THE EFFECT OF SOME INSECTICIDES AND HORMONES ON SPODOPTERA LITTORALIS BOISD. IN JORDAN VALLEY

BY

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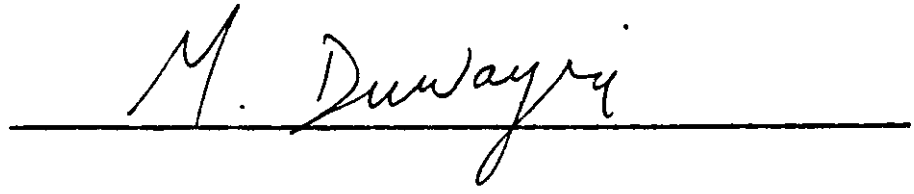

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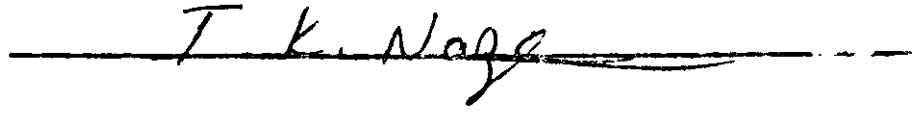

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INTRODUCTION

Spodopteral littoralis Boisd is a serious pest in Jordan and the Middle Eastern Countries. It ravages many of the important crops and vegetables in these areas.

This thesis has three objectives:

1. By genitalic comparisons, Wiltshire 1977 reported the presence of Spodoptera frugiperda in the Jordan Valley. Therefore it is of prime importance to identify the species of Spodoptera used in this work.

2. Also it is intended in this work to find the toxic levels of three insecticides: lannate (methomyl), dursban(chloropyrifos) and ripcord (cypermethrin) against Spodoptera littoralis populations in the northern and central parts of the Jordan Valley. Site and seasonal variations in the response of the leafworm to the three insecticides were also points in view. These three insecticides were chosen according to the different groups to which they pertain and to the history of their use in Jordan.

3. Several authors recommended the integration of hormones with insecticides to increase sterility, decrease pupation and emergence, shortened male life of S. littoralis , Ascher and Nemny 1974, El-Guindy et al., 1975.

Resistant S. littoralis to insecticides can be slightly cross resistant to juvenile hormone analgoues (JHAS)(El-Guindy et al., 1975, El-Guindy and Bishara 1977).

It is then of prime importance to know the effect of sublethal doses of JHAS and insecticides on the food consumption, prolongation of larval and pupal periods of the survivors which may acquire resistance to the JHAS.

REVIEW OF LITERATURE

Part I : Genitalic Identification Of Spodopteral littoralis.

Brown and Dewhurst 1975 and Wiltshire 1977 used three structures in the male genitalia in the identification of Spodoptera littoralis; these three structures are;the clasper, juxta and the cornutum inside the aedeagus.

Part II : Toxicity Studies.

Spodoptera littoralis, readily acquires resistance to the insecticides used against it. In Egypt, the recommended dose of 60% EC toxaphene/feddan was 1.5-2 liters in 1956 (Bishara, 1957, cf. Moustafa et al., 1977) had to be increased to 3.5-4 liter per feddan after two years and again up to 4.5 liters per feddan in 1961.

Brown 1970, reported that it developed resistance to toxaphene in Egypt in 1961 and to organophosphorus compounds and carbamates since 1966.

The larvae of S. littoralis became resistant to insecticides at different rates depending on:

1. Insecticides used, taking into consideration cross resistance of insecticides which are not used (Abdel-Aal et al., 1970 cf. Saad et al., 1977).

2. Source of the strain (Odent et al., 1976 in Turkey), (Zeidan et al., 1974, cf. Moustafa et al., 1977 in Egypt).

3. Higher doses of insecticides provide ample material for rapid progress in genetic selection (Abdel-Salam and Mostageer 1969).

Moustafa et al., 1977, revealed that the inheritance of resistance of S. littoralis to organophosphorus insecticide was due to a single gene allele which was partially dominant as was revealed by Dittrich 1972 in spider mites.

Reversion of insecticide resistance in S. littoralis is possible if the insecticide treatments were excluded according to (El-Defrawi et al., 1964, and Atallah 1971).

Usually a gradual increase in the resistance expressed as increases in LC_{50} is obtained in the first generations followed by a sharp increase later on. El-Guindy et al., 1974, obtained this sharp increase in the 8th generation of a Kalyobia field strain against phosvel.

S. littoralis developed resistance to different insecticides at different rates. According to Moustafa et al., 1977,

the worms collected from Abis (Alexandria) developed 9.93 folds tolerance to monitor, 5.32 fold to triazophos and far less to profenfos during seven generations. Its cross resistance extended more to organophosphorus and carbamates than to pyrethroids.

Selection pressure by one organophosphorus insecticide develops cross tolerance or cross resistance to other organophosphates or insecticides of other groups. Many examples are set in support of the different parts of the above statement. The following references are cited (Hassanein et al., 1958; El-Toube et al., 1965 ; Maher 1969 ; Helal 1969 ; El-Sebae et al., 1973; El-Guindy et al., 1974, 1975 cf. Moustafa, et al., 1977; Salem 1970). As an example of the above statement, the monitor resistant strain developed by Moustafa et al., 1977, acquired cross resistance to cyolane but cross tolerance to cytrolane, triazophos and orthene. The triazophos resistant strain developed resistance to other organophosphates and more susceptibility to chloropyriphos than the parental strain. A 10 folds of the LC_{50} indicates resistance and 2-9 folds indicates tolerance to insecticides. The monitor, triazophos strains were highly susceptible to cyclodienes and synthetic pyrethroids. The triazophos resistant strain was cross tolerant to methomyl, whereas the monitor resistant strain was slightly cross tolerant to it, Moustafa et al.,1977.

The strains obtained by some of the above authors, showed similar cross ressistance to certain insecticides and sometimes disagreed in this respect. As an example of the first category : Maher 1965 after indicating seasonal variation in its tolerance to toxaphene and sevin, assumed that toxaphene predisposes its populations to become sevin resistant. This was confirmed by El-Toubge et al., 1965.

As an example of the disagreements among strains in cross resistance to the different insecticides of strains resistant to certain insecticides, the endrin resistant strains obtained by El-Sebae et al., 1973 and Helal 1969, cf. Moustafa et al., 1977, both were susceptible to carbamates. The strain of El-Sebae et al., 1973 was highly susceptible to zectran, moderately tolerant to azodrin, cytrolane and dursban, whereas endrin resistant strain (6.9 folds) was more susceptible than the parent strain to mesurol, pyrolan, dursban and sumithion, moderate and low cross tolerant to carbaryl, zectran and diptrex ... etc. (Helal 1969).

Cross resistance studies were useful in finding the mechanism of intoxication by certain insecticides. Fahmy and Fukuto 1970 compared the toxicities of different carbamates on susceptible and resistant strains. They reported that the deacylation of N acyl carbamates to N methyl carbamate is an important step leading to poisoning.

valexon. Both insecticides aliphatic organophosphates esters.

2. El-Guindy et al., 1974 noticed that the phosvel resistant strain developed slight cross tolerance considered as vigor tolerance against insecticides containing the diethoxy group as cyolane, cytrolane and dursban. It developed high cross resistance to monoctrophos.

A correlation is sometimes found between resistance and the effect of the insecticide on cholinesterase and aliesterase activities.

1. In susceptible and resistant m-parathion strains, a group of insecticides differed among themselves in their synergistic, additive and antagonistic actions on both strains susceptible and resistant: M-parathion and DDT produced synergistic effect on the resistant and only additive effect on the susceptible strain. According to Ali et al., 1967, the synergistic effect of insecticides combinations severely depressed cholinesterase activity while the antagonistic ones

mildly inhibited it. This depression was the result and not the cause of synergism. Whereas aliesterase was depressed to the same degree regardless of synergism or antagonism. This agrees with the results obtained by other authors working on some other insects. The mechanism of Culex tarsalis resistance to organophosphorus insecticides is enhanced detoxification and to a less extent the possession of acetylcholinesterase which is insensitive to organophosphates and carbamate insecticides, Apperson and Georghiou 1974. Also resistance is due to the insensitivity at the target enzyme acetylcholinesterase to inhibition by toxicants in Anopheles albimanus, Hafez and Georghiou 1975.

The green rice leafhopper Nephotettix cincticeps developed resistance to carbamates through the mechanism of cholinesterase insensitivity, Toshikazu and Hiroshi 1971.

2. Abdalla et al., 1973, found that cholinesterase activity was higher in methyl parathion resistant strain whereas aliesterase activity was higher in the susceptible strain.

3. Moustafa et al., 1977a, found that Abis strain which showed higher resistance than Tarh and laboratory susceptible strains, also showed higher choline, ali and aromatic esterase activities. This rule was, however, not applied to Tarh and laboratory strains, the latter being more susceptible and has higher

generation lower than 34 μg/larva for the field collected (parent) strain. Tolerance of the selected strain to any of the above insecticides tested was not increased (dursban, lannate, endrin and gardona). The strains resistant to gardona or endrin were fully susceptible to dimilin.

Part III : Effect Of Juvenile Hormone Analogues.

