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INSECTICIDE RESISTANCE IN PHTHORIMAEA OPERCULELLA (ZELL.): LARVAL RESPONSES TO ENDRIN AND AZINPHOS-ETHYL

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SUMMARY

The responses to endrin and azinphos-ethyl of all larval instars of a typical Queensland strain of *Phthorimaea operculella* are defined. Endrin resistance, previously reported in adults, was demonstrated in larvae. An increase in variability of larval response to azinophos-ethyl is recorded, as opposed to lack of any significant shift in tolerance when adults were used as test material.

I. INTRODUCTION

Resistances in *Phthorimaea opercullela* (Zell.) to DDT and endrin have been reported from Queensland previously but no resistance was recorded to azinphos-ethyl, the other major insecticide used locally for control of this pest (Champ and Shepherd 1965). In that text, adult females were used to establish tolerance levels and the DDT resistance was characterized further by comparison of larval responses. In the present study, comparisons have been made of larval responses to endrin and azinphos-ethyl, confirming the endrin resistance and providing evidence of an increase in tolerance to azinphos-ethyl, particularly in final instar larvae.

II. MATERIALS AND METHODS

A susceptible strain of *P. operculella* described previously (Champ and Shepherd 1965) was used as a reference strain and compared in all tests with a DDT-endrin resistant strain from Millaroo, North Queensland. Breeding, handling and treatment methods for both larvae and adults were similar. Larval responses were derived from unsexed material in the feeding phase of each instar. Technical grades of endrin and azinphos-ethyl were used for topical testing. Commercial emulsifiable concentrates containing 20 and 50% active ingredient respectively of endrin and azinphos-ethyl were used in dipping tests.

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III. RESULTS

Growth-weight curves for larval male and female *P. operculella* are given in Figure 1.

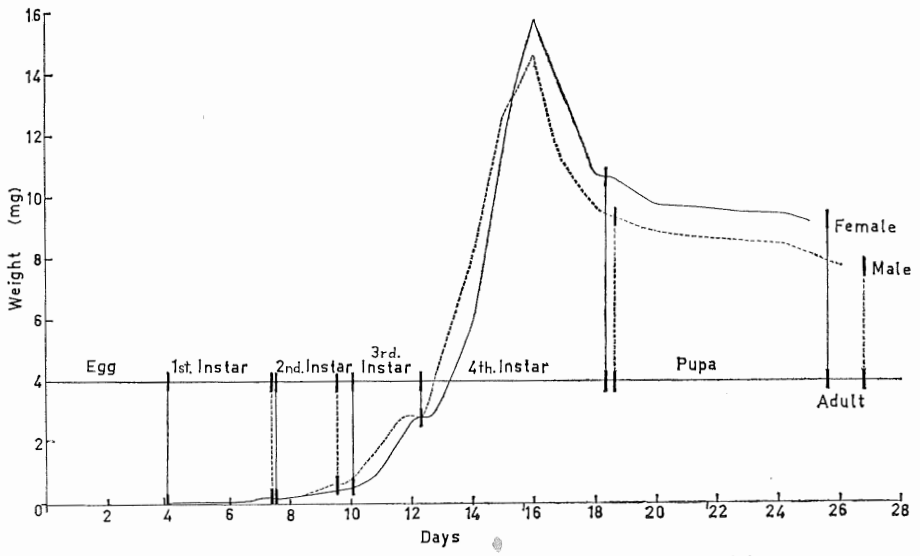


Figure 1.—Growth-weigth curves of *Phthorimaea operculella.*

(a) Endrin

First and second instars.—Percentage successful entries of newly hatched first instar larvae into tobacco plants dipped in endrin emulsion at the concentrations indicated are given in Table 1 together with mortality of second instar larvae present in leaf mines when dipped as for first instar larvae.

