THE BOOTS COMPANY LIMITED
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EVALUATION OF MITAC ON COTTON

II. TRIALS IN EL SALVADOR

October 1st to December 4th, 1977

by

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Objectives:

1. To examine the value of MITAC for the control of cotton pests, especially Heliothis spp, when applied by aircraft under practical conditions.

2. To compare the insecticidal efficacy of new ultra-low volume formulations of MITAC.

3. To investigate the insecticidal potential of tank-mixes with products other than parathions.

CONTENTS

SUMMARY

1. The first series of large scale aerial ULV spraying trials to evaluate the efficacy of MITAC commercial EC product (bfn 6554) when used in conjunction with Bladan Ultra 900A (600 g/l ethyl parathion, 300 g/l methyl parathion), ultra low volume formulation, were rather inconclusive and indicated little more than that when Bladan 900A gave effective control of Heliothis zea Bladan/MITAC mixtures did likewise and vice-versa.

2. The second series of large scale aerial ULV spraying trials to compare the insecticidal performance of three formulations of MITAC, bfn 6554, bfn 7935 and bfn 7946, gave results which indicated a generally better performance against H. zea by bfn's 7935 and 7946 than by bfn 6554.

3. Small scale trials using mist-blower application gave strength to promising reports from Lenton and Boots' trials in Turkey of MITAC mixtures with Lannate but the MITAC/Pounce (pyrethroid) results were less encouraging.

4. A final series of large scale aerial spraying trials with MITAC/Lannate mixtures gave very promising results and a good commercially viable treatment seems probable. Further assessment is considered essential before launch on the market.

5. A brief consideration is given of the biology of H. zea in El Salvador in relation to the efficacy of insecticide applications.

INTRODUCTION

Cotton in El Salvador, as in Guatemala, is grown on the flat plains bordering the Pacific Ocean. The total area planted in 1975-76 was 105,700 manzanas (1 manzana, mz = 0.699 hectares) with a production of 3,650,000 quintales (164,250 tons). Farm sizes vary considerably with the larger farms being around 500 to 1000 mz in total area. Field size on the larger farms appears to be 35 to 80 mz.

Planting takes place in May-June and harvesting commences in mid-to late November. The final picking is in January and the plants are subsequently ploughed in. The rainy season is from June to November.

The planting is in rows with about one metre between rows and after establishment the plants are thinned out to approximately 50 cm apart. The mature plants form a dense interlocking canopy and under good soil and fertiliser conditions they grow to up to 2 metres in height. Little husbandry is required once the crop is established but movement within the cotton field is extremely difficult and demands considerable physical effort if cross-row traverses are required.

As elsewhere, the cotton is subjected to attack by a number of pests; the most serious of which are the boll weevil or picudo, Anthonomus grandis and the bollworm or bellotero, Heliothis zea. Other important pests are loopers or falso medidor, Trichoplusia ni and Pseudoplusia ni, army worm or gusano soldado, Spodoptera exigua, and whitefly or mosca blanca, Bemisia tabaci. This report deals primarily with Heliothis zea.

The criterion for using insecticides to control H. zea is the observation by scouts, or plagueros, of a level of infestation of first and second instar larvae which exceeds a level thought to represent the threshold for potential economic loss caused by the larval feeding. Schmutterer (1977) quotes these levels as follows:

(1) Based on counts of a number (usually 10 or 20) of 2 m lengths of planting row;

60-70 days after planting	1.2 to 1.5 larvae;
70 days to first picking of crop	1.0 to 1.2 larvae;
first to second picking of crop	0.8 to 1.0 larvae;
and, subsequently,	1.0 to 1.2 larvae.

or (2) Based on counts of 25 or 50 plants per field;

60-70 days after planting	24 to 30 larvae;
70 days to first picking of crop	20 to 24 larvae;
first to second picking of crop	15 to 20 larvae;
and, subsequently,	20 to 24 larvae.

In practice, most farmers seem to regard 25 larvae per 100 plants (25%) as the critical level and time their spraying accordingly. Similarly, any insecticide application which does not bring the level of infestation below 25% and/or does not maintain that level for more than 3-4 days is adjudged totally unsuccessful by the farmer.

GENERAL METHODS

The following work was carried out under the direction of the author: Three series of large scale trials with aerial applications of insecticides; a series of small plot trials using a low volume mist blower application; an assessment of ovicidal effect of ultra low volume application of MITAC formulations; and an assessment of droplet dispersion of ULV applications.

Three formulations of MITAC were used: bfn 6554 (the commercially produced emulsifiable concentrate (EC)); and bfn's 7935 and 7946 (both experimental ULV formulations). The assessment of H. zea infestations, and of other insect species, was made in all the trials by the regular hacienda (farm) employees, plagueros. These men made daily counts of the insect levels on 25 or 50 plants depending on the field or plot size (10 plants in the small plot trials). Counts were not made on the day of spraying or, if parathions were used, on the day after spraying. Of particular significance are the counts of white, newly deposited, eggs and of young larvae, $L_1 + L_2$.

LARGE SCALE TRIALS - SERIES A

To evaluate efficacy of MITAC commercial EC product (bfn 6554) when used in conjunction with Bladan Ultra 900 A (600 g/l ethyl parathion, 300 g/l methyl parathion), ultra low volume formulation.

Site Hacienda Santa Teresa El Porfiado, La Paz.
Kilometre 57, Carretera de la Herradura.
Proprietor: Sr. Juan A. Alvarado

Trials A1 and A2 - single application by aircraft

Trial area. Two fields (Lote 1 and Lote 2), total area 74 manzanas, bounded to the east by the Carretera de La Herradura and to the west by a drainage channel. The trial plots are shown on the plan (Fig. 1) and were marked out so as to allow four treatments and two replicates of each treatment. Each plot had a width of 75 metres equivalent to 3 spray swathes of 25 m each. The northern field (Lote 2) was 800 m long and Lote 1 was 600 m in length. The area of the plots in Lote 2 was, therefore, 8.58 mz; except plot D which was truncated by the drainage channel and was only 7.24 mz. The plots in Lote 1 were all 6.44 mz.

In each plot a central area 50 m in width and 600 m long in Lote 2 and 400 m in Lote 1 was marked for assessment.

The state of the cotton planting was in general good with a few areas subject to waterlogging and thus crop deterioration.

Other details

A maximum-minimum thermometer was positioned on a coconut palm alongside the hacienda road at the southern end of Lote 1. The thermometer, which was at a height of 2 m to minimise interference by passers-by, was semi-shaded by the palms. Readings of the maximum and minimum temperatures were taken at each visit to the hacienda, Table 1.

At the time of spraying, measurements of relative humidity were taken.