Six JH analogues were tested by Ascher and Nemny 1974 against big and medium size larvae of S. littoralis, by topical application: R_o20-3600 at 20 μg, ZR-515 and ZR-619 at 5 μg per larva, inflicted 90% mortality in big larvae (3 cm long). The first was about equitoxic for both sizes, the other two were age specific more toxic to big larvae, most of the mortalities occurred in the prepupal stage. The other compounds R_o6-9550, R_o8-4314 and ZR-512 (hydroprene) were inactive against medium size larvae, but slightly or moderately (ZR-512) effective against big larvae. The above experiments were run on larvae kept on alfalfa at 27°C in basins of saw dust. Forty to one hundred larvae of each size were used at each concentration of every compound. Acetone solutions of the above hormones were applied between the two black spots of the first abdominal segment.

As to emergence of normal adults R_o20-3600 was as effective

against medium as against big larvae, whereas ZR-515 and to a certain extent ZR-619 were less active against medium size larvae than against big ones. Contrary to Zoecon Corporation data sheets ZR-515 which was recommended by the company to be highly active against Diptera and ZR-512 against Lepidoptera, the former was much more active than the latter against S. littoralis.

In conclusion the two authors suggested that it may be difficult to combat in practice S. littoralis with JH analogues which are predominantly active during the last larval instar.

Hydroprene (Altozar) at a higher level than 0.25 μg/ g caused a high level of sterility to S. littoralis when topically applied alone in the laboratory. This level became even higher when chloropyrifos (0.33 μg/g) was applied with Altozar. Fewer larvae pupated and fewer pupae gave rise to adults when hydroprene was applied alone than when it was applied with chloropyrifos. Treatment with chloropyrifos alone significantly increased the length of adult male life, but treatment with 2.5 μg hydroprene/g with or without chloropyrifos shortened it. On the other hand, the duration of adult female was significantly increased by either dose of hydroprene when combined with chloropyrifos and by the higher dose of hydroprene applied alone (El-Guindy et al., 1975).

Gwaad et al. (1974) found that ZR-619 (triprene) and Zk-512 had no effect on hatching rate of S. littoralis, but the latter delayed hatching. ZR-777 (kinoprene), ZR-512 (hydroprene), ZR-520 (ethyl(2E,4E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate) and ZR-619 were applied to the larvae, the mortality in the larval or pupal stage were 84.9,92, 100,100 respectively with increase in larval weight. The experiments were done in the laboratory by applying 3% sprays of the four hormones to eggs and the 3rd instar larvae.

Abdallah et al. (1974) compared the effect of Bactospeine to that of JHA R_o20-3600 applied to the soil. Groups of 20-25 larvae of S. littoralis were then introduced. The severity of malformations caused by the JHA to larvae in the 4th, 5th, early and late 6th instars averaged 5,1,7.2 and 6.2 respectively for applications at 10 ppm, and 7.3, 6.1,8.7 and 7 for 100 ppm. Greater effects resulted from the exposure of larvae to soil than to treated castor leaves. The effect of JHA could be detected up to 60 days after application to the soil. The bactospeine did not affect pupation, but affected emergence of adults, egg production, weight and hatchability at 0, 3, 6 and 12 g/liter.

Abdallah et al. (1974) reported R_o20-3600 at 0.039-20 μg/g pupa as a factor of sterility or partial sterility in emerging females. It reduced hatchability and produced delayed

postembryonic development at 0.0225-0.144µg/egg treatment. 0.009 µg/egg treated on the day of oviposition caused 89% mortality in the larval stage, eggs of S. littoralis tolerated the hormones better on the 2nd and 3rd days.

El-Guindy et al. (1975d)reported that strains of S. littoralis highly resistant to endrin and aminocarb showed a slight degree of tolerance to the regulators R-20458 and ENT-34070, but were susceptible to hydroprene. The low levels to cross tolerance were considered to be the result of vigor tolerance. A fenitrothion resistant strain showed higher cross tolerance to altozar and especially ENT-34070.

Abdel-Aal (1971) found that the vapors of 5-[[5-(3-ethyl-3-methyloxyranyl-3-methyl-2-pentenyl] oxy] -1,3 benzdioxole inhibits embryonic growth better than 3-[5-(4-chlorphenoxy)-3 methyl-3-pentenyl] -2-ethyl-2-methyloxirane. The two compounds were equally potent in producing intermediate form incapable of surviving when applied topically to 6th instar larvae. When applied to the pupae at 6-8 μ_g/insect, both hormones produced deformed adults and 90% reduction in fertility of adults which survived and mated.

Krypsin-Sørensen et al., 1977 reported that methoprene does not affect the growth respiratory metabolism of the penultimate-instar larvae of S. littoralis which contained

endogenous JH. In the last larval instar JHA (methoprene) induced large somatic growth, formation of supernumeraries were formed. But in any case unlike ssome other species,there was no hypermetabolic response to juvenoid treatment.

El-Guindy and Bishara (1977) studied the effect of Ay 22, 342, ecdysterone, and a combination of the two, on adults of S. littoralis emerging from pupae treated topically at different ages. The experiment was run on a susceptible strain and on those strains resistant to endrin, fenitrothion and amino carb (matacil). In general, the effects of Ay 22, 342 (a mixture of isomers of methyl 7-ethyl-9-(3-ethyl-3-methyloxiranyl)-3-methyl-2,6-nonadienoate) were more marked than those of ecdysterones. The synergistic effect of ecdysterone on Ay 22, 342 was evident after treatment of the pupae when they were 5 and 7 days old. All the three resistant strains, and especially that resistant to endrin show appreciable tolerance to Ay 22, 342 and ecdysterone separately and in combination. The synergist piperonylbutoxide did not enhance the morphogenetic effects of Ay 22, 342 or ecdysterone in the strain resistant to aminocarb.

Gelbic and Nemec (1978) reported that topical treatment of S. littoralis by 0.2 mg/larva of altosid during the last instar or shortly after the molt to the penultimate instar delayed pupation and elicited extra larval molts, accompanied by accumulation of glycogen and fat and changes in water contents.

MATERIALS AND METHODS

Part 1: Identification Of S. littoralis

Moths from all tests of Part II and III were kept in 10% alcohol pending the dissection of their genitalia. The genitalic identification of S. littoralis was based on the work of Brown and Dewhurst 1975, and Wiltshire 1977. Sixty males genitalia were dissected in Puri's media and examined from ventral and dorsal sides.

Part 2: Toxicity Studies

1. Insecticides and concentrations.

The following concentrations were freshly made for each insecticide in tap water:

a. Methomyl (lannate) 90% WP (S-methyl N(methyl carbamoyloxy) thioacetamidate).
   Concentrations: 27, 13.5, 6.75, 3.375 and 1.6875%. a.i

b. Chlorpyrifos (dursban) 40% EC(0,0-diethyl 0-3,5,6-trichloro-2-pyridyl phosphorothioate).
   Concentrations: 2,1, 0.5, 0.25, and 0.125%. a.i

c. Cypermethrin (ripcord) 40%EC(∝-cyano-3-phenoxybenzyl 2,2-dimethyl-3-(2,2-dichlorovinyl)cyclopropane carboxylate).
   Concentrations: 1,0.5.0.25,and 0.125%a.i in 1978 experiment,

and 0.5, 0.25, 0.125, 0.0625 and 0.03125a.i in 1979 experiment d-Control with tap water.

2. Insects:

(a) Rearing of S. littoralis in the laboratory and the field for experimental purposes:

Medicago sativa (alfalfa)and Nerium oleander leaves were used as oviposition sites inside the cages containing the mating moths in the laboratory. Batches of S. litteralis were incubated at 25°C in plastic cups (200 cc). The hatching larvae were kept on alfalfa leaves for 5 days before transfering them to alfalfa plants under large cages in the green house or in the field (Fig. 1 and 4).

Newly designed, economic, half cylinderical 3.5x1.25x0.7m muslin cages were set in the green house on half circular wires 0.3 cm in diameter. These wires were fixed in the ground from both ends (Fig. 3) at a distance of 0.5 m from each other. A side opening 2x0.25 m closed with two zippers was made from one side of the muslin which is spread along and around the wires. The edges of the muslin were tightly tacked to wood timbers 5 x 3 cm placed on the four sides of the cage (Fig. 2). In the field (Fig. 4 and 5), the sides of the screen cloth cage were burried in the ground, those cages were 2 x 1 x 0.7 m in dimension.

The 5 days old larvae were transferred to the alfalfa planted under the cages. If the alfalfa inside the cages becomes insufficient, crop harvested alfalfa could be supplied to the growing larvae.

Completely developed larvae were enclosed in smaller wooden cages 25 x 25 x 25 cm with a layer of sand for pupation.

After 3 days of pupation, the pupae were sexed and 1 - 2 males with 4-5 females were enclosed in the above wooden cage containing a branch of Nerium oleander (Fig. 6), and a petri dish which contains sugar solution 10% and a sponge to keep the moths from drowning in the syrup.

Some Problems of Rearing.

The virus disease ravaged the larval population several times during this work in the green house in the early spring. The screen cloth cages in the field were the best habitat for limiting the infection. However other problems arose, as for example the heavy infestation by the alfalfa aphids in the field and greenhouse. Also the drastic field conditions as the cold spells which occur early in the spring, produced sterile moths.