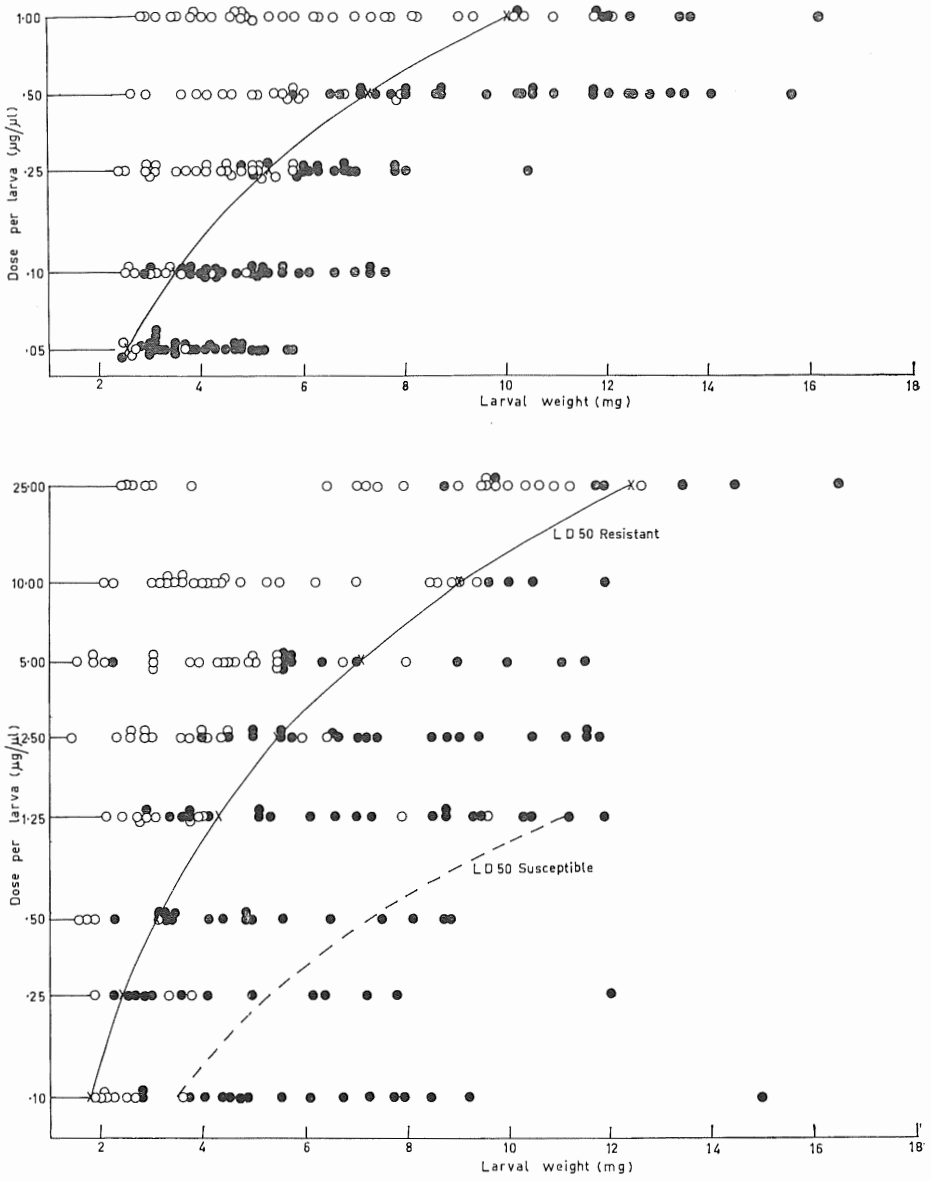
TABLE 1

COMPARISON OF THE ENDRIN SUSCEPTIBILITY OF ENDRIN SUSCEPTIBLE AND RESISTANT FIRST AND SECOND INSTAR LARVAE OF *Phthorimaea operculella*

Dipping Concentration (% endrin)	0	0·0005	0·001	0·002	0·003	0·005	0·01	0·02	0·05
First instar (% successful entries)									
Susceptible	98	9	5	..	0	..	0	..	..
Resistant	81	57	51	..	45	..	3	..	..
Second instar (% mortality)									
Susceptible	0	..	..	65	..	83	86	94	100
Resistant	0	..	..	..	..	29	43	44	82

Differences in tolerance between strains were marked for newly hatched larvae and though present with second instar larvae were less obvious, probably because of poor penetration of endrin into leaf tissue.

