SMART on PESTICIDES maryland

February 12, 2020

House Environmental & Transportation Committee
House Office Building, 6 Bladen St., Annapolis, Maryland 21401

Testimony in Support of HB 229: Pesticides - Use of Chlorpyrifos - Prohibition

Mr. Chair, Mr. Vice Chair and Members of the Committee:

My name is Bonnie Raindrop. I am the coordinator of 105-member Smart on Pesticides Coalition and Board member of Central Maryland Beekeepers Association. **My testimony concerns research I have led in compiling a document in your testimony packet called "Alternatives to Chlorpyrifos for Maryland Agriculture."** This 42-pg report assembles data and resources that are **readily available for finding alternative insecticides to chlorpyrifos**—all data is backed by studies from prestigious agriculture institutions including **USDA Agriculture Resource Service's Interregional Research Project No.4 (IR-4)**, a federally funded program established in 1963 to conduct the research necessary for obtaining registrations of pest control agents needed to grow crops, **Purdue, Rutgers, Penn State, IPM Institute of North America, Pesticide Research Institute, University of Maryland** and many others.

The report focuses on insects of concern for Maryland crops, where chlorpyrifos may be used. It demonstrates that Maryland farmers, orchards, vineyards and golf courses have scores of safer alternative products they can adopt to successfully and cost-effectively manage all Maryland agriculture and turf pests—even Spotted Lanternfly, Peach Tree Borer and Annual Bluegrass Weevil--without using chlorpyrifos. Additionally, your testimony packet includes a farmer letter supporting HB 229 that is signed by over 70 Maryland farms who use some of these products and practices quite successfully in their operations.

Fear is powerful, especially if we are being told of catastrophic consequences that could literally wipe out the family farm. No one wants that. This report highlights just some of the advances that are being made in agriculture, turf care, and in the fast-growing industry of safer biological and biorational insect control—a $3.3 billion industry expected to grow to $9.5 billion by 2025.

Safer biorational pesticides are on the rise, but without the millions of dollars the conventional pesticide industry has to influence farmer product choices, you need to look for them. The "Alternatives to Chlorpyrifos for Maryland Agriculture" provides the evidence that it only takes a "need to know" for a farmer to tap into a vast pool of study data, expertise, best management practices and products that will provide safer and better solutions to pest pressures. HB 229 includes a provision to provide this education and training for farmers who will need to make the switch from chlorpyrifos to better solutions. Every industry must evolve, and external pressures are almost always what drives us to change and innovate. Clearly, the industry is moving away from older, highly toxic chemistry.

Following are some example alternatives for pests of concern to Maryland growers and land managers:

Spotted Lanternfly (SLF)
USDA formed an expert task force at Penn State to study and recommend the most effective Best Management Practices (BMP) for Spotted Lanternfly in Pennsylvania and neighboring states. From that research, Pennsylvania BMPs include cultural/mechanical practices such as scraping eggs, banding and trap trees, and a list of insecticides they found to be most effective for killing SLF at the nymph and adult stages. The task force report **"**Updated Insecticide Recommendations for Spotted Lanternfly on Tree Fruit**,"** is included in the attached "Alternatives to Chlorpyrifos for Maryland Agriculture**"** report, pg.9.

The Penn State study recommends 15 products for treating SLF at the nymph and adult stages for grape and peach. With many products considered "excellent" or "good"—5 products for grape and 11 products for peach had results of **98%-100% knockdown**—***none of these products contain chlorpyrifos.*** Maryland allows 12 products labelled for SLF, 7 of them are recommended by Penn State; none of these products contain chlorpyrifos; chlorpyrifos is not allowed for this use in Maryland.

A Penn State Green Industry educator, Emilie Swackhammer said, *"Spotted Lanternfly is not that hard to kill, and Penn State Extension is recommending using least toxic insecticides, including pyrethrin, Neem, and Spinosad"* along with an IPM calendar and other cultural measures.

You may hear that chlorpyrifos kills 100% of eggs. Even though chlorpyrifos was found to kill egg masses, it is too toxic to use when other safer approaches exist, such as JMS Styletoil which was also effective in killing 71% of eggs in a single application.

Penn State recommends the best time to treat SLF is not at the egg stage but rather at the nymph stage, when they are stationary and **easy for growers to kill using the same insecticides already being applied for other common pests at that time.**

Golf Courses and Annual Bluegrass Weevil (ABW)
You may also hear the golf course industry needs chlorpyrifos to manage annual bluegrass weevil (ABW). The golf industry is actually moving away from chlorpyrifos: A March 2018 article in ***GCM Magazine*** **for golf course superintendents, recommends they move to less toxic biorational insecticides and cultural means to manage weevil populations**, **and away from chemicals including chlorpyrifos,** due to insect resistance which is inevitable and unsustainable.

In the report attached to my testimony, pg. 15 cites alternative practices being used, such as allowing AWB to feed on *Poa annua* and then over seeding with ABW-resistant grasses, and products, including 75 insecticides labelled for ABW, 17 that are moderate or low hazard biorational products.

Fourteen Maryland golf courses report they do not use chlorpyrifos—Compass Point, Eisenhower, Hobbits Glen, Kenwood, Wicomico Shores, Hunt Valley Country Club, Carroll Park, Chesapeake Hills, Clifton Park, Forest Park, Mt. Pleasant, and others, including Eagle's Landing, Whiskey Creek and Mountain Branch Golf Courses plant ABW-resistant grasses, which eliminate the need to use insecticides for ABW (see attached golf course fact sheet).

Orchards and Peach Tree Borer
While orchardists may believe that chlorpyrifos is their only effective control for peach tree borer and other pests, this is not so. For example, **USDA found a single application of nematodes suppress 88% of orchard borer infestations; a spring and fall application suppressed 100%.**

Maryland Dept. of Agriculture's Pesticide Database lists over 100 products labelled for peach tree borer. Page 17 of the alternatives report identifies moderate and low hazard products and practices that are successfully used for borers, with an expanded list of other orchard insects and products on pages 28 and 40.

The Pesticide Industry is Prepared to Ban Chlorpyrifos

The IR-4 Project is where the pesticide industry is supported in the regulatory process of submitting new pesticide registrations and they work on roughly 100 new requests by the pesticide industry every year. In a conversation with IR-4 Project's Dan Kunkle, Senior Associate Director, Food & International Program, he said the majority of work IR-4 has been engaged in, directly or indirectly, for the last two years has been around the expected banning of chlorpyrifos. So, growers are not going to be left without alternative options. The industry has seen the writing on the wall, and it is just good business to be ready with alternative solutions, and they are.

Maryland can also apply for a Special Local Need (SLN) or Emergency Use (24c) request for quick approval if something else is needed.

Farmers, Farmers Markets and Farm Tourism

We all want to support Maryland farmers. The growing popularity of buying local at farmers markets, farm tourism, and pick-your-own fruit with families underscores the need to eliminate the use of chlorpyrifos in these settings where children and pregnant women can be exposed onsite, and in the fruits and vegetables they purchase. A chlorpyrifos ban will move growers to using newer and safer methods to grow their produce and Marylanders to support "buying local" without worry that by doing so, they are risking irreversible harm to their children.

As Marylanders, we depend on our legislators to weigh the evidence of serious costs to human health with the knowledge that we have proven safer and effective management tactics readily at hand for every pest for which makers of chlorpyrifos raise alarm.

We ask you to take a stand for the health and well-being of Maryland children, families including our farm families, our pollinators and the Bay, and pass HB 229, with no weakening amendments.

Thank you,

Bonnie Raindrop,
Smart on Pesticides Coalition
2913 Overland Avenue
Baltimore, MD 21214
410-404-3808
legislate@centralmarylandbees.org

* Interregional Research Project No. 4 (IR-4) is a federally funded program established in 1963 to conduct the research necessary for obtaining registrations of pest control agents needed to grow crops. IR-4 works with farmers, agricultural scientists, and extension personnel to conduct research and petition the Environmental Protection Agency (EPA) for tolerances for specific pesticides. The IR-4 program has grown to include biological pest control agents and biochemicals, which are important in the implementation of Integrated Pest Management (IPM).

SAFER AND EFFECTIVE *AGRICULTURE ALTERNATIVES TO CHLORPYRIFOS IN MARYLAND*

RESOURCES FOR FARMERS

SAFER ALTERNATIVES TO CHLORPYRIFOS

- Maryland Department of Agriculture Pesticide Database Searches
- Integrated Pest Management (IPM) Institute of North America
- Rutgers University IR-4 Project
- Pesticide Research Institute
- Alternatives to Chlorpyrifos for Maryland Agriculture report
- University of Maryland Extension Service

Chlorpyrifos (chlor·pyr·i·fos) is a toxic, nerve agent pesticide that has been found to damage children's brain development, contaminate waterways and injure wildlife. Safer, effective alternatives to chlorpyrifos exist for agriculture use to control every Maryland crop pest, such as conventional pesticides, biopesticides, organic pesticides and cultural controls.

Maryland farmers—including organic and conventional farmers—are able to produce thriving crops without relying on brain-harming chlorpyrifos. Listed below are numerous alternative treatments and practices available to Maryland farmers and golf course owners.

Effective Alternative Treatments Against Key Maryland Pests

** While High Hazard rated pesticides increase the number of alternative options, this fact sheet highlights insecticides rated as Low Hazard or Moderate Hazard (by Pesticide Research Institute and Rutgers IR-4 Project)*

Orchard Fruits

Pests	Alternative Treatments
Peach tree borer	Over 100 products including 16 Moderate/Low Hazard insecticides plus cultural practices • USDA found a single application of nematodes suppressed 88% of orchard borer infestation; spring and fall application suppressed 100% infestation USDA Agriculture Research Service study • Cultural practices include painting the first 12 inches of trunk area with Surround WP Kaolin clay or Latex paint. Other options are to set pheromone traps or to spread cedar chips or bark around the bases of the trees.
Coddling moth	Over 300 products

FACTS

- "The apple industry is moving away from organophosphates like chlorpyrifos due to safety concerns. For many pests, reduced-risk pesticides and non-pesticide alternatives have replaced chlorpyrifos."
  - Vincent P. Jones et al., Outlooks on Pest Management
- "A study of apple orchards found no difference in fruit damage between blocks treated with reduced-risk pesticides (clean fruit: 90-96%) and blocks treated with growers standard pesticides, which were mostly organophosphates like chlorpyrifos (clean fruit: 93%-96%)."
  - Arthur M. Agnello et al., American Entomologist

Vegetables & Grains

Pests	Alternative Treatments
Corn rootworm	Over 75 products, including 19 Moderate/Low Hazard insecticides
Seedcorn maggot	Over 100 products, including 13 Moderate/Low Hazard insecticides, plus Regard SC Seed Treatment as well as biological and cultural controls

FACTS

- There are 50 organic corn growers in Maryland who do not use chlorpyrifos
- "Chlorpyrifos-treated seeds can leach chlorpyrifos into the soil, ending up in our waterways as 95% of seed coatings wash off and can become runoff."
  - Dave Goulson, School of Life Sciences, University of Sussex

Golf Courses

Pests	Alternative Treatments	Cultural Controls/Practices
Annual bluegrass weevil (ABW)	Over 75 products including 17 Moderate/Low Hazard insecticides	• Maryland Cooperative Extension recommends various biological and cultural controls for upkeeping golf courses. • Cultural practices include the use of ABW-tolerant Bermuda grass and creeping bent grass, which is naturally resistant to ABW. *– NJ Turfgrass Assoc on Rutgers Annual Bluegrass Weevil Research*

FACTS

Many Maryland golf courses report they do not use chlorpyrifos

"Because highly resistant weevil populations are also more tolerant of—if not resistant to—most of the currently available larvicides, superintendents will also have to start relying more on biorational insecticides and cultural means to manage weevil populations."
— Golf Course Superintendents Association of America's GCM Magazine

PEST: Spotted Lanternfly

Target Crops	Alternative Treatments	Cultural Controls/Practices
Tree fruit and Wine grapes	15 products that do not contain chlorpyrifos identified as "excellent" or "good" by the Spotted Lanternfly Task Force at Penn State • 10 products are 98-100% effective for nymphs and adults • Insecticides used for other pests will also kill SLF nymphs	Cultural controls include scraping egg masses, baiting trees and using sticky tape

SMART on PESTICIDES maryland
For Safe Water & Healthy Kids

The Smart on Pesticides Maryland coalition, spearheaded by the Maryland Pesticide Education Network, works to protect Marylanders and the natural systems we depend upon from the toxic impacts of pesticides. The coalition includes more than 100 organizations, and institutions representing communities, businesses, health care providers, farmers, environmentalists, waterkeepers, interfaith.

SMARTONPESTICIDES.ORG

SMART on PESTICIDES maryland

Golf courses don't need chlorpyrifos!

Chlorpyrifos is a toxic, nerve agent pesticide proven to cause brain damage in children, contaminate waterways and harm wildlife. Golf courses that spray chlorpyrifos to control pests expose their patrons and their families, as well as nearby neighborhoods, schools and waterways, to its harmful effects. Recent surveys suggest that the annual bluegrass weevil, which chlorpyrifos is sometimes used to control, is becoming more resistant to the chemical and other insecticides.

Many courses in the Chesapeake Bay region are already using safer alternatives. Here are some examples:

Eisenhower Golf Course, Crownsville, MD

Treats pests with other chemicals in early spring, late spring and summer.

