

Technical Information Update

Impact of DuPont™ Exirel™ on transmission of greening disease by Asian citrus psyllid

DuPont™
Exirel™
 insect control
 powered by
 CYAZYPYR™

The Asian citrus psyllid (ACP), *Diaphorina citri* Kuwayama, is an invasive citrus pest in the U.S. It vectors the bacteria *Candidatus Liberibacter asiaticus*, which causes huanglongbing (HLB) or citrus greening, known as the most devastating disease of citrus in the world. Citrus greening was detected first in Florida citrus in August 2005; since then, it has appeared in Texas (January 2012) and California (March 2012).

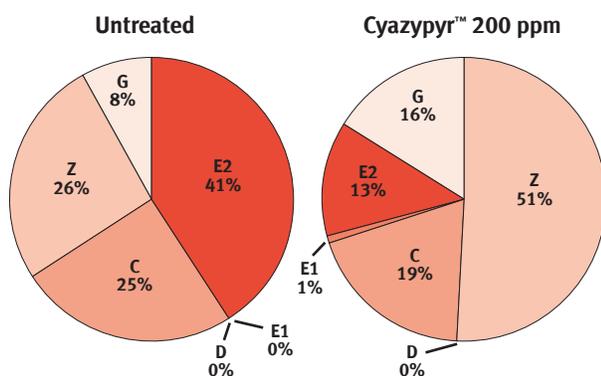
- Managing populations of ACP with insect control products is a recommended practice for reducing the impact of greening on citrus production.

- DuPont™ Exirel™ contains Cyazypyr™ and was granted reduced-risk classification by EPA for all registered crops and is selective for beneficial arthropods, except bees.
- Exirel™ has been assigned to IRAC group 28 (ryanodine receptor modulators). It delivers a novel mode of action for psyllids and other sucking pests, with no cross-resistance to existing chemistries.
- Exirel™ impacts insects by impairing muscle function. Intoxicated insects stop feeding rapidly, resulting in excellent plant protection and the reduction of some insect-vectored diseases.

Results from laboratory studies conducted by USDA, IFAS University of Florida and private researchers on the impact of Exirel™ to reduce transmission of HLB by Asian citrus psyllid in citrus

Determining the Potential to Reduce Transmission of Greening Disease by Asian Citrus Psyllid Using Electrical Penetration Graph Studies

Laboratory studies were conducted using electrical penetration graph (EPG) technology to monitor ACP feeding as a way to evaluate the impact of Cyazypyr™ on reducing the transmission of greening disease.



Z = nonprobing/nonwalking; C = stylet penetration; D = phloem penetration; E1 = phloem salivation; E2 = phloem ingestion; G = xylem ingestion

Average time calculated using only insects that exhibited specific behavior.

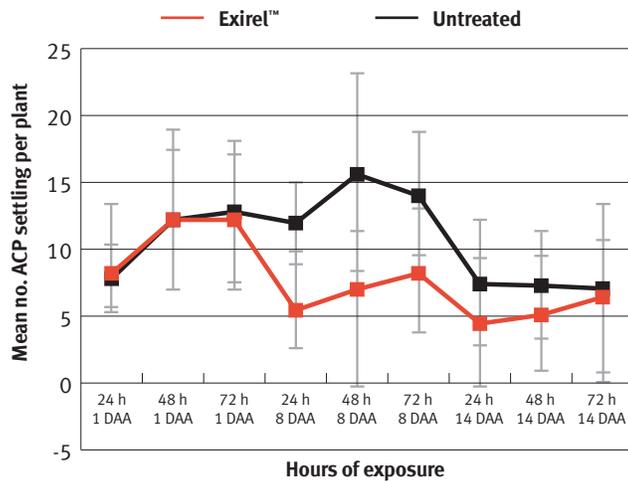
During a six-hour study, citrus psyllid adults (n = 20 ACP adults/treatment tested) feeding on Cyazypyr™-treated citrus spent 13% of the time (all behaviors = 1,435 minutes) feeding in the phloem (E2) as compared to 41% of the time (all behaviors = 1,523 minutes) when feeding on untreated citrus. It has been determined that HLB transmission requires 15 minutes to 7 hours of feeding in the phloem (Capoor, et al., 1974; Buitendag and von Broembsen, 1993*), thus this data indicate that foliar applications of Exirel™ may reduce the ability of ACP adults to transmit HLB. Furthermore, Exirel™ is highly effective and provides long-lasting residual control of ACP nymphs. Studies have shown that ACP nymphs also play a key role in the transmission of greening (K. S. Pelz-Stelinski, et al., 2010*).

