Insecticide Resistance Levels in *Heliothis spp.*

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Introduction

Heliothis spp. are arguably the most important agricultural pests in Australia. There are two pest species, *Heliothis armigera* (the cotton bollworm) and *Heliothis punctigera* (the native budworm). *Heliothis armigera* has a long history of insecticide resistance in Australia. In 1974, following the occurrence of DDT resistant *Heliothis armigera*, a *Heliothis* resistance monitoring program was initiated by the NSW Department of Agriculture at Tamworth. All insecticide management decisions require a solid platform of reliable data and this can only be achieved by a long term committment to pesticide studies, obtaining baseline susceptibility data and monitoring of changes in resistance levels. In this paper, a summary of findings from this resistance monitoring program from 1974 to 1988 will be presented. Insecticides screened have been pyrethoids, endosulfan, carbamates and organophosphorous compounds. At the same time, research has been conducted to develop innovative bioassay methods for chemicals with novel modes of action or unusual methods of entry into *Heliothis* spp.

Endosulfan Resistance in *Heliothis armigera*

Endosulfan susceptibility in NSW and Queensland has been monitored since the 1970's and a summary of data since 1979 is shown in Figure 1. The mean LD_{50}'s and slopes of dosage mortality lines are plotted yearly.

Endosulfan resistance in *Heliothis armigera* larvae is evident, in 1983, there was a significant increase in the mean LD_{50} and have remained high ever since. Decreasing slope values, at the same time, showed that there was much heterogeneity in the response of the population toward endosulfan. In 1986/87-87/88, to save time, we screened for endosulfan resistance by means of a discriminating dose on 30-40 mg larvae. Data from New South Wales (unsprayed sites) is shown in Table 1 and shows that low levels of endosulfan resistance were widespread in *Heliothis armigera* communities in eastern Australia.

Carbamate Resistance in *Heliothis armigera*

Since 1983, plenty of baseline data for methomyl has been obtained *Heliothis armigera* collected in eastern Australia were bioassayed as third instar larvae. The mean LD_{50}'s for each year are plotted in Figure 2, they showed increasing methomyl tolerance 1983-1986. In 1986 resistance was proven in larvae from crops where methomyl had failed to control *Heliothis armigera*. The resistance factor was estimated to be about 30x (Figure 3). Since 1986/87 the resistance frequency in the population has been estimated by using the discriminating dose technique, 1986-88 data are shown in Table 1. Results show low levels of methomyl resistance are widespread in New South Wales *Heliothis armigera* larvae.

There is no sign of resistance to another carbamate thiodicarb, recently introduced for *Heliothis* control (Figure 4).

Methomyl is also used as an ovicide against *Heliothis armigera*. It was considered necessary to ascertain whether the methomyl resistance found in larvae was also expressed by *Heliothis* eggs. A Bioassay method was developed to test the efficacy of methomyl against *Heliothis armigera* eggs. No differences were found between the eggs of methomyl resistant and susceptible strains (Figure 5), indicating that methomyl resistance was not expressed in the *Heliothis armigera* egg stage. Studies to 1988 show that *Heliothis armigera* eggs continue to be susceptible to methomyl.

Organophosphorus Insecticides

Sulprofos and profenfos have been monitored against 3rd instar *Heliothis armigera* since 1983 and valuable baseline data has been accumulated. Data obtained is summarised in Figure 6, there have been no significant changes in mean LD^{*}_{50}'s from 1983-1988.

1st Instar Bioassay of *Heliothis* Larvae

The 3rd instar larval bioassay of *Heliothis spp.* is very time consuming and expensive because it involves a lot of insect rearing. In the last season, efficient labour saving techniques to bioassay first instar *Heliothis* larvae have been developed. One seasons data, for 1987/88, testing the efficacy organophosphates, methomyl and endosulfan against 1st instar *Heliothis armigera* and *Heliothis punctigera* exists.

