TOBACCO LEAF-PEST CONTROL DEMONSTRATION TRIALS, 1960-1962

By J. J. DAVIS, B.Sc., and G. W. SAUNDERS, B.Agr.Sc.*

SUMMARY

During 1960-1962 four field control demonstration trials were conducted against tobacco leaf pests in North Queensland. These showed that a properly timed schedule of DDT and endrin (or dieldrin) sprays gave satisfactory control of all pests at the levels of infestation encountered in the trials.

The serious pests involved were leaf-miner, *Phthorimaea operculella* (Zell.), budworms, *Heliothis punctigera* Wallengr. and *H. armigera* (Hubn.), and looper, *Plusia argentifera* Guen.

Recommended spray control schedules were shown to increase the yield and value of cured leaf up to nearly four times that from unsprayed control plots, demonstrating the vital importance of pest control in tobacco production in North Queensland.

Effective control was obtained at a minimum cost varying according to the programme used from £14 to £23 per acre covering insecticides and application costs. These costs are low in relation to the value of the crop.

I. INTRODUCTION

The major field pests of tobacco (*Nicotiana tabacum* L.) in North Queensland are leaf-miner, *Phthorimaea operculella* (Zell.), budworms, *Heliothis punctigera* Wallengr. and *H. armigera* (Hubn.), and looper, *Plusia argentifera* Guen.

Following trials showing the value of "Telodrin" against leaf-miner (Saunders and Ettershank 1961), the recommended control for tobacco pests comprised a schedule of DDT and endrin (or dieldrin) with the addition of Telodrin into the programme as required to counter heavy infestations of leaf-miner (Smith and Saunders 1961). During 1960-1962, four field control demonstration trials based on this schedule were carried out on furrow-irrigated tobacco in North Queensland.

* Entomologists, Queensland Department of Primary Industries.

II. MATERIALS

DDT.—An emulsion concentrate containing 25 per cent. w/v *pp'* isomer (Millaroo trials).

—A mayonnaise emulsion concentrate containing 25 per cent. w/v *pp'* isomer (Parada trials).

Dieldrin.—An emulsifiable concentrate containing 15 per cent. w/v active constituent.

Endrin.—An emulsifiable concentrate containing 20 per cent. w/v active constituent.

"Telodrin".—An emulsifiable concentrate containing 15 per cent. w/v 1,3,4,5,6,7,8, 8-octochloro–1,3,3a,4,7,7a-hexahydro–4, 7-methano-isobenzofuran.

In all trials DDT and Telodrin were used at 0·1 per cent. active constituent and dieldrin and endrin at 0·05 per cent. active constituent.

III. METHODS AND RESULTS

(1) Spray Applications

Trial A, Parada 1960-61.—The four treatment programmes (Table 1) were commenced following transplanting of seedlings into the field. Both sides of all leaves were sprayed to visible wetness. Insect counts were made regularly to determine timing of spray applications. The spray programmes involved treatment with DDT/endrin and DDT/dieldrin, each of these combinations both with and without the addition of Telodrin.

The field layout was in randomized blocks with six replications. Each plot consisted of 80 plants in two rows of 40 plants each with an untreated row adjacent to each plot. Pairs of untreated rows between replicates were used as check plots and comparative results taken. The sprayer used was a power-driven "Marino Packet Sprayer Unit" with nylex hoses and hand lances.

Trial B, Parada 1961-62.—The three spray programmes were commenced one week after transplanting into the field and continued as listed in Table 2. The methods of spray application and the field layout of the plots were the same as for Trial A. In each programme DDT and endrin were used. In Programme 1 no attempt was made to restrict volume of spray material used. In Programme 2 the volume was kept at or below 50 gal per ac and in Programme 3 below 100 gal per ac to determine whether spray volume influenced the pest control obtained. Control over volume was by the number and size of nozzles used and the speed of application.

