



DUET™

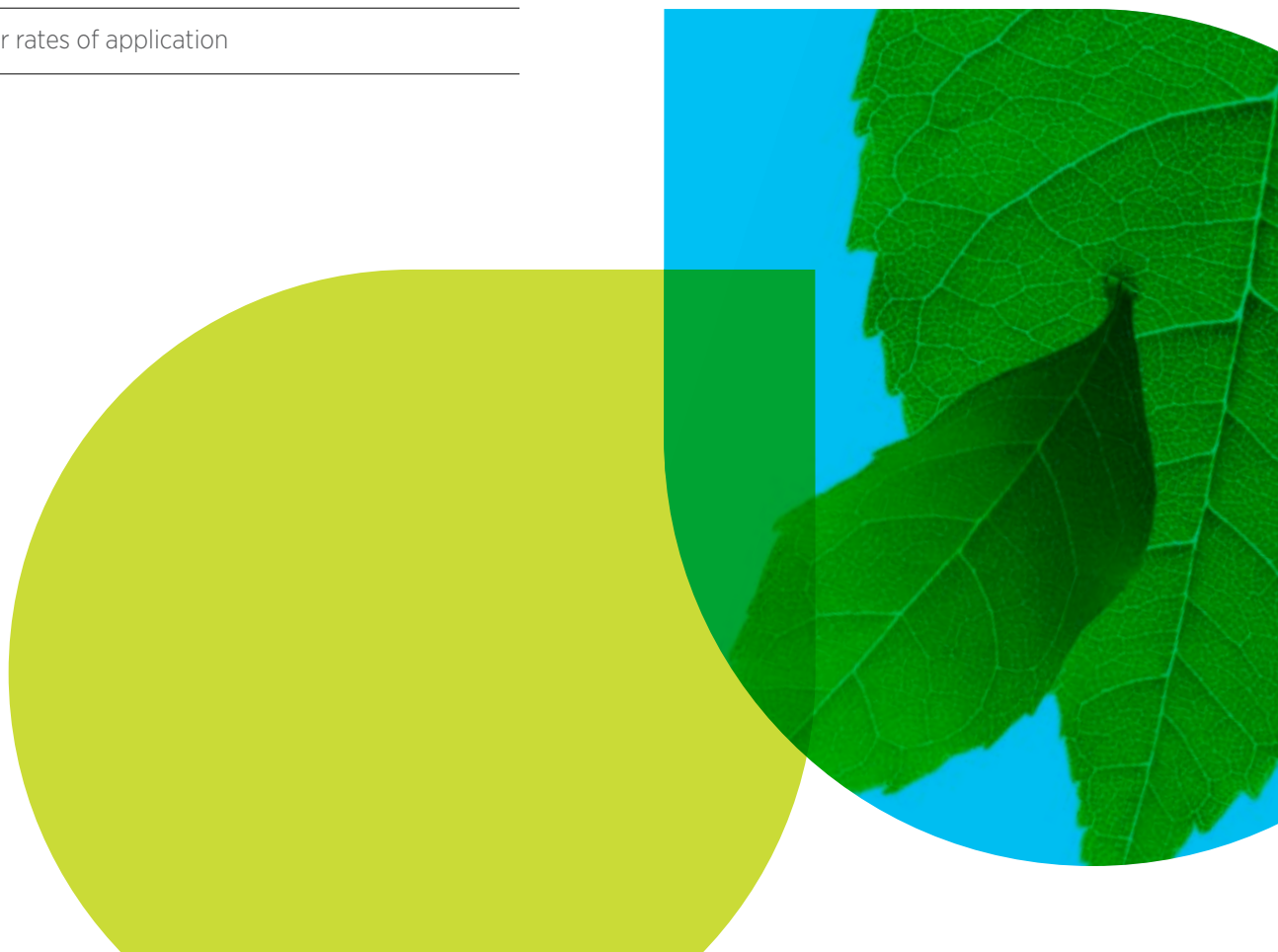
DUAL-ACTION EFFICACY

Adulticide for Mosquito Control

Delivers more control of natural mosquito populations

Versatile in a range of operational conditions

Effective even at lower rates of application



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 >>

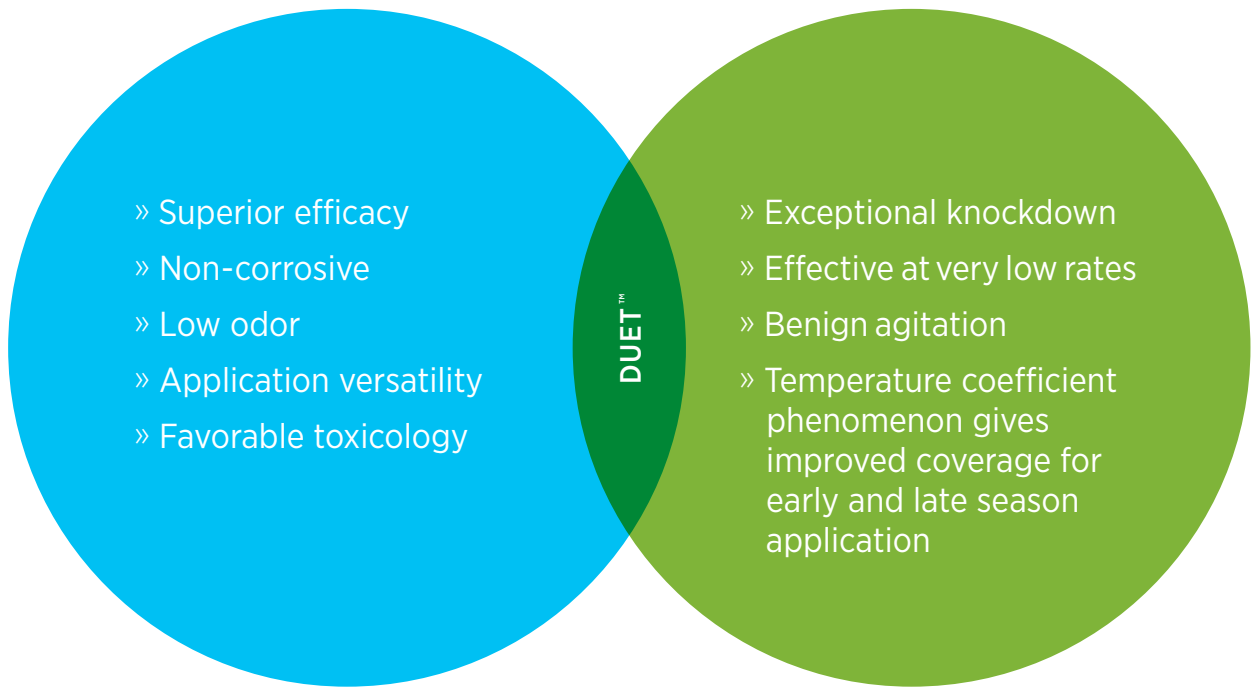
Delivers more control of natural mosquito populations

Versatile in a range of operational conditions