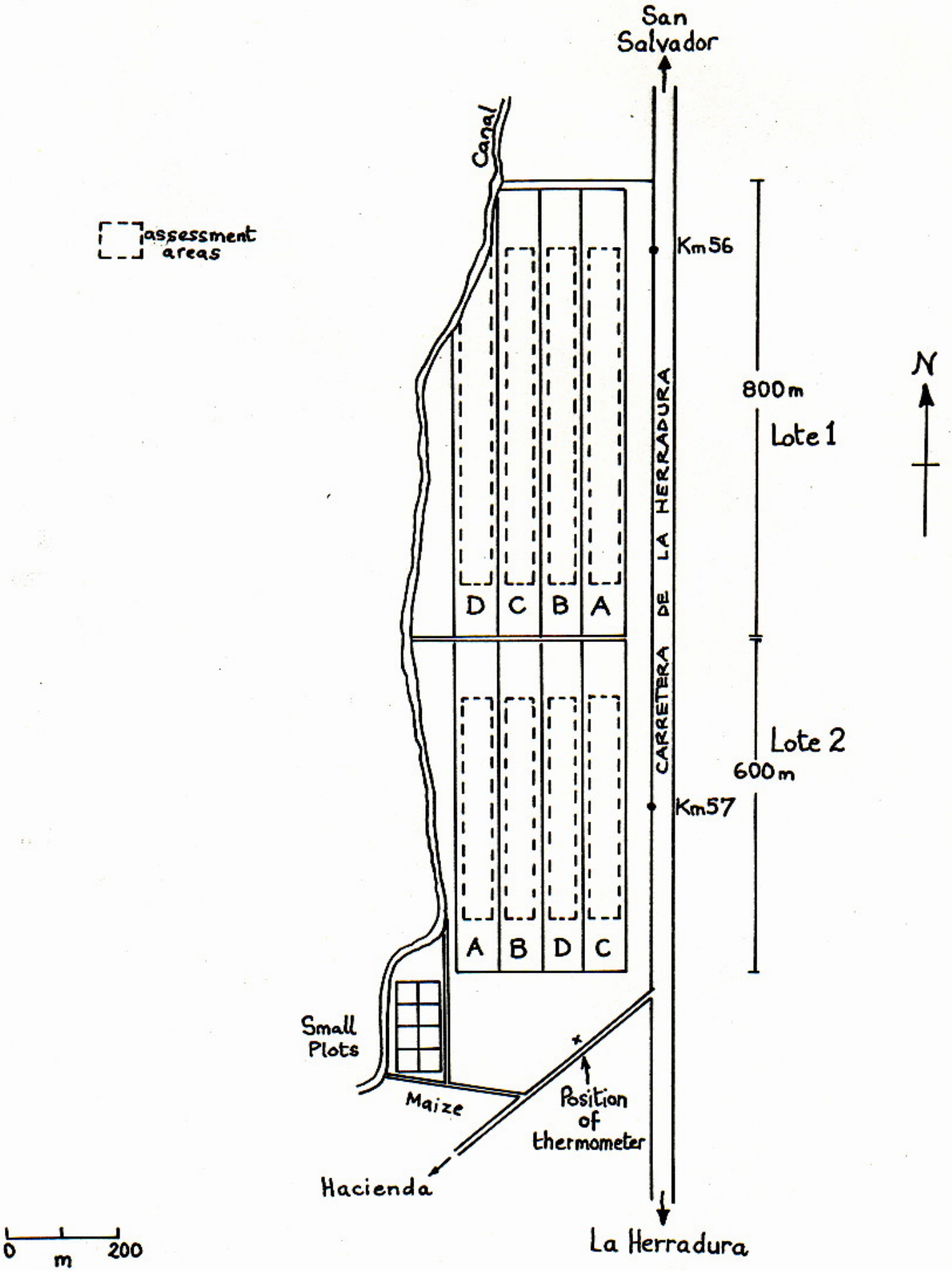


Fig. 1. Plan of trials sites; Hacienda Santa Teresa El Porfiado

TABLE 1

Temperature records - Santa Teresa El Porfiado

Date of reading	Time of reading	Temp at time	°C Max.	Min.
17th October	08.20	-	39.5	22
18th October	13.40	-	41	24
19th October	14.15	-	39	23
20th October	13.30	-	36	23
21st October	14.00	-	37	23
22nd October	12.30	-	36.5	22.5
24th October	11.30	-	36	24
25th October	12.30	-	39	25
26th October	12.00	-	38	23
27th October	12.00	-	38.5	25
28th October	13.00	-	38.5	25
29th October	-	-	-	-
31st October	10.30	-	41.5	23
1st November	10.30	33	40	24.5
4th November	11.30	37	39.5	23
7th November	11.00	32	47	22
10th November	11.00	33	38	22.5
11th November	10.00	32.5	39	22.5
15th November	11.30	41	45	22
16th November	14.30	33	43	21

Mean min. 23.2°C

Mean max. 39.6°C

TRIAL A1

Date of application: 15th October, 1977

Method of application: By Ultra Low Volume aerial spraying.

Cessna aircraft fitted with 6 Acumist atomisers. Flying speed approximately 110 m.p.h. Width of spray swath 25 metres. (Pilot Sr. Carlos Alfredo Villalobos).

Dosages

	Plots A	B	C	D
MITAC 200 EC	1.25 l/mz*	1.625 l/mz	2.0 l/mz	0
Bladan 900A	2.5 l/mz	2.5 l/mz	2.5 l/mz	2.5 l/mz

Conditions at time of spraying

Temperature at 0915, 30°C; % RH 36

Wind fresh to moderate

Temperature at 1225, 35°C

Note

For logistic reasons the whole field (Lote 1 and Lote 2) was sprayed first with Bladan 900A at 2.5 l/mz. The treatments A, B and C were then applied separately.

The rate of application was controlled by the pilot with nozzle settings and pump pressures according to his practical knowledge.

TRIAL A2

Date of application: 24th October, 1977

Method of application: As in Trial A1

Dosages

	Plots A	B	C	D
MITAC 200 EC	3.8 l/mz	2.0 l/mz	1.5 l/mz	0
Bladan 900A	2.0 l/mz	2.0 l/mz	2.0 l/mz	2.0 l/mz

* For key to dosage rates see appendix

Conditions at time of spraying

Temperature at 0930; 32°C; % RH 60-70; 40 mm rain in night before. Wind nil. Rain subsequently in afternoon, 10 mm.

An attempt was made to control the application rate more "scientifically" by using orifice and pressure settings calculated from the manufacturer's manual - the intended 2.0 l/mz of MITAC on Plot A was applied at about 3.8 l/mz as calculated from the actual amount discharged. The remainder of the applications were at the orifice and pressure settings recommended by the pilot. The reasons for the discrepancy will be discussed later.

TRIAL A3

Trial area. Lote 4 at Hda. Santa Teresa was used. This field has a total area of 34 mz. It is 350 m wide and is divided into two sections; one 360 m long, area 18 mz, designated A; and the second 320 m long, area 16 mz designated B.

Date of application: 20th October, 1977

Method of application: As in Trial A1

Dosages

Area A was treated with MITAC 1.25 l/mz mixed with Bladan 900A at 2.5 l/mz.

Area B was treated with MITAC 1.25 l/mz sprayed separately from Bladan 900A at 2.5 l/mz.

Conditions at time of spraying

A sprayed between 0830 and 0845 and B between 1005 and 1015 (delay caused by aircraft malfunction).

Wind nil to very light. RH about 50%. Temperature reached 33°C by 1015.

Note

Application according to pilot's recommendation.

RESULTS AND DISCUSSION OF TRIALS SERIES A

The white egg and L_{1-2} larval levels based on counts of 25 plants per replicate are shown in Fig. 2 for Trials A1 and A2. As can be seen the apparent effect of all four insecticide treatments in Trial A1 was to give an excellent control of H. zea. The larval level in treatment D, Bladan alone, rose on day 7 (22nd October) to a higher level than in the three MITAC/Bladan treatments. The percentage survival or hatch in the four treatments is shown in Table 2. The apparent better performance of MITAC in this trial, where it was sprayed separately from the Bladan, than had been reported from commercial applications as a mixture with Bladan prompted the thought that the method of applying the MITAC and Bladan separately might indicate some incompatibility between the two products when tank mixed.

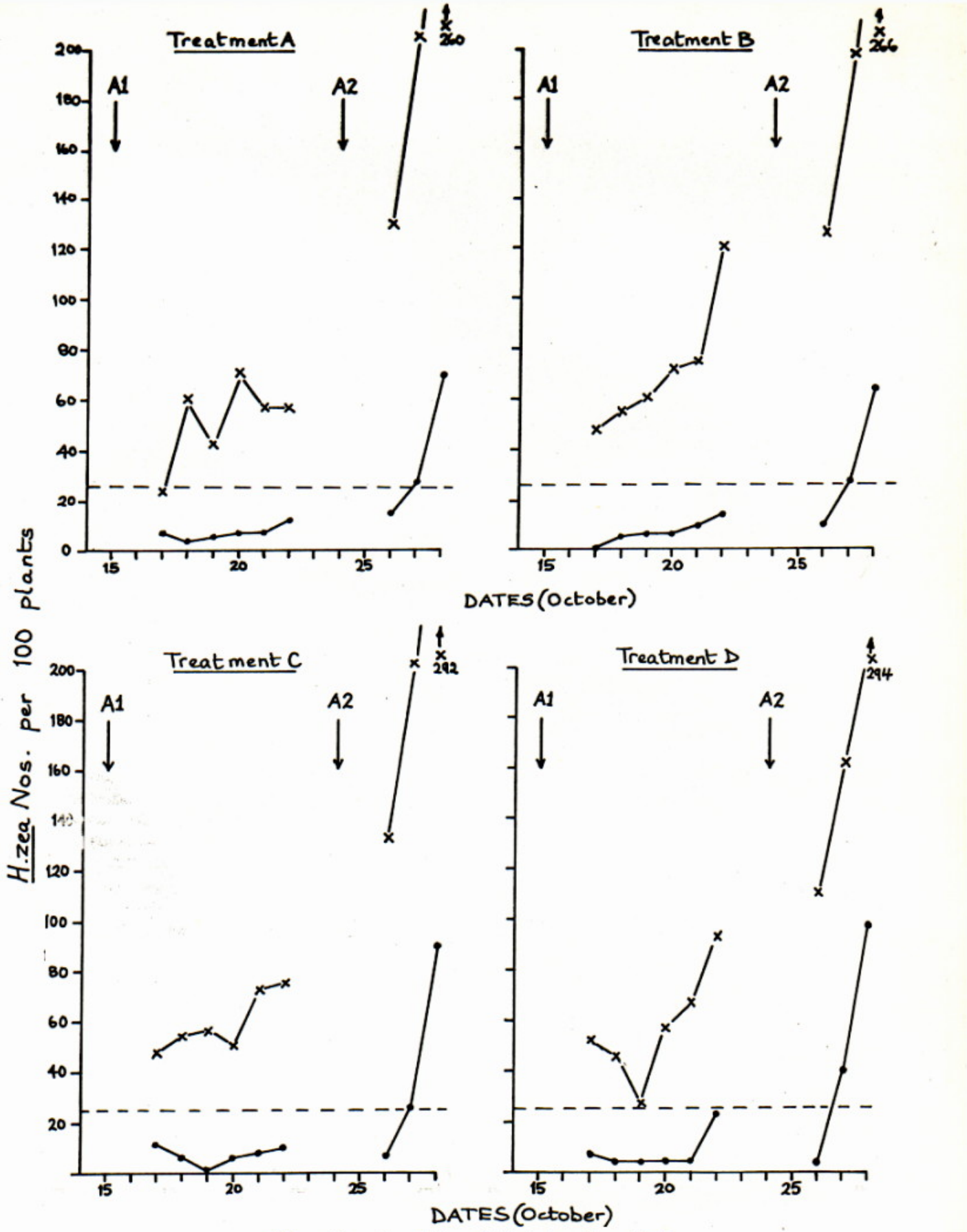


Fig. 2. Results of Trials A1 and A2

Treatments A, B and C were MITAC plus Bladan

Treatment D was Bladan alone

x —— x white eggs

. —— . $L_1 + L_2$ larvae

------- 25% level

For treatment rates see p.6.