The newly designed cage which cost only 5 JDs was helpful in the greenhouse during winter time. In the field they did not produce the required numbers of larvae due to the cold

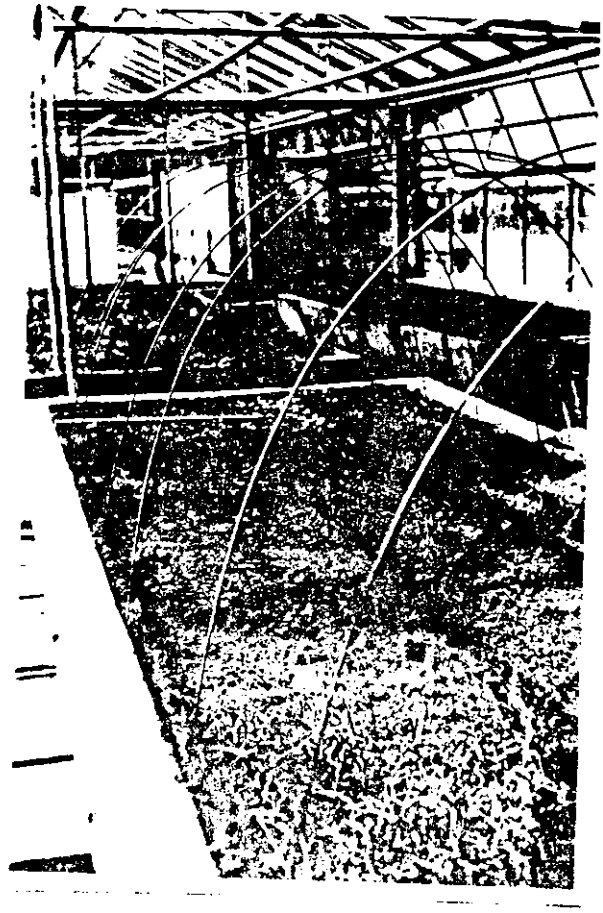

Fig. 3: A view showing wire fixing in the ground, for making a rearing cage for S.littoralis.

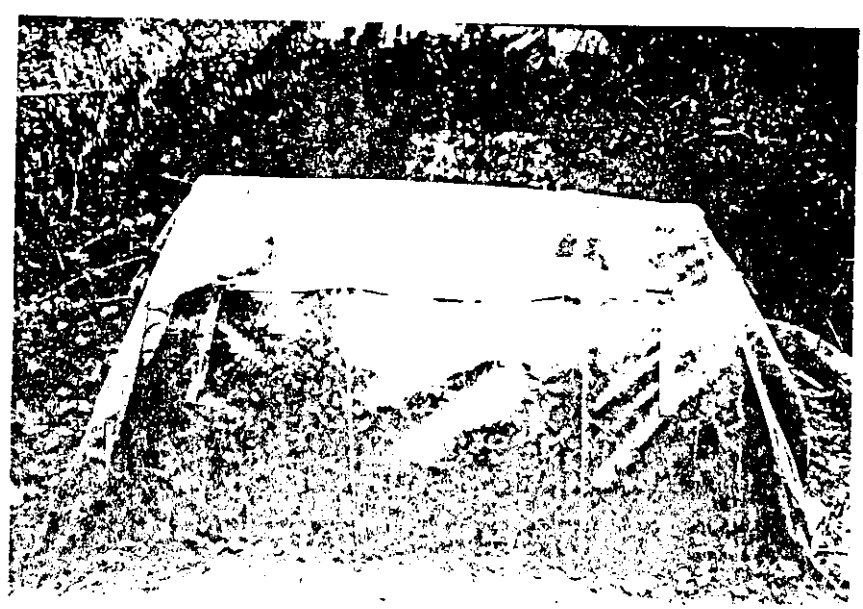

Fig. 4: General view (closed) showing a cage for rearing S. littoralis in the field.

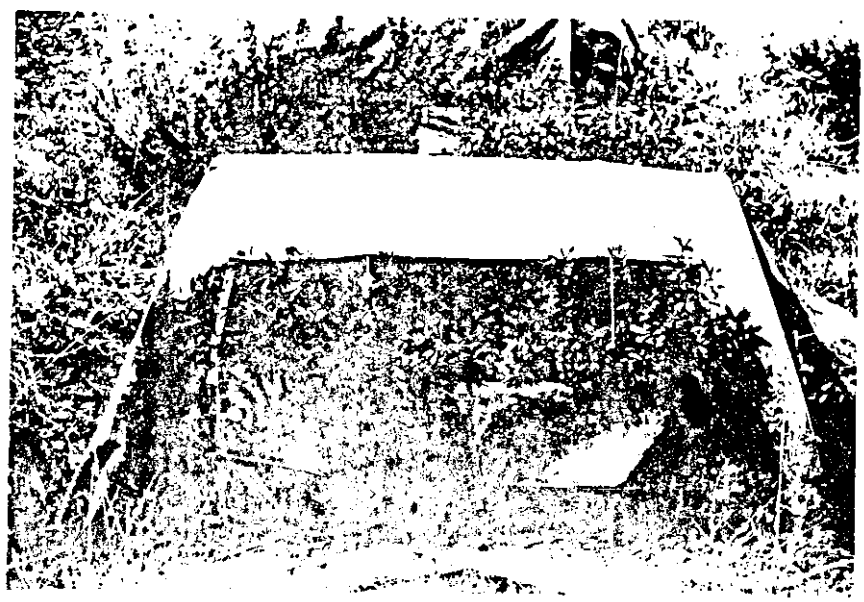

Fig. 5: General view (opened) showing a cage for rearing S. littoralis in the field.

Fig. 6: Caged moths with a branch of Nerium oleander and a sugar syrup for feeding and oviposition.

3. Equipments

Syringe microburet - Model No. S132 manufactured by Micrometric Instrument Company. Cleveland-OHIO was used.

4. Procedure

Larvae were starved for 24 hours. Then were treated topically by 3 µl of the above working solutions on the first abdominal segment between the two black spots. After treatment the larvae were watched carefully until the drop of insecticide which was applied to its back permeates or dries up. The larvae which turn upside down or loose some of the applied dose by contact to the surrounding surfaces were excluded. Then the larvae were separately put in plastic cups (100 cc) covered with toilet paper and put at room temperature(average20°C). Then they were scored for mortalities after 24 hours. Dead and semi dead larvae were counted after poking or prodding them with a pencil to ensure their death.

The mortality percentages were adjusted by Abbott's formula Finney 1971. Three replicates were run for each concentration of insecticides on four separate groups of S. littoralis.

The standard methods set for detection of insecticide resistance in Heliothis zea and H. virescens (Anonymous 1969)

were mostly applied in this work. As no diapause problems in S. littoralis as in H. viriscens or H. zea, the larvae were not held individually on synthetic media or subjected the moths to certain light regime.

In this work eggs or newly hatched larvae were sampled for the toxicological tests (not any larva used was beyond F_2 as recommended) from alfalfa fields and larvae were bred on the alfalfa in the laboratory until they attain more than 3 cm in length. Treated larvae were held on the diet during the postreatment observation period. Mortalities of the control in this work never reached 10% at which results should be discarded.

Fifty larvae at each of the five dosages (taken in two years period) and a control were treated on each of 3-5 different days.

Part 3: Effect Of Sublethal Doses Of Hormones And Insecticides On Leaf Consumption.

1. Reagents and working solutions:

a. ZR-515(Altosid)(methoprene) 1%(isopropyl 1,1-methoxyl-3,7,11-trimethyldodeca-2,4-dienoate).

b. CIBA 13339 1%(Ethyl 4-(4-benzyl phenoxy)-3-methyl-2-butenoate)

c. Ripcord 0.02% d-Control with ethanol or water.

2. Equipments:

a. Syringe Microburet Model No. 5132 (Micrometric Instrument Co.-Cleveland-OHIO).

b. Photometric areameter (LI-COR-Model 3100 Areameter)

3. Larval stock was obtained as mentioned above.

4. Procedure.

Two to three replicates of ten or twenty (4th instar) larvae each (2-2.5 cm long) were topically treated by each of the above reagents. The larvae were starved for 24 hours before treatment to eliminate the interference of previously consumed food with the toxicity or larval development for ripcord or hormones treatments. The larvae were treated each with 3 μl of the working solutions topically applied on the first abdominal segment (between the black spots). Then they were separately put in 100 cc plastic cups containing a dry sand layer of two centimeter depth, the cups were covered with toilet paper for aeration. The treated larvae were daily provided each by 3-4 leaves of alfalfa and allowed to eat to their fill.

The consumed foliage was daily determined by measuring the leaf area before and after feeding by using the photometric areameter, the accumulated leaf consumptions of each

larvae were given in cm^2 till pupation or death. Mortalities in the treated and control larvae were daily recorded. Special attention was paid to screening pupal and adult abnormalities e.g. as curly wings retention of larval colors on pupal segments etc... . The normal pupae were sexed and each couple were separately placed in a cage (25 x 25 x 25 cm), pending their emergence. Adults were provided with sugar solution 10% , and a branch of Nerium oleander for oviposition. The longevity of adults and pupal period were recorded.

RESULTS

Part 1. Identification of S. littoralis

The juxta is a shield shaped structure midway on the ventral region of the penis, it is derived from the fused gonapophyses of the 9th segment gonopods. It has a function in supporting and guiding the penis (Fig. 7).

The aedeagus (Fig. 8 a and b) is the terminal portion of the penis or phallus, the caudal end of aedeagus invaginates and forms a structure called the vesica or endophallus. The invaginated endophallic tube is the vesica, it is eversible from the tip of the aedeagus, often bears various sclerotized spines, scobinate patches... etc. termed cornuti. The cornutum enters into the bursa copulatrix and may serve a close fitting into it.