Compass Pointe Golf Courses, Pasadena, MD

Superintendent Tim Takarski doesn't like to use chemicals like chlorpyrifos, when there are so many other products available.

Sprays bifenthrin on those areas where there has been bluegrass weevil in the early spring. However, they switched 27 of 36 holes to Bermuda grass which is more insect tolerant, reducing the need for pesticide spraying in these areas.

Kenwood Golf and Country Club, Bethesda, MD

"These insecticides mess with the bugs' nervous system and apparently overexposure can mess with your own nervous system… **we do not use organophosphate chemicals anymore, because safer and more effective insecticides have been developed**."
– John Casady, superintendent

Hobbit's Glen Golf Club, Columbia, MD

Uses Acelepyrn once a year in lieu of chlorpyrifos

Hunt Valley Country Club, Phoenix, MD

Uses nitrogen and biorational controls

Other courses report using no chlorpyrifos, including:

Carroll Park Golf Course, Baltimore, MD

Chesapeake Hills Golf Course, Lusby, MD

Clifton Park Golf Course, Baltimore, MD

Forest Park Golf Course, Baltimore, MD

Mount Pleasant Golf Course, Baltimore, MD

Wicomico Shores Golf Course, Mechanicsville, MD

Some Maryland golf courses report planting grasses that are resistant to annual bluegrass weevil and thereby eliminate the need to control the insect — these include:

- *Eagle's Landing Golf Course, Ocean City, MD*
- *Whiskey Creek Golf Course, Frederick MD*
- *Mountain Branch Golf Course, Joppa, MD.*

More on golf courses and chlorpyrifos:

"Entomopathogenic nematodes can provide significant control of annual bluegrass weevil larve."
– *Benjamin A. McGraw, Ph.D, Albrecht M. Koppenhofer, Ph.D., Rutgers University*

"If more courses move away from primary reliance on adulticides, monitoring of larvae will become more important, which could, in turn, reduce total insecticide use. Because highly resistant weevil populations are also more tolerant of — if not resistant to — most of the currently available larvicides, superintendents will also have to start relying more on bio-rational insecticides and cultural means to manage weevil populations."
– *Golf Course Superintendents Association of America's March 2017 issue of GCM*

"Getting on the pesticide treadmill with [annual bluegrass weevil] is a one-way road that over time gets ever uglier and harder to leave. The sooner you leave the better! Best not to get there in the first place."
– *Rutgers New Jersey Agricultural Experiment Station*

"We refuse to use [chlorpyrifos]. **It damages children's brains and is toxic to Bay life.**"
– *Cutler Robinson, head groundskeeper, Bayville Golf Club, Virginia Beach, VA*
Chesapeake Bay Journal, Jan. 18, 2018

It's Time to Ban Chlorpyrifos!

The Smart on Pesticides Maryland coalition, spearheaded by the Maryland Pesticide Education Network, works to protect Marylanders and the natural systems we depend upon from the toxic impacts of pesticides. The coalition includes over 100 organizations and institutions representing communities, businesses, health care providers, farmers, environmentalists, waterkeepers, interfaith congregants as well as environmental justice, public health and wildlife advocates. Smartonpesticides.org

FACTS re: Chlorpyrifos Bans in Other States

Have any other states banned chlorpyrifos?

Three states have banned chlorpyrifos, California, New York, and Hawaii.
(Other states have chlorpyrifos ban bills proceeding through their state legislatures.)

Do any of the other state bans include exemptions that would allow chlorpyrifos to still be used?

New York: All uses are banned after Dec. 31, 2020 other than applications to apple tree trunks, which are allowed until July 2021. Therefore, by the middle of next year, New York will ban all uses. https://www.governor.ny.gov/news/governor-cuomo-directs-dec-ban-use-chlorpyrifos

Hawaii: Will implement a total ban taking effect January 2023.
https://governor.hawaii.gov/newsroom/latest-news/office-of-the-governor-news-release-with-photos-hawaii-becomes-first-in-nation-to-enact-law-banning-pesticides-containing-chlorpyrifos/

California: All sales to growers ended on Feb. 6, 2020. Growers may use up their inventories until Dec. 31, 2020; after this date growers will no longer be allowed to possess or use chlorpyrifos. A few products in granular form, representing less than 1% of the market will be allowed. (California relies on its own risk assessment process and has yet to assess impacts of granular formulations.)
https://calepa.ca.gov/2019/10/09/press-release-agreement-reached-to-end-sale-of-chlorpyrifos-in-ca-by-feb-2020/

(Importantly, USEPA determined that granular uses do pose risks to farmers and farmworkers who handle chlorpyrifos in granular form. In 2016, EPA assessed 291 different scenarios in which farmers or farmworkers may handle chlorpyrifos. These included at least 73 scenarios involving granular formulations, dermal and inhalation exposures combined exceeded the level EPA determined was safe even when maximal personal protective or engineering controls were assumed.)

With Corteva's (Dow) announcement it will stop producing chlorpyrifos {Lorsban) by the end of the year, why does Maryland need to still ban chlorpyrifos?

Chlorpyrifos remains on the market through other manufacturers who will compete to fill the market space vacated by Corteva.

"**Other people are going to continue to profit from harming children**.
It's a great signal that people don't want brain-damaging pesticides on their food. But we're going to continue to keep fighting to make sure children and farmworkers are protected."
– Marisa Ordonia, attorney with Earthjustice, a member of the Smart on Pesticides Coalition
https://www.theguardian.com/environment/2020/feb/06/chlorpyrifos-pesticide-corteva-trump-administration?CMP

Alternatives to Chlorpyrifos for Maryland Agriculture Crops

Surround WP, kaolin clay crop protectant is effective in Mid-Atlantic orchards

A report prepared for the
Maryland General Assembly

February 4, 2020

Table of Contents

Executive Summary

Brief Background

Chlorpyrifos is a member of the organophosphate class of insecticides and acts as a nerve agent on humans and other species. In 2000, Dow AgroSciences and other manufacturers agreed to eliminate virtually all home uses of chlorpyrifos. Under the agreement, Dow halted the manufacture of chlorpyrifos for nearly all indoor residential uses including homes, schools and day care centers, due to both toxicity and its highly volatile nature, which increases pesticide drift.

In 2015, after extensive study, EPA scientists confirmed that chlorpyrifos cannot be considered safe at any detectible level and recommended that the pesticide be banned for agricultural uses. The agency cited the high risk of children's exposure in utero or during critical periods of growth and to the link between chlorpyrifos exposure and autism, childhood cancers, ADHD and other neurodevelopmental issues.

In April 2017, former EPA administrator Scott Pruitt appointed by President Trump, overrode the recommendations of EPA's own scientists to ban the use of chlorpyrifos. Maryland was among several states that sued the EPA for its decision to reverse the ban on chlorpyrifos for agricultural uses. In response, the Ninth Circuit Court of Appeals ruled in August 2018 that the EPA must "revoke all tolerances and cancel all registrations for chlorpyrifos." They said there was "no justification for the EPA's decision in April 2017 [to reverse its decision to ban]… in the face of scientific evidence that its residue on food causes neurodevelopmental damage to children." EPA appealed this decision and now, what is likely to be a lengthy court process regarding the legality of the reversal is underway.

Alternatives for Chlorpyrifos in Agriculture

This report addresses safer and effective alternatives to chlorpyrifos that are available to Maryland grain growers, specialty crop farmers and applicators for pests that can be of concern to Maryland farmers, orchardists, winegrowers, golf course superintendents and land care professionals.

The report includes alternative insecticides and practices for insects of particular concern in Maryland—Annual Bluegrass Weevil (ABW) for turf grass on golf courses, Peachtree Borer for tree fruit, and Spotted Lanternfly (SLF), a new invasive species which has impacted vineyards and tree fruit in Southeastern Pennsylvania and is expected to become a problem in Maryland.

Spotted Lanternfly (SLF)

A USDA-convened expert task force at Penn State has completed research on the most effective insecticides and practices to manage SLF. Updated Insecticide Recommendations for Spotted Lanternfly on Tree Fruit, published in January 2019, identified 15 insecticides as most effective for SLF nymphs and adults on grape and peach, many had excellent knockdown at 98-100%. **No insecticides with chlorpyrifos were recommended** in this report.

The Penn State report findings, links to other fact sheets about SLF management, and guidelines by the Pa. Dept. of Agriculture can be found in this report, beginning on page 8.

Annual Bluegrass Weevil (ABW)

As the golf course industry looks toward moving away from reliance on adulticides such as chlorpyrifos for control of ABW, due to increasing problems of insecticide resistance, this report highlights advances in the industry using effective practices and safer products, on page 15.

Peach Tree Borer

An insect of concern to orchardists is peach tree borer. Maryland's pesticide database identifies over 100 products for peach tree borer, this report highlights 24 products and practices which are successfully used in production orchards in the Mid-Atlantic and other regions for effective control of peach tree borer and other orchard pests (pages 17, 28 and 40).

This report has been compiled by the Maryland Pesticide Education Network, based on input from Rutgers University, The IR-4 Project, Purdue University, IPM Institute of North America, Pesticide Research Institute, Penn State Extension, University of Maryland Extension and other agricultural sources.

The HB 229 /SB 300 testimony packet also includes a list of more than 70 Maryland farms, as examples of operations which successfully use alternatives to chlorpyrifos.

How Much Chlorpyrifos is Used in Maryland?

Reported Chlorpyrifos Use on Maryland Crops

Maryland Dept. of Agriculture's (MDA) 2014 sample pesticide use survey, conducted by USDA National Agriculture Statistics Service (NASS), reported 3,900 lbs. of chlorpyrifos was used on Maryland Agriculture that year. The 2014 MDA report ranks pesticide use by pounds used statewide, with chlorpyrifos listed at #62 out of 286 pesticides applied (compared #1 glyphosate at 634,954 lbs and #286 cholecalciferol at 1 lb).

However, according to the **US Geological Survey calculations* for 2014, the state of Maryland uses between 3,348 lbs and 82,730 lbs of chlorpyrifos every year**. These USGS estimates refer only to agricultural use and do not capture golf course use.

Crops / Insects Which May Be Treated with Chlorpyrifos

Maryland Crop	**Most Common Listed Pests in Maryland** which may be treated with chlorpyrifos
Soybeans	Aphid, bean leaf beetle, grasshopper, spider mite, stinkbug
Corn Grain	Corn rootworm, cutworm, white grub, European corn borer, seedcorn maggot
Wheat	Aphid, grasshopper, wheat blossom midge
Brassicas (broccoli, brussel sprouts, cauliflower, cabbage, etc.)	Maggots, aphids
Onions	Onion maggots
Sweet potatoes	Flea beetle, Southern corn rootworm, wireworm
Pome and stone fruit (apple, peach, pear, etc.)	Peach tree borer, aphids, codling moth, mites, apple maggot, pear psylla, plum curculio, scale insects, brown marmorated stink bug
Strawberries	Strawberry aphid, leafhoppers, sap beetles, tarnished plant bugs, two-spotted mites, spotted wing drosphila
Turf	Annual bluegrass weevil, white grub, chinch bug, sod webworm

From chlorpyrifos.com, Dow Agrosciences' "Use and Benefits of Chlorpyrifos in Agriculture" (2016).

* USGS data from: https://water.usgs.gov/nawqa/pnsp/usage/maps/county-level/StateLevel/HighEstimate_AgPestUsebyCropGroup92to16.txt and https://water.usgs.gov/nawqa/pnsp/usage/maps/county-level/StateLevel/LowEstimate_AgPestUsebyCropGroup92to16.txt

Managing Pests of Greater Concern Without Chlorpyrifos

Spotted Lanternfly
Annual Bluegrass Weevil
Peach Tree Borer
Seedcorn Maggot
Corn Root Worm

Spotted Lanternfly: Latest Research on Management

Sixteen insecticide products have been tested and recommended by task force—chlorpyrifos was eliminated in the first trial for nymphs and adult spotted lanternfly.

Spotted Lanternfly (SLF) has been found in Maryland. The insecticides that vineyards typically use when nymphs would be present, in the normal course of vineyard management, will also kill SLF nymphs effectively.

Nearby states are looking to the USDA expert task force at Penn State and PA Dept. of Agriculture, who are leading the study and development of best management practices for control of spotted lanternfly. The task force released an updated report January 2019 (page 9) with research findings for the most effective insecticides to combat spotted lanternfly at the nymph and adult stages.

These studies found 12 products for fruit and grape to be “excellent” or “good” in effectiveness. Penn State Extension is continuing study and recommendation of less toxic controls. *Updated Insecticide Recommendations for Spotted Lanternfly report, next page.*

In Maryland, 12 products are labelled for use on spotted lanternfly (CDM Label Database), including 7 products recommended by Penn State research. Chlorpyrifos is not among them.

Concern among vineyards has prompted interest in using chlorpyrifos because one trial found it 100% effective on eggs, JMS Styletoil, a mineral oil, was also found to be 71% effective. However, Penn State recommends killing SLF at the nymph stage when they are stationary and **the insecticides that vineyards typically use on other pests in their normal course of vineyard management, will also kill the nymphs effectively at this time**.

