SELECTIVE BIOINSECTICIDES, SELECTIVE CHEMICAL INSECTICIDES: IMPORTANT OPTIONS FOR INTERGRATED PEST MANAGEMENT (IPM) IN CABBAGE.

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ABSTRACT

In PNG the utilization of selective bioinsecticides such as Bacillus thuringiensis *(Bt) products for pest control is still in its infancy. The paper compares Bt-products with competing chemical insecticides, the Insect Growth Regulator (IGR) Atabron and commonly used broadspectrum insecticides. Biocontrol compatibility, current status of insecticide resistance, resistance management and product safety are discussed in the context of IPM. Judicious use of Bt-products in combination with IGR and biological control techniques is highly recommended to achieve most effective and sustainable use.*

INTRODUCTION

The Diamondback Moth *Plutella xylostella* (DBM) is a cosmopolitan pest in brassicas and has developed resistance against almost all types of chemical insecticides where used intensively. In PNG the efficacy of recommanded chemical insecticides to control the leaf defoliating larvae of DBM is decreasing at an alarming rate. Because chemical insecticides can also be harmful for human health and environment, the era of a solely chemical control approach is on the decline.

Selective bioinsecticides based on *Bacillus thuringiensis* Berliner *(Bt)* are an effective alternative control option. They play a key role in integrated pest management (IPM) programs in many countries of the world. Despite several advantageous characteristics, *Bt* - products are rarely used in PNG. This article discusses general features of *Bt* in comparison with the selective chemical insecticide Atabron and conventional broadspectrum insecticides, highlighting selective properties and environmental aspects in the context of pest control in cabbage. Recommendations for use are given in this paper.

WHAT IS A BIOINSECTICIDE?

Biological control involves the utilization of living organisms for pest control. Organisms that are utilized are insects (parasitoidis, predators) and pathogenic microorganisms such as bacteria, viruses, fungi, protozoa and nematodes.

In case of *Bt* (a naturally occuring disease of various caterpillars) a spore forming bacterium is involved. Therefore *Bt*-products are bioinsecticides or microbial insecticides. Commercial formulations usually contain two synergistic principles; (i) a bioinsecticide component (toxic protein crystals) and (ii) the microbial component (living spores).

SELECTIVE INSECTICIDES AND BIOLOGICAL CONTROL

An insecticide is called selective when it kills target pests only, without harming natural enemies of the pest and other non target organisms. Important natural enemies of cabbage pests are parasitic and predatory wasps as well as the spiders. The contribution of beneficial insects to pest control is called biological control or "biocontrol". It can prevent pest species to reach pest proportions and farmers may have to apply costly insecticides less often.

Broadspectrum insecticides often wipe out the entire insect fauna and are therefore not biocontrol compatible. Because a "natural enemy-clean" field is an ideal breeding ground for new infesting pests due to lack of biological control agents, pest populations can propagate unhampered and farmers may be urged to spray more often. In case of insecticide resistance DBM survives even enhanced insecticide use and total crop loss may be the result despite costly spraying. For DBM the level of biocontrol is apparently not sufficient. The impact of the introduced exotic parasitic wasp *(Diadegma semiclausum)* on DBM is currently under investigation but it is obvious that any insecticide used in combination with *D. semiclausum* should be a selective one.

MODE OF ACTION AND SELECTIVITY

In PNG two selective insecticides, a) the *Bt*-product Thuricide(R) (Sandoz), Biobit(R) (Farmset), respectively and b) the selective chemical insecticide Atabron(R) (ICI) are suitable for pest control in cabbage. Their general features, compared with commonly used broad spectrum insecticides Karate and Orthene, are summarized in table 1. Selectivity relies mainly on the mode of action as briefly described in table 1.

Table 1. **A comparison of commonly used insecticides with *Bacillus thuringiensis* products for pest control in cabbage.**

	Chemical Insecticides		Bioinsecticides
	Karate, Orthene	Atabron	*Bacillus thuringiensis*
Product properties			
Selectivity	kills all insects	selective for leaf chewing caterpillars	highly selective for leaf chewing caterpillars
Impact on beneficial insects	direct toxicity to beneficials	no direct toxicity to adult beneficials same as parasitoids and Predator	no direct toxicity to larval and adult stages of predators and Parasitoids
Speed of kill	usually fast	slow, 1-4 days	slow, 1-4 days
Residual activity	persists for several days to weeks	persists for several days	24 - 48 hours
Resistance(*)	encountered on all farm levels	strong evidence on commercial farm level	not encountered but development possible
Product safety			
Chemical residues	interval to harvest required	interval to harvest required	crop can be harvested immediately
Hazards	dangerous for human health and environment	dangerous for human health and environment	no hazard for human health and environment
Shelflife	long, for several years	long, for several years	1-2 years if stored cool and dry
Costs			
Price per 15l Knapsack	ca.K1.70 Orthene ca. K 0.58 Karate	ca.K 2.47	ca. K 0.70 (**)

(*) Present situation in PNG; (**) Bt product Thuricide.

a) *Bt*-products are stomach poisons. Caterpillars feeding on sprayed leaves, ingest two active igredients, toxic protein crystals and living spores. The swallowed protein crystals dissolve and damage the gut wall and the spores cause a blood infection. Caterpillars with a damaged gut stop feeding and finally die due to the combined effect of a destroyed gut and blood poisoning within 1-4 days.

