QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 581

THRIPS TABACI LIND. AS A SEEDLING PROBLEM IN QUEENSLAND COTTON

By T. PASSLOW, M.Sc.Agr.

SUMMARY

Investigations on the pest status and population movements of *Thrips tabaci* in seedling cotton in southern Queensland showed that rapid and extreme fluctuations occurred in samples taken regularly during the growth of a number of sequential plantings. These variations were similar to prior trends in numbers of adult thrips as shown by sticky traps. Populations of thrips in cotton seedlings therefore were more related to external breeding than to actual population build-up in the crop.

The thrips populations present on cotton seedlings caused significant damage to plant structure and delayed boll maturity only in early plantings. Growth of these plants, however, was slow from climatic causes and this coincided with the peak in thrips numbers moving from external sources. Later plantings produced more rapid early growth, were subjected to lower population levels of thrips and suffered virtually no plant injury or delay in boll maturity.

Twenty-two insecticides, mainly as foliar sprays, but also as soil and seed dressings, were tested for effects on thrips populations. Dieldrin at 0·025% active constituent at rates as low as 25 gal/ac as a foliar spray gave the most effective reduction of thrips numbers. Other insecticides as sprays giving noticeable population reductions were isobenzan 0·1%, endosulfan 0·1%, phosphamidon 0·04% and azinphos-methyl 0·05%. Soil applications of phorate and disulfoton at planting time gave good control of nymphal thrips but had little influence on adult populations. Applications of dimethoate wettable powder to the seed immediately prior to planting severely limited germination. Post-germination side dressings with these three insecticides were ineffective as thrips controls.

Significant increases in yield of seed cotton were not obtained following the use of any of the insecticides. This confirms what appears to be a consistent pattern, and economic returns for thrips control in cotton seedlings, despite good kills with insecticides such as dieldrin, are unlikely in all except crops planted particularly early.

I. INTRODUCTION

Thrips (*Thrips tabaci* Lind.) is regularly encountered in association with the seedling stage of cotton crops in Queensland. While cotton was produced entirely in central and northern districts, this insect was not considered to be a pest of economic significance (Passlow 1958). With the introduction of cotton-growing into southern Queensland under irrigated conditions, the occurrence of thrips on the seedlings of these crops tended to cause widespread concern.

Populations of thrips in southern Queensland crops have been high and resulting plant injury has been obvious in a large percentage of crops. As the growing season for cotton in these areas is considerably shorter than in the more northern parts of the State, and because thrips populations are usually higher, it appeared that the pest was of appreciable economic importance. It was therefore necessary to determine the effect of the feeding of these high populations in terms of plant stunting, poor plant structure, delay in boll maturity and possible yield reduction. Furthermore, although commercial applications of insecticides for thrips control on young cotton plants had provided satisfactory pest kills, the economic significance of such population reductions remained doubtful.

These studies included investigations of seasonal population changes in relation to a number of staggered plantings, the influence of field movement of adult thrips as shown on traps, the effects of systemic insecticides applied to the soil, pest kills in insecticide trials and yields from insecticidal thrips control programmes.

II. MATERIALS AND METHODS

The materials used in the insecticidal trials are shown in Table 1.

TABLE 1

Materials Used in the Insecticidal Trials

Treatment	Formulation	Active Constituent (%)	Spray Strength (%)	Trial No.
Azinphos-ethyl ..	emulsifiable concentrate	40·0 w/v	0·05	2
Azinphos-methyl ..	wettable powder	25·0 w/w	0·05	2
Carbaryl	wettable powder	80·0 w/w	0·1	2
Carbophenothion ..	wettable powder	30·0 w/w	0·05	2
DDT	emulsifiable concentrate	25·0 w/v	0·1	1, 2, 4, 5, 6, 7, 8
Demeton-s-methyl ..	emulsifiable concentrate	25·0 w/v	0·025	1
Dieldrin	emulsifiable concentrate	15·0 w/v	0·025	5, 6, 7
			0·05	5, 6, 7
			0·1	1, 2, 3, 4, 5, 6, 7
Dimethoate	(a) emulsifiable concentrate	30·0 w/v	0·025	1, 4
	(b) wettable powder	20·0 w/w	1 lb/ac	3
Disulfoton	granular preparation	10·0 w/w	0·5 lb/ac	3
			1·0 lb/ac	3
			2·0 lb/ac	3
Endosulfan	emulsifiable concentrate	35·0 w/v	0·1	2
Endrin	(a) emulsifiable concentrate	25·0 w/v	0·05	1
	(b) emulsifiable concentrate	20·0 w/v	0·05	4, 8
Fenitrothion	emulsifiable concentrate	50·0 w/v	0·05	2
Fenthion	emulsifiable concentrate	55·0 w/v	0·025	1
Isobenzan	emulsifiable concentrate	15·0 w/v	0·1	1
Lindane	miscible oil preparation	16·0 w/v	0·03	1
Maldison	emulsifiable concentrate	50·0 w/v	0·05	2
Mesurol	wettable powder	50·0 w/v	0·1	1
Parathion	emulsifiable concentrate	50·0 w/v	0·015	2
Phenthoate	emulsifiable concentrate	50·0 w/v	0·1	2
Phorate	(a) granular preparation	10·0 w/w	2·0 lb/ac	3
	(b) liquid concentrate	100·0 w/v	2·0 lb/ac	3
Phosphamidon ..	emulsifiable concentrate	50·0 w/v	0·04	2
Trichlorphon	emulsifiable concentrate	62·5 w/v	0·1	2