Source: Dr. Marcelo Miranda, Fundecitrus, Sao Paulo, Brazil, and Dr. Rosana Serikawa, DuPont Brazil

* Capoor, S. P., D. G. Rao, and S. M. Viswanath. 1974. "Greening disease of citrus in the Deccan Trap Country and its relationship with the vector, *Diaphorina citri* Kuwayama," pp. 43–49. In L. G. Weathers and M. Cohen [eds.], *Proceedings of the 6th Conference of the International Organization of Citrus Virologists, 21–28 August 1973, Swaziland*. Division of Agricultural Science, University of California, Berkeley, CA.
 Buitendag, C. H., and L. A. von Broembsen. 1993. "Living with citrus greening in South Africa." *Citrus J.* 3: 29–32.
 Pelz-Stelinski, K. S., R. H. Bransky, T. A. Ebert, and M. E. Rogers 2010. "Transmission parameters for *Candidatus Liberibacter asiaticus* by Asian citrus psyllid (Hemiptera: Psyllidae)." *J. Econ. Entomol.* 103(5): 1531–1541.

Determining the Potential of Exirel™ to Reduce Transmission of Greening Disease by Studying the Settling Preference of Adult Citrus Psyllids on Treated Citrus Plants

To evaluate the settling behavior of ACP on Exirel™-treated versus untreated citrus, adults were tested using one-year-old “Valencia” *Citrus sinensis* plants. Citrus plants were sprayed with Exirel™ at 0.25 ppm ai and then compared to plants sprayed with the same carrier without Exirel™ (untreated). Plants were allowed to air dry before moving into cages. Treatments were randomly arranged within each cage as a choice test. The test was repeated at 1, 8 and 14 days after treatment with Exirel™. There were five cages, with each cage representing a single replicate (there were 4 replicates for the test performed 14 days after application). Fifty ACP adults were released into the center of each cage. The cages were housed under temperature-controlled conditions of $25 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity with a 14:10 hour light:dark photoperiod. The total number of ACP settling on each plant was recorded 24, 48 and 72 hours after release.



Source: IFAS, University of Florida, Lake Alfred, Fla., 2014.

Except for the 1 day after application timing, ACP adults showed a lack of preference for Exirel™-treated plants as compared to untreated plants 24, 48 and 72 hours after exposure at 8 and 14 days after application. While these differences were not statistically significant (CI $p = 0.1$ overlapped), similar results were reported earlier by Tiwari and Stelinski (2013)* and El-Desouky (2014, reported here), further supporting the evidence for lack of preference of ACP adults for Exirel™-treated plants.

*Tiwari, S., and L. L. Stelinski. 2013. "Effects of cyantraniliprole, a novel anthranilic diamide insecticide, against Asian citrus psyllid under laboratory and field conditions." *Pest Management Science*.

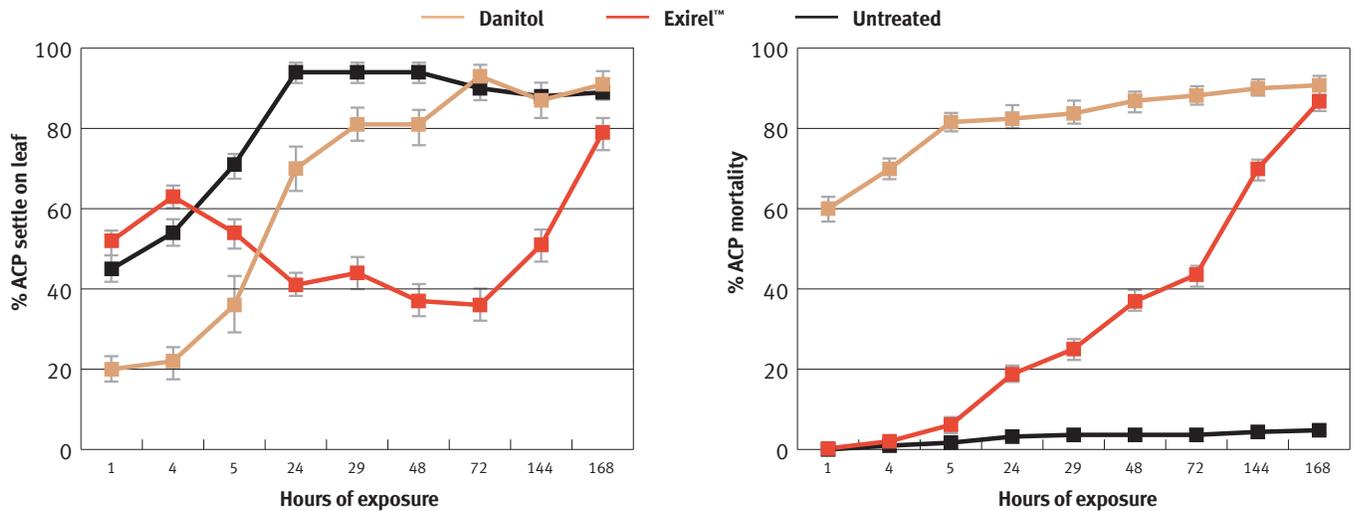


Determining the Potential of Exirel™ to Reduce Transmission of Greening Disease by Asian Citrus Psyllid Using the Rapid Excised Leaf “Inoculativity” Assay Method*



