SUSCEPTIBILITY OF APHID, *APHIS GOSSYPII* (*APHIDIDAE, HOMOPTERA*) TO CERTAIN *BACILLUS THURINGIENSIS* FORMULATIONS IN KUWAIT

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Abstract

Laboratory studies were conducted to determine the insecticidal activities of five preparations of *Bacillus thuringiensis* (Bt) on adults and nymphs of *Aphis gossypii*. Both nymphs and adults were highly susceptible to Bactospeine and Dipel, whereas Thuricide 64 was the least toxic. Results suggest a useful role of Bt formulations; Bactospeine and Dipel, against sucking insects such as aphids on vegetable crops in Kuwait .

INTRODUCTION

Aphid is one of the most noxious insects for vegetable crops. It causes leaf curling and stunning in plants and transmits viral diseases. Aphids are common in Kuwait and are identified as *Aphis gossypii* Glover, an common vector of CMV and many other viruses (Converse 1993). Like many other countries, the agriculture sector in Kuwait suffers tremendous losses due to insects most notably aphids (Anonymus, 1995). In greenhouses, the problem of aphids becomes serious due to their reproduction in very short time (Converse 1993). Currently, aphid population is controlled by chemical insecticides which are potentially hazardous, environmentally unsafe and insects frequently develop resistance to them. The development of alternative control methods is therefore urgently required.

Bioinsecticides have emerged as feasible alternatives to conventional chemical insecticides (Sommerville, 1978; Aronsom *et al.*, 1986; Hofte and Whiteley 1989). Such insecticides are environmentally safer and more economical and the insects do not develop resistance to them (Kirschbaum 1985). During the past decade, some *Bacillus thuringiensis* (Bt) strains have been successfully exploited for the control of specific target pests. More than 182 species of insects have been found to be sus-

ceptible to Bt-based bioinsecticies (Dean 1984). However, very few studies on sap-sucking insects such as aphids have been reported. In this study five formulations of *Bacilus thuringiensis* were screened for their insecticidal activities against aphid nymphs and adults.

MATERIALS AND METHODS

Aphid nymphs and adults were collected from their host plants inside the greenhouses. These insects were reared under laboratory conditions (25±2°C, 65% ± 5% R.H.) with artificial light from 12 to 24 h/d inside rearing cages. Cucumber and eggplant were used as host plants. A number of seedlings were treated with various concentrations of five bioinsecticides. Aphid nymphs and adults were transferred to the test seedlings. In each treatment 10 nymphs and 10 adults were used. Three replicates were used in each treatment and untreated controls were treated with tap water only. Mortality rates were recorded 72 hours after treatment. The data were corrected for natural mortality according to Abbott's formula (1925).

The bioinsecticide formulations used were Thuricide 48 LV, (Bt. subspecies Kurstaki; potency 12, 000 IU/mg), Thuricide 64 LV (Bt. subspecies Kurstaki; potency 16.000 IU/mg), Thuricide HPC, (Bt. Berliner; potency4,000 IU/mg), Dipel Es, (Bt. var *Kurstaki*; potency 17,600 IU/mg) and Bactospeine, (Bt var Kurstaki; potency 16.000 IU/mg.). Plant treatments were done by the dipping techniques and concentrations were prepared; $128x10^7$, $64x10^7$, $32x10^7$, $16x10^7$ and $4x10^7$ IU/L.

RESULTS AND DISCUSSION

The survival of aphid nymphs and adults was remarkably reduced at all tested concentrations of the five Bt-formulations. The results presented in Tables 1 and 2 clearly show that their effect on the nymph stage is greater than that on the adult. They also show that the highest concentration ($128x10^7$ IU/l) resulted in 86.7, 23.3., 80, 93.3 and 96.7% mortality, whereas the lowest concentration ($4x10^7$ IU/l) resulted in 13.3, 3.3, 16.7, 40 and 40% mortality in nymphs from Thuricide 48 LV, Thuricide 64 LV, Thuricide HPC, Dipel and Bactospeine, respectively. In the case of aphid adults, the highest concentration showed 66.7, 16.7, 60,70 and 90% mortality, whereas the lowest concentration resulted in 3.3, 3.3, 16.7, 26.7 and 36.7% mortality, respectively. There was a significant difference in the mortality rates between the preparations and the untreated control. Bactospeine and Dipel were the

Table 1. Effect of 5 Bioinsecticides on the Mortality Rates of Aphid Nymphs.

