



Photo J.C. Martin: INRA,

DiPel & Foray

Some commonly asked questions on the use of DiPel and Foray

1. What are DiPel and Foray?

DiPel and Foray are biological insecticides containing the spores and crystal proteins produced by the gram-positive bacterium *Bacillus thuringiensis* subspecies *kurstaki*, commonly known as *B.t.k.*

2. What is *Bacillus thuringiensis* or *B.t.k*?

Bacillus thuringiensis or *B.t.k* is a naturally occurring rod-shaped, spore-forming, aerobic, gram-positive micro-organism (bacterium) that is found through most areas of the world. It can be found in soils and on leaves/needles and in other common environmental situation. When the bacteria produce spores, it also produces unique crystal proteins. When absorbed by the larvae of Lepidopteran insects, these natural proteins, after transformation into protoxins under the high pH situation of the mid gut and in active toxins after enzymatic reaction, are destroying the cells of the mid gut walls of the larvae, but are innocuous to human beings, birds, or other animals.

3. How many other *B.t.*'s are there?

There are many varieties or subspecies of *B.t.*, and they do not all share the same properties. *Bacillus thuringiensis* subspecies *kurstaki* (*B.t.k*) is the *B.t.* most widely used commercially to protect agricultural crops, fruit trees, rural and urban forests from defoliating Lepidoptera larvae. This particular type of *B.t.* has been used for over 30 years. Other subspecies of *B.t.* developed commercially by Valent Biosciences are the subspecies *aizawai*, active against Lepidoptera pests; H-14, active against mosquito and black fly larvae; *sphaericus*, active against *Culex* mosquito larvae, and *tenebrionis*, which is active against some Coleopteran larvae.

4. Does *B.t.k* occur naturally?

Soil is the natural environment for *B.t.k*. Varieties of *B.t.* were isolated from urban, forest, and agricultural soils long before the material was used in insect control programs. *B.t.* has been detected in soils and other substrates around the world including Canada, the United States, Japan, Germany, France. *B.t.* can also be found on the leaves of deciduous and coniferous trees. Varieties of *B.t.* have also been found in grain elevators and grain dust.

5. How do DiPel and Foray work?

DiPel and Foray must be absorbed to be effective. Both products contain protein crystals and living spores. Protein crystals, after transformation into active endotoxins are a highly effective stomach poison, which destroy the gut walls of the larvae. Spores contribute to toxicity by entering through the ruptured gut into the hemocel and multiplying to induce septicemia.

- a) Larvae ingest DiPel's and Foray's crystal proteins from leaves.
- b) Larvae stop feeding within minutes as crystals are dissociated in the gut (high pH) and the released protoxins are activated into active toxins. These toxin molecules attach to receptors on the gut endothelium.
- c) Toxins cause gut perforation, spores enter through gut wall and germinate rapidly in body cavity to cause septicemia..
- d) Larvae stop feeding in as little as half hour and die within 1-3 days.

6. How are DiPel and Foray Made?

Foray and DiPel are produced from *B.t.k* grown in large quantities in enclosed fermentation tanks, in ways very similar to the production of antibiotics and alcoholic beverages. The fermentation broth containing spores and the crystal proteins is formulated with approved ingredients and water to make the final formulation.

7. Why should I use DiPel and Foray?

Simply put: growers use *B.t.k* because it works. DiPel and Foray have proven to be highly effective against damaging Lepidopteran pests in agricultural crops, ornamentals or forestry.

Additionally, DiPel can be used as a stand-alone insecticide or in your tank mix or as part of your crop protection rotation program.

DiPel and Foray are environmentally friendly B.t.k-based compounds that have not been observed to be harmful to wildlife. In addition, studies have shown that DiPel and Foray are not harmful to beneficial insects, including bees. Both products can be handled by workers efficiently without the use of costly protective gear normally associated with other pesticides. DiPel and Foray can also play an integral part of a grower's IPM program, offering extraordinary relief when the pests build up resistance to other chemicals.

8. Why is *B.t.k* used for forest spraying?

B.t.k was developed in response to the growing concern among the scientific community and the public in the 1960's and 1970's over the use of chemical pesticides in the forest environment. At that time, forest managers realized that an alternative to broad spectrum chemical insecticides would be needed if forest protection was to remain a component of future forest management efforts.

The new insecticide would have to be: effective when applied in small amount, more host-specific than chemicals, more quickly broken down in the environment than chemicals, and harmless to non-target organisms such as bees, fish and mammals. As well, the cost of the new insecticide would have to be comparable to the cost of chemicals.