General methods.—Throughout the investigations, except in the 1962-63 insecticide trial (Trial 1), thrips populations were assessed according to a standard technique. Each sample comprised a uniform number of seedlings on each sampling date. These were lifted gently from the soil, the foliar parts placed in 1·0% formalin solution in a container and the roots then removed and discarded. Thrips numbers from each sample were later assessed in the laboratory in the following manner. Each container was well shaken and the liquid filtered through a Buchner funnel using a 9 cm black Whatman No. 29 filter paper. After this filtration the sample was washed with water, the container shaken and the liquid filtered. Five washings and filtrations were made to ensure that virtually all thrips were collected on the filter paper. By using a standard pouring method during filtration, reasonably uniform dispersal of the thrips was obtained on the paper, which prior to use had been marked with white ink into eight equal radial sectors. The sectors were examined with a binocular stereo-microscope and thrips numbers recorded or calculated according to their density as follows:

Sector Density	No. of Sectors Counted	Total Thrips
Fewer than 10 thrips ..	all sectors	recorded
10 to 19 thrips	6 sectors	calculated
20 to 49 thrips	4 sectors	calculated
50 to 99 thrips	3 sectors	calculated
100 or more thrips	2 sectors	calculated

In Trials 2, 3 and 4, however, populations were very high at pretreatment and only one sector was then counted.

Trial 1—*Screening test,* 1962-63.—An 11 x 3 randomized block layout was used with unit plot of 4 rows, each 66 ft. long, spaced 40 in. apart, the two inner rows comprising the datum plot. The variety was Empire, and the seedlings were 6 weeks old at the time of treatment on November 19, 1962. Applications were made by knapsack sprayer at the rate of 33 gal/ac. Insecticides used and spray strengths are given in Table 2.

Samples for thrips populations were taken prior to treatment and again 1, 7 and 14 days after the treatment. One sample per plot was taken on each occasion and comprised 10 leaves picked from the seedlings at random in both rows. Each leaf was uniformly the third from the terminal. The samples in this trial were held in 50% alcohol; otherwise the technique of collection and filtration was uniform with the other trials. Numbers were recorded without differentiation of the adult and nymphal stages.

Trial 2—*Screening test,* 1963-64.—A 16 x 3 randomized block layout was used with unit plot of 3 rows each 20 ft. long, and spaced 40 in. apart. A single untreated guard row separated plots. The trial area was planted on October 4, 1963, with the variety Dixie King. Treatments were applied on October 28, by knapsack sprayer giving thorough coverage to "runoff", with 110 gal/ac. Insecticides used and spray strengths are given in Table 3.

Two samples of seedlings per plot were taken for assessment of thrips numbers at pretreatment and at 2, 8 and 16 days post-treatment. Fifteen seedlings comprised each sample at pretreatment and 10 seedlings at each post-treatment assessment.

Trial 3—*Systemic insecticides trial,* 1963-64.—A 13 x 3 randomized block layout was used with unit plots of 4 rows each 66 ft. long and spaced 40 in. apart. The trial area was planted on October 4, 1963, with the variety Dixie King. Granular insecticide treatments made at planting time were applied through the fertilizer boxes of a 4-row planter, after thorough mixing of the insecticide with coarse sand and with the boxes adjusted to apply 200 lb of sand mixture per acre. The seed-dressing treatment was applied by mixing the commercial wettable powder directly with seed immediately prior to planting. Side-dressings of granular insecticides were applied to the soil surface suitably diluted in coarse sand. Side-dressings of liquid and wettable powder preparations were applied as jets from a knapsack spray. All side-dressings were made on October 21 and placed 1-4 in. laterally from the rows of plants.

The standard dieldrin spray treatment was applied on October 29 by knapsack to give thorough coverage to "runoff". Details of insecticide treatments and rates of application are given in Table 4.

To determine germination suppression or phytotoxic effects of seed treatments and granular insecticides applied at planting, counts of seedlings per row were carried out on October 18 and 25, 1963.

Thrips populations were assessed on October 29, November 6, 13 and 20, 1963, from two samples per plot, each sample comprising 15 seedlings.

Trial 4—*Yield trial,* 1963-64.—A 5 x 5 randomized block layout was used with unit plot of 4 rows each 66 ft. long spaced 40 in. apart, the two inner rows comprising the datum plot for yield assessment. The trial area was planted on October 4, 1963, with the variety Dixie King. Treatments were applied on October 29, 1963, using a power-operated, twin-nozzle, single-row hand applicator. Details of treatments and rates of application are given in Table 5.

Thrips population assessments were made at pretreatment on October 29 and at 8, 15 and 22 days post-treatment from two samples per plot, each sample comprising 20 seedlings. Yields of seed cotton per plot were obtained on April 30 and July 1, 1964, using a twin-row mechanical picker.

Trials 5, 6 *and* 7—*Yield trials,* 1964-65.—Each of these three yield trials comprised a 5 x 5 randomized block layout with unit plot of two rows each 2 chains long spaced 38 in. apart, and with one guard row between plots. Trials 5 and 6 were planted with the variety Dixie King and Trial 7 with Acala 1517BR. Insecticide applications were made in trial 5 on October 16 (5 weeks post-planting), in trial 6 on October 27 (2 weeks), and in trial 7 on November 3 (2 weeks). Details of treatments and spray strengths are given in Table 6.

