SUMMARY

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Part (I)

U.V. light and Sex-pheromone traps for ecological estimations :

1- Population dynamics of *Spodoptera littoralis* adults :

Daily counts were recorded for the numbers of moths caught at El-Kanater El-Khairiya district (Qalubia Governorate) throughout two successive years (1994 & 1995) by using U.V. light and Sex pheromone traps . Daily temperature (min. & max.) and R.H. were also recorded in order to find out the efficiency of these traps in attracting *S.littoralis* moths on one hand and the correlation between the catch and weather factors, on the other hand .

A. by using U.V. light traps :

The total population of adults was generally higher in 1995 (976.5 adults) than 1994 (444 moths) . The high adults abundance occurred throughout the last week of May in 1994 and the second week of July in 1995 (23 and 49 adults / trap , respectively) .

B. By using pheromone traps :

Six peaks of adults' abundance were detected in 1994 (the highest peak was detected on May, 27 *th* and the lowest was detected on March, 25 *th*) . In 1995 four peaks were detected (the highest peak was detected on July, 8 *th* and the lowest was detected on March, 18 *th*) .

2- Comparison between *S.littoralis* male catch by using U.V. light and the Sex - pheromone traps :

The data indicated that the total males' catch was nearly 4.4 times higher in the pheromone traps (1942.5) than in the light trap (444) during 1994 but in 1995 it was nearly 5.5 times higher in the pheromone traps (5413.2) than in the light trap (976.5) . The two years data indicated that the two years males' catch by the sex. pheromone trap (7355.7 moths) was 5.2 times higher than those caught by the light trap (1420.5 moths) .

3- Effect of weather factors :

Correlation coefficient values were calculated between the size of weekly catch by pheromone traps and the weekly records of max. & min. temperatures , and % R.H .

A. Maximum temperature :

There was a significant positive relationship between the moths' catch and the maximum temperature (r = + 0.794 in 1994 and + 0.848 in 1995) at two weeks earlier in 1994 and at five weeks earlier in 1995 .

B. Minimum temperature :

A significant positive correlation was detected also between moths' population abundance and the minimum temperature (r = + 0.866 in 1994 & + 0.794 in 1995) at one week earlier in 1994, but at four weeks earlier in 1995 .

C. Relative humidity :

The relationship between the population at *S.littoralis* moths and relative humidity was significantly negative in 1994 and also in 1995 (r. = -0.445 in 1994 and -0.797 in 1995) at five weeks earlier in 1994 and at three weeks earlier in 1995 .

D. The combined effect of three weather factors :

The partial regression values and the explained variance percentages were calculated to determinne the combined effect of the three weather factors . In 1994, the explained variance percentages were 84.3, 87.6 and 74% for the maximum & minimum temperatures and % relative humidity, respectively . The minimum temperature was the most effective factor on the cotton leaf worm population, followed by the maximum temperature, while the % ralative humidity was the least effective factor. In 1995, the % R.H. was the most effective factor (95% explained variance), followed by the maximum temperature (93.1%) and the least effective factor was the minimum temperature (85.6%) .

4- Relationship between the volume of moth'catch and the cotton leafworm egg - masses in cotton fields :

Positive correlation was evident between the captured number of male moths and number of egg - masses in the field ; *f. e.* , more egg - masses in the field are expected to be found as the captured males in the sex - pheromone traps increase . The higest significant regression value (b = + 0.71) was detected 3 days earlier throughout the period from May, 21 *st* to July, 17 *th* 1994 . That meant that for every 7 male moths captured by the

sex-pheromone traps, about 10 of the cotton leafworm egg - massess are expected to be detected / feddan on cotton leaves at El - Kanater El - Khairiya during May - July . In 1995, the highest significant regression value (b = 0.608) occurred at three days earlier; *i . e .* for every 6 male moths captured in the sex - pheromone traps, there were about 10 egg - masses of the cotton leafworm on cotton leaves throughout the same mentioned period .