Insecticide resistance status of *Heliothis punctigera*

The susceptibility of *Heliothis punctigera* to various insecticides has been monitored against 3rd instar larvae since the late 1970's to the present and considerable baseline toxicity data exists, especially for fenvalerate, deltamethim and endosulfan. During this study time there has been no evidence of any developing tolerance *Heliothis punctigera* toward insecticides.

Summary

Heliothis armigera and *Heliothis punctigera* have been monitored for insecticide resistance at the Tamworth Agricultural Research Centre since the 1970's. In *Heliothis armigera*, endosulfan resistance have been obvious since 1983, concurrent with greatly increased endosulfan use in crops. Low levels of endosulfan resistance are widespread in Queensland and New South Wales. There is low-level resistance to the carbamate methomyl in *Heliothis armigera* larvae, but this resistance is not expressed in the egg stage. No signs of resistance have been detected in *Heliothis armigera* toward the organophosphorous insecticides. *Heliothis punctigera* larvae and eggs remain susceptible to all insecticides.

Table 1. *Heliothis armigera* larval insecticide resistance levels in unsprayed cropping areas of New South Wales

		% Resistance*		
Insecticide	Season+	Stage 1	Stage 2	Stage 3
endosulfan	1986/87	15.0±1.9	16.0±3.5	2.67±5.3
	1987/88	28.2	13.0	
methomyl	1986/87	21.6±1.5	24.8±5.6	37.5±8.0
	1987/88	19.0	27.7	

* determined by a discriminating dose technique.

+ data from 1987/88 season is not yet complete.