Third and fourth instars.—A comparison of the endrin susceptibility of third and fourth instar larvae is given in Table 2 and Figures 2 and 3. Doses are expressed as endrin content ($\mu g/\mu l$) of applied solution. Methods used for fourth instar larvae were essentially similar to those of Way (1954) for individual mortality records of larvae of various weights.



Figures 2, 3.—Response of endrin susceptible and resistant fourth instar larvae of *Phthorimaea operculella* to endrin. (2) susceptible strain; (3) resistant strain. Closed circles represent larvae that survived treatment and open circles those that died. The estimated median response curves are included.

TABLE 2

COMPARISON OF THE ENDRIN SUSCEPTIBILITY OF ENDRIN SUSCEPTIBLE AND RESISTANT THIRD AND FOURTH INSTAR LARVAE OF *Phthorimaea operculella*

Instar	Third		Fourth		
Strain	Susceptible	Resistant	Susceptible	Resistant	Larval weight (mg)
Heterogeneity factor ..	0·618	2·68	0·64	1·69	
Degrees of freedom ..	5	6	15	25	
Parameters of regression equation					
Position	0·414	2·851	4·468	4·047	
Dose	2·333±0·345	0·853±0·289	5·010±0·669	1·694±0·264	
Weight	..	..	−11·001±1·536	−4·845±0·852	
Median concentration (μg/μl)	0·46	1·65	0·07	0·42	3
			0·42	4·77	7
			1·24	17·35	11
95% mortality (μg/μl)	2·34	149·35	0·15	4·0	3
			0·98	44·6	7
			2·63	162·0	11
Transformations ..	Dose (μg/μl)—log $\left(\frac{x}{5}\right)+3$		Weight (mg)—log X_2		

Differences between the two strains in tolerance to endrin were again evident.

(b) Azinphos-ethyl

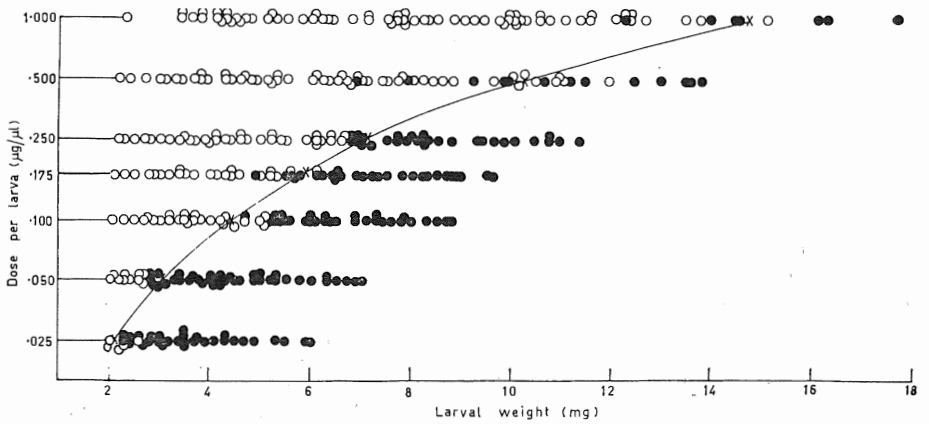
First and second instars.—Percentage successful entries of newly hatched first instar larvae into tobacco plants dipped in azinphos-ethyl emulsion at the concentrations indicated are given in Table 3 together with the mortality of second instar larvae present in leaf mines when dipped as for first instar larvae.