Thrips population assessments were made at pretreatment and 7, 14 and 21 days post-treatment in trials 5 and 7 and at pretreatment and 9, 16 and 23 days post-treatment in trial 6. The assessments were made from samples each comprising 20 seedlings, two samples per plot being taken on all dates except at pretreatment in trial 5 and at the second and third post-treatments in trial 7, when only one sample per plot was taken.

Yields were obtained by single-row mechanical picker in trial 5 on March 10 and April 12, 1965 and in trial 6 on March 11. Trial 7 was not harvested.

Trial 8—*Seasonal incidence of thrips populations and effects on seedlings,* 1964-65.—Four replications of six times of planting were used in this trial. The variety was D & PL14 Smooth Leaf, and planting dates were September 10, October 13, 27, November 10, 24 and December 8. Each plot included rows which were sprayed weekly with insecticide (DDT 0·1% and endrin 0·05%) and rows which were unsprayed. Populations of thrips were assessed regularly (weekly or twice weekly) throughout the seedling stage from single samples comprising 20 seedlings taken at random from each plot in the unsprayed sections of each replicate of each planting.

Observations on plant growth in adjacent rows of insecticide-treated and untreated cotton in each plot were made throughout the season. At an appropriate time for each planting, maturity comparisons for treated and untreated plants were also made. For this purpose, from three uniformly selected starting points in each row all consecutive bolls to 100 were counted along the row and the number of mature bolls was recorded. An assessment of plant structure was made at the same time. In this instance all plants in each treated and untreated row were recorded as normal or severely branched, the accepted criterion for severe branching being three or more vegetative branches per plant.

Trial 9—Field movement of thrips over a cotton field, 1964-65.—During the period September 9, 1964, to February 2, 1965, in association with trial 8 the numbers of thrips taken per week on sticky paper traps facing N.W., N.E., S.E. and S.W. were recorded. The traps varied from 2 ft. high by 1 ft. wide at the beginning of the season to 2 ft. by 2 in. for most of the season. Numbers of thrips for the earlier counts were adjusted to the latter size of trap in the results presented. The traps were erected so that the base was 12 in. above the ground surface. The trapping mixture comprised 12 oz of resin in 27 oz of castor oil and was applied liberally to heavy brown paper tacked to wooden screens.

III. RESULTS

The results of trials 1-7 are presented in Tables 2-6 and those of trials 8 and 9 in Table 7 and Figures 1 and 2.

TABLE 2

TRIAL 1, SCREENING TEST, 1962–63: MEAN NUMBERS OF THRIPS PER PLOT SAMPLE

Treatment	At Pretreatment (Nov. 19, 1962)		1 Day after Treatment		7 Days after Treatment		14 Days after Treatment
	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Mean No.
Dieldrin 0·1% spray	13·00	169	4·08	17	4·03	16	2
Isobenzan 0·1% spray	14·17	201	5·21	27	5·34	29	6
Dimethoate e.c. 0·025% spray	13·92	194	5·84	34	6·75	46	5
Endrin 0·05% spray	12·88	166	6·86	47	7·19	52	5
Demeton-s-methyl 0·025% spray	13·45	181	7·53	57	8·48	72	5
Fenthion 0·025% spray	13·24	175	5·99	36	10·34	107	15
Mesurol 0·1% spray	14·43	208	5·38	29	11·00	121	7
DDT 0·1% spray	13·47	181	10·46	109	11·29	128	5
Lindane 0·03% spray	14·71	216	9·43	89	13·61	185	9
Check (mean of two)	13·33	178	16·93	287	15·19	231	10
S.E.	0·788		0·942		1·183		
Necessary difference for significance among insecticides							Not analysed
5%	2·32		2·77		3·48		
1%	3·16		3·77		4·73		
Necessary differences for significance, involving unsprayed checks							Not analysed
5%	2·01		2·40		3·01		
1%	2·73		3·27		4·10		

* $\sqrt{x}$ transformation.

TABLE 3

Trial 2, Screening Test, 1963–64: Mean Numbers of Thrips per Examination Unit per Sample (⅛ of a Sample from Each Plot)

