Alternatives to Chlorpyrifos for Maryland Agriculture Crops and Land Care

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

A report for Growers & Land Care Professionals
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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

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


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

• 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/
Updated Insecticide Recommendations for Spotted Lanternfly on Grape

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

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

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

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

Grape

<table>
<thead>
<tr>
<th>Product name</th>
<th>Active ingredient</th>
<th>Rate/acre tested</th>
<th>Mean % mortality 0 days after spray</th>
<th>Mean % mortality 7 days after spray</th>
<th>Mean % mortality 14 days after spray</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brigade 10WSB</td>
<td>bifenthrin</td>
<td>16 oz</td>
<td>100 a</td>
<td>100 a</td>
<td>94.0 a</td>
</tr>
<tr>
<td>Actara 25WDG</td>
<td>thiamethoxam</td>
<td>3.5 oz</td>
<td>100 a</td>
<td>100 a</td>
<td>60.0 ab</td>
</tr>
<tr>
<td>Scorpion 35SL</td>
<td>dinotefuran</td>
<td>5 fl oz</td>
<td>100 a</td>
<td>98.0 a</td>
<td>30.0 b</td>
</tr>
<tr>
<td>Carbaryl 4L</td>
<td>carabaryl</td>
<td>2 qt</td>
<td>98.0 ab</td>
<td>96.0 a</td>
<td>22.0 b</td>
</tr>
</tbody>
</table>
### Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

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

<table>
<thead>
<tr>
<th>Product name</th>
<th>Active ingredient</th>
<th>Rate/acre tested</th>
<th>Mean % mortality 0 days after spray</th>
<th>Mean % mortality 7 days after spray</th>
<th>Mean % mortality 14 days after spray</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admire Pro</td>
<td>imidacloprid</td>
<td>1.4 oz</td>
<td>79.5 ab</td>
<td>48.3 b</td>
<td>---</td>
</tr>
<tr>
<td>Mustang Maxx 0.8EC</td>
<td>zeta-cypermethrin</td>
<td>4 fl oz</td>
<td>64.0 ab</td>
<td>88.0 a</td>
<td>11.0 b</td>
</tr>
<tr>
<td>Sivanto Prime 1.67SC</td>
<td>flupyradiflorone</td>
<td>14 fl oz</td>
<td>46.0 bcd</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Assail 30SG</td>
<td>acetamiprid</td>
<td>5.2 oz</td>
<td>38.0 cd</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Closer 2SC</td>
<td>sulfoxaflor</td>
<td>5.75 fl oz</td>
<td>20.0 cde</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Avaunt 30DG</td>
<td>indoxacarb</td>
<td>6 oz</td>
<td>20.0 cde</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Imidan 70WP, high rate</td>
<td>phosmet</td>
<td>2.125 lb</td>
<td>20.0 cde</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Venerate</td>
<td><em>Burkholderia spp.</em> strain A396</td>
<td>4 qt</td>
<td>14.0 de</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Imidan 70WP, low rate</td>
<td>phosmet</td>
<td>1.33 lb</td>
<td>6.0 e</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Entrust 2SC</td>
<td>spinosad</td>
<td>2.5 fl oz</td>
<td>4.0 e</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Delegate</td>
<td>spinetoram</td>
<td>5 oz</td>
<td>2.0 e</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Water Control</td>
<td>---</td>
<td>---</td>
<td>20.0 e</td>
<td>11.3 b</td>
<td>10.0 b</td>
</tr>
</tbody>
</table>
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. “b”) 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
Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