Figure 1. Endosulfan resistance in H. armigera in 1979-1986

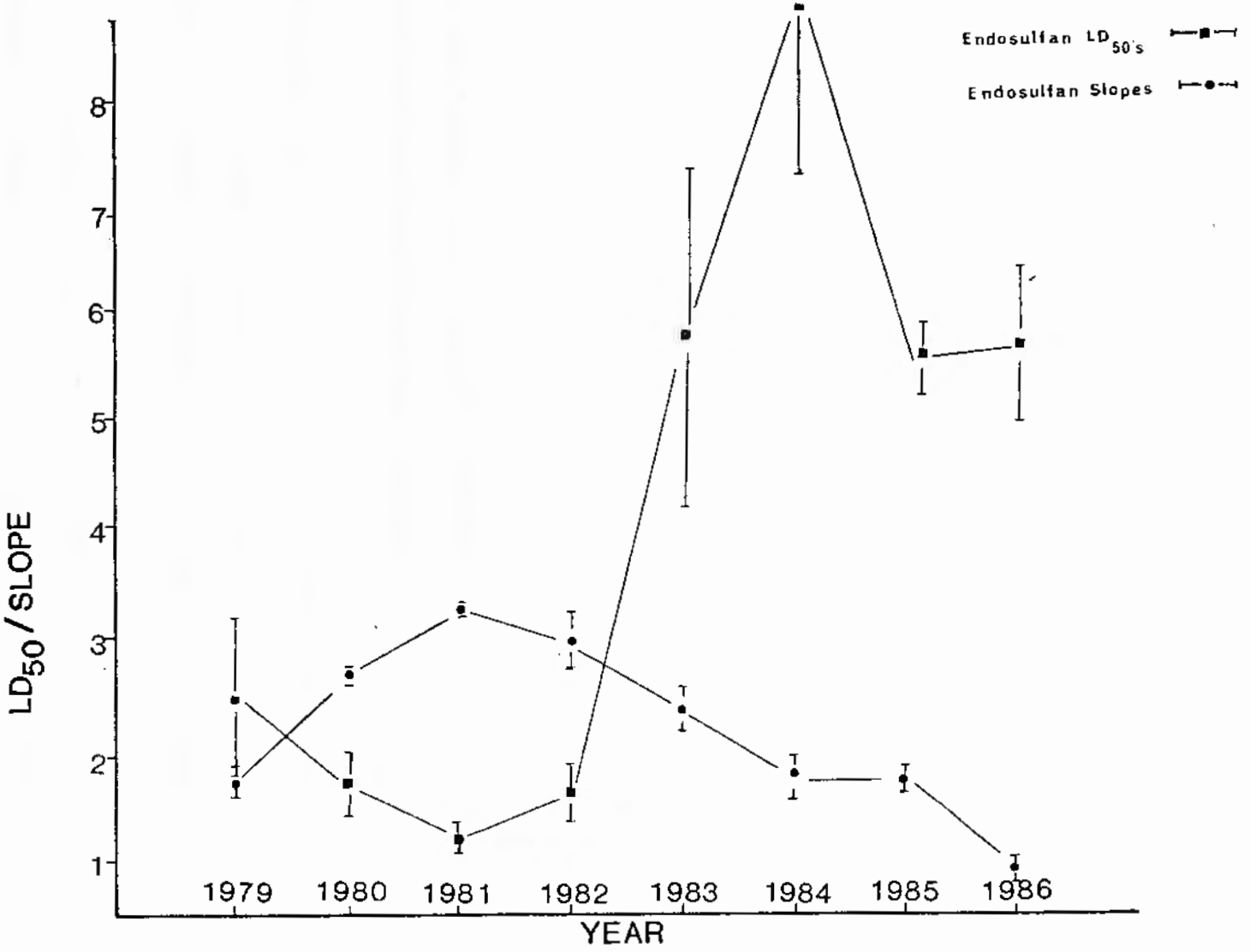

Figure 2. Toxicity of methomyl to H. armigera larvae 1983-1986.

