



# NATULAR<sup>®</sup>

## NATURALLY DERIVED ACTIVE INGREDIENT

Larvicide for Mosquito Control

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Reduced Risk active ingredient

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Unique mode of action

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Novel class of chemistry for public health

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Formulated for sustainable solutions

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# THE FIRST AND ONLY COMPLETE PORTFOLIO OF LARVICIDES WITH A NATURALLY DERIVED ACTIVE INGREDIENT

For years there have been only five active ingredient choices for larval control. Now there's a sixth, and it's found only in **Natular**<sup>®</sup>. With formulations developed and manufactured exclusively by Clarke, its patented ingredient, spinosad, is a product derived from a naturally occurring bacterium. Natular is in a chemical class different from all other larvicides and has a unique mode of action that helps fight resistance. Simply stated, Natular is like no other larvicide on the market.

## BENEFITS INCLUDE >>

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### Reduced Risk active ingredient

The active ingredient in Natular formulations is designated by the E.P.A. as Reduced Risk. This means reduced risks to human health and the environment when compared to other chemical and biochemical larvicides.

### Unique mode of action

The unique mode of action of spinosad ensures no cross resistance with other chemistries.

### Novel class of chemistry

Natular formulations are Group 5 insecticides — the first public health larvicides in this class — that provide you confident, resistance fighting performance.

### Formulated for sustainable solutions

All formulations, except Natular DT are OMRI (Organic Materials Review Institute) Listed, enabling them to be used in and around organic agriculture. The international tablet has not been submitted for review.

## What makes Natular® so unique?

Natular and its active ingredient, spinosad, offer a healthier alternative to protecting the well-being of communities.



Provides the right  
balance of efficacy  
with environmental  
stewardship

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Excellent option for  
resistance management  
and rotational use

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All formulations of  
Natular were designed as  
sustainability solutions

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Six advanced  
formulations to fit  
any habitat

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Offers exceptional  
control of larvae from  
the first through early  
4th instar stages

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Minimal PPE  
requirements for  
application

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Breaks down rapidly in soil—  
spinosad degrades into  
carbon dioxide and water

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Green Chemistry active  
lets you use with confidence  
in your community

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# WE'RE SETTING NEW BENCHMARKS WITH SPINOSAD

**Spinosad**, a product derived from a naturally occurring soil bacterium, is the active ingredient in Natular®. It provides the perfect balance of efficacy and environmental stewardship. Spinosad has an excellent safety record. It breaks down quickly and does not bioaccumulate in the environment. In addition, all inert ingredients in domestic Natular formulations are included on the EPA's List of Minimal Risk Inert Ingredients.

## The Structure

Chemical name: *Saccharopolyspora spinosa*

Common name: Spinosad, a patented combination of spinosyn A and spinosyn D

	SPINOSYN A	SPINOSYN D
Molecular Formula	C <sub>41</sub> H <sub>65</sub> NO <sub>10</sub>	C <sub>42</sub> H <sub>67</sub> NO <sub>10</sub>
Molecular Weight	731.98	746.00
Color and State	Crystalline Solid, White to Tan	Crystalline Solid, White to Tan
Vapor Pressure (25°C)	3.0 x 10 <sup>-11</sup> kPa	2.0 x 10 <sup>-11</sup> kPa
Melting Point	84 – 100°C	161 – 170°C
Water Solubility: (20°C)		
pH 5	290 mg/L	28.7 mg/L
pH 7	235 mg/L	0.332 mg/L
pH 9	16 mg/L	0.053 mg/L

## The Origins of Spinosad and Natular®

In 1982, a vacationing scientist took a soil sample from a drum that was used to make rum in the Caribbean. From this sample, a new species of bacteria was identified in 1986: *Saccharopolyspora spinosa*. (This translates into “spiny sugar.”) The bacteria was later fermented in a lab and yielded spinosyns A and D, the most active metabolites of *S. spinosa*. Together, they comprise spinosad.

In 2002, Clarke acquired the public health development rights to spinosad. After six years and over 35,000 hours of development and regulatory review, Natular larvicides became the first public health label for spinosad, and also the first aquatic use pattern with the active as well.

## The First Reduced Risk Larvicide

In 1993, the U. S. Environmental Protection Agency created the Reduced Risk Pesticide Initiative to “encourage the development, registration and use of lower-risk pesticide products, which would therefore result in reduced risks to human health and the environment when compared to existing alternatives.”

Spinosad, the active ingredient in Natular, is one of only sixteen chemicals registered as a Reduced Risk pesticide and the only Reduced Risk larvicide for mosquito control. According to the EPA, the advantages of Reduced Risk pesticides include:

- » Low impact on human health
- » Lower toxicity to non-target organisms (birds, fish, plants)
- » Low potential for groundwater contamination
- » Low use rates
- » Low pest resistance potential
- » Compatibility with Integrated Pest Management (IPM) practices

## Recipient of The Presidential Green Chemistry Challenge Award

Spinosad is one of only five pesticide products to ever receive the Presidential Green Chemistry Challenge Award\*, one of the U.S. Government’s highest environmental honors.

Green chemistry, also known as sustainable chemistry, is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. The benefits of green chemistry technologies include:

- » Reduced waste, eliminating costly end-of-the-pipe treatments
- » Safer products
- » Reduced use of energy and resources

Green chemistry applies across the life cycle, including the design, manufacture, and use of a chemical product.

\*[www.epa.gov/greenchemistry](http://www.epa.gov/greenchemistry)

# A REVOLUTIONARY MODE OF ACTION THAT'S IDEAL FOR ROTATIONAL USE

## Delivering a Unique Mode of Action

The active ingredient in Natular® works like no other larvicide. Spinosad alters the function of insect nicotinic acetylcholine receptors in a unique action that causes continuous nervous impulses. This constant involuntary nervous stimulus causes paralysis and death. The action results primarily by ingestion, as well as by contact with the active.

## In a Class by Itself: Group 5

Because of its unique mode of action, spinosad is classified as a Group 5 insecticide by the Insecticide Resistance Action Committee. It's the only active ingredient classified in Group 5 used for mosquito control. Because this class is unique and distinct from all other public health larvicides, this makes the Natular portfolio truly one of a kind.

It also makes an excellent option for resistance management. Its novel mode of action and distinct class grouping makes Natular ideal for rotational use since it shows no cross-resistance with existing products used for mosquito control.

## Proven Performance

The consistent performance of spinosad — logged and observed in testing and operational work — has demonstrated exceptional control of larvae from the first through early fourth instar stages. Spinosad begins to work immediately upon contact and ingestion; its first visible effects are seen within hours of application. Optimal control is reached within 24-72 hours, sustained at very uniform levels for the labeled control period.

Natular formulations have been very effective in a wide spectrum of habitats in more than 50 domestic tests and 15 international studies. Data has been gathered on more than 20 species and will be expanded as usage increases.

We believe that an important part of being an environmental steward is product rotation. Our product rotation methods maximize the effectiveness of every program by preventing cross-resistance. To help select products for rotation in your program, visit [clarke.com/mosquitocontrolproducts](http://clarke.com/mosquitocontrolproducts) to view our full line of product offerings.

# FORMULATED TO MEET THE NEEDS OF ENVIRONMENTALLY SENSITIVE HABITATS

## Meets Organic and Sustainable Practice Standards

Natular® larvicides were formulated with a respect for the ever increasing number of communities with green or sustainability programs. All formulations except Natular DT have been listed by OMRI for use in organic production. Just knowing these products can be used in and around organic food production can give you confidence when using in public spaces.

