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5. SUMMARY

The aim of present study was to enhance the potency of some *B. thuringiensis* formulations against the cotton leafworm *Spodoptera littoralis* Boisd. During the course of this study the following approaches were studied :

1. The effect of the tested *B. thuringiensis* compounds (Xentari,Protecto and Dipel 2x) and biocides [(Spintor,Vertimec and Virocet (Nuclear polyhedrosis)] on the toxicity and biotic potential of *Spodoptera littoralis* Boisd. under laboratory conditions at 25 ± 2 ºC and 70 ± 5 % relative humidity.

2. The interaction between the *B. thuringiensis* biocides and the tested microbial insect pathogens.

3. The joint action between the lethal concentrations of tested insecticides Decis 2.5 % E.C.,Dursban 48% E.C.,Lannate 90% WSP., and Consult 10 % E.C and candidate *B. thuringiensis* biocides

4. Enhancement the efficiency of *B. thuringiensis* biocides against the cotton leafworm, *Spodoptera littoralis* by different chemical additives.

5. Also,studies were conducted to increase the potency of *B. thuringiensis* against *Spodoptera littoralis* in cotton fields.

The obtained results could be summarized as follows :

1. The results of feeding the cotton leaf worm larvae on recommended, ¾ recommended, ½ recommended and ¼ recommended dose of *B. thuringiensis* biocides Xentari,Protecto and Dipel 2x. After 48h. of feeding on the higher (recommended) concentration, only 9 , 5 and 7 % larval mortality were observed, respectively . After 12 days , such larval mortality were increased to 57.1,27.5 and 34.1% respectively, while that of the control reached 8% .

The data indicated that treatment of larvae with recommended concentrations the tested *B. thuringiensis* compounds Xentari , Protecto and Dipel 2x, respectively drastically reduced the rate of pupation to 29.0, 66 and 60.0 %, while that of the control was 96.7 %. Also, these treatments reduced the rate of emergency of moth obtained from treated 2nd instar larvae to 34.48 % for Xentari, to 46.97 % for Protecto and 46.66 % for Dipel2x, while that of the control reached 92.31% .

The treatment of *Spodoptera littoralis* larvae with recommended dose of *B. thuringiensis* biocides reduced egg production by rates of 51.82 , 43.75 and 52.73 % for

Xentari,Protecto and Dipel 2x, respectively .With regard to hatchability, the obtaind results indicated that Dipel 2x was the most effective (31.13 % hatchability) followed by Xentari (33.51 % hatchability) and Protecto (51.39 % hatchability), when they were applied at their recommended doses, while the hatchability rate of the control was 96.41 % ..

The results revealed that Xentari was the most effective *B. thuringiensis* formulations followed by Dipel 2x while Protecto was the least active.

2. When the other bio-compounds Spintor,Vertimec and Virocet were tested against the 2nd instar larvae of *Spodoptera littoralis*. drastically reduced the % of mortality in larvae, % of pupation, % of mortality and deformation in pupae, % of emergence and deformation in moths, the mean number of eggs / female , % of hatchability and % of sterility were drastically reduced.

The larval mortality rates obtaind before pupation due to treatment the 2nd instar larvae for 48 hours with the tested concentrations of the candidate biocides indicated that Spintor was the most active, Virocet was the least active while Vertimec showed intermediate bio-activity against the tested larvae of *Spodoptera littoralis* .

3. Data indicated that the experimental *B. thuringiensis* formulations (Xentari, Protecto and Dipel 2x) at their different concentrations were potentiated when used in admixture with Spintor. The highest potency was observed when ¾ recommended dose of *B.thuringiensis* was mixed with ¼ recommended dose of Spintor by Co-toxicity factors of 98.22 for Xentari , 86.95 for Protecto and 89.29 for Dipel 2x after three days of treatment. The combination of ½ recommended dose of both tested *B.thuringiensis.* and Spintor showed intermediate potentiation. The toxicity was increased by a Co-toxicity factor of 45.96 , 70.69 and 50.21 for Xentari , Protecto and Dipel 2x , respectively.

