

Gemstar®
BIOLOGICAL INSECTICIDE



For Use on Sweet Corn and Other Vegetable Crops

Gemstar® is an aqueous suspension concentrate biological insecticide from Certis USA, registered for use on a broad range of crops. It contains a naturally occurring virus that infects and kills larvae of *Heliothis* and *Helicoverpa* species, such as corn earworm, tomato fruitworm, cotton bollworm and tobacco budworm. Gemstar carries a "Caution" signal word and a minimum 4 hour restricted entry interval (REI). It can be sprayed the same day as harvest (zero PHI).

Always read and carefully follow label directions.

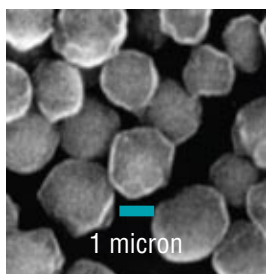
Product Features

- Liquid suspension concentrate bioinsecticide
- Target pests: Corn earworm, tomato fruitworm, bollworm, and tobacco budworm
- Broad crop label: Sweet corn, tomatoes, peppers, leafy and other vegetables, cotton, tobacco, ornamental plants, and many other crops
- Application rates: 4 to 10 fl. oz. per acre
- Application methods: Aerial, ground, or overhead sprinkler chemigation
- Compatible with most agricultural chemicals
- 4 hour REI and zero PHI
- OMRI listed and NOP compliant

Mode of Action

The scientific name for the active ingredient of Gemstar is *Helicoverpa zea* single capsid nucleopolyhedrovirus or HzSNPV. Multiple HzSNPV particles are naturally microencapsulated within a roughly spherical occlusion body (OB) that protects it to some degree from degradation.

Each OB measures about 1 to 2 microns in diameter; a single layer of more than a million Gemstar OBs could fit on the head of a pin.



Scanning electron photomicrograph of purified OBs.

A larva must ingest OBs in order to become infected with the virus. The highly alkaline environment of the larval digestive tract (where pH can be as high as 10) dissolves the OBs and releases the virus, which penetrates the cells lining the midgut. Once inside, the viral DNA "hijacks" the nucleus of the cell, causing it to replicate numerous copies of the virus which rapidly spread the infection to other organs. Within a few days the infected larva stops feeding, becoming pale and sluggish as its internal organs fill with virus. Upon death the larva "melts," its fragile outer skin disintegrating to release the liquefied remains of its internal organs, containing billions of new virus OBs. Each of these is capable of initiating a new infection if ingested by another larva feeding at that site or wherever OBs have been deposited by raindrops, gravity, or by spraying Gemstar.

Laboratory studies have determined that a dose of only a few OBs is sufficient to initiate a lethal infection in newly-hatched larvae. A single ounce of Gemstar contains nearly 60 billion OBs. Of course, not every OB in a spray will be ingested by a larva, but the highly virulent nature of HzSNPV toward its host means that it is effective at very low use rates.



Virus-infected larva, showing abnormally pale color and sluggish behavior.

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Virus Transmission

H_zSNPV occurs naturally in *Helicoverpa* and *Heliothis* populations, but usually at levels too low to prevent damaging outbreaks in commercial agricultural crops. The virus can persist for years in protected environments such as soil and crop residue. Rainfall, wind, cultivation, movement of animals and birds, and other physical forces can move OBs onto areas such as foliage or fruit where they can be ingested by larvae to begin another cycle of infection. However, the most effective way to initiate infection is to spray the virus onto the crop in much higher amounts than would otherwise occur naturally.

Once virus infection has occurred within a larval generation, there are several ways it can be maintained within the target pest population. Horizontal transmission occurs when larvae become infected by ingesting virus released into the environment when diseased larvae die. Sometimes infection occurs too late and at too low a dose to kill a larva outright, even though the virus has entered the host cells. A female that survives this sublethal infection may transmit the virus to her offspring,



Virus-killed caterpillar on a cotton leaf. Note how leakage of liquefied body contents releases new OBs that can be eaten by and infect other larvae (horizontal transmission).

a process known as vertical transmission. Latent infection can also occur, in which the virus lies dormant in the host until stress brought on by overwintering, overcrowding, lack of food, or exposure to

insecticides causes an outbreak of virus that kills the host. Latent virus can kill host insects months after the initial infection.

