

Ecological and physiological studies on bollworms

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The present work was carried out during the two successive seasons of 2000 and 2001 at kafer El-geraeyaa, Zagazig region, Sharkia Governorate to study the seasonal fluctuation and field generation numbers of pink, spiny and american bollworms under field conditions and also to evaluate the effects of Chinmix, Spintor and Biorepel compounds against cotton bollworms in the cotton fields. Laboratory experiments were carried out in the Laboratories of Plant Protection Institute (Sharkia Branch) at Zagazig to evaluate the biological, biochemical and histological effects of above - mentioned compounds against pink and spiny bollworms.

1- Field experiments:

1-1-Seasonal population fluctuations of pink, spiny and american bollworm moths by using sex pheromone traps.

1-1-1-Pink bollworm: Male moths of pink bollworm started to attract by sex pheromone traps on the 1st week of April with about 0.4 and 0.2 male moth/trap/week for 2000 and 2001 seasons, respectively. Afterwards, the insect population fluctuated in numbers recording about five peaks of activity occurred in both seasons. The highest number of captured pink bollworm moths recorded at the 3rd week of September in both seasons.

1-1-2-Spiny bollworm: Spiny bollworm moths remained active throughout the year with population fluctuation in numbers recording about eight peaks of activity occurred during 2000 and 2001 seasons. The highest peak recorded at the 4th week of August in the both seasons.

1-1-3-American bollworm: Male moths of american bollworm started to attract by sex pheromone traps on the 3rd week of April with about 0.8 male moth/trap/week and the 1st week of April with about 0.6 male moth/trap/week during 2000 and 2001 seasons, respectively. Afterwards, the insect population fluctuated in numbers recording about five peaks of activity occurred during the two seasons. The highest peak recorded at the 1st week of August in both seasons.

1-2- Estimating field generation numbers of pink, spiny and american bollworms:

1-2-1-Pink bollworm: Pink bollworm captured moths had 5 generations a year . The fourth generation is the highest one with relatively percentages (37.93 & 39.8 %) of the total captures in 2000 and 2001 seasons, respectively.

1-2-2-Spiny bollworm: Spiny bollworm captured moths had 6 generations a year. The fourth generation is the highest one with relatively percentages (43.41 & 46.45 %) of the total captures in 2000 and 2001 seasons, respectively.

1-2-3- American bollworm: American bollworm captured moths had 3 generations a year. The second generation is the highest one with relatively percentage (54.95 — 45.71 %) of the total captures in 2000 and 2001 seasons, respectively.

1-3-Effect of certain weather factors on the population density of cotton bollworms:

1-3-1-Pink bollworm: The effect of maximum and minimum temperature on the number of male moths captured in pheromone traps was positive and highly significant during 2000 and 2001 seasons. While the effect of mean daily relative humidity was negative and nonsignificant during the first season and positive and nonsignificant during the second season . On the other hand, the explained variances by the effect of combined three weather factors were positive and highly significant in the two seasons.

1-3-2-Spiny bollworm: The effect of maximum and minimum temperature on the fluctuations in the number of trapped moths was positive and highly significant in both seasons. While The effect of mean daily relative humidity was negative and insignificant correlation during in the first season and positive and nonsignificant correlation during the second season. On the other hand the explained variances by the effect of combined three weather factors were positive and highly significant in the two seasons.

1-3-3-American bollworm: The effect of maximum and minimum temperature on the fluctuations in the number of trapped moths was positive and highly significant in both seasons. While The effect of mean daily relative humidity was

positive and nonsignificant correlation during 2000 and 2001 seasons. On the other hand, the explained variances by the effect of combined three weather factors were positive and highly significant in the both seasons.

1-4-Evaluate the effects of Chinmix, Spintor and Bioreple compounds against cotton bollworms:Chinmix was the most effective compound against cotton bollworms followed by Spintor and Biorepel showing annual percent of infestation reduction of 39.90, 63.72 and 34.71; 94.31, 69.21 and 37.72 % in 2000 and 2001 seasons, respectively.