5- Comparison between the average number of *S.littoralis egg* - masses / feddan in treated and untreated areas with pheromone traps :

The 3 days average number of egg - masses collected during 1994 season from May, 18 *th* to July, 17 *th* was 20.9 and 43.5 / feddan in the areas treated with pheromone traps and the untreated areas . In 1995, these averages were 54.43 and 91.38 egg-masses / feddan in the treated and untreated areas from May, 21 *st* to July, 17 th . Thus showed reductions in the egg-mass counts by 53.53 and 41.28% in 1994 and 1995, respectively . with average reduction of (53.53% in 1994 and 41.28% in 1995) .

Statistical analysis of data indicated positive significant correlation between the number of egg - masses in the treated and untreted areas . A highly significant regression value (b = + 1.59 in 1994 and + 1.48 in 1995) were calculated . These meant that for every 10 egg - masses in areas provided with pheromone traps; there was about 16 egg - masses in cotton fields which were not provided with pheromone traps, while in 1995, for every 10 egg - masses in cotton fields that received pheromone traps, there was about 15 egg-masses in areas which were not provided with pheromone traps .

6- Effect of the mean temperature on the egg - laying activity of *Spodoptera littoralis* moths :

Positive significant correlation was detected between the mean temperature and the egg - laying activity (r = + 0.699 in treated and + 0.769 in untreated areas) . A highly significant regression values (b = + 7.63 in treated and + 12.867 in untteated areas during 1995 season) . That meant that an increase of 1°C in the daily mean temperature . increases the number of egg - masses laid by moths of *S. littoralis* by 7.63 and 12.86 on the average in treated areas with Pheromone traps and untreated areas .

Part II

Non - chemical substances against *S. littoralis*

This experimental work was carried out to evalute the effetiveness of some substances against the cotton leafworm *S. littoralis* by using semi - field technique . The non-chemical substances used in these experiments included : " Bio-clean " (a bioinsecticide contains *Bacillus thuringiensis* and *Beauveria bassiana)* , IKI PP 145 & Consult 100 EC & Consult 100 SC and the water suspension of a hedge plant, *Clerodendron inerme* dry leaves . These substances were applied in the field on cotton plants to be assayed in the laboratory against the 2 *nd* and 4 *th* instar larvae of *S.littoralis* larvae which were fed for 24 hrs. on cotton treated leaves after different periods from field application .

1. Toxicological and biological activity of " Bio-clean " on *Spodoptera littoralis :*

1.1. Acute toxicity of "Bio - clean " :

The results showed that feeding of *S .littoralis* larvae for 24 hrs. on Bio - clean treated cotton leaves caused mortalities that ranged between 40-96% and 30-92% by treatment in the 2 *nd* and 4 *th* instars at zero time and after 9 days of application, respectively, compared to 14% amongst the control larvae .

1.2. Biological activity of Bio-clean :

The delayed effects of Bio-clean on the surviving larvae and the subsequent stages after treatments of the 2 *nd* and 4 *th* larval instars may be summarized as follows :

1.2.A. Effect on larval duration :

The period of *S. littoralis* larval stage was affected due to 2 *nd* and 4 *th* instar larval feeding on Bio-clean treated cotton leaves such effect was the lengthening of this period (23 ± 0.2 - 27.5 ± 0.5 days by treatment in the 2 *nd* instar and 19.2 ± 0.3 - 24.2 ± 0.6 days by treatment in the 4 *th* instar opposed to 20.6 ± 0.1 and 18.5 ± 0.3 days for the larval period of the control larvae) . This effect increased by shortening the period from application to treatment .

1.2.B. Effect on pupal duration :

Bio-clean treatment caused increases in the duration of the subsequent pupae which resulted from larval treatment . The longest pupal period (20.3 ± 0.7 days) from pupae resulted from larvae fed in their 4 *th* instar at zero time,

while the pupal duration of pupae resulted from the 2 *nd* instar larval treatment was 20.0 ± 0.7 days opposed to 16.5 ± 0.2 and 16.4 ±0.1 days in case of control pupae, respectively . .