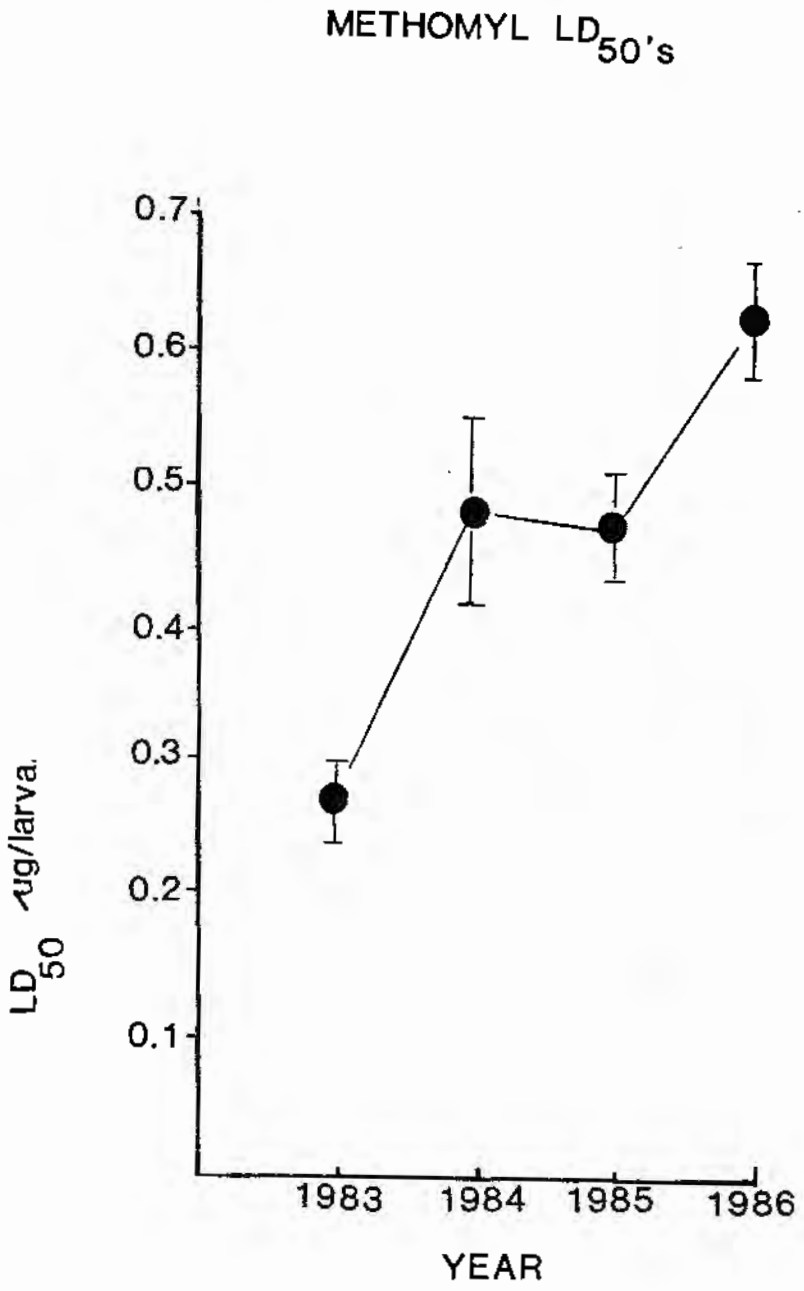

Figure 5.

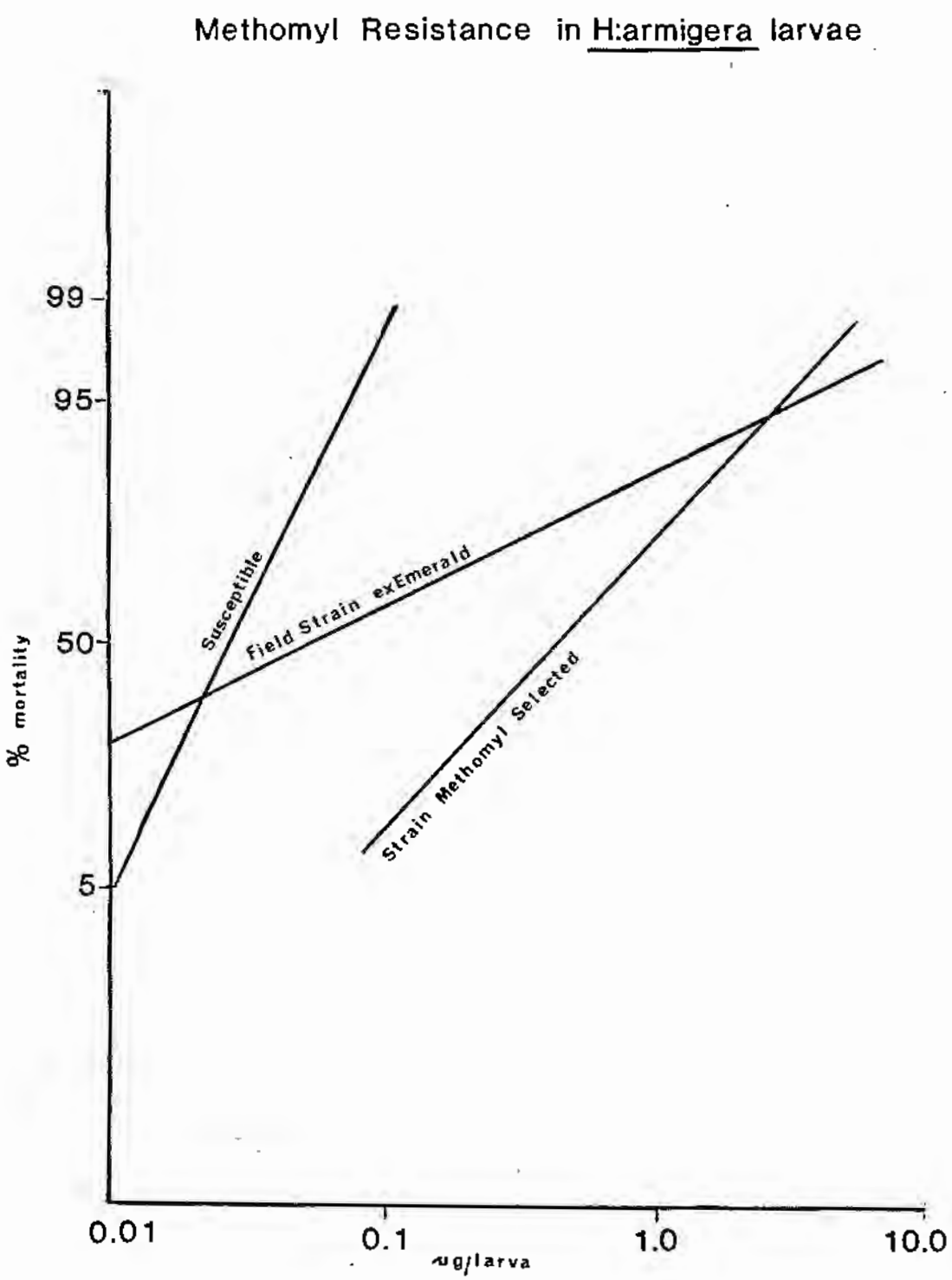
Methomyl Resistance in H:armigera larvae
99
95
50
5
% mortality
Susceptible
Field Strain exEmerald
Strain Methomyl Selected
0.01
0.1
1.0
10.0
ug/larva

