The Control of Diamondback Moth with Thuricide

E. Brunner and P. F. E. Stevens[1]
P. T. Sandi Aneka Warna, P. O. Box 3326, Jakarta, Indonesia, and [1]Sandoz Ltd, CH-4002, Basle, Switzerland

Abstract

Thuricide, a *Bacillus thuringiensis* formulation, is active against more than 200 lepidopterous species in their larval stage. Best efficacy is obtained when Thuricide is applied at hatching time and/or on 1st to 3rd larval instars during their intensive feeding period. Since Thuricide must be eaten by the insect to be effective, thorough leaf coverage is essential for best results. Thuricide HP is used in most areas of Asia where diamondback moth (*Plutella xylostella* L) is a serious pest. In our trials in Malaysia, Indonesia, India, and Australia, this product has given control of diamondback moth comparable to or better than standard organophosphorus insecticides. Thuricide has no adverse effect on hymenopterous parasites of diamondback moth.

General Aspects

Introduction

Insect pathogens are microorganisms that kill insects. They may be bacteria, fungi, protozoa, or viruses. They may kill by infecting the insect and causing a fatal disease, or they may produce a toxic chemical that poisons the insect. Since pathogens do kill insects, but have a limited spectrum of insecticidal activity, they offer the possibility of selective insect control. *Bacillus thuringiensis* Berliner var *kurstaki* (*Bt*), the best known and most widely used pathogen, produces a toxin that attacks larvae of many lepidopterous species.

Thuricide

Thuricide is a biological insecticide, the active ingredient of which is based on *Bt*. It is only active against the larval stages of Lepidoptera, which comprise many economically important insect pests. It is selective against lepidopterous larvae and has no harmful effects on humans, domestic animals, honeybees, wildlife, fish, and predator and parasitic insects. Due to its specificity, Thuricide does not disrupt the natural balance between pests and beneficials.

This product is exempt from tolerance requirements in the United States and other countries for all recommended uses. It does not leave harmful residues.

Biological Action

Thuricide acts specifically against species of Lepidoptera. Only larvae are susceptible, whereas eggs or adults are not affected. Thuricide is a stomach poison and has no contact action. Larvae feeding on the treated plants stop feeding within a short

time (less than two hours) after the ingestion of a lethal dose. The death usually occurs within three to five days during which there is no further feeding.

Insect resistance

The build-up of resistance to *Bt* among target insects has never been observed in the field even though it has been used throughout the world for more than 25 years. A recent report (McGaughey 1985), however, does indicate the possibility of storage insects becoming resistant to *Bt*. DBM has not shown any resistance to *Bt*.

Biological Properties

The biological properties of *Bt* have been studied worldwide in laboratory and greenhouse tests, as well as numerous field trials, which were conducted by our own research and development organizations, and by other investigators or government institutions.

Spectrum of activity

More than 200 lepidopterous species in their larval stages were found to be susceptible in some degree to *Bt*. Best efficacy is obtained when Thuricide is applied at hatching time and/or on 1st to 3rd larval instars during the intensive feeding period. Since Thuricide must be eaten by the insect to be effective, thorough leaf coverage is essential for best results.

Crop safety and residual efficacy

Thuricide does not injure foliage or taint the produce when applied as directed. *Bt*, a naturally occurring microorganism, is commonly found in the environment. A commercial application of this product may significantly increase the local density of the bacterium, but this density slowly returns to its natural, low level equilibrium, depending on environmental conditions. Under average field conditions, Thuricide normally retains residual effectiveness for 4 to 10 days. Reapplication depends mainly on the growth of the crop and the population dynamics of the pest.

Effect on beneficial insects

No adverse effect on beneficial arthropods, predators or parasites has been observed up to now in all laboratory tests and field experiments with Thuricide. The major species against which Thuricide was tested are shown in Table 1. This is of particular advantage for control programs of forest pests and others where it is desirable to maintain a natural balance of beneficials to suppress the resurgence of damaging insects.

