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CORRELATION BETWEEN TOXIC NATURE OF PYRETHROID AND BEHAVIORAL RESPONSE OF DESERT LOCUSTS

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ABSTRACT:

Optomotor normal visual response of the locust *Schistocerca gregaria* was compared when injected (between 1st and 2nd thoracic segments) with 10, 5, 2.5 and 1.25 µg/g body weight doses of Permethrin after different intervals of time (just after injection, 10 and 20 minutes). LD_{50} value for Permethrin was calculated to be 3.0 µg/g. Results are analyzed statistically by *I.* test and ANOVA technique. It was noticed that there was a significant decrease of vision (P<0.005, Table II) in treated locusts and at the same time Permethrine effect is significantly time related (P<0.05, ANOVA, table III).

Correlation between increasing age, weight and increasing toxicity has also been established. The inhibition of neural *enzyme* Cholinesterase with Permethrin and as a result more accumulation of acetylcholine at nerve junctions and less passage of the transmission of impulses thus less response from the locusts has also been explored and discussed.

INTRODUCTION

In laboratory the degree of toxicity of an insecticide was based mainly on the manner in which the insecticide made contact with the insect. The insecticide was usually applied as a formulation and composition of formulation could effect the rate of penetration of an insecticide into the body of the insect. A decreased toxicity could be due to less penetration of the insecticide rather than a real decrease in the toxicity of the insecticide (MacCuaig, 1957; Parry, 1964, and Ahmed and Gardiner, 1979).

Toxicity of insecticide was effected by the mode of application. Injection of the insecticide in the body was more toxic than its topical application (Farnham et al., 1965). The main reason for these toxicity variations was perhaps the presence of efficient mechanism of detoxification in insects due to which a rapid build up at the site of toxic action was prevented or delayed either due to less penetration or lack of active transportation to site of toxic action (Ahmed and Gardinar, 1968). Difference in susceptibility to insecticides in different regions of the body had also been reported by Ahmed and Gardiner (1968, 1969). They observed that malathion had more toxic effect when applied to neck membrane of desert locust than to other parts of the body.

Much of the above mentioned work had been done to show that how the mode of contact, the site and detoxification mechanism of insect effect the toxicity of the different insecticides. No observation had been reported showing effect of insecticides on eyes of locusts specifically relating to their resolving power.

An effort was made to estimate the variations in the behavioral responses from the locusts by use of different concentrations and doses of Pyrethroids which are an important set of insecticides.

MATERIAL AND METHODS

Adults of both sexes of Schistocerca *greearfa* were obtained from the desert area of Sind, Pakistan and were reared in our laboratory. Experimental set up including recoding, stimulating and illuminating device of Burn and Rail (1974) and Horridge (1966) were used in this work. For calculating and injecting different doses of insecticides, dosage calculator and microdrop apparatus capable of giving small measured volumes of insecticidal solutions (MacCuaig and Watts, 1960) were used.

Insecticide Permethrin belonging to Pyrethroids group of insecticides was used in this work. Solutions of 10, 5, 2.5 and 1.25 µg/g. body weight of Permethrin were prepared in xylene (because Permethrine is only miscible in this solvent) at room temperature. Each insect was weighed and the amount of insecticide (actual ingredient) adjusted according to the body weight. The volume of the insecticide applied to each locusts therefore varied according to the dose as well as to the weight of the insect.

Various sites of application of insecticide in locusts were tried. Injection of insecticide between 1st and 2nd thoracic segment was proved to be best to *give* more toxic effects on the vision. The record of resolving power from the locust both treated and control were recorded by Physiograph, whose pen was calibrated such that it moved through 0.5mm, on the recording paper, when 0.1 volts of current was passed through it. So by simply measuring the height of the spike on the recording paper, resolving power of the locust was determined in volts.

Table I
Effect of Various Doses of Permethrin on Visual Responses of Locusts
***Schistocerca gregoria,* Average of 10 Locusts in each case**
Difference is Mean ± S.E.

