Insect Pests of Grapes in the North Central Region

Grapevines in the North Central region of the United States are affected by a complex of native and invasive exotic insect pests. The most damaging of these, in order of economic importance, are the grape berry moth, grape and potato leafhoppers, Japanese beetle, grape root borer and grape phylloxera. These insects are the focus of pest management programs and are responsible for the majority of insecticide applications, but there are other sporadic insect pests that are also of economic importance. These are all listed below, along with the current management strategies, potential gaps in available management tools, and needs for further research.

GRAPE BERRY MOTH (*Paralobesia viteana*[1])

Biology and management

- Berry moth is the most common internal-feeding insect in the region's vineyards.
- Has 2-4 generations per year depending on the location and season. The later generations create a risk of contamination in the harvested fruit.
- There is a USDA standard for larvae during inspection at all processing plants. Winemakers may have more strict thresholds, because larvae can introduce pathogens into the fruit.
- Truckload quantities of grapes have been rejected in recent years due to uncontrolled infestations ($300,000 value in Michigan during 2002).
- Population densities of grape berry moth have increased in the region's vineyards over the past 10 years, resulting in a greater number of vineyards with un-harvested fruit, especially at the vineyard borders. This is further suspected of contributing to the increase.
- Fruit infested with this insect is more susceptible to sour rots and botrytis, so more fungicides are used to control these diseases in the vineyards affected.
- Control is needed through the season, so extending REI's and PHI's of organophosphatess and carbamates would have a negative impact and necessitate a switch to less effective chemistries, which could upset current IPM programs.
- Penncap-M and Guthion are now restricted from use in vineyards due to FQPA, but new reduced-risk insecticides are more expensive and complicated to use, requiring more accurate timing. These products also tend to be active on some, but not all, life-stages of this pest.

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[1] Recently renamed from *Endopiza viteana* by J. Brown, USDA-ARS Beltsville, MD.

- Wild grapevines are alternate hosts, and these are common in the woods around vineyards creating a continual source of moths.
- Note: Worker re-entry is important for shoot positioning, leaf pulling, and harvest of wine grapes but not juice grapes. Increased REI values for insecticides used in-season will make it difficult to integrate insecticides into management of vineyards grown for wine.
- Grape berry moth tends to be less of a problem in areas with low grape acreage, but wild grape is distributed across the eastern US and wild grape berry moth populations are likely endemic in all parts of the region and likely to find commercial vineyards.

Registered insecticide efficacy

- **Organophosphates**
  - azinphos-methyl (Guthion)
    - Grapes taken off the label in 2005, but still has a tolerance. All old supplies are being used up.
  - phosmet (Imidan)
    - Main remaining organophosphate used in vineyards.
    - Shorter residual control than Guthion.
    - Efficacy: Good-Very Good
    - -Requires high rate (2lb) and pH 6 spray water for optimal performance.
    - 7-day PHI but 14 day REI; makes use in season more challenging (this is a recent change); REI is causing problems (makes management in vineyards more difficult)
  - Diazinon (Diazinon)
    - not used much (because other products are more effective)
  - malathion (Malathion)
    - not used
- **Carbamates**
  - carbaryl (Sevin)
    - Efficacy: Fair to Good
    - Widely used for grape berry moth control, active on other pests.
    - Provides good control of larvae, but with relatively short residual for the 80S formulation (needs to be used more often), XLR Plus formulation tends to have a longer residual; due to its greater washoff resistance; solupaks make use easier.
  - methomyl (Lannate)
    - Efficacy: Good (with proper timing)
    - Short residual control, so main use is early season; material is very toxic to non target organisms.

- **Pyrethroids** (resistance is a potential issue for all of these)
  - fenpropathrin (Danitol)
    - Efficacy: Good-Excellent
    - Has received wide adoption as the use of organophosphates is restricted
    - Common insecticide for grape berry moth control
    - Broad activity on other pests
    - No mite outbreaks reported to date (over five years use)
    - Restricted use pesticide
    - Cutworm damage much less since this used for grape berry moth control
    - 8-10 oz rates used

  - bifenthrin (Capture, being changed to Brigade for 2007 season)
    - Efficacy: Good-Excellent
    - Recently registered (2006)
    - Cheaper than many alternatives
    - Two sprays allowed per season at the 3.2oz rate