Bioinsecticides Concentration (IU/1)	Thuricide 48 LV	Thuricide 64 LV	Thuricide HPC	Dipel	Bactospeine
$128x10^7$	86.7±4.7a	23.3±4.7a	80.0±8.2a	93.3±4.7a	96.7±4.7a
$64x10^7$	80.0±0a	16.7±4.7a	76.7±4.7a	86.7±4.7a	93.3±4.7a
$32x10^7$	60.0±8.2b	13.3±4.7a	66.7±4.7ab	80.0±8.2ab	86.7±4.7ab
$16x10^7$	53.3±4.7b	6.7±2.4b	60.0±8.2b	70.0±8.2b	73.3±4.7b
$8x10^7$	33.3±4.7c	3.3±0b	36.7±4.7c	56.7±4.7c	60.0±8.2cb
$4x10^7$	13.3±4.7d	3.3±0b	16.7±4.7d	40.0±8.2dc	40.0±8.2d
Control	0.0 e	0.0 b	0.0 e	0.0 e	0.0 e

- Mortality percentages were adjusted by Abbott's formula.
- Means of three replicates ± SD
- Means in a column followed by different letters are significantly different at a 0.05 level of probability (LSD)
- Means in a column followed by the same letters are not significantly different at a 0.05 level of probability (LSD)

Table 2. Effect of 5 Bioinsecticides on the Mortality Rates of Aphid Nymphs.

Bioinsecticides Concentration (IU/1)	Thuricide 48 LV	Thuricide 64 LV	Thuricide HPC	Dipel	Bactospeine
$128x10^7$	66.7±9.4a	16.7±4.7a	60.0±8.2a	70.0±8.2a	90.0±4.7a
$64x10^7$	60.0±8.2a	10.0±0a	56.7±4.7a	63.3±4.7ab	86.7±8.2a
$32x10^7$	46.7±4.7b	6.7±2.4a	46.7±4.7b	60.0±8.2ab	80.0±4.7a
$16x10^7$	26.7±2.0c	6.7±2.4a	43.3±4.7b	53.3±4.7b	63.3±9.4b
$8x10^7$	6.7±2.4d	3.3±Oa	33.3±4.7b	40.0±8.2c	56.7±9.4b
$4x10^7$	3.3±0d	3.3±Oa	16.7±4.7c	26.7±9.4d	36.7±0c
Control	0.0 d	0.0 a	0.0 d	0.0 e	0.0 d

- Mortality percentages were adjusted by Abbott's formula.
- Means of three replicates ± SD
- Means in a column followed by different letters are significantly different at a 0.05 level of probability (LSD)
- Means in a column followed by the same letters are not significantly different at a 0.05 level of probability (LSD)

Table 3. LC50 Values of the Bioinsecticides against Aphid Nymphs and Adults.

LC50 Values (IU/l)					
Insect	Thuricide 48 LV	Thuricide 64 LV	Thuricide HPC	Dipel	Bactospeine
Aphid Nymph	19.8×10^7	384.5 x 107	14.7×10^7	12.8×10^7	6.4×10^7
Aphid Adult	45.8×10^7	447.5 x 107	39.2×10^7	17.2×10^7	8.2×10^7

most effective bioinsecticides, whereas Thuricide 64LV showed the least effect. The LC50 values of Dipel and Bactospeine on aphid nymphs were $12.8x10^7$ and $6.4x10^7$ IU/l, respectively. They were slightly higher in case of aphid adults; 17.2×10^7 and 8.2×10^7 IU/l, respectively, Table 3.

The Bt-based bioinsecticides possess a number of important attributes that favour their use in pest management programmes. Among these, are its nontoxic nature to both plants and vertebrates and its relative specificity to certain insect species. Formulations of Bt bioinsecticides are widely used to control Lepidoptera, Diptera and Coleoptera (Ali and Watson, 1982; Potter *et al.*, 1982; Klowden *et al.*, 1983; Shaheen *et al.*, 1989; Riley *et al.*, 1992). However, limited informations are available on their effect on sap sucking insects. The data obtained in this study are in consistent with those reported by Radwan *et al.* (1984) on whitefly, another sap-sucking homoperous insect. It is well known that these Bt based bionisecticides must be ingested to exhibit their effects against the pest. A possible explanation for the observed toxicity of the Bt-formulations against aphids could be through the contact action of the tested bioinsecticides. This explanation agrees with the suggestion of Wilkinson *et al.* (1975) who reported that *Bacillus thuringiensis* had contact toxicity against several insect predators and parasites. Radwan *et al.* (1984) also offered a similar explanation for the toxicity of certain Bt-formulations against whitefly. This study suggests that *B.thuringiensis* formulations can be potentially used to control aphid populations on vegetable crops. However, further studies are required to determine their mode of action toward such insects.