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

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Active ingredient</th>
<th>Class</th>
<th>Rate per acre</th>
<th>PHI (days)</th>
<th>REL (hrs)</th>
<th>Days of activity</th>
<th>Labeled for SLF?</th>
<th>SLF activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imidan 70WP - high</td>
<td>phosmet</td>
<td>Organophosphate</td>
<td>3 lb (peach)</td>
<td>C, I</td>
<td>14</td>
<td>336</td>
<td>14</td>
<td>Yes. 2(EE)</td>
</tr>
<tr>
<td>Imidan 70WP - medium</td>
<td>phosmet</td>
<td>Organophosphate</td>
<td>2.125 lb (grape)</td>
<td>C, I</td>
<td>14</td>
<td>336</td>
<td>0</td>
<td>Yes. 2(EE)</td>
</tr>
<tr>
<td>Imidan 70WP - low</td>
<td>phosmet</td>
<td>Organophosphate</td>
<td>1.33 lb (grape)</td>
<td>C, I</td>
<td>7</td>
<td>336</td>
<td>0</td>
<td>Yes. 2(EE)</td>
</tr>
<tr>
<td>Scorpion 35SL</td>
<td>dinofuran</td>
<td>Neonicotinoid</td>
<td>5 fl oz</td>
<td>S, C</td>
<td>1</td>
<td>12</td>
<td>&lt;14</td>
<td>Yes. 2(EE)</td>
</tr>
<tr>
<td>Brigade 10WSB</td>
<td>bifenthrin</td>
<td>Pyrethroid</td>
<td>16 oz.</td>
<td>C, I</td>
<td>30</td>
<td>12</td>
<td>21</td>
<td>Yes. 2(EE)</td>
</tr>
<tr>
<td>Mustang Maxx 0.8BC</td>
<td>zeta-cypermethrin</td>
<td>Pyrethroid</td>
<td>4 fl oz.</td>
<td>C, I</td>
<td>1</td>
<td>12</td>
<td>&lt;7</td>
<td>Yes. 2(EE)</td>
</tr>
<tr>
<td>Closer 25C</td>
<td>sulfoxaflor</td>
<td>Sulfoximine</td>
<td>5.75 oz</td>
<td>S, C</td>
<td>7</td>
<td>12</td>
<td>0</td>
<td>2(EE) pending</td>
</tr>
<tr>
<td>Actara 25WG</td>
<td>thiamethoxam</td>
<td>Neonicotinoid</td>
<td>3.5 oz</td>
<td>S, C</td>
<td>5</td>
<td>12</td>
<td>&lt;21</td>
<td>Yes. 2(EE)</td>
</tr>
<tr>
<td>Assail 30SG</td>
<td>acetamiprid</td>
<td>Neonicotinoid</td>
<td>5.3 oz (grape), 8.0 (peach)</td>
<td>S, C</td>
<td>3</td>
<td>48</td>
<td>&lt;7</td>
<td>Yes. 2(EE) on nymphs only</td>
</tr>
<tr>
<td>Carbaryl 4L</td>
<td>carbaryl</td>
<td>Carbamate</td>
<td>2 qt</td>
<td>C, I</td>
<td>7</td>
<td>12</td>
<td>&lt;14</td>
<td>No</td>
</tr>
</tbody>
</table>

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.”


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 larva.”
- 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.

Nematodes – 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 naphthalene

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 (Hazard Tier 3) and 84 moderate hazard products (Hazard Tier 2) 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](http://www.ipminstitute.org)
  IPM Pesticide Risk Tool – estimates risk of negative impacts of pesticide applications, [www.pesticiderisk.org](http://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](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](http://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/](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](http://transparencymarketresearch.com)
Rutgers University IR-4 Project Recommends
Biological 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.

Biological 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
  - Scentity 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*
Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

- **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
  - **Bacillus thuringiensis**
    - *subsp. kurstaki* strain EG2348
      - Condor Wettable Powder
  - **Bacillus thuringiensis**
    - *subspecies kurstaki* strain EG7841
      - Crymax Bioinsecticide
  - **Bacillus thuringiensis**
    - *subspecies 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
Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

- 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

- **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
Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

- 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
Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

- 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

- 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

- Slugs
  - Capsaicin
    - Bugitol
    - Dazitol Concentrate
  - Spinosad
    - Bug-N-Sluggo
  - Sodium Ferric EDTA

- 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

- Slugs
  - Capsaicin
    - Bugitol
    - Dazitol Concentrate
  - Spinosad
    - Bug-N-Sluggo
  - Sodium Ferric EDTA

- 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

- Slugs
  - Capsaicin
    - Bugitol
    - Dazitol Concentrate
  - Spinosad
    - Bug-N-Sluggo
  - Sodium Ferric EDTA
Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

- 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

- 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.