  - beta-cyfluthrin (Baythroid XL)
    - Efficacy: excellent on grape berry moth at the higher labeled rate. Shorter residual at half rate.
    - Recently registered (2006); not widely used yet

  - zeta-cypermethrin (Mustang Max)
    - Efficacy: not tested yet for grape berry moth
    - Recently registered (2007); not widely used yet

- **Other insecticides**
  - methoxyfenozide (Intrepid)
    - Efficacy: Good-Excellent (if good cluster coverage)
    - Growth regulator
    - Should be applied just before, during or just after egg hatch
    - Highly selective to moth pests
    - No disruption of natural enemies
    - Needs good cluster coverage to be effective
    - Usage later in the season (within PHI)
    - Expensive
    - Not widely used

  - spinosad (Spintor, Entrust)
    - Efficacy: Good
    - Requires ingestion to be lethal, not fast acting
    - Expensive
    - Susceptible to washing off
    - Entrust registered for use in organic production, 7-10 day residual control
    - Not used

- spinetoram (Delegate)
  - Expected to be more active than Spinosad, with broader activity
  - Trials conducted in 2007 showing good activity
  - Registered for 2008 season, but limited experience in commercial vineyards

- indoxacarb (Avaunt)
  - Active on GBM, beetles, leafhoppers
  - Registered for 2008, but limited experience in commercial vineyards

- acetamiprid (Assail)
  - Efficacy: Good
  - Not widely used but growers in Ohio report good control

- *Bacillus thuringiensis* = *B.t.* (Dipel, Javelin, etc.)
  - Efficacy: good if repeat applications
  - Small plot trials indicate high activity
  - Adoption low due to short residual, meaning multiple applications needed.
  - May be useful for organic growers, late season?

- kaolin (Surround)
  - Efficacy: good
  - Not used in most North Central region vineyards.
  - Requires many applications.
  - Maintaining coverage is difficult with rainfall.
  - Expensive
  - Used by organic growers

- **Mating disruption**
  - Sprayable pheromone no longer produced by 3M Company

  - Season-long twist ties (Isomate grape berry moth) available from Pacific Biocontrol
    - Population size and vineyard characteristics are important for efficacy: works best in large blocks, isolated from adjacent woods, and with low grape berry moth populations

  - Development of wax-based pheromone formulations underway in Michigan. Shows promise for grape berry moth control. Because the composition of grape berry moth pheromone may be different in different areas the North Central Region, this research should be replicated in several locations across the region.

PIPELINE:

Company and IR-4 projects are bringing new products to grapes for grape berry moth control.

- rynaxypyr (Altacor)
  - Very effective against grape berry moth
  - Expected EPA registration 2009

- thiacloprid (Calypso)
  - Preliminary data from small plot vineyard trials are promising for grape berry moth and grape leafhopper
  - Registration delayed/prevented

- metaflumizone (Alverde)
  - Effectiveness for grape berry moth control unknown – 2007 trials planned

- flubendiamide (Belt)
  - Effectiveness for grape berry moth control unknown – 2007 trials planned

- ***Pest management aids***
  - Vineyard monitoring using pheromone traps and scouting for grape berry moth eggs and damage can reduce need for insecticides or improve timing of sprays.
  - Treating vineyard perimeters rather than entire vineyards can be an effective way to reduce insecticide use, if the distribution of GBM is known.
  - Optimizing coverage of clusters is critical for control.
  - No commercially available biological control agents are effective, but 4-5 native parasitic wasps that parasitize larvae have been identified in Michigan and a *Trichogramma* egg parasitoid is under investigation.
  - Removal of wild grape from woods shown to have no effect on adjacent vineyard populations.

"To do" list for grape berry moth management

Research needs:

- Test new insecticides to find alternatives to organophosphate, carbamate and pyrethroid insecticides.
- Develop and validate a pest phenology model for grape berry moth.
- Continue to evaluate spray application strategies designed to reduce pesticide use.
- Determine the role of moth movement in creating border effects – when do moths move from woods to vineyards?
- Evaluate new mating disruption formulations that may reduce labor, time and costs
- Varietal differences with regards to grape berry moth infestation

Regulatory needs:

- Engage the IR-4 Pesticide Clearance Report (PCR) process to accelerate registration of candidate new insecticides that can economically and effectively control grape berry moth.
- Imidan 14-day REI is restrictive. More data are needed from North Central Region to support return to 7 day REI

Education needs:

- As products and/or insect management strategies become available, educate users and crop consultants.
- Proper use of mating disruption in vineyards.