TABLE 1

SPRAY PROGRAMMES, PARADA 1960–61, TRIAL A

Date of Application	Programme 1		Programme 2		Programme 3		Programme 4		Equipment
	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	
22.ix.60	DDT & dieldrin	25	DDT & endrin	25	DDT & dieldrin	25	DDT & endrin	25	Knapsack
29.ix.60	DDT & dieldrin	25	DDT & endrin	25	DDT & dieldrin	25	DDT & endrin	25	Knapsack
6.x.60	DDT & dieldrin	25	DDT & endrin	25	DDT & dieldrin	25	DDT & endrin	25	Knapsack
13.x.60	DDT & dieldrin	100	DDT & endrin	100	DDT & dieldrin	100	DDT & endrin	100	Power spray
31.x.60	DDT & dieldrin	180	DDT & endrin	180	DDT & dieldrin	180	DDT & endrin	180	Power spray
21.xi.60	DDT & dieldrin	200	DDT & endrin	200	DDT & dieldrin	200	DDT & endrin	200	Power spray
5.xii.60	DDT	200	DDT	200	DDT & Telodrin	200	DDT & Telodrin	200	Power spray
19.xii.60	DDT & dieldrin	200	DDT & endrin	200	DDT & dieldrin	200	DDT & endrin	200	Power spray
10.i.61	DDT	200	DDT	200	DDT & Telodrin	200	DDT & Telodrin	200	Power spray
17.i.61	DDT & dieldrin	200	DDT & endrin	200	DDT & Telodrin	200	DDT & Telodrin	200	Power spray

TABLE 2

SPRAY PROGRAMMES, PARADA 1961–62, TRIAL B

Date of Application	Programme 1		Programme 2		Programme 3		Equipment
	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	
20.ix.61	DDT & endrin	30	DDT & endrin	30	DDT & endrin	30	Knapsack
27.ix.61	DDT & endrin	30	DDT & endrin	30	DDT & endrin	30	Knapsack
4.x.61	DDT & endrin	30	DDT & endrin	30	DDT & endrin	30	Knapsack
11.x.61	DDT & endrin	90	DDT & endrin	40	DDT & endrin	40	Knapsack
19.x.61	DDT & endrin	100	DDT & endrin	40	DDT & endrin	60	Power spray
31.x.61	DDT & endrin	180	DDT & endrin	50	DDT & endrin	90	Power spray
10.xi.61	DDT & endrin	200	DDT & endrin	50	DDT & endrin	100	Power spray
21.xi.61	DDT & endrin	200	DDT & endrin	50	DDT & endrin	100	Power spray
5.xii.61	DDT & endrin	200	DDT & endrin	50	DDT & endrin	100	Power spray
19.xii.61	DDT & endrin	200	DDT & endrin	50	DDT & endrin	100	Power spray
28.xii.61	DDT & endrin	150	DDT & endrin	40	DDT & endrin	100	Power spray

TABLE 3

SPRAY PROGRAMMES, MILLAROO 1960–61, TRIAL C

Date of Application	Programme 1		Programme 2		Programme 3		Programme 4		Equipment
	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	
16.ix.60	DDT & dieldrin	25	DDT & endrin	25	DDT & dieldrin	25	DDT & endrin	25	All treatments applied by knapsack spray
23.ix.60	DDT & dieldrin	25	DDT & endrin	25	DDT & dieldrin	25	DDT & endrin	25	
30.ix.60	DDT & dieldrin	25	DDT & endrin	25	DDT & dieldrin	25	DDT & endrin	25	
7.x.60	DDT	25	DDT	25	DDT	25	DDT	25	
14.x.60	DDT	40	DDT	40	DDT	40	DDT	40	
21.x.60	DDT & dieldrin	70	DDT & endrin	75	DDT & dieldrin	70	DDT & endrin	75	
28.x.60	DDT & dieldrin	80	DDT & endrin	85	DDT & Telodrin	70	DDT & Telodrin	70	
4.xi.60	DDT & dieldrin	60	DDT & endrin	60	DDT & dieldrin	60	DDT & endrin	60	
11.xi.60	DDT & dieldrin	120	DDT & endrin	120	DDT & dieldrin + Telodrin	120	DDT & endrin + Telodrin	120	
18.xi.60*	DDT	35	DDT	35	DDT	35	DDT	35	
30.xi.60	DDT & dieldrin	130	DDT & endrin	105	DDT & dieldrin	130	DDT & endrin	105	
7.xii.60	DDT & dieldrin	85	DDT & endrin	85	DDT & dieldrin	85	DDT & endrin	85	
16.xii.60* ..	DDT & dieldrin	25	DDT & endrin	25	DDT & dieldrin	25	DDT & endrin	25	
23.xii.60* ..	DDT	20	DDT	20	DDT	20	DDT	20	

