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V. SUMMARY

Eleven materials from plant origin and one from IGRs were studied against the pink bollworm larvae by topical application method and some experiments were done using the feeding method.

A susceptible strain of cotton pink bollworm, *Pectinophora gossypiella* (Saund.) was reared under the laboratory conditions of $27 \pm 2^\circ\text{C}$ and $70 \pm 5\%$ R.H. The artificial diet described by Rashad and Ammar (1985) was prepared. Eleven plant materials were provided by the Faculty of Pharmacy, University of Alexandria, namely; chicory crude extract, Isoquercetrin, Esculetin, Cichoriin, caffeic acid, Amaryllis crude extract, Rutin, Juniper crude extract, Scutellarin, Quercetagenin and Inula oily layer. Another chemical compound which is Nomolt (ideal IGR) was used for comparison the results. The following criterions were studied for all the tested materials: mortality percentage, pupation percentage, number of pupae that failed to develop, number of normal adults, larvae, pupae and adult weights with some materials, successful adult formation percentage, inhibition of adult formation percentage, number of dead adults, mating efficiency, number of eggs laid per female, egg hatchability and number of produced normal and abnormal spermatophores. Also, histological investigations were conducted for the testes and ovarioles. The antifeeding activity of Inula oily layer against the neonate pink bollworm larvae was investigated by choice and no-choice test. Also, the effect of Nomolt on the food consumption and utilization by the fourth instar larvae was investigated. The nutritional indices, namely

the relative consumption rate, relative growth rate, efficiency of conversion of ingested food, efficiency of conversion of digested food and approximate digestibility were calculated. The larvae produced from the above experiment were allowed to develop to pupae and adults. The mortality percentages, daily weights of the larvae fed on treated and untreated diets were recorded. Also, the larval, pupal and adult periods and weights (males and females) were recorded. The growth curves were constructed. Finally, the measurement of chitin from body walls of larvae fed on diet treated with Nomolt were conducted. The following results were obtained:

1. Results of chicory extracts

- 1.1. The 4th instar larvae of the pink bollworm treated with topical application showed low mortality percentages ranged from zero to 20% for the dosages of 0.5, 1, 2.5 and 5 micrograms per larva.
- 1.2. The inhibition of pupation percentages were 16.67, 23.08, 40 and 62.5%, in respect, for the tested dosages.
- 1.3. The inhibition of adult formation percentages were 33.33, 50, 66.67 and 83.33%, in respect.
- 1.4. Numbers of abnormal larvae, pupae and adults were obtained.
- 1.5. The dosage of 1 microgram per larva caused increase in the number of laid eggs per female, while the dosage of 2.5 micrograms caused production of abnormal spermatophores. Also, the hatchability percentages were decreased.
- 1.6. The dissection histological studies on the testes and ovaries proved that severe damage was happened.

2. Results of Isoquercetrin

- 2.1. The dosages of 0.25 and 0.5 micrograms per larva did not cause any larval mortality, while the dosages of 1 and 2 micrograms caused 10% mortality for each.
- 2.2. Considerable numbers of abnormal pupae were produced.
- 2.3. The inhibition of pupation percentages were 6.67, 10, 18.52 and 18.52, in respect, for the dosages of 0.25, 0.5, 1 and 2 micrograms.
- 2.4. The inhibition of adult formation percentages were 23.33, 33.33, 40 and 50%, in respect, for the tested dosages.

3. Results of Esculetin

- 3.1. The Esculetin dosages of 1, 1.25, 2.5 and 5 micrograms per larva caused low mortalities.
- 3.2. A considerable number of abnormal pupae was produced.
- 3.3. The inhibition of pupation percentages were 16.67, 18.52, 25.93 and 37.04, in respect, for the tested dosages.
- 3.4. Esculetin inhibited the adult formation at the rates of 33.33, 40, 70 and 90%.
- 3.5. The produced pupae were small in size and the resulted adults were also small in size, while some moths had large abdomen end and with bent wings.
- 3.6. The number of eggs per female was severely decreased.
- 3.7. The hatchability percentage was strongly affected which may be due to the few number of produced spermatophores.

4. The results of Cichoriin

- 4.1. The larval mortality percentages ranged from 16.6 to 50% for the dosages of 0.5, 1, 2.5 and 5 micrograms per larva.
- 4.2. The inhibition of pupation percentages were 20, 25, 25 and 66.67%.
- 4.3. The inhibition of adult formation percentages were 33.4, 66.7, 83.4 and 100%, in respect, for the tested dosages.