1-5-Estimation of the cotton yield loss:The percentages of cotton yield losses in the cotton areas treated with Chinmix, Spintor and Biorepel were less than that of untreated cotton areas. The percent of cotton yield losses 0.89 : 2.26%, 10.23 : 12.55% and 19.15: 23.85% for Chinmix, Spintor and Biorepel as compared to control 28.30: 31.36% in 2000 and 2001 seasons, respectively.

2-Laboratory experiments:

2-1-Evaluation the biological effects of Chinmix, Spintor and Biorepl compounds against pink and spiny bollworms.

2-1-1-Toxic effect:Spintor compound was the most potent against *P.gossypiella* (LC50 was 0.131 ppm) and *E. insulana*, (LC 50 was 102 ppm) then Chinmix compound (LC50 was 0.284 and 0.306 ppm), respectively.

2-1-2 Latent effect:

2-1-2-1 Pink bollworm:- Larval duration:Chinmix and Spintor compounds caused a highly significant prolonged in larval duration, but the influence of Biorepel proved to be nonsignificant. The impact of different concentrations of each compound on this biological aspect was highly significant. The percent elongation in duration period of the larval stage ranged between 10.86 : 14.41 %, 3.48 : 16.63 % and 3.27 : 3.97 % for Chinmix, Spintor and Biorepel, respectively according to the concentration applied.

-Larval weight:Chinmix and Spintor compounds caused a highly significant reduction in larval weight, but Biorepel showed nonrisignificant effect. The influence of different concenof each compound on this biological aspect proved to be trations highly significant for Chinmix and nonsignificant for Spintor and between —Biorepel. The reduction percentages in larval weight ranged 10.34 : — 18.16 %, — 4.19 : — 10.89 and — 1.96 : 2.51% for Chirunix, Spintor and Biorepel, to the concentration applied. respectively according-

Larval mortality percentages:Mean larval mortality percentages increased from 3 % in untreated check to 15.75, 35.25 and 39.0 the % concentrations for Biorepel, 0Chinmix and Spintor, respectively. Increasing hof all tested compounds induced a gradual increase in larval mortality percentages.

-Pupal duration:Pupal duration of pink bollworm increase& highly significantly as influenced by Chinmix and Biorepel as compared with untrated larvae, but Spintor compound showed nonnsignificant effect. The influence of different concentrations of each compound on this biological aspect proved to be highly significant for Chinmix and Biorepel and significant for Spin. The percent elongation in duration period of the pupal stage.ranged between 5.26: 909 % g, — 0.48 : 2.51 % and 8.49:10.65 % for Chinmix, Spintor and Bioreel, reaccording to the concentration applied. p spectively,

SUMMARY• 175-Pupation percentages:Mean percent of pupation decreased from 97.0 % in untreated check to 84.75, 64.75 and 61.0 % for Biorepel, Chinmix and Spintor, respectively. Increasing the concentration of each compound induced a gradual. decrease in percent of pupation.

-Pupal weight:Chinmix caused a highly significant reduction in pupalweight, whereas Spintor and Biorepel showed nonsignificant effect. The impact of different concentrations of each compound on this biological aspect was highly significant for Chinmix and Spintor and significant for Biorepel. The reduction percentages in pupal weight ranged between — 14.94 : 23.75 %, - 2.68 : -13.03 % and — 3.83 : - 5.75 %. For Chinmix, Spintor an Biorepel, respectively according to the concentration applied.

-Adult emergence:The Biorepel induced high decreasing in adult emergence, 89.88 %, while Spintor caused the highest increas in the emergence percentage reached 93.80 % comparing with 98.0 % for untreated. Increasing the concentration of Chinmix induced a gradual decrease in adult emergence but in case of Spintor and Biorepel the trend was not detected for the effect of concentration on adult emergence.

