

**SPOD-X® LC:
BIOLOGICAL INSECTICIDE
FOR BEET ARMYWORM**

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Abstract

A new bioinsecticide for control of beet armyworm, SPOD-X LC, is based on an insect-specific baculovirus which causes a lethal infection in larvae. It is produced *in vivo* (i.e. in beet armyworm larvae) by biosys and became commercially available in 1995. It provides a safe and effective means of controlling young larvae without disrupting natural control of cotton pests by natural enemies. Recommendations are given for using SPOD-X LC in management of beet armyworm on cotton.

Introduction

SPOD-X LC is a new liquid concentrate biological insecticide for use against larvae of the beet armyworm (*Spodoptera exigua*) on cotton and other crops. The active ingredient, *Spodoptera exigua* nuclear polyhedrosis virus (SeNPV), is a naturally-occurring baculovirus that frequently causes disease outbreaks in beet armyworms in the field. SeNPV is specific to the beet armyworm, with no effects on other insects or on nontarget organisms such as fish, birds, and mammals. SeNPV is exempt from residue tolerance and EPA lists SPOD-X LC as a safe pesticide (i.e. only 4 hour reentry interval). SPOD-X LC is labeled in all cotton-growing states and is distributed in the USA exclusively by Helena Chemical Co.

Structure and Mode of Action

The mode of action of SPOD-X LC is unique among cotton bioinsecticides. A virus is a “genetic parasite,” little more than nucleic acid (DNA or RNA) surrounded by a protein coat, and is unable to replicate outside a living host cell. Viral genes redirect the biochemical machinery of the infected host cell so that it produces numerous copies of the virus instead of carrying out normal functions. The DNA of SeNPV and other baculoviruses is enclosed in proteinaceous rods called nucleocapsids. The nucleocapsids in SPOD-X LC are packaged together in groups of about 3 to 20 within a unit membrane, forming a single infectious unit known as a virion. Multiple virions are themselves enclosed within a proteinaceous matrix referred to as an occlusion body (OB). The OB protects the virus from degradation by harsh environmental conditions and serves

as the vehicle for transmission of the disease from one larva to the next or between larval generations.

OB's on plants sprayed with SPOD-X LC are ingested by beet armyworms as they feed. The OB's dissolve rapidly within the alkaline midgut, releasing virions which attach to the cells lining the gut wall. Nucleocapsids penetrate the nuclei of the midgut cells and begin to replicate. The progeny nucleocapsids of this initial round of replication exit the infected midgut cell and enter the hemocoel (bloodstream) of the larva, circulating to other organs. Several more rounds of replication can occur, resulting in systemic infection of nearly all major organs. Infected larvae turn pale or even white at this stage and stop feeding. Late in the infection cycle the progeny nucleocapsids, instead of budding into the hemocoel, are assembled into virions, and OB's are formed around them within the infected nuclei. As the infected insect dies, its internal organs disintegrate into liquid containing billions of OB's. The fragile integument of the cadaver is easily ruptured, releasing OB's to contaminate surrounding plant material and infect other larvae.

The infection process proceeds more rapidly at higher temperatures (within the range that supports larval growth and survival), and symptoms appear sooner in small larvae than in large larvae. Generally, under normal conditions in cotton the symptoms of SeNPV infection (pale coloration, cessation of feeding) are apparent about 4 days after spraying SPOD-X LC. Infected larvae begin to die 5 to 7 days after application, and control is usually visible at 7 to 10 days.

Production and Quality Control

SPOD-X LC is manufactured at the biosys production facility in Decatur, IL by infecting beet armyworm larvae with SeNPV under controlled conditions of mass rearing. Infected larvae are incubated to allow the natural process of virus replication and amplification to proceed. The cadavers of virus-killed larvae are harvested and processed into an aqueous slurry rich in OB's. Formulated SPOD-X LC contains 2 billion OB's per ml, or 0.64% a.i. by weight.

Each batch of SPOD-X LC is subjected to rigorous Quality Control testing before it is released for distribution. OB concentration is determined microscopically, and a laboratory bioassay is conducted to confirm potency against *S. exigua*. Gel electrophoresis of DNA restriction fragments (“DNA fingerprinting”) is conducted to ensure that the AI is genetically identical to the SeNPV reference standard strain used to infect the production larvae, and that the product is free of contamination by other baculoviruses that might also infect *S. exigua*. Standard microbial assays are performed to ensure that the batch is also not contaminated with bacteria or other microorganisms at levels that may cause spoilage or inactivation of the virus. A sample from each batch is

tested for the presence of mammalian pathogens by intraperitoneal injection into laboratory mice.