TABLE 2

Percentage hatch of H. zea eggs in Trial A1

Sprayed 15th October, 1977

	White Eggs 17th Oct	Larvae L_{1-2} 21st Oct	
Treatment A	33.3	20.0	MITAC 1.25 l/mz + Bladan 900A 2.5 l/mz
Treatment B	20.8	25.9	MITAC 1.625 l/mz + Bladan 900A 2.5 l/mz
Treatment C	16.7	18.5	MITAC 2.0 l/mz + Bladan 900A 2.5 l/mz
Treatment D	7.7	47.8	Bladan 900A only

A time interval of four days from observation of white eggs to hatch of larvae is used for these calculations.

Trial A3 was applied to investigate this possibility. Table 3 shows the results which, if anything, indicated a failure of Bladan to control L_{1-2} larvae.

The results of Trial A2, in Fig. 2, showed a possible slight improvement in control on day 3 (27th October) after the MITAC/Bladan treatments in comparison with the Bladan only treatment. There was no apparent difference in control achieved by the three levels of MITAC.

At this point there is little more to say other than that the results of Trials series A were inconclusive.

SMALL PLOT TRIALS

To evaluate promising alternative mixtures of MITAC and other insecticides as suggested from work at Lenton and in Turkey.

Site Hacienda Santa Teresa El Porfiado, La Paz.

Trial Area. In south western corner of Lote 2, Fig. 1. Area about 2 mz bounded by drainage canal, farm track and maize planting. Arrangement of trial plots, each 40m^2, shown in Fig. 3. Planting rows diagonally across plots, see inset Fig. 3, approximately 16 plants per 10 m of row, total row length in plot about 1800 m giving about 3000 plants per plot.

Every five rows the plants were gently pushed aside to provide a path for the sprayman.

TRIAL S1

Dates of application: 31st October, Plots C and D, and 1st November, Plots A and B.

Method of application: By Solo back-pack motorised mist blower equipped for low volume and ULV application. At a moderate walking pace the time to treat each plot was 10 to 11 minutes. The theoretical discharge rate for water using the smallest orifice was 1.76 l, in practice some 3 l was discharged when using the insecticide emulsions and mixtures.

Dosages MITAC used was the commercial EC formulation.

A MITAC at 1.5 l/mz plus Lannate 90% WP at 4 oz/mz (113.5g)

B Lannate 90% WP at 8 oz/mz (227g)

C MITAC at 1.5 l/mz plus Pounce 7.5% at 1.0 l/mz

D Pounce 7.5% at 1.0 l/mz

Pounce is Bayer's pyrethroid product (NRDC 143 Permethrin). Lannate is Du Pont methomyl.

Conditions at time of spraying

On 31st October, wind light to moderate, time 0945 to 1030 (cotton too wet before), temperature at end 30°C.

On 1st November, time 0830 to 0945, wind nil to light, temperature at end 31°C, RH about 60%

TABLE 3

Trial A3 Results

H. zea counts

	white eggs (W)	grey eggs (G)	larvae L_{1-2}	larvae L_{3-5}
14th October		Bladan 900A 2.5 l/mz		
15th October		No count		
16th October	112	34	12	28
17th October	56	20	12	4
18th October	54	14	10	16
19th October	62	20	32	14
20th October		MITAC-Bladan trial application		
21st October		No count		

	A				B			
	W	G	L_{1-2}	L_{3-5}	W	G	L_{1-2}	L_{3-5}
22nd October	160	76	28	20	12	48	52	4
23rd October	164	40	40	32	76	20	60	48

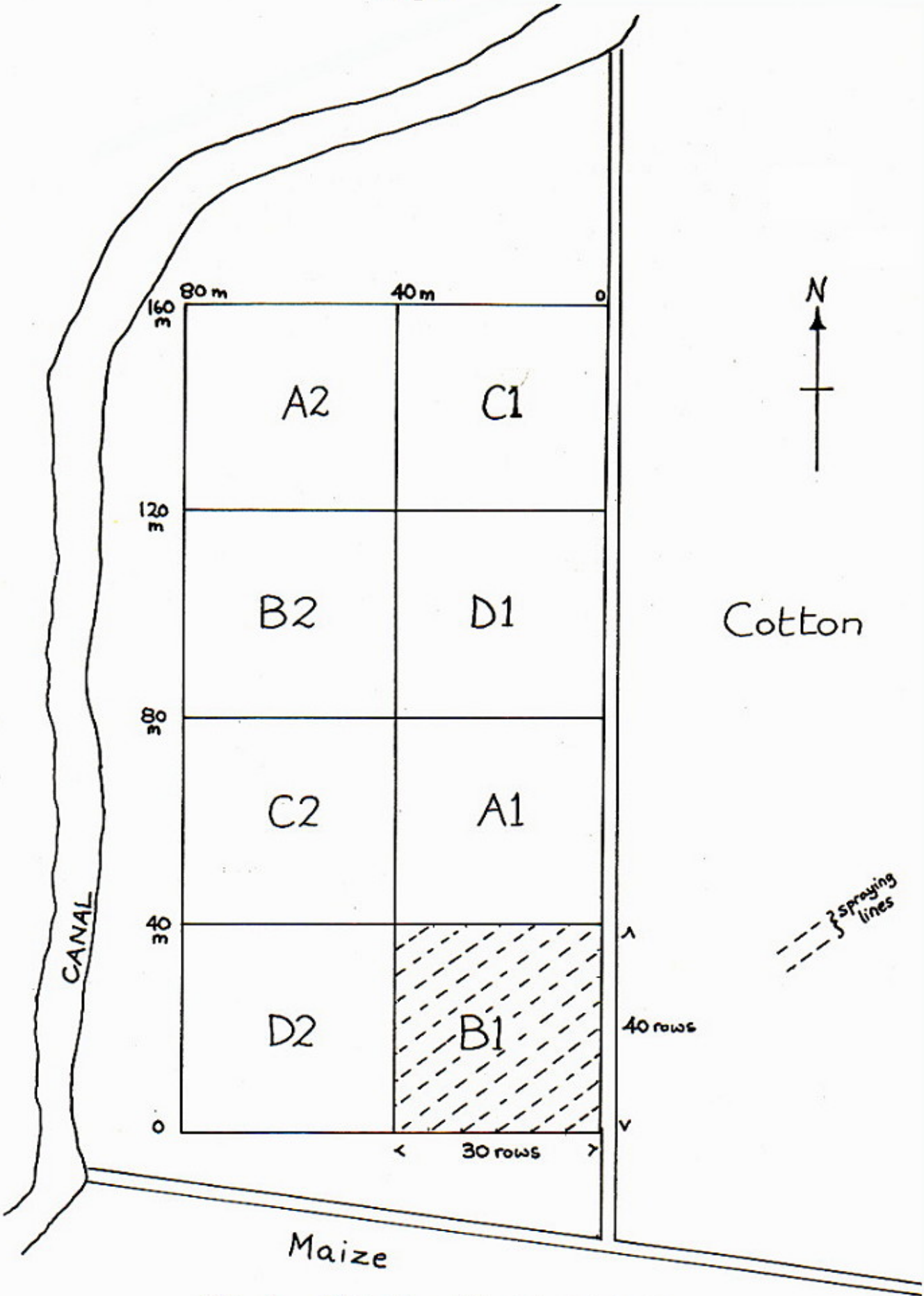


Fig. 3. Plan of small plot trial site at Eda. Santa Teresa

Note

Plot D^1 and $\frac{2}{3}$ of Plot D^2 sprayed with Pounce at 1.0 l/mz on 28th October but work had to be abandoned that day for technical reasons.

TRIAL S2

Dates of application: 10th November on Plots C and D, 11th November on Plots A and B.

Method of application: As in Trial S1.

Dosages

A MITAC at 1.5 l/mz plus Pounce 7.5% at 1.0 l/mz

B Pounce 7.5% at 1.0 l/mz

C MITAC at 2.0 l/mz plus Pounce 7.5% at 1.0 l/mz

D MITAC at 2.0 l/mz plus Pounce 7.5% at 0.75 l/mz

Conditions at time of spraying

Similar on both days but wind stronger (fresh to moderate) on 11th November Time of spraying 10th November 0903 to 1011 and 11th November 0820 to 0931. Temperature at end about 32°C on both days.

RESULTS AND DISCUSSION OF SMALL PLOT TRIALS

The small plot trials proved extremely difficult to set up and carry out but probably the major drawback was the non-uniformity of the cotton plantings even in the relatively small area of under two manzanas. Logistically the biggest problem was simply the short period of time, about two hours, between the crop being too wet because of heavy dew and the onset of the mid-morning winds, which then made spraying difficult and indeed hazardous.

The results obtained for Heliothis levels are shown in Fig.4. The best performances in the first series S1 were from the MITAC/Lannate treatment and the Pounce only treatment. Moreover, the Lannate only treatment produced pronounced phytotoxicity. A purely visual assessment of damage showed a marked good control of loopers, T. ni and P. ni, on the MITAC/Pounce and Pounce only plots, with moderate control on the MITAC/Lannate plot but little control and severe defoliation in the Lannate only plot.

The S2 series was limited unfortunately to a single assessment. Little can be said regarding the one count except to note that MITAC 2.0 l/Pounce 1.0 l mixture gave pronouncedly poorer Heliothis control.