-Sex ratio:Mean sex ratio recorded 50.07, 52.25 and 52.65 % for Chinmix, Spintor and Biorepel, respectively as compared with 49.96 % of control (check). distinct trends for the effect pink bollworm. In each compound, there are no of concentrations on sex ratio of-Malformation percentage of emerged adults:Mean malformation percentage of emerged adults increased from 1.14 % in untreated check to 6.74, 10.29 and 10.38 % for Spintor, Biorepel and Chinmix, respectively. Increasing the concentration of Chinmix induced a gradual increase in malformation percentage of emerged adults ,but in case of Spintor and Biorepel the trend was not detected.

-Adult longevity:

I-Male longevity: The reduction percentages in male longevity ranged between —9.12 : —14.31 %, - 6.63 : -12.68 % and -3.42 : - 8.20% for Chinmix, Spintor and Biorepel, respectively according to the concentration applied. II-Female longevity: The reduction percentages in female longevity ranged between — 4.94 : -10.01 %, - 0.092 : - 8.21 % and — 1.85 : — 0.0% for Chinmix, Spintor and Biorepel, respectively according to the concentration applied. -Oviposition periods of emerged females: I-Pre-oviposition: The highest pre-oviposition period of 3.29 days was recorded for Chinmix, whereas the lowest average of 2.88 days was recorded for Spintor. The larvae treated with Biorepel showed the median average of 3.23 days as compared with 2.93 days of control (check). II-Oviposition periods: Mean oviposition periods decreased from 14.33 days in untreated check to 13.43, 11.99 and 10.76 days for Biorepel, Spintor and Chinmix, respectively. III-Post-Oviposition: Mean post-oviposition increased from 5.40 days in untreated check to 5.63, 6.58 and 6.85 for Biorepel, Spintor and Chinmix, respectively. -Fecundity: The effects of both compounds and their concentrations were highly significant. The reduction percentages in number of laid eggs/female ranged between — 21.97 : — 50.28 %, — 16.60 : — 33.06 % and — 10.71 : — 17.99 % for Chinmix, Spintor and Biorepel, respectively according to the concentration applied. -Duration of egg stage: The highest mean incubation periods of 5.52, 5.51 and 5.22 days were recorded with the highest concentrations of 0.244, 0.122 and 2000 ppm. for Chinmix, Spintor and Biorepel, respectively. While, the lowest means of 5.19, 5.17 and 5.14 days with the lowest concentration of 0.030, 0.015 and 250ppm., respectively. -Fertility of eggs: Mean percentages of egg hatching decreased from 94.67% in untreated check to 85.42, 78.58 and 83.0 % for Biorepel, Spintor and Chinmix. The reduction percentages in percentages of egg hatching ranged between — 19.64 : - 29.94%, - 10.92 : - 25.71 % and — 8.1 : - 11.62 % of Chinmix, Spintor and Biorepel, respectively according to the concentration applied. 2-1-2-2 Spiny bollworm: - Larval duration: Chinmix and Spintor caused a highly significant prolonged in larval duration, but the influence of Biorepel proved to be nonsignificant. The impact of different concentrations of each compound on this biological aspect was highly significant for Spintor and Chinmix and significant for Biorepel. The percent elongation in duration period of the larval stage ranged between 15.35: 15.78 % , 15.19 : 15.97 % and 14.23 : 14.33 % for Chinmix, Spintor and Biorepel, respectively according to the concentration applied. - Larval weight: Chinmix and Spintor compounds caused a highly significant reduction in larval weight, but Biorepel showed nonsignificant effect. The influence of concentrations of each compound on this biological aspect proved to be highly significant. The reduction percentages in larval weight ranged between — 5.55 : - 9.22 % , - 3.70 : - 8.25 % and — 1.99 : -3.56%, for Chinmix , Spintor and Biorepel compounds respectively according to the concentration applied. -Larval mortality percentages: Mean larval mortality percentages increased from 5% in untreated check to 18.75, 30.50 and 42.75% for Biorepel, Chinmix and Spintor, respectively. Increasing the concentrations of all tested compounds induced a gradual increase in larval mortality percentages. -Pupal duration: Pupal duration of spiny bollworm increased highly significantly as influenced by Chinmix and Spintor as compared with untreated Larvae, but Biorepel showed nonsignificant effect. The influence of concentrations of each compound on this biological aspects proved to be highly significant. The percent elongation in duration period of the pupal stage ranged between 2.31 : 11.56 % , 4.19: 9.58 % and 0.44: 3.30 % , for Spintor, Chinmix and Biorepel compounds, respectively according to the concentration applied. -Pupation percentages: Mean percent of pupation decreased from 98.0 % in untreated check to 81.25, 69.5 and 57.25 % for Biorepel, Chinmix and Spintor, respectively. Increasing the concentration of each compound induced a gradual decrease in percent of pupation. -Pupal weight: Chinmix and Spintor caused a highly significant reduction in pupal weight, but Biorepel showed nonsignificant effect. The impact of different concentrations of each compound on this biological aspect was highly significant for Spintor and Chinmix and insignificant for Biorepel. The reduction percentages in pupal weight ranged between — 5.24 : - 11.49 % , - 4.84 : - 8.06% and — 0.40 : -1.61 % for Chinmix, Spintor and Biorepel, respectively according to the concentration applied. -Adult emergence: The highest adult emergence of 89.55 % was recorded for Chinmix, whereas the lowest average of 87.69 % was recorded for Biorepel. The larvae treated with Spintor showed the median average of 88.21 % as compared with 97.82 % of control (check). -Sex ratio: The effect of Chinmix, Spintor and Biorepel