Spotted Lanternfly Resources

- Website: Penn State Extension: Spotted Lanternfly
  https://extension.psu.edu/spotted-lanternfly

- Pa. Dept of Agriculture Guidelines for Control of Spotted Lanternfly
  https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/Entomology/spotted_lanternfly/Documents/Spotted%20Lanternfly%20%20Property%20Management.pdf

- Updated Insecticide Recommendations for Spotted Lanternfly on Grape
  https://extension.psu.edu/updated-insecticide-recommendations-for-spotted-lanternfly-on-tree-fruit

- Spotted Lanternfly Management: Placing Sticky Bands on Trees
  https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/Entomology/spotted_lanternfly/program-information/Documents/Tree%20Banding%20factsheet.pdf

- Spotted Lanternfly IPM Management Calendar
  https://extension.psu.edu/downloadable/download/sample/sample_id/2577/

PennState Extension

HOME | UPDATED INSECTICIDE RECOMMENDATIONS FOR SPOTTED LANTERNFLY ON GRAPE

Updated Insecticide Recommendations for Spotted Lanternfly on Grape

Insecticide recommendations for spotted lanternfly in grape, updated January 2019.

ARTICLES | **UPDATED: JANUARY 11, 2019**

Spotted lanternfly feeding on grapevine. Image by Erica Smyers.

Spotted lanternfly (SLF) is an invasive and important pest for grapes and tree fruit in Southeastern PA. Evaluation of insecticides for managing this insect in the 2018 growing season are now complete. There is no current economic threshold for SLF damage. Both nymphs and adults of this pest have been reported feeding on grapes, while only adults have been reported feeding on apple and peach. The most damage has been reported from SLF adults, which have been observed aggregating and feeding heavily on apples and grapes. In areas with heavy feeding, grape growers have reported yield loss, reduced berry quality, and vines not being able to survive the 2017-2018 winter. For more information about the damage that SLF poses, please refer to " Spotted Lanternfly on Grapes and Tree Fruit ."

Insecticide results for control of spotted lanternfly nymphs on peach and grape

From "Updated Insecticide Recommendations for Spotted Lanternfly on Grape" - Penn State Extension

Peach

Product name	Active ingredient	Rate/acre tested	Mean % mortality 0 days after spray	Mean % mortality 7 days after spray	Mean % mortality 14 days after spray
Brigade 10WSB	bifenthrin	16 oz	100 a	100 a	78.8 a
Carbaryl 4L	carabaryl	3 qt	100 a	100 a	10.0 c
Imidan 70WP	phosmet	3 lb	100 a	96.7 ab	48.1 bc
Vydate 2L	oxamyl	8 pt	100 a	83.9 ab	2.2 c
Danitol 2.4EC	fenpropathrin	21.33 fl oz	100 a	80.6 ab	24.1 bc
Actara 25WDG	thiamethoxam	5.5 oz	100 a	70.2 ab	17.0 bc
Scorpion 35SL	dinotefuron	7 fl oz	100 a	55.9 cd	24.5 bc
Acephate 97WDG	acephate	1 lb	100 a	45.8 cd	---
Mustang Maxx 0.8EC	zeta-cypermethrin	4 fl oz	100 a	29.4 cd	---
Sivanto Prime 1.67SC	flupyradiferone	14 fl oz	100 a	23.3 cd	--
Lannate 90SP	methomyl	1 lb	100 a	8.2 d	---

From "Updated Insecticide Recommendations for Spotted Lanternfly on Grape" - Penn State Extension

Product name	Active ingredient	Rate/acre tested	Mean % mortality 0 days after spray	Mean % mortality 7 days after spray	Mean % mortality 14 days after spray
Avaunt 30DG	indoxicarb	6 oz	98 a	---	---
Closer 2SC	sulfoxaflor	5.75 fl oz	90.7 a	62.8 bc	23.0 bc
Assail 30SG	acetamiprid	8 oz	89.5 a	8.6 cd	---
Entrust 2SC	spinosad	2.5 fl oz	57.9 b	24.4 cd	---
Movento 2SC	spirotetramat + LI-700 (2.6 g/L)	9 fl oz	37.9 bc	---	---
Water Control	---	---	0.0 d	25.2 cd	0.0 c

Grape

Product name	Active ingredient	Rate/acre tested	Mean % mortality 0 days after spray	Mean % mortality 7 days after spray	Mean % mortality 14 days after spray
Brigade 10WSB	bifenthrin	16 oz	100 a	100 a	94.0 a
Actara 25WDG	thiamethoxam	3.5 oz	100 a	100 a	60.0 ab
Scorpion 35SL	dinotefuron	5 fl oz	100 a	98.0 a	30.0 b
Carbaryl 4L	carabaryl	2 qt	98.0 ab	96.0 a	22.0 b

From "Updated Insecticide Recommendations for Spotted Lanternfly on Grape" - Penn State Extension

Product name	Active ingredient	Rate/acre tested	Mean % mortality 0 days after spray	Mean % mortality 7 days after spray	Mean % mortality 14 days after spray
Admire Pro	imidacloprid	1.4 oz	79.5 ab	48.3 b	---
Mustang Maxx 0.8EC	zeta-cypermethrin	4 fl oz	64.0 ab	88.0 a	11.0 b
Sivanto Prime 1.67SC	flupyradiferone	14 fl oz	46.0 bcd	---	--
Assail 30SG	acetamiprid	5.2 oz	38.0 cd	---	---
Closer 2SC	sulfoxaflor	5.75 fl oz	20.0 cde	---	---
Avaunt 30DG	indoxicarb	6 oz	20.0 cde	---	---
Imidan 70WP, high rate	phosmet	2.125 lb	20.0 cde	---	---
Venerate	*Burkholderia spp*. strain A396	4 qt	14.0 de	---	---
Imidan 70WP, low rate	phosmet	1.33 lb	6.0 e	---	---
Entrust 2SC	spinosad	2.5 fl oz	4.0 e	---	---
Delegate	spinetoram	5 oz	2.0 e	---	---
Water Control	---	---	20.0 e	11.3 b	10.0 b

From "Updated Insecticide Recommendations for Spotted Lanternfly on Grape" - Penn State Extension

Percent mortality of spotted lanternfly nymphs and adults after 48 h exposure to foliage sprayed with different insecticides. Different letters following each percent mortality mean within a column indicate a significant difference at a 95% confidence limit. The letter "a" represents the compounds with the highest mortality level, while the subsequent letters (i.e. "e") represent lower mortality levels and means followed by the same letter were not significantly different. The maximum registered peach rates are not necessarily the same rates as those registered for grape.

Of the insecticides tested on peach in the table above, 14 of the 16 chemicals had excellent knockdown activity. Seven days after the application, the insecticides that still had above 60% mortality were: Closer, Imidan, Actara, Danitol, Carbaryl, Brigade, and Vydate. *Note:* Control mortality on the 7-day assessment (24.7%) was higher than the 0-day and 14-day assessments possibly due to very high temperatures. Only two products had mortality greater than 40% at 14 days after the application: Imidan (48% mortality) and Brigade (79% mortality). The Avaunt 7-day mortality reading was mistakenly not taken at the same time as the other products, but all nymphs when evaluated several days late, were dead indicating this product will at least last for 7 days.

Of the insecticides tested for adults on grape in the table above, 5 of the 15 insecticides evaluated had excellent knockdown activity. Seven days after the application, the insecticides that still had above 60% mortality were: Brigade, Actara, Scorpion, Cabaryl, and Mustang Maxx. On both the 14 day and 21 day (not shown) assessment, both Brigade and Actara had at least 60% mortality, and all other products failed at that time. Note that Imidan did not perform well in the adult trial with the two rates tested. However, in the nymph trial at the labeled rate for peaches (3 lb/acre), it performed very well. Both the rate and the life stage could be responsible for this variation.

Please note that some of the chemicals evaluated in this peach trial not are currently labeled specifically for use on SLF. However, many of the insecticides used for other pests in grape, peach, and apple (such as brown marmorated stink bug, Japanese beetle, and grape berry moth) will provide some protection against SLF damage. The control timing of sprays for BMSB adult in apple coincide with the movement of SLF adults into the orchards and two products which have special emergency (section 18) registrations for BMSB in apple are very effective on SLF. Results from this and future trials in the next few weeks are being utilized by several pesticide companies to modify their insecticide labels to specifically include SLF on their

From "Updated Insecticide Recommendations for Spotted Lanternfly on Grape" - Penn State Extension

insecticides applied at different rates. Pyrethroids in particular are very disruptive to biological control , and may cause flares of secondary pests such as mites, aphids, scale, or mealybugs.

These SLF control trials have been made available to most pesticide companies so that they will be able to make label changes if necessary. Registrations and recommendations change, so keep informed through our website and your local extension educator.

Insecticides for control of spotted lanternfly in tree fruit

Trade name	Active ingredient	Class	Rate per acre	Systemic, Contact, Ingestion	PHI (days)	REI (hrs)	Days of activity	Labeled for SLF?	SLF activity
Imidan 70WP – high	phosmet	Organophosphate	3 lb (peach)	C, I	14	336	14	Yes, 2(ee)	Excellent (Note: this rate only evaluated for nymphs)
Imidan 70WP – medium	phosmet	Organophosphate	2.125 lb (grape)	C, I	14	336	0	Yes, 2(ee)	Poor
Imidan 70WP - low	phosmet	Organophosphate	1.33 lb (grape)	C, I	7	336	0	Yes, 2(ee)	Poor
Scorpion 35SL	dinotefuran	Neonicitinoid	5 fl oz	S, C, I	1	12	<14	Yes, 2(ee)	Excellent
Brigade 10WSB	bifenthrin	Pyrethroid	16 oz.	C, I	30	12	21	Yes, 2(ee)	Excellent
Mustang Maxx 0.8EC	zeta-cypermethrin	Pyrethroid	4 fl. oz.	C, I	1	12	<7	Yes, 2(ee)	Good
Closer 2SC	sulfoxaflor	Sulfoximine	5.75 fl oz.	S, C, I	7	12	0	2(ee) pending	Poor
Actara 25WDG	thiamethoxam	Neonicitinoid	3.5 oz	S, C, I	5	12	<21	Yes, 2(ee)	Excellent
Assail 30SG	acetamiprid	Neonicitinoid	5.3 oz (grape), 8.0 (peach)	S, C, I	3	48	<7	Yes, 2(ee) on nymphs only	High rate good on nymphs, Low rate poor on adults
Carbaryl 4L	carbaryl	Carbamate	2 qt	C, I	7	12	<14	No	Excellent

Please note that registrations and labels may change, and human error is always possible. You must check the most current label before applying any pesticide.

Annual Bluegrass Weevil Control on Turf Grass (Golf Courses)

Annual Bluegrass (Poa annua) is a problematic weed on golf fairways in the Northeast and annual bluegrass weevil is its primary pest. Some Maryland golf courses experience problems with annual bluegrass weevil.

> **14 Maryland golf courses report they do not use chlorpyrifos for AWB**:
> Compass Pointe Golf Course; Eisenhower Golf Course, Hobbit's Glen Golf Club; Kenwood Golf Club; Hunt Valley Country Club; Carroll Park Golf Course; Chesapeake Hills Golf Course; Clifton Park Golf Course; Forest Park Golf Course; Mt. Pleasant Golf Course; Wicomico Shores Golf Course; Eagles Landing Golf Course; Whiskey Creek Golf Course; Mountain Branch Golf Course

Several plant AWB-resistant grasses to eliminate the problem and need for any pesticides – Eagle's Landing Golf Course, Whiskey Greek Golf Course and Mountain Branch Golf Course

The industry is moving away from using insecticide treatments, pyrethroids and chlorpyrifos being most popular. The Golf Course Superintendents Association of America is recommending other strategies, due to the increasing problem of insecticide resistance in ABW populations.

> "Because highly resistant weevil populations are also more tolerant of—if not resistant to—most of the currently available larvicides, **superintendents will also have to start relying more on biorational insecticides and cultural means to manage weevil populations."**
>
> **— Golf Course Superintendents Association of America's GCM Magazine** (March, 2017)
> Article: "A Survey of Annual Bluegrass Weevil Management"
> https://www.gcsaa.org/gcm/2017/march/a-survey-of-annual-bluegrass-weevil-management

Research Supporting IPM, Cultural Practices and Biorationals for ABW

- Alter management to allow ABW to feed on *Poa annua* for mid-range damage, then overseed year after year with desirable turfgrass (i.e. Bermuda grass, bentgrasses), naturally resistant to ABW. – NJ Turfgrass Assoc on Rutgers Annual Bluegrass Weevil Research
- Northeastern IPM Institute also recommends overseeding non-bluegrass grasses while using nematodes early in the season
- The U.S. Golf Association sponsored research at Rutgers University found "Entomopathogenic nematodes can provide significant control (65%) of annual bluegrass weevil larve."
- Bt has been used to reduce larval populations by 50-65% (Vittum 2005). Spinosad has been found to be 80% effective against larvae. – Annual Bluegrass Weevil in Turf, NC State Extension
- Cultural management includes minimizing stress on perimeter of fairway; maintaining sufficient soil moisture and proper fertility levels; and keeping surrounding woodlands clean of debris.
- Best preventive control for ABW is to keep Poa annua percentages as low as possible using cultural practices and herbicides, monitor populations to make decisions, minimize sprays, get good first-generation control of larvae, minimize adult treatments and concentrate on larvae.
- New York State working with Cornell Extension did not recommend chlorpyrifos. – Reducing Chemical Use on Golf Course Turf: Redefining IPM

- Rutgers NJ Agricultural Experiment Station warns against insecticide use and ABW resistance: **"Getting on the pesticide treadmill with ABW is a one-way road that over time gets ever uglier and harder to leave. The sooner you leave the better! Best not to get there in the first place."**

Less Toxic Products That Are Proven Effective for ABW

- Acelepryn
- Anti-Pest-O Original Concentrate
- Anti-Pest-O RTU
- AzaGuard Botanical Insecticide/Nematicide
- Azatin O
- Azatrol EC Insecticide
- Bifenthrin
- BotaniGard 22 WP
- BotaniGard ES
- Bt (Bacillus thuringiensis)
- Debug Turbo EC
- Entomopathogenic nematoads
- Met52 EC
- Naturalis L
- Spinosad
- VST-006330 EP or Spear
- Use of ABW-tolerant Bermuda grass, creeping bent grass, etc. reducing need to spray
- Cultural management techniques

Maryland Pesticide Database lists over 100 conventional pesticides for AWB.
http://www.kellysolutions.com/md/pesticideindex.htm

Peach Tree Borer Control on Orchard Tree Fruits

While Maryland orchardists may believe chlorpyrifos is their only option against peach tree borer, the Maryland Pesticide Database lists over 100 conventional pesticides for peach tree borer.