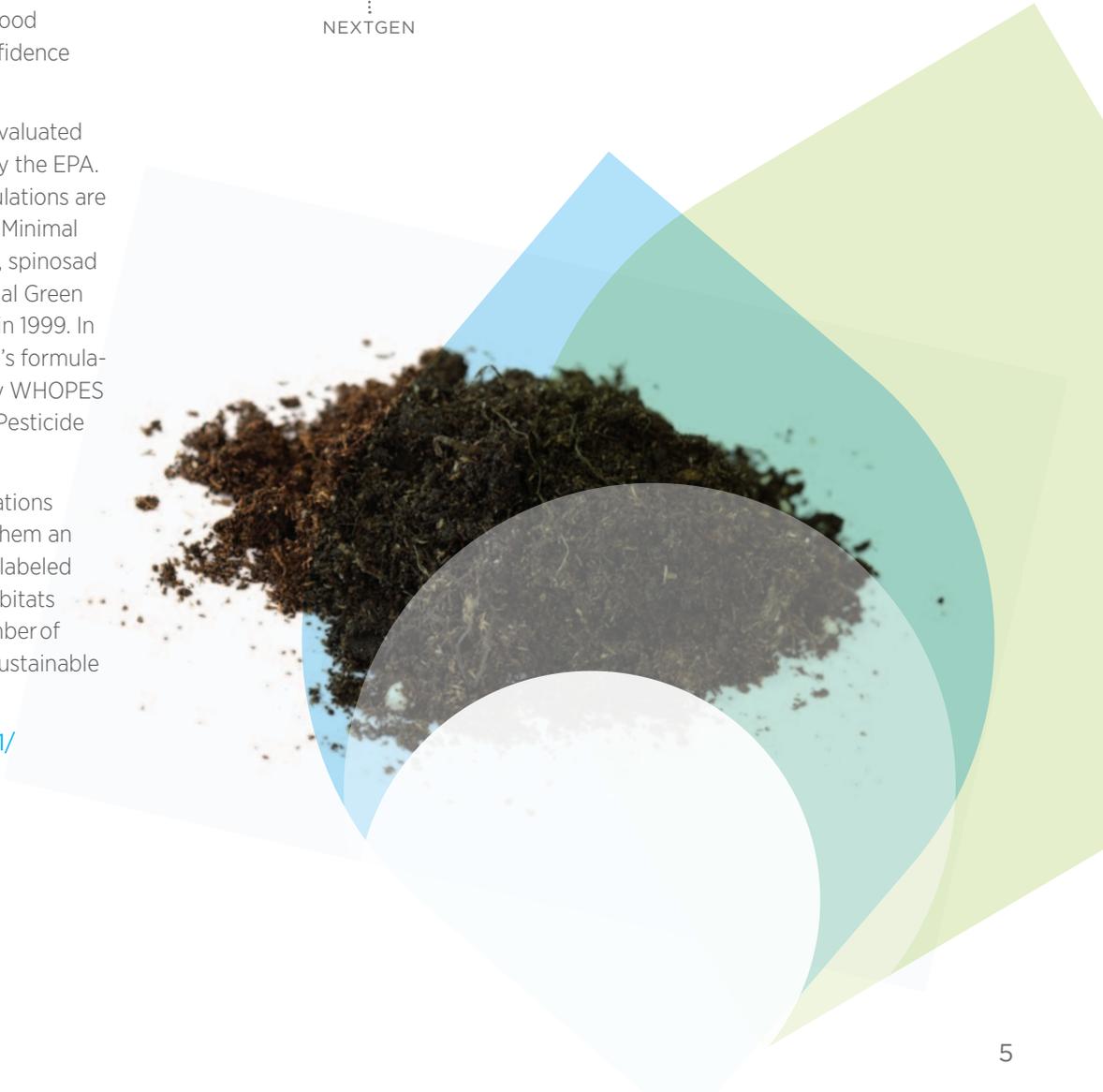
Natular is the first larvicide evaluated as a Reduced Risk product by the EPA. All ingredients in all its formulations are included on the EPA's List of Minimal Risk Inert Ingredients. In fact, spinosad received the EPA's Presidential Green Chemistry Challenge Award in 1999. In addition, two of the portfolio's formulations have been evaluated by WHOPEP (World Health Organization Pesticide Evaluation Scheme).

Bottom Line: Natular formulations meet the criteria that make them an excellent choice for not only labeled environmentally-sensitive habitats but also for the growing number of communities with green or sustainable practice guidelines.

Visit [www.epa.gov/opprd001/workplan/reducedrisk.html](http://www.epa.gov/opprd001/workplan/reducedrisk.html) for more details.

## Introducing NextGen Products

Natular is also the first product to be ranked in the "NextGen" category on the Clarke Eco-Tier™ Index of environmental impact.



# SIX DISTINCT FORMULATIONS

Natular® is available in six advanced formulations to fit the needs of any habitat. Each formulation offers exceptional handling characteristics and is labeled for only protective eyewear PPE.

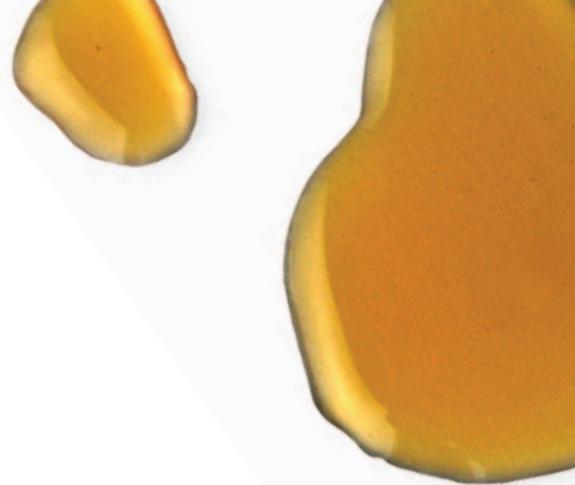
	FORMULATION	CARRIER & APPEARANCE	APPLICATION RATE*	BULK DENSITY
EC	Single-brood liquid	Liquid, dark and slightly cloudy in appearance	1.1 – 2.8 fl oz/ac	9.68 lbs/gal
G	Single-brood granule	Granules made from corn cobs	3.5 – 9 lbs/ac	33 lbs/cf
T30	Multiple-brood 30-day tablet	A dust-free tablet	1/100 sf	6 g/tablet
XRT	Multiple-brood extended release tablet	A dust-free tablet	1/100 sf	40 g/tablet
G30	Multiple-brood extended release granule	Granules made from silica	5 – 20 lbs/ac	85 lbs/cf
DT (not available in US)	Multiple-brood tablet for containerized water	Bi-layer tablet	1/container	1.35 g/tablet

## For International Use: Natular DT

In rural and urban areas of Latin America, the Middle East, Africa and Asia, the need to treat water barrels and other containers is crucial in the fight against Dengue, Yellow Fever and Chikungunya. To meet this need, Clarke developed the innovative bi-layer Natular DT formulation.

One layer works immediately while the second dissolves slowly. Thus, each tablet can treat a 200 liter barrel of water for more than 60 days. Successfully evaluated by WHOPEs, Natular DT has significantly reduced volume requirements, making transportation and storage much easier.

\* depending on area of treatment



DT





2EC



G30



T30



XRT



G



# REDUCING ENVIRONMENTAL IMPACT

The active ingredient in Natular® larvicides, spinosad, is a highly selective insect control product with high potency for target insects but **low toxicity toward mammals and other non-target organisms.**

## Environmental Fate

**In Soil:** Spinosad degrades readily in the soil environment and is non-persistent. Primary mechanisms of degradation are sunlight photolysis and microbial breakdown. Under field conditions, spinosad breaks down rapidly in the soil with observed half-lives of less than one day, degrading into carbon dioxide and water by the soil microbial community. It is moderately to strongly absorbed by soil particles and is considered to be “relatively immobile to immobile” with regard to leaching.

**In Water:** In natural water systems, spinosad degrades rapidly in sunlight. A water column half-life of less than one day has been observed in artificial pond systems in outdoor conditions.

**In Animals:** Because of its unique mode of action, spinosad is highly selective to insects. In mammals, spinosad is not readily absorbed through the skin; any minute amounts that are absorbed or ingested are rapidly metabolized to inactive by-products, which are excreted. As a result, it has very low acute toxicity. In long term studies, no evidence of carcinogenicity, mutagenicity, or neurotoxicity has been observed.

