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A Feeding Stimulant for Improving the Efficacy of *Bacillus thuringiensis* var. *kurstaki* in Larval Control of the Grape Moth, *Lobesia botrana* Den. & Schiff. (Lepidoptera : Tortricidae)

H. Abou Bakr
Biological Control Research Laboratory, Faculty of Agriculture, Cairo University
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ABSTRACT

The addition of sugar as a feeding stimulant to a 50% reduced field rate of *B.t.*-based product Dipel-2X resulted in higher control rates (80%) against the grape moth, *Lobesis botrana* Den.& Schiff. compared to using the recommendedfield rates of Dipel-2X alone (75%) or Silicon (72.7%).

Key Words: *Lobesis botrana, Bacillus thuringiensis,* sugar, feeding stimulant, efficacy, vineyards.

INRODUCTION

The tortricid grape moth, *Lobesia botrana* Den. & Schiff. is a wide spread species, causing economic damage to vineyards, where larvae of the 2nd and 3rd generations attack developing bunches. This pest is usually controlled by chemical insecticides (Bono *et al.*, 2000; Boselli *et al.*; 2000 and Navaro *et al.*, 2001). Recently, use of the entomopathogenic bacteria *Bacillus thuringiensis* (*B.t.*) has been recommended in IPM strategies for vineyard protection (Baillod *et al.*,1990 and Schirra *et al.*, 1998).

Although tortricid larvae are susceptible to spore-endotoxin-complex of *B.t.* in laboratory tests, microbial control of these pests in fruit orchards and forests gave unsatisfactory results (Krieg, 1970). In the past, use of *B.t.* was limited because of the critical timing of application against the newly hatched larvae on one hand, and because of its low efficacy under field conditions to this pest on the other hand. El-Husseini and Sermann (1977) related such field results to the feeding behavior of the newly hatched larvae that bore directly into the host plant tissues, and thus avoid ingesting the sprayed microbial preparation or at most receiving in only little rates.

El-Husseini and Sermann (1977) noticed that when sugar was added to the microbial insecticide Entobakterin-3 (*B. thuringiensis* var. *galleriae*), newly hatched larvae of the tortricid *Pandemis heperana* Den. & Schif. tended to feed surfacely on the treated apple leaves and fruits showing a lapping-like feeding behavior on the sweetened sprayed material for at least 24 hrs before boring into the plant tissues. Accordingly, the tortricid larvae ingest larger amounts of the applied *B.t.* material (spores and endotoxin) which secured an infection leading to death. Such a behavior was absent when *B.t.* was applied alone as well as in the case of untreated plant material; a fact that explains the low efficacy of *B.t.* Against boring lepidopterous insect pests especially under field conditions (El-Husseini and Afifi, 1981). The addition of feeding stimulants like sugars and molasses to the *B.t.* commercial preparations proved to be one of the practical approaches for increasing efficacy of these bioinsecticides against tortricid larvae in both laboratory and field applications (El-Husseini and Sermann, 1977; Schmidt and Antonin, 1977; Celli *et al.*, 1985; Monta *et al.*, 1986; Barbieri *et al.*, 1988; and Scalo *et al.*, 1997).

In view of the previously mentioned results, the present study was carried out to improve the efficacy of the *B.t.*-based product Dipel-2X in controlling the grape moth larvae, *L. botrana* by adding sugar as a feeding stimulant in field application.

MATERALS AND METHODS

The study took place in 5-feddans of a 8-years-old vineyard of the seedless variety "Banaty" located in Nubaryia, Behera Governorate, was subjected to the present study. One feddan was treated with Dipel-2X (*B. thuringiensis* var.*kurstaki*) at the recommended rate of ½ kg/feddan (in 200 L water); another feddan was treated with a reduced rate of *B.t.* in mixture of ¼ kg of Dipel-2X + ¼ kg of cane sugar. The remaining 3 feddans were conventionally treated with the chemical insecticide Actelic EC 50% at the recommended rate of 150 ml/100 L water. In the treatment including the feeding stimulant, Dipel-2X and sugar were first mixed well as dry components in a 10-liter buckle, followed by adding water gradually under continuous stirring (as in the case of Dipel alone). Then, the mixture was poured into the 200-L tank of the spraying machine (El-Husseini, 1975). The sprayed material was directed only to the grape bunches hanging down from the roof of the vineyard plantation to save cost and material (Baraniet *al.*, 1997).

Timing of applications was determined according to moth detection and monitoring using the sex pheromone sticky traps as recommended by Madatyan and Sharipov (1984), Atac *et al.* (1987), Anshelvich *et al.* (1994) and Nassizadeh and Bassiri (1994). The traps and pheromone capsules (dispensers) were produced by the Plant Protection Institute, ARC, MALR, Dokki, Giza. They were placed with a rate of 2 traps/feddan, at 50 m distance and fixed at 1.5-2 m above the ground (Beskrovnaya and Krivoshchenko, 1984).The capsules were renewed after 20 days.

