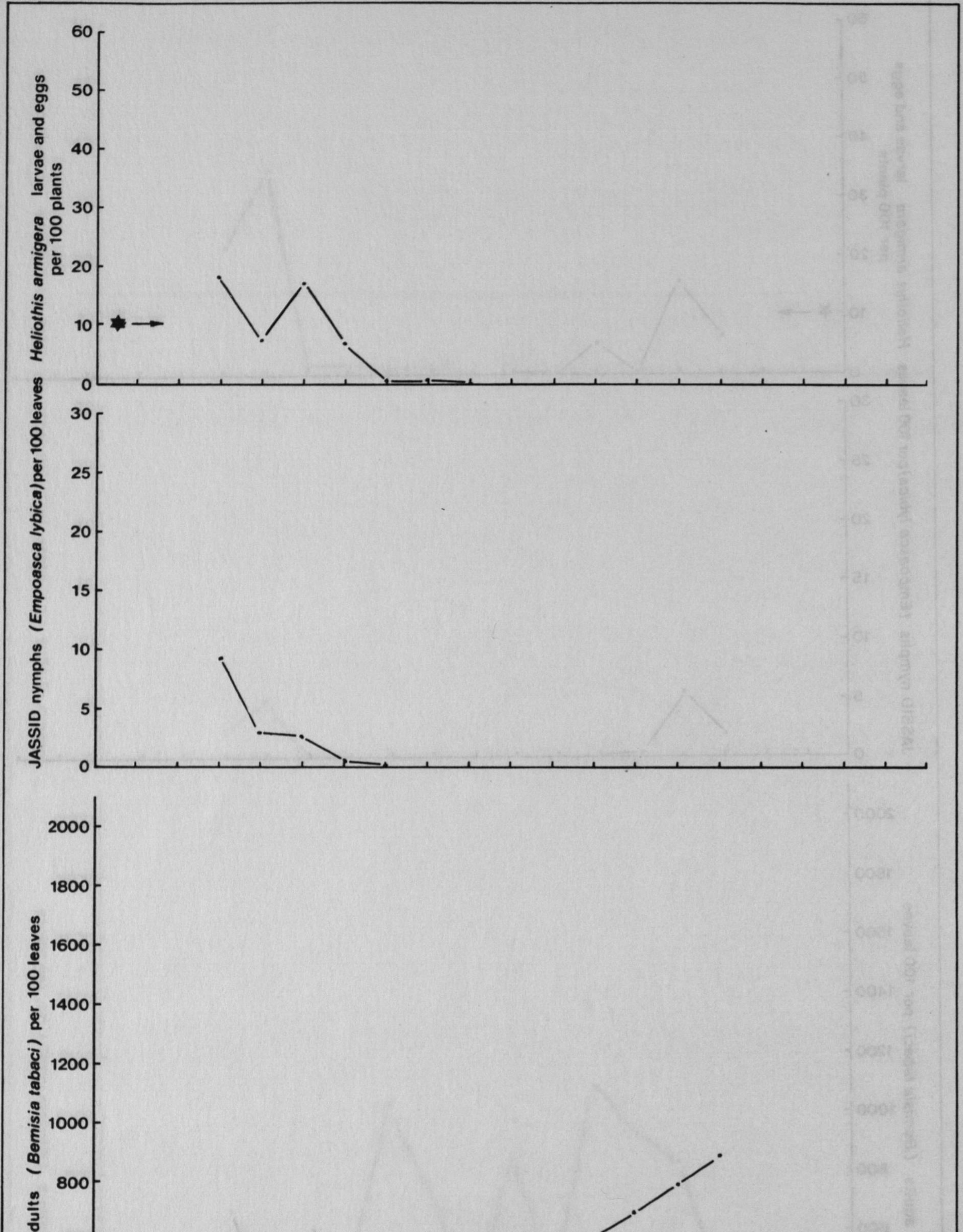

FIGURE A.E.17 TAHAMID GROUP, BLOCK 87