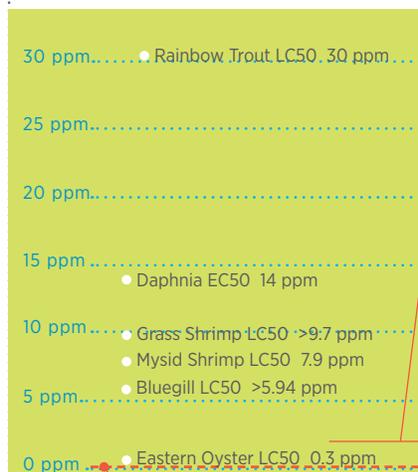
## Toxicity, Mutagenicity, Genotoxicity

Spinosad is well known to present a relatively low risk to beneficial and non-target insects compared to other broad-spectrum, insecticide products. It is not acutely toxic to terrestrial birds, wildlife, or to fish and most aquatic invertebrates. Investigated in a battery of genotoxicity studies, it has been found to possess no mutagenic potential.

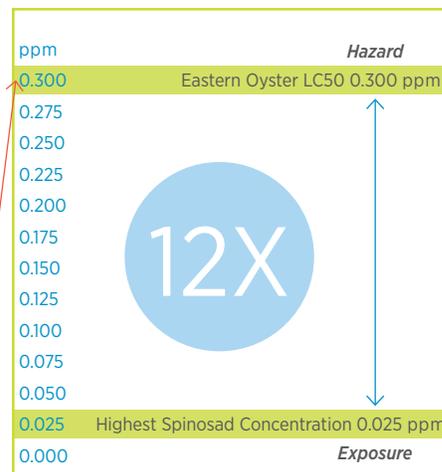
During the six years of development and the operational use of Natular products since introduction in 2009, there have been no observed or validated non-target effects. Many characteristics of spinosad make this possible: low dose rate, rapid breakdown by sunlight, binding to soil, rapid dissolution in water, as well as non-target location and lifecycle at time of application.

### Indicator Aquatic & Invertebrate Specie Sensitivity to Spinosad

#### TOXICITY CONCENTRATIONS PPM



Spinosad concentration level with Natular products: 0.015 – 0.025 ppm



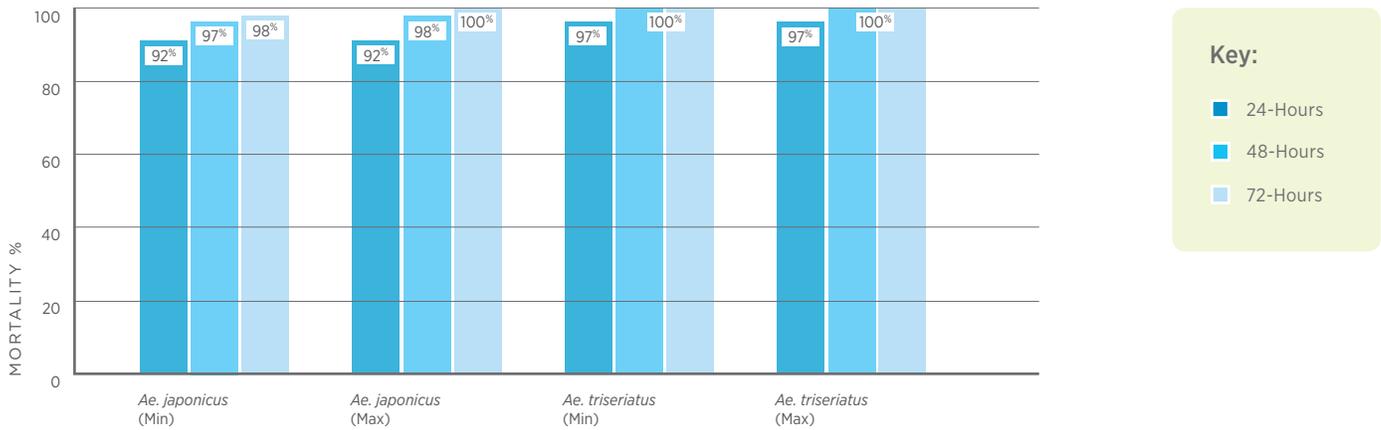
Spinosad demonstrates a 12X margin of safety when comparing exposure to acute toxic hazard.

# RESULTS

## Natular® EC

Rate: 1.1 fl oz/ac (Min), 2.8 fl oz/ac (Max)

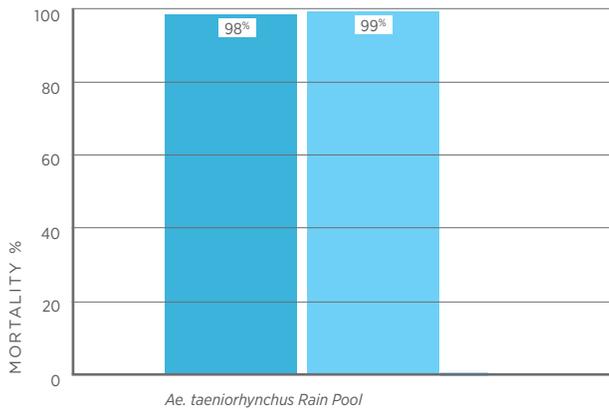
Location: Kentucky, 2008



## Natular G

Rate: 9 lb/ac (Max)

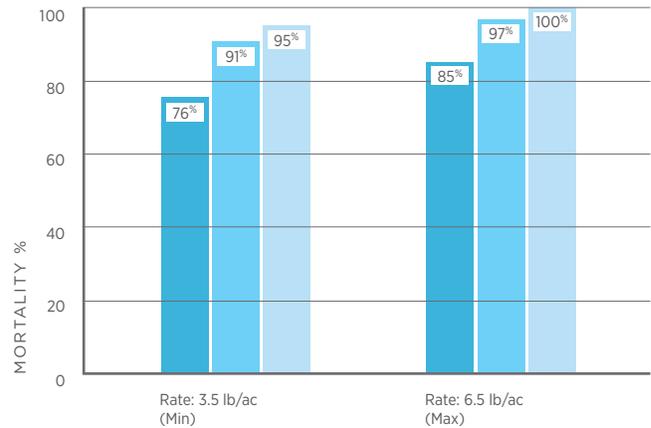
Location: Florida, 2008



## Natular G

Species: *Ae. trivittatus*

Location: Kentucky, 2008



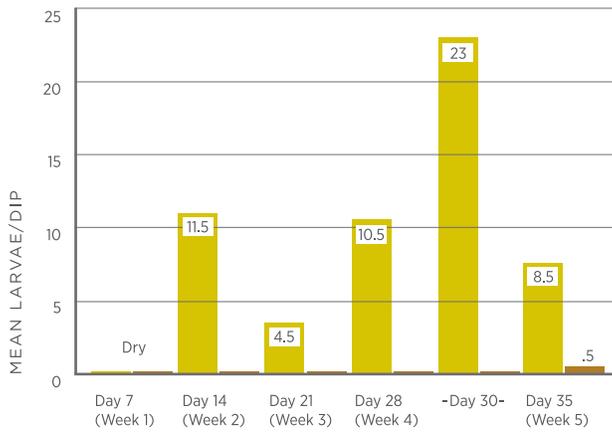
# RESULTS

**Key:**

- Unt
- Trt

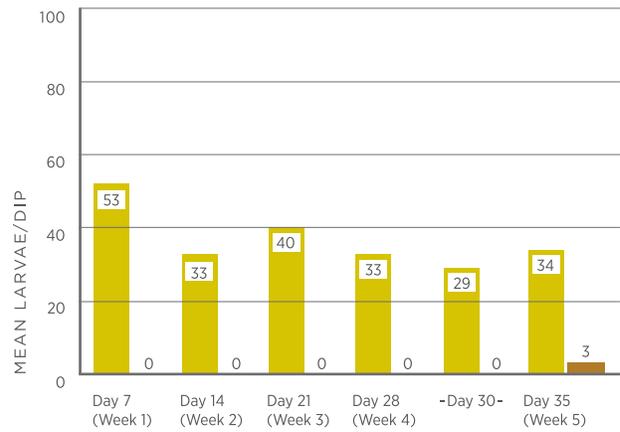
## Natular G30

Habitat: Retention Ponds/*Ae. vexans*-*Cx. pipiens*  
 Rate: 10 lb/ac (<Mid)  
 Location: Illinois, 2008