The treatments took place on April 7 and 14, and May 5, 2004. Starting just before the 1st application, weekly randomized samples each of 100 grape bunches/ treatment were marked and inspected *in sito* without without removing them for recording the rate of infestation till May 19, 2004. The presence of one larva (or more) in the bunch was considered as 1% infestation value.

RESULTS AND DISCUSSION

As moth of *L. botrana* began to peak at early April 2004, the infestation rate among the grape bunches was 8% (Table 1), where the 1st application of the three tested treatments took place (April 7, 2004). One week post application, the treatment with Dipel-2X alone decreased the rate of infestation among grape bunches to 3% showing a control level of 62.5%. Meanwhile, the reduced rate of *B.t.* (¼ kg Dipel-2X) mixed with equal amount of sugar as a feeding stimulant decreased the infestation to zero%, and thus represented a 100% control level. On the other hand, the conventional treatment with Actelic suppressed the infestation to 2% which is equivalent to 75% control level.

The 2nd application took place on April 14, 2004; and one week later, the control levels recorded were 75, 100 and 87% for the treatments *B.t.* alone, *B.t.* + sugar, and Actelic, respectively (Table 1). The 3rd application was carried out on May 5, 2004, where the infestation rates among the three respective vineyards increased to 9, 5, and 11%. One week post application, the 1st treatment (*B.t.* alone) suppressed the infestation to 4% showing a control level of 55.5%. The 2nd treatment (50% reduced rate of *B.t.* + sugar) resulted in 1% infestation value corresponding to 80% control level compared to 72.7% control in case of the insecticide treatment (Actelic) as shown in Table (1).

The above mentioned results indicate that the addition of sugar as a feeding stimulant to a reduced rate of *B. thuringiensis* -bioinsecticide Dipel-2X increased its efficacy by 37.5, 25 and 24.5% one week after each application than the recommended rate alone. Similar results were obtained with other *B.t.* products in controlling the grape moth *L. botrana*; Reynaud and Baldacchino (1996) increased the efficacy of a reduced rate of Biobit (*B.t.kurstaki*) from 67.38 to 78.1 by adding a sweetener as feeding stimulant. Even only 1% sugar improved the efficacy of *B.t.* against this pest (Senn *et al.*, 1992). Efficacy of *B.t.* bioinsecticides was also increased against other tortricid pests as in the case of the fruit leaf-roller *Pandemis heparana* Den.& Schiff. with Entobakterin-3 (*B.t.galleriae*) (El-Husseini and Sermann, 1977). Also, the addition of sugar to reduced rates of *B.t.* products increased its efficacy against the boring larvae of the spiny bollworm *Earias insulana* Boisd.(El-Husseini and Afifi, 1981).

The conventional treatment with chemical insecticides like organophosphates, tebofenozide, etrimphos and chlorpyrifos in vineyards around the world (Celli *et al.*;1985;Monta *et al.*,1986; Barbieri *et al*, 1988; Navon *et al.*, 1994; Scalo *et al.*, 1997; Bono *et al.*, 2000; Boselli *et al.*, 2000 and Navaro *et al.*, 2001) recorded nearly the same control level (72.7- 87%) obtained in the present study for Actelic.

The approach of adding sweeteners as feeding stimulants to reduced rates of bioinsecticides based on the entomopathogenic bacteria *B. thuringiensis* for controlling different lepidopterous larvae and the recommendation to include it in IPM strategies has important ecological and economic values. The consequent reduction of applied *B.t.* amounts, and volume of sprayed water when treating only the grape bunches contribute to saving the control costs (El-Husseini and Sermann, 1977 and Barani *et al.*,1997). Moreover, the use of *B.t.* to control *L. botrana* in vineyards suppressed the grape infestation with *Botrytis* moulds (Fougeroux and Lacroze, 1996), and did not impair the production of high quality grapes as compared to chemical insecticides (Reynaud and Baldacchino, 1996).

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Table 1. Infestation rates (%) in grape bunches with *L. botrana* in relation to three different treatments.

Sampling dates	Dipel -2X ½ kg/f		Dipel -2X ¼ kg + Sugar ¼ kg/f		Actelic EC 50% 150 ml/100L water	
	infest. %	control %	infest. %	control %	infest. %	control %
April 7*	8	-	8	-	8	-
14*	3	62.5	0	100	2	75
21	2	75	0	100	1	87
28	5	-	2	-	2	-
May 5*	9	-	5	-	11	-
12	4	55.5	1	80	3	72.7
19	6	-	3	-	7	-

* Application dates

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