1 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.

2 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.

3 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):

<table>
<thead>
<tr>
<th>Soybean</th>
<th>Number of Alternative PRI-Listed Products</th>
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</thead>
<tbody>
<tr>
<td>Aphid</td>
<td>45 products</td>
</tr>
<tr>
<td>Bean Leaf Beetle</td>
<td>29 products</td>
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<tr>
<td>Corn Earworm</td>
<td>38 products</td>
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<tr>
<td>Grasshopper</td>
<td>19 products</td>
</tr>
<tr>
<td>Green Clover worm</td>
<td>38 products</td>
</tr>
<tr>
<td>Spider Mites</td>
<td>3 products</td>
</tr>
<tr>
<td>Stinkbug</td>
<td>6 products</td>
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</table>

<table>
<thead>
<tr>
<th>Corn Grain</th>
<th>Number of Alternative PRI-Listed Products</th>
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</thead>
<tbody>
<tr>
<td>Cinnamon Stalk Borer</td>
<td>9 products</td>
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<tr>
<td>Corn Rootworm</td>
<td>19 products</td>
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<tr>
<td>Cutworms &amp; Armyworm</td>
<td>59 products</td>
</tr>
<tr>
<td>European Corn Borer</td>
<td>26 products</td>
</tr>
<tr>
<td>Flea Beetle</td>
<td>21 products</td>
</tr>
<tr>
<td>Rootworm</td>
<td>19 products</td>
</tr>
<tr>
<td>Slugs</td>
<td>12 products</td>
</tr>
<tr>
<td>White Grub</td>
<td>28 products</td>
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<tr>
<td>Wireworm</td>
<td>6 products</td>
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</table>

<table>
<thead>
<tr>
<th>Wheat</th>
<th>Number of Alternative PRI-Listed Products</th>
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</thead>
<tbody>
<tr>
<td>Aphid</td>
<td>27 products</td>
</tr>
<tr>
<td>Grasshopper</td>
<td>10 products</td>
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<tr>
<td>Wheat blossom Midge</td>
<td>11 products</td>
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</table>

Vegetable Crops

<table>
<thead>
<tr>
<th>Brassicas (i.e. broccoli, cabbage, etc.)</th>
<th>Number of Alternative PRI-Listed Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphids</td>
<td>60 products</td>
</tr>
<tr>
<td>Cabbage Maggots</td>
<td>36 products</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Sweet Potatoes</th>
<th>Number of Alternative PRI-Listed Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flea Beetles</td>
<td>24 products</td>
</tr>
<tr>
<td>Southern Corn Rootworm</td>
<td>13 products</td>
</tr>
<tr>
<td>Wireworms</td>
<td>4 products</td>
</tr>
</tbody>
</table>
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, roundheaded 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


### 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/y9ng8gm
- 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
- 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)
### Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

#### Pesticide Research Institute

**Pesticide Product Evaluator**

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Registration Number</th>
<th>Hazard Tier</th>
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<tr>
<td>BONIDE ALL SEASONS HORTICULTURAL SPRAY OIL RTU</td>
<td>4-419</td>
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<tr>
<td>Product type: Fungicide; Insecticide; Miticide</td>
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<tr>
<td>DEBUG TURBO</td>
<td>70310-5</td>
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<td>Product type: Fungicide; Nematocide; Insecticide; Miticide; Repellent Or Feeding Repressant</td>
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<td>GLACIAL SPRAY FLUID</td>
<td>34704-849</td>
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<td>Product type: Fungicide; Insecticide</td>
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<tr>
<td>JMS STYLET-OIL</td>
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<td>Product type: Fungicide; Insecticide; Miticide; Wruicide</td>
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<tr>
<td>MYCOTROL ES</td>
<td>82074-1</td>
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<td>Product type: Biochemical Pesticide; Insecticide; Miticide</td>
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<tr>
<td>PONCHO 600</td>
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<td>Product type: Insecticide</td>
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<tr>
<td>PONCHO/VOTIVO</td>
<td>264-1109</td>
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[http://www.pesticideresearch.com/site/evaluator/products/advance_search?hazard_tier=2&fus_e_type=&pest_name=Rootworm&psi_pest_code=4NAMB%0D%0A&acti...](http://www.pesticideresearch.com/site/evaluator/products/advance_search?hazard_tier=2&fus_e_type=&pest_name=Rootworm&psi_pest_code=4NAMB%0D%0A&acti...)