## Natular T30

Habitat: Catch Basins/*Cx. restuans* - *pipiens*  
 Location: Illinois, 2008

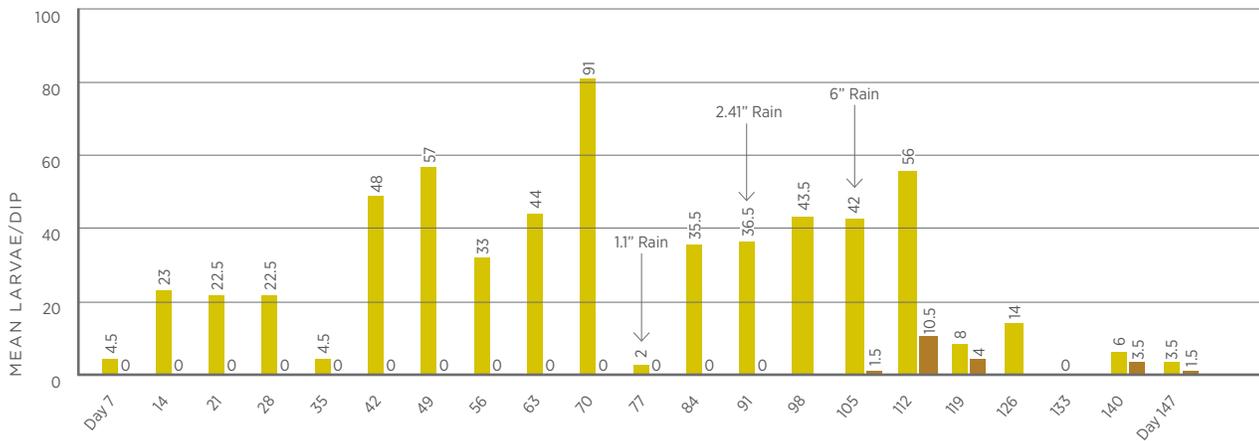


**Key:**

- Unt
- Trt

## Natular XRT

Habitat: Catch Basin/*Cx. pipiens*  
 Location: Illinois, 2008



# RESULTS

## Natular G30

Habitat: Sample from Benthic Soils, Lake Monroe

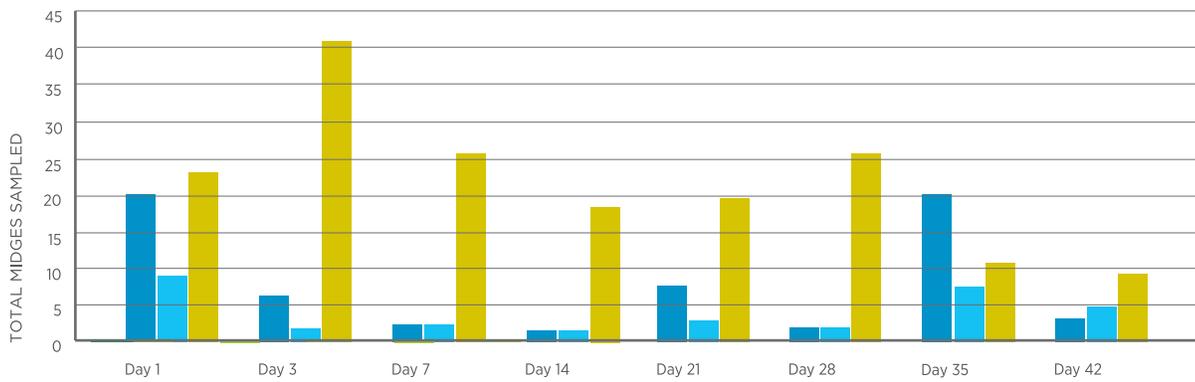
Rate: 12 lb/Acre and 12.5 lb/Acre

Location: Lake Monroe Florida, Volusia County, 2010

Species: Non-Biting Midge: *Glyptotendipes paripes* and *Chironomus crassicaudatus*

### Key:

- Natular 12 lb/Acre
- Natular 12.5 lb/Acre
- Control



\*Data provided by Edward D. Northey, Environmental Specialist, Volusia County MC, FL

### Key:

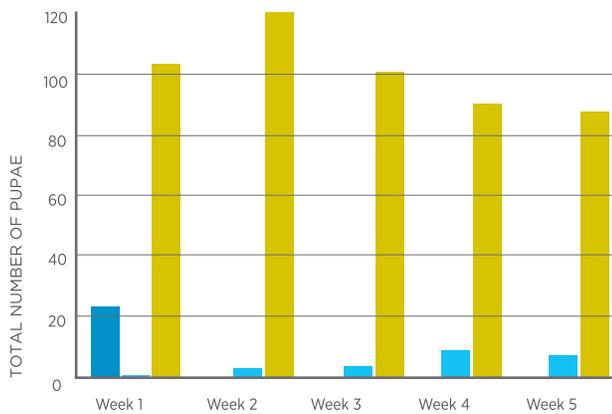
- Natular T30
- Natular G30
- Control

## Natular T30 and Natular G30

Location: Kenya Medical Research Institute, Kisumu, Kenya, 2010

Species: *Anopheles gambiae*

Large Simulated Barrow Pit Study



### Key:

- Natular 5 lb/Acre
- Natular 10 lb/Acre

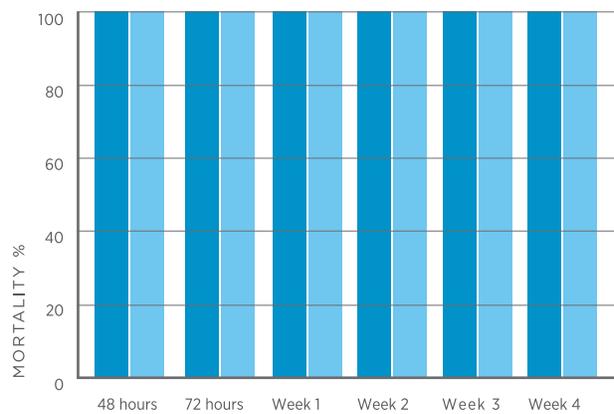
## Natular G30

Habitat: Wetlands

Rate: 10lb/A and 5lb/A

Location: Washoe County, Nevada, 2009

Species: *Cs. morsitans*, *Cx. tarsalis*



# FREQUENTLY ASKED QUESTIONS

## **Q: What is the active ingredient in Natular® larvicides?**

A: Spinosad. It is a naturally derived active ingredient produced during fermentation by the soil organism, *Saccharopolyspora spinosa*. The natural metabolites produced during the fermentation process were termed “spinosyns”. Spinosad is the collective term for the two most prominent and most active compounds in the fermentation broth (spinosyn A and spinosyn D). Hence the name “Spinosad”.

## **Q: How is the active ingredient manufactured?**

A: Spinosad is produced in a state-of-the-art fermentation facility in the United States, using natural feed-stocks to maintain the fermentation process.

## **Q: Is spinosad new?**

A: No. Spinosad’s first global registration was in 1996. Today it’s used on more than 250 crops and in consumer and animal health uses in over 85 countries. Although Natular larvicides are the first public health usage of the active.

## **Q: How does the active ingredient in Natular formulations control mosquito larvae?**

A: Spinosad has a novel mode of action; it alters the function of insect nicotinic acetylcholine receptors in a unique manner. Ultimately paralysis sets in upon ingestion and contact and the mosquito larvae don’t recover.

## **Q: Are Natular formulations suitable for use in organic agriculture?**

A: All domestic formulations of Natular are listed by the Organic Materials Review Institute (OMRI) for use in and around organic agriculture.

## **Q: What does Group 5 Insecticide mean on the Natular label?**

A: Group 5 is a designation by IRAC (Insect Resistance Action Committee), which is a global industry organization that promotes the development of insecticide resistance management strategies to maintain efficacy and support sustainable agriculture and improved public health. Each group has a distinctly different mode of action. Spinosad is the only active ingredient in Group 5 used for mosquito control. The benefit of this is that it has no cross-resistance with existing products – making Natular an excellent option for resistance management.