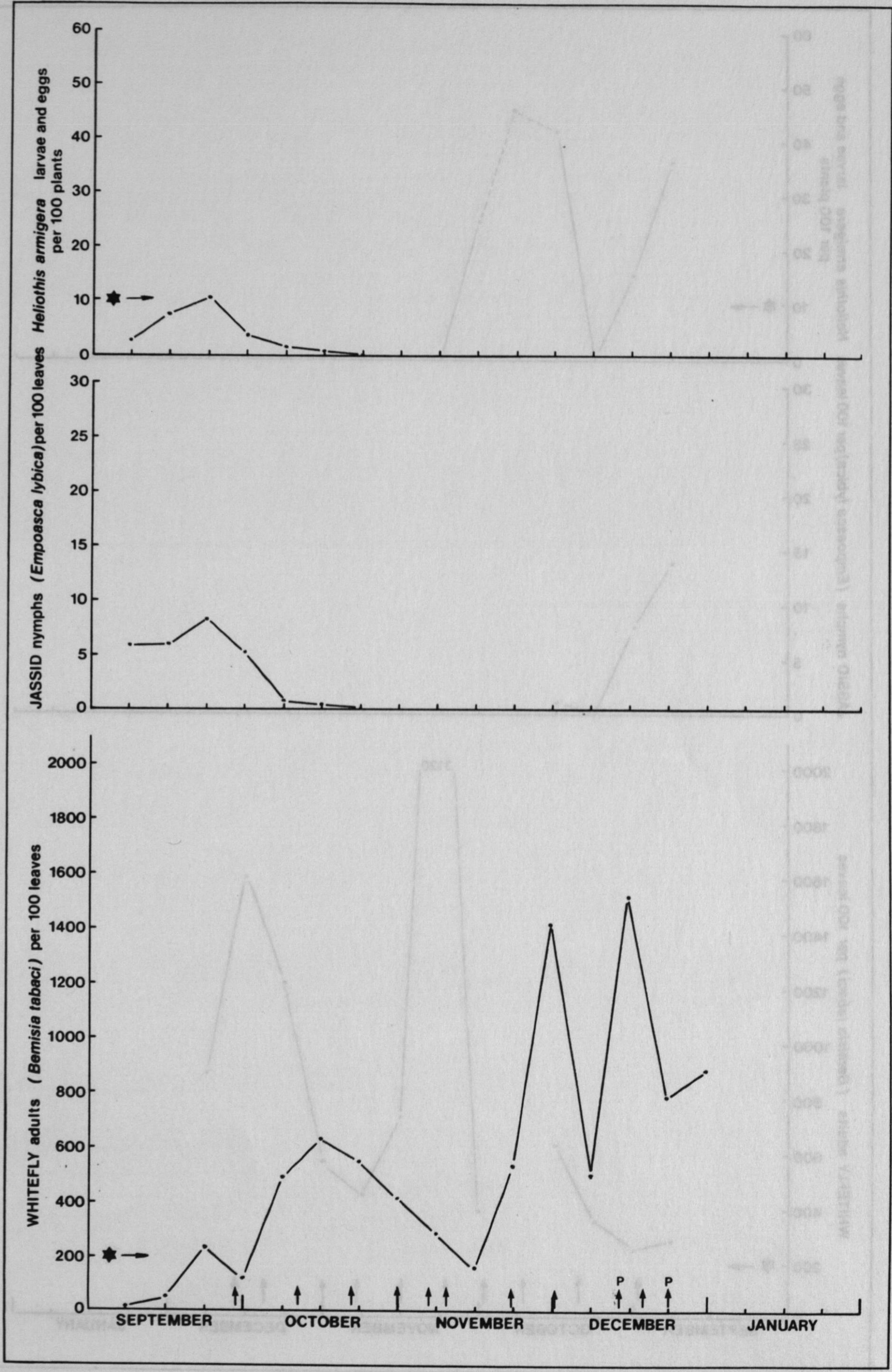

FIGURE A.E.18 GAMUSI GROUP, BLOCK 102