5. The results of caffeic acid

- 5.1. The dosages of 0.5, 1, 2.5 and 5 micrograms per larva caused low mortalities ranged from 16.6 to 23.33%.
- 5.2. A considerable numbers of abnormal pupae were obtained.
- 5.3. The inhibition of pupation percentages were 0, 20, 41.67 and 65.22%.
- 5.4. The inhibition of the adult formation percentages were 33.33, 66.67, 83.33 and 86.87%, in respect, for the tested dosages.
- 5.5. The caffeic acid caused marked effect on the fecundity and fertility of the pink bollworm adults.
- 5.6. The female laid few number of eggs ranged from 17 to 52 eggs, while stopped egg laying with 5 micrograms dosage.
- 5.7. The males produced abnormal spermatophores or stopped the spermatophore production.
- 5.8. The histological studies showed few oocytes in the ovarioles.
- 5.9. The longitudinal section of the testis showed damage (existence of many vacuoles and the sperm bundles became small in size and short in length).

6. The results of Amaryllis extract

- 6.1. There were no larval mortalities at all tested dosages which were 1, 1.25, 2.5 and 5 micrograms per larva.
- 6.2. Abnormal pupae were resulted in increasing numbers depending on the tested dosage.
- 6.3. Although considerable numbers of pupae were produced, the inhibition of pupation percentages happened at low rates (0, 0, 16.67 and 20%).
- 6.4. The inhibition of adult formation percentages were 0, 16.7, 33.4 and 50%.
- 6.5. The number of eggs laid by treated female was increased and ranged from 160 to 310 eggs, while it was 172 in the check.
- 6.6. There was moderate effect on the hatchability percentages which ranged from 14.05 to 60%, while it was 89.54 in the check.
- 6.7. There were abnormal spermatophores at all tested dosages.
- 6.8. The histological examinations of the testis showed thickness in the testicular epithelial coat and it was shown to be destroyed in some points. Also, the internal structural components were hypertrophied.

7. The results of Rutin

- 7.1. When the dosages of 1, 1.25, 2.5 and 5 micrograms Rutin per larva were applied, low mortalities ranged from 3.33 to 16.6% were found. The same dosages of Amaryllis extract gave no mortalities, so it means that the Rutin is present in the crude extract at low concentration.

- 7.2. Big numbers of abnormal pupae were produced.
- 7.3. The inhibition of pupation percentages were 0, 17.24, 37.04 and 48%, in respect, for the tested dosages.
- 7.4. A considerable numbers of abnormal adults were resulted.
- 7.5. The inhibition of adult formation percentages were 20, 36.67, 53.33 and 83.33%, in respect, for the tested dosages.
- 7.6. It was observed that some of the couples resulting from the treatment can not separate which may be due to the malformation of the reproductive system.
- 7.7. Females resulting from larval treatment laid a big number of eggs ranged from 169 to 308, while it was 161 in the check. The only treatment caused decreasing or stopping the egg laying was the dosage of 5 micrograms.
- 7.8. The hatchability percentages in mating possibilities were ranged from 39.62 to 66.67% at the first three dosages. Only the dosage of 5 micrograms caused hatchability percentages ranged from zero to 46.47%. It may be due to the lack of normal spermatophores in the bursa copulatricies.
- 7.9. The histological studies of the testis emphasized the marked effects on the hatchability percentages. The testis was very small in size and the sperm bundles became thickner and shorter.

8. Results of Juniper extract

- 8.1. Dosages of 1, 1.25, 2.5 and 5 micrograms per larva caused no mortalities to the pink bollworm larvae.

- 8.2. Pupae produced were classified to normal and abnormal which were 20 & 10, 25 & 5, 25 & 5 and 20 & 10, in respect, for the tested dosages.
- 8.3. Five pupae of each dosage tested were failed in development.
- 8.4. The inhibition of the adult formation percentages were ranged from 16.67 to 66.67%.
- 8.5. Larvae treated with high dosages exhibited serious disturbances during adult eclosion. Adults developed within the pupal cuticle and unable to shed the exuviae. These non-viable forms were much small.
- 8.6. The larvae formed into mosaics had both larval and pupal characteristics.
- 8.7. These intermediates did not undergo subsequent developmental changes and ultimately died.

9. Results of Scutellarin

- 9.1. Dosages of 1, 1.5, 2.5 and 5 micrograms per larva did not give any larval mortality.
- 9.2. A considerable number of abnormal pupae were produced.
- 9.3. Low numbers of resulted pupae failed to development.
- 9.4. Big numbers of abnormal adults were resulted.
- 9.5. The inhibition of adult formation percentages were 30, 50, 60 and 70%, in respect, for the tested dosages.
- 9.6. The effects of Scutellarin were similar to those of Juniper extract, except slight increasing in the effect of Scutellarin. It may be attributed to the use of Scutellarin as active ingredient, while it was found in the Juniper extract as one of different constituents.

- 9.7. The pupae developed to adults gave moths very small in size.
- 9.8. The numbers of eggs laid per female were increased with the dosages of 1, 1.25 and 2.5 micrograms.
- 9.9. The hatchability percentages for the mating possibilities ranged from 32.94 to 79.44% for the tested dosages, while it was 91.86% in the check.
- 9.10. Deformed and normal spermatophores were found inside the bursa copulatricies.