## **Q: What are the inert ingredients in Natular?**

A: All inert components in domestic Natular formulations are included in EPA’s list of Minimal Risk Inert Ingredients. Inerts are non-synthetic (natural) or are synthetic components which do not contribute to mammalian or aquatic toxicity.

## **Q: What impact does spinosad have on non-targets?**

A: Spinosad is of low acute and chronic toxicity to a wide range of non-target species. Under laboratory conditions, spinosad is toxic to some aquatic invertebrates, primarily upon chronic exposure. Fortunately, the rapid degradation of spinosad in natural aquatic environments prevents the long-term exposure that would be needed for these effects to occur in real world situations.

## **Q: How effective is Natular in an open / floodwater habitats with sunlight (*Aedes vexans*)?**

A: Excellent, based on numerous cooperator and university trials.

## **Q: Do Natular larvicides control all of the important mosquito species?**

A: Natular formulations have been tested on twenty of the most common vector and nuisance mosquito species and spinosad is effective against all of them. Given the fact that spinosad is a new active ingredient and has a completely unique mode of action; we expect to see consistent performance across all species.

## **Q: How do Natular™ formulations perform in habitats containing high organic matter?**

A: We have seen excellent results in habitats with high concentrations of organic debris with Natular formulations, e.g. polluted water, sewage lagoons, and waters with high concentrations of leaf litter or other organic debris.

**Q: How have Natular products performed in catch basins?**

A: Both the 30-day Natular T30 and Natular XRT have performed exceptionally well in catch basins – even in the face of significant rain events as well as wet/dry cycles. The 30-day Natular T30 provides 30 days of control, while the XRT has consistently reached full season limits with control up to 180 days.

**Q: How does varying amounts of sunlight affect the performance of Natular products?**

A: Natular formulations were developed specifically for use in natural mosquito habitats, with single or multi-brood control objectives in mind. To date we have seen very uniform control levels regardless of sunlight intensity, and consistent with the labeled control claim of each Natular formulation.

**Q: What about resistance?**

A: The active ingredient in Natular products, spinosad, has not previously been used to control mosquitoes, hence there is no resistance to it. Spinosad is in a unique chemical class different from any other current products used in mosquito control, so there is no cross-resistance. Clarke will implement a resistance management program. To manage resistance, Clarke will steward and monitor the applications of these products to ensure consistent use according to label directions.

**Q: What is the ecological toxicity of the Natular formulations?**

A: Spinosad was registered under the US EPA Reduced Risk program and has favorable environmental characteristics compared to other mosquito larvicides. The active ingredient in Natular larvicides, spinosad, is well known to present a relatively low risk to beneficial and non-target insects compared to other broad-spectrum, insecticide products. Spinosad is not acutely toxic to terrestrial birds, wildlife, or to fish and most aquatic invertebrates. Extensive field experience indicates that spinosad's overall impact on beneficial insects is generally limited and transitory, and spinosad fits well into Integrated Pest Management (IPM) programs.

**Q: What impact does spinosad have on non-targets?**

A: Spinosad is of low acute and chronic toxicity to a wide range of non-target species. Under laboratory conditions, spinosad is toxic to some aquatic invertebrates, primarily upon chronic exposure. The rapid degradation of spinosad in natural aquatic environments prevents the long-term exposure to levels needed for these effects to occur in real world situations. Indeed, field studies indicate that effect on non-target species is not mitigated by virtue of low application rates and rapid dissipation of spinosad.

**Q: How do Natular products affect honey bees?**

A: Field testing has demonstrated that once liquid spray residues have been allowed to dry for up to 3 hours that spinosad is not harmful to foraging honeybees and bumblebees. Spinosad has been used extensively in more than 85 countries with over 250 registered crop uses since its first launch in agriculture without any reported adverse effects on bees. This would be applicable ONLY TO THE LIQUID formulation. Granular and tablet formulations will not pose a bee hazard.

**Q: Why are Natular formulations good rotational products?**

A: Natular formulations are the new standard in larvicide control and are excellent as rotational products because they contain a new active ingredient with a distinctly different mode of action. Natular products are a key component in rotational programs for larvicide control. Rotation will help preserve the continued use of existing products.

**Q: Is Natular's active ingredient toxic to mammals?**

A: Mammals rapidly metabolize spinosad and any by-products are excreted. So spinosad has a very favorable mammalian toxicity profile:

- » Low acute tox for both technical and end-use formulations
- » No reproductive effects, not a teratogen
- » Negative in genotoxicity tests
- » Not a carcinogen
- » No endocrine effects



# Clarke

## GLOBAL HEADQUARTERS

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[www.clarke.com](http://www.clarke.com)

Clarke is a global environmental products and services company. Each year, Clarke helps make communities around the world more livable, safe and comfortable by pioneering, developing and delivering environmentally responsible disease prevention and habitat management solutions. In 2008, Clarke founded The Clarke Cares Foundation, a non-profit created to provide disease prevention support for communities with critical needs.

This brochure was printed with the following eco-friendly criteria: uses recycled content paper; uses soy-based inks to avoid petroleum-based inks and to reduce the amount of pigment required; plus recycle all waste from the trimming process.

Join us in reducing paper usage by sharing this brochure with someone else.

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# DUET™

## DUAL-ACTION EFFICACY

### Adulticide for Mosquito Control

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Delivers more control of natural mosquito populations

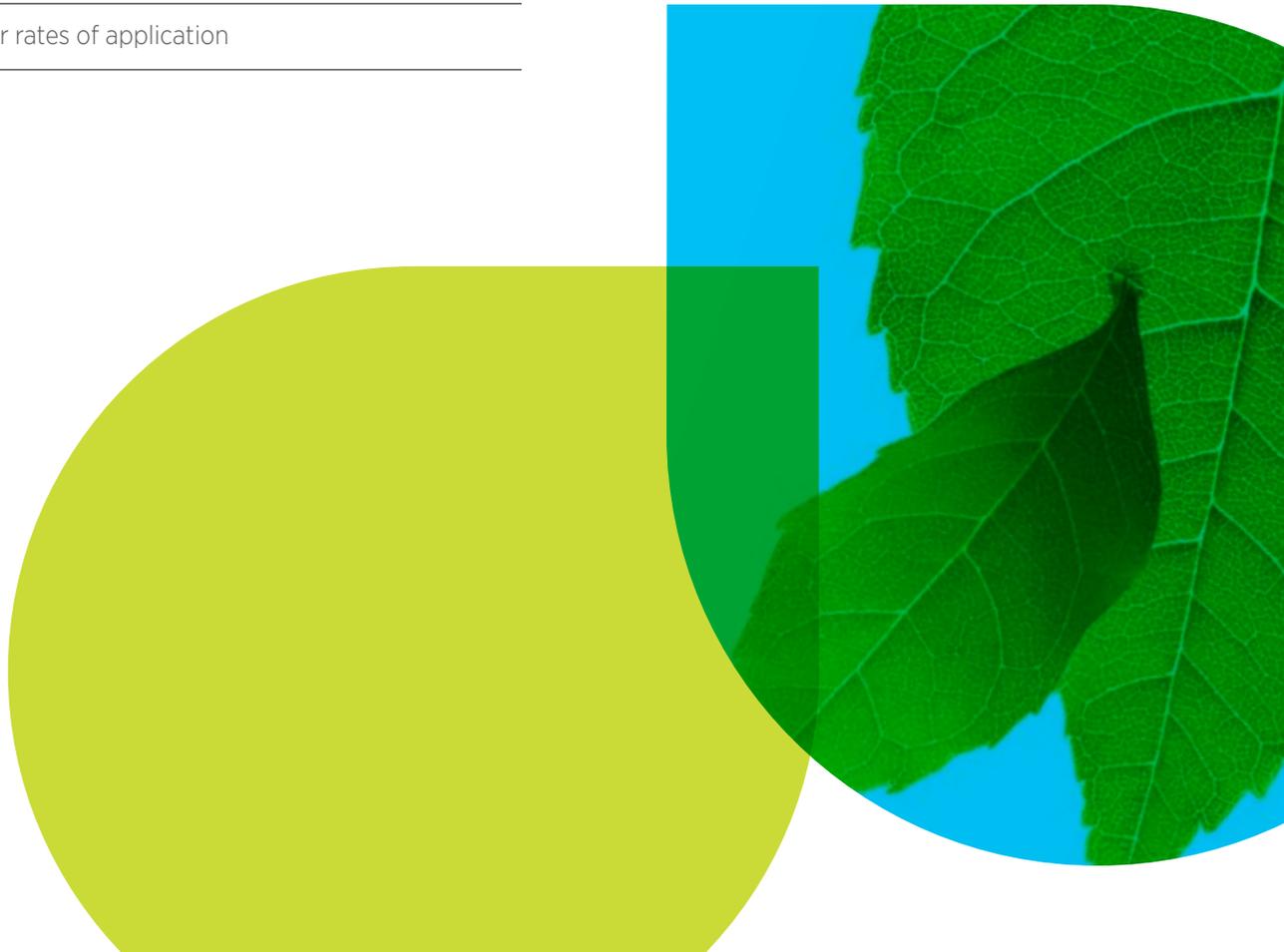
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Versatile in a range of operational conditions