Ventrally, claspers of S. littoralis were broadly dilated at base and located on the valves. Also the juxta appears from the ventral side with its rectangular shape (Fig. 8a), it appears fixed on the ventral side of the aedeagus and articulated with the sacculus.

The aedeagus was examined dorsally to see the cornutum, which is obtuse, rounded apically with a small subapical tooth

FIG7. MALE GENITALIA OF S.LITTORALIS

FIG.8.(A)VENTRAL AND (B) DORSAL VIEWS OF AEDEAGUS OF S. LITTORALIS

and a tuft of needle-like hairs with brown color (Fig. 8,b).

Part 2: Toxicity Tests

The toxicity data tabulated in tables (1,2 and 3) were analysed by different statistical methods. These methods were used to secure the three important toxicity parameters: LD_{50}, LD_{90} and slopes of the probit regression lines, Fig. 9, 10 and 11); also their standard errors and fiducial limits were calculated. The fiducial limits were mostly used to verify the significance of the differences among each of these parameters and the others. The statistical analysis of the data was performed by the following methods:

a. X^2 test to check the right positions of the probit regression lines which were eye fitted, tables (1,2,3).

b. Finney probit analysis and the simplified Litchfield method, table (4) to obtain the standard errors of the toxicity parameters and their fiducial limits.

c. Duncan Multiple Range Test (DMRT), table (5) was used to check the significance of the differences in these parameters (Appendices I,II and III) versus the overlapping of the fiducial limits (Steel and Torrie 1960). The overlapping of the fiducial limits is considered in this work as a simple measure of non-significance. This simple

method was used by Kunkel 1973, in his work on the effect of the JH on Blatella germanica.

Samples of S. littoralis were collected from two regions in the Jordan Valley, Shouna in the north and Dier Alla in the middle of the Valley in two different seasons 1978 and 1979.

Three insecticides were chosen against S. littoralis on grounds of the history of the insecticides used against it in Jordan. Lannate was officially used since November 1971 (according to the Certified Insect Records of Ministry of Agriculture), dursban as a close second to it as it was used a month later in far less areas, whereas ripcord is not used yet. In addition each of these insecticides pertain to a different chemical group.

To follow the yearly variation in the response of the leafworm to these three insecticides, the S. littoralis was sampled from both areas in October 1978 and 1979.

The three toxicity parameters, LD_{50}, LD_{90} and the slopes of the probit regression lines, are in full agreement on the following declining order of the toxicity of the three insecticides to S. littoralis in Jordan Valley:

ripcord > dursban > lannate. This order was clearly observed in both sampling sites and years regardless of the

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the Litchfield method. The two methods however completely

by the Litchfield method, table (4).

Duncan Multiple Range Test (DMRT) (Appendix I) showed that only slopes of lannate 1978 and 1979 and dursban lines of Shouna 1978 were insignificant from each other, table (5). However, slopes of lines of each of the three insecticides significantly differed from the slopes of the others except for few exceptions as shown in table (5). These exceptions of the slopes which do not significantly differ from one another as shown by DMRT are:

1. Lannate-Shouna 1978 and 1979 on one hand, dursban Dier Alla and Shouna 1978 on the other hand.
2. Ripcord Shouna 1979 and dursban Dier Alla 1978.

The overlapping of the fiducial limits of the slopes of the above six insecticide lines showed significant differences between slopes of lannate and ripcord. Also it showed significant differences between lannate and dursban except dursban Shouna 1978 (table 6) which overlapped with the fiducial limits of all the four lannate lines. Slopes of dursban and ripcord differed significantly from each others as indicated by the ranges of their fiducial limits. However the DMRT showed insignificant differences between dursban Dier Alla 1978 and ripcord Shouna 1979, table (5).

The slopes as measured by Finney's method represent the

bare reality of the lines slopes as they are directly measured from the line. The probit units were divided by the corresponding log doses units which strictly apply to definition of the slope of any line. Also slopes determined by Finney's method conformed well with the calculated slopes of the lines as determined by the maximum likelihood method, Finney 1970. Therefore, the slopes as defined by Finney's method are used in combination with LD_{50} and LD_{90} to verify the resistance of S. littoralis to lannate.

According to this method lannate lines were always the flattest of all the other lines. The probit regression of dursban were steeper than those of lannate except in Shouna 1978. Dursban lines were flatter than ripcord lines except in Shouna and Dier Alla 1979. The flatness of the probit regression lines of lannate strongly proves the resistance of the leafworm to lannate. Finney's method conformed well with the calculated slope of the line as determined by the maximum likelihood method.

The yearly variation was expected in the light of the seasonal variation mentioned by Maher et al., 1965. S.littoralis did not manifest such variation in both places from which it was sampled in Jordan. LD_{50} and LD_{90} data when analysed by the DMRT (Appendix II and III) did not show the yearly

variations in the response of the leafworm sampled from both locations to the three insecticides, table (5). However, when the fiducial limits of the LD_{50} were tested by overlapping, table (6), lannate in both locations and ripcord in Shouna only showed no significant yearly variations. Only dursban which showed this yearly variation in both locations. On the other hand the fiducial limits of LD_{90}s of lannate, dursban and ripcord overlapped in both places, showing no significant yearly variation. Whereas the DMRT showed yearly difference in lannate Shouna only, table (5 and 6).

Site variations proved insignificant in both years by the overlapping of the fiducial limits of LD_{50}s and LD_{90}s or by the DMRT, table (5 and 6).

The overlapping of fiducial limits which is a simple estimation of non-significance conformed with DMRT in most cases and differed with it in few cases. The results analysed by Finney's Probit method are used to draw conclusions from the toxicity data in this dissertation.

As ripcord is a new insecticide newly registered in Jordan but is not yet used, it can be considered as a standard insecticide. Whereas lannate is a widespread insecticide which was extensively used in Jordan for nearly the last nine years. Dursban on the other hand is sparingly used although it was

introduced shortly after lannate. The usage periods of these three insecticides are well reflected in the present data. In addition to the flatness of the lannate probit regression lines relative to ripcord, the 25-88 X differences in the LD_{50}s of the two insecticides lannate and ripcord are good indications of the resistance of the leafworm to lannate. These differences are augmented 90-155.4 X when the two insecticides were compared on the basis of LD_{90}, table (6).

The cross resistance between dursban and lannate is clarified by differences in LD_{50}s of dursban versus the standard insecticide ripcord in the season of 1979 only. These differences approximately ranged from 12-15 X, and decreased to 5-6 X on LD_{90} basis, table (6). However these differences may be due to field selection pressure from dursban per se which was sparingly used in Jordan in the last few years rather than to cross resistance with lannate or other insecticides.

Part 3: <u>The Effect Of Sublethal Doses Of JHAS And Ripcord</u>.

The effects of ripcord, ZR-515 and C1BA on the average consumption of alfalfa leaves were studied during the first six days after treatment and during the rest of the larval period (from the beginning of fourth instar which was 2-2.5 cm long until pupation).In addition to their effect on the larval

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The effect of the above treatments on the pupal period (Appendix IV.d) showed no significant effect between the different treatments. It was noticed that the pupal period increased by these chemicals from 19.94 to 21.07 and 22.9 days with C1BA and ZR-515 treatment , and to a less extent 20.8 days by ripcord,(table 7).

The effect of a sublethal dose of ripcord and the hormones (ZR-515 and C1BA) on the average daily consumption of food showed that ripcord significantly reduced it when compared with the other treatments and the control, as shown in table (7).

The effect of the above chemicals on the average daily consumption in the first six days (Appendix IV.a) is in conformity with their effect on the average daily consumption of larvae through the larval stage. The average daily consumption (Appendix IV.b) was less than the average consumption

in the first six days except in ripcord survivors only. This was due to the fact that the daily consumption was stopped or drastically reduced few days after treatment with ripcord then was gradually restored.

Ripcord significantly decreased average leaf consumption from 14.53 to 11.42 cm^2/larva. The total leaf consumption by ripcord survivors 69.205 cm^2 is less than control 96.04 cm^2/larva and far less than the survivors of the two hormones ZR-515 139.95 cm^2 and C1BA 111.4 cm^2/larva.

In comparing C1BA with ZR-515 the latter induced higher mortalities 50% versus 37.5%, but C1BA did not encourage higher total leaf consumption than ZR-515. Actually C1BA induced higher daily average consumption but did not prolong the larval stage as ZR-515 did. The higher daily consumption caused by C1BA in comparison with ZR-515 may be attributed to increasing growth and the overall metabolic intensity (Kryspin-Sørensen et al., 1977), or to more accumulation of glycogen and fat or to change in water content (Gelbic and Nemic 1978).