1/2
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<thead>
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<td>GOLDEN PEST SPRAY OIL</td>
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<td>GRANDEVO</td>
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<td>NEU 1160 VEGETABLE OIL INSECTICIDE</td>
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<td>PN ALL SEASON SPRAY OIL</td>
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<td>Product type: Insecticide; Miticide; Fungicide/Fungistat</td>
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<td>PURESPRAY GREEN</td>
<td>69526-9</td>
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<td>Product type: Fungicide; Insecticide; Miticide</td>
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</tr>
<tr>
<td>69526-5</td>
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## Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Product Code</th>
<th>Product Type</th>
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<tbody>
<tr>
<td>PURESPRAY SPRAY OIL</td>
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<tr>
<td>SPRAY OIL 470</td>
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<td>SUNSPRAY 6E</td>
<td>86330-6</td>
<td>Fungicide; Insecticide; Miticide</td>
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<tr>
<td>SUNSPRAY 6E WESTERN</td>
<td>86330-15</td>
<td>Insecticide; Miticide</td>
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<tr>
<td>MYCOTROL O</td>
<td>82074-3</td>
<td>Biochemical Pesticide; Insecticide; Miticide</td>
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</table>

1 - 11 of 11

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PRI Pest Management Bulletins
Contact

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[Link to original document]
2) **Product: Venerate for Control of Corn Rootworm**
<table>
<thead>
<tr>
<th>Pest</th>
<th>Alternative Pest (Notes)</th>
<th>Alternative Pest (Notes)</th>
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<tbody>
<tr>
<td>Banana Skippier</td>
<td>Beet Armyworm (Foliar)</td>
<td>Beets (Garden) (Soil)</td>
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<td>Blackheaded Budworms</td>
<td>Blossom Weevils (Foliar)</td>
<td>Black Safely (Foliar)</td>
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<td>Cockroach-Looper</td>
<td>Cabbage Webworm (Foliar)</td>
<td>Blackberries (Foliar)</td>
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<td>California Oakworm</td>
<td>Cankerworms (Foliar)</td>
<td>Broccoli (Foliar)</td>
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<tr>
<td>Cherry Fruitworm</td>
<td>Chinchi Bug (Foliar)</td>
<td>Broccoli Raab (Foliar)</td>
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<tr>
<td>Citrus Cucumber</td>
<td>Chinchi Sunflowers</td>
<td>Brussels Sprouts (Soil)</td>
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<tr>
<td>Citrus Psyllid</td>
<td>Citrus Rust Mite</td>
<td>Brussel Sprouts (Foliar)</td>
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<td>Citrus Red Mite</td>
<td>Coddling Moth (Foliar)</td>
<td>Burdock (Edible) (Foliar)</td>
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<td>Citrus Thrips</td>
<td>Com Leaf Aphid (Foliar)</td>
<td>Burdock (Soil) Treatment</td>
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<td>Corn Earworm</td>
<td>Cotton Bollworm (Foliar)</td>
<td>Burnt (Foliar) Treatment</td>
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<td>Cross-Striped Cabbage worm</td>
<td>Cranberry Weevil</td>
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<td>Cabbage Looper</td>
<td>Cutworms (Foliar)</td>
<td>Butternut Squash (Foliar)</td>
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<td>Douglas-Fir Tussock Moth</td>
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<td>European Corn Borer</td>
<td>European Red Mite (Foliar)</td>
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<td>Fall Webworm</td>
<td>Filbert Leafroller (Foliar)</td>
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<td>Fireworms (Foliar)</td>
<td>Carola (Foliar) Treatment</td>
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<td>Florida Red Scale</td>
<td>Fruitbly Leafroller (Foliar)</td>
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<td>Mid-American Spider Mite</td>
<td>Lens Nematodes (Foliar)</td>
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<td>Maspilus (Foliar)</td>
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<td>Oldfieldi Orange (Foliar)</td>
<td>Chinese Artichoke (Soil) Treatment</td>
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<td>Orangédog</td>
<td>Oriental Fruit Moth (Foliar)</td>
<td>Chinese Artichoke (Soil)</td>
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<td>Pacific Spider Mite</td>
<td>Ponderosa Leafroller (Foliar)</td>
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<td>Pear Psylla (Foliar)</td>
<td>Chinese Cabbage (Bok) (Foliar) Treatment</td>
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<td>Peck Nut Casebearer</td>
<td>Pepper Waveli (Foliar)</td>
<td>Chinese Cabbage (Bok) (Soil) Treatment</td>
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<td>Pinkworm</td>
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<td>Chinese Cabbage (Bok) (Foliar) Treatment</td>
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<td>Pine Tip Moths</td>
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<td>Tobacco Budworm</td>
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http://www.pesticidereasearch.com/site/evaluator/products/view/84059-14
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<td>Rutabagas (Foliar Treatment)</td>
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http://www.pesticide research.com/site/evaluator/products/view/84059-14
### Alternatives to Chlorpyrifos in Maryland Agriculture, February 4, 2020