* Only upper parts of plants sprayed

TABLE 4

SPRAY PROGRAMMES, MILLAROO 1961–62, TRIAL D

Date of Application	Programme 1		Programme 2		Programme 3		Equipment
	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	Materials	Spray Applied (gal/ac)	
7.ix.61	DDT & endrin	18	DDT & endrin	18	DDT & endrin	18	All treatments applied by knapsack spray
14.ix.61	DDT & endrin	23	DDT & endrin	23	DDT & endrin	23	
20.ix.61	DDT & endrin	25	DDT & endrin	25	DDT & endrin	25	
27.ix.61	DDT & endrin	25	DDT & endrin	25	DDT & endrin	25	
4.x.61	DDT & endrin	30	DDT & endrin	30	Nil	Nil	
11.x.61	Endrin	41	Endrin	41	Nil	Nil	
19.x.61	DDT & endrin	55	DDT & endrin	55	DDT & endrin	55	
7.xi.61	DDT & endrin	40	DDT & endrin	40	DDT & endrin	40	
21.xi.61	DDT & endrin	90	DDT & endrin	90	Nil	Nil	
5.xii.61	DDT & endrin	105	DDT, endrin & Telodrin	90	DDT*	30	
22.xii.61*	DDT	27	DDT	27	DDT	27	

* Only upper parts of plants sprayed

TABLE 5

INSECT COUNTS, PARADA 1960–61, TRIAL A

Mean total number of leaf mines (LM) and Heliothis larvae (H) on 10 plants per plot

—	13.x.60		24.x.60		9.xi.60		21.xi.60		5.xii.60		12.xii.60		9.i.61		16.i.61	
	LM	H	LM	H	LM	H	LM	H	LM	H	LM	H	LM	H	LM	H
Programme 1	1·0	0	0	0	0·7	0	1·2	7·5	36·5	0	33·0	0	204·0	0	272·2	0
Programme 2	0	0	0·3	0	1·7	0	0·7	4·5	13·5	0	14·7	0	113·2	0	127·7	0
Programme 3	0	0	0·8	0	0·7	0	3·3	5·0	39·3	0	27·5	0	98·8	0	131·2	0
Programme 4	0	0	0·2	0	1·3	0	1·3	4·2	18·5	0	19·5	0	55·8	0	69·3	0
Check	0	0	0·6	8·4	8·9	0·7	16·6	8·7	127·5	0·6	95·5	0·1	201·0	0·1	319·6	0·1

Trial C, Millaroo 1960-61.—The four programmes and layout were similar to those used for the Parada Trial A, but a greater number of applications was made. The programmes and materials used in each application are listed in Table 3. Spray applications commenced one week after transplanting and a hand-operated knapsack sprayer was used throughout.

Trial D, Millaroo 1961-62.—Of the three programmes used in this trial, Programme 1 was the standard DDT/endrin schedule and Programme 2 the DDT/endrin/Telodrin schedule. Programme 3 was a "minimum" schedule designed to obtain some information on the smallest possible outlay for insecticides. The programmes are listed in Table 4. The layout and methods were the same as for Trial C, except that eight treatment replications were used.