As less larvae were available for the ZR-515 than for C1BA, the above comparisons between the two JHAS should be conservatively accepted but not disregarded. Assuming that the two compounds have parallel effect and their parameters

sampled from Dier Alla and Shouna-north in Oct. 1978 and 1979

χ^2 (P)	W	nw	nwx	nwx^2	Slope $b \pm S_b$	$LD_{50} \pm 95\%$ Fiducial limits μg/ larva	$LD_{90} \pm 95\%$ Fiducial limits μg/larva
54	0.636	31.80	18.1261	10.332	1.22±0.2259	3.9±2	43.5±25.41
35	0.606	30.30	26.361	22.934			
72	0.526	26.30	30.771	36.002			
57	0.409	20.45	30.062	44.190			
18	0.282	14.10	24.957	44.174			
336		122.95	130.277	157.632			
0204, 95%flLD_{50}=2 ; $S_{log}.LD_{90}$=0.1295, S.E=12.9642, 95%flLD_{90}=25.41 ;							
61	0.254	12.70	07.239	4.126	2.65±0.075	18.5±3.11	59±18.27
89	0.343	17.15	14.921	12.981			
0	0.624	31.20	36.504	42.710			
34	0.622	31.10	45.717	67.204			
94	0.254	12.70	22.479	39.788			
678		104.85	126.860	166.809			
67, 95%fLD_{50}=3.11 ; $S_{Log}.LD_{90}$=0.0661, S.E=9.324, 95%fLD_{90}=18.27 ;							
15	0.636	31.80	18.126	10.332	1.1±0.2195	3.65±2.16	52±35.2
95	0.587	28.90	25.143	21.874			
40	0.563	28.15	32.936	38.535			
55	0.412	20.60	30.282	44.145			
05	0.345	17.25	30.533	54.043			
91		126.70	137.020	168.929			
102, 95%fLD_{50}=2.16 ; $S_{log}.LD_{90}$=0.1501, S.E=17.9591, 95%fLD_{90}=35.2 ;							
12	0.253	12.65	7.211	4.110	2.59±0.257	19.3±3.367	60±18.257
61	0.442	22.10	19.227	16.727			
31	0.548	27.40	32.058	37.508			
34	0.577	28.85	42.410	62.342			
D	17.25	17.25	30.533	54.043			
0638		108.25	131.439	174.730			
1.7178, 95flLD_{50}=3.367 ; $S_{log}.LD_{90}$=0.0675, S.E=9.3148, 95%fLD_{90}=18.257							

Spodoptera littoralis collected from Dier Alla and Shouna-north

)2 - P)	W	nw	nwx	nwx^2	Slope $b \pm S_b$	LD_{50} ±95% Fiducial limits μg/larva	LD_{90} ±95% Fiducial limits μg/larva
00	0.621	31.05	17.699	10.088	2.38±0.3713	4.9±1.188	17±5.44
09	0.591	29.55	25.709	22.366			
45	0.377	18.85	22.055	25.804			
84	0.154	07.70	11.319	16.639			
38		87.15	76.782	74.897			

1,95%fLD$_{50}$=1.188 ; S_{log}.LD$_{90}$=0.071,S.E=2.7765,95%fLD$_{90}$=5.44 ;

90	0.616	30.80	-0.924	0.028	1.57±0.234	1.48±0.394	9.65±4.28
80	0.629	31.45	08.492	2.293			
03	0.548	27.40	15.618	8.902			
15	0.405	20.25	17.618	15.327			
40	0.238	11.90	13.923	16.290			
28		121.80	54.727	42.840			

.201,95%fLD$_{50}$=0.3941 ; S_{log}.LD$_{90}$=0.0984,S.E=2.1888,95%fLD$_{90}$=4.2804 ;

91	0.599	29.95	17.071	9.731	1.71±0.3914	2.2±1.36	12.2±4.7
38	0.419	20.95	18.227	15.857			
48	0.292	14.60	17.082	19.986			
56	0.140	07.00	10.290	5.126			
33		72.50	62.670	60.700			

.6938,95%fLD$_{50}$=1.358 ; S_{log}.LD$_{90}$=0.0854,S.E=2.3969,95%fLD$_{90}$=4.696 ;

58	0.629	34.60	-1.038	0.031	1.435±0.221	1.27±0.455	11.3±5.527
49	0.624	31.20	8.424	02.274			
00	0.548	27.40	15.618	08.902			
52	0.419	20.95	18.227	15.857			
28	0.286	14.30	16.730	19.575			
87		128.45	57.961	46.609			

.2322,95%fLD$_{50}$=0.4551 ; S_{log}=0.1085,S.E=2.8199,95%fLD$_{90}$=5.527 ;

Table 4: Slopes and LD_{50}s of lannate, dursban and ripcord against S. littoralis sampled from Dier Alla and Shouna-north in 1978 and 1979 analysed by Litchfield method.

Treatment	Slope	LD_{50} and fiducial limits
Lannate		
Dier Alla 1978	8.01	113(78.73 - 162.73)
Dier Alla 1979	8.03	105(72.88 - 151.27)
Shouna 1978	6.31	105(73.17 - 150.66)
Shouna 1979	7.18	112(79.28 - 158.21)
Dursban		
Dier Alla 1978	6.51	3.9(2.70 - 5.62)
Dier Alla 1979	2.38	18.5(15.61 - 21.92)
Shouna 1978	7.21	3.65(2.33 - 5.70)
Shouna 1979	2.41	19.3(16.24 - 22.93)
Ripcord		
Dier Alla 1978	2.59	4.9(3.95 - 6.07)
Dier Alla 1979	4.33	1.48(1.06 - 2.06)
Shouna 1978	3.78	2.2(1.52 - 3.18)
Shouna 1979	5.46	1.27(0.86 - 1.86)

Table 5: Significance test DMRT of the treatments of lannate, dursban and ripcord against S. littoralis sampled from Dier Alla and Shouna-north in 1978 and 1979.

Treatment	Slope	LD_{50}	LD_{90}
Lannate			
Dier Alla 1978	1.1^{h}	113^{a}	1600^{ab}
Dier Alla 1979	1.09^{h}	105^{a}	1500^{a}
Shouna 1978	1.25^{gh}	105^{a}	1100^{b}
Shouna 1979	1.15^{h}	112^{a}	1400^{a}
Dursban			
Dier Alla 1978	1.22^{fg}	3.9^{b}	43.5^{c}
Dier Alla 1979	2.65^{a}	18.5^{b}	59^{c}
Shouna 1978	1.1^{gh}	3.65^{b}	52^{c}
Shouna 1979	2.59^{b}	19.3^{b}	60^{c}
Ripcord			
Dier Alla 1978	2.38^{c}	4.9^{b}	17^{c}
Dier Alla 1979	1.57^{d}	1.48^{b}	9.65^{c}
Shouna 1978	1.71^{e}	2.2^{b}	12.2^{c}
Shouna 1979	1.43^{f}	1.27^{b}	11.3^{c}

* Mean separation within columns by Duncan's multiple range test at the 5% level.

Table 6: Slopes, LD_{50}s and LD_{90}s with fiducial limits of lannate, dursban and ripcord against S.littoralis sampled from Dier Alla and Shouna-north in 1978 and 1979 calculated by Finney's method.

Treatment	Slope(b) ± S_b	LD_{50}	LD_{90}
Lannate			
Dier Alla 1978	1.1(1.06-1.141)	113(69.71-156.29)	1600(233.18-2966.8
Dier Alla 1979	1.09(1.049-1.131)	105(63.06-146.94)	1500(194.26-2805.
Shouna 1978	1.25(1.161-1.339)	105(68.45-141.44)	1100(358.66-1841.
Shouna 1979	1.15(1.094-1.206)	112(69.23-154.77)	1400(153.54-2646.
Dursban			
Dier Alla 1978	1.22(1.169-1.271)	3.9(1.9-5.9)	43.5(18.05-68.54)
Dier Alla 1979	2.65(2.575-2.725)	18.5(15.39.21.61)	59(40.73-77.27)
Shouna 1978	1.18(1.052-1.148)	3.65(1.49-5.81)	52(16.8-87.2)
Shouna 1979	2.59(2.424-2.656)	19.3(15.93-19.66)	60(41.74-78.25)
Ripcord			
Dier Alla 1978	2.38(1.99-2.76)	4.9(3.71-6.08)	17(11.56-22.44)
Dier Alla 1979	1.57(1.515-1.625)	1.48(1.08-1.87)	9.65(5.37-13.93)
Shouna 1978	1.71(1.23-2.18)	2.2(0.84-3.56)	12.2(7.5-16.9)
Shouna 1979	1.47(1.421-1.519)	1.27(0.81-1.72)	11.3(5.77-16.82)

Table 7: Effect of sublethal doses of ZR-515, CIBA 13339 and ripcord on larval leaf consumption, larval and pupal periods and the mortalities of larvae and pupae of Spodoptera littoralis.

Treatment	No. of treated larvae	Total Consumption cm^2/larva	Average daily leaf consumption in the first 6 days of treatment cm^2/larva	Average daily leaf consumption from treatment until pupation cm^2/larva	Average larval period in days	Average pupal period in days	No. of abnormal adults	Mortality (larvae+pupae) %
Control	40	96.04[a]	14.87[a]	14.53[a]	6.61[b]	19.94	0/32	20
ZR-515	20	139.95[a]	15.39[a]	15.13[a]	9.25[a]	22.90	7/10	50
CIBA 13339	40	111.40[a]	16.95[a]	15.78[a]	7.06[b]	21.07	14/25	37.5
Ripcord	40	69.20[b]	10.54[b]	11.42[b]	6.06[b]	20.87	0/21	47.5

[z] Mean separation within columns by Duncan's multiple range test at the 5% level.

DISCUSSION

The genitalic identification of the males (of which parental larvae survived the chemical treatments) in this work proved that they were S. littoralis, and not the other species of Spodoptera and especially not S. frugiperda which was reported in the Jordan Valley by Wiltshire 1977. The three genitalic parts: claspers, juxta and cornutum in the sixty males used were positively those of S. littoralis according to Wiltshire 1977 and Brown and Dewhurst 1975.