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REFERENCES

1 . Abbott, W.S. 1925. A method for computing the effectiveness of an insecticide. J.Econm. Entomol. 18: 265-267.

2 . Ali, A.S.A. and T.F. Watson. 1982. Effects of *B.thuringiensis var Kurstaki* on tobacco budworm adult and egg stage. J. Econm. Entomol. 75: 596-598 .

3 . Anonymus. 1995. Master plan for development of Kuwait's Agriculture Sector (1995-2015). Final Report No. 4615. KISR Vol. IV. Kuwait Institute for Scientific Research.

4 . Aronson, A.I., W. Beckman, and P. Dunn. 1986. *B.thuringiensis* and related insect pathogens. *Microbiol.* Rev. 50: 1-24.

5 . Converse, R.H. 1993. Crop production and projected potentials and plant support services. Consultant's Report. AG-67. Kuwait Institute for Scientific Research.

6 . Dean, D.H. 1984. Biochemical genetics of the bacterial insect control agent *Bacillus thuringiensis.* Basic principles and prospects for genetic engineering. In Kaplan, E.S. (Ed). Biotechnology and Genetic Engineering Reviews, : 341-363. Intercept LTd., USA.

7. Hofte, H., and H.R. Whiteley. 1989. Insecticidal crystal proteins of *Bacillus thuringiensis. Microbiol.* Rev. 53 : 242-255.

8. Kirschbaum, J.B. 1985. Potential implications of genetic engineering and other biotechnologies to insect control. Ann. Rev. Entomol. 30: 51-70.

9. Klowden, M.J., G.A. Held and L.A. Bulla, Jr. 1983. Toxicity of *Bacillus thuringiensis* sub species Israelensis to adult *Aedes aegypti* mosquitoes. Appl. Environ. Microbiol. 46: 312-315.

10. Potter, M.F., M.P. Jensen and T.F. Watson. 1982. Influence of sweet *bait-Bacilus thuringiensis* var Kurstaki combinations on adult tobacco budworm, Lepidoptera. J. Econm. Entomol. 75: 1157-1160.

11. Radwan, H.S.A., I.M.A. Ammar, A.A. Eissa, H.I.H. Omar and E.A.M. Moflah. 1984. Latent effects of certain Bacilus preparations on the biology of the cotton whitefly, *Bemisia tabaci.* Minufiya. Journal of Agricultural Research. 8: 417-429.

12. Riely, M.J.C., J.C. Wiesner, W.D. Scoh, J. Weatherby and R.G. Downer. 1992. Evaluating the field efficacy of *Bacilus thuringiensis* Berliner against the Western Spruce budworm (Lepidoptera: Tortricidae). Pesticide Formulation and Application Systems. 11 : 271-290.

13. Shaheen, N.A., M.N. Shaaban, M.A.E. Hamaky and M.H. Rashwan. 1989. Relative susceptibility of the cotton leaf worm larvae to certain preparations of *Bacilus thuringiensis*. Minufiya. Journal of Agricutlural Research 11 (4): 1939-1953.

14. Sommerville, H.J. 1978. Insect toxin in spores and protein crystal of *Bacilus thuringiensis*. Trends Biochem. Sci. 3: 108-110.

15. Wilkinson, J.D., K.D. Biever and M. Ignoffo. 1975. Contact toxicity of some chemical and biological pesticides to several insect parasitoids and predators. Entomology Phaga 20: 113-120.

حساسية حشرة المن *Aphis gossypii* لبعض مستحضرات الباسلاس ثورنجنسز فى الكويت

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إجريت الدراسات المعملية لتحديد سمية المبيدات الحشرية لخمسة مستحضرات للباسلاس ثورنجنسز (Bt) للقضاء على حشرة المن Aphis gossypii فى طورى الحشره الكامله والحورية.

وقد تبين أن الحشرة فى كلا الطورين تتأثر تأثرا كبيرا عند معاملتها بالباكتوسبين والديابيل، بينما مستحضر (Bt) المركب على هيئة ثوريسيد ٦٤ كان الأقل سمية.

وتقترح نتائج الدراسة دورا مفيدا لمستحضرات (Bt) المركبة على هيئة باكتوسبين وديابيل لمكافحة الحشرات الماصة مثل المن و التى تصيب محاصيل الخضروات.