THE EFFECT OF SUBLETHAL DOSES OF SOME INSECTICIDES ON THE FECUNDITY OF COTTON LEAFWORM MOTHS, SPODOPTERA LITTORALIS. (BOISD.)

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A C K N O W L E D G E M E N T

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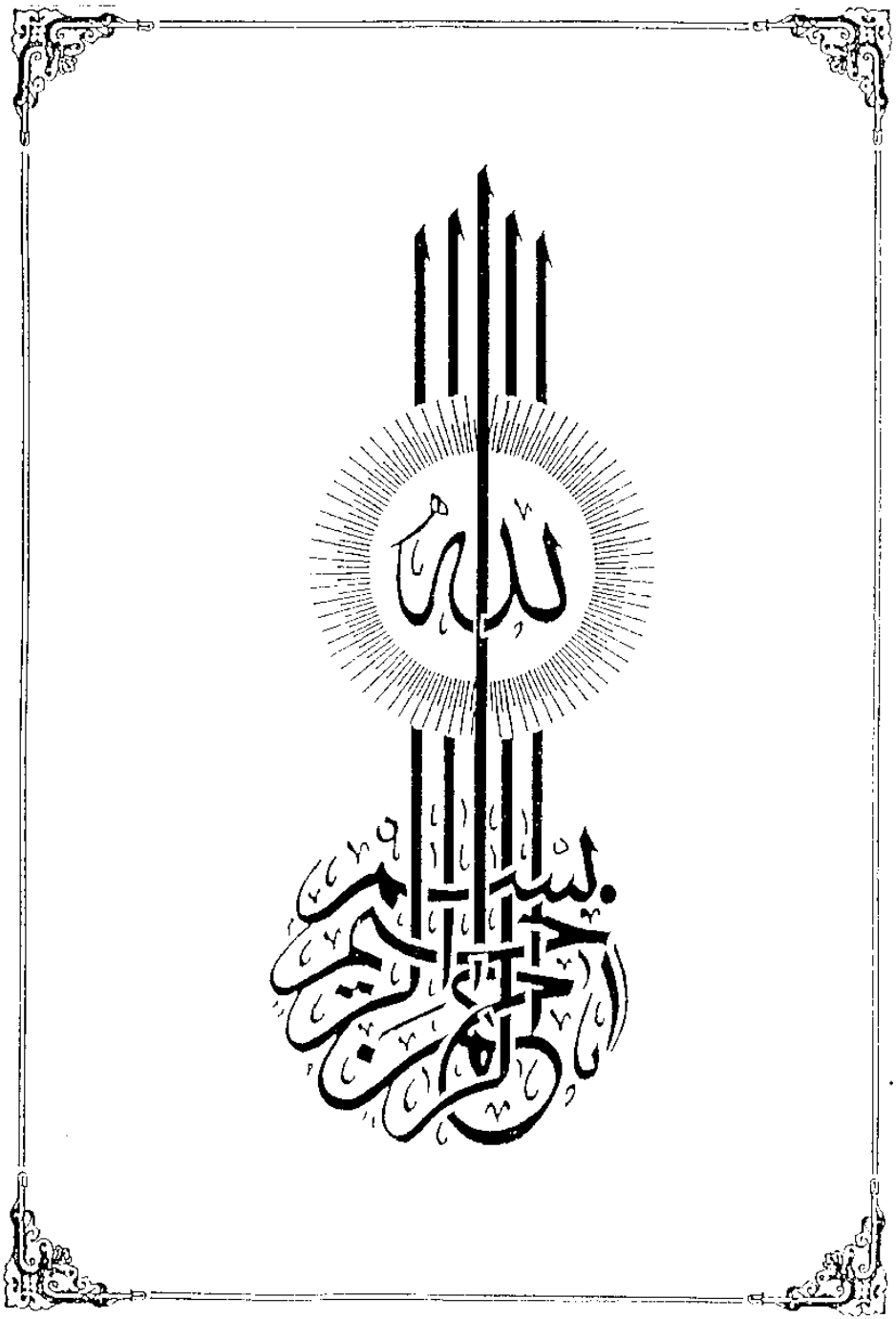

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I N T R O D U C T I O N

It is a well known fact that a considerable number of insects do not receive lethal dosages of the toxicant in the field, due to many factors among which are the mis-application of insecticides and failure of some insects to come in contact with treated surfaces. Accordingly insect population can be divided into two groups, one that receives lethal doses, and the other which receives sublethal doses and almost survives. The latter group has received much attention from Entomologists during the recent years. It is probable that some changes would occur in the individuals of such insects, resulting in a certain degree of deviation from the characteristic pattern of the population. The Egyptian cotton leaf worm Spodoptera littoralis (Boisd.), the main cotton insect pest in Egypt is controlled by using chemicals especially when hatching takes place. The aim of the present work was to study the effect of sublethal doses of certain insecticides on :

1- The duration and longevity of the larval stage.
2- The duration and longevity of pupal stage.
3- The activity and reproductibility of moths emerged from treated larvae.