4. The joint action between three traditional insecticides (chlorpyrifos-ethyl , deltamethrin,methomyl) and one IGR (hexaflumuron) at their LC_{25} and LC_{50} and biocides (Xentari , Protecto and Dipel 2x) at their full, ¾ and ½ recommended rateswas determined. Data indicated that Deltamethrin was the most toxic insecticide against the 2^{nd} instar larvae of *Spodoptera littoralis* with Co-toxicity factor 92.94 , 46.67 and 91.25, respectively while Methomyl was the least effective with Co-toxicity factor -3.53 , -11.00 and -25.00.

Data indicated that the experimental biocides (Xentari, Protecto and Dipel 2x) at their different tested rates were generally potentiated when used in admixture with LC_{25} and LC_{50} of deltamethrin. The highest potency was observed at LC_{25} of deltamethrin with the recommended rate of tested biocides..

5. Adding some non-toxic inorganic salts (calcium carbonate,sodium carbonate and potassium carbonate) increased the activity and potency of tested *B. thuringiensis* compounds. Synergistic factor reached the maximum with Dipel 2x (2.09) and Xentari (1.99) when these compounds were mixed with potassium carbonate (at 0.1%) against the 2^{nd} instar larvae of *Spodoptera littoralis* .

Data indicated that the tested amino acids Argenine and Alanine (at 0.05%) increased the toxicity of Xentari,Protecto and Dipel 2x when used in admixture with these compounds against the 2^{nd} instar larvae of the cotton leafworm. The toxicity increased by synergistic factor ranging between 1.41 (for Protecto with Alanine) and 1.84 (for Dipel 2x with Argenine).

Also the data show that the tested fatty acids Oleic and Formic at 0.05% in admixture with the tested *B. thuringiensis* compounds caused synergistic action. The synergistic factors ranged between 1.12 (for Protecto with

Formic acid) and 1.48 (for Dipel 2x with Oleic acid).

Data indicated that the tested alpha Z-oil at 0.5% caused an additve effect to Dipel 2x by synergistic factor of 1.00 and slight synergism to Xentari and Protecto by synergistic factor of 1.01 and 1.04 , respectively. Also the tested vegetable oils (cuminum , garlic and nigella) caused slight synergism to the candidate *B. thuringiensis* Xentari , Protecto and Dipel 2x by synergistic factors ranging between 1.01 and 1.04 .

6. Field experiments were carried out in El-Blashon district , Belbas , Sharkia Governorate.

The experiments included ten different treatments. Three treatments with the tested *B. thuringiensis*: Xentari,Protecto and Dipel 2x at their recommended doses 200,300 and 200 g / fed , respectively. The other seven treatments were as follow : *B. thuringiensis* Xentari (the most toxic tested *B.t*.) at ¾ recommended dose with Spintor and Vertimec at their ¼ recommended dose, Xentari at ¼ recommended dose with Virocet at ¾ recommended dose, Xentari at its recommended dose mixed with arginine, olic acid and potassium carbonate at 20 g/fed for each and finally, Xentari at its recommended dose with dursban at 26.96 ppm . All treatments included the control were replicated four times.

The results obtains from the semi-field experiments revealed that the mixtures of Xentari with Spintor, Potassium carbonate and Dursban showed higher initial kill and residual activity.

The field experiments showed that Xentari was the most potent *B. thuringiensis* biocide in reducing the population of the cotton leafworm larvae after 7 days of application, particulary when this compound was mixed with Dursban , Spintor and potassium carbonate. The reduction in larval population after 7 days of treatment were 91.12 , 90.36 and 82.77,respectively.

The previous results suggest that *Bacillus thuringiensis* biocides mixtures with Spintor, low dose of Dursban, potassium carbonate, amino acid argenine and olec acid may be recommended as an effective component of the future IPM programs against *Spodoptera littoralis* , on cotton fields.