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SUMITHRIN

PRALLETHRIN



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.

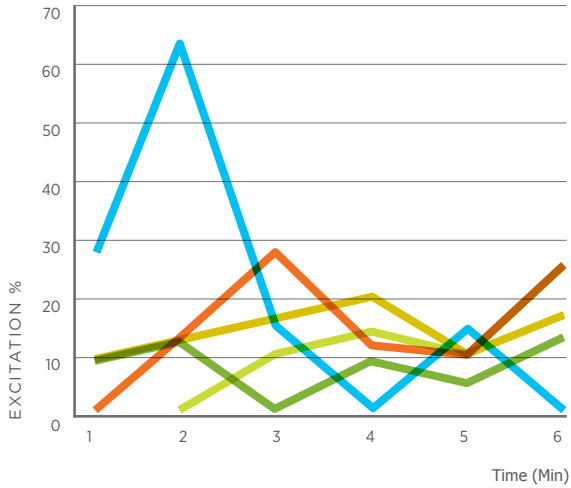
*Study by Gary G. Clark and Sandra A. Allan of the CMAVE, USDA, Gainesville, FL; Miriam F. Cooperband with APHIS, USDA, Otis ANGB, MA, and William Jany, Clarke. Tests conducted with female *Culex quinquefasciatus* using a range of adulticides with different active ingredients.