compounds and their concentrations were nonsignificant on this biological aspect.

-Malformation percentage of emerged adults: Mean percent malformation of emerged adults increased from 0.0 % in untreated check to 7.47, 7.55 and 8.60 % for Spintor, Biorepel and Chinmix, respectively. Increasing the concentration of either Chinmix or Spintor induced a gradual increase in percent malformation of emerged adults but in case of Biorepel, there is no distinct trend for the effect of concentration on this biological aspect.

-Adult longevity:

I-Male longevity: The reduction percentages in male longevity ranged between - 7.83 : - 11.90 %, - 7.12 : - 9.35 % and - 1.37 : - 2.39% for Chinmix, Spintor and Biorepel, respectively according to the concentration applied.

II-Female longevity: The reduction percentages between - 9.11 : - 10.11 %, - 5.95 : - for Chinmix, Spintor and Biorepel, concentration applied.

-Oviposition periods of emerged females:

I-Pre-Oviposition: The highest pre-oviposition period of 3.40 days was recorded for Chinmix, whereas the lowest average of 2.94 days was recorded for Spintor. The larvae treated with Biorepel showed the median average of 3.10 days as compared with 3.07 days of control (check).

II-Oviposition periods: Mean oviposition period decreased from 11.93 days in untreated check to 11.18, 9.81 and 9.09 days for Biorepel, Spintor and Chinmix, respectively.

III-Post —Oviposition: All tested compounds caused nonsignificant prolongation in post-oviposition, but the influence of concentrations of each compound was highly significant for Chinmix and Spintor and significant for Biorepel.

-Fecundity: The reduction percentages in number of laid eggs/female ranged between — 30.11 : - 56.81 %, 23.57 : - 44.60 % and —14.94: - 31.25 % for Chinmix, Spintor and Biorepel, respectively according to the concentration applied.

-Duration of egg stage: The effects of the compounds and their concentrations were highly significant. Increasing the concentration of each compound induced a gradual increase in incubation periods.

-Fertility of eggs: The reduction percentages in percentages of egg hatching ranged between - 11.64 : - 32.73 %, -9.46 : - 19.28 % and - 4.36: -10.19 % of Chinmix, Spintor and Biorepel, respectively according to the concentration applied.

2-1-2-3 Morphogenetic effect: Biorepel compound gave highly abnormality rating for pink bollworm followed by Chinmix and Spintor. whereas in case of spiny bollworm Biorepel gave highly abnormality rating followed by Spintor and Chinmix. The relationship between concentration and abnormality rating in case of pink bollworm did not reveal a distinct trend and varied from one compound to another. On the contrary in case of spiny bollworm the results showed that there was positive relationship between the concentrations of each compound and the resulted malformed effect.