Up from one case of resistance in 1908, there were 12 species with resistant strains in 1940 and more than 364 in 1975, Georghiou and Taylor 1977.

Factors which influence the evolution of resistance include the initial frequency and dominence of alleles which confer resistance, inward migration of unselected individuals, refugia, dose of insecticide and timing of application, Georghiou and Taylor 1977. They examined and quantified the discrete influence of certain genetic and biological factors in the evolution of resistance. The operational factors concerned with the structure of the chemical, its persistance and relation to earlier used chemicals can be controlled in contrast to the genetic and the majority of the biological factors. Also the

2. The yearly replenishment of S. littoralis population after the drastic summer conditions by inward immigrants which dilutes the genetic pool of this leafworm.

3. The reproductive disadvantage of the resistant leafworm, Atallah 1971 and Abo-Elghar 1971.

The operational factors, Georghiou and Taylor 1977, as timing of application, dose of insecticide, spot spraying etc... are not controlled in the Jordan Valley. The Jordanian farmer is intensively applying insecticides at the appearance of symptoms and not at economic injury level. Pesticide sales in Jordan attained more than 2600 tons of 318 different pesticides at the cost of more than 2.4 million J.Ds in the last four years (1976-1979) according to the certified insecticide record - Ministry of Agriculture - Jordan. The lannate sales attain more than 260000 JDs far more than those of dursban 12800 JDs. This may overbalance all the above genetic factors and accelerates the formation of resistant strains in Jordan. Therefore, it is highly expected from the usage of the three insecticides that lannate stands out as the insecticide which had a strong field selective pressure. Its intensive use in the last nine years induced resistance into the population of the leafworm and may be cross resistance to other insecticides as dursban or pyrethroids as ripcord.

The source of the leafworm may have its role in the rate of the evolution of resistance in S. littoralis , Odent et al., 1976 in Turkey, Moustafa et al., 1977 in Egypt. Therefore it was sampled from two locations north and center of the Jordan Valley.

Results analysed by DMRT showed that there was no significant site variations in the resistance of the leafworm to the three insecticides. Also there was no yearly variation in their toxicities expressed as LD_{50} and LD_{90}. The slopes of the probit regression lines did not apply to the above rule only in the case of ripcord 1978, 1979 and dursban 1979. Therefore the presence of two different strains of S. littoralis in the north and center of the Jordan Valley is declaimed for two reasons:

1. The difference in the toxicity of the three insecticides expressed as LD_{50}s and LD_{90}s to the leafworms sampled from the north or center of the Valley proved insignificant by DMRT. Also their fiducial limits were overlapping conforming the insignificance of the site variations except ripcord 1978.

2. Allozyme variations in the natural population should be studied according to Sluss and Graham 1979 to settle the evolution of two different strains in the north and center of the Valley.

There are different ways to reveal and quantitate the resistance of a pest to the insecticides:

(a) Resistance can be quantitated in comparison with a laboratory susceptible strain, Harding et al., 1977, cf. Crowder et al., 1978.

(b) Resistance can be measured by the determination of LD_{50}, LD_{90} and slope of the probit regression line of different insecticides. The field insects showed higher LD_{50}, LD_{90} values and flatter slopes to the insecticides which they tolerate than to the other insecticides especially those which were not used before in field application, All et al., 1977, and Hall et al., 1977.

Unfortunately an international agreement on the limits which are put to consider an insecticide being weak to a certain pest is not at hand. Except for considering 10 X difference as a limit between tolerance and resistance according to Keiding 1956 cf. Toppozoda 1966, also except for such differences in LD_{50}s given by other workers on other insects, there is no other standard to compare the relative resistance of S. littoralis to the three insecticides.

The difference in LD_{50}s of lannate and dursban obtained in this work against S. littoralis may be accepted or not accepted as resistance levels when compared with other resistance levels in other insects. The aldrin resistant strains

of three rootworms Hylemia spp. showed resistant levels to aldrin higher than the susceptible strains 504X, 1213X, 947X, and to chlordane 119, 238, 90 X, Harris 1971. These differences far exceeded those obtained in this work.

The methyl parathion tolerant field Heliothis viriscens in Arizona showed higher LD_{50} values and flatter slopes than the susceptible (domestic) strains to bidrin and permethrin; about 6X differences was noted between the LD_{50}s, Crowder et al., 1978. Davis et al., 1975 cf. Crowder et al., 1978 reported a 5X higher susceptibility to permethrin in an organophosphate susceptible strain compared with field collected strains of tobacco budworms in Texas. Harding et al., 1977 cf. Crowder et al., 1978 reported a 21X difference in LD_{50}s of bidrin between laboratory methyl parathion susceptible and field collected strains of tobacco budworm in Texas.

In Arizona levels of tolerance to methyl parathion had increased by 1977 to 12X the 1972 values with decreasing dose probit mortality slope values, and 20X when compared to the demostic strain of Heliothis viriscens which has been in culture without insecticide challenge since 1965, Crowder et al., 1979.

In Jordan there is no toxicity data of lannate against S. littoralis since its introduction in 1971 and of dursban

which was introduced few months later.

In Arizona pyrethroids are recently introduced against the organophosphates resistant tobacco budworm. Spectacular differences in their toxicities and those of organophosphate are noted. All et al., 1977 reported that permethrin had an LD_{50} of 0.12 $\mu g/g$ compared to 0.53 $\mu g/g$ for methyl parathion (about 4.5 X differences). The difference between these two compounds was even more pronounced for the Arizona population in which a 132 X difference was noted, Crowder et al., 1979.

In Jordan, the spectacular increase in the concentrations of lannate sprays against S. littoralis in the three years 1972, 1973 and 1979 supports the resistance build up of the leafworm to lannate. It was recommended in 1972 to use 6g of lannate 90% per 20 liters of water Annonymous 1973. It was further increased to 8g/20 liters of water in 1973, Kabour 1973. In 1979 a drastic increase of the dose to 10-15 g/20 liters water was recommended, Sodah, 1979.

In Jordan Valley on LD_{50} basis ripcord was many times (about 25-88X) more toxic than lannate and far less times 12-15 X(in 1979) more toxic than dursban. Also dursban was many times about (5-28) more toxic than lannate,(table 6).

consumption in the first six days which is less than the cumulative daily consumption.

10. The total leaf consumption was increased over that of the control by the JHA treatments, while it was decreased in ripcord treatments.

CONCLUSION

Spodoptera littoralis in the north and center of the Jordan-Valley had developed resistance to lannate (due to its intensive use in the last nine years), and some tolerance to dursban (which was less used than lannate). No significant yearly or location variations (with few exceptions) were observed on the basis of LD_{50}s and LD_{90}s in the toxicity of the three insecticides to the insect, which may indicate that there is no different strains of the insect in the north and center of the Jordan Valley. So it is time to apply judiciously dursban or other organophosphates to prolong their useful life time and then in the long run ripcord or other pyrethroids in these areas.

Juvenile hormone analogues (JHAS) are less toxic than insecticides and they increase the average larval period,the average pupal period and the total leaf consumption, so they should not be used alone unless they are generally equitoxic to insecticides or the JHAS are integrated with compatible insecticides, which will restrict the demage of the survivors and bolance the adverse effects of the JHA survivors.

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ARABIC SUMMARY

تأثير بعض المبيدات الحشرية والهرمونات على دودة ورق القطن في وادي الاردن

أولا : التعرف على دودة ورق القطن

قرر Wiltshire, 1977 وجود النوع **Spodoptera frugiperda** مع **Spodoptera littoralis** في وادي الاردن ، لذا كان من الضروري التأكد من نوع **Spodoptera** الذي استعمل في هذا البحث . ولقد بين تشريح الاعضاء التناسلية الخارجية لذكر الحشرة الكاملة المستعملة في هذا البحث أنها دودة ورق القطن **Spodoptera littoralis** .

ثانيا : تسمية بعض المبيدات لدودة ورق القطن

استعملت ثلاث مبيدات حشرية تابعة لثلاثة مجموعات كيميائية مختلفة وهذه المبيدات هي لانيت (lannate) ٩٠٪ مسحوق قابل للبلل (كربماتي) ، والمبيد دورسبان (dursban) ٤٠٪ سائل (فسفوري) ، والمبيد ريبكورد (ripcord) ٤٠٪ سائل (من البايروثرويدات) . ولقد أختبرت هذه المبيدات بناء على تاريخ استعمالها في الاردن حيث أن المبيدين الاولين استعملا منذ حوالي تسع سنوات حيث استخدمت فيها كميات ضخمة من لانيت وقليلة من دورسبان بينما لم يستعمل المبيد الاخير بعد ، ولذلك استعمل المبيد الاخير ريبكورد Cypermethrin كأساس لمقارنة مقاومة الدودة للمبيدين الاخرين .

جمعت قطع البيض واليرقات من منطقتين مختلفتين ، دير علا والشونة الشمالية في وسط وشمال وادي الاردن ، وتم تربية هذه الحشرات منفصلة في أقفاص داخل البيت الزجاجي وفي الحقل وكانت هذه الاقفاص رخيصة جدا ويسهل تركيبها وفكها ثم تخزينها .

عوملت يرقات العمر السادس معاملة خارجية على الكيوتيكل بتركيزات مختلفة من هذه المبيدات ورسمت منحنيات السمية وحللت النتائج بطريقة Finney و Maximum likelihood و Litchfield ولقد كررت التجربة لسنتين متواليتين عام ١٩٧٨ و ١٩٧٩ .

