EFFECT OF PIPERONYL BUTOXIDE ON THE TOXICITY OF SOME PESTICIDES TO THE PALM MITE, *RAOIELLA INDICA* HIRST (TENUIPALPIDAE : ACARINA)

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Piperonyl butoxide was found to synergize trichlorphon, dichlorvos, chlorobenzilate, [1, 1, bis (4-chlorophenyl)-2, 2, 2-trichloroethanol] and [2, 2-bis (*p*-chlorophenyl) ethanol] as co-toxicity coefficient values were > 1·8, > 2·8, 1·570, 1·910 and 1·853 respectively, while it antagonized parathion, [0, 0-diethyl S-(*p*-chlorophenyl thiomethyl) phosphorothioate] and phosphamidon, as the co-toxicity coefficient values were 0·056, 0·431 and 0·281, against the adult palm mite, *Raoiella indica* Hirst. Results obtained have been discussed in the light of earlier work.

Sun and Johnson (1960) have shown that sesamex, a pyrethrins synergist, increased the toxicity of some pesticides to *Musca domestica* L. by 38·7 times. Efforts were therefore made to see the effect of piperonyl butoxide, a pyrethrins synergist, on the toxicity of pesticides to the palm mite, *Raoiella indica* Hirst.

Materials and Methods

The technical grades of insecticides were formulated as emulsions, using 1% v/v benzene as solvent and 0·05% v/v polyoxyethylene sorbitan monooleate (commercially known as Tween 80) as emulsifier. Commercially formulated emulsion concentrate, based on chlorobenzilate, was diluted with distilled water up to 0·1% concentration and, while preparing concentrations lower than that, the requisite quantities of benzene and emulsifier, as given above, were added. The proportion of piperonyl butoxide in its mixture with pesticide was maintained at 10 : 1. Piperonyl butoxide was used at a highest concentration of 1% v/v and was found to be non-toxic to the mites.

The leaves, bearing the mites on the under surface, were cut into small strips (4 cm × 2 cm) and sprayed under Potter's Tower with one ml of pesticidal emulsion at 24 cm Hg pressure. The amount of wet spray was found to be 1·20 mg per sq. cm. After treatment, the leaf strips, bearing the treated mites, were kept in petridishes on cotton soaked in water and were stored in a room maintaining a temperature of about 21° C. Mortality observations of the adult mites were taken 48 hours after treatment under a binocular microscope. At least 30 mites were used for each treatment. The mortality data were subjected to Probit analysis (Finney 1952) and the results are presented in Table I and Figs. 1–8. The maximum mortality of the mites in control was found to be 19%.

As piperonyl butoxide was non-toxic to the mites at a concentration of 1·0%, the co-toxicity coefficient factor was calculated by the following formula:

$$\begin{bmatrix}\text{Co-toxicity coefficient factor} \\ \text{(C.F.)}\end{bmatrix} = \frac{LC_{50} \text{ of toxicant alone}}{LC_{50} \text{ of toxicant in mixture}}.$$

If the value of C.F. is more than unity, the mixture indicates synergism and if it is less than unity, it shows antagonism.

Results and Discussion

It is evident from Table I and Figs. 1–8 that piperonyl butoxide synergizes trichlorphon, dichlorvos, chlorobenzilate, chemical-2 [1, 1, bis (4-chlorophenyl)-2, 2, 2-trichloroethanol, commercially known as kelthane] and chemical-3 [2, 2-bis (*p*-chlorophenyl) ethanol, commercially known as Dimite or DMC]

Fig. 1.

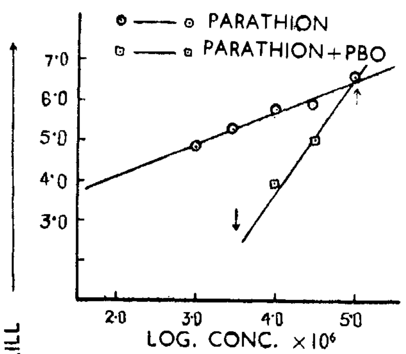
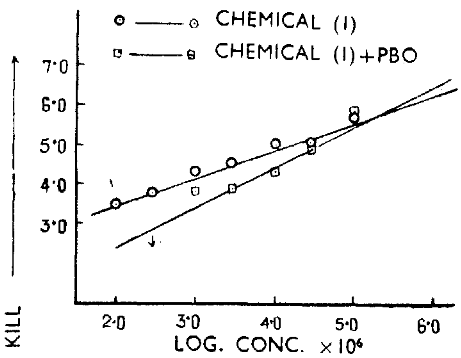


Fig. 2.