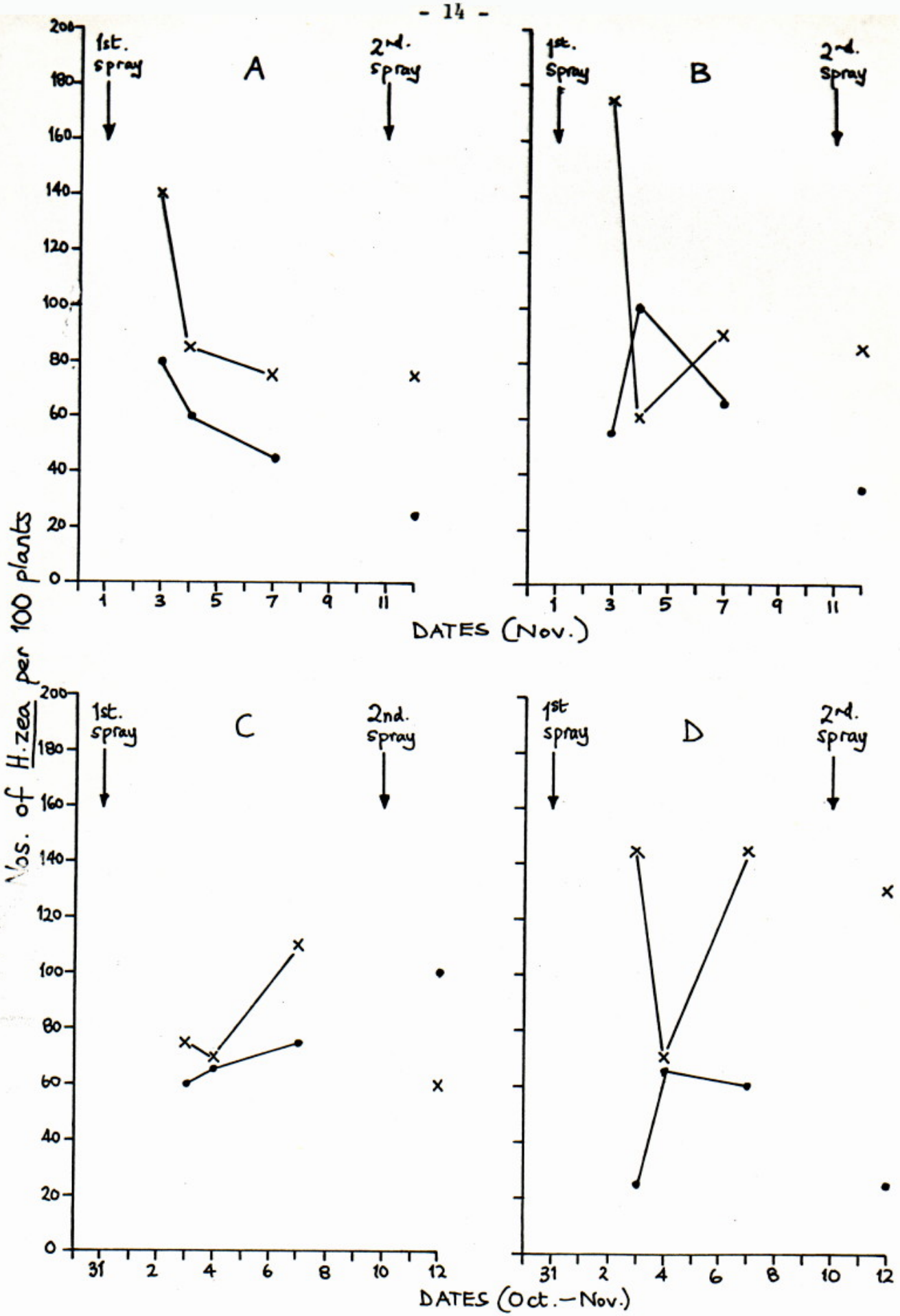


Fig. 4. Results of Trials S1 and S2 at Hda. Santa Teresa

LARGE SCALE TRIALS - SERIES B

Site Hacienda Santa Lucia Orcoyo, Carretera Littoral, La Libertad - Comalapa.
(Owners: Kriete (TACA airline company))

TRIAL B1 To compare insecticidal performance of three formulations of MITAC.

Trial Area. Lote Orcoyo, total area 71 mz. Divided for spraying into 8 strips of constant width 110 m, except strip 8, but varying length, Fig. 5. Status of cotton planting good to moderate in central area.

Date of applications: 9th, 15th and 20th November, 1977.

Method of application: By Ultra Low Volume aerial spraying.

Piper aircraft fitted with boom and nozzle system. Pressure standardised at 45 lb/m^2 discharge rate dependent on nozzle numbers and sizes. Nozzle size (orifice) 80015 used. Sixteen nozzles, 8 per wing, used for 2.0 l/mz and 28 nozzles for 3.5 l/mz. Flying speed approximately 110 m.p.h. Swath width 22m.
Pilot Sr. Gino Camilot.

Dosages

Strips 5 & 7	Bladan Ultra 900A at 2.0 l/mz
Strips 1 & 4	MITAC EC formulation 6554 at 1.5 l/mz plus Bladan Ultra 900A at 2.0 l/mz
Strips 2 & 6	MITAC ULV formulation 7953 at 1.5 l/mz plus Bladan Ultra 900A at 2.0 l/mz
Strips 3 & 8	MITAC ULV formulation 7946 at 1.5 l/mz plus Bladan Ultra 900A at 2.0 l/mz

Note

On 9th November MITAC 6554 was applied and not 7946.

Conditions at time of spraying

9th November	Temperature 32-33°C; RH about 40% Time of spraying operation 0900 to 1115. No wind.
15th November	Temperature 32-33°C; RH about 60% Time of spraying operation 0925 to 1028. Wind nil to light.
20th November	Temperature about 34°C; RH not measured Time of spraying operation 1015 to 1103. Wind light to moderate.

Note

i) Ovicidal activity of 15th November treatments assessed by marking eggs on 14th November and examining on 18th November, see results later.

ii) Droplet dispersion assessed by using oil sensitive paper on 20th November, see results later.

TRIAL B2 To assess efficacy of MITAC/Lannate mixtures (actually post-dates first application in Trial B3 below)

Trial Area. As in Trial B1.

Date of application: 25th November, 1977.

Method of application: As in Trial B1 except nozzles changed to permit conventional spraying of 10 gallons/mz for Lannate mixtures in water. Pump pressure for conventional spraying was 40 lb/in^2.

Dosages

Strips 5 & 7	Bladan Ultra 900A at 2.0 l/mz
Strips 1 & 4	Lannate 90% WP at 6.7 oz/mz plus Folidol 800 at 750 ml/mz in 10 gallons aqueous mixture/mz
Strips 2 & 6	Lannate 90% WP at 4 oz/mz plus MITAC bfn 7935 + emulsifier at 1.5 l/mz in 10 gallons aqueous mixture/mz
Strips 3 & 8	Lannate 90% WP at 4 oz/mz plus MITAC bfn 7935 + emulsifier at 1.0 l/mz in 10 gallons aqueous mixture/mz

Folidol 800 is Bayer 80% methyl parathion.

Conditions at time of spraying

Temperature estimated at 30-32°C.
Time of spraying operation 0837 to 0938. Wind light.

TRIAL B3 Whole field application of Lannate/MITAC mixture

Trial Area. Lote Vainilla, immediately to south and across river from Lote Orcoyo, see Fig. 5. Total area 80 mz. State of cotton planting mostly moderate with some poor areas subject to waterlogging.

Date of applications: 17th and 25th November, 1977

Method of application: As in Trial B2 for conventional spraying of 10 gallons aqueous mixtures per manzana.

Dosage

Lannate 90% WP at 4 oz/mz plus MITAC at 1.5 l/mz applied in aqueous mixture at 10 galls/mz (on 17th November MITAC EC formulation 6554 was used and on 25th November 66.5 mz were treated with MITAC bfn 7946 + emulsifier and the remaining 13.5 mz with MITAC bfn 7935 + emulsifier).

Conditions at time of spraying

17th November	Temperature about 32°C; Time of spraying operation 0900 to 0945. Wind nil.
25th November	Temperature about 32°C; Time of spraying operation 0945 to 1030. Wind light.

Fig. 5. Plan of Lote Orcoyo, Hacienda Sta. Lucia, showing trial strips

TRIAL B1 - Assessment of ovicidal effect

On 14th November a search was made to locate freshly deposited (white) eggs of H. zea on plants in Lote Orcoyo. A number of plants were examined in each of the trial strips and two plants chosen in each strip so as to give a total of 10 to 12 eggs in each strip. All the plants were readily accessible from the marker line (Fig. 5). White plastic tape was used to mark the plants as close to the respective eggs as possible.

Spraying took place on 15th November and assessment of hatch or otherwise of the labelled eggs was attempted on 18th November. The results are presented and discussed later.

TRIAL B1 - Assessment of droplet size and dispersion

Prior to the spraying of Lote Orcoyo on 20th November stakes with short lengths of oil sensitive marker paper affixed were positioned in each of the trial strips. Stakes of just under 2 m length were used and the marker papers were positioned as follows: One paper horizontally on the top of the stake; four papers, one facing towards each of the cardinal points of the compass, at 165 cm above ground; and four papers, again facing the compass points, at 90 cm above ground.

Flight direction and wind direction and strength were observed. Assessment of the droplet size and dispersion on the indicator papers was undertaken by the Formulations Department and the results are given later.