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Effective even at lower rates of application

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# TWO ACTIVE INGREDIENTS FOR GREATER STRENGTH AND VERSATILITY

**Duet**,™ an advanced dual-action mosquito adulticide, combines the proven efficacy of Sumithrin® (the active ingredient found in Anvil®) plus the exceptional knock-down of prallethrin. Together, these two active ingredients provide you a unique, effective and faster way to control mosquitoes.

## DUET'S BENEFITS >>

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**Delivers more control** of natural mosquito populations

**Versatile** in a range of operational conditions

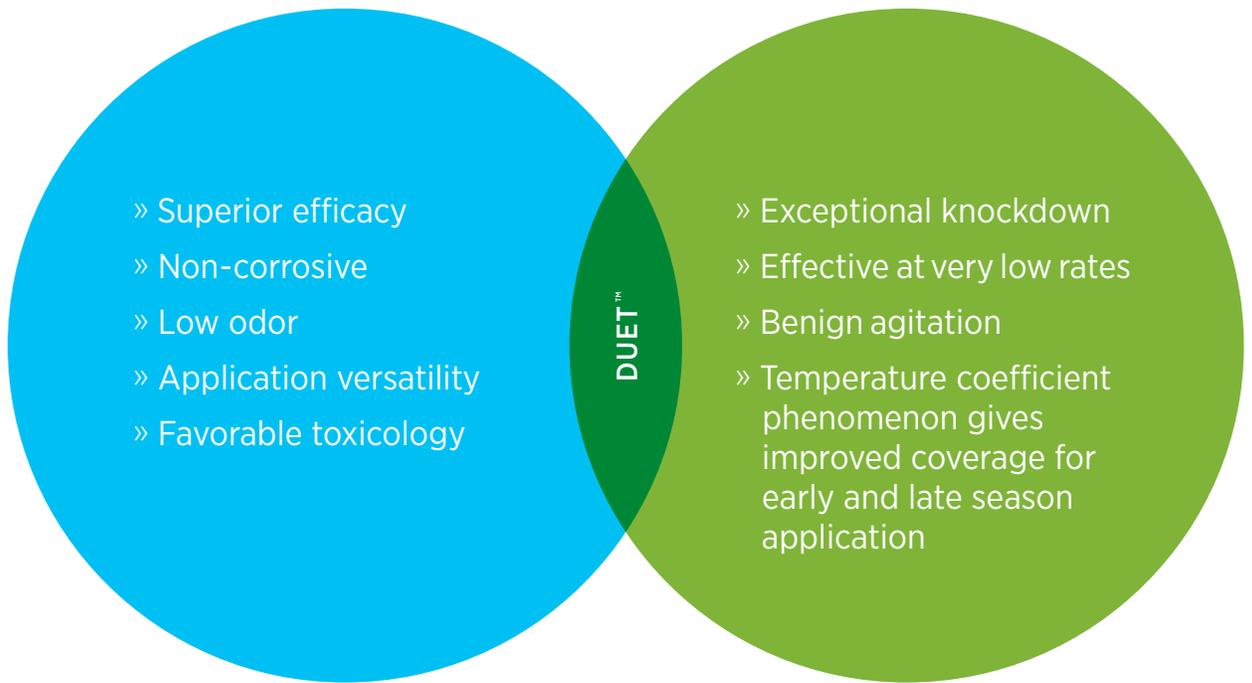
**Effective** at even low rates of application

## SUMITHRIN

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## PRALLETHRIN

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### Stronger and Faster

With the combination of Sumithrin and prallethrin, Duet effectively controls more mosquitoes more quickly. Duet has a faster knockdown than other products. In addition, despite its potent combination of active ingredients, Duet has approximately the same toxicity profile as Anvil®. This offers increased efficacy with the *same low toxicity*.

### Biodegradable

More than a generation ago, scientists created synthetic pyrethroids, which emulate naturally occurring pyrethrins, found in chrysanthemum flowers. Two of these synthetic pyrethroids — Sumithrin and prallethrin (brand name ETOC®) — kill mosquitoes effectively, yet biodegrade rapidly in the presence of sunlight and/or microorganisms. The two actives with the synergist piperonyl butoxide (PBO) yield superior performance for mosquito control.

### Active Ingredients:

**Prallethrin** (1%)  
(RS)-2-methyl-4-oxo-3-(2-propynyl) cyclopent-2-enyl-(1RS)-cis, transchrysanthemate

**Sumithrin** (5%)  
3-Phenoxybenzyl-(1RS, 3RS; 1RS, 3SR)-2, 2-dimethyl-3-(2-methylprop-1-enyl) cyclopropanecarboxylate

**Piperonyl Butoxide** (5%)

**Other Ingredients** (89%)

# BENIGN AGITATION: EXCELLENT KNOCKDOWN AND GREATER CONTROL

Field trial and cage observations have shown that **Duet™ causes benign agitation — a non-biting excitation of mosquitoes.** This has the potential to draw mosquitoes from a resting state, causing more of them to come in contact with droplets and increase efficacy. As a result, you can have greater control on a larger percentage of the total mosquito population.

## **Benign Agitation Studies Prove Duet's Effectiveness**

In laboratory studies,\* benign agitation was demonstrated by looking at the active ingredients in Duet, separately.

Ultra low volume (ULV) droplets were introduced into a wind tunnel. The response of resting mosquitoes was video recorded and movement/flight pattern observed before, during, and after exposure. Mosquitoes exposed to insecticides moved faster when sprayed. Prallethrin produced increased flight activity during spray while Sumithrin (the other active ingredient in Duet) produced increased activity during the post-spray period.

In another study\*\* that showed the formulated product of Duet increases the percentage of resting mosquitoes to take flight post spray, it was also demonstrated that mosquitoes remain in flight longer than with competitive formulations.

The bottom line: With Duet, more resting mosquitoes take flight to come in contact with more droplets, thus improving the efficacy of the application.

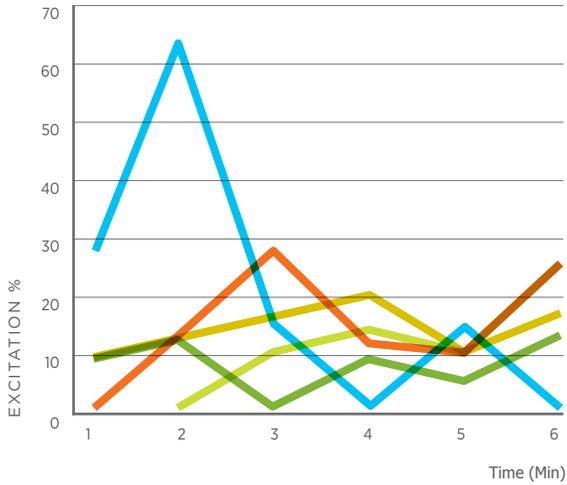
\*Study by Gary G. Clark and Sandra A. Allan of the CMAVE, USDA, Gainesville, FL; Miriam F. Cooperband with APHIS, USDA, Otis ANGB, MA, and William Jany, Clarke. Tests conducted with female *Culex quinquefasciatus* using a range of adulticides with different active ingredients.