S. No.	**Dose µg/g B.W.**	**Visual responses of locusts at different intervals before and after treatment with insecticides (volts)**					
		Before Treatment	**Just after Treatment**	**10 Mins. After Treatment**	**20 Mins. After Treatment**	**30 Mins. After Treatment**	**40 Mins. After Treatment**
1)	10	7.36 ± 0.023	0.7 ±0.307	*	----	----	----
2)	05	7.39 ± 0.010	7.17 ± 0.472	4.08 ± 0.048	3.17 ± 0.47	*	
3)	2.5	7.38 ± 1.013	7.03 ± 0.03	5.12 ± 0.044	3.51 ± 0.132	5.58 ± 0.312	7.375** ± 0.014
4)	1.25	7.45 ± 0.266	7.49 ± 0.073	5.86 ± 0.073	6.79 ± 0.179	7.4** ± 0.00	----

* = Dead, **= Become Normal

Table II

Dose µg/g B.W.	Normal with just After treatment	Normal with 10 mins. after treatment	Normal with 20 mins. after treatment
5	7.17 ± 0.472	4.08 ± 0.048*	3.17 ± 0.47*
2.5	7.03 ± 0.03*	5.12 ± 0.044*	3.51 ± 0.012*
1.25	7.49 ± 0.073	5.86 ± 0.073*	6.79 ± 1.179***

** = P<0.005
*** = P<0.025
Difference is Mean ± S.E.

Table III
Comparison of Effect of Different Doses of Permethrin at Different Time Intervals on Visual Responses of Locust *Schistocerca gregaris*

Source	ANOVA			
	DF	SS	MS	F
A	3	21.33	7.11	7.561
B	2	4.86	2.43	2.59
Error	6	5.63	0.94	
Total	11	31.82		

* = P<0.05
A = Times (Just after Treatment) 10 & 20 Mins. After Treatment
B = Doses (5, 2.5 & 1.25 pg/g of 6. W. Permethrin)

RESULTS AND DISCUSSION

Average values of resolving power of ten adult locusts with different doses of Permethrin were studies with different intervals of time (Table-I). A value of 3.0 µg/g. body weight was estimated as LD_{50} value for permethrin. All P. values are calculated by t-test and ANOVA technique.

With high dose, 10 µg/g. of Permethrin the response of the locust decreased sharply from normal value of 7.36 ± 0.02 to 0.7V ± 0.30 volts in one to two minutes after injection compared to 6.79 t 0.17 volts after 20 minutes of injection with a dilute dose of 1.25 pg/g. body weight (Fig. IA and ID). Similar decreasing responses from normal were also observed with toxicities ranging between two above-mentioned doses (Fig. 1-b 5 µg/g. and 1-c 2.5 µ/g). The pattern of response was different for different doses i.e. with lower toxicities normal response was regained in matter of 10-20 minutes which was never obtained or delayed with higher toxicities (Fig. 1).

Effect of different doses of Permethrin on visual response was then calculated statistically by t-test and ANOVA technique. It had been noticed (Table II) that there was a significant decrease in the vision of locusts ($P<0.005$) and insecticidal effect is significantly time related ($P<0.05$, ANOVA, Table III).

Toxicity of an insecticide depends on factors like mode and site of application of insecticide and also on weight and sex of an insect.

Studies showed that toxicity of insecticide is effected mainly by mode and site of its application is extensively undertaken by many workers (Ahmed and Gardiner, 1968, 1970; MacCuaig, 1958) and the present studies also confirm the previous findings. MacCuaig (1958) working on locusts had reported that when malathion was applied topically to the vertex, it killed locusts more quickly and in greater number than when applied to the abdomen. These findings were also confirmed by Ahmed and Gardiner (1968, 1970).