RESULTS AND DISCUSSION OF TRIALS SERIES B

Fig. 6 shows the results of the assessments of the levels of Heliothis white eggs and small larvae, $L_1 + L_2$ instars, on Lote Orcoyo between 6th and 30th November, which followed treatment of the whole field on 5th November with Azonate at 2.0 l/mz (product containing 450 g/l Azodrin (monocrotophos) and 190 g/l Lannate) were similar in all the experimental strips.

The first application of the Trial B1 treatments led to satisfactory control of H. zea for 5 days but there was no difference in performance between the Bladan only strips and the Bladan plus MITAC strips. The second application gave more significant results in that there appeared to be a markedly better degree and duration of control in the strips treated with Bladan plus the experimental ULV formulations, 7953 and 7946, of MITAC than in the Bladan only and Bladan plus commercial MITAC, 6554, treated strips.

This result combined with the assessment of the ovicidal effect of the treatments, Table 4, strongly suggested a poorer performance of MITAC 6554 than of the ULV formulations. However, the third application led to a similar level of control by the three MITAC treatments and all three gave one to two days longer control than the Bladan only treatment.

The comprehensive assessment system used at the Hacienda Sta. Lucia, unlike that at Sta. Teresa, includes information on the levels of other species of pest viz. red spider mite, whitefly, loopers, armyworm and boll weevils, and an indication of damage attributable to weevils and Heliothis. Table 5 summarises the damage incidence, as a percentage of the total, caused by Heliothis on flower buds and young bolls. The effect of the use of MITAC in

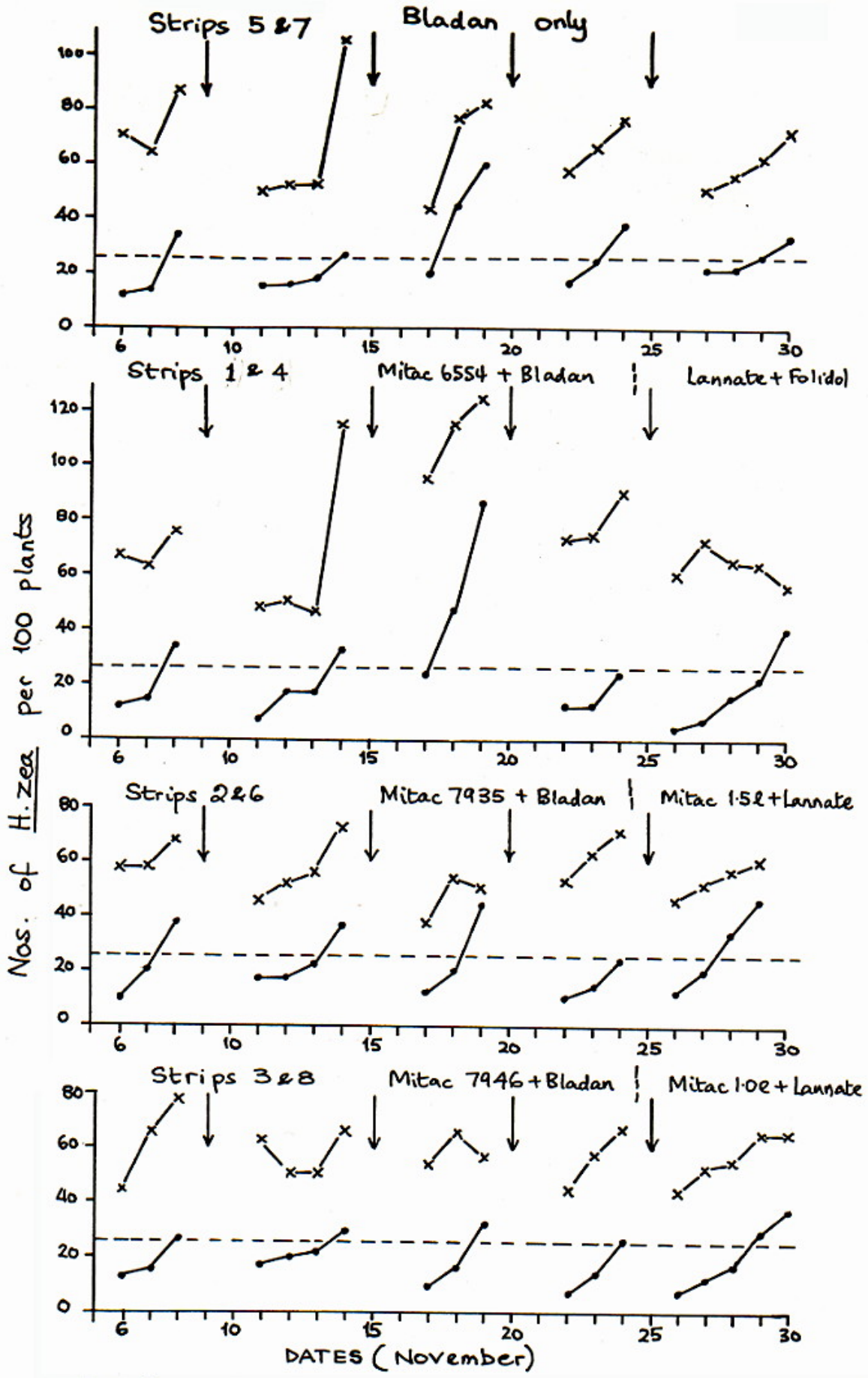


Fig. 6. Results of Trials B1 and B2 on Lote Orcoyo, Hda. Santa Lucia

For treatment rates see p.15 and 17.

TABLE 4

Results of assessment of ovicidal activity (see p.18)

Treatments	No. of eggs labelled	No. of dead eggs	No. of live or hatched eggs	No. of eggs not found	% Hatch of total found
Strip 5	13	5	5	3	50
Strip 7	9	5	3	1	37.5
Bladan only	22	10	8	4	44.4
Strip 1	8	6	-	2	0
Strip 4	12	9	3	-	25
MITAC 6554	20	15	3	2	16.7
Strip 2	12	11	-	1	0
Strip 6	11	8	2	1	20
MITAC 7935	23	19	2	2	9.5
Strip 3	11	9	1	1	10
Strip 8	10	7	1	2	12.5
MITAC 7946	21	16	2	3	11.1

TABLE 5

H. zea damage incidence in Trial Series B1 and B2 on Lote Orcoyo

Date	Strips: Bladan 5 & 7	6554 1 & 4	7935 2 & 6	7946 3 & 8
11th November	28	16	22	26
12th November	28	24	18	26
13th November	26	22	24	26
14th November	36	34	38	34
Ave. (1st treatment B1)	29.5	24	25.5	28
17th November	18	30	20	20
18th November	36	30	26	24
19th November	52	72	32	36
Ave. (2nd treatment B1)	35.3	44.5	26	26.7
22nd November	46	32	28	20
23rd November	46	30	26	24
24th November	52	32	28	34
Ave. (3rd treatment B1)	48	31.5	27	26
26th November	-	22	16	22
27th November	30	22	18	28
28th November	32	24	20	30
29th November	34	32	34	36
30th November	44	42	48	44
Ave. (treatment B2)	33	28.5	27	32

For treatment details see p.15 and 17.

combination with Bladan was in all instances, except the second MITAC 6554 treatment, to give a better performance, in terms of less damage, than the Bladan only treatment.

The results of the counts of looper 1st and 2nd instar larvae following treatment in Trials B1 and B2 are shown in Fig. 7. The effect of the treatments in Trial B1 showed little variation in the degree of control. Possibly the best control was by Bladan plus MITAC 7946 but this was only a marginal improvement that may have been due to crop variation.

Following the encouraging results in Trial S1 (Fig.4, p.14) the use of a Lannate/MITAC treatment was observed on a large field, Lote Vainilla. Fig. 8 shows the levels of Heliothis white eggs and small larvae on Lote Vainilla and for comparison gives the results of treatment with other products on the adjacent Lote Morro. The effect of the first Lannate/MITAC treatment was to give a good degree of control for some seven days after spraying. On Lote Morro treatment with Bladan 900A at 2 l/mz plus Fundal (chlordimeform) 50% at 500 ml/mz did not give satisfactory control and a succeeding treatment with Belmark 30% (Shell fenvalerate pyrethroid) at 400 ml/mz plus Folidol 800 at 750 ml/mz gave only two days control.

The second Lannate/MITAC treatment again gave good control for five days while on Lote Morro Bladan 900A at 2 l/mz gave only 3 days control. Of importance was the fact that the Lannate/MITAC treatment gave very little in the way of phytotoxicity even after the second application.

Lote Orcoyo was used for a series of comparative treatments of Bladan only, commercially recommended Lannate/Folidol application (by Du Pont) and experimental Lannate/MITAC mixtures. The results of these treatments are shown in Fig. 6. There is little difference between the effects of the four treatments although, perhaps significantly, the Lannate at 4 oz/mz plus MITAC at 1.0 l/mz appeared to perform better than the Lannate at 4 oz/mz plus MITAC at 1.5 l/mz. More important was the indication of phytotoxicity in the Lannate at 6.7 oz/mz plus Folidol 800 at 750 ml/mz treatment which would almost certainly have precluded an immediate repeat application of that treatment. The Lannate/MITAC mixtures showed no significant phytotoxicity.

Comparison of the Heliothis hatch on the Lotes Morro and Vainilla, Table 6, confirm the good ovicidal and/or early instar larvicidal effect of the Lannate/MITAC mixture.

