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SUMMARY

1- Toxicological studies:

Bioassays were carried out using leaf-dipping technique for monitoring resistance spectrum toward organophosphates, synthetic pyrethroids and IGR, ecdysteroid agonist in six different field populations representing Lower and Middle Egypt Governorates of the cotton leafworm *Spodoptera littoralis* (Boised.) collected before and after implementing the recommended chemical control program in the cotton fields. The results could be summarized as follows:

- The toxicity data based on LC_{50} values indicated that the synthetic pyrethroid Esvenvalerate was the most toxic insecticides against the laboratory strain (reference strain) of the cotton leafworm and was followed closely by the ecdysteroid agonist Tebufenozide while the organophosphate Profenofos was the least toxic one.

- Resistance ratios (RR) values revealed that all tested field populations exhibited high resistance levels to the traditional insecticides, which were much higher for the synthetic pyrethroids Esvenvalerate (RR for early = 145.8 – 311.7 versus RR for late = 250 – 491 fold) than for the organo-phosphate Profenofos (RR for early = 20.14 – 41.42 versus RR for late = 22.8 – 68.9 fold). However, the lowest resistance levels in all Governorates were detected for the ecdysteroid agonist Tebufenozide (RR for early = 8.53 – 26.8 versus RR for late = 12.62 – 34.87 fold).

- The resistance spectrum was relatively higher in the late season as compared with that of the early in the season.

- Development of the tolerance rate (T.R) during the season was relatively higher and faster for the synthetic pyrethroid and OP insecticides compared with that for the ecdysteroid agonist.

- The development of tolerance rate (T.R) showed the highest level for Profenofos in Dakahlia and Behera strains while the highest tolerance rate for Esfenvalerate was detected in Kalubya and Kafr El-Shekh strains. However, slightly increase in tolerance rate was detected for the ecdysteroid agonist Tebufenozide during the season in all strains.

- Continuous selection by the nonsteroidal ecdysteroid agonist Tebufenozide at LC₂₅ level against the 4th instar larvae for 8 successive generations, did not result in remarkable shift of insect susceptibility even after the first 4 generations whereas it increased by 1.68 times at the 8th generation relative to the status at parent generation

- The ecdysteroid agonist Tebufenozide-selected strain while exhibiting 58.87 fold for resistance to the selected agent, it also showed varying levels of high pronounced cross-resistance to insecticides representing different chemical groups, recording RR = 79.19 fold for the organophosphate, Profenofos and RR = 370.85 fold for the synthetic pyrethroid, Esvenvalerate.

2- Physiological studies:

The newly moulting 4th instar larvae of *S. littoralis* were allowed to feed on castor bean leaves treated through dipping technique with sublethal (LC₀ and LC₁₀) concentrations of each experimental pesticide for 48 h, then feeding continued for 3 days on untreated fresh leaves.

The weights of fresh leaves (either treated or untreated), larvae, untreated leaves and faeces were recorded daily and divided by the number of survived larvae each day to get the different values per larvae/day. Subsequently the effect for/and the changes in different physiological parameters were calculated daily till the end of the whole testing period (5 days) in comparison with control larvae. The results could be summarized as follows:

Antifeeding activity (A. A.):

- Tebufenozide at both sublethal concentrations tested revealed significantly the highest mean antifeeding activity against the laboratory reference strain whereas both Profenofos and Esfenvalerate exhibited significantly less antifeeding activity.

- Similar performance but of less magnitude was almostly achieved in both highly resistant larval populations of Kalubya and Behera Governorates.

- The highest resistant strain (Behera) exhibited the least antifeeding activity for the 3 tested insecticides.

Weight of food consumed (C.W.):

- Cumulative food consumed was remarkably higher in L-strain compared with larvae of field strains when were fed untreated leaves.

- Considerable decrease in cumulative consumed food was obvious when larvae were fed leaves treated with LC_0 and LC_{10} of the tested pesticides particularly IGR. Such decrease was more pronounced in case of Behera-strain which highly tolerate the tested IGR.

Consumption index (C.I.):

- Based on the overall mean C.I. obtained after the 5 days experimental period a significant decrease was recorded in Tebufenozide treatments compared with other treatments including the control.

- The decrease in C.I. was relatively more remarkably in Behera strain than Kalubya strain particularly at the higher sublethal concentration (LC₁₀).

Growth rate (G.R.)

- Feeding larvae of *S. littoralis* on leaves treated with sublethal concentrations of Tebufenozide resulted in mean growth rate (G.R.) significantly lower than in both of control and other treatments.

- A proportional relationship was remarkably observed between values of consumed food (C.W.), consumption index (C.I.) and growth rate (G.R.), particularly in case of Tebufenozide treatments.

Efficacy conversion of ingested food (E.C.I.):

- Comparison based on mean E.C.I recorded after the whole experimental period revealed that mean E.C.I values in Profenofos and Esvenvalerate treatments was almostly similar to those of control regardless the strain tested.