Treatment	At Pretreatment (Oct. 28)				2 Days After Treatment				8 Days After Treatment				16 Days After Treatment			
	Total Thrips		Adult Thrips		Total Thrips		Adult Thrips		Total Thrips		Adult Thrips		Total Thrips		Adult Thrips	
	Trans. Mean†	Equiv. Mean	Trans. Mean†	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean
Dieldrin 0·1%	7·50	56·17	4·25	18·10	3·59	12·91	1·79	3·20	2·88	8·29	2·68	7·20	2·09	4 38	1·80	3·26
Endosulfan 0·1%	6·01	36·15	3·71	13·78	3·47	12·01	1·63	2·66	2·93	8·57	2·76	7·63	2·61	6·80	2·23	4·96
Phosphamidon 0·04%	7·05	49·63	3·62	13·11	3·27	10·72	1·89	3·57	3·33	11·08	2·96	8·79	3·57	12·72	2·11	4·44
Azinphos-methyl 0·05% ..	6·67	44 43	4·02	16·13	3·20	10·21	2·28	5·21	3·38	11·44	3·18	10·13	4 58	21·02	3·12	9·75
Parathion 0·015%	7·59	57·59	3·98	15·87	3·64	13·23	2·47	6·13	4·22	17·84	3·93	15·43	4·19	17·58	2·87	8·23
Fenitrothion 0·05%	5·67	32·19	3·66	13·36	3·55	12·58	2·43	5·90	4·25	18·05	4·14	17·12	4·49	20·14	3·18	10·13
Carbophenothion 0·05% ..	5·60	31·35	3·84	14·72	3·76	14·12	3·11	9·64	4·28	18·29	4·01	16·07	5·60	31·38	3·42	11·68
Carbaryl 0·1%	5·11	26·12	3·96	15·65	2·57	6·61	2·18	4·74	4·39	19·25	4·16	17·32	4·63	21·40	2·92	8·52
DDT 0·1%	6·35	40·27	4·12	16·97	3·11	9·67	2·33	5·41	4·40	19·39	4·11	16·92	3·64	13·26	2·81	7·91
Maldison 0·05%	5·42	29·37	3·74	13·96	3·76	14·17	3·21	10·33	4·56	20·79	4·12	16·96	3·99	15·93	2·62	6·84
Azinphos-ethyl 0·05% ..	5·45	29·68	3·99	15·95	3·39	11·47	2·76	7·64	4·60	21·14	4·36	18·99	4·57	20·91	2·91	8·47
Phenthoate 0·1%	5·30	28·10	3·91	15·28	2·98	8·89	2·77	7·65	4·61	21·22	4 45	19·78	4·44	19·70	3·06	9 36
Trichlorphon 0 1%	7·66	58·67	4·37	19·14	4·10	16·78	2·91	8·49	5·35	28·61	4·74	22·42	4·96	24·59	2·89	8·36
Check	5·36	28·67	4·20	17·62	4·61	21·20	3·98	15·86	6·31	39·83	4·62	21·35	4·89	23·92	2·51	6·32
Check	6·28	39·44	4·56	20·76	5·81	33·79	4·57	20·91	6·34	40·20	4·80	23·01	4·99	24·88	2·78	7·75
Check	6·72	45·11	3·99	15·94	5·43	29·51	4·66	21·70	6·57	43·15	4·11	16·90	3·00	8·97	1·62	2·64
S.E.	0·92		2·54		0·62		0·41		0·41		0·37		0·55		0·27	
Necessary differences 5%	2·66		0·73		1·80		1·19		1·18		1·06		1·59		0·79	
For significance .. 1%	3·59		0·99		2·43		1·60		1·59		1·43		2·14		1·07	

$\sqrt{x}$ transformation. † Analyses of variance F value not significant. * Analyses of variance F value significant at 1% level.

TABLE 4

TRIAL 3, SYSTEMIC INSECTICIDES TRIAL, 1963–64: MEAN NUMBERS OF SEEDLINGS PER PLOT AND MEAN NUMBERS OF THRIPS PER EXAMINATION UNIT PER SAMPLE ($\frac{1}{8}$ OF A SAMPLE FROM EACH PLOT)

Treatment	Seedlings per Plot		No. of Thrips per Examination Unit															
	Oct. 18	Oct. 25	On Oct. 29				On Nov. 6				On Nov. 13				On Nov. 20			
			Total Thrips		Nymphal Thrips		Total Thrips		Nymphal Thrips		Total Thrips		Nymphal Thrips		Total Thrips		Nymphal Thrips	
			Trans. Mean†	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean†	Equiv. Mean	Trans. Mean*	Equiv. Mean
Dimethoate disp. powd. 1 lb/ac seed dressing	(26·3)	(107·0)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phorate granules 2 lb/ac at planting	577·7	649·3	5·42	29·4	1·14	1·3	4·55	20·7	1·97	3·9	3·85	14·8	2·06	4·3	3·57	12·7	1·95	3·8
Disulfoton granules 2 lb/ac at planting	593·0	719·0	4·89	23·9	1·47	2·2	5·11	26·2	2·59	6·7	3·96	15·7	1·99	4·0	4·82	23·3	2·94	8·7
Disulfoton granules 1 lb/ac at planting	531·3	640·7	6·35	40·4	1·44	2·1	6·48	42·0	4·41	19·4	4·18	17·5	2·80	7·8	4·67	21·8	2·45	6·0
Disulfoton granules 5 lb/ac at planting	616·0	679·7	6·41	41·1	3·23	10·4	7·34	53·9	5·15	26·5	5·89	34·7	4·65	21·6	4·00	16·0	2·12	4·5
Phorate granules 2 lb/ac as side-dressing	..	..	7·44	55·3	5·10	26·0	8·36	69·9	6·99	48·9	6·51	42·3	5·57	31·0	4·50	20·2	2·85	8·1
Disulfoton granules 2lb/ac as side-dressing	..	..	7·31	53·5	4·81	23·1	6·74	45·5	5·10	26·1	6·08	37·0	5·06	25·6	4·53	20·5	2·64	7·0
Dimethoate disp. powd. 1 lb/ac as side-dressing	..	..	8·24	67·9	5·50	30·2	7·26	52·8	5·93	35·2	5·01	25·1	3·98	15·9	4·09	16·7	2·24	5·0
Phorate liquid conc. 2 lb/ac as side-dressing	..	..	6·62	43·9	3·86	14·9	8·12	65·9	6·26	39·1	5·22	27·2	4·44	19·7	4·68	21·9	2·92	8·5
Dieldrin 0·1% spray	..	..	8·35	69·8	6·37	40·6	2·26	5·1	1·09	1·2	2·18	4·8	0·76	0·6	3·49	12·2	1·22	1·5
Check (mean of 3)	595·3	705·7	7·11	50·6	4·90	24·0	8·40	70·5	6·55	42·9	6·51	42·3	5·53	30·6	4·43	19·6	2·67	7·1
S.E. (among insecticides) ..	34·7	37·8	0·72	..	0·57	..	0·60	..	0·53	..	0·81	..	0·84	..	0·31	..	0·27	..
S.E. (involving checks)	40·1	43·6	0·89	..	0·70	..	0·74	..	0·65	..	0·99	..	1·03	..	0·38	..	0·33	..
cessary differences for significance (among insecticides) .. 5%	76·4	84·2	1·49	..	1·18	..	1·25	..	1·10	..	1·68	..	1·74	..	0·64	..	0·56	..
1%	107·8	119·8	2·02	..	1·60	..	1·69	..	1·49	..	2·28	..	2·36	..	0·87	..	0·76	..
Necessary differences for significance (involving checks) 5%	88·2	97·2	1·83	..	1·44	..	1·53	..	1·35	..	2·05	..	2·13	..	0·79	..	0·69	..
1%	124·5	138·3	2·48	..	1·95	..	2·07	..	1·83	..	2·79	..	2·89	..	1·07	..	0·93	..