Safety Data

Since the active ingredient of Thuricide is a living organism, safety assessment has included investigations of infectivity and persistence, in addition to classical toxicological tests. No mortality, infectivity, irritation, sensitization reaction, or any topical response, was observed in any exposure which could be attributed to *Bt* itself or to formulation ingredients.

Table 1. Beneficial arthropods against which Thuricide has been tested[a]

Class Order	Family	Genus	Common name
Arachnida	—	—	Spider species
Insecta			
Heteroptera	Anthocoridae	Orius	predaceous bugs
	Lygaeidae	Geocoris	big eyed bugs
	Nabidae	Nabis	damsel bugs
	Reduviidae	Zelus	assassin bugs
Neuroptera	Chrysopidae	Chrysopa	lacewings
Coleoptera	Coccinellidae	Hippodamia	lady bird beetles
	Melyridae	Collops	soft-winged flower beetles
Hymenoptera	Trichogrammatidae	Trichogramma	parasitic wasps
	Vespidae	Polistes	paper-nest wasps
	Apidae	Apis	honey bees

[a] Data from Thuricide Technical Bulletin, Sandoz Ltd, Basle, Switzerland.

To ensure the purity of each Thuricide production batch as well as the continued safety to man and the environment, quality control screens including intraperitoneal injection toxicity/infectivity tests in mice, immunoassay, are routinely performed. Because of this safety record, Thuricide may be used on crops up to harvest.

Thuricide Trials in Various Countries

Malaysia

In the lowlands, Mohamad et al (1979) used Thuricide HP along with three chemical insecticides to control diamondback moth (DBM), *Plutella xylostella* L (Lepidoptera: Yponomeutidae), on cabbage. A total of six applications were made at seven-day intervals, starting two weeks after transplanting. A randomized complete block design with 4 x 13 plant replicates per treatment was employed. Assessment was done by pre-spray counting of the larvae on every third plant of each treatment, totalling five plants per plot. Leaf damage was assessed weekly, commencing at seven-week old plants.

All insecticides reduced the population of DBM larvae and foliage damage compared to the check plot (Table 2). In this trial, Thuricide was evaluated at half of the normally recommended dosage rate. At full rate, it is expected to give better DBM control. There was no statistically significant difference in yield obtained among the insecticide treatment. However, these yields were more than twice as much as the untreated plots.

Table 2. Efficacy of insecticides against DBM on lowland cabbage in Malaysia[ab]

Insecticide	Rate kg AI/ha	No.DBM larvae/ 10 plants	Foliage protection index[c]	Mean weight cabbage head (g)
Thuricide HP	0.450[c]	35.01a	75.2a	712a
Acephate 75EC	0.340	36.81a	82.9a	733a
Diflubenzuron 25EC	0.070	32.50a	77.5a	594a
Methamidophos 60EC	0.270	31.00a	81.7a	722a
Control		61.31b	53.8b	300b

[a] Source: Mohamad et al 1979. [b] Means in each vertical column followed by the same letter are not significantly different at 5% level according to Duncan's multiple range test. [c] Product/ha. [c] According to Chuo (1973).

Indonesia

In an insecticide screening trial in North Sumatra, Hutabarat (1975) compared the efficacy of Thuricide HP with a standard organophosphorus compound, quinalphos, to control DBM on cabbage. The insecticides were applied at a seven-day interval eight times during the season. Efficacy evaluation was accomplished by recording the number of DBM larvae on 10 plants per plot (35 sq m).

Thuricide HP sprayed at 0.10% to 0.15% reduced the number of insects feeding on plants considerably and consequently increased yield substantially (Table 3). The chemical insecticide was not effective, indicating the possibility of insecticide resistance. Based on these and other observations, *Bt* was successfully incorporated in DBM control programs with the introduction of a parasite, *Diadegma eucerophaga*, in vegetable production areas of North Sumatra.