Efficacy

SPOD-X bioinsecticides have been tested extensively since 1991 on vegetable crops and greenhouse flowers in the USA, Europe, and Asia. The results demonstrate effective control of beet armyworms comparable to or exceeding levels achieved with other biologicals, and in some cases also outperforming chemical insecticides (particularly where resistance is common). Very little field data were available for cotton prior to 1995, but an ambitious program of research and demonstration trials was conducted last season in conjunction with the commercial launch of the product. The results of several of these trials are presented elsewhere in these proceedings by the investigators that carried them out, and thus will not be presented in detail here. Good to excellent control was reported by university cooperators and consultants when SPOD-X LC was used according to recommendations in key areas with serious beet armyworm pressure, such as the Lower Rio Grande Valley of Texas (fig. 1), the Tennessee River Valley of northern Alabama, southern and central Alabama, and the Mississippi Hills. More importantly, the 1995 season provided an education in how to best utilize SPOD-X LC in management of beet armyworms.

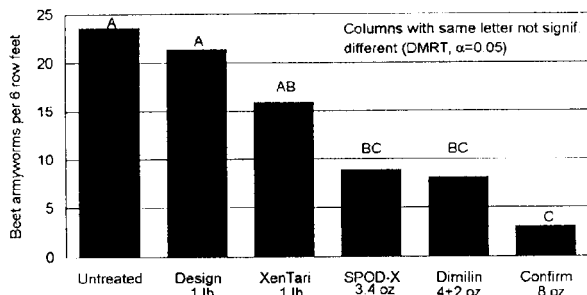


Figure 1. Control of beet armyworm on cotton in the Lower Rio Grande Valley, 1995. All treatments applied twice (Jun 16 & 21), except Confirm (Jun 16 only) with backpack sprayer (10 gpa, 3 nozzles/row). Plots 4 rows × 25 ft. with 4 replicates per treatment. Study conducted by Dr. A.N. Sparks, Jr., Texas A&M University, Weslaco, Texas.

Recommendations for Use

SPOD-X LC should be applied at a rate of 1.7 - 3.4 fl. oz. per acre (125 - 250 ml per hectare). At these rates, one gallon of product is sufficient to treat up to 80 acres. The lower rate represents about 0.4 grams a.i., or approximately 100 billion OB's per acre, the equivalent amount of SeNPV produced by about 100 infected larvae. SPOD-X LC can be applied by airplane or ground sprayer in 5 to 100 gallons of water per acre. Since it must be ingested by larvae in order to be effective, thorough coverage of the plant is essential

and may be enhanced by use of a surfactant. A buffer should also be included in the spray mix if the water pH exceeds 9, since the virus is degraded by highly alkaline conditions.

Because SeNPV is relatively short-lived in the field (1-3 days on cotton), SPOD-X LC should be applied at least twice (2-5 days apart) during each beet armyworm cycle, targeting young larvae. Efficacy should be evaluated 7-10 days after the first application by searching for larvae exhibiting signs of virus infection. The goal is to initiate a disease outbreak in the larval population by maintaining a high level of SeNPV on the foliage. The earlier this process is started in the resident beet armyworm population, the more likely it is that the virus will keep infestations from getting out of hand later in the season. SPOD-X should *not* be used as a curative measure against a large, established population of mature larvae. While many large larvae will become infected and die (producing plenty of new SeNPV in the process), they will continue to feed for 5 to 7 days before they succumb to the virus, causing extensive damage to the crop. An effective strategy may be to use SPOD-X LC against the first one or two beet armyworm generations, then switch to a chemical insecticide against outbreak levels later in the season.

SPOD-X LC and Management of Cotton Pests

In addition to being effective for control of beet armyworms, SPOD-X LC is one of the safest insecticides available today, and is cost competitive (grower cost of \$7/acre in 1996) with other insecticides currently used to control this insect. Because it has no toxicity to non-target organisms, by using SPOD-X LC a cotton grower can preserve beneficial insects and thereby avoid secondary outbreaks of pests normally kept in check by predators and parasitoids. Because of its unique mode of action, SPOD-X LC can be used as an alternative to or in rotations/combinations with chemical insecticides as a means of managing resistance. SPOD-X LC is also the only commercially available biopesticide that can be used for control of beet armyworms on Bt cotton.