**Table:**

<table>
<thead>
<tr>
<th>Chemical ID Information on Known Ingredients in this Product</th>
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<tbody>
<tr>
<td><strong>Chemical Name &amp; Synonyms</strong></td>
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<tr>
<td>Burkholderia sp strain 396 cells and spent fermentation media</td>
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<td><strong>Use Type</strong></td>
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<td><strong>Classification</strong></td>
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<td><strong>Hazard Information on Known Ingredients in this Product</strong></td>
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<tr>
<td><strong>Human Health Hazards</strong></td>
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<tr>
<td><strong>Water Pollution Potential</strong></td>
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<tr>
<td><strong>Low Toxicity Indicators</strong></td>
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<td>Parent</td>
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<tr>
<td>Reproductive/Developmental Toxicity</td>
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<td>Endocrine Disruptor Status</td>
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**Website:** [http://www.pesticideresearch.com/site/evaluator/products/view/84059-14](http://www.pesticideresearch.com/site/evaluator/products/view/84059-14)
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**Human Health Hazards**

- Groundwater Uptake (Soil)  
  - NDA
- Soil Mobility  
  - NDA

**Water Pollution Potential**

- Aerobic Half-Life (days)  
  - NDA

**Low Toxicity Indicators**

- Bovine CA Specific (mg/dL)  
  - NDA
- Potential Bioaccumulative Toxicant  
  - No

**Section 330c(d) Listing**  
- Check/No  
  - No Data Available

---

**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**

---

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

**Materials and Methods**

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

**Conclusions**

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

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>PreHarvest Interval</th>
<th>Organic</th>
<th>Pest</th>
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<td>Peach tree borer</td>
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<tr>
<td>Anti-Pest-O RTU</td>
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<td>Peach tree borer</td>
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<td>Aza-Direct</td>
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<td>Yes</td>
<td>Peach tree borer</td>
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<tr>
<td>AzaGuard Botanical Insecticide/Nematicide</td>
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<td>No</td>
<td>Peach tree borer</td>
</tr>
<tr>
<td>Azatin O</td>
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<td>Peach tree borer</td>
</tr>
<tr>
<td>Agroneem Plus Agricultural</td>
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<td>Borer</td>
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<tr>
<td>Alllyn Insect Repellent</td>
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<td>Borer</td>
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<tr>
<td>Aza-Direct</td>
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<tr>
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<tr>
<td>Bugitol</td>
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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; trichogramma 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.

Report prepared by Maryland Pesticide Education Network, updated February 4, 2020