The following less toxic biorational pesticides and practices have been tested and are recommended by Rutgers University IR-4 Project and other agriculture institutions.

> **Namatodes – single application found to suppress 88% of orchard borer infestations; spring and fall application suppressed 100%**
> - **USDA Agriculture Research Service study** by Shapiro-Ilan and Cottrell Southeastern Fruit and Tree Nut Research Lab in Byron, Ga, working with Moselle U. Fl and Horton U. GA (2008)

- Azadirachtin
  - Anti-Pest-O Original Concentrate
  - Anti-Pest-O RTU
  - Aza-Direct
  - AzaGuard Botanical Insecticide/Nematicide
  - Azatin O
  - Azatin XL Plus
  - Debug Turbo EC
- BT kurstaki (Bt-j)Capsaicin
  - Bugitol
- Citrus extract sprays, i.e. Orange Guard
- 70% Neem oil
- Parasitic wasps for lesser peach tree borer eggs
- Pheromone
  - Isomate-P
  - Scentry Lures
- Pyrethrins
  - PyGanic Crop Protection EC 5.0 II
- Spinosad
- Surround WP kaolin clay - Paint tree trunks and exposed roots with paste of Surround WP up to 12 inches; latex paint has also been used
- Cultural practices, i.e.
  - removing wild plum, wild cherry and replacing older stressed trees;
  - keeping trees well-watered, strong and undamaged;
  - probing small holes in truck at soil line to crush larve beneath bark
  - for severe infestation, scoop soil from around tree crown where frass collects and dig out the larve
- Use pheromone traps, mating disruption hormones i.e. Tangle-Trap Insect Trap Coating
- Cedar chips and bark spread around stone fruit tree bases
- Moth crystals from napthalene

Expanded list of common Maryland tree fruit pests and biorational alternatives, pgs 28 and 39.

Seedcorn Maggot Control

The Maryland Pesticide Database lists over 100 conventional pesticides for seedcorn maggot.

Cultural practices can play a significant role in creating conditions attractive to seedcorn maggot. Planting on freshly tilled fields and in fields where the cover crops or green manure are still decaying may increase the risk of seedcorn maggot infestations since the female flies are attracted to disturbed soil and decaying organic matter to lay their eggs. Delaying planting after tillage and incorporating cover crops may suppress injury from seedcorn maggot feeding.

Cultural Practices
1) Delayed planting to avoid cold wet soil temperatures
2) Shallow planting to speed up germination
3) Higher seeding rates to overcome minor field loss
4) Turning over or otherwise terminating cover crops at least 2-3 weeks before corn planting to ensure breakdown of crop residue
5) Conservation tillage or no till
6) Use of fertilizers other than manure
7) Planting of corn after grasses, rather than legumes
8) Plant between the 4-5 generations by counting 450 Growing Degree Days from the peak infestation the prior year
9) Monitor with yellow sticky traps
10) Attract predators of the eggs, larvae and pupae of the seedcorn maggot (gray fly), including ground beetles, dung flies, wasps, ants, mites, spiders, yellow jacket, and birds
11) Preserve the beneficial predators by not spraying broad spectrum pesticides
12) Crop rotation

Low Toxic Insecticides and Biopesticide Controls
1) Venerate
2) Azadirachtin (including Azatin O)
3) Spinosad
4) Regard SC Seed Treatment
5) Introduce Insect Pathogens, such as the parasitic nematode steinernema feltiae
6) Introduce beneficial fungi, such as the fungus entonophthone muscae

Chemical Controls
1) Fipronil
2) Permethrin
3) Diazinon 14G
4) Bifenthrin (i.e. Sniper)
5) Lamda Cyhalothrin
6) Terbufos
7) Clothianidin
8) Tefluthrin
9) Thiamethoxam (i.e. Cruiser)
10) Beta Cyfluthrin

Grain: Corn Rootworm and White Grub Control

Principal uses in Maryland agriculture for chlorpyrifos, as reported by the Maryland Grain Producers Association, are for control of corn rootworm and grub outbreaks on crops planted with untreated corn seed.

The Maryland Pesticide Database lists over 75 conventional pesticides for corn rootworm and 150 conventional pesticides for white grub.

This report lists 19 less toxic alternative products for corn rootworm and 28 products for white grub control on corn, beginning on page 29, with scientific data on efficacy, pages 29 and 40.

Strawberries: UMD Extension IPM Recommendations

University of Maryland Extension cites, "The IPM approach used by organic growers should be nearly identical to the one employed by conventional growers." Cultural control practices and organic insecticides are recommended including Bt, botanical insecticides (Neem, pyrethrin), GPM (usually a pyrethrum, sulfur and copper), horticultural oils (Dorman Oil, Superior Oil, Untr-fine Horticultural Oil) insecticidal soap, Spinosad, Surround (kaolin clay). Recommended non-organic insecticides: Carbaryl, GPM, Malathion—chlorpyrifos is not recommended.
https://extension.umd.edu/hgic/topics/fruit-insecticides

PRI Product Evaluator identifies 57 low hazard products and 84 moderate hazard products as alternative insecticides to chlorpyrifos for strawberries.

Hemp: Industrial and Medical Cannabis

Industrial hemp is an emerging market and possibly a lucrative one for farmers and the state of Maryland. The importance of establishing this market is understandable, however there is no need to include chlorpyrifos in the process. Banning chlorpyrifos in Maryland would have little to no effect on the hemp market due to its documented resiliency and the 226 chlorpyrifos-free insecticide recommendations for overall cannabis production available in the United States, with 77 already registered in Maryland under the approved pesticide list for medical cannabis.

Hemp's resilient nature also implies that low to moderate risk pesticides could be enough for maintenance and there are numerous options for each pest that has been seen to affect industrial hemp so far. If the Maryland Industrial Hemp Research Pilot Program demonstrates a need for pesticides in industrial hemp production, the state of Maryland has extensive avenues to pursue successful growing methods, that may or may not include pesticides however, based on current resources on industrial hemp, it should never need chlorpyrifos.

Maryland's approved pesticides for medical cannabis compared to Colorado's approved pesticides for cannabis production shares 77 low hazard insecticides which have been found effective in Colorado and are already approved for use on medical cannabis in Maryland.

The full report, "Insecticides for Maryland Hemp Crop Pests," includes lists of specific insecticide products for industrial and medical cannabis, and is available by request, please email info@mdpestnet.org.

Help for Farmers in Finding Safe, Effective Alternatives

Extensive scientific data is available on safe and effective alternatives to chlorpyrifos. The following resources are available to the public and provide farmers with searchable databases, no-cost expertise, access to science, and contacts for safer pest control tools.

- **IPM Institute of North America**, Specialty Crop Grower Services - www.ipminstitute.org
  IPM Pesticide Risk Tool – estimates risk of negative impacts of pesticide applications, www.pesticiderisk.org

- **Rutgers University, The IR-4 Project** - fifty years of successful research into sustainable crop protection in specialty crops and off-label uses, http://ir4.rutgers.edu/index.html

- **Pesticide Research Institute** – provides research, analysis, technical services, expert consulting on chemistry and toxicology of pesticides - www.pesticideresearch.com

- **PRI Pesticide Product Evaluator** - an online tool also available as a mobile app providing information for over 18,000 pesticide products, http://pesticideresearch.com/site/evaluator/

The Rise of Biorational Pesticides and Biopesticides

Pesticides vary in their toxicity and in their potential to cause undesirable human and ecological impacts. Pest control materials that are effective on the target pest, yet relatively non-toxic with few ecological side-effects are sometimes called "biorational" pesticides; the EPA uses the term "biopesticides" for this pesticide type. The major categories of biorational pesticides include botanicals, microbials, minerals, and synthetic materials. Some, but not all, biorationals qualify for use on organic farms.

This biopesticide market has advanced rapidly in the last 10 years, valued at $3.3 billion in 2017, it is expected to grow 13.9% to $9.5 billion by 2025.
- from Transparency Market Research

Rutgers University IR-4 Project Recommends Biorational Alternatives for Common Maryland Crop Pests

Since 1963, the Rutgers University IR-4 Project has been the major resource for supplying pest management tools for specialty crop growers by developing research data to support new EPA tolerances and labeled product uses.

The following list was prepared by IR-4 Project staff to identify biopesticide alternatives and practices to using chlorpyrifos for Maryland crop pests.

Biorational Alternatives to Chlorpyrifos by Maryland Pest:

- **Turf grass - Annual bluegrass weevil (ABW)**
  - Anti-Pest-O Original Concentrate
  - Anti-Pest-O RTU
  - AzaGuard Botanical Insecticide/Nematicide
  - Azatin O
  - Azatrol EC Insecticide
  - BotaniGard 22 WP
  - BotaniGard ES
  - Debug Turbo EC
  - Met52 EC
  - Naturalis L
  - VST-006330 EP or Spear
- **Peach tree borer**
  - Azadirachtin
    - Anti-Pest-O Original Concentrate
    - Anti-Pest-O RTU
    - Aza-Direct
    - AzaGuard Botanical Insecticide/Nematicide
    - Azatin O
    - Azatin XL Plus
    - Debug Turbo EC
  - Capsaicin
    - Bugitol
  - Pheromone
    - Isomate-P
    - Scentry Lures
  - Pyrethrins
    - PyGanic Crop Protection EC 5.0 II
- **Seed corn maggots**
  - Azadirachtin
    - Azatin O
  - Spinosad
    - Regard
- **Large grasshoppers**
  - Azadirachtin
    - Agroneem Plus Agricultural
    - Agroneem Plus Lawn & Turf
    - Anti-Pest-O Original Concentrate
    - Anti-Pest-O RTU
    - AzaGuard Botanical Insecticide/Nematicide
    - Azatin O
    - Azatrol EC Insecticide
    - Debug Turbo EC
    - Neemix 4.5 EC
    - Nimbecidine EC
  - *Beauveria bassiana* strain GHA
    - BotaniGard ES
    - Mycotrol WPO
  - Capsaicin
    - Bugitol
  - *Nosema Locustae*

        - Nolo Bait
        - Semaspore Bait
    - Pyrethrins
        - PyGanic Crop Protection EC 5.0 II
    - Kaolin
        - Surround WP Crop Protectant
- **Soybean aphid**
    - Azadirachtin
        - Agroneem Plus Agricultural
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - AzaGuard Botanical Insecticide/Nematicide
        - Azera Insecticide
        - Debug Turbo EC
    - *Beauveria bassiana* strain ANT-03
        - BioCeres WP
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
        - Mycotrol WPO
    - Canola oil
        - Vegol Insecticidal Oil
    - Capsaicin
        - Bugitol
    - Cinnamaldehyde
        - Cinnacure 30%
    - Potassium salts of fatty acids
        - Des-X Insecticidal Soap
- **Soybean leaf beetle**
    - Azadirachtin
        - Agroneem Plus Agricultural
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - AzaGuard Botanical Insecticide/Nematicide
        - Debug Turbo EC
    - *Bacillus thuringiensis* galleriae
        - beetleGONE!
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
    - Capsaicin
        - Bugitol
- **Corn ear worm**
    - Azadirachtin
        - Agroneem Plus Agricultural
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - Azera Insecticide
        - Debug Turbo EC
    - Capsaicin
        - Bugitol
    - *Bacillus thuringiensis subsp. kurstaki* strain EG2348
        - Condor Wettable Powder
    - *Bacillus thuringiensis subspecies kurstaki* strain EG7841
        - Crymax Bioinsecticide
    - *Bacillus thuringiensis subsp. kurstaki* strain ABTS-351
        - Dipel ES
    - *Bacillus thuringiensis subspecies kurstaki* strain EG7826 Lepidopteran active toxin
        - Lepinox WDG Bioinsecticide
    - Polyhedral occlusion bodies (OBs) of the nuclear polyhedrosis virus of *Helicoverpa zea*
        - Gemstar LC
    - Pyrethrins
        - PyGanic Crop Protection EC 5.0 II
    - Oil
        - Golden Pest Spray Oil