Fig 4 Toxicity of thiodicarb against H.armigera 1983 - 1988

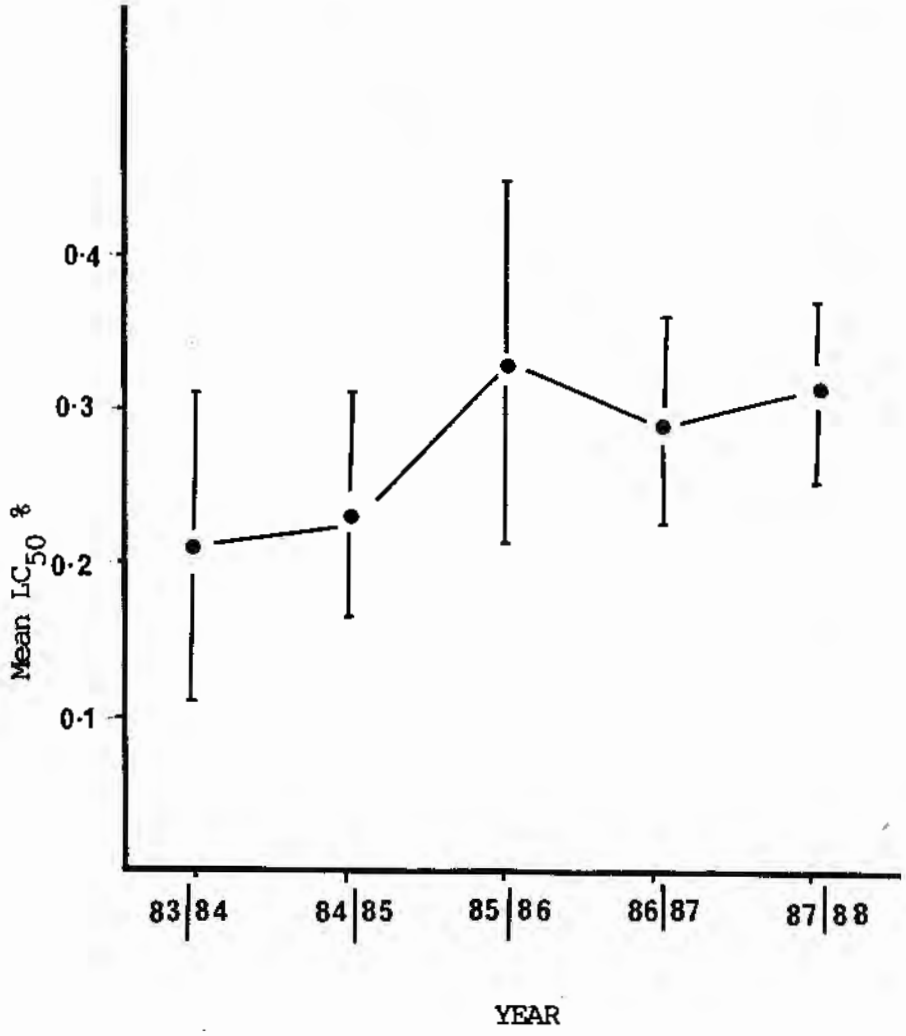

Figure 5. Toxicity of methomyl to H. armigera eggs.