Our data also supports the above observations that toxicity of an insecticide depended mainly on mode and loci of its application. We have explored experimentally that injection of insecticide between first and second thoracic segment proved to be the best mode and site for getting excellent toxicity results.

Latter Ahmed and Gardiner (1970) confirmed their previous findings by emphasizing that there were some inherent differences in the susceptibility of various body regions associated perhaps with the differential vulnerability of some vital internal organs as central nervous system.

Permethrin like all synthetic pyrethroids kills insects by strongly exciting their nervous system, rather than sending a single impulse, Permethrin exposed nerves send a train of impulses. This excitation is because Permethrin blocks the movements of sodium ions from outside to inside *of ne*rve cells (Vijverhery, 1990).

It had been examined extensively that toxicity of insecticides varied with age and particularly weight of an insect. The change in toxicity between age groups might be due to differences in the rate of penetration through the cuticle. More penetration in instars is due to thin cuticle as compared to the adult locusts. Age of the locusts combined with different weights could cause great changes in the toxicity of an insecticide (MacCuaig, 1957; Farnham, et al., 1965; and Haque and Jaleel, 1969).

Research work done also reveals the fact that sensitivity of Pemethrin is also related age to adults being less affected than children (Cantalamena, 1993 and Caroline Con 1998).

Our work also confirmed the above findings showing that locusts having less weight were greatly effected by the insecticides which was perhaps due to the fact that the cuticle is sot) and more permeable to insecticide in less weight locusts. But penetration of insecticide was tine only when the insecticide was applied topically. In our work insecticide was injected in the body through first and second thoracic segment but same degree of differences in toxicity were observed between light and heavy locusts may be due to their tolerance ability.

MacCuaig and *Sawyer* (1951) had noticed the differences in toxicity, males being easily effected by insecticide than females. Latter MacCuaig et al. (1958) had confirmed these results showing that females required more than twice as much insecticide per locust to obtain the same percentage kill of both sexes.

Some differences in sex and toxicity was also noticed in our experiment. Females always responded more strongly to given stimulus than males of same age but with less weight. Similarly males showed more toxic effects to insecticide than females of approximately same age but more weight.

It is well known fact that insecticides particularly Organophosphates act as potent inhibitors of neural enzyme chol^{i}nesterase in insects (Winteringahm, 1955; Mengle and Casida, 1960. MacCuaig, 1962 b; Parry, 1964; Bigley, 1966; Burt, et al., 1966; O'Brinc, 1966, 1969 and Eugene, et al., 1966). Due to inhibition of Cholinesterase, acetylcholine accumulated at the nerve junctions and hindered the transmission of the impulses, the more toxic the insecticide more inhibition of the Cholinesterase. Thus more accumulation of acetylcholine and less response from the locusts. Permetherin inhibits a variety of nervous system enzymes, ATPase, monoamine oxidase-A and thus there is an increased release of acetylecholine with reduced breakdown (Al-Rahiji 1990, Rao & Rao 1993 & 1995).

Our studies also yielded the same results as obtained above i.e. higher doses (10, 5 µg/g, body wt.) of Permethrin inhibited more cholinesterase, as a result accumulated more acetylcholine accumulated at nerve endings and thus showed less responses as compared to dilute doses of Permethrin (2.5, 1,25 µg/g body wt.).

So we can conclude our findings that visual response of locusts is effected by Permethrin (Pyrethorids) and with lower concentration the visual response after initial degradation became normal again, this reversible change in response may be due to existence of an efficient mechanism of detoxification which was also reported by Ahmed (1969) in locusts. This aspect needs some molecular biochemical and histological studies before making final recommendation on large scale use of Permethrin.