$\sqrt{x}$ transformation. † Analysis of variance F value significant at 5% level. * Analysis of variance F value significant at 1% level.

TABLE 5

TRIAL 4, YIELD TRIAL, 1963–64: MEAN YIELDS OF SEED COTTON PER PLOT AND MEAN NUMBERS OF THRIPS PER EXAMINATION UNIT PER SAMPLE ($\frac{1}{8}$ OF A SAMPLE FROM EACH PLOT)

Treatment	Yield (lb seed cotton per ac)		No. of Thrips per Examination Unit															
			Pretreatment (Oct. 29)				8 Days After Treatment				15 Days After Treatment				22 Days after Treatment			
	First Pick	Total Yield	Total Thrips		Nymphal Thrips		Total Thrips		Nymphal Thrips		Total Thrips		Nymphal Thrips		Total Thrips		Nymphal Thrips	
			Trans. Mean†	Equiv. Mean	Trans. Mean†	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean	Trans. Mean*	Equiv. Mean
DDT 0·1%, 0·62 lb/ac	1,229	2,000	6·09	37·1	3·18	10·1	4·19	17·5	1·69	2·8	4·82	23·2	2·87	8·2	4·90	24·0	3·30	10·9
Endrin 0·05%, 0·31 lb/ac ..	1,326	2,176	6·32	40·0	2·72	7·4	3·81	14·5	1·69	2·9	4·26	18·1	2·14	4·6	4·47	20·0	2·75	7·6
Dieldrin 0·1%, 0·58 lb/ac ..	1,260	2,016	6·69	44·7	3·46	12·0	2·45	6·0	0·93	0·9	3·42	11·7	1·48	2·2	3·41	11·6	1·74	3·0
Dimethoate 0·025%, 0·16 lb/ac	1,013	1,804	6·05	36·6	3·24	10·5	3·84	14·8	1·36	1·8	3·92	15·4	1·88	3·6	4·83	23·4	3·01	9·1
Check—no insecticide	1,299	2,095	5·78	33·5	2·74	7·5	8·60	73·9	6·60	43·5	6·94	48·2	5·62	31·6	5·40	29·2	3·31	10·9
S.E.	..	..	0·35	..	0·30	..	0·32	..	0·33	..	0·28	..	0·30	..	0·32	..	0·41	..
Necessary differences for significance 5%	N.S.D.	N.S.D.	0·75	..	0·68	..	0·67	..	0·70	..	0·59	..	0·63	..	0·68	..	0·86	..
Necessary differences for significance 1%	..	..	1·03	..	0·87	..	0·92	..	0·97	..	0·82	..	0·87	..	0·93	..	1·19	..

$\sqrt{x}$ transformation. † Analyses of variance F values not significant. * Analyses of variance F values significant at 1% level.