2-1-3 Effect of Biorepel on oviposition of pink and spiny bollworm moths: Biorepel compound has repellent effect on oviposition of pink and Spiny bollworms the mean number of eggs laid by pink or spiny bollworm moths on the treated part from cover of cages with Biorepel was lower than on the control were 19.67 and 528.0 ; 10.0, and 90.0 eggs with repellency percentages 96.27 and 88.98 % for pink and spiny bollworm moths on treated and untreated part, respectively.

2-2-Biochemical effects of Chinmix, Spintor and Biorepel compounds on larvae of pink and spiny bollworms:

2-2-1 Under laboratory condition:

A- Carbohydrate hydrolyzing enzymes: Chinmix, Spintor and Biorepel compounds decreased the activity of invertase, trehalase and amylase enzymes in the larvae of pink and spiny bollworms as compared to the control. In addition, in case of pink bollworm the highest decrease in invertase and trehalase activity recorded with Chinmix compound, while the highest decrease in amylase activity recorded with Spintor compound. The least decrease in invertase, trehalase and amylase activity recorded with Biorepel compound. In state of spiny bollworm the highest decrease in invertase, trehalase and amylase activity recorded with Spintor compound, while the least decrease recorded with Biorepel.

b-Transaminase enzymes (GPT & GOT) Generally, the tested compounds decreased the activity of GPT and GOT enzymes in larvae of pink and spiny bollworms as compared to the control, in addition in case of pink bollworm the highest decrease in GPT and GOT activity recorded with Chinmix compound, while in case of Spiny bollworm the highest decrease in GOT and GPT activity recorded with Spintor compound. The least decrease in GOT and GPT activity was noticed in Biorepel-treated larvae of pink and spiny bollworm.

c-Alpha and beta esterase (a — E & 13 - E): Chinmix and Spintor compounds decreased the activity of a - E and 13 - E enzymes in larvae of pink and spiny bollworms as compared to the control, meanwhile, the inverse is true in case of Biorepel compound.

d-Total soluble protein: The tested compounds decreased total soluble protein

in larvae of pink and spiny bollworms as compared to the control. Also, in case of pink bollworm the highest decrease in total soluble protein recorded with Biorepel compound while in case of spiny bollworm the highest decrease in total soluble protein recorded with Chinmix compound. The least decrease in total soluble protein was noticed in Spintor-treated larvae of pink and spiny bollworms.

2-2-2- Under field condition:

A-Carbohydrate hydrolyzing enzymes: Chinmix and Spintor caused increase in the activity of invertase and amylase enzymes and decrease in the activity of trehalase in larvae of pink bollworm. On the other hand, Biorepel caused decrease in the activity of invertase, trehalase and amylase enzymes.

B-Total soluble protein: Chinmix, Spintor and Biorepel compounds caused increase in the total soluble protein in larvae of pink bollworm as compared to control.

C-Transaminase enzymes (GPT & GOT): Chinmix, Spintor and Biorepel compounds caused increase in the activity of GPT&GOT enzymes in larvae of pink bollworm as compared to control.

D-Alpha and beta esterase (α - E & - E): Chinmix, Spintor and Biorepel compounds caused increase in the activity of α - E & R - E enzymes in larvae of pink bollworm as compared to control.

2-3-Histological effects of Chinmix, Spintor and Biorepel compounds on larvae of pink and spiny bollworms: The cross section of mid-gut of larvae of pink and spiny bollworms fed with newly hatched larvae with Chinmix, Spintor and Biorepel compounds showing many abnormalities in the internal components of the mid-gut compared with the control. Spintor compound caused destruction of epithelial cells in some points and separation of epithelial cells from basement membranes in the mid-gut larvae of pink and spiny bollworms. While Chinmix compound caused destruction of epithelial cells, peritrophic and basement membranes in mid-gut of larvae of pink and spiny bollworms. On the other hand, Biorepel compound caused separation of epithelial cells from basement membranes in some points and thickness of epithelial cells in the mid-gut larvae of pink bollworm and caused deformed of epithelial cells and degeneration in some points in mid-gut larvae of spiny bollworm.