\*\*Work by Gary Benzon, Benzon Research, Carlisle, PA.

**Key:**

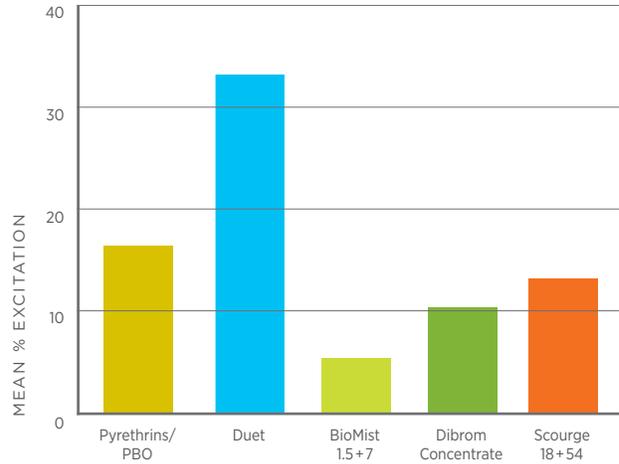
- Duet™
- Py / PBO
- Dibrom Concentrate
- Scourge
- BioMist

**Excitation Over Time**



Source: G. Benzon, Benzon Research, Carlisle, PA.

**5 Minutes After Exposure**



Source: Dr. Hajime Hirai, Sumi World, 1997

**Comparative Insecticidal Activity**

COMPOUND	LD50 (µG / INSECT) MOSQUITO <sup>2</sup>
Prallethrin	0.0032
Pyrethrins	0.022

<sup>2</sup> *Culex pipiens pallens*, female adult

Prallethrin exhibits high killing activity against mosquitoes compared to pyrethrins.

We believe that an important part of being an environmental steward is product rotation. Product rotation maximizes the effectiveness of every program by preventing cross-resistance.

To help select products for rotation in your program, visit [clarke.com/mosquitocontrolproducts](http://clarke.com/mosquitocontrolproducts) to view our full line of product offerings.



# PROFILE OF AN ADVANCED ADULTICIDE OPTION

## Product Density

ACTIVE INGREDIENT	SUMITHRIN	PRALLETHRIN	DUET
Specific Gravity	1.060	1.03	.87
Molecular Weight	350.5	300.4	—
Viscosity	—	—	13.4CP @24 C
Vapor Pressure	1.4 x 10 <sup>-7</sup> mm/Hg @21.4°C	3.5 x 10 <sup>-5</sup> mm/Hg @21.4°C	—

## Toxicology

STUDY	SUMITHRIN	PRALLETHRIN
96 Hr Acute Flow Through LC50 Rainbow Trout	17 µg/l	12 µg/l
96 Hr Acute Flow Through LC50 Bluegill	18 µg/l	22 µg/l
48 Hr Acute EC 50 <i>Daphnia magna</i>	4.3 µg/l	6.2 µg/l
Honey Bee 48 Hr Acute Contact LD50	0.064 µg/bee	0.028 µg/bee
Acute Oral LC50 Bobwhite Quail	2510 mg/kg	1171 mg/kg

## Acute Toxicology

SPECIES	DUET
Oral LD50 (rats)	> 5000 mg/kg
Dermal LD50 (rats)	> 5000 mg/kg
Eye Irritation (rabbits)	Minimal irritation
Inhalation LC50 (rats)	> 2.04 mg/l
Skin Sensitization (guinea pig)	Negative

## Environmental Toxicity

**In Sunlight:** The active ingredients in Duet™ are photolabile. The molecules easily decompose in the presence of sunlight. The half-lives of Sumithrin and prallethrin in water in the presence of light range from 9.1 to 13.9 hours. The degradation products of Sumithrin and prallethrin are non-persistent. Moderately rapid aerobic and anaerobic soil degradation was found in the absence of sunlight.

**In Soil:** Sumithrin and prallethrin are not readily transported from the site of application. Neither Sumithrin nor prallethrin bioaccumulates.

## Eco-Tier™ Ranking:

The Clarke Eco-Tier™ Index offers three tiers of products, equipment and services ranked by their impact on the environment. Duet is ranked as an “Advanced” product.



# CAGED TRIAL RESULTS

## SUPERIOR KNOCKDOWN AND CONTROL

### Initial Field Research

Initial field research for Duet™ has demonstrated excellent results. Tests were conducted involving the following species:

**Michigan:** *An. punctipennis*, *Oc. trivittatus* and *Ae. vexans*

**Florida:** *Oc. taeniorhynchus*

**Illinois:** *Coq. perturbans*, *Oc. trivittatus* and *Culex restuans*

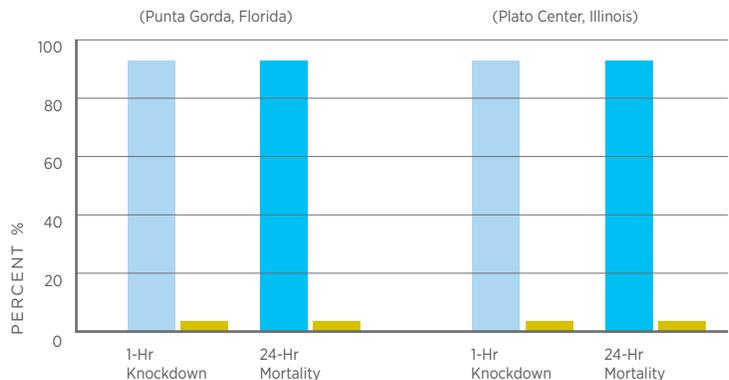
### Protocols:

- » Mosquitoes collected via CO<sub>2</sub> baited ABC traps
- » Mouth-aspirate mosquitoes
- » Cages placed @100-200' intervals
- » 10 min. exposure then transferred to holding cages
- » Mosquitoes fed 10% sugar-water solution
- » Monitor knockdown @1-Hr, and 24-Hr mortality
- » Controls handled same as treated mosquitoes



### Duet Ground ULV @150'

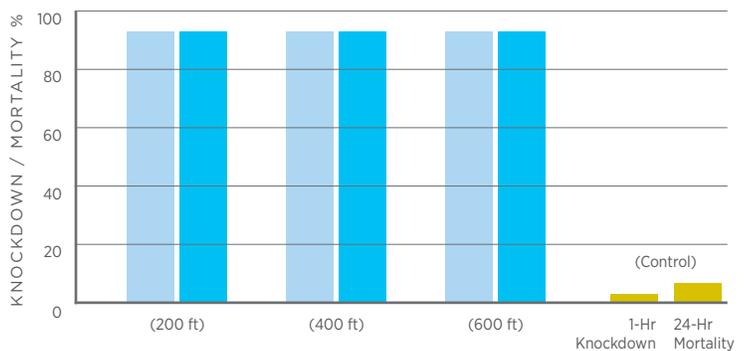
Rate: 0.41 oz/acre rate



### Duet ULV at Long Distances

Location: Saginaw, MI – 9/1/06

Rate: 0.0012 ai/acre Sumithrin and 0.0003 lbs/acre prallethrin



Even at distances up to 600ft from the spray nozzle, Duet demonstrates superior knockdown and control.

# APPLICATION METHODS OPTIMIZED FOR YOUR EQUIPMENT

Duet™ has been proven effective whether applied by air or ground (truck, ATV, backpack). Optimized for all standard ULV application equipment and nozzles, Duet is non-corroding to your application apparatus.

## Applying Duet by Air

Aerial applications can be completed with fixed wing or rotary aircraft. Based on your program needs, Duet can be applied at a range of .41 to 1.23 fl. oz/acre. Droplet VMD (volume median diameter) should be optimized between 25–30 microns. In wind tunnel atomization studies, Duet has shown to effectively produce this droplet size range when sprayed through equipment that has been correctly calibrated.

### To Optimize Your Aerial Application:



### Select the Proper Nozzle

Refer to the table to achieve the optimized less-than-30-micron droplet VMD. Some of the best nozzles for Duet usage are rotary (e.g. Beecomist or Micronair). Note that flat fan nozzles require orientation 130 degrees into the wind, and may not produce droplets within the desired spectrum when aircraft travel below 170 mph.