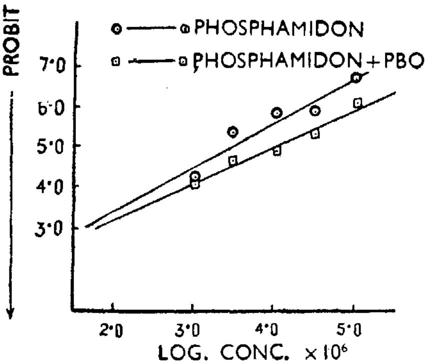


Fig. 3.

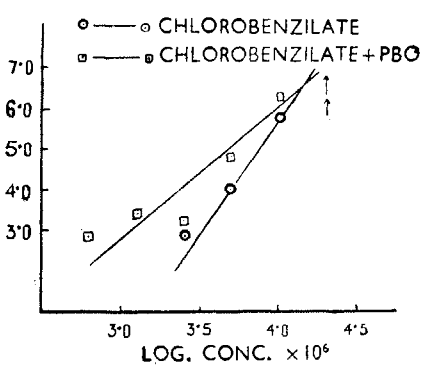


Fig. 4.

as C.F. values are > 1·8, > 2·8, 1·570, 1·910 and 1·853 respectively, while it antagonizes parathion, chemical-1 [0, 0-diethyl S-(*p*-chlorophenyl thiomethyl) phosphorothioate, commercially known as Trithion] and phosphamidon, as the respective C.F. values are 0·056, 0·431 and 0·281.

Fig. 5

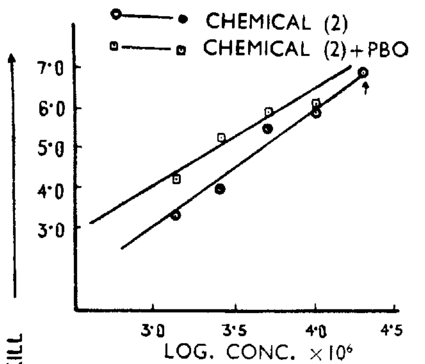
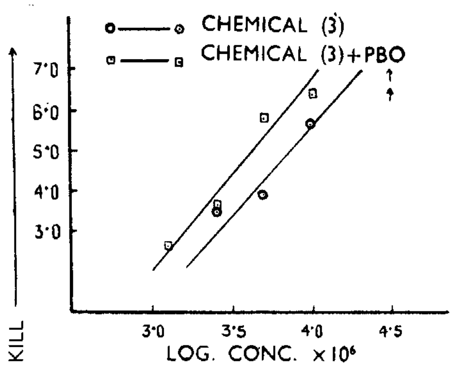


Fig. 6



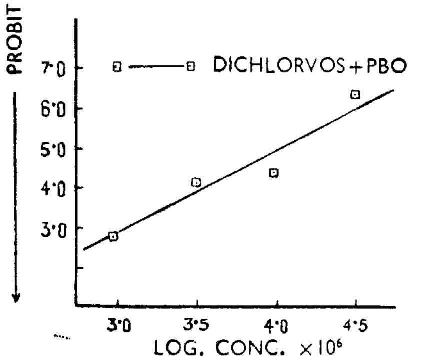


Fig. 7.

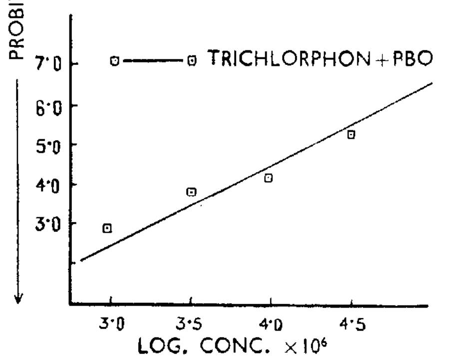


Fig. 8.

Sun and Johnson (1960) have shown that sesamex antagonizes parathion (C.F. = 0·63) in *M. domestica* and have indicated that it might be inhibiting the *in vivo* conversion of parathion by oxidation to paraoxon, a more toxic product. In the present investigations against the mite (*R. indica*), piperonyl butoxide has been found to antagonize parathion (C.F. = 0·056) and chemical-1 (C.F. = 0·431), both of which are known to be oxidized to more toxic products. Sun and Johnson (1960) have found that sesamex synergizes phosphamidon against *M. domestica* (C.F. = 14·6) and have mentioned that it might be inhibiting the degradation of phosphamidon. However, in studies with *R. indica* piperonyl butoxide antagonizes phosphamidon (C.F. = 0·281). It may be of interest to mention here that in kidney bean plants, one of the metabolites of phosphamidon named desethyl-phosphamidon [0, 0-dimethyl-(2-chloro-2-ethyl carbamoyl-1-methyl vinyl)-phosphate] is twice more toxic in fly-feeding tests than phosphamidon (Anliker *et al.* 1960).