TABLE 6

TRIALS 5, 6 AND 7, YIELD TRIALS, 1964–65: MEAN NUMBERS OF THRIPS PER SAMPLE AND YIELDS OF SEED COTTON

Treatment	No. of Thrips per Sample								Yields (lb seed cotton per ac)	
	At Pretreatment		At Post-treatment							
	Total	Nymphs	Total	Nymphs	Total	Nymphs	Total	Nymphs		
Trial 5	Oct. 16 †	†	7 days **	*	14 days **	*	21 days **	**	First Pick†	Total Yield†
DDT 0·1%	763·6	749·5	43·4	3·90	26·2	10·1	46·3	27·7	2,866	3,291
Dieldrin 0·1%	859·4	835·1	25·6	5·60	14·2	4·4	33·5	16·1	2,689	3,104
Dieldrin 0·05%	736·4	711·1	22·3	4·70	14·6	3·8	26·9	13·5	2,663	3,159
Dieldrin 0·025%	767·9	736·3	32·2	4·10	27·6	12·6	42·6	19·4	2,590	3,000
Check	768·1	742·7	35·8	7·40	41·2	15·5	70·6	51·6	2,461	2,947
S.E.	59·2	58·0	3·47	0·73	2·37	2·41	5·17	4·54	123	175
Necessary differences for significance 5%	182·4	178·7	10·71	2·26	7·31	7·43	15·93	13·98	401	569
Necessary differences for significance 1%	255·8	250·6	15·01	3·16	10·25	10·42	22·33	19·60	584	828
Trial 6	Oct. 27 †		9 days **	**	16 days **	**	23 days †	†	First Pick†	Total Yield
DDT 0·1%	14·8	Nymphal numbers not recorded	54·7	13·5	151·20	120·2	29·7	26·40	3,160	One pick only
Dieldrin 0·1%	15·7		13·9	1·8	36·70	24·8	20·0	15·70	3,285	
Dieldrin 0·05%	16·1		21·9	7·0	44·80	9·1	21·7	17·70	3,292	
Dieldrin 0·025%	15·8		29·3	16·4	82·83	60·4	32·5	24·45	3,150	
Check	19·3		103·6	75·6	110·17	75·4	34·1	26·00	3,176	
S.E.	3·12	..	3·94	3·09	16·29	15·33	6·90	5·88	129	..
Necessary differences for significance 5%	9·35	..	11·80	9·27	48·82	45·96	20·79	17·72	387	..
Necessary differences for significance 1%	12·88	..	16·26	12·77	67·27	63·33	28·74	24·50	533	..

TABLE 6—continued

Trial 7	Nov. 3 †		7 days **	**	14 days **	**	21 days **	**	First Pick	Total Yield
DDT 0·1%	17·7	Nymphal numbers not recorded	36·0	5·1	179·53	38·40	234·13	23·73	Yields not taken	
Dieldrin 0·1%	17·9		16·3	1·1	103·00	28·27	220·13	15·47		
Dieldrin 0·05%	12·2		21·8	4·5	85·27	29·00	169·33	11·47		
Dieldrin 0·025%	14·3		23·3	4·8	102·47	29·00	137·67	5·73		
Check	18·5		76·1	22·3	237·47	101·87	374·53	64·93		
S.E.	2·26	..	5·18	2·94	29·02	12·54	27·92	8·80		
Necessary differences for significance 5%	6·78	..	15·53	8·82	86·99	37·61	83·70	26·37		
Necessary differences for significance 1%	9·34	..	21·40	12·15	119·85	51·82	115·32	36·34		

† Analyses of variance F value not significant.
* Analyses of variance F value significant at 5% level.
** Analyses of variance F value significant at 1% level.

TABLE 7

TRIAL 8: EFFECTS OF THRIPS FEEDING ON PLANT STRUCTURE AND BOLL MATURITY

Treatment (Planting Date)	Plant Structure No. Branched Plants (%)		Boll Maturity No. Mature Bolls (% of total bolls)	
	Insecticide Treated	No Insecticide	Insecticide Treated	No Insecticide
Sept. 10, 1964 ..	30·3*	83·2*	19·1*	5·5*
Oct. 13, 1964 ..	37·5 †	41·7 †	17·5 †	12·4 †
Oct. 27, 1964 ..	33·9 †	42·8 †	28·5 †	28·1 †
Nov. 10, 1964 ..	33·3 ‡	32·0 ‡	15·9‡	27·1‡
Nov. 24, 1964 ..	27·6 ‡	28·6 ‡	17·5 **	19·2 **
Dec. 8, 1964 ..	20·2 ‡	16·6 ‡	11·0 **	13·5 **

* Data collected Apr. 6, 1965.
† Data collected Apr. 14, 1965.
‡ Data collected Apr. 21, 1965.
** Data collected May 11, 1965.

IV. DISCUSSION

Trial 1—*Screening test,* 1962-63.—The data presented for trial 1 (Table 2) show that dieldrin and isobenzan, at the rates used, gave good thrips control, followed by dimethoate and endrin. It is noted that although highly significant differences among populations were present at 7 days after treatment, thrips populations at this time were showing a natural decline and at 14 days had virtually disappeared from both treated and untreated plots within the trial area.

Trial 2—*Screening test,* 1963-64.—Of the 13 chemicals tested in trial 2 (Table 3), dieldrin, endosulfan and phosphamidon gave efficacious results at 8 days post-treatment. Parathion gave only reasonable results against these and as in the previous trial DDT was disappointing.

Trial 3—*Systemic insecticides trials,* 1963-64.—The results of trial 3 (Table 4) show that the systemic insecticides phorate and disulfoton applied as granules at planting time gave a suppression of thrips breeding, as indicated by numbers of nymphal thrips, for up to 46 days post-planting. These materials, however, are shown to exert little real influence on numbers of adult thrips during the same period. The same chemicals applied as side-dressings, post-planting, were relatively ineffective against both adult and nymphal populations. This is probably related to the inability of the chemical to reach the seedlings and be absorbed by them, since the materials were applied to the soil surface, which was in a dry crusty condition, and no rain fell during the following 3 weeks.

Dimethoate wettable powder applied as a dressing direct to the seed prior to planting had an obvious and severe effect upon germination and data on thrips control for this treatment could not be obtained.