(2) Insect Counts

In Trials A and B counts were made of budworms and loopers and of leaf mines caused by leaf-miner larvae. At no stage were loopers prevalent; thus the figures in Table 5 are for leaf mines and budworms and in Table 6 for leaf mines only. Budworm activity in Trial B was insignificant. In Trials C and D counts of insects were not made, but pest activity was recorded each week and is summarized as follows.

TABLE 6

INSECT COUNTS, PARADA 1961–62, TRIAL B

Mean total number of leaf mines (LM) on 10 plants per plot

—	10.x.61	18.x.61	26.x.61	7.xi.61	27.xi.61	21.xii.61
	LM	LM	LM	LM	LM	LM
Programme 1	0	0·3	0	0·2	3·3	14·0
Programme 2	0	0·2	0	1·2	13·5	40·2
Programme 3	0·3	0·2	0·2	0·8	6·5	15·3
Check	0·3	4·2	4·2	40·8	231·3	80·0

In Trial C, egg-laying by budworm occurred from two weeks after planting out and for the next two months the pest caused serious damage, ruining all check-row leaf. In mid November 3 in. of rain fell and the damaged plants made good regrowth. Thereafter, budworm activity was restricted to tops and upper parts of plants and caused little damage. Looper activity occurred in two

well-marked waves, one in mid October and the other in late November. Damage by the first wave was slight and largely masked by that caused by budworm. Damage by the second wave was hardly noticeable. In both cases the infestation developing was only light, though easily detected. Small leaf-miner mines were noticed two weeks after planting out. Throughout the trial leaf-miner could be found on the plants, but no significant infestation developed.

In Trial D, no noticeable egg-laying by budworm occurred until early October, about a month after planting out. Damage was then evident until late November, with larval numbers at one or two per plant. In December, budworm was present only in flower heads and upper parts of plants, and did little damage to harvestable leaf. The activity of looper was negligible. Damage by leaf-miner was continuously present throughout the trial in lower leaves. In unsprayed plots the damage extended well up the plants.

Fig. 1.—Tobacco leaf-pest control plot. Untreated row in foreground.

(3) Yields

Leaf from the four trials was harvested, cured and bulked-down ready for grading. The grades adopted were a standard series used by the Department in all tobacco trials. Relative grade values were also a standard arbitrary series adopted by the Department and serve to compare leaf values. Summaries of the analyses on yield data are given in Tables 7–10.

TABLE 7

YIELD OF CURED LEAF (MEAN VALUES), PARADA 1960–61, TRIAL A

Programme	Graded Yield (lb/ac)	Relative Acre Index ('000/ac)	Average Grade Index
1	1561	102·6	65·0
2	1522	98·0	64·4
3	1524	100·9	65·8
4	1526	97·3	63·9
s.e.	± 72·5	± 6·87	± 2·02
	No significant differences		
Check (not included in analyses) ..	1101	63·6	57·7

TABLE 8

YIELD OF CURED LEAF (MEAN VALUES), PARADA 1961–62, TRIAL B

Programme	Graded Yield (lb/ac)	Relative Acre Index ('000/ac)	Average Grade Index
1	1633	89·85	54·55
2	1827	102·32	56·10
3	1996	115·47	57·84
s.e.	± 132·7	± 8·571	± 1·405
	No significant differences		
Check (not included in analyses) ..	1217	60·25	48·91

TABLE 9

YIELD OF CURED LEAF (MEAN VALUES), MILLAROO 1960–61, TRIAL C

Programme	Graded Yield (lb/ac)	Relative Acre Index ('000/ac)	Average Grade Index
1	1391	64·1	88·98
2	1386	66·8	92·48
3	1349	66·7	89·80
4	1370	67·8	93·04
s.e.	± 43·83	± 0·99	± 2·152
	No significant differences		
Check (not included in analyses) ..	294	17·52	59·5