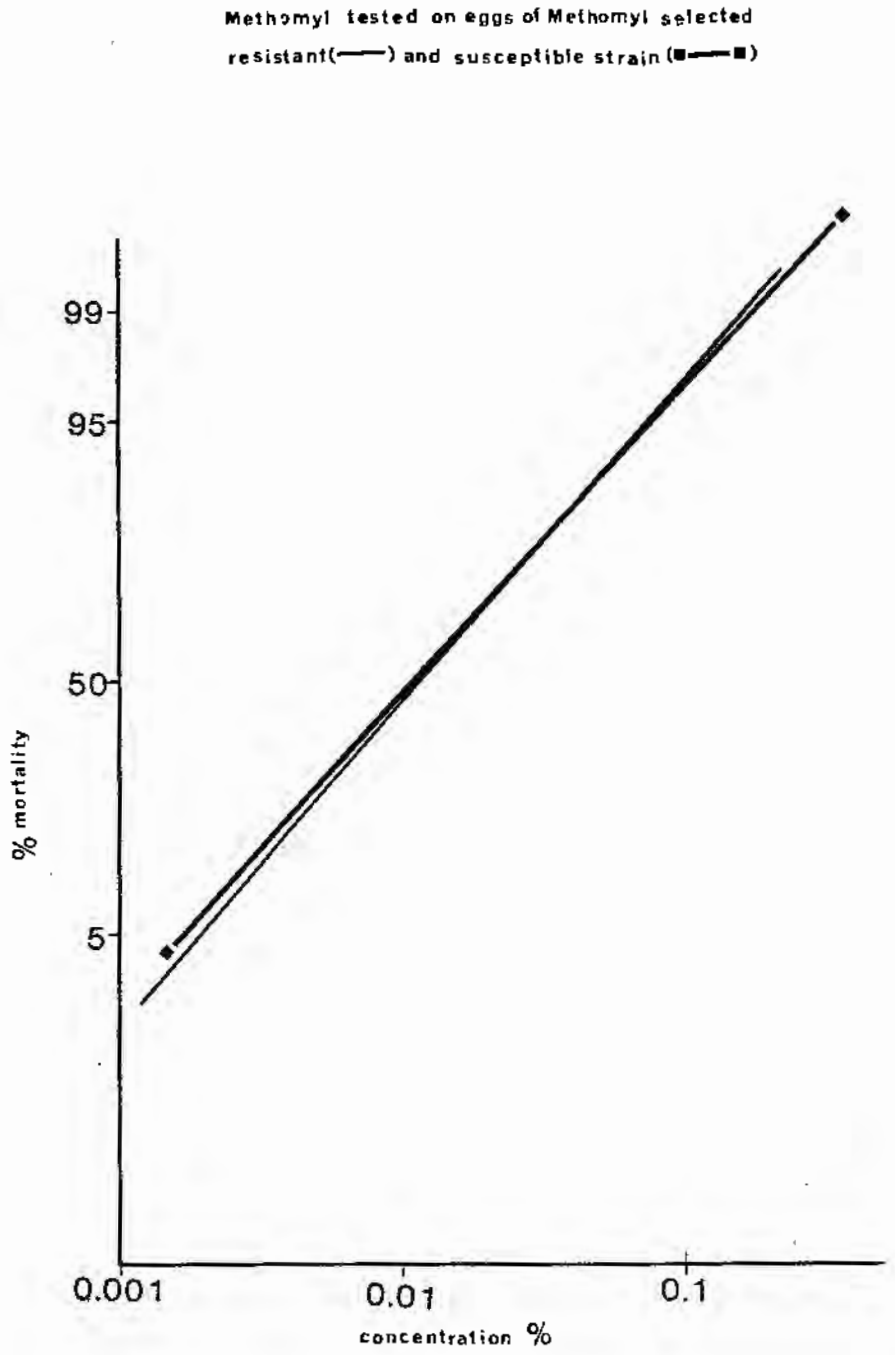

Fig 6 Toxicity of organohosphates against H.armigera larva 1983 - 1988