1.2.C. Effect on pupal weight :

Larval treatment in the earlier instar (2 *nd* instar) lead to pupae less in weight than those resulted from larvae treated in the latter one (4 *th* instar); the recorded weights were 272 and 284 mg / pupa due to larval treatment at zero time opposed to 416 and 414 mg. for control pupa .

1.2.D. Effect on pupation :

The severest effect occurred when treatment took place on the earlier larval instar . The percentage of pupation due to 2 *nd* and 4 *th* instars larval treatment at zero time were 24 and 32%, respectively opposed to 90 & 92% pupation in case of the control pupae .

1.2.E. Effect on adults' emergence :

The percentages of adults'emergence were 16.7 and 25% by treatment of the 2 *nd* and 4 *th* instars larvae at zero time, opposed to 95.5 and 93.5%, respectively , form pupae resulted from untreated larvae

1.2.F. Deformations amongst different stages :

The total percentages of malformed stages ranged from 6 to 32% and 8-26% by treatments of the 2 *nd* and 4 *th* instar larvae at zero time and after 9 days of field applications, respectively .

1.2.G. Effect on the resultant adults :

1.2.G.1. Effect on adult's life-span :

The moths resulted from the 2 *nd* instar larval treatment lived for 6-5 days in case of males and females, respectively . The longevities of males and females resulted after 4 *th* instar larval treatment were 6-5.7 days opposed to 9.9-8.9 of control moths, respectively .

1.2.G.2. Effect on eggs' reproductivity and hatchability :

The females resulted from 2 *nd* instar larval treatment, deposited fewer number of eggs (140 eggs/female) resulted after larval treatment at zero time opposed to 310 eggs/ control female) . The females, resulted from 4 *th* instar larval treatment, deposited 151 eggs/female from larvae treated at zero time opposed to 315 eggs/ control female . Amongst the deposited eggs, the hatchability % was found to be reduced to Bio-clean larval treatment, being 20-35 and 23-47 %, respectively, opposed to 90 & 80% from eggs of the control check .

2. Toxicolgical and biological activity of " IGR compounds " on *Spodoptera littoralis* :

Consult 100 EC caused the highest mortality rates amongst the treated larvae, being 38 - 96% and 32 - 96% opposed to 34 - 96% and 30 - 90% in case of Consult 100 SC and 26 - 94% and 30 - 90% in case of IKI PP 145, by treatment the 2 *nd* and 4 *th* instar larvae, respectively .

2.2 Latent toxicity of " IGR compounds " :

IGR's caused reductions in the weight of resultant pupae, pupation, emergence and eggs'reproductivity . These effects were dependent on, the period after the IGR application to treatment and also on the assayed compound .

2.3. Biological activity of IGR's :

The delayed effects of IGR's on the surviving larvae and the subsequent stages after treatments of the 2 *nd* and 4 *th* larval instars .

2.3.A Effect on larval duration :

Generally, the effect of *S. littoralis* larval feeding on cotton leaves treated by IGR compounds (prolongation of the larval period) increased by shortening the period from field of the compound application to laboratory treatment . By treatment at zero time, the longest larval periods were detected (IKI PP 145; 27.9 ± 0.3 (25-29), Consult 100 EC; 26.4 ± 0.4 (25-30) and Consult 100 SC; 26.6 ± 0.3 (25-29) days for larvae were fed on treated food (IKI PP 145; 23.6 ± 0.6 (19-28), Consult 100 EC; 23.5 ± 0.7 (20-29) and Consult 100 SC; 23.6 ± 0.7 (20-28) days) at zero time .