TABLE 10

YIELD OF CURED LEAF (MEAN VALUES), MILLAROO 1961–62, TRIAL D

Programme	Gross Yield (lb/ac)	Graded Yield (lb/ac)	Relative Value Index ('000/ac)	Average Grade Index
1	1498	1402	67·7	45·3
2	1488	1394	65·2	43·8
3	1410	1254	53·9	38·2
s.e.	± 34·6	Not analysed	± 2·55	± 1·25
Necessary differences for significance 5%	105	..	7·7	3·8
Necessary differences for significance 1%	146	..	10·7	5·3
	No sig. diffs.	..	1, 2, >> 3	1, 2 >> 3
Check (not included in analyses)	906	681	25·4	28·0

(4) Costs

Prices used in the estimation of insecticide costs (Table 11) are those which ruled commercially at the time of each trial. Plots were sprayed with knapsack sprayers or with hand-held hoses from a stationary power sprayer. These methods would probably be too costly of labour if used on a commercial scale on large areas. In practice, most growers use boom sprays and the estimated full costs of applying the programmes with this type of machinery are given in Table 11.

(5) Phytotoxicity

None of the programmes produced phytotoxic effects.

TABLE 11

COSTS OF SPRAY PROGRAMMES PER ACRE

Programme	Trial A			Trial B			Trial C			Trial D		
	Materials	Application	Total	Materials	Application	Total	Materials	Application	Total	Materials	Application	Total
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1 ..	17 11 0	5 0 0	22 11 0	17 0 0	5 10 0	22 10 0	11 10 0	7 0 0	18 10 0	8 9 0	5 10 0	13 19 0
2 ..	22 3 0	5 0 0	27 3 0	8 15 0	5 10 0	14 5 0	13 4 0	7 0 0	20 4 0	11 3 0	5 10 0	16 13 0
3 ..	32 0 0	5 0 0	37 0 0	15 5 0	5 10 0	20 15 0	16 19 0	7 0 0	23 19 0	3 18 0	4 0 0	7 18 0
4 ..	35 13 0	5 0 0	40 13 0	..	..	..	18 6 0	7 0 0	25 6 0	..	..	..

IV. GENERAL DISCUSSION AND CONCLUSIONS

Endrin and dieldrin were equally efficacious in the tobacco pest control schedules used in the trials. The cost for dieldrin was up to £5 per ac less than for endrin.

The addition of Telodrin to a DDT/endrin or DDT/dieldrin schedule added significantly to the cost without correspondingly increasing the return. Its use can only be justified where the normal schedule fails to control leaf-miner under conditions of very heavy infestation.

A weekly DDT/endrin or DDT/dieldrin schedule satisfactorily controlled all tobacco pests. The minimum total cost of an effective spray programme in each of the four trials varied from about £14 to £23 per ac. In Programmes 2 in Trial B and 1 in Trial D an outlay of £14 per ac gave a net gain over unsprayed plots estimated at £250 per ac.

In mature tobacco a spray volume of 50 gal per ac was adequate for effective control of all pests. This quantity of insecticide must be distributed evenly over both surfaces of all leaves.

V. ACKNOWLEDGEMENTS

Facilities for conducting the trials were provided by the Agriculture Branch and the Research Stations Board of the Department. The work was financed in part by the Tobacco Industry Trust Account. Statistical analyses were carried out by the Biometrics Branch of the Department.

REFERENCES

SAUNDERS, G. W., and ETTERSHANK, G. (1961)—Insecticidal control of leaf-miner in tobacco. *Qd J. Agric. Sci.* 18:403-5.

SMITH, W. A., and SAUNDERS, G. W. (1961)—Tobacco pests in Queensland. *Qd Agric. J.* 87:100-13.

(Received for publication June 20, 1963)