Against looper populations, T. ni and P. ni, the Lannate/MITAC mixtures generally performed better than the alternative treatments, Fig. 7. Interestingly the Lannate at 4 oz/mz plus MITAC at 1.0 l/mz gave the better performance of the two MITAC mixtures. Results of the counts of looper populations on Lote Vainilla are given in Table 7. In addition to an immediate reduction in the population of small larvae there is a gradual decrease in the population of large larvae which is perhaps more marked than otherwise would be expected.

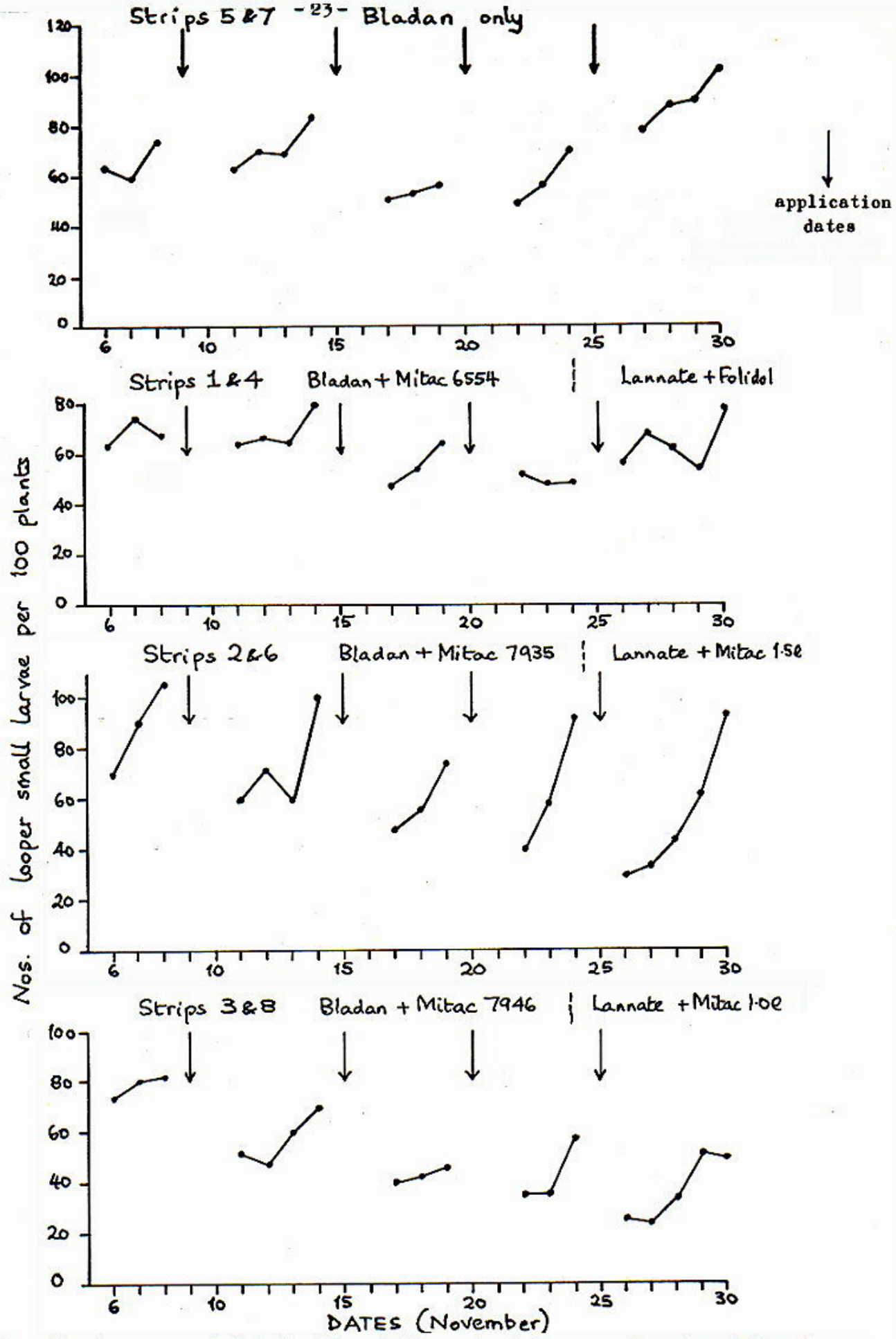


Fig. 7. Results of Trials B1 and B2 against loopers, T. ni and P. ni

For treatment rate see p.15 and 17.

Fig. 8. Results of insecticide applications
Lotes Morro and Vainilla

x——x white eggs

.——. $L_1 + L_2$ larvae

------ 25% level

Applications (⟶) as follows:-

Lote Morro

1. Bladan 900A at 2033 ml/mz + Fundal 50% at 500 ml/mz
2. Belmark 30% at 400 ml/mz + Folidol 800 at 756 ml/mz
3. Bladan 900A at 2.0 l/mz
4. Bladan 900A at 2.0 l/mz