Host Specificity

H_zSNPV is highly specific to *Heliothis* and *Helicoverpa* larvae. It is not effective against other caterpillars, or against other orders of insect pests. It is noninfectious toward beneficial insects, fish, wildlife, livestock, or humans.

Application Rate

The label recommended application rate for Gemstar is 4 to 10 fl. oz. per acre. This equates roughly to 250 to 600 billion OBs per acre. Gemstar can be applied at the low label rate (4 fl. oz. per acre) if pest pressure is low, frequent applications are planned, or when mixing or rotating with another insecticide that will provide more rapid knock-down of larvae and/or adults. Multiple sprays at low rates and short intervals are likely to provide better control than a single spray at a high rate.

Application Method

Gemstar can be applied using standard ground sprayers, aerial application, and overhead sprinkler chemigation. Apply Gemstar in sufficient water to obtain thorough coverage of the crop canopy without excessive runoff. Actual application volume will depend on the type of spray equipment used.

Application Timing

Gemstar applications should be targeted against first or second instar larvae. H_zSNPV must replicate within the host larva in order to be effective, so Gemstar is slower to kill larvae compared to many chemical insecticides having a toxic mode of action. Smaller virus-infected larvae may still cause superficial damage, but they usually die before causing more serious damage. Higher doses of virus are required to kill larger larvae, which may do considerable damage to the crop before the infection advances sufficiently to stop them from feeding.

Establishment of H_zSNPV infection in the first generation may also carry over into later generations, making them easier to control with other tactics.

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- Meets National Organic Program (NOP) standards.
- Organic Materials Review Institute (OMRI) listed.



Compatibility With Other Pesticides

Gemstar can be mixed or applied in rotation with most chemical insecticides in order to provide a broader spectrum of control (including more rapid knock-down effect), to kill moths and eggs as well as larvae, or to control *Heliothis* or *Helicoverpa* larvae resistant to chemical insecticides. Due to Gemstar's unique mode of action (viral infection), there is no known cross-resistance with chemical insecticides. Gemstar will infect and kill both susceptible and resistant larvae.

Some agricultural chemicals such as foliar fertilizers may cause high pH in the spray tank, which could inactivate Gemstar by premature dissolution of the viral OBs (similar to what occurs naturally in the gut of the target larva). In some areas, water used to mix sprays may itself be highly alkaline. Check the pH in the mix tank before adding Gemstar. If pH is 9 or higher, buffer to pH 7 to preserve bioactivity.

Do not mix Gemstar with any pesticide bearing a label that prohibits tank mixing with other products.

Use of Spray Adjuvants

Because of the way it is made, Gemstar contains natural compounds derived from host larvae that can provide some protection from the UV rays in sunlight. Additional protection, as well as enhanced spray deposition and rainfastness, may be obtained by using certain adjuvants with Gemstar. Pinolene or related stickers, latex, methylated seed oils, humic acid, and powdered skim milk have been used with some degree of success to enhance the performance of viral insecticides. Avoid mixing Gemstar with silicone-based adjuvants intended only as "spreaders." Such compounds may interfere with the natural ability of the virus to stick to plant surfaces.

Refer to the adjuvant label or see your dealer for more information on a specific adjuvant.

Exposure to sunlight can be reduced and effectiveness of the virus may be increased by

• spraying Gemstar in the late afternoon or early evening. Avoid spraying in intense sunlight.

Using Gemstar in Organic Crops

• Gemstar meets National Organic Program (NOP) requirements and is listed by the Organic Materials Review Institute (OMRI) for use in organic production.

• Performance of Gemstar may be improved by addition of a feeding stimulant such as sugar or molasses at a rate of 5 pounds per acre. Larvae will then ingest virus more quickly as they feed preferentially on spray droplets, reducing the time of exposure of the virus to sunlight and increasing the rate of infection. Molasses may also provide some protection from sunlight.

Storage and Handling

• Gemstar can be stored at room temperature for up to two months without significant loss of bioactivity. Shelf life can be extended to one year by refrigeration. Gemstar can also be frozen for longer term storage (several years) if necessary.