REVIEW OF LITERATURE

Speyer (1924) found that arsenicals produced partial or complete sterility of lepidopterous adults. Copper arsenate reduced the number of eggs produced by the Southern army warm, Prodenia exidana (Cramer). However, egg hatch apparently was not affected (Ferguson 1942).

Parkin (1946) investigated the effect of ethylene dichloride and tetrachloroethylene on the female granary weevil. Sitophilus granarius (L.), (as Calandra graneria (L.)) and found no adverse effects on the reproductive organs. Sodium fluoride at high but sublethal concentrations reduced initial egg production of the confused flour beetle, Tribolium confusum Jacquelin du Val, which then returned to greater or normal numbers. However, low dosages stimulated increased egg production without effecting hatching of the eggs (Johansson 1950).

In experiments carried out by Tenhet (1947) where large numbers of the cigarette beetle, Lasioderma serricorne (F.), were exposed to sublethal dosages of pyrethrum spray, it was shown that surviving beetles deposited only about half as many eggs as beetles not exposed to such spray. Consequently, the control of the cigarette beetle in tobacco

warehouses was consistently better than was indicated by the mortality data from lots of test insects. For example, if a spray killed 50 per cent of the cigarette beetles present and also reduced by 50 per cent the number of eggs deposited by the surviving beetles, the total effect was equivalent to a 75 per cent reduction in population

Knuston (1955) studied the effect of exposing Drosophela melanogaster to sublethal doses of Dieldrin.

Dieldrin-exposed flies, produced 76 per cent more eggs, 5.6 per cent more larvae, 5.7 per cent more pupae, and 5.8 per cent more adults than control flies.

The average number of eggs laid per day per fly by treated flies was, however, only about 0.9 per cent greater than that of untreated and corresponding average number of resulting larvae per day per fly from treated flies was actually about 1.3 per cent less than that of untreated. The greater total progeny from treated flies resulted not because of stimulation of greater progeny production per given unit of time, but apparently because these flies lived longer than the untreated flies and therefore had a longer time to produce

According to Salt (1955), it was reported that sublethal treatment causes effects that vary in permanence and severity, but may be sufficient to inhibit the major developmental changes. This was confirmed by observations on the effect of chilling on eggs of Oncopeltus fasciatus (Dall.) and on the immature stages of Cryptolestes (Laemophloeus) ferrugineus (Steph). Arbitrary mortality counts may be adequate for some comparative purposes, but survivors should be considered for determination of the relative effectiveness of different dosages, since the potentialities for effective reproduction of insects that survive high and low dosages will be different.

Lakocy (1958) found that, when fourth instar larvae of Leptinotarsa (Say) were dusted with DDT, the treatment had no effect on the subsequent duration of development of the survivors, but the mortality rate of the resulting adults was increased, whether they were fed or not, and the females laid more eggs than did untreated beetles.

Abo El-Nasr and Moufied (1960) studied the longevity of moths of Prodenia litura F. under natural conditions in different seasons. Laboratory investigations were made on the effect of mating and type of food on survival of moths.

In addition the effect of food or rate of oviposition and hatchability of eggs were treated.

Cold weather was found to prolong the longevity of adults as moth lived longer in winter and early spring than in summer or autumn. Mating shortened longevity of females while it has no significant effect on the males. Longevity of moths was also prolonged when fed on 20 % solution of honey, while unfed moths had the shortest life span. Rate of oviposition and hatchability of eggs were significantly dependent on the type of food offered to moths.

Kamel (1960) recorded that in laboratory tests on the various instars of the cotton leaf worm using Lindane, Endrin, Dieldrin, DDT and Toxaphene as stomach poisons. He proved that the effect of each individual insecticide on any larval instars decreases successively by the decrease of percentage of insecticide used. Endrin seems to give the highest kill against the 1st, 2nd, 3rd, and 4th instars, and was followed by Lindane, Dieldrin, DDT and Toxaphene. Against the 5th and 6th instars, Linade seems to be somewhat effective than Endrin.

Residual studies proved that Endrin was the most persistent material and was followed by Dieldrin, DDT, Lindane and Toxaphene in a descending order.

Lakocy (1960) investigated laboratory the effect of sublethal doses of DDT on the development of potato beetle Leptinotarsa decemlineata (Say). Fourth instar larvae and adults of L. decemlineata were dusted under a bell-jar with sublethal doses of a 5 per cent DDT dust and observed for the effect of the poison throughout the rest of their lives. When fourth-instar larvae were treated, mortality was increased during the pupal stage and the period before the resulting adults entered hibernation, as compared with untreated insects. Summer adults showed no increased mortality when treated eight days after emerging, but mortality was increased during hibernation and decreased after it when they were dusted just before entering hibernation. Beetles dusted eight days after emerging from hibernation showed greatly increased mortality. As regards feeding and fecundity after the diapause, the two lotes of beetles treated before hibernation both showed considerable increases, whereas those dusted after hibernation showed decreases. The fertility of the eggs laid did not differ from that in the control series.