Insects that do not feed on cabbage (beneficial insects or neutral species) are not affected by the spray deposit. The active components are furthermore highly specific for lepidopterous larvae and have no adverse effects on other insects..

b) Atabron, an insect growth regulator (IGR), is also mostly a stomach poison. The swallowed chemical disrupts chitin formation (the main substance of the insect skin), and kills insects when they moult. Atabron has selective properties because only growing insect stages (larvae) are affected but not adult insects. As a result adult stages survive and the population is preserved in the field. Atabron is less specific than Bt because it can also interfere with the moulting process of insects other than caterpillars such as beneficial beetle larvae, hoverfly larvae and immature spiders.

PRODUCT SAFETY

Because the active ingredients of BT are biodegradable they accumulate neither in crop nor in environment as many chemical insecticides do. Highly specific for caterpillars, they do not affect human health. Therefore there are no federal restrictions for their use until harvest. For Atabron the same precautions apply as for conventional chemical insecticides.

INSECTICIDE RESISTANCE

Generally speaking, DBM control is usually excellent when it is confronted with a new type of insecticide. But in the long run, if frequently exposed to one and the same chemical, this highly adaptive insect can build up resistance. After several cropping periods with good DBM control farmers often encounter a rapid drop in efficacy. Because restoration of DBM susceptibility to an insecticide in the absence of treatments can take several years, not only farmers but also pesticide industry have an interest to avoid resistance.

Nevertheless even for *Bt*-products resistance can be expected when used as a conventional insecticide. Several countries report evidence that field populations of DBM have developed resistance against *Bt*-products due to indiscriminate use (Tabashnik *et. al.* 1990).

RESISTANCE MANAGEMENT

Integrated control by alternating Bt with another bioinsecticide or a chemical insecticide with preferably selective properties should be implemented. For example, Disthaporn (1992) demonstrated good DBM control by alternating Bt with neem seed kernel extracts (NSKE) of the Indian Neem Tree (*Azadirachta indica*). Successfully tested under PNG conditions, neem would be ideal for spray alternation with Bt. At present, due to restricted NSKE resources in PNG. Atabron is the only further selective control option for Bt-products.

To preserve the efficacy of *Bt* (and other selective insecticides) their judicious use is recommended. Some guidelines are listed below:

- Spray only if insect damage occurs. As a rule of thumb spray when there are more than 1-3 DBM larvae per plant (check 30 plants).
- Do not spray exclusively *Bt* (and other insecticides).
- When frequent spraying is necessary, alternate *Bt* with a different type of insecticide.
- Use preferably bioproducts (such as neem) or chemicals with selective properties (like Atabron) for spray alternation.
- To minimize chemical residues on your produce, choose *Bt* for the final application before harvest.
- Do not prepare mixtures of *Bt* with chemical insecticides (Spray-mixtures trigger development of multiple insecticide resistance).
- Use a sticking agent e.g. Holimpas (60 ml / 15 l Knapsack) or a detergent to achieve good foliar coverage.
- Prepare only the amount of spray for the day's work.
- Avoid spraying before rain or irrigation.
- Spray *Bt* in the evening because the spray deposit is rapidly destroyed by sunlight. (In the highlands, with frequent rains in the evening spray early in the morning).
- Store Bt-products in a cool and dry place

At present the *Bt* product Thuricide(R) and Biobit(R) are on the PNG market and can be procured at Simkor, Farmset Limited, respectively. In field trials at Laloki

A.R.S. (CP) and Kabiufa Adventists High School (E.H.P.) both products achieved good DBM control. Trial work is currently conducted on different competing formulations for recommendations under PNG conditions.

OUTLOOK

Due to the many advantages that bioproducts have in comparison to conventional chemical insecticides, Bt products deserve broader usage for pest control in cabbage. In view of resistance management they are best used in IPM programs in combination with selective insecticides (e.g Atabron or neem extracts) and biological control techniques. This appears to be the most appropriate way to achieve an environmentally sound cultivation practice and to prevent or at least to postpone the resistance problems.

FURTHER READING

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