2.3.B. Effect on pupal duration :

IKI PP 145 showed the greatest efficiency on the pupel durtion, the longest pupel periods occurred from 2 *nd* instar larvae at zero time, being 20.8 ± 0.6 days, 20.3 ± 0.7 days for Consult 100 SC and 20 ± 0.7 for Consult 100 EC. When treatment took place on the 4 *th* instar lervae, at zero time

(19.9 ± 0.7, 19.8 ± 0.9 and 19.7 ± 0.7 days for treatments by IKI PP 145, Consult 100 SC and Consult 100 EC, respectively) .

2.3.C. Effect on pupal weight :

The pupae became heavier in their weights as the period after application until starting larval feeding became longer . The highest effect of IGR'S in reducing the pupal weight occurred by treatment the second instar *S. littoralis* larvae at zero time (270, 278 and 292 mg. by using IKI PP 145, Consult 100 EC and Consult 100 SC, respectively opposed to 415 mg. for the control pupae) . By treatment of the 4 *th* instar larvae, at zero time also, the recorded values of pupal weight were 280, 285 and 300 mg., respectively .

2.3.D. Effect on pupation :

The serverest effect occurred when treatment took place just after application of IGR compounds . This effect decreased and the percentage of normally formed pupae increased by the lengthening of the period from IGR application to treatment . The 2 *nd* instar larvae were more susceptible than the 4 *th* instar larvae . The mean percentages of pupation were 128, 26 and 26% by using IKI PP 145, Consult 100 EC and Consult 100 SC, respectively by treatment the 2 *nd* instar larvae at zero time . While the treatment of 4 *th* instar larvae, the mean percentage of pupation was 30% by using the three IGR compounds at zero time .

2.3.E. Effect on adults' emergence :

The percentages of adults' emergence (28.6, 23.1 and 23.1% by treatment of the 2 *nd* instar larvae with IKI PP 145, Consult 100 EC and Consult 100 SC at zero time, respectively .

While the percentages of adults' emergence (40,33.3 and 33.3%) by treatment of the 4 *th* instar larvae with IKI PP 145, Consult 100 EC and Consult 100 SC at zero time, respectively .

2.3.F. Deformations amongst different stages :

Higher percentages of deformities occurred amongst the treated larvae (4 to 28 & 4 to 24%) than amongst the resultant pupae (0 to 8 & 2 to 10%) and adults (0 to 6 & 2 to 4%) by treatment of the 2 *nd* & 4 *th* instars larvae at zero time and after 9 days of IKI PP 145 application, respectively .

2.3.G. Effect on the resulatant adults :

The delayed effect was also detected on the adult stage which showed shorter life - span and decreased fecundity than control .

2.3.G.1. Effect on adult's life - span :

The moths resulted from the 2 *nd* instar larval treatment with IKI PP 145, Consult 100 EC and Consult 100 SC were lived for 5.5 & 5, 6 & 5 and 6 & 5 days in case of males & females, respectively, at zero time . While the moths resulted from the 4 *th* instar larval treatment with IKI PP 145, Consult 100 EC and Consult 100 SC were lived for 6.7 & 5.5, 6.5 & 5.5 and 6.5 & 5.5 days in case of males & females at zero time, respectively .

2.3.G.2 Effect on eggs' reproductivity and hatchability :

By using IKI PP 145, Consult 100 EC and Consult 100 SC against 2 *nd* instar larvae, the numbers of deposited eggs were 147, 149 and 152 eggs / female by treatment the larvae at zero time, respectively, while the larval treatment of 4 *th* instar larvae, the numbers of deposited eggs were 157, 158 and 159 eggs / female, respectively . Amongst the deposited eggs, the hatchability percentage was 0% in cases of the three IGR compounds by the treatments of 2 *nd* & 4 *th* instar larvae at zero time .

3- Toxicological and biological activity of *clerodendron inerme* on *Spodoptera littoralis* :

3.1. Acute toxicity of *Clerodendron inerme* :

Water suspension of *clerodendron inerme* dry leaves caused higher mortality rates amongst treated larvae (24-88% and 20-82% by treatment in the 2 *nd* and 4 *th* instars, respectively compared to 12-14% in the control larvae) .