Under the conditions of this trial a single spray application of dieldrin at the appropriate time gave the most efficacious control of thrips.

Trial 4 *and trials* 5, 6 *and* 7—*Yield trials,* 1963-64, 1964-65.—Significant differences were obtained in the first pick yields in trial 5 only (Table 6). In no instances were significant differences shown in total yields. The yield improvement in the first pick of trial 5, and suggestion of improvement in total yield in favour of DDT in this trial, were associated with a relatively severe infestation of the jassid *Austroasca terraereginae* (Paoli) in the immediate post-application period in this trial. Observations gave a clear indication of the superiority of DDT against this pest when compared with dieldrin and check treatments.

The lack of yield responses in the remaining trials demonstrated that at the infestation levels encountered, *Thrips tabaci* was not a pest of economic importance.

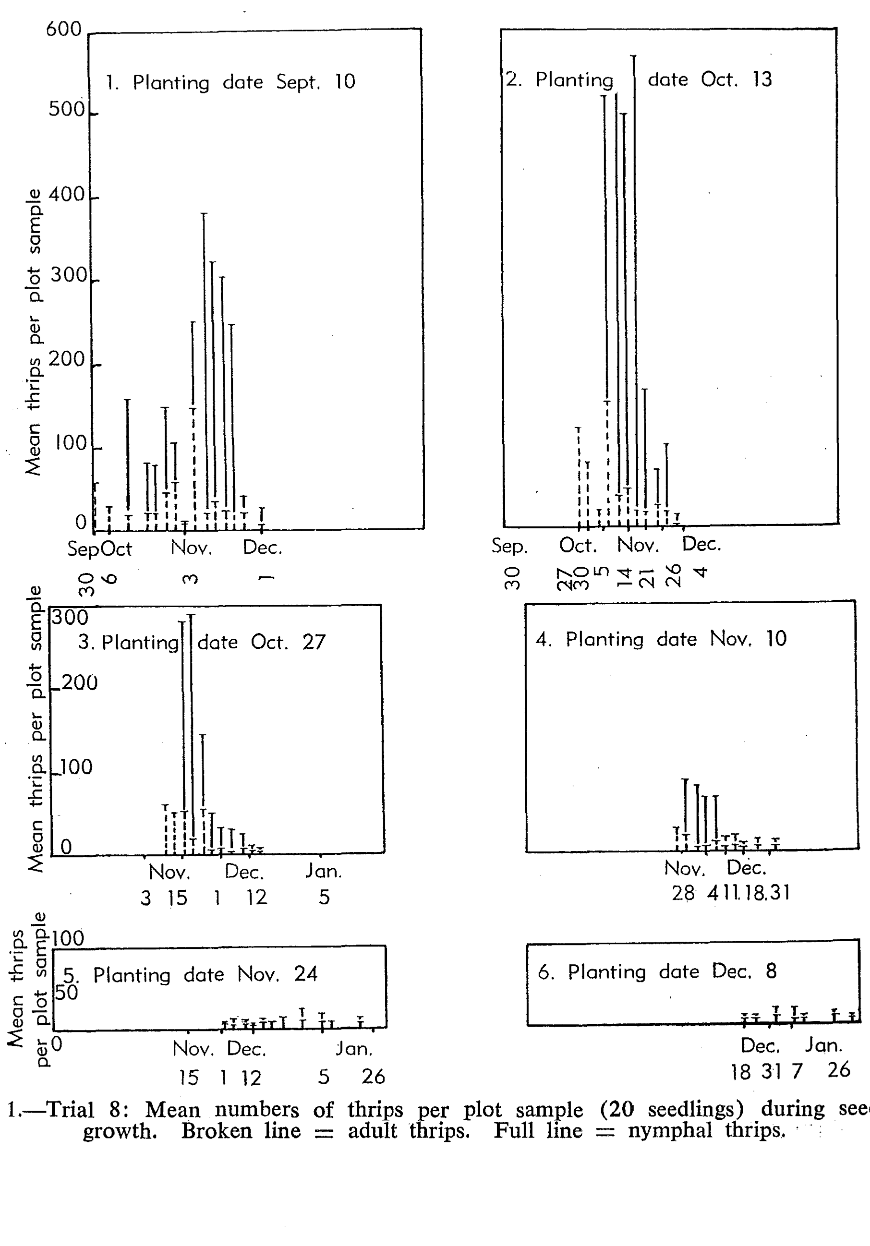

Fig. 1.—Trial 8: Mean numbers of thrips per plot sample (20 seedlings) during seeding growth. Broken line = adult thrips. Full line = nymphal thrips.

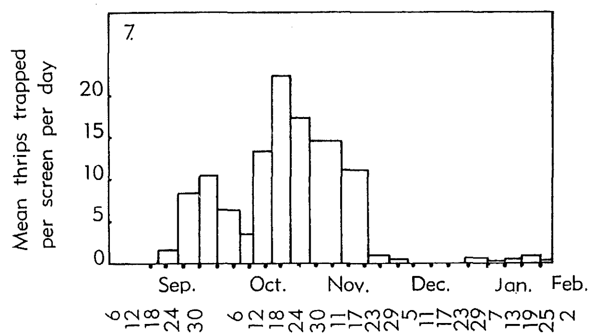

Fig. 2.—Trial 9: Mean numbers of thrips trapped per day per 2 ft. x 2 in. sticky screen.