TABLE I

Data on the toxicity of pesticides alone and in mixture with piperonyl butoxide to palm mite, **Raoiella indica** *Hirst.*

Pesticides		Heterogeneity	Regression equation	LC_{50}	Co-toxicity coefficient
Parathion	(a) ..	$\chi^2_{(3)} = 0{\cdot}438$	$Y = 0{\cdot}821x + 2{\cdot}389$	0·001514	
	(b) ..	$\chi^2_{(3)} = 0{\cdot}676$	$Y = 2{\cdot}958x - 8{\cdot}110$	0·02704	0·056
Chemical-1	(a) ..	$\chi^2_{(5)} = 1{\cdot}596$	$Y = 0{\cdot}710x + 2{\cdot}071$	0·01334	
	(b) ..	$\chi^2_{(3)} = 5{\cdot}380$	$Y = 1{\cdot}005x + 0{\cdot}487$	0·03094	0·431
Phosphamidon	(a) ..	$\chi^2_{(3)} = 6{\cdot}687$	$Y = 1{\cdot}123x + 1{\cdot}204$	0·002399	
	(b) ..	$\chi^2_{(3)} = 2{\cdot}429$	$Y = 0{\cdot}926x + 1{\cdot}360$	0·008527	0·281
Dichlorvos	(a) ..	0·1% concentration gave only 41% kill of the mites			
	(b) ..	$\chi^2_{(2)} = 4{\cdot}710$	$Y = 1{\cdot}987x - 4{\cdot}030$	0·03499	> 2·8
Trichlorphon	(a) ..	0·1% concentration gave only 19% kill of the mites			
	(b) ..	$\chi^2_{(2)} = 3{\cdot}797$	$Y = 2{\cdot}010x - 4{\cdot}515$	0·05407	> 1·8
Chlorobenzilate	(a) ..	$\chi^2_{(2)} = 0{\cdot}491$	$Y = 5{\cdot}874x - 17{\cdot}632$	0·007112	
	(b) ..	$\chi^2_{(4)} = 5{\cdot}152$	$Y = 3{\cdot}416x - 7{\cdot}490$	0·004529	1·570
Chemical-2	(a)* ..	$\chi^2_{(3)} = 8{\cdot}654$	$Y = 3{\cdot}067x - 6{\cdot}193$	0·004457	
	(b) ..	$\chi^2_{(3)} = 6{\cdot}595$	$Y = 2{\cdot}401x - 3{\cdot}987$	0·002333	1·910
Chemical-3	(a) ..	$\chi^2_{(2)} = 3{\cdot}562$	$Y = 4{\cdot}650x - 13{\cdot}031$	0·007534	
	(b) ..	$\chi^2_{(2)} = 0{\cdot}200$	$Y = 4{\cdot}665x - 11{\cdot}838$	0·004064	1·853

* The data were found to be heterogeneous at P = 0·05.
Y = Probit kill. x = log. concentration $\times 10^6$.
LC_{50} = The concentration calculated to give 50% kill.
(a) = Pesticide alone.
(b) = Pesticide : piperonyl butoxide :: 1 : 10, but concentration mentioned on basis of pesticide alone.

The stabilization of dichlorvos against detoxication has been mentioned by Sun and Johnson (1960) to account for synergistic effect of sesamex with it, against house-flies (C.F. = 2·2). Against *R. indica* also piperonyl butoxide synergizes dichlorvos (C.F. = > 2·8). Metcalf *et al.* (1959) and Miyamoto (1959) have shown that trichlorphon changes non-enzymatically to dichlorvos and the former's lethal action is due to the latter. Thus, it may be inferred that the synergistic action of piperonyl butoxide with trichlorphon in *R. indica* (C.F. = > 1·8) may be due to its first conversion to dichlorvos and then the stabilization of the latter against detoxication.

There is no information available on the metabolism of the acaricides, i.e. chlorobenzilate and chemical-2 and -3. As discussed earlier if synergism of pesticides with pyrethrins synergists indicates detoxication *in vivo* and antagonism indicates activation, then these acaricides probably undergo detoxication in *R. indica*, as piperonyl butoxide has been found to synergize chlorobenzilate (C.F. = 1·57), chemical-2 (C.F. = 1·91) and chemical-3 (C.F. = 1·853). It is of interest to mention here that according to Perry *et al.* (1953) chemical-3 undergoes degradation in *M. domestica*.

Acknowledgements

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