حللت النتائج بطرق احصائية مختلفة وفيما يلي أهم الاستنتاجات:

١ - كانت اسمية المبيدات الثلاثة خلال سنتي البحث للحشرات المعاملة من كلا المنطقتين كما يلي : ريبكورد أشد من سميه يليه دورسبان ثم لانيت .

٢ - كانت هناك فروق كبيرة في السمية على مستوى ج ق ٥٠ ، ج ق ٩٠ بين الريبكورد من جهة والمبيدين الاخرين من جهة أخرى .

٣ - كانت منحنيات السميه لمبيد لانيت أكثر تفلطحا يليه دورسبان بينما كان ريبكورد أشد ميلا باستثناء حالات قليلة .

٤ - ارتفاع الـ ج ق ٥٠ والـ ج ق ٩٠ وتفلطح منحنى السميه لمبيد لانيت يدل دلالة واضحة على أن دودة ورق القطن تظهر مقاومة للمبيد المذكور .

٥ - أوضحت الدراسة أنه لا يوجد تأثير للزمن أو الموقع على سميه تلك المبيدات لتلك الحشرة باستثناء حالات قليلة .

ثالثا : تأثير الجرعات غير القاتلة لبعض الهرمونات ومبيد حشري

استعمل في هذه الدراسة هرمونان هما: ZR-515 (methoprene) C1BA 13339. Ethyl 4-(4-benzyl phenoxy)-3-methyl-2-butenoate والمبيد الحشري ريبكورد ، حيث عوملت يرقات العمر الرابع من دودة ورق القطن بجرعات غير قاتلة بمعدل ٠.٠٣ ر من السم³ بتركيز ١ ٪ من الهرمونات وتركيز ٠.٠١ ٪ من المبيد ريبكورد وعوملت الحشرات معاملة خارجية على الكيوتيكل ، وكانت تغذى

اليرقات يوميا بأوراق فصه محسوبة مساحتها بالسم^2 وكانت تحسب كمية الاستهلاك اليومي بقياس مساحة الورق المتبقي بعد ٢٤ ساعة من التغذية واستمرت التجربة حتى وصلت الحشرات الى الطور الكامل وبينت الدراسة ما يلي :

١ - ازداد عمر الطور اليرقي من ٦١ر٦ الى ٢٥ر٦ و ٧٠ر٦ يوم وعمر طور العذراء من ٩٤ر١٩ الى ٩ر٢٢ و ٠٧ر٢١ يوم نتيجة لاستعمال الهرمونات المبينة أعلاه ZR-515 و C1BA بالترتيب بينما قل الجيد ريكورد عمر الطور اليرقي من ٦١ر٦ الى ٠٦ر٦ يوم وزاد عمر طور العذراء من ٩٤ر١٩ الى ٨٧ر٢٠ يوم .

٢ - زاد معدل استهلاك العذاء اليومي نتيجة المعاملة بالهرمونات من ٥٣ر١٤ الى ١٣ر١٥ و ٧٨ر١٥ للهرمونين المذكورين اعلاه بالترتيب بينما سم^2 نقص معدل الاستهلاك نتيجة المعاملة بالجيد ريكورد من ٥٣ر١٤ الى ٤٢ر١١ سم^2 ز

APPENDIX I

Duncan Multiple Range Test (DMRT) on slopes of the three insecticides (lannate, dursban and ripcord) against Spodoptera littoralis sampled from Dier Alla and Shouna-North in 1978 and 1979.

I.a: Slopes per plot for the three insecticides against S. littoralis in 1978.

	Area									
	Dier Alla					Shouna-North				
Rep. / Insecticides	I	II	III	Total	$\bar{X}$	I	II	III	Total	$\bar{X}$
Lannate	1.17	1.19	1.05	3.41	1.13	1.07	1.49	1.07	3.63	1.21
Dursban	1.48	1.41	1.08	3.97	1.32	1.07	1.13	1.34	3.54	1.18
Ripcord	2.23	2.31	1.85	6.39	2.13	1.52	1.38	2.02	4.92	1.64
Total	4.88	4.91	3.98	13.77		3.66	4.00	4.43	12.09	

I.b: Total slopes per plot for the year 1978.

Rep. / Insecticides	I	II	III	Total	$\bar{X}$
Lannate	2.24	2.68	2.12	7.04	2.35
Dursban	2.55	2.54	2.42	7.51	2.50
Ripcord	3.75	3.69	3.87	11.31	3.77
Total	8.54	8.91	8.41	25.86	

I.c: Analysis of variance for the slopes of the year 1978.

Source of variation	df	SS	MS	Observed F	Required F 5%	1%
Total	17	2.8342				
Main plots	8	1.9280				
Blocks	2	0.0224				
Insecticides	2	1.8274	0.9137	46.85**	6.94	18
Error(a)	4	0.0782	0.0195			
Areas	1	0.1568	0.1568	2.53	7.71	21.20
Area X blocks	2	0.2597				
Areas X insecticides	2	0.2422	0.1211	1.95	6.94	18
Error(b)	4	0.2475	0.0619			

I.d: Slopes per plot for the three insecticides against S. littoralis in 1979.

	Area									
	Dier Alla					Shouna-North				
Insecticides \ Reps	I	II	III	Total	X	I	II	III	Total	X
Lannate	1.03	1.03	1.14	3.20	1.06	1.15	1.12	1.03	3.30	1.10
Dursban	3.52	2.49	2.80	8.81	2.93	2.57	2.58	2.40	7.55	2.51
Ripcord	2.22	2.00	1.41	5.63	1.87	1.42	1.31	1.63	4.36	1.45
Total	6.77	5.52	5.35	17.64		5.14	5.01	5.06	25.21	

I.e: Total slopes per plot for the year 1979.

Rep. / Insecticides	I	II	III	Total	$\bar{X}$
Lannate	2.18	2.15	2.17	6.50	2.17
Dursban	6.09	5.07	5.20	16.36	5.45
Ripcord	3.64	3.31	3.04	9.99	3.33
Total	11.91	10.53	10.41	32.85	

I.f: Analysis of variance for the slopes of the year 1979.

Source of variation	df	SS	MS	Observed F	Required F 5%	1%
Total	17	9.8657				
Main plots	8	8.7303				
Blocks	2	0.2316				
Insecticides	2	8.3321	4.166	99.665**	6.094	18
Error(a)	4	0.1671	0.0418			
Areas	1	0.3281	0.3281	3.0691	7.71	21.20
Areas X blocks	2	0.1721				
Areas X insecticides	2	0.2070	0.1035	0.9682	6.94	18
Error(b)	4	0.4277	0.1069			

I.g: Total slopes per insecticide plot over the two years (1978 and 1979).

Rep. / Insecticides	I	II	III	Total	$\bar{X}$
Lannate	4.42	4.83	4.29	13.54	4.51
Dursban	8.64	7.61	7.62	23.87	7.95
Ripcord	7.39	7.00	6.91	21.30	7.10
Total	20.45	19.44	18.82	58.71	

I.h: Analysis of variance of slopes over the the two years.

Source of variation	df	SS	MS	Observed F	Required F 5%	Required F 1%
Total	17	24.0321				
Main plots	8	9.9354				
Blocks	2	0.2257				
Insecticides	2	9.6407	4.8203	279.43**	6.94	18
Error(a)	4	0.0690	0.0172			
Years	1	2.7145	2.7145	23.16**	5.99	13.74
Years X insecticides	2	10.6789	5.3394	45.55**	5.14	10.92
Blocks X years	2	0.4214	0.2107			
Blocks X insecticides X years	4	0.2819	0.0704			
Error (b)	6	0.7033	0.1172			

Correction factor (c) = $\frac{(58.71)^2}{18}$ = 191.49

SS Total = $(2.24)^2$ ..... $(3.04)^2$ - c = 24.0321

SS Main plots = $\frac{(4.42)^2 \ldots (6.91)^2}{2}$ - c = 9.9354

SS Block = $\frac{(20.45)^2 \ldots (18.82)^2}{6}$ - c = 0.2257

SS Insecticides = $\frac{(13.54)^2 \ldots (21.3)^2}{6}$ - c = 9.6407

SS Error(a) = SS Main plots - SS insecticides -SS blocks=0.069

SS Years = $\frac{(25.86)^2 + (32.85)^2}{9}$ - c = 2.7145

SS (insecticide X years) = $\frac{(7.04)^2 \ldots (9.99)^2}{3}$ -c-insecticides - SS years = 10.6789.

SS Blocks X years = $\frac{(8.54)^2 \ldots (10.41)^2}{3}$ -c- SS blocks -SS years. = 0.4214

SS Blocks X insecticides X years = SS total-SS Main plots - SS years - SS insecticides X years - SS blocks X years = 0.2819.

SS Error(b) = SS Blocks X years + SS blocks X years X insecticides = 0.7033.

MS = $\frac{SS}{df}$, F = $\frac{MS\ treatment}{MS\ error}$.