        - Vegol Insecticidal Oil
        - JMS Stylet-Oil
- **Green clover worm**
    - *Bacillus thuringiensis* (various strains)
        - Agree WG Biological Insecticide
        - Biobit HP Biological Insecticide
        - BMP 123 (2X WDG)
        - Bonide Dipel 150 Dust For Vegetable
        - Crymax Bioinsecticide
        - Deliver Biological Insecticide
        - Dipel ES
        - Entrust SC Naturalyte Insect Control
        - Javelin WG Biological Insecticide
        - Lepinox WDG Bioinsecticide
    - Spinosad
        - Dipel Pro DF
- **Spider mites**
    - Azadirachtin
        - Agroneem Plus Lawn & Turf
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - Azatrol EC Insecticide
        - Debug Turbo
    - Capsaicin
        - Bonide Hot Pepper Wax Insect Repellent RTU
        - Hot Pepper Wax Insect Agricultural
        - Hot Pepper Wax Insect Concentrate
    - Potassium salts of fatty acids
        - Des-X Insecticidal Soap
        - M-Pede Insecticide Miticide Fungicide
    - *Isaria fumosorosea Apopka* Strain 97
        - PFR-97 20% WDG
    - Extract of *Chenopodium ambrosioides*
        - QRD 400
        - Requiem EC
    - Potassium silicate
        - Sil-Matrix
    - Oils
        - Trilogy
        - Vegol
        - Golden Pest Spray Oil
- **Stinkbug**
    - Azadirachtin
        - Aza-Direct
        - AzaGuard Botanical Insecticide/Nematicide
        - Azatin O
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
    - Cinnamaldehyde
        - Cinnacure
- **Corn grain cinnamon stalk borer**
    - Azadirachtin
        - Anti-Pest-O Original Concentrate
        - AzaGuard Botanical Insecticide/Nematicide
        - Azatin O
        - Debug Turbo EC
        - Neemix 4.5 EC
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
    - *Bacillus thuringiensis*
        - Dipel ES
    - Capsaicin
        - Bugitol
- **Corn rootworm**
    - *Beauveria bassiana* strain GHA

        - BotaniGard ES
    - Buffalo gourd root powder (feeding stimulant for beetles)
        - Cidetrak D
    - Oil
        - Golden Pest Spray Oil
        - Vegol Insecticidal Oil
        - JMS Stylet-Oil
    - GS-omega/kappa-Hxtx-Hv1a
        - VST-006330 EP or Spear
- **Cutworms & armyworm**
    - Azadirachtin
        - Agroneem Plus Agricultural
        - Agroneem Plus Lawn & Turf
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - Aza-Direct
        - AzaGuard Botanical Insecticide/Nematicide
        - Azatin O
        - Azatin XL Plus
        - Azatrol EC Insecticide
        - Azera
        - Debug Turbo EC
        - Ecozin 3%
        - Fortune AZA 3% EC
        - Molt-X
    - *Bacillus thuringiensis*
        - Agree WG Biological Insecticide
        - Biobit
        - BMP 123 (2X WDG)
        - Condor Wettable Powder
        - Crymax Bioinsecticide
        - Deliver Biological Insecticide
        - Dipel ES
        - Entrust SC Naturalyte Insect Control
        - Javelin WG Biological Insecticide
        - Lepinox WDG Bioinsecticide
        - Dipel Pro DF
        - Foray XG
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
    - *Beauveria bassiana* (ATCC 74040)
        - Naturalis L
    - Spinosad
        - Entrust SC Naturalyte Insect Control
    - Capsaicin
        - Nemitol
    - Oil
        - Golden Pest Spray Oil
        - Vegol Insecticidal Oil
        - JMS Stylet-Oil
    - Pyrethrins
        - PyGanic Crop Protection EC 5.0 II
    - Kaolin
        - Surround WP Crop Protectant
    - GS-omega/kappa-Hxtx-Hv1a
        - VST-006330 EP or Spear
- **European corn borer**
    - Azadirachtin
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - Aza-Direct
        - AzaGuard Botanical Insecticide/Nematicide
        - Azatin O
        - Azatin XL Plus
        - Debug Turbo EC
    - Capsaicin
        - Bugitol
    - Pheromone
        - Isomate-P

        - Scentry Lures
    - Pyrethrins
        - PyGanic Crop Protection EC 5.0 II
- **Flea beetle**
    - Azadirachtin
        - Agroneem Plus Agricultural
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - AzaGuard Botanical Insecticide/Nematicide
        - Azatin O
        - Azatrol EC Insecticide
        - Azera
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
    - Spinosad
        - Entrust SC Naturalyte Insect Control
    - Kaolin
        - Surround WP Crop Protectant
- **Rootworm**
    - Azadirachtin
        - Agroneem Plus Agricultural
        - Debug Turbo
    - Capsaicin
        - Bugitol
    - Oil
        - Golden Pest Spray Oil
        - JMS Stylet-Oil
    - *Isaria fumosorosea Apopka* Strain 97
        - PFR-97 20% WDG
- **Slugs**
    - Capsaicin
        - Bugitol
        - Dazitol Concentrate
    - Spinosad
        - Bug-N-Sluggo
    - Sodium Ferric EDTA
        - Ferroxx
    - Iron phosphate
        - Sluggo Slug and Snail Bait
    - Kaolin
        - Surround WP Crop Protectant
- **White grub**
    - Azadirachtin
        - Agroneem Plus Lawn & Turf
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - Debug Turbo
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
    - Capsaicin
        - Bugitol
        - Dazitol Concentrate
    - Allyl isothiocyanate
        - Dominus
    - GS-omega/kappa-Hxtx-Hv1a
        - VST-006330 EP or Spear
    - Potassium salts of fatty acids
        - M-Pede Insecticide Miticide Fungicide
- **Wireworm**
    - Azadirachtin
        - Azatin O
    - Capsaicin
        - Bugitol
        - Dazitol Concentrate
- **Wheat aphid**
    - Azadirachtin
        - Agroneem Plus Agricultural
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - AzaGuard Botanical Insecticide/Nematicide
        - Aza-Direct

        - Azera
        - Debug Turbo
    - *Beauveria bassiana* strain ANT-03
        - BioCeres WP
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
        - Mycotrol WPO
    - Capsaicin
        - Bugitol
    - Potassium salts of fatty acids
        - Des-X Insecticidal Soap
        - M-Pede
- **Wheat blossom midge**
    - AzaGuard Botanical Insecticide/Nematicide
- **Brassicas – aphids**
    - Azadirachtin
        - Agroneem Plus Agricultural
        - Aza-Direct
        - AzaGuard
        - Azatin O
        - Azera
        - Nimbecidine EC
        - Neemix 4.5 EC
    - Capsaicin
        - Bugitol
    - Cinnamaldehyde
        - Cinnacure 30%
    - Potassium salts of fatty acids
        - M-Pede Insecticide Miticide Fungicide
- **Cabbage maggots**
    - Azadirachtin
        - Anti-Pest-O Original Concentrate
        - Neemix 4.5 EC
    - Pyrethrins
        - PyGanic Crop Protection EC 5.0 II
- **Onions maggots**
    - Azadirachtin
        - Agroneem Plus Agricultural
        - Anti-Pest-O Original Concentrate
        - AzaGuard
        - Azatin O
        - Debug Turbo
        - Neemix 4.5 EC
    - Spinosad
        - Regard
- **Sweet potatoes flea beetles**
    - Azadirachtin
        - Anti-Pest-O Original Concentrate
        - Anti-Pest-O RTU
        - Azatrol EC Insecticide
        - Azera
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
- **Southern corn rootworm**
    - *Beauveria bassiana* strain GHA
        - BotaniGard ES
    - Buffalo gourd root powder (feeding stimulant for beetles)
        - Cidetrak D
    - Oil
        - Golden Pest Spray Oil
        - Vegol Insecticidal Oil
        - JMS Stylet-Oil
    - GS-omega/kappa-Hxtx-Hv1a
        - VST-006330 EP or Spear

Access the IR-4 Project database:
https://www.ir4project.org/

Understanding Pesticide Product Hazard Rankings

Growers who seek safer alternatives to chlorpyrifos will find many resources to help them identify alternatives, review science on their efficacy and application including the IPM Institute of North America, Rutgers IR-4 Project, the Pesticide Research Institute, IPM consultants, universities, extension services, and others.

An online resource, PRI Product Evaluator database, is a public website available to growers to access a wealth of information on more than 18,000 pesticide products and can be used to acquire comprehensive information on each product. Growers can enter search queries based on crop type, pest type, hazard tier ranking and other variable, to return results listing product options with complete labelling and use information for each product. Access the database at: http://www.pesticideresearch.com

Hazard Tier Ranking System

PRI Product Evaluator ranks its 18,000 listed products with a hazard tier ranking. This is a scientific analysis, based on the complete labeling and product registration information.

Highest Concern
The formulated product has a DANGER signal word on the label because of high acute toxicity, is listed by US EPA as a Restricted Use Product (RUP), and/or is highly toxic to fish or other aquatic life, birds, wildlife, or honey bees. Alternatively, one or more of the known ingredients in the product meets at least one of the following criteria: **Known or probable carcinogen, reproductive or developmental toxicant, suspected endocrine disruptor, persistent bioaccumulative toxic substance, or listed as a non-point source water pollutant on the Clean Water Act Section 303(d) list**.

Moderate Concern
The formulated product has a WARNING signal word on the label because of moderate acute toxicity and/or is moderately toxic to fish or other aquatic life, birds, wildlife, or honey bees. Alternatively, one or more of the known ingredients in the product is not a Hazard Tier 1 ingredient but meets at least one of the following criteria: **Possible carcinogen or potential ground or surface water contaminant.**

Low Concern (often a biorational or biopesticide)
The formulated product has a CAUTION or no signal word on the label because of low acute toxicity and/or has no warnings about toxicity to fish or other aquatic life, birds, wildlife, or honeybees. For the known ingredients in the product, **no hazard criteria** are flagged for Tier 1 or Tier 2.

Numbers of Lower Toxicity Alternative Products to Chlorpyrifos, by Maryland Crop and Pest

In the following lists, only chlorpyrifos alternative products identified as Low or Moderate Concern in Hazard Tier Ranking.

Numbers of alternative agricultural products, by crop pest (2018 data):

Soybean	**Number of Alternative PRI-Listed Products**
Aphid	45 products
Bean Leaf Beetle	29 products
Corn Earworm	38 products
Grasshopper	19 products
Green Clover worm	38 products
Spider Mites	3 products
Stinkbug	6 products

Corn Grain	**Number of Alternative PRI-Listed Products**
Cinnamon Stalk Borer	9 products
Corn Rootworm	19 products
Cutworms & Armyworm	59 products
European Corn Borer	26 products
Flea Beetle	21 products
Rootworm	19 products
Slugs	12 products
White Grub	28 products
Wireworm	6 products

Wheat	**Number of Alternative PRI-Listed Products**
Aphid	27 products
Grasshopper	10 products
Wheat blossom Midge	11 products

Vegetable Crops

Brassicas (i.e. broccoli, cabbage, etc.)	**Number of Alternative PRI-Listed Products**
Aphids	60 products
Cabbage Maggots	36 products

Sweet Potatoes	**Number of Alternative PRI-Listed Products**
Flea Beetles	24 products
Southern Corn Rootworm	13 products
Wireworms	4 products

Onions	**Number of Alternative PRI-Listed Products**
Onion Maggots	36 products

Pome & Stone Fruit	**Alternative Products** (PRI, *Rutgers IR-4, IPMI)
Peach tree borer (LPTB, GPTB)	16 products*
Borers – dogwood, roundheadded apple, American plum, apple twig, black stem	10 products*
Aphid – rosy apple, green apple, wooly apple	93 products
Mites	120 products
Apple maggot	34 products
Pear psylla	9 products
Plum curculio	10 products
Scale insects	92 products
Brown marmorated stink bug	6 products

Turf	**Number of Alternative Products***, Rutgers IR-4
White grub	11 products
Chinch bug	20 products
Sod webworm	16 products
Annual bluegrass weevil	16 products

* https://extension.entm.purdue.edu/publications/E-61.pdf

Additional Studies on Effectiveness

Corn Rootworm

- 2015 Venerate XC In-furrow corn rootworm study, AgoPro/Iowa - https://tinyurl.com/ya7bs5z8
- 2015 AgPro Partners Iowa Venerate VX in-furrow corn rootworm study (excel) - https://tinyurl.com/y8hquque
- 2015 SS Ag Ohio Venerate XC In-furrow corn rootworm study - https://tinyurl.com/y9joxw5u
- 2016 Iowa State University corn rootworm study - https://tinyurl.com/y7fkz9e4
- 2016 Purdue University Venerate XC In-Furrow corn rootworm - https://tinyurl.com/y9nkmd5r