• Bioactivity of the virus can be reduced by prolonged exposure to temperatures above 90°F. Short-term exposure (a few days) will not immediately deactivate the virus. However, always store Gemstar in its original bottle in a cool, dry place, out of direct sunlight.

• Shake well before use.

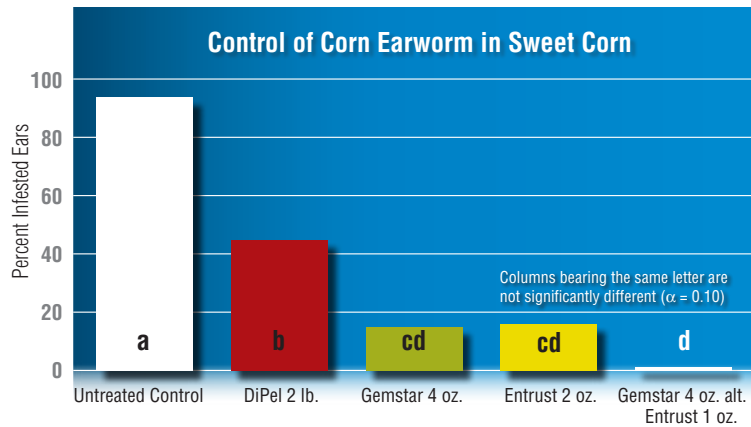
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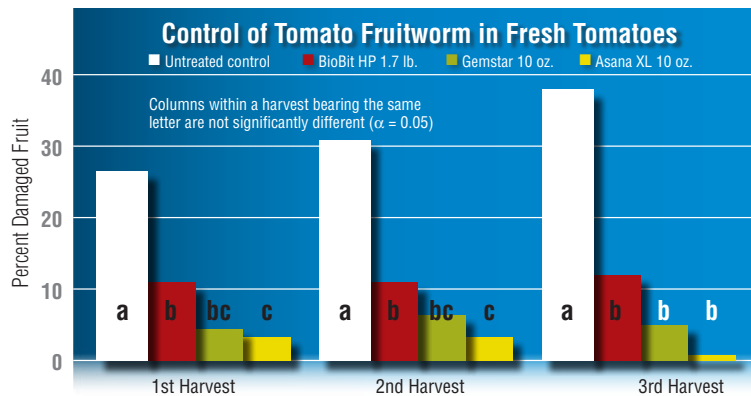
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Results From Replicated Field Plot Trials With Gemstar

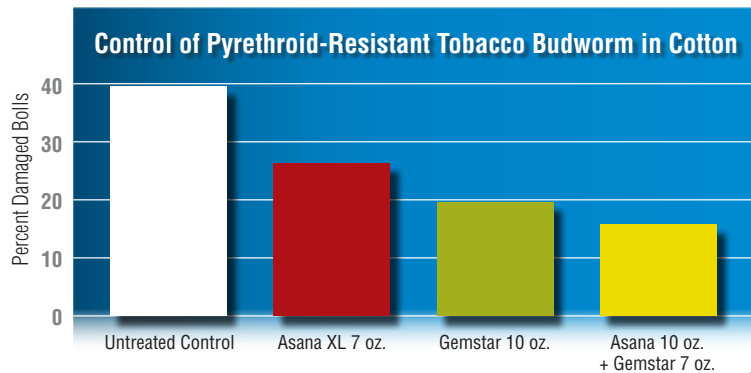
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All rates in pounds of product per acre, applied via overhead sprinkler chemigation in 0.1" of water. Single treatments were applied 5 times, every 5 days. Alternating Gemstar and Entrust every 6 days (with 12 days between each of 4 applications of the same product) resulted in 99% reduction in infested ears compared to the untreated check. Trial conducted in 2008 in the Mid-Columbia Basin of Washington.



All rates are in pounds of product per acre. Six weekly applications via CO₂ backpack sprayer in 60 gallons of water per acre. Gemstar treatment included 5 ounces of powdered milk as UV screen. Trial conducted in 1994 in North Carolina.



All rates are in pounds of product per acre. Five weekly applications via CO₂ backpack sprayer in 7.3 gallons of water per acre. Trial conducted in 1994 in Nueces County, Texas.

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