Table 3. Screening of Thuricide HP for the control of DBM on cabbage at Karo Highland, North Sumatra[a]

Insecticide	Spray conc. % AI	No. larvae/ 10 plants[b]	Yield kg/plot
Thuricide HP	0.100	17.59	149.7
Thuricide HP	0.125	6.07	176.7
Thuricide HP	0.150	0.00	185.7
Quinalphos 25EC	0.200	58.40	91.7

[a] Source: Hutabarat 1975. [b] Arcsin transformation.

Similarly, in a laboratory trial, Sudarwohadi and Said (1977) compared the efficacy of Thuricide HP with that of standard organophosphorus compound, quinalphos. As expected there was low initial mortality in the Thuricide HP treatment, but with time the mortality increased and was comparable with that of the standard organophosphorus compound (Table 4).

Table 4. Efficacy of Thuricide to DBM in laboratory[a]

Insecticide	Spray product %	Average % mortality[b] days after treatment		
		1	3	7
Thuricide HP	0.20	46.72	55.44	56.94
Thuricide HP	0.15	43.33	54.00	58.61
Thuricide HP	0.10	37.50	54.00	56.94
Quinalphos 25EC	0.20	52.55	53.78	58.45
Control		0.00	0.00	0.00

[a] Source: Sudarwohadi and Said 1977. [b] Average of four replicates, data are Aresin transformation.

India

Sandoz (India) Ltd conducted several trials with Thuricide HP in different parts of the country between 1977 and 1981 to control DBM on cabbage and cauliflower. In all cases, applications were made at pre-blossom stage in cauliflower and pre-head formation stage in cabbage. In most cases useful levels of mortality were observed only two days after first application. The mortality continued to increase up to 10 days. The dose response studies indicated that Thuricide HP need be applied at the rate of 1.0 to 1.5 kg/ha. In the case of reinfestation by succeeding generations of DBM, a second

or third application at a 10 day interval was necessary. A sharp rise in DBM mortality was observed in the first few days after the second or third application. Under Indian conditions an application interval of 10 days was adequate; shortening the interval to five days did not have any beneficial effect.

Australia

Clarke (1976) tested Thuricide HP for the control of DBM on cabbage in southern Victoria. Thuricide was used at the rate of 0.28 and 0.56 kg product/ha applied at 7 and 14-day intervals. Triton B-1956 at 280 ml was added to a spray volume of 1000 l/ha. The efficacy evaluation was made at six and two weeks before harvest and consisted of counting DBM and pupae/10 plant/plot. The plants were also rated for damage on 1 to 7 scale (1 = severe damage, 7 = no damage).

The results are summarized in Table 5. Thuricide HP used at 0.28 and 0.56 kg/ha and at both 7 and 14-day intervals significantly reduced DBM larval populations over the untreated check and a methomyl treatment. The pupal population was significantly reduced especially when Thuricide was applied at weekly intervals. Weekly applications also significantly reduced plant damage over control and two other treatments. According to Clarke (1976) the wetting agent helped to extend the life of Thuricide and also helped to spread the product to more inaccessible parts of the host plant.

Table 5. Efficacy of Thuricide in controlling DBM on cabbage in Victoria, Australia[ab]

Insecticide	Rate kg product per ha	Spray interval (days)	No.larvae per 10 plants	No. pupae per 10 plants	Damage rating[c]
Thuricide HP	0.28	7	8.2a	43.2ab	4.6a
Thuricide HP	0.56	7	8.3a	51.3bc	4.6a
Thuricide HP	0.28	14	19.0bc	155.3e	3.0bc
Thuricide HP	0.56	14	16.1b	111.8de	2.8c
Methomyl 90EC	0.56	14	40.3cd	133.0e	3.2bc
Control	—	—	73.5d	409.1f	2.0d

[a] Source: Clarke 1976. [b] Mean in each vertical column followed by the same letter are not significantly different at 5% level according to Duncan's multiple range test. [c] 1 = severe damage, 7 = no damage.

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