3.2. Biological activity of *Clerodendron inerme* :

3.2.A. Effect on larval duration :

The general trend of such effect was the lengthening of this period (22.2 ± 0.2 - 26.4 ± 0.4 days by treatment in the 2 *nd* instar and 19.8 ± 0.2 - 23.3 ± 0.5 days by treatment in the 4 *th* instar opposed to 21.5 ± 0.2 and 19.4 ± 0.2 days for the control larvae, respectively) . The prolongation of larval period increased also by shortening the period from *C. inerme* application to laboratory treatment, as the longest larval periods (26.4 ± 0.4 24-29 and 23.3 ± 0.5 19-28 days) were detected by treatment the 2 *nd* and 4 *th* instars, respectively, just after application of the plant water suspension .

3.2.B. Effect on pupal duration :

Pupae resulted from *S. littoralis* larvae treated in the 4 *th* instar showed longer pupal period than those resulted from larvae treated in their 2 *nd* instar. The longest pupal period (19.9 ± 0.6 ; 17-22 days) was estimated from pupae resulted after 4 *th* instar larval feeding on treated cotton leaves at zero time, opposed to 16.8 ± 0.5 (10-18) days for the control pupae, indicating 18.5% increase in the pupal duration due to treatment .

3.2.C. Effect on pupal weight :

Generally, the average weight of pupae obtained from *C. inerme* fed larvae were less than those resulted from the control larvae and the larval treatment in the 2 *nd* instar lead to pupae less in weight than those resulted from larval treatment in the 4 *th* instar (282-352 mg . in the fromer case opposed to 289-382 mg. pupa in the latter one) , opposed to 416 ± 0.2 mg. for the control pupa .

3.2. D. Effect on pupation :

The mean percentages of normally formed pupae varied amongst pupae from different treatments being 32-84% normal pupae from larvae treated in their 2 *nd* instar and 38-88% from larvae treated at their 4 *th* instar at zero time and after 9 days of application, respectively opposed to 92 and 94% pupation from the untreated larvae .

3.2. E. Effect on Adults' emergence :

C. inerme was caused reduction in the percentages of adults' emergence (37.5-90.5% and 47.4-93.6% by treatment of the 2 *nd* and 4 *th* instar larvae just after application, respectively .

3.2 .F. Deformations amongst different stages :

More deformation percentages were recorded amongst the treated larvae (2-18 and 0.0-8.0%) than amongst the resultant pupae (0.0-12 and 6.0%) and adults (2.0-14.0 and 0.0-10.0%) due to larval treatment in the 2 *nd* and 4 *th* instars, respectively .

3.2. G. Effect on the resultant adults :

C. inerme treatment caused shortened life-span and decreased fecundity than control Adults resulted from treated larvae lived for 7.3 days (at zero time) to 9.4 days (by larval treatment after 9 days of application) in

case of males and for 6.7-8.9 days, respectively in case of females resulted from 2 *nd* instar larval treatment, while the respective longevities of males and females resulted after 4 *th* instar larval treatment were 7.4-9.6 and 7.0-8.8 days opposed to 9.8 and 8.9 days, respectively in case of the control moths .

The Female moths which resulted from larval treatment deposited fewer number of eggs that ranged from 154 to 242 eggs / female by 2 *nd* instar larval treatment at zero time and after 9 days of the field application, respectively opposed to mean of 310 eggs / control female, while the number of eggs ranged from 163 to 265 eggs, respectively / female by 4 *th* instar larval treatment, opposed to 315 eggs / female control . Also, the hatchability percentages were reduced due to larval treatment (27-57% and 29-71% in cases of 2 *nd* and 4 *th* instar larval treatment, respectively compared to 90-91% hatching from normally developed females from untreated larvae .