AIRCRAFT TYPE	NOZZLE TYPE	SIZE	ANGLE
Fixed wing	Flat fan	80-110° small orifice 005-04	135° forward
Fixed wing	Micronair Nozzles** AU5000*	Standard cage mesh	Straight back
Fixed wing	Beecomist*	10, 20 or 40 µm screen	Straight back
Rotary wing	Micronair Nozzles** AU5000*	Standard cage mesh	Straight back
Rotary wing	Beecomist*	40 µm screen	Straight back

\* Adjust RPM of nozzles to deliver the appropriate droplet spectrum required for your application.

\*\* AU 4,000, AU 5,000, AU 6,600 brushless

**Note:** Data is for general information only. Actual droplet size will depend on the application conditions and factors such as nozzle and atomizer condition. Always calibrate sprayers to ensure required dosage rate and conditions are met. **As always, read and follow label directions.**

2



### Calibration Process

#### To adjust your spray system for proper flow rate:

- » Determine the number of acres per minute your aircraft will treat by using the first formula shown.
- » Select the Duet™ labeled flow rate (in ounces per acre) required for your needs.
- » Using the second formula, multiply the figures derived from the two steps above to determine the proper Calibration Flow.

$$\frac{\text{Swath} \times \text{Speed}}{495} = \text{Acres} / \text{Min}$$

$$\left( \frac{\text{Acres}}{\text{Min}} \right) \left( \frac{\text{Oz}}{\text{Acre}} \right) = \frac{\text{Oz}}{\text{Min}}$$

↓  
**Calibration Flow**

PRALLETHRIN	SUMITHRIN	PBO	FLOW RATES
0.00072 lbs. Al/acre	0.0036 lbs. Al/acre	0.0036 lbs. Al/acre	1.23 fl. oz/acre
0.00044 lbs. Al/acre	0.0022 lbs. Al/acre	0.0022 lbs. Al/acre	0.75 fl. oz/acre
0.00036 lbs. Al/acre	0.0018 lbs. Al/acre	0.0018 lbs. Al/acre	0.61 fl. oz/acre
0.00024 lbs. Al/acre	0.0012 lbs. Al/acre	0.0012 lbs. Al/acre	0.41 fl. oz/acre

3

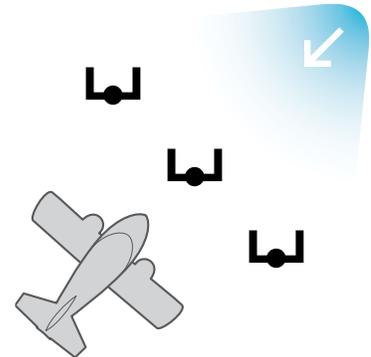


### Droplet Dynamics

Droplet VMD should be optimized between 25-30 microns to achieve maximum performance. Confirm the droplet size by placing slide impingers with Teflon coated slides as described in the diagram. Droplets on slides can be measured using a compound microscope with a mechanical stage and an ocular micrometer. Starting at one end of the slide, measure each droplet as they pass through the eyepiece micrometer. The expected spread factor for Duet is 0.59 (minimum of 200 droplets collected). Use this factor until the actual spread factor is determined.

#### To Determine Appropriate Offset:

- » Place droplet collectors 50 ft apart and 90 degrees to the wind direction.
- » Fly directly into wind over slides at 75 ft. Spray for 15 seconds after passing over slide collectors.
- » Wait 10 minutes after application for upwind droplets to reach collectors.



## Duet™ By Ground

Duet should be applied using ULV spray equipment capable of producing ULV spray droplets with a VMD of 8-30 microns.

### Use the Following Guidelines, Assuming a 300ft Swath:

Fl. oz/acre	* Flow rates in fluid oz/min at truck speeds of:			
DUET	5 MPH	10 MPH	15 MPH	20 MPH
1.23 oz/acre	3.7 oz	7.4 oz	11.2 oz	14.9 oz
0.75 oz/acre	2.3 oz	4.6 oz	6.8 oz	9.1 oz
0.61 oz/acre	1.9 oz	3.7 oz	5.6 oz	7.4 oz
0.41 oz/acre	1.2 oz	2.5 oz	3.7 oz	5.0 oz

\*Assumes a 300 ft spray swath

### To Optimize Your Ground Application:

To achieve maximum performance, droplet VMD should be optimized between 10-20 microns. Droplet spectrum may be determined by using the hot-wire method using a DCIII (AIMS) unit that measures and calculates VMD or MMD for oil-based liquids. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

### Standard Droplet Collection:

- » Use Teflon-coated microscope slide
- » Attach slide to 3'—4' rod
- » Stand 10'—25' downwind from nozzle
- » Distance is dependent on sprayer velocity
- » Higher velocity of sprayer = further distance from nozzle (not to exceed 25')
- » Swing rod (with coated slide facing the insecticide) once rapidly in a baseball swing/diagonal motion toward the sprayer, through the spray cloud

### Standard Droplet Measurement:

- » Use a compound microscope equipped with a mechanical stage and an ocular micrometer placed in the eyepiece.
- » Starting at one end of the slide, measure each droplet as they pass through the eyepiece micrometer.
- » A minimum of 200 droplets should be measured to obtain an adequate sample.
- » Spread factor for Duet: 0.59.

## ENVIRONMENTAL CONDITIONS FOR AIR AND GROUND APPLICATION

Duet should be applied when conditions are favorable for ULV applications. Favorable application conditions occur when the atmosphere at application height to immediately above ground level is stable. This condition is characteristic of an inversion, which occurs when temperatures increase with height. Stability is also influenced by solar radiation and heat exchange between air, soil and vegetation. As a result, favorable conditions for ULV applications usually occur prior to sunrise and after dusk. Duet has been shown to have a negative temperature coefficient. This means it is extremely effective, early and late season when temperatures are between 50°-65° F and most mosquitoes are active.

# FREQUENTLY ASKED QUESTIONS

**Q: What is prallethrin and how did it come into use as a mosquito adulticide?**

A: Prallethrin was developed in the 1980s as an alternative to pyrethrins. It was first registered for use with the U.S. EPA in 1995. Since then, it has been in use in pest control products throughout the world.

**Q: Does Duet™ pose a health risk to community residents?**

A: All products involve a balance between risks and benefits. The active ingredients in Duet have been carefully tested. Duet is registered for ground and aerial applications in outdoor residential and recreational areas.

**Q: Does the combination of prallethrin and Sumithrin in Duet increase toxicity?**

A: No. Duet has the same toxicology profile as Anvil®.

**Q: How does Duet break down in the environment?**

A: Duet's active ingredients break down rapidly in sunlight into carbon dioxide and water vapor.

**Q: What is Sumithrin, and how does it impact mosquitoes?**

A: Sumithrin, best known in the Anvil formulation, is an active ingredient used for adult mosquito control. A synthetic pyrethroid, Sumithrin replicates the mosquito controlling properties of pyrethrin, derived from chrysanthemum plants. It has been widely used in mosquito control since 1975, and in the Anvil formulation has been used in every major mosquito control effort in the U.S. since 1999. Both prallethrin and Sumithrin interrupt the sodium channel complex in mosquito nerve axons.

**Q: Is adult control effective?**

A: Generally, spraying for adult mosquitoes is highly effective at killing adult mosquitoes on the wing. With Duet, the dual-active formulation provides excellent control among commonly controlled mosquitoes even at low application rates.

**Q: How much Duet is typically applied?**

A: Duet is applied in very low dosages, from less than half an ounce to a little more than one ounce of formulated product per acre (.41 to 1.23 fl oz/ac). In lay terms, approximately a teaspoon of formulated product treats an area the size of a football field.



# Clarke

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Clarke is a global environmental products and services company. Each year, Clarke helps make communities around the world more livable, safe and comfortable by pioneering, developing and delivering environmentally responsible disease prevention and habitat management solutions. In 2008, Clarke founded The Clarke Cares Foundation, a non-profit created to provide disease prevention support for communities with critical needs.

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