Trial 8—*Seasonal history*.—The data on thrips occurrence on seedlings in sequential plantings presented in Figures 1 and 2 demonstrated quite clearly that *Thrips tabaci* does not breed continuously and prolifically on cotton. During October and early November the seedlings were invaded by adult thrips but the only period, irrespective of time of planting, during which significant breeding occurred was from mid to late November. The population of both adults and nymphs on cotton seedlings were shown to vary in the same general pattern as the seasonal fluctuations as determined by the numbers taken on sticky traps. The fact that high numbers of nymphs did not continue after the peak period of adults was shown on the traps suggested that cotton is not a highly favoured host of this species. Total populations of thrips on cotton were more a factor of movement from other hosts than of breeding on the cotton seedlings. Had the reverse been the case it would have been expected that high adult numbers would have been taken on the sticky traps or on the seedlings after the November period of high nymphal populations. On the data presented it must be concluded that mortality amongst the thrips in late November-early December must have been extremely high.

The data on plant structure and boll maturity presented in Table 7 illustrate the effects of feeding by the thrips. A much greater percentage of plants were severely branched in the untreated early sowing of September 10 than in the same planting which was given insecticide protection. This branching effect was followed by a logical delay in boll maturity. A similar but much less significant effect was shown in the October plantings, since the seedlings in these were subject to thrips injury for a much shorter period and growth was more vigorous through the seedling stage.

Observations on the growth of the seedlings supported the data discussed above and presented in Table 7. For example, growth was slow in the September 10 planting and by November 24 a height difference, 4 in. high in sprayed seedling and 2-3 in. in unsprayed, was apparent, although the number of internodes per seedling was the same in both groups of plants. Thrips injury was obvious on unsprayed seedlings, with puckering and silvering of the leaves and early development of axillary shoots at the nodes. Such axillary shoots were not present on the sprayed seedlings. By December 15 the height difference was still apparent, 5-6 in. high in sprayed against 3-4 in. in unsprayed plants, and axillary shooting, although present on some sprayed plants, was much more obvious on the unsprayed.

Height differences were apparent in the October 13 planted seedlings during late November but became much less obvious as growth proceeded, and axillary shooting was at no stage pronounced.

Slight leaf symptoms were apparent in the October 27 planted seedlings during late November and December, but difference between sprayed and unsprayed seedlings was not apparent. Later plantings did not exhibit injury symptoms of note at any stage.

The difference in the pattern of symptoms between the September and October plantings was undoubtedly related to growth rate. During late September and early October temperatures were low and growth was slow. Thrips feeding, therefore, occurred over a longer period and under the conditions of static growth plant injury did occur. In the later plantings (October) similar and higher populations were active for shorter periods but with steady and continuous growth injury symptoms either did not appear or were masked by the more rapid growth rate.

Conclusions.—The results demonstrated that of a wide variety of chemicals tested dieldrin at 0·05% spray applied at approximately $\frac{1}{2}$ lb active constituent per acre can be expected to give the most satisfactory control of thrips on cotton seedlings.

Systemic insecticides such as phorate and disulfoton applied as granules to the soil at planting gave good control of thrips breeding, but because reinfestation by adults from other hosts was continuous the chemicals had little effect on adult numbers. The application of these materials as field controls therefore is unlikely to reduce thrips populations under existing conditions of cotton-growing.

Yield trial results illustrated that significant increases in yield are unlikely from spray application in cotton crops which develop vigorously from the time of seedling emergence.

The seasonal history study illustrated that populations vary from week to week from very high levels to virtually nil irrespective of insecticide applications. These data explain the "excellent results" which have been reported in commercial crops where chemicals now shown to give poor pest kills were applied.

The study involving a range of planting times with plots sprayed regularly to minimize thrips numbers and with plots receiving no insecticide illustrates that the early sown stands of seedlings can suffer injury which will result in malformation of plant structure and in delayed boll maturity. Later sown crops which suffer severe growth checks during seedling development may, by analogy, suffer similar injury when similar thrips populations are present. Such injury has been observed following severe moisture stress and periods of harsh drying winds.

The application of an insecticide, therefore, for thrips kills has little likelihood of influencing total yields in southern Queensland cotton when conditions for plant growth are uniformly good from the time of planting. On the other hand, crops sown under cold conditions may suffer injury resulting in malformation of growth and delayed boll maturity. Control under such conditions will be warranted in potentially high-yielding irrigated crops to ensure uniformity of crop production. Alternatively and preferably, planting should be delayed until after mid October.

V. ACKNOWLEDGEMENTS

All statistical analyses were carried out by the Biometrics Branch of the Department of Primary Industries. Messrs. J. W. Turner and G. D. Shaw assisted with the collection of field data, and Mrs. Marianne Roubicek carried out a large section of the insect counts in the laboratory. Mr. W. Yarrow carried out the 1962-63 screening trial. Several farmers in the Brookstead and Forest Hill districts made facilities available for field trials and the staff of the Hermitage Research Station assisted with the Seasonal History study.

REFERENCE

PASSLOW, T. (1958).—Control of insects in cotton in Central Queensland. *Qd agric. J.* 84:557-60.

(Received for publication January 25, 1971)

The author is an officer of Entomology Branch, Queensland Department of Primary Industries, stationed at Toowoomba.