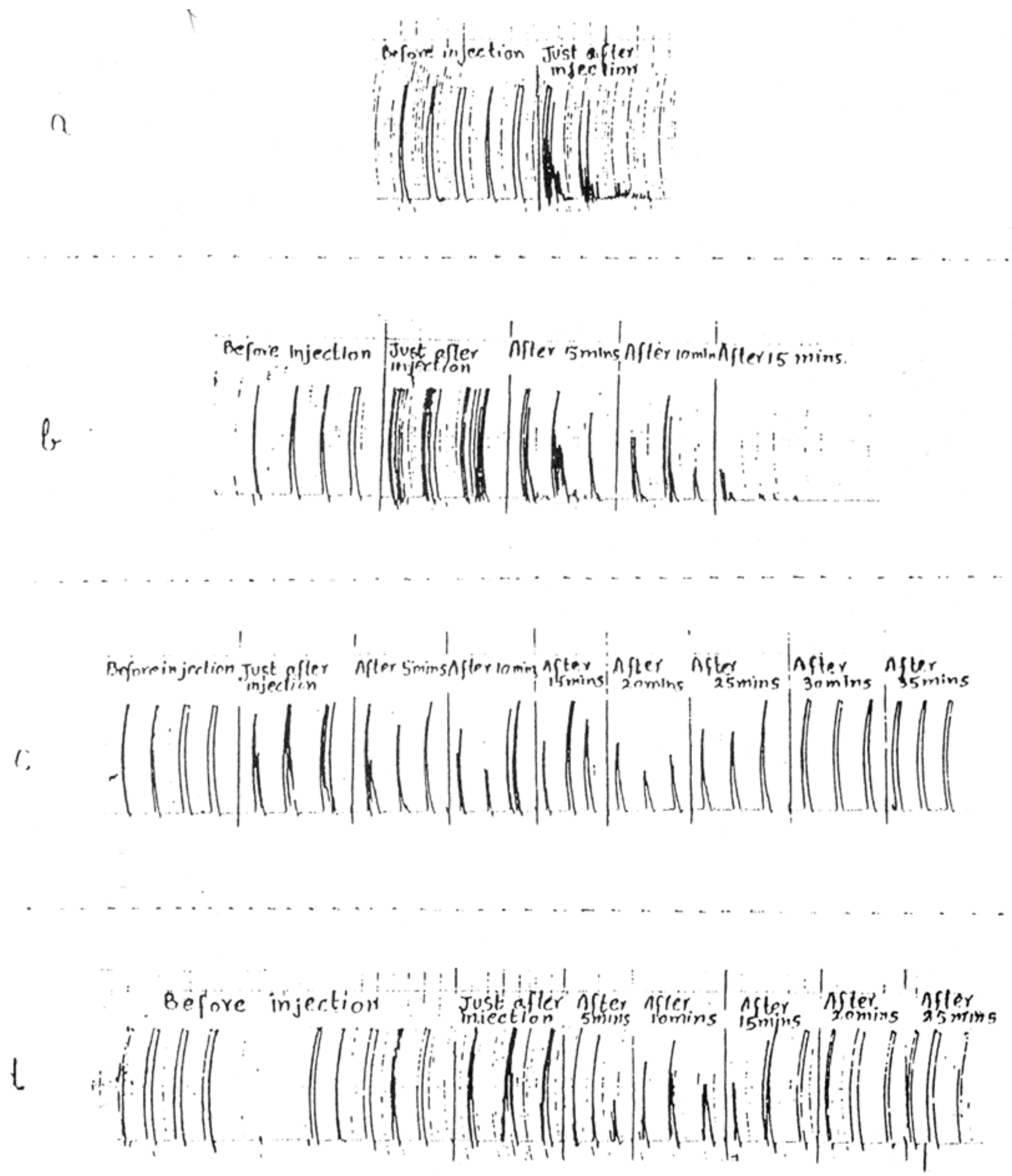

Fig. 1. Visual responses of locust of *Schistocerca gregaria* before and after treatment with varying doses of Permethrin at different time intervals. With doses of (a) 10 μg/g (b) 5 μg/g (c) 2.5 μg/g (d) 1.25 μg/g.

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