B.t.k was not an immediate success in terms of effectiveness and cost, but intensive research and development produced a product that now meets all of these criteria. *B.t.k* is now the material of choice in the majority of forest protection programs world wide, especially in North America and Europe. This product has gained a level of public acceptance that was unheard of even 10 years ago and, as a result, *B.t.k* is widely used to protect trees from insect infestations in both rural and urban settings. The major reason that *B.t.k* is used today is because it is considered ecologically friendly and effective.

9. How effective is *B.t.k*?

B.t.k effectiveness is comparable to chemical applications in controlling many pest insects when pest population densities are low to moderate. *B.t.k* is less likely to be as effective as chemicals when pest populations are extremely high unless multiple applications are conducted. However, a control strategy should not kill all the target insects in an area in order to support the population of beneficial insects.

Because it can take several days for *B.t.k* to kill larvae, there is not an immediate reduction in the pest population as is the case when some chemical insecticides are used. This has created the erroneous perception that *B.t.k* does not work. *B.t.k* does work but it takes a little longer to see the results.



However, it is important to mention that the larvae stop feeding a few hours after absorption.

Appropriate conditions are essential for *B.t.k* to be effective. *B.t.* toxins are sensitive to sunlight and heat and will only remain active on foliage for 3-7 days. Since *B.t.k* has to be absorbed to kill target larvae, it is important that the spray takes place during a period of active feeding and covers well all the foliage. Optimum efficacy is obtained when application is done on young larvae, which have usually a high metabolism, feed actively and need to absorb less material to reach the lethal dose.

Depending on the life cycle of the pest and climatic conditions, more than one application of *B.t.k* can be necessary to achieve the desired level of control. When eradication is the goal of a control program, a single application of *B.t.k* may be somewhat less effective than some chemical insecticide in reducing the population to zero. However, because of its low impact on non-target organisms, *B.t.k* is the product of choice for most forest pest control programs (including eradications) such as the ones conducted in North America and around the world.

10. What are the effects of DiPel and Foray on bees and other beneficial insects?

Tests have shown that DiPel and Foray will not harm bees, bird, fish or wildlife in general. Studies have shown that DiPel and Foray will not harm beneficial insects that help keep secondary insects in check.

11. Are DiPel and Foray harmful to humans or animals?

Because of their specific mode of action, DiPel and Foray are not harmful to humans or animals. The biological compounds put less stress on the environment than many synthetic chemicals and have not been observed to be harmful to fish, wildlife or livestock.

Workers are also able to handle DiPel and Foray with considerably more ease than chemical-based compounds. As with any insecticide, applicators are required to wear gloves, long sleeves and long trousers when handling DiPel and Foray. Workers are permitted to re-enter fields in as little as 4 hours after DiPel and Foray has been applied.

6. What kind of application equipment is necessary for DiPel and Foray?

Because of the mode of action of DiPel and Foray, it is extremely important to achieve a good coverage of the vegetation to be protected during *B.t.* application. Motorized boom sprayers (self-propelled or mounted on tractors or trucks) are used for band and broadcast treatments in vegetable field, in orchards, and on row crops such as corn, cotton, and soybeans. Aerial applications are also common in many crops, and especially in forestry.



Air blast sprayers, primarily used in fruit operation, use a combination of air and liquid rather than liquid alone to deliver the insecticide.

Further application tips:

- Foliar application of DiPel will provide excellent worm control. Be certain to cover the part of the plant the pests will eat. To maximize the effectiveness, sprays should thoroughly cover all plant surfaces, even the undersides of leaves.
- Always selected a nozzle type that is appropriate for the crop you are treating, positioning the boom and using enough pressure to penetrate the foliage entirely.
- To maximize coverage, spray when the wind speeds are 10 mph or less

7. What Formulation of DiPel and Foray are available?

Dipel is available as DiPel 8L, an oil based emulsifiable suspension. Foray is available as Foray 48B, water based aqueous suspension.

If DiPel 8 L is used diluted it is important to always mix DiPel 8 L with a higher amount of water. The ratio 40 % DiPel and 60 % water should at least be used to avoid viscosity problem with this complex biological formulation. On the other hand, DiPel 8L has a longer storagibility than Foray 48B.

8. Exclusive distributor for Dipel and VectoBac in Algeria:



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9. Who is producing VectoBac?



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