Lakocy (1960) dusted 4th instar larvae and adults 8 days after emergence of Leptinotarsa decemlineata (Say) under a bell-jar with a sublethal dose of 5 per cent DDT dust over eight generations. He found that treatment in

one generation increased mortality in the progeny, particularly at the hatching stage and during larval development. The increases observed were irregular, but in the 8th generation mortality after hatching was 84 per cent, as compared with 46.2 per cent for an untreated strain, and that during larval development was 60.4 per cent, as compared with 16.4 per cent for no treatment. After hibernation, treated adults showed increased feeding and reproductive ability. There was no apparent increase in resistance to DDT as a result of the treatment.

In laboratory tests carried out by Loschiavo (1960) in Manitoba, in which adults of Tribolium confusum Duv. were exposed to low doses of 1, 1.5 or 2 mg ethylene dibromide per litre for five hours at 27°C. (80.6°F.) and then transferred to a culture medium, females proved more susceptible than males and the survivors laid few eggs during the next ten days, whether mated with treated or untreated males. The percentage of eggs that hatched was reduced when both parents had been treated with 1.5 - 2 mg. per l., but viable eggs gave rise to larvae that developed normally. Eggs were fumigated similarly, and those treated when four days old failed to hatch, whereas one day-old eggs were unaffected by 0.5 mg. but were reduced in viability by 1 mg.

ethylene dibromide per litre, development after hatching was normal. Fumigation of pupae with 0.5 - 2 mg. per litre showed that susceptibility increased with age and was greater for females than for males, many showed abnormal darkening of the cuticle and abnormal development at emergence. There was no evidence of a strain of T. confusum Duv. resistant to the fumigant.

Eldafrawi et al. (1964) carried out laboratory tests to study the susceptibility of different larval instars of Spodoptera littoralis to insecticides. Insecticides tested were dissolved in acetone and were used topically. The LD_{50}'s of dichlorous, trichlorophon, pyrethrins and toxaphene were found to be 0.082, 0.233, 0.1 and 2.64 mg. per g. body weight, respectively, for 3rd instar larvae; 0.1, 0.152, 0.042 and 1.43 mg. for 4th instar larvae; and 0.042, 0.201, 0.15 mg. and an undetermined larger amount for 5th instar larvae. The lethal dose per larva increased proportionately with the increased weight of the larva in successive instars and within a single instar. It is concluded that susceptibility remained almost constant throughout the larval stage.

Eldafrawi et al. (1964) carried out investigations to study the reversion of toxaphene resistance in the cotton leafworm S. littoralis (Biosd.). Toxaphene has been used

against S. littoralis on cotton in Egypt from about 1955 until 1961 when it failed to give control in many parts of the country, therefore it was replaced by carbaryl and trichlorphon in 1962.

A colony of S. littoralis derived from egg-masses collected at five localities in Behaira province, where toxaphene had been in use until nine months earlier. The susceptibility of the third-instar larvae was tested laboratory by topical application of acetone solutions of toxaphene, the LD_{50}'s were 4.8, 2.4, 2.9, 2.1 and 0.92 mg.per g. body weight in July and December 1962 and May, July and August 1963, respectively. The trend in increased susceptibility to toxaphene was also shown in field populations that had been exposed to carbaryl and trichlorophone. Reversion appeared to have taken place.

Kuipers (1964) studied the effect of sublethal doses of DDT and Parathion on the egg production of the clorado beetle Leptinotarsa decemlineata (Say), in Holand. The author found that the injection of sublethal doses of P.P. DDT in oil solution into the abdomen of females five or six days old, slightly increased egg production during the first and second weeks of oviposition, but doses high enough to cause heavy mortality reduced fecundity.

Re-injection of survivors 11 days later with half the original dose caused the death of many of the females by mechanical injury. In an other test a significant increase in egg production throughout the laying period resulted from the application of low doses of P.P. DDT in acetone to the pronotum, and in fourth week only, from similar treatment with 97 per cent Parathion. In order to increase oviposition, treatment had to be made at the beginning of oviposition, later application resulted in hyperactivity, low mortality and irregular and reduced egg-laying. Since the Corpora allata of some females externally treated with P.P. DDT proved to be slightly (though not significantly) larger than those of untreated ones, it is suggested that the material may stimulate the production of hormones.

Osherova (1964) studied the effect of sublethal doses of demeton (merkaptefes) at two concentrations (0.015 and 0.001 per cent) corresponding to the LC_{80-90} and the LC_{30-40}, on the survival, development and fecundity of Tetranychus telarius (L.). when 0.015 per cent demeton was applied in the 1st, 2nd, 4th, 7th and 9th generation, the untreated female progeny lived for an average of 7.1 days, as compared with 9.6 when the parents