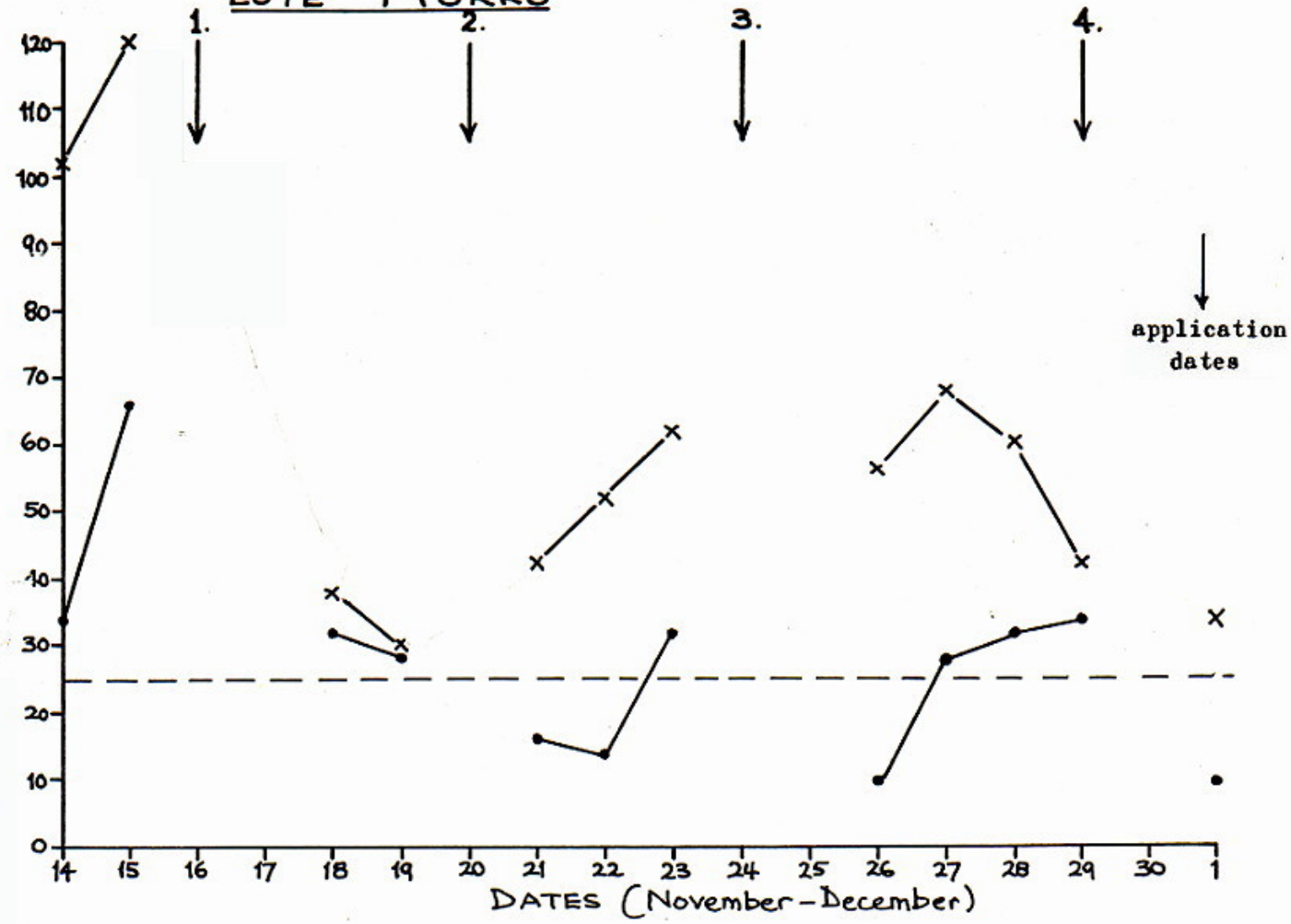
Lote Vainilla

1. MITAC at 1500 ml/mz + Lannate 90% WP at 4 oz/mz

1a. Folidol 800 at 758 ml/mz

2. MITAC at 1500 ml/mz + Lannate 90% WP at 4 oz/mz

LOTE MORRO



LOTE VAINILLA

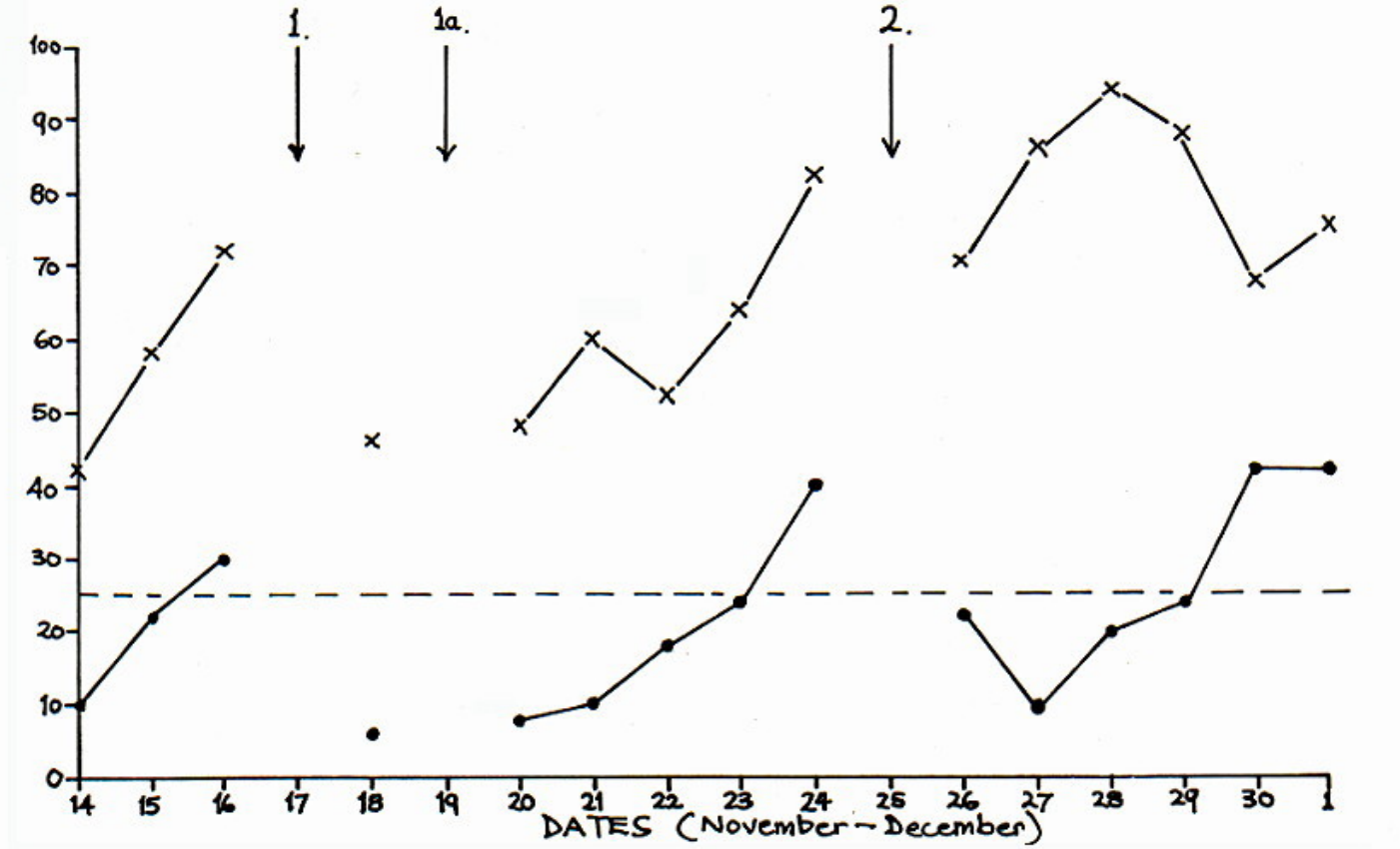


TABLE 6

Comparison of Heliothis hatch in Lotes Morro and Vainilla

Morro

Treatment + days	Date	% hatch
1 + 2	18th November	25
2 + 1	21st November	36.8
2 + 2	22nd November	100
3 + 2	26th November	20.4
3 + 3	27th November	45.2

Treatment 1 = Bladan plus Fundal

Treatment 2 = Belmark plus Folidol

Treatment 3 = Bladan

Vainilla

Treatment + days	Date	% hatch
1 + 1	18th November	14.3
1 + 3	20th November	11.1
1 + 4	21st November	39.1
1 + 7	24th November	83.3
2 + 1	26th November	42.3
2 + 2	27th November	15.6
2 + 3	28th November	24.4
2 + 5	30th November	60.0

Treatments = Lannate plus MITAC

% hatch calculated from the numbers of small live larvae, L_1 + L_2 instars, found four days after the respective white egg count.

TABLE 7

Counts of looper populations on Lote Vainilla

Date (Nov.)	10	11	12	13	14	15	16	17	18	19	20
Eggs	*	202	+	-	492	504	594	B3	460	-	494
Small larvae	*	102	+	-	310	296	344	B3	68	-	70
Large larvae	*	88	+	-	298	316	332	B3	308	-	290

Date (Nov.)	21	22	23	24	25	26	27	28	29	30
Eggs	466	452	384	410	B3	388	300	328	332	228
Small larvae	66	82	104	122	B3	80	72	86	92	118
Large larvae	266	260	192	188	B3	122	112	108	112	90

* Treatment with Folidol 800 at 756 ml/mz plus Fundal 50% at 500 ml/mz

\+ Treatment with Bladan Ultra 900M at 2 l/mz

B3 Treatment with Lannate 90% WP at 4 oz/mz plus MITAC at 1.5 l/mz

19th November Treatment with Folidol 800 at 758 ml/mz (against weevils)

SUMMARY OF TRIALS FINDINGS

Prior to the commencement of the trials, information was received that the use of MITAC/Bladan mixtures to control Heliothis populations in El Salvador was not giving satisfactory results. The first commercial applications were with MITAC 20 EC (formulation 6554) at 1.5 l/mz plus Bladan 900A at 2.0 l/mz. Dosages of MITAC at 1.75 l/mz were regarded as reasonably successful although in cases of high oviposition 2.0 l/mz of MITAC were being considered necessary.

The series of trials (Trials A1, A2 and A3) at Hacienda Sta. Teresa were rather inconclusive and indicated little more than that when Bladan 900A gave effective control, Bladan/MITAC mixtures did likewise and vice-versa. The long period of control in Trial A1 probably owes itself more to the high daytime temperatures and consequent egg and young larval mortality (see Fye and Surber, 1971) than to the effect of the insecticides.

When, (after three weeks in Customs hands) the experimental ULV formulations of MITAC became available, Trials series B was initiated. The results of Series B1 indicate that, whereas it may not be as effective as hoped, MITAC 6554 did exercise some extra insecticidal effect when applied with Bladan 900A and that was at 1.5 l/mz of MITAC. However, the non-effectiveness of Bladan 900A following the 15th November application was paralleled by a non-functioning of the Bladan/MITAC 6554 mixture. At the same time, the Bladan mixtures with MITAC 7935 and 7946 were effective. It seems very likely that there is some incompatibility between Bladan 900A and MITAC 6554 which leads to a failure of performance.

The success of the Lannate/MITAC mixtures in the small scale trials, Series S1 and in the Lote Vainilla trial, B3, all of which were performed with the 6554 formulation serve to underline this suggestion of incompatibility of 6554 and Bladan 900A (as formulated for the El Salvador market).

Samples of the MITAC 6554 formulated in El Salvador were collected from the Bayer Company warehouse and from farm storehouses and despatched to Boots Agricultural Formulations for analysis. The full results of the analysis will be published in due course, but it is clear from initial data that much of the material was not within specifications in terms of water content.

OBSERVATIONS ON POPULATION CYCLES OF H. ZEA AND ON THE EFFICACY OF INSECTICIDE APPLICATIONS

During the first two weeks in El Salvador several familiarisation visits were made to haciendas in the La Paz, Usulutan and San Miguel areas. As the first reports were being received of MITAC failing to give satisfactory results, attention was given to the results of use of other insecticides. Results seen on 4th and 5th October showed that several compounds, including Curacron (Ciba-Geigy profenfos), Pounce (Bayer FMC pyrethroid) and Niran (Monsanto 3 methyl-1.5 ethyl parathion) were giving good control of H. zea but one week later, 11th October, the same compounds were not performing nearly so well.

These apparent week to week inconsistencies in insecticide performance were highlighted by the results of the first trials, A1 and A2, at Santa Teresa in which the first application gave apparently excellent control of H. zea for over seven days but the second application was unsuccessful.

The good quality of the recording of insect levels at Santa Lucia and the sister farm of the TACA company, Valle San Juan in the Usulutan region of eastern Salvador, enabled graphical analyses of the H. zea levels throughout September, October and November to be made for three fields on each farm.

From these analyses the following biological points are believed to be of significance:

(1) There are clear macrocycles in population level with three or four maxima of oviposition in the three month period. These maxima appear to be at 16-20 day intervals and are not influenced by the phases of the moon in the manner reported by Nemec (1971) from observations in the United States.

(2) Underlying the macrocycle is a short cycle of oviposition with peaks every fourth day. The author knows of no previous reports of such curious cyclic behaviour but notes that the data of Nemec (1971) shows short-term fluctuations in oviposition which Nemec simply attributed to environmental factors.

(3) Paralleling the four day oviposition cycle is a cycle of $L_1 + L_2$ larval levels indicating both a four day incubation period and a four day first instar period.