Tree Fruit

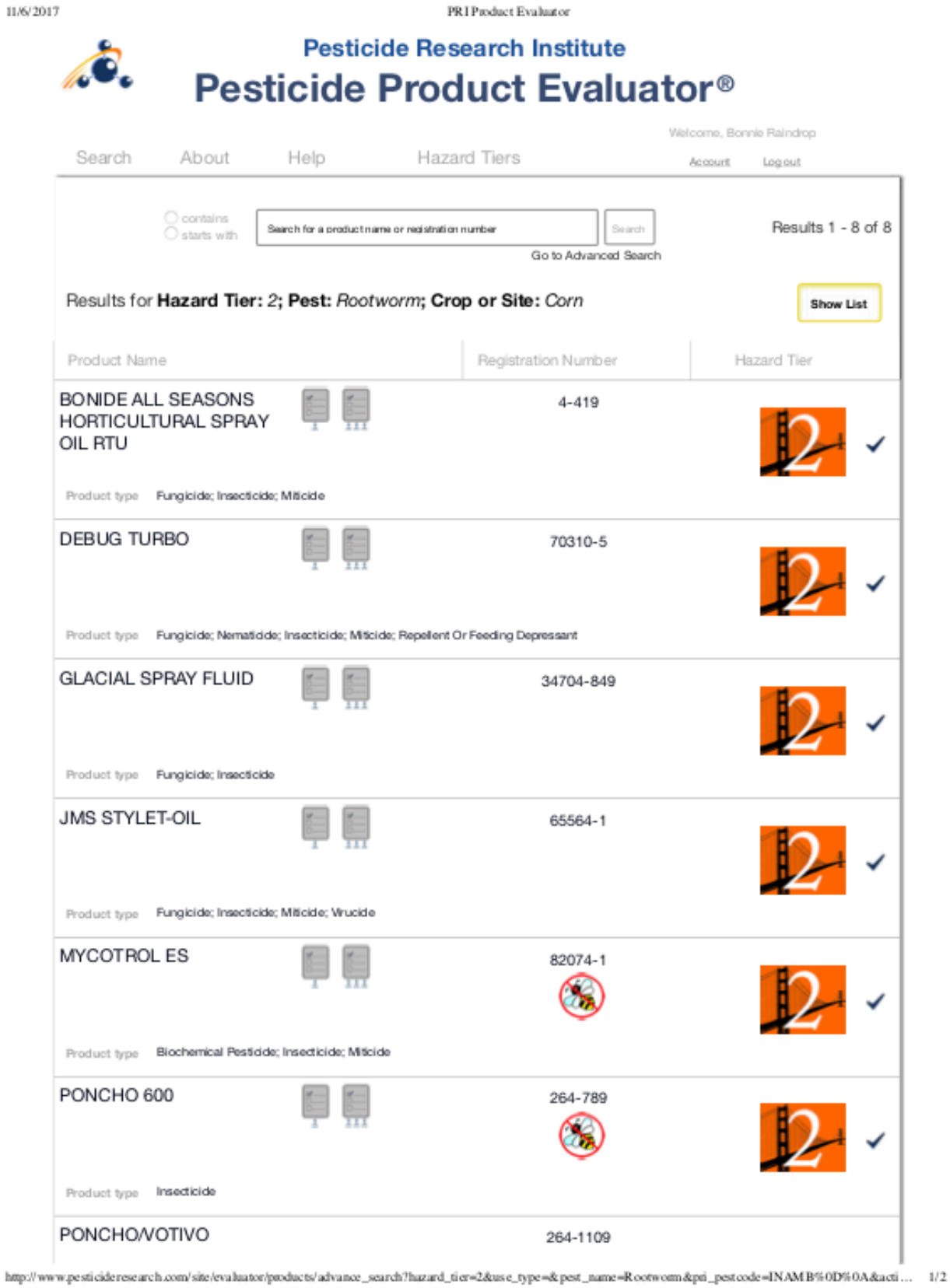
- IPM Institute: *Chlorpyrifos alternatives for select tree fruit pests - https://tinyurl.com/y8r3vutn
- Mounding soils to avoid infestation of dogwood borer in apple - https://tinyurl.com/ybwewofn
- 2014 San Jose scale study – NEFCON Massachusetts - https://tinyurl.com/y962w9dg
- 2017 Hudson Valley Research Lab San Jose scale – part 1 - https://tinyurl.com/y7ebwu2n
- 2017 Hudson Valley Research Lab San Jose scale – part 2 - https://tinyurl.com/y9ng8gpm
- 2017 Hudson Valley Research Lab San Jose scale – part 3 - https://tinyurl.com/y7swp6d8
- 2017 Michigan State University Wooly apply aphid apple - https://tinyurl.com/y9ymhfnx
- 2017 Rutgers University San Jose scale report on peaches - https://tinyurl.com/ycu7uf8h
- Assail – efficacy-DWB trials Wise et al 2003 - https://tinyurl.com/y7nslsln
- Control of Apple Maggot on Apples in Massachusetts & New York - https://tinyurl.com/y79be9s9

Products to Manage Corn Rootworm (CRW)

Data on products and efficacy of biorational products for corn rootworm is representative of readily available data. This section will:

1) Identify products listed for Corn Rootworm from the PRI Product Evaluator
2) Provide product data on Venerate, a biorational from Marrone BioInnovation
3) Findings - summary data on studies conducted on Venerate and CRW

1) Corn Rootworm – Alternative Products List (PRI)



11/6/2017 PRI Product Evaluator

Pesticide Research Institute

Pesticide Product Evaluator®

Welcome, Bonnie Raindrop

Search About Help Hazard Tiers Account Logout

contains / starts with — Search for a product name or registration number — Search

Go to Advanced Search

Results 1 - 8 of 8

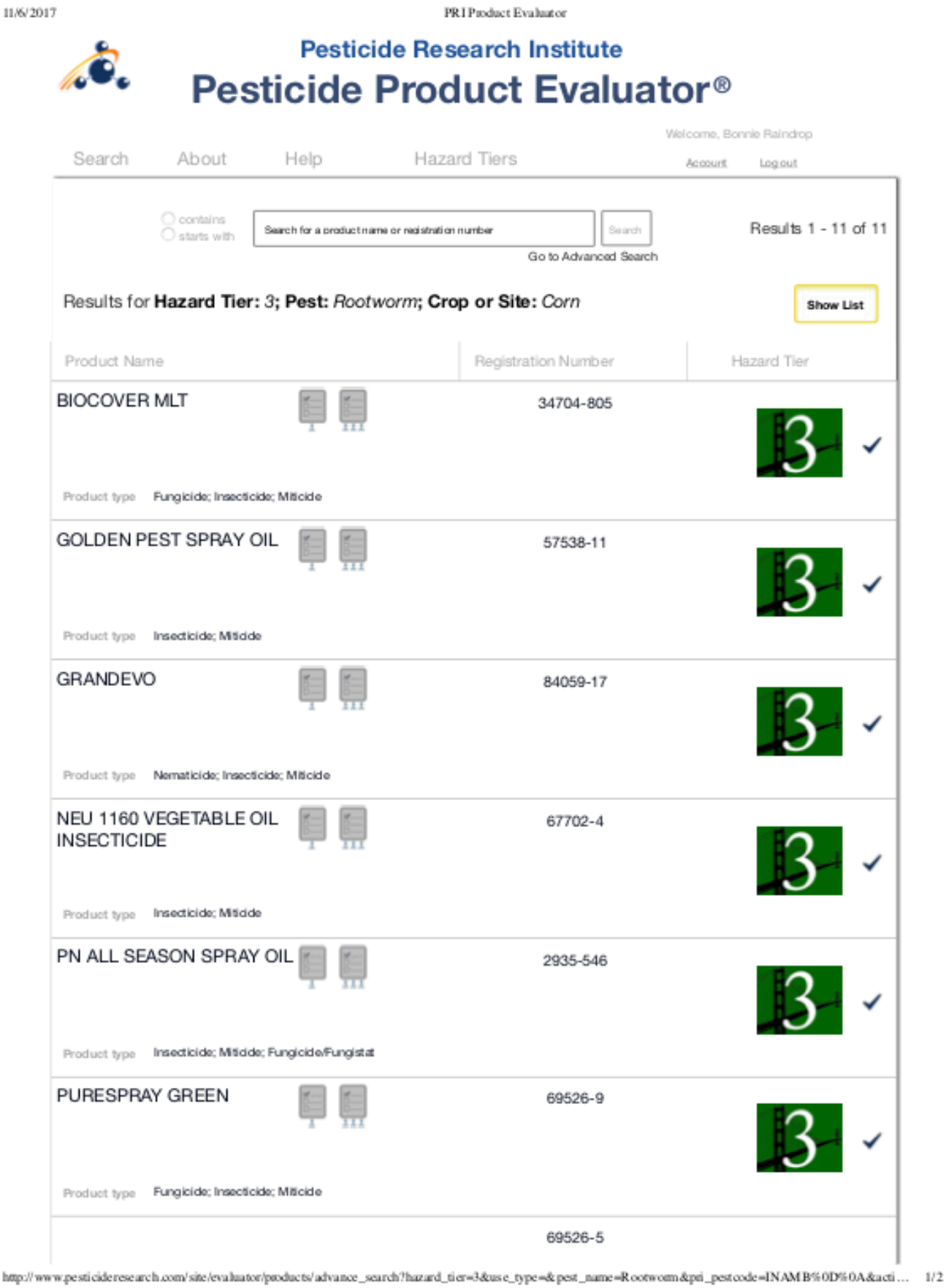
Results for **Hazard Tier:** *2*; **Pest:** *Rootworm*; **Crop or Site:** *Corn*

Show List

Product Name	Registration Number	Hazard Tier
BONIDE ALL SEASONS HORTICULTURAL SPRAY OIL RTU Product type: Fungicide; Insecticide; Miticide	4-419	2
DEBUG TURBO Product type: Fungicide; Nematicide; Insecticide; Miticide; Repellent Or Feeding Depressant	70310-5	2
GLACIAL SPRAY FLUID Product type: Fungicide; Insecticide	34704-849	2
JMS STYLET-OIL Product type: Fungicide; Insecticide; Miticide; Virucide	65564-1	2
MYCOTROL ES Product type: Biochemical Pesticide; Insecticide; Miticide	82074-1	2
PONCHO 600 Product type: Insecticide	264-789	2
PONCHO/VOTIVO	264-1109	

http://www.pesticideresearch.com/site/evaluator/products/advance_search?hazard_tier=2&use_type=&pest_name=Rootworm&pri_pestcode=INAMB%0D%0A&acti… 1/2


11/6/2017
PRI Product Evaluator
Product type Nematicide; Insecticide
SUNSPRAY 6E PLUS
86330-11
Product type Insecticide; Miticide
1 - 8 of 8
PRI Services
PRI Pest Management Bulletins
Contact
© Copyright 2014 Pesticide Research Institute / Please read our Terms of Use and Privacy Policy



11/6/2017 PRI Product Evaluator

Pesticide Research Institute

Pesticide Product Evaluator®

Welcome, Bonnie Raindrop

Search About Help Hazard Tiers Account Logout

contains / starts with — Search for a product name or registration number — Search

Go to Advanced Search

Results 1 - 11 of 11

Results for **Hazard Tier:** *3*; **Pest:** *Rootworm*; **Crop or Site:** *Corn*

Show List

Product Name	Registration Number	Hazard Tier
BIOCOVER MLT Product type Fungicide; Insecticide; Miticide	34704-805	3 ✓
GOLDEN PEST SPRAY OIL Product type Insecticide; Miticide	57538-11	3 ✓
GRANDEVO Product type Nematicide; Insecticide; Miticide	84059-17	3 ✓
NEU 1160 VEGETABLE OIL INSECTICIDE Product type Insecticide; Miticide	67702-4	3 ✓
PN ALL SEASON SPRAY OIL Product type Insecticide; Miticide; Fungicide/Fungistat	2935-546	3 ✓
PURESPRAY GREEN Product type Fungicide; Insecticide; Miticide	69526-9	3 ✓
	69526-5	

http://www.pesticideresearch.com/site/evaluator/products/advance_search/?hazard_tier=3&use_type=&pest_name=Rootworm&pri_pestcode=INAMB%0D%0A&acti... 1/2

PURESPRAY SPRAY OIL 10E Product type: Fungicide; Insecticide; Miticide		3
SPRAY OIL 470 Product type: Fungicide; Insecticide; Miticide	34704-809	3
SUNSPRAY 6E Product type: Fungicide; Insecticide; Miticide	86330-6	3
SUNSPRAY 6E WESTERN Product type: Insecticide; Miticide	86330-15	3
MYCOTROL O Product type: Biochemical Pesticide; Insecticide; Miticide	82074-3	3

1 - 11 of 11

PRI Services PRI Pest Management Bulletins Contact

2) Product: Venerate for Control of Corn Rootworm

1/31/2018 MBI-206 EP

Pesticide Research Institute

Pesticide Product Evaluator®

MBI-206 EP

Registration Number
84059-14

Hazard Tier
NOT YET RATED

Product type: Insecticide

Product Information

Registration Status	Manufacturer
EPA: Active	Marrone Bio Innovations
CA: Active	Find MSDS / US EPA Label

Find Registration Status in Other States

Cancellation Date	Currently registered
Acute Toxicity Signal Word	CAUTION
Restricted Use	No
Formulation	Emulsifiable Concentrate

Active Ingredients

Burkholderia sp strain A396 cells and spent fermentation media, 94.46%

Other Known Ingredients

Registration Numbers

EPA	84059-14
CA	84059-14-ZA, 84059-14-AA, 84059-14-ZB

Previous EPA Registration Numbers: None

Other Names for This Product

EPA Reg. No.	Product Name
84059-14-42750	Biost Insecticide 100
84059-14-42750	Biost Nematicide 100
84059-14-ZA	MAJESTENE
84059-14	MBI-206 EP
84059-14-ZA	VENERATE
84059-14-ZA	VENERATE XC

Pests Targeted By This Product

Aphids
Artichoke Plume Moth
Bacterial Gummosis
Armyworm
Avocado Leafroller
Bagworm

Hazard Tier Assessment

This product has not yet been assigned a Hazard Tier Ranking by PRI. To request a Hazard Tier evaluation, please email PRI at support@pesticideresearch.com

Follow all label instructions when using this product.