10. Results of Quercetagetin

- 10.1. The larval mortality percentages were 0, 16.6, 23.33 and 33.3%, in respect, for the dosages of 0.5, 1, 2.5 and 5 micrograms per larva.
- 10.2. The numbers of resulted normal and abnormal pupae were 20 & 10, 20 & 5, 13 & 10 and 10 & 10, in respect, for the tested dosages.
- 10.3. The inhibition of pupation percentages were 16.67, 20, 43.47 and 50%, in respect, for the tested dosages.
- 10.4. The inhibition of adult formation percentages were 33.33, 53.33, 73.33 and 83.4%, in respect.
- 10.5. The number of eggs laid per female recorded severe decreasing and ranged between 12 and 40 eggs, and in some cases the female stopped egg laying.
- 10.6. The hatchability percentages were decreased and ranged from zero to 71.43%.
- 10.7. The male moth produced normal and abnormal spermatophores, and in some cases the male failed to form the spermatophores.

10.8. Dissection of the male reproductive showed that the testis was small in size and abnormal in shape.

10.9. The histological studies of the testis showed disturbance in the arrangement of the testis structure. The sperm bundles and spermatocytes were ruptured, dispersed and reduced.

11. Results of Inula oily layer

11.1. The topical application of oily layer of Inula plant against pink bollworm 4th instar larvae caused mortalities between 10, 20 and 33.33% for the dosages of 0.05, 0.08 and 0.1 microgram per larva, in respect, while the dosages of 0.003 and 0.03 gave no mortalities.

11.2. Abnormal pupae were found at all tested dosages.

11.3. Inhibition of pupation percentages were 20, 20, 22.2, 25 and 50%, in respect for the tested dosages.

11.4. Abnormal adults were found and ranged from 3 to 9 adults.

11.5. The inhibition of adult formation percentages were 30, 40, 43.33, 50 and 70%, in respect for the tested dosages.

11.6. The treatment decreased the number of eggs per female and in some cases stopped the egg laying.

11.7. The hatchability percentages were decreased.

11.8. Toxicity was studied also by the feeding method with the oily layer of Inula at concentrations of 0.3, 1.7, 3.3, 6.7, 8 and 20%.

11.9. Mortalities after 24 h ranged from 12 to 60% and after 48 h mortalities ranged from 18

indicated that the concentration of 20% suppressed the feeding by 77.78% for the pink bollworm larvae.

12. Results of Nomolt

- 12.1. The topical application with the dosages of 0.00001, 0.0001, 0.0005 and 0.001 microgram per pink bollworm 4th instar larva caused mortalities ranged from 13.3 to 86.7%.
- 12.2. Abnormal larvae were found and abnormal pupae were produced.
- 12.3. The inhibition of pupation percentages were 14.3, 57.7, 66.7 and 100%, in respect, for the tested dosages.
- 12.4. Inhibition of the adult formation percentages were 40, 86.67, 93.33 and 100%, in respect.
- 12.5. Dosage of 0.001 microgram per larva gave no adults, while the dose of 0.0005 gave few adults which stopped egg laying.
- 12.6. At the dosages of 0.0005 and 0.001, the males could not produce spermatophores and the pairs could not perform mating.
- 12.7. Also, the hatchability percentage was zero %.
- 12.8. Studying the toxicity of Nomolt by feeding method on the first instar larvae of pink bollworm showed that the mortalities after 24 h, 48 h and 72 h, in respect recorded 6.67, 13.33 and 40% for the concentration of 0.5 ppm; 20, 26.67 and 53.33% for the concentration of 5 ppm; 33.33, 40 and 80% for the concentration of 25 ppm.
- 12.9. Measurements of the efficiency of conversion of ingested food (E.C.I) and the efficiency of conversion of digested food (E.C.D) were decreased with the increasing of the concentration of Nomolt.

- 12.10. The E.C.I and E.C.D values were 2.65 & 2.78, 1.66 & 1.72 and 1.34 & 1.39, in respect, for the concentrations of 0.5, 5 and 25 ppm.
- 12.11. The larval growth was decreased and increasing the Nomolt concentration caused decreasing in the larval weight.
- 12.12. Generally, male pupa weight was less than female pupa, but the weight of male pupa resulted from treatment reduced as the time passed from 17.4 mg in the 1st day to 11.3 mg in the 6th day.
- 12.13. The female pupa weight reduced also from 20.7 to 13.3 mg.
- 12.14. The adult weight, generally, increased between 2nd and 5th day and goes down again.
- 12.15. Weight of the female was drastically decreased because of the egg laying.
- 12.16. Measurements of chitin from body walls of larvae revealed that the Nomolt retarded slightly the chitin formation ratios which were 22.47, 19.81, 11.33, 9, 7.72 and 8.19 mg/g in the check for the exposure periods of 0, 3, 7, 12, 26 and 42 hours. Those records were 20.05, 9.55, 7.83, 6.97 and 6.67 for the treatment with Nomolt.