Efficacy of insecticides

The apparent effect of an insecticide application, in almost all instances, was to give satisfactory control, from the point of view of the farmer, when applied during a downward trend of the oviposition macrocycle and to give unsatisfactory control when applied during an upward trend. This is considered by the author to be due primarily to the method of assessing control solely on the criterion of maintaining an H. zea population level of less than 25 $L_1 + L_2$ larvae per 100 plants (or thereabouts). For example:

(1) Belmark 30% applied at 400 ml/mz on 19th October reduced a white egg level of 42 (on 18th October) to an $L_1 + L_2$ level of 22 (on 22nd October); an acceptable larval level and therefore a "successful" application despite a mortality of only 47.6%.

but Belmark 30% applied at 400 ml/mz on 7th November reduced a white egg level of 290 (on 6th November) to an $L_1 + L_2$ level of 80 (on 10th November); an unacceptable larval level and therefore an "unsuccessful" application despite a mortality of 72.4%.

(2) MITAC applied at 1.5 l/mz plus Bladan 900A at 2.0 l/mz on 10th October reduced a white egg level of 84 (on 9th October) to an $L_1 + L_2$ level of 10 (on 13th October); an acceptable larval level and therefore a "successful" application with a mortality of 88.1%.

but MITAC applied at 1.78 l/mz plus Bladan 900A at 2.08 l/mz on 6th November reduced an egg level of 304 (on 5th November) to an $L_1 + L_2$ level of 58 (on 9th November); an unacceptable level of larvae and therefore an unsuccessful application despite a mortality of 80.9%.

In both "successful" instances quoted above the insecticide treatment was applied in a period when the population macrocycle was in a downward phase and the "unsuccessful" instances were when the application was made during an upward phase of the population macrocycle.

In interpreting the results, allowance was made for the four day incubation period from white egg to L_1 larvae.

To return to the results of the trials; Trial A1 was applied at a low point in the macrocycle and this coupled with the high temperatures led to the successful result but when Trial A2 was applied the oviposition macrocycle had entered an upward phase and the treatment was unsuccessful. Unfortunately, as the Santa Teresa insect records were of a low standard, this interpretation is based on the Santa Lucia population levels and may not be wholly valid.

The Trial series B can be interpreted with rather more confidence and it seems likely that the B1 application on 9th November was at a low point in the oviposition macrocycle and thus all four treatments were successful. The second application on 15th November was at a time when the macrocycle was in a vigorous upward phase and thus the MITAC ULV formulations were effective when Bladan alone and MITAC 6554 plus Bladan were ineffective. On 20th November the macrocycle had shifted downwards and again all four treatments were successful.

The B2 application on 25th November was at a low point in the macrocycle although the trend was upwards and all four treatments were successful.

The first application on Lote Vainilla of Lannate/MITAC on 17th November, Trial B3, was at a time when the macrocycle was in a relatively low phase, although this minimum was not as low as at earlier minima, and this may have enhanced the success of the treatment. The second application, however, was during an upward phase of the macrocycle and the good result is most encouraging under these conditions.

Comparison of the H. zea populations in El Salvador and Guatemala

A brief visit to cotton farms in Guatemala enabled the author to obtain H. zea population data and the results of a farmer-conducted trials series from a hacienda in the Tiquisate area. In this area MITAC bfn 6554 has been found effective at 1.0 l/mz when sprayed in combination with methyl-ethyl parathion 4 - 2 at 2.5 l/mz.

The most marked observation from the Guatemalan trials results is the similarity between the $L_1 + L_2$ levels, no matter what treatment was used. The levels of oviposition were much higher but there was not a higher level of $L_1 + L_2$ survival than in Salvador. This indicates that the population of H. zea in Guatemala is rather less vigorous than that in Salvador and therefore, perhaps, less able to survive insecticide treatment. The higher level of oviposition is a sign of a less vigorous population.

In the author's opinion the occurrence of populations (races ?) that vary in their response to insecticide pressure but that are not readily distinguishable by conventional taxonomic methods is more common than is realised by most authorities on pest control.

CONCLUSIONS

1) MITAC bfn 6554

The reports of unsatisfactory results (see p.28) which followed the launch of MITAC have been examined in conjunction with the author's results and subsequent commercial applications but the conclusions on this will be reported under separate cover. It suffices to note here that, in the ovicidal test and in the first MITAC/Lannate trial, bfn 6554 gave satisfactory control.

2) MITAC ULV formulations

Two formulations, bfn 7935 and bfn 7946, were tested (Trial B1) and the indications are that both these performed better than bfn 6554 when applied by Ultra Low Volume spraying. There was no evidence of phytotoxicity even after three successive applications. Significantly, they gave good Heliothis control at a time when Bladan 900A alone and Bladan 900A plus MITAC 6554 did not perform well.

Both formulations also gave good results when emulsifier was added and they were used in a 10 gal/mz aqueous suspension with Lannate.

3) MITAC/Lannate mixed application

Undoubtedly, the good performance obtained in Trials B2 and B3 from MITAC/Lannate mixtures offers promise of a commercially viable and attractive treatment. The salutary experience with the MITAC/Bladan mixtures underlines the need for a cautious approach. If a premature launch of MITAC/Lannate should be made with even slightly unsatisfactory results then MITAC as a marketable product in El Salvador will probably be finished.

The Key questions that will need to be considered are as follows:-

i) Will MITAC/Lannate function under conditions of insect population pressure?

ii) Will repeated applications under actively growing crop conditions show marked phytotoxicity?

iii) What should be the optimum dosage recommendation? Will this need to be varied at different times of the season?

4) Technical points

During the course of the trials a number of technical points were raised.

a) The application of ULV treatments is clearly affected by the viscosity, and therefore the flow rate, of the insecticide mixtures. Manufacturers' data sheets on ULV equipment usually quote flow rates for water at 20°C (68°F) (for example) and although it is accepted that field calibration is desirable, the difficulties with such extremely toxic mixtures as parathion are obvious. It was not possible to find any data on viscosity

of insecticide or other agrochemical products at different temperatures and perhaps Boots could take a lead on this.

b) Meteorological conditions changed rapidly during the course of normal aerial spraying operations e.g. dawn temperatures are around 25°C or less but by mid-morning temperatures are 32-33°C rising to a daily maximum around 39°C; at dawn, 0630, and until about 0830 the plants are usually wet with dew, conditions which mitigate against pure ULV formulations; and, by mid-morning a wind has sprung up causing some considerable spraydrift but spraying goes on unabated at peak pest times. These varying conditions are of clear importance in developing suitable formulations but probably a compromise formulation will have to be the best answer.

c) How do different products and mixtures affect spray penetration into the dense cotton crops of Central America? Attempts were made to obtain data on this question but the results were insufficient to form an opinion.

d) The storage of products on haciendas gives some cause for concern. At worst, drums of chemical are left in the open air probably reaching temperatures in excess of 50°C on occasion and, at best, the drums are kept in corrugated iron sheds where again temperature conditions can be excessive. As with the formulation problem it seems likely that little can be done other than to urge collaborators to encourage farmers to improve their stores especially in terms of improving ventilation.

e) A farmer in Guatemala commented that stability of products in aqueous suspension is occasionally essential as aircraft mechanical failures may necessitate removal of spray tank contents and these expensive contents will be stored until the aircraft becomes available again.

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APPENDIX

Dosage rates used in trials.

	l/mz	l/ha	g ai/ha
MITAC 20	1.25	1.79	358
"	1.5	2.15	430
"	1.625	2.32	464
"	2.0	2.86	572
"	3.8	5.44	1088
Bladan 900A (ethyl/methyl parathion)	2.0	2.86	1716 ethyl/858 methyl
	2.5	3.58	2148 ethyl/1074 methyl
Pounce 7.5%	0.75	1.07	80.25
"	1.0	1.43	107.25
Folidol 800 (methyl parathion)	0.75	1.07	856
Belmark 30%	0.4	0.57	171
Fundal 50%	0.5	0.71	355

	oz/mz	oz/ha	g/ha	g ai/ha
Lannate 90% WP	4.0	5.72	162	146
"	6.7	9.59	190	171
"	8.0	11.44	325	292


Esquipulas
Cerro Las Minas 2849 m
Grande de Otoro River
Ulúa River
Monjas
Santa Catarina Mita
Nueva Ocotepeque
PARQUE NACIONAL CELAQUE
HONDURAS
Ayarza
Asunción Mita
Cerro El Pital 2730 m
C O R D I L L E R A
MONTECILLOS
Villa de Antonio
San José Acatempa
Jutiapa
Metapán
Yamaranguila
La Esperanza
La Paz
San Cristóbal Frontera
Santiago de la Frontera
Erandique
D E
MOUNTAINS
Atescatempa
Texistepeque
Valladolid
Tablazón
Candelaria de La Frontera
Concepción Quezaltepeque
Chalatenango
T I L A R A N
Concepción del Sur
Chalchuapa
Santa Ana
Aguilares
Ahuachapán
Turín
Ciudad Arce
San Juan Opico
Suchitoto
Sensuntepeque
El Rincón
Izalco Volcano
Espinal
Quezaltepeque
Nuevo Edén de San Juan
Corinto
Apaneca
Juayúa
San Salvador Volcano
Apopa
EL SALVADOR
Nahuizalco
Izalco
Botoncillal
Ciudad Barrios
Sonsonate
San Salvador
Cojutepeque
Chapeltique
Jocoro
Santa Rosa de Lima
Metalío
Litoral Highway
San Vicente
Nueva Guadalupe
Acajutla
Oloculita
Hacienda San Antonio
Santiago Nonualco
Zacatecoluca
Chinameca
San Miguel
Nacaome
La Libertad
Las Isletas
Tierra Blanca
El Pacayal Peak
San Jorge
San Miguel Volcano
La Unión
Jiquilisco
Usulután
Lempa River
Conchagüita
Chirilagua
Gulf of Fonseca
0 km
20
40
60
80
100