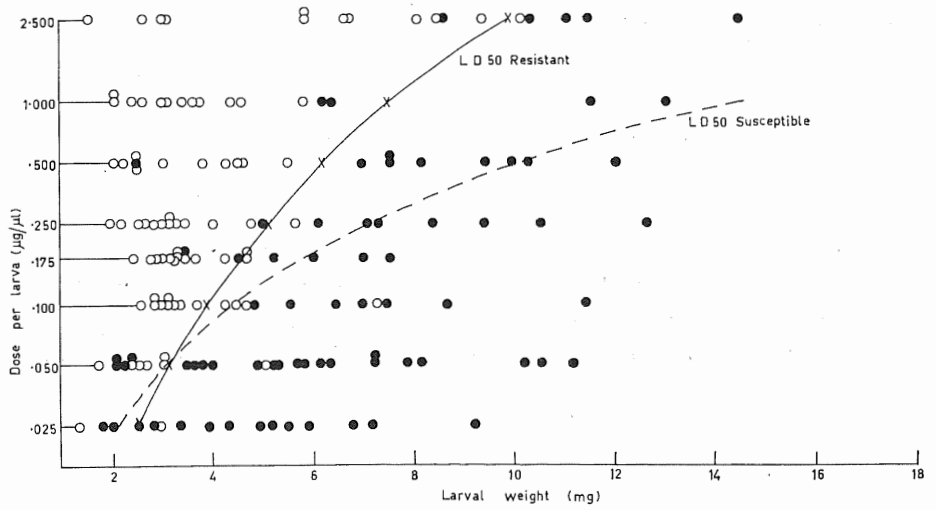
TABLE 3

COMPARISON OF THE AZINPHOS-ETHYL SUSCEPTIBILITY OF DDT AND ENDRIN SUSCEPTIBLE AND RESISTANT FIRST AND SECOND INSTAR LARVAE OF *Phthorimaea operculella*

Dipping Concentration (% azinphos-ethyl)	0	0·0005	0·001	0·002	0·003	0·005	0·01	0·02	0·05
First instar (% successful entries)									
DDT-endrin susceptible ..	98	0	0	..	0	..	0	..	..
DDT-endrin resistant ..	81	0	0	..	0	..	0	..	..
Second instar (% mortality)									
DDT-endrin susceptible ..	0	..	..	98	..	98	100	100	100
DDT-endrin resistant ..	0	..	..	..	..	100	86	91	100

A slight increase in tolerance of the DDT-endrin resistant strain to azinphos-ethyl was indicated in second instar larvae.





Figures 4, 5.—Response of DDT-endrin susceptible and resistant fourth instar larvae of *Phthorimaea operculella* to azinphos-ethyl: (4) susceptible strain; (5) resistant strain. Closed circles represent larvae that survived treatment and open circles those that died. The estimated median response curves are included.

Third and fourth instars.—A comparison of the azinphos-ethyl susceptibility of third and fourth instar larvae is given in Table 4 and Figures 4 and 5. These data were derived as for endrin comparisons presented earlier.

TABLE 4

COMPARISON OF AZINPHOS-ETHYL SUSCEPTIBILITY OF DDT AND ENDRIN SUSCEPTIBLE AND RESISTANT THIRD AND FOURTH INSTAR LARVAE OF *Phthorimaea operculella*

Instar	Third		Fourth		
Strain	Susceptible	Resistant	Susceptible	Resistant	
Heterogeneity factor ..	0·036	0·914	1·78	0·27	Larval weight (mg)
Degrees of freedom ..	4	6	24	14	
Parameters of regression equation					
Position	−2·632	2·161	4·618	6·480	
Dose	4·622±0·18	1·561±0·254	5·917±0·628	2·074±0·321	
Weight	..	..	−11·343±1·328	−7·097±1·146	
Median concentration (μg/μl)	0·22	0·33	0·05	0·04	3
			0·24	0·76	7
			0·58	3·53	11
95% mortality (μg/μl)	0·51	3·73	0·09	0·26	3
			0·46	4·94	7
			1·09	21·95	11
Transformations ..	Dose (μg/μl)—$\log\left(\frac{x}{5}\right)+3$		Weight (mg)—$\log X_2$		

A change in regression coefficients, indicating a greater spread of the tolerance distribution in the DDT-endrin resistant strain, was evident from Table 4. As there has been little change in the position parameter, true resistance was unlikely—rather the population tested was a step closer to resistance, with the increased tolerances appearing at extreme mortalities and larval weights, allowing an enhanced selection rate.

IV. DISCUSSION

The results presented demonstrate the presence of endrin resistance in larval *P. operculella* and a greater variability in response of local strains to azinphos-ethyl when compared with a DDT-endrin susceptible strain. Adult material did not indicate this change of tolerance characteristics (Champ and Shepherd 1965). It must be presumed that if selection is allowed to operate, which it must under field conditions, then azinphos-ethyl resistance will appear in the foreseeable future.

V. ACKNOWLEDGEMENTS

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