Mean separation by DMRT method:

$$LSD_{05} = \sqrt{\frac{2S^2}{r}} = 0.1483$$

$$SSD = {}^{*}R_{05}(LSD)$$

P	1	2	3	4	5	6	7	8	9	10	11	12
	2.93	2.51	2.13	1.87	1.64	1.45	1.32	1.21	1.18	1.13	1.10	1.06
	1	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
SSD=0.1483	0.1512	0.1512	0.1512	0.1512	0.1512	0.1512	0.1512	0.1512	0.1512	0.1512	0.1512	0.1512
	2.93	2.51	2.13	1.87	1.64	1.45	1.32	1.21	1.81	1.13	1.10	1.06
	a	b	c	d	e	f	fg	gh	gh	h	h	h

* Values of R 5% from tables.

APPENDIX II

Duncan Multiple Range Test (DMRT) on LD_{50}s of the three insecticides (lannate, dursban and ripcord) against Spodoptera littoralis sampled from Dier Alla and Shouna-North in 1978 and 1979.

II.a: LD_{50}s per plot for the three insecticides against S. littoralis.

Area	Dier Alla					Shouna-North				
Insecticides \ Rep.	I	II	III	Total	$\bar{X}$	I	II	III	Total	$\bar{X}$
Lannate	105	132	115	352	120.66	94.0	124.00	94	312	104
Dursban	4.80	3.95	4	12.75	4.25	4.6	3.75	4.65	13	4.33
Ripcord	6.50	5	4.75	16.25	5.41	1.9	1.53	4.10	7.53	2.51
Total	116.30	140.95	123.75	381		100.5	129.28	102.75	332.53	

II.b: Total LD_{50}s per plot for the year 1978.

Insecticides \ Rep.	I	II	III	Total	$\bar{X}$
Lannate	199.00	256.00	209.00	664.00	221.3
Dursban	9.40	7.70	8.65	25.75	8.58
Ripcord	8.40	6.53	8.85	23.78	7.92
Total	216.80	270.23	226.50	713.53	

II.e: Total LD_{50}s per plot for the year 1979.

Rep. / Insecticides	I	II	III	Total	$\bar{X}$
Lannate	190.0	237.0	259.00	686.00	225.33
Dursban	36.1	40.5	39.50	116.10	38.70
Ripcord	3.8	3.2	3.67	10.67	3.55
Total	229.9	280.7	302.17	812.77	

II.f: Analysis of variance for the LD_{50}s of the year 1979.

Source of variation	df	SS	MS	Observed F	Required F 5%	Required F 1%
Total	17	55841.28				
Main plot	8	45246.20				
Blocks	2	459.14				
Insecticides	2	43998.45	21999.22	111.5848**	6.94	18
Error (a)	4	788.61	197.15			
Areas	1	0.286	0.286	0.0034	7.71	21.20
Areas X blocks	2	256.03				
Areas X insecticides	2	6.79	3.39	0.0409	6.94	18
Error (b)	4	331.98	82.99			

II.g: Total LD_{50}s per insecticide plot over the two years(1978 and 1979)

Insecticide \ Rep.	I	II	III	Total	$\bar{X}$
Lannate	389.00	493.00	486.00	1350.00	450.00
Dursban	45.50	48.20	48.15	141.85	37.28
Ripcord	12.20	9.73	12.52	34.45	11.38
Total	446.70	550.93	528.67	1526.30	

II.h: Analysis of variance of LD_{50}s over the two years.

Source of variation	df	SS	MS	Observed F	Required 5%	Required 1%
Total	17	183702.10				
Main plots	8	181331.33				
Blocks	2	1004.36				
Insecticides	2	177879.62	88939.81	145.36**	6.94	18
Error (a)	4	2447.35	611.84			
Years	1	547.15	547.15	3.22*	5.99	13.74
Years X insecticides	2	804.36	402.18	2.36	5.14	10.92
Blocks X years	2	454.05				
Blocks X insecticides X years	4	565.21	141.30	0.8318		
Error (b)	6	1019.27	169.87			

Mean separation: By Duncan Multiple Range Test (DMRT) method.

LSD = 27.9315

19% 66 115 33 113 33 104 19.7 19 5.41 4.33 4.25 2.51 2.05 1.50.

APPENDIX III

Duncan Multipla Range Test (DMRT) on LD_{90}s of the three insecticide (lannate, dursban and ripcord against Spodoptera littoralis sampled from Dier Alla and Shouna-North in 1978 and 1979.

III.a: LD_{90}s per plot for the three insecticides against S. littoralis in 1978.

Area	Dier Alla					Shouna-North				
Rep. / Insecticides	I	II	III	Total	$\bar{X}$	I	II	III	Total	$\bar{X}$
Lannate	1300.0	1550.0	1950	4800.0	1600.00	1480	880	1480.0	3840.0	1280.0
Dursban	36.0	32.5	60	128.5	42.8	65	49	40.5	154.5	51.5
Ripcord	19.8	18.0	23	60.8	20.26	13	13	17.5	43.5	14.5
Total	1355.8	1600.5	2033	4989.3		1558	942	1538	4038	

III.b: Total LD_{90}s per plot for the year 1978.

Rep. / Insecticides	I	II	III	Total	$\bar{X}$
Lannate	2780.0	2430.0	3430.0	8640.0	2880.0
Dursban	101	81.5	100.5	283.0	94.3
Ripcord	32.8	31	40.5	104.3	34.7
Total	2913.8	2542.5	3571	9027.3	

III.c: Analysis of variance for the LD_{90}s of the year 1978.

Source of variation	df	SS	MS	Observed F	Required F 5%	1%
Total	17	8538966.49				
Main plots	8	8186868.99				
Blocks	2	90421.60				
Insecticides	2	7929419.98	3964709.99	236.602**	6.94	18
Error (a)	4	67027.41	16756.85			
Areas	1	90881.20	90881.20	2.147	7.71	21.20
Areas X blocks	2	29040.90				
Areas X insecticides	2	62881.31	31440.65	0.7428	6.94	18
Error (b)	4	169294.09	42323.52			

III.d: LD_{90}s per plot for the three insecticides against S. littoralis in 1979.

	Area									
	Dier Alla					Shouna-North				
Rep. / Insecticides	I	II	III	Total	$\bar{X}$	I	II	III	Total	$\bar{X}$
Lannate	1600.0	1850	1870	5320.0	1773.0	1300.0	1750.0	2000.0	5050.0	1683.00
Dursban	58.0	66	60	184.0	61.3	60.0	64.0	64.0	188.0	62.60
Ripcord	6.9	8	13	27.9	9.3	16.5	12.8	7.2	36.5	12.16
Total	1664.9	1924	1943	5531.9		1376.5	1826.8	2071.2	5274.5	

III.e: Total LD_{90}s per plot for the year 1979.

Rep. / Insecticides	I	II	III	Total	$\bar{X}$
Lannate	2900.0	3600.0	3870.0	10370.0	3456.6
Dursban	118.0	130.0	124.0	372.0	124.0
Ripcord	23.4	20.8	20.2	64.4	21.4
Total	3041.4	3750.8	4014.2	10806.4	

III.f: Analysis of variance for the LD_{90}s of the year 1979.

Source of variation	df	SS	MS	Observed F	Required F 5%	1%
Total	17	11768098.34				
Main plots	8	11709561.92				
Blocks	2	84386.95				
Insecticides	2	11458889.69	5729444.84	86.065**	6.94	18
Error (a)	4	266285.28	66571.07			
Areas	1	3680.80	3680.80	0.9082	7.71	21.20
Areas X blocks	2	14495.45				
Areas X insecticides	2	24150.86	12075.43	2.9797	6.94	18
Error (b)	4	16209.31	4052.42			

III.g: Total LD_{90}s per insecticide plot over the two years(1978 and 1979).

Rep. / Insecticides	I	II	III	Total	$\bar{X}$
Lannate	5680.0	6030.0	7300.0	19010.0	6336.6
Dursban	219.0	211.5	224.5	655.0	218.3
Ripcord	66.2	51.8	60.7	178.7	59.5
Total	5965.2	6293.3	7558.2	19843.7	

III.h: Analysis of variance of LD_{90}s over the two years (1978 and 1979).

Source of variation	df	SS	MS	Observed F	Required 5%	1%
Total	17	39946663.83				
Main plots	8	39157326.83				
Blocks	2	244504.00				
Insecticides	2	38430598.11	19215299.05	159**	6.94	18
Error (a)	4	482224.72	120556.18			
Years	1	153801.00	153801.00	3.187	5.99	13.74
Years X insecticides	2	346022.16	173011.08	3.585	5.14	10.92
Blocks X insecticides	2	105114.10				
X years	4	184399.28	46099.57	0.9553		
Error (b)	6	289513.38	48252.23			

Mean separation: By Duncan Multiple Range Test (DMRT) method.

1773 1683 1600 1380 62.6 61.3 51.5 42.8 20.26 14.5 12.16 9.3

IV.c: Average larval period (days) for S. littoralis.

Rep. / Treatments	I	II	III	Total	$\bar{X}$
Control	8.35	6.60	4.90	19.85	6.61
ZR-515	11.26	9.40	7.10	27.76	9.25
CIBA 13339	7.30	7.50	6.40	21.20	7.66
Ripcord	7.12	7.58	3.5	18.20	6.06
Total	34.03	31.08	21.90	87.01	

Analysis of variance for average larval period

Source of variation	df	SS	MS	Observed F	Required F 5%	1%
Total	11	42.86				
Blocks	2	20.01				
Treatments	3	17.55	5.85	6.64*	4.76	9.78
Error	6	5.3	0.88			

LSD = 1.62

Mean separation by (DMRT) method:

9.25	7.06	6.61	6.06
a	b	b	b