GRAPE LEAFHOPPER (*Erythroneura comes*)


Biology and management

Grape leafhopper adults are orange-yellow colored with some dark spots and yellow lines on the forewings, and are about 1/8 inch long. The grape leafhopper has 1.5-2 generations per year, with peak abundance of adults in late July and again in late August. Adults overwinter in leaf litter in or around vineyards, and feed on weeds as temperatures exceed 60 ^{o}F in the spring. After mating, they move to young grape foliage in late May and early July to lay clear crescent shaped eggs. These are inserted singly under the lower leaf surface. Eggs of the first generation hatch in mid-late June, and the flightless nymphs take a month to develop to adults. Cold, wet springs and winters are damaging to leafhoppers, and egg parasites are rare. Grapevines can tolerate populations of up to 15 hoppers per leaf with little or no economic damage. However, heavy leafhopper feeding can result in premature leaf drop, lowered sugar content, increased acid, and poor color of the fruit. Ripening fruit is often smutted or stained by the sticky excrement ("honeydew") of the hoppers, which affects appearance and supports the growth of sooty molds (NY State IPM: http://www.nysipm.cornell.edu/factsheets/grapes/pests/glh/glh.asp). Researchers in New York have created a conservative provisional action threshold in juice grapes of five nymphs per leaf before August 1, and ten nymphs per leaf thereafter. Sprays should be directed when mostly nymphs are present (nymphs are more susceptible to pesticides than adults). This insect is typically a pest of native labrusca and some hybrid varieties, and is less of a pest in winegrapes.

Registered insecticide efficacy

- **Organophosphates**
  - azinphos-methyl (Guthion)
    - Efficacy:
    - Grapes taken off the label in 2005, but still has a tolerance. Not used
  - phosmet (Imidan)
    - Main remaining OP used in vineyards.
    - Shorter residual control than Guthion.
    - Fair control,
    - Requires high rate and pH 6 spray water for optimal performance.
    - 7-day PHI but 14-day REI; makes use in season more challenging.
    - Not used
  - Diazinon (Diazinon)
    - Not used.

- Malathion (Malathion)
  - Not used

- **Carbamates**
  - carbaryl (Sevin)
    - Widely used for grape leafhopper control, active on other pests.
    - Provides good control of adults, but with relatively short residual.
    - Efficacy: Good-Fair (may show resistance)

  - methomyl (Lannate)
    - Short residual control; may be used, not used as much anymore (replaced by pyrethroids)

- **Pyrethroids**
  - fenpropathrin (Danitol)
    - Efficacy: Excellent
    - Broad activity on other pests
    - No mite outbreaks reported to date (over five years use)

  - bifenthrin (Capture)
    - Efficacy: Excellent
    - Recently registered (2006)

  - beta-cyfluthrin (Baythroid XL)
    - Efficacy: Excellent
    - Recently registered (2006)

  - zeta-cypermethrin (Mustang Max)
    - Efficacy: Excellent
    - Recently registered (2007)
    -

- **Other insecticides**
  - imidacloprid (Provado Pro)
    - Efficacy: Excellent
    - Neonicotinoid insecticide
    - Reduced-risk, systemic insecticide
    - Expensive and primarily controls leafhopper

  - imidacloprid (Admire)
    - Efficacy: good in recent research trials.
    - Soil formulation of Provado (imidacloprid)
    - Not used due to price?

  - acetamiprid (Assail)
    - Efficacy: Excellent
    - New neonicotinoid insecticide
    - Soil and foliar application allowed

- o dinotefuran (Venom)
  - New neonicotinoid insecticide
  - Efficacy: Not known

- o azadiractin (Neemix, Ecozin)
  - Efficacy: Not known

- o spinosad (Spintor)
  - Efficacy: Not known

- o spinosad (Entrust)
  - Efficacy: Not known

- o pyrethrum (Pyganic)
  - Efficacy: Not known

- o pyrethrum (Evergreen)
  - Pyrethrum plus PBO (PBO = piperonyl butoxide which is a pesticide synergist that increases the activity of pyrethrum insecticides)
  - Efficacy: Not known