PRI Comments

EPA Data Updated	PRI Review Date
8/6/2017	Detailed review not yet available

Find IPM Solutions

Environmental Hazards

PRI has not yet evaluated the environmental hazards of this product. Email PRI to request a review. See the product label for more information.

Acute Human Health Hazards

PRI has not yet evaluated the acute human health hazards of this product. Email PRI to request a review. See the product label for more information.

Crops/Sites On Which This Product Is Approved For Use

Acerola (Foliar Treatment)
Almonds (Foliar Treatment)
Angelica (Foliar Treatment)
Apricots (Foliar Treatment)
Artichokes (Soil Treatment)
Atemoya (Foliar Treatment)
Balm (Foliar Treatment)
Barley (Foliar Treatment)
Beets (Foliar Treatment)
Aerial Application
Amaranthus (Foliar Treatment)
Apples (Foliar Treatment)
Artichokes (Foliar Treatment)
Asparagus (Foliar Treatment)
Avocado (Foliar Treatment)
Bananas (Foliar Treatment)
Basil (Foliar Treatment)

http://www.pesticideresearch.com/site/evaluator/products/view/84059-14 1/5

Banana Skipper
Beet Armyworm
Blackheaded Budworms
Blossom Weevils
Cabbage Looper
Cabbage Webworm
California Oakworm
Cankerworms
Cherry Fruitworm
Chinch Bug
Citrus Cutworm
Citrus Leafminers
Citrus Peelminer
Citrus Psyllid
Citrus Red Mite
Citrus Rust Mite
Citrus Thrips
Codling Moth
Corn Earworm
Corn Leaf Aphid
Cotton Aphid
Cotton Bollworm
Cranberry Fruitworm
Cranberry Weevil
Cross-Striped
Cutworms
Cabbageworm
Diamondback Moth
Douglas-Fir Tussock Moth
Elm Sparworm
European Corn Borer
European Red Mite
Fall Webworm
Filbert Leafroller
Filbert Worm
Fireworms
Florida Red Scale
Fruittree Leafroller
Grape Berry Moth
Grape Leafroller
Grapeleaf Skeletonizer
Green Cloverworm
Green Fruitworm
Greenbug
Greenstriped Mapleworm
Gummosis
Gypsy Moth
Heliothis Caterpillars
Hemlock Looper
Hickory Shuckworm
Hornworms
Imported Cabbageworm
Jack Pine Budworm
Lace Bugs
Leafrollers
Lesion Nematodes
Loopers
Lygus Bugs
Mcdaniel Spider Mite
Mealybugs
Melonworm
Mimosa Webworm
Mites
Navel Orangeworm
No Pest
Obliquebanded Leafroller
Omnivorous Leafroller
Orange Tortrix
Orangedog
Oriental Fruit Moth
Pacific Spider Mite
Pandemis Leafroller
Peach Twig Borer
Pear Psylla
Pecan Nut Casebearer
Pepper Weevil
Pickleworm
Pine Butterfly
Pine Tip Moths
Plant Bugs
Plum Curculio
Pod Worm
Potato Aphid
Potato Leafhopper
Psyllids
Raspberry Fruitworms
Redbanded Leafhopper
Redbanded Leafroller
Redhumped Caterpillar
Reniform Nematodes
Ringworm Complex
Ring Nematodes
Root-Knot Nematodes
Saddleback Caterpillar
Saddled Prominent
Saltmarsh Caterpillar
Silverleaf Whitefly
Sixspotted Mite
Southwestern Corn Borer
Soybean Looper
Sparganothis Fruitworm
Spruce Budworm
Sting Nematodes
Stink Bugs
Stunt Nematodes
Tecia Thecla Basilides
Tent Caterpillars
Texas Citrus Mite
Thecla Thecla Basilides
Thrips
Tobacco Budworm
Tomato Fruitworm
Tomato Pinworm
Tufted Apple Bud Moth
Tussock Moths
Twig Borers
Twospotted Spider Mite
Variegated Cutworm
Variegated Leafroller
Velvetbean Caterpillar
Walnut Caterpillar
Webworms
Western Bean Cutworm
Western Tussock Moth
Whiteflies
Willamette Spider Mite

Beets (Garden) (Foliar Treatment)
Beets (Garden) (Soil Treatment)
Black Raspberries (Foliar Treatment)
Black Salsify (Foliar Treatment)
Black Salsify (Soil Treatment)
Blackberries (Foliar Treatment)
Blueberries (Foliar Treatment)
Borage (Foliar Treatment)
Broccoli (Foliar Treatment)
Broccoli (Soil Treatment)
Broccoli Raab (Foliar Treatment)
Broccoli Raab (Soil Treatment)
Brussels Sprouts (Foliar Treatment)
Brussels Sprouts (Soil Treatment)
Buckwheat (Foliar Treatment)
Burdock (Edible) (Foliar Treatment)
Burdock (Soil Treatment)
Burnet (Foliar Treatment)
Cabbage (Foliar Treatment)
Cabbage (Soil Treatment)
Canistel (Foliar Treatment)
Canola (Foliar Treatment)
Cantaloupes (Foliar Treatment)
Cantaloupes (Soil Treatment)
Carrots (Foliar Treatment)
Carrots (Soil Treatment)
Cashews (Foliar Treatment)
Cassava (Foliar Treatment)
Cassava (Soil Treatment)
Catnip (Foliar Treatment)
Cauliflower (Foliar Treatment)
Cauliflower (Soil Treatment)
Celeriac (Foliar Treatment)
Celeriac (Soil Treatment)
Celery (Foliar Treatment)
Celery (Soil Treatment)
Chayote (Foliar Treatment)
Chayote (Soil Treatment)
Cherimoya (Foliar Treatment)
Cherries (Foliar Treatment)
Chervil (Foliar Treatment)
Chestnuts (Foliar Treatment)
Chicory (Foliar Treatment)
Chicory (Soil Treatment)
Chinese Artichoke (Foliar Treatment)
Chinese Artichoke (Soil Treatment)
Chinese Broccoli (Foliar Treatment)
Chinese Broccoli (Soil Treatment)
Chinese Cabbage (Bok Choy) (Foliar Treatment)
Chinese Cabbage (Bok Choy) (Soil Treatment)
Chinese Cabbage (Foliar Treatment)
Chinese Cabbage (Gai Choy) (Soil Treatment)
Chinese Cabbage (Mizuna) (Foliar Treatment)
Chinese Cabbage (Mizuna) (Soil Treatment)
Chinese Cabbage (Napa) (Foliar Treatment)
Chinese Cabbage (Napa) (Soil Treatment)
Chinese Mustard (Gai Choy) (Foliar Treatment)
Chive (Foliar Treatment)
Christmas Tree Plantings (Foliar Treatment)
Chrysanthemum (Edible) (Foliar Treatment)
Chrysanthemum (Edible) (Soil Treatment)
Cilantro (Foliar Treatment)
Clary Sage (Foliar Treatment)
Collards (Foliar Treatment)
Collards (Soil Treatment)
Coriander (Foliar Treatment)
Corn (Field) (Foliar Treatment)
Corn (Field) (Soil Treatment)
Corn (Pop) (Foliar Treatment)
Corn (Pop) (Soil Treatment)
Corn (Seed Crop Foliar Treatment)
Corn (Seed Treatment)
Corn (Soil Treatment)
Corn (Sweet) (Foliar Treatment)
Corn (Sweet) (Soil Treatment)
Corn Salad (Foliar Treatment)
Corn Salad (Soil Treatment)
Costmary (Foliar Treatment)
Cotton (Foliar Treatment)
Cotton (Seed Treatment)
Cotton (Soil Treatment)
Crabapples (Foliar Treatment)
Cranberries (Foliar Treatment)
Cress (Foliar Treatment)
Cress (Soil Treatment)
Cucumbers (Foliar Treatment)
Cucumbers (Soil Treatment)
Currants (Foliar Treatment)
Curry Leaf (Foliar Treatment)
Custard Apple (Foliar Treatment)
Dandelion (Foliar Treatment)
Dandelion (Soil Treatment)
Dill (Foliar Treatment)
Dock (Sorrel) (Foliar Treatment)
Dock (Sorrel) (Soil Treatment)
Eggplant (Foliar Treatment)
Eggplant (Soil Treatment)
Elderberry (Foliar Treatment)
Endive (Escarole) (Foliar Treatment)
Endive (Escarole) (Soil Treatment)
Feijoa (Foliar Treatment)
Fennel (Soil Treatment)
Fennel (Foliar Treatment)
Figs (Foliar Treatment)
Filberts (Foliar Treatment)
Forest Trees (Foliar Treatment)
Garden Peas (Foliar Treatment)
Garlic (Foliar Treatment)
Garlic (Soil Treatment)
Ginger (Foliar Treatment)
Ginger (Soil Treatment)
Ginseng (Foliar Treatment)
Ginseng (Soil Treatment)

Gooseberries (Foliar Treatment)
Gourds (Edible) (Soil Treatment)
Grapes (Foliar Treatment)
Ground Cherry (Soil Treatment)
Herbs (Foliar Treatment)
Horehound (Foliar Treatment)
Horseradish (Soil Treatment)
Hyssop (Foliar Treatment)
Jerusalem Artichoke (Foliar Treatment)
Juneberries (Foliar Treatment)
Kiwi (Foliar Treatment)
Kohlrabi (Soil Treatment)
Leeks (Foliar Treatment)
Lemons (Foliar Treatment)
Lettuce (Head) (Soil Treatment)
Lettuce (Leaf) (Soil Treatment)
Longan (Foliar Treatment)
Macadamia Nuts (Foliar Treatment)
Mangos (Foliar Treatment)
Muskmelons (Foliar Treatment)
Mustard (Greens) (Foliar Treatment)
Mustard (Spinach) (Foliar Treatment)
Nasturtium (Foliar Treatment)
Oats (Foliar Treatment)
Okra (Soil Treatment)
Onions (Bulb) (Soil Treatment)
Onions (Green) (Soil Treatment)
Oriental Radish (Foliar Treatment)
Ornamental Broadleaf Evergreen Shrubs (Foliar Treatment)
Ornamental Foliage Plants (Foliar Treatment)
Ornamental Trees (Foliar Treatment)
Ornamental Woody Shrubs (Foliar Treatment)
Parsley (Soil Treatment)
Parsnips (Soil Treatment)
Peaches (Foliar Treatment)
Pears (Foliar Treatment)
Pepinos (Foliar Treatment)
Peppermint (Foliar Treatment)
Pineapple (Foliar Treatment)
Plums (Foliar Treatment)
Potatoes (Foliar Treatment)
Proso Millet (Foliar Treatment)
Pumpkin (Soil Treatment)
Purslane (Soil Treatment)
Radicchio (Foliar Treatment)
Radishes (Soil Treatment)
Rapeseed (Greens) (Foliar Treatment)
Red Raspberries (Foliar Treatment)
Rosemary (Foliar Treatment)
Gourds (Edible) (Foliar Treatment)
Grapefruit (Foliar Treatment)
Ground Cherry (Foliar Treatment)
Guava (Foliar Treatment)
Hazelnut (Foliar Treatment)
Hops (Foliar Treatment)
Horseradish (Foliar Treatment)
Huckleberries (Foliar Treatment)
Jaboticaba (Foliar Treatment)
Jerusalem Artichoke (Soil Treatment)
Kale (Foliar Treatment)
Kale (Soil Treatment)
Kohlrabi (Foliar Treatment)
Lavender (Foliar Treatment)
Leeks (Soil Treatment)
Lettuce (Head) (Foliar Treatment)
Lettuce (Leaf) (Foliar Treatment)
Limes (Foliar Treatment)
Loganberries (Foliar Treatment)
Loquat (Foliar Treatment)
Mamey Sapote (Foliar Treatment)
Marjoram (Foliar Treatment)
Muskmelons (Soil Treatment)
Mustard (Greens) (Soil Treatment)
Mustard (Spinach) (Soil Treatment)
Nectarines (Foliar Treatment)
Okra (Foliar Treatment)
Onions (Bulb) (Foliar Treatment)
Onions (Foliar Treatment)
Onions (Green) (Foliar Treatment)
Oranges (Foliar Treatment)
Orchards (Foliar Treatment)
Oriental Radish (Soil Treatment)
Ornamental Conifers (Foliar Treatment)
Ornamental Flowering Plants (Foliar Treatment)
Ornamental Shade Trees (Foliar Treatment)
Ornamental Turf (Foliar Treatment)
Papayas (Foliar Treatment)
Parsley (Foliar Treatment)
Parsnips (Foliar Treatment)
Passion Fruit (Foliar Treatment)
Pearl Millet (Foliar Treatment)
Pecans (Foliar Treatment)
Pepinos (Soil Treatment)
Peppers (Foliar Treatment)
Peppers (Soil Treatment)
Pistachio Nuts (Foliar Treatment)
Pomegranates (Foliar Treatment)
Potatoes (Soil Treatment)
Prunes (Foliar Treatment)
Pumpkin (Foliar Treatment)
Purslane (Foliar Treatment)
Quinces (Foliar Treatment)
Radicchio (Soil Treatment)
Radishes (Foliar Treatment)
Rambutan (Foliar Treatment)
Rapeseed (Greens) (Soil Treatment)
Rhubarb (Foliar Treatment)
Rhubarb (Soil Treatment)
Rutabagas (Foliar Treatment)

Rutabagas (Soil Treatment)
Rye (Foliar Treatment)
Safflower (Oil Crop) (Foliar Treatment)
Sage (Foliar Treatment)
Salsify (Foliar Treatment)
Salsify (Soil Treatment)
Sapodilla (Foliar Treatment)
Savory (Summer) (Foliar Treatment)
Savory (Winter) (Foliar Treatment)
Shallots (Soil Treatment)
Skirret (Foliar Treatment)
Skirret (Soil Treatment)
Sorghum (Foliar Treatment)
Sorghum (Milo) (Foliar Treatment)
Soursop (Foliar Treatment)
Soybeans (Foliar Treatment)
Soybeans (Seed Treatment)
Soybeans (Soil Treatment)
Spanish Lime (Foliar Treatment)
Spanish Salsify (Foliar Treatment)
Spanish Salsify (Soil Treatment)
Spices (Foliar Treatment)
Spinach (Foliar Treatment)
Spinach (Soil Treatment)
Squash (Summer) (Foliar Treatment)
Squash (Summer) (Soil Treatment)
Squash (Winter) (Foliar Treatment)
Squash (Winter) (Soil Treatment)
Star Apple (Foliar Treatment)
Starfruit (Foliar Treatment)
Strawberries (Foliar Treatment)
Strawberries (Soil Treatment)
Sugar Apple (Foliar Treatment)
Sugar Beets (Foliar Treatment)
Sugar Beets (Soil Treatment)
Sunflowers (Oil Crop) (Foliar Treatment)
Sunflowers (Seed Crop Foliar Treatment)
Sweet Bay (Foliar Treatment)
Sweet Potatoes (Foliar Treatment)
Sweet Potatoes (Soil Treatment)
Swiss Chard (Foliar Treatment)
Swiss Chard (Soil Treatment)
Tangerines (Foliar Treatment)
Tank Mix
Tansy (Foliar Treatment)
Tarragon (Foliar Treatment)
Thyme (Foliar Treatment)
Tobacco (Foliar Treatment)
Tobacco (Soil Treatment)
Tomatillo (Foliar Treatment)
Tomatillo (Soil Treatment)
Tomatoes (Foliar Treatment)
Tomatoes (Soil Treatment)
Tree Farms (Foliar Treatment)
Triticale (Foliar Treatment)
Turmeric (Foliar Treatment)
Turnips (Foliar Treatment)
Turnips (Greens) (Foliar Treatment)
Turnips (Soil Treatment)
Walnuts (Foliar Treatment)
Watercress (Foliar Treatment)
Watermelon (Foliar Treatment)
Watermelon (Soil Treatment)
Wheat (Foliar Treatment)
White Sapote (Foliar Treatment)
Wintergreen (Foliar Treatment)
Woodruff (Foliar Treatment)
Wormwood (Foliar Treatment)
Yams (Foliar Treatment)
Yams (Soil Treatment)

Chemical ID Information on Known Ingredients in this Product

Chemical ID

Burkholderia sp strain A396 cells and spent fermentation media

Chemical Name & Synonyms	Use Type	Classification	CAS Number	Molecular Weight
Burkholderia sp strain A396 cells and spent fermentation media	Fungicide	Microbial	NDA	NDA
Burkholderia sp strain A396 cells and spent fermentation media				

Registration

CA DPR Code: 6064
USGS Code: NDA
US: Yes
CA: Yes
EPA PC Code: 006534
PMRA Code: BUA
EU: NDA

NDA = No Data Available

Hazard Information on Known Ingredients in this Product

Human Health Hazards | Water Pollution Potential | Low Toxicity Indicators

Percent	Chemical Name	Cancer Ranking	Reproductive/Developmental Toxicity	Endocrine Disruptor Status

Percent	Chemical Name	Cancer Ranking	Reproductive/Developmental Toxicity	Endocrine Disruptor Status
94.46	Burkholderia sp strain A396 cells and spent fermentation media	Not Listed	Not Listed	Not Listed

NDA = No Data Available

Human Health Hazards | Water Pollution Potential | Low Toxicity Indicators

Percent	Chemical Name	Groundwater Ubiquity Score (GUS)	Soil Mobility	Aerobic Half-Life (days)	Exceeds CA Specific Numeric Values	Persistent Bioaccumulative Toxicant	Section 303(d) Listing
94.46	Burkholderia sp strain A396 cells and spent fermentation media	NDA	NDA	NDA	Not Listed	No	Check local 303(d) listing

NDA = No Data Available

Human Health Hazards | Water Pollution Potential | Low Toxicity Indicators

Percent	Chemical Name	Section 25(b) Minimal Risk	Organic Approved	US EPA Biopesticide	US EPA Waived Data Requests
94.46	Burkholderia sp strain A396 cells and spent fermentation media	No	Yes	Yes	No data

NDA = No Data Available

Review

Share your experience using this product. In what situations did you find the product to be most effective? Are there particular pests or sites that you would not recommend this product for use?

Post your review here

Post

3) Findings: Venerate XC for Control of Corn Rootworm Larvae, 2015-2016

Burkholderia sp. rinojensis (strain A396) MBI-206

VENERATE

- Discovered in MBI's screening program; isolated from soil.
- Active compounds found within the cell and in the whole cell broth with bioactivity against certain insects, mites and plant parasitic nematodes.
- Commercial product contains 94.46% heat-killed cells and spent fermentation media, no viable cells.
- Excellent non-target and toxicological profile.
- Commercial name for insecticide/miticide is Venerate®
- U.S. launch in late 2014, launch in Mexico in late 2016
- Commercial name for nematicide in the U.S. as Majestene®

Marrone Bio Innovations

The pest and the damage – western corn rootworm (*Diabrotica virgifera virgifera*)

smart. natural. solutions.

Marrone Bio Innovations

Materials and Methods

smart. natural. solutions.

In-furrow applications made with Venerate XC (*B. rinojensis A396)*

Small plot RCBD with six replications. Individual plots were four rows wide and 35-50 feet in length

Roots dug after adult emergence and grain harvested at end of season

Data analyzed by ANOVA and SNK where applicable

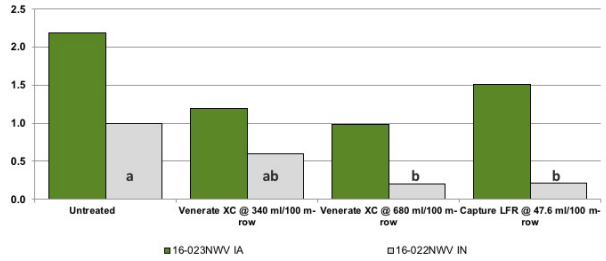
4

Marrone Bio Innovations

Corn Root Protection With Venerate XC – 2016 Trials

ISU 0-3 Nodal Root Damage Ratings at Iowa and Indiana Locations

smart. natural. solutions.



Trial design was a randomized complete block with 6 replications. A replication was 4 rows on 0.76 meter spacing x 9-15 meters in length. Treatments applied with planter-equipped units delivering materials in an in-furrow band over the open seed furrow before row closure. Means followed by different letters are statistically different from one another at p=0.05.
16-023NWV Aaron Gassman Iowa State University
16-022NWV Christian Krupke Purdue University

8

Marrone Bio Innovations

Conclusions

smart. natural. solutions.

1. Venerate significantly reduced CRW feeding damage when applied in-furrow.
2. When CRW feeding damage was reduced, yields were significantly higher than in untreated plots.
3. Venerate offers an alternative for corn rootworm control with favorable toxicological profiles compared to standard chemical treatments.

9

Marrone Bio Innovations

Low Toxicity Products for Apples & Pome Fruit Pests

Purdue IR-4 Project Results for Pest Management on Pome Fruits

Trade Name	PreHarvest Interval	Organic	Pest
Anti-Pest-O Original Concentrate	0 days	No	Peach tree borer
Anti-Pest-O RTU	0 days	No	Peach tree borer
Aza-Direct	0 days	Yes	Peach tree borer
AzaGuard Botanical Insecticide/Nematicide	0 days	No	Peach tree borer
Azatin O	0 days	Yes	Peach tree borer
Agroneem Plus Agricultural	0 days	Yes	Borer
Allityn Insect Repellent	12 hours	No	Borer
Anti-Pest-O Original Concentrate	0 days	No	Borer
Aza-Direct	0 days	Yes	Borer
AzaGuard Botanical Insecticide/Nematicide	0 days	No	Borer
Azatin O	0 days	Yes	Borer
BotaniGard ES	0 days	No	Borer
Bugitol	0 days	No	Borer
Debug Turbo EC	0 days	Yes	Borer
DiPel DF	0 days	Yes	Borer
Neemix 4.5 EC	0 days	Yes	Borer
PyGanic Crop Protection EC 5.0 II	0 days	Yes	Borer
Agroneem Plus Agricultural	0 days	Yes	Aphid
Allityn Insect Repellent	12 hours	No	Aphid
Anti-Pest-O Original Concentrate	0 days	No	Aphid
Anti-Pest-O RTU	0 days	No	Aphid
Aza-Direct	0 days	Yes	Aphid
AzaGuard Botanical Insecticide/Nematicide	0 days	No	Aphid
Azatin O	0 days	Yes	Aphid
Azatrol EC Insecticide	0 days	Yes	Aphid
Azera Insecticide	0 days	Yes	Aphid
BioCeres WP	0 days	Yes	Aphid
BotaniGard ES	0 days	No	Aphid
Bugitol	0 days	No	Aphid
Cinnacure 30%	0 days	No	Aphid
Debug Turbo EC	0 days	Yes	Aphid
Des-X Insecticidal Soap	0 days	Yes	Aphid
Ecozin 3% EC	0 days	Yes	Aphid
Golden Pest Spray Oil	0 days	No	Aphid
Naturalis L	0 days	No	Aphid
Neemix 4.5 EC	0 days	Yes	Aphid
Nimbecidine EC	0 days	No	Aphid
PFR-97 20% WDG	0 days	Yes	Aphid
PyGanic Crop Protection EC 5.0 II	0 days	Yes	Aphid
Sil-MATRIX	0 days	Yes	Aphid
SuffOil-X	0 days	Yes	Aphid
Trilogy	0 days	Yes	Aphid
Vegol Insecticidal Oil	0 days	Yes	Aphid
Acaritouch	1 day	No	Mites
Agroneem Plus Agricultural	0 days	Yes	Mites
Allityn Insect Repellent	12 hours	No	Mites
Aza-Direct	0 days	Yes	Mites
AzaGuard Botanical Insecticide/Nematicide	0 days	No	Mites
Bugitol	0 days	No	Mites
Cinnacure 30%	0 days	No	Mites
Debug Turbo EC	0 days	Yes	Mites
Des-X Insecticidal Soap	0 days	Yes	Mites
Golden Pest Spray Oil	0 days	No	Mites
JMS Stylet-Oil	0 days	Yes	Mites
Nimbecidine EC	0 days	No	Mites
PFR-97 20% WDG	0 days	Yes	Mites
PyGanic Crop Protection EC 1.4 II	0 days	Yes	Mites
Sil-MATRIX	0 days	Yes	Mites
SuffOil-X	0 days	Yes	Mites

Alternative Practices to Using Chlorpyrifos

In addition to commercial product alternatives to Chlorpyrifos, U.S. organic producers have developed effective OMRI-certified practices which can be adopted by conventional growers for any crop.

There are growers in Maryland who are successfully growing without the use of chlorpyrifos, by utilizing these practices. In California, in preparation for the ban that was expected until the EPA's abrupt reversal, conventional farmers have already begun to shift to both preventive measures and alternative treatments. We can do the same here in Maryland.

Preventive measures include mechanical and cultural practices that are core principles of organic or regenerative farming. They include:

- Planting pest-resistant varieties
- Adjusting planting times
- Disruption of the target pest's mating cycle
- Field sanitation practices
- Crop rotations
- Use of cover crops to suppress certain insects
- Establishment of habitat and food for predator insects, bats or other predators
- Introduction of predator insects (e.g., lacewings, soldier bugs or damsel bugs for soybean aphids; trichogamma wasps and lacewing larvae for corn borer eggs; ground beetles, parasitoids for cutworms; parasitic wasps for wheat greenbugs)
- Application of soil beneficial nematodes (e.g., steinernema feltiae kills over 230 different soil pests from fleas and gnats to weevils and grubs)
- Insect traps, pheromone lures, or trap crops to both monitor and control pests
- Introduction of diseases caused by viruses, bacteria, nematodes or fungal pathogens (e.g., beneficial fungi and bacteria for cutworms, milky spore for Japanese beetles, beneficial nematodes for wireworms in potatoes and onions)
- Introduction of materials to slice, repel, confuse or exclude pests (e.g., diatomaceous earth, kaolin clay, hot pepper wax, etc.)
- For vegetable crops, use of mechanical controls such as row covers against flea beetles on brassicas, or hand picking and water spray on vegetables pests
- Scouting to determine economic thresholds of loss, before spraying
- Most importantly, application of non-toxic inputs such as botanical pesticides and the hundreds of non-toxic or less toxic inputs listed in the tiered lists available through several reliable third parties, including Rutgers University I4 project, IPM Institute of North America, and the Pesticide Research Institute (PRI) Pesticide Product Evaluator set forth herein.