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

Key:

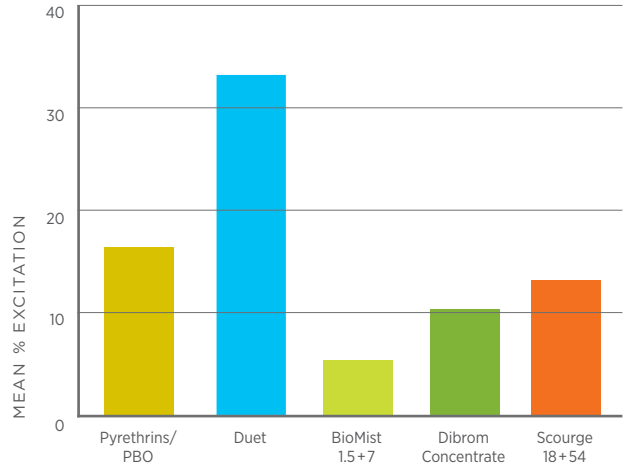
- Duet™
- Py / PBO
- Dibrom Concentrate
- Scourge
- BioMist

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 ²
Prallethrin	0.0032
Pyrethrins	0.022

²*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 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	—	—	13.4 ^{CP} @24 C
Vapor Pressure	1.4 x 10 ⁻⁷ mm/Hg @21.4°C	3.5 x 10 ⁻⁵ 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*

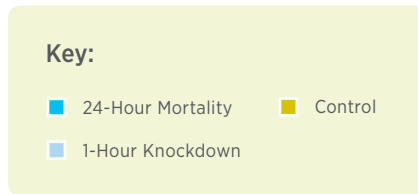
Florida: *Oc. taeniorhynchus*

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

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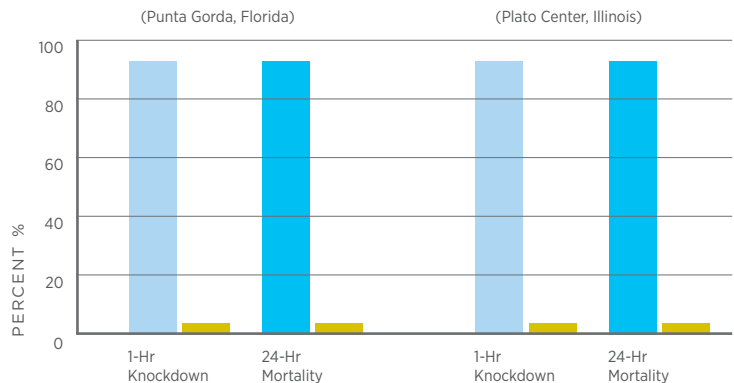
Protocols:

- » Mosquitoes collected via CO₂ 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'

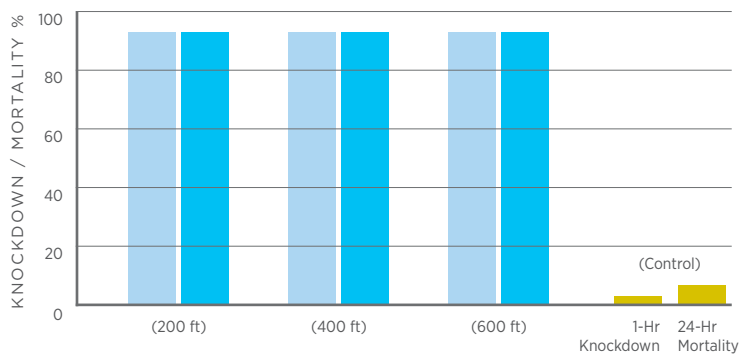
Rate: 0.41 oz/acre rate



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.**

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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

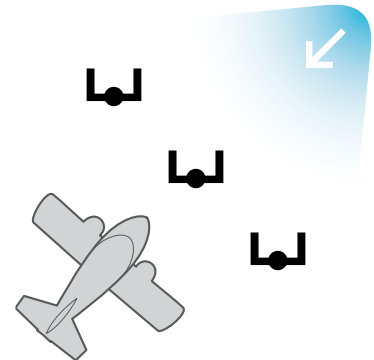


Droplet Dynamics

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

GLOBAL HEADQUARTERS

110 E. Irving Park Road, 4th Floor P.O. Box 72197 Roselle, IL 60172

Phone: 1.800.323.5727 Fax: 1.630.894.1774

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.

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