- It was obvious that Tebufenozide resulted in E.C.I. significantly lower than either both other insecticides or/and the control. The effect was more pronounced for larvae fed on higher (LC₁₀) sublethal concentration of Tebufenozide.

- In general the more resistant the strain (population) the lower E.C.I achieved. Also the more progress in larval age the higher the decrease in E.C.I.

- The E.C.I was directly proportional to the E.C.D and inversely proportional to A.D.

Approximate digestibility (A.D.):

- The overall mean of A.D. revealed that feeding larvae of either lab. or/and field strains on sublethal concentrations of Profenofos and Esvenvalerate resulted in A.D values almostly similar to those of control.

- In contrast, Tebufenozide treatments exhibited remarkable reduction in A.D. values which was significantly lower when compared with other treatments including control.

Efficacy conversion of digested food (E.C.D.):

- Comparison based on overall mean during the whole testing period revealed insignificant variation in E.C.D. values between each of Profenofos, Esvenvalerate and control whereas, significant reduction in E.C.D. values was achieved in Tebufenozide treatments.

- The decrease in (E.C.D.) value of IGR-treatments was more obvious in higher sublethal concentration (LC_{10}) than in lower one (LC_0).

3- Biochemical Studies:

The biochemical studies were performed to evaluate the effects of sublethal concentration (LC_{25}) of the tested insecticides on some enzyme activity of cotton leafworm *S. littoralis* field strains collected in the early and late season and also of the IGR-R and IGR-L strains. The results could be summarized as follows:

a - Esterases (α -E and β -E):

- In normal state, the larvae of *S. littoralis* field strains and also the resistance strain were characterized by higher titer of non specific esterases compared to the laboratory strain, also the field strains larvae collected after spraying season had non-specific esterase activity greater than that collected before spraying season.

- The data revealed also that larvae collected before spraying season exhibited great reductions in their α -E and β -E activities post treatment with the OP insecticide, while that treated with pyrethroid and IGR exhibited an increase in their α -E activity.

- The larvae collected after spraying season showed change in α -E and β -E activity closed to control in all tested strains except Dakahlia strain.

b - Cholinesterases (AChE):

- Generally, field strains in normal state were characterized by low level of AChE activity than the laboratory strain.

- The sublethal concentrations of the tested insecticides showed variable decreases in AChE activity of both Kalubya and Behera strains larvae collected before spraying season, while a high level in AChE activity was shown in the other tested field strains.

- On the other hand, after spraying season the larvae of Menofia and Behera strains exhibited variable reductions in their AChE activity compared with the other tested strains

c - Aliphaticesterases (AliE):

- In normal state, both Behera and Kafr El-Sheikh strains collected during early season had low level of AliE activity than lab strain, while the other four tested field strains had high level of AliE

activity comparing to lab strain. During the late spraying season Dakahlia and Kalubyia had low level of AliE activity than lab strain, and a high level of AliE activity was recorded for the other field strains.

- The data emerged from insecticides treatment revealed that the OP Profenofos caused variable inhibition in AliE activity of most tested field strains collected before and after spraying season

d - Phosphatases (AcP & AlkP):

- All tested field strains collected before and after spraying season had phosphatases activities greater than laboratory strain.

- The sublethal concentration (LC₂₅) of the tested insecticides caused a dramatic decrease in the level of both AcP and AlkP activities in most tested field strains, while an increase in the level of phosphatases were recorded in IGR-resistant strain.

e - Carbohydrates hydrolyzing enzymes:

- All field strains had trehalase enzyme much greater than laboratory strain. Menofia, Kafr El-Sheikh, Behera and Dakahlia field strains collected after spraying season revealed high level of trehalase compared with that collected before spraying season, while the opposite trend was obtained from Kalubyia and Menia field strains. Also the IGR-resistant strain had trehalase activity much higher than IGR-laboratory strain.

- The data obtained from trehalase enzyme showed an elevation in the enzyme activity of most tested field strains during the course of insecticides poisoning, also the IGR-resistant and IGR-laboratory strains revealed an increase in their trehalase activity after insecticides treatment

- Generally all field strains in normal state had invertase activity much greater than laboratory strain. However, Menofia, Menia, Kalubya and Dakahlia field strains collected after spraying season had low levels of invertase activity compared with that collected before spraying season, while the opposite trend was obtained from Behera and Kafr El-Sheikh field strains.

- The data resulted from carbohydrate hydrolyzing enzymes (trehalase and invertase) revealed that, a pronounced increase in trehalase activity was observed as a result of treating the cotton leafworm field strains with the sublethal concentrations of each of Profenofos, Esvenvalerate and Tebufenozide insecticides, while a decrease in invertase activity was obtained as a result of insecticides poisoning comparing to control.

f - Total protein :

- All field strains in normal state were characterized by a high level of total protein than laboratory strain with exception Menofia, Behera and Kafr El-Sheikh collected before spraying season had low level of protein content than laboratory strain

- Data showed also that total protein were decreased in most tested strains due to insecticides treatment.