Young, medium-sized excised sweet orange leaves were dipped into Exirel™ (125 ppm) or Danitol (450 ppm) solutions, air dried for 24 hours and inoculated with 10 HLB infectious or noninfectious ACP adults per leaf in units shown in the photo on the right. The number of live adults settled on leaves; live adults not on the leaf; and dead or moribund adults were recorded at 1, 3.5, 5, 24, 29, 48, 72, 144 and 168 hours after exposure.

Effects of Exirel™ and Danitol on survival and settling of ACP



These results indicate that ACP adults showed a lack of preference for Exirel™-treated leaves as compared to Danitol-treated leaves or untreated leaves. ACP adult mortality was initially slower in Exirel™, but at 168 hours it became equivalent to Danitol.

Treatment	Mean % HLB transmission ^a	
	LJ900 primers ^b	HLBasper primers ^c
Exirel™	17.5b	12.5b
Danitol	10.0b	2.5b
Positive control	85.0a	47.5a
Negative control ^d	2.5b	0.0b

^a Means in the same column followed by the same letter are not significantly different according to the Ryan-Einot-Gabriel-Welsch multiple range test, P = 0.05.
^b F_{3,3} = 34.2, P = 0.008.
^c F_{3,3} = 39.3, P = 0.007.
^d Only one of 40 leaves tested positive based on the LJ900 primers
Analyses on arcsine transformed percentages, raw percentages presented.

Effects of Exirel™ and Danitol on HLB transmission by ACP adults

Young, medium-sized excised sweet orange leaves were dipped into Exirel™ (125 ppm) or Danitol (450 ppm) solutions, air dried for 24 hours and inoculated with 10 HLB infectious or noninfectious ACP adults per leaf in units shown in photo. The number of live adults settled on leaves; live adults not on the leaf; and dead or moribund adults were recorded at 1, 3.5, 5, 24, 29, 48, 72, 144 and 168 hours after exposure. Real-time polymerase chain reaction (RT-PCR) analysis was then conducted on the psyllids and leaves using two primers as a way to determine the presence of HLB bacteria.

These results indicate that while ACP adult mortality was slow in Exirel™, HLB transmission was significantly reduced to levels similar to Danitol, likely due to a combination of feeding cessation, lack of preference for the treated material, and mortality.

Source: Dr. El-Desouky Ammar and Dr. David G. Hall, ARS-USDA, Fort Pierce, FL; Dr. Juan M. Alvarez, DuPont Crop Protection, Newark, DE, 2014

* Ammar, E-D, A. J. Walter, and D. G. Hall. 2013. "A new excised-leaf assay method to test the inoculativity of the Asian citrus psyllid with *Candidatus Liberibacter asiaticus* associated with citrus huanglongbing disease." *J. Econ. Entomol.* 106: 25-35.



Summary

DuPont™ Exirel™ can reduce the ability of ACP adults to transmit greening disease in multiple ways:

- Rapid feeding cessation, which prevents psyllids from acquiring and or transmitting the bacteria when they feed in the plant's phloem
- Lack of preference of adult ACP settling on Exirel™-treated plants
- Direct control of ACP adults and nymphs, which prevents feeding and secondary spread of the disease

Exirel™ benefits in citrus

Economic

- Protection of new flush
- Protection from greening disease
- Yield improvement over grower standard program
- Better fruit quality (less markings on fresh)

Environmental

- Nondisruptive to beneficials, except bees
- Nonpersistent in the environment and negligible toxicity to mammals, birds, fish and earthworms*
- New mode of action (MOA) for sucking insects

Societal

- Granted reduced-risk classification from EPA under its Reduced Risk Pesticide Program for all registered crops
- Minimal PPE requirements

* A buffer zone of 25 feet is required to mitigate toxicity to some aquatic and sediment invertebrates.

Help your trees realize their ultimate potential

DuPont™ Exirel™ insect control powered by Cyazypyr™ is a groundbreaking new product from DuPont that provides you with early-season protection from insect pests for healthier and better looking trees. When you put Exirel™ to work on your operation, you can expect a level of protection unlike anything you've seen before.

Learn more.

Contact your local DuPont retailer or representative to learn how you can produce a more appealing crop at harvest with Exirel™ insect control from DuPont. Visit us at exirelcitrus.dupont.com.

The EPA-registered label contains the statement, "DuPont™ Exirel™ is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow to drift to blooming crops or weeds if bees are foraging the treatment area."

Always read and follow all label directions and precautions for use when using any pesticide alone or in tank-mix combinations.

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