- o kaolin (Surround)
  - Not used in most North Central region vineyards.
  - Requires many applications.
  - Maintaining coverage is difficult with rainfall.
  - Expensive

PIPELINE:

- o indoxacarb (Avaunt)
  - Reduced risk
  - Active on grape leafhopper
  - Registration for 2008 season

- o thiamethoxam (Actara)
  - High efficacy expected
  - Registered for 2008 season

- o thiamethoxam (Platinum – soil formulation)
  - High efficacy expected
  - Timing issues need to be worked out
  - Registered for 2008 season

- o thiacloprid (Calypso)
  - Neonicotinoid
  - High efficacy expected, with wide spectrum of activity

- clothianidin (Belay)
  - Soil applied formulation
  - Neonicotinoid
  - Effective in small plot and potted vine studies

- ***Pest management aids***
  - Yellow sticky traps, combined with examination of foliage, can help detect infestation.

"To do" list for grape leafhopper
Research needs:
- Determine range of susceptibility of cultivars
- Determine efficacy of soil-applied insecticides and foliar insecticides
- Determine thresholds for moderately and highly susceptible cultivars
- New chemicals for resistance management

Regulatory needs:

Education needs:
- Demonstrate use of action thresholds for leafhopper nymphs to time sprays on moderately and highly susceptible cultivars

POTATO LEAFHOPPER (*Empoasca fabae*)

Biology and management

The adult leafhopper is pale to bright green, and about 1/8 inch long. The adults are very active, jumping, flying or running when disturbed. The immature forms, or nymphs, are pale green and wingless. They are distinctive in moving sideways rapidly when disturbed. The potato leafhopper does not overwinter north of the Gulf states, but adults migrate each spring on southerly winds and are deposited from May-June in spring rains.

Potato leafhopper can be very destructive in hybrid or vinifera varieties that are sensitive to the toxins it injects while feeding. These cause leaf yellowing and cupping, with different levels of these symptoms among varieties. Feeding is concentrated on young tissues at the shoot tips, and can also lead to shortened shoot internodes. Few insects are needed to cause these symptoms. This insect is typically not a pest in native juice grapes.

Because these insects preferentially feed on the tips of new shoots, it is difficult to retain coverage of insecticides. In infested vineyards with sensitive cultivars, potato leafhopper control may require multiple applications of an effective insecticide.

Registered insecticide efficacy

- **Organophosphates**
  - azinphos-methyl (Guthion)
    - Efficacy:
    - Grapes taken off the label in 2004 (?), but still has a tolerance. Not used

  - phosmet (Imidan)
    - Main remaining OP used in vineyards.
    - Shorter residual control than Guthion.
    - Fair control,
    - Requires high rate and pH 6 spray water for optimal performance.
    - 7-day PHI but 14 day REI; makes use in season more challenging.
    - Not used

- Diazinon (Diazinon)
  - Not used

- Malathion (Malathion)
  - Not used

- **Carbamates**
  - carbaryl (Sevin)
    - Widely used for potato leafhopper control in northern MI, active on other pests.
    - Provides good control of adults, but with relatively short residual.
    - Efficacy: Excellent

  - methomyl (Lannate)
    - Short residual control
    - Not used much.

- **Pyrethroids**
  - fenpropathrin (Danitol)
    - Efficacy: Excellent
    - Broad activity on other pests
    - No mite outbreaks reported to date (over five years use)

  - bifenthrin (Capture)
    - Efficacy:
    - Recently registered (2006).
    - Not used

  - beta-cyfluthrin (Baythroid XL)
    - Efficacy:
    - Recently registered (2006).
    - Not used

  - zeta-cypermethrin (Mustang Max)
    - Efficacy: Still largely untested in grape, but Mustang Max (at 2.24 to 4.0 oz/acre rates) is very effective at potato leafhopper control in alfalfa.
    - Recently registered (2007).
    - Not used

- **Other insecticides**
  - imidacloprid (Provado Pro)
    - Efficacy: Excellent
    - Neonicotinoid insecticide
    - Reduced-risk, systemic insecticide

  - imidacloprid (Admire)
    - Efficacy: good in recent research trials.
    - Soil formulation of Provado (imidacloprid)
    - Not used due to price?

- acetamiprid (Assail)
  - Efficacy: Poor in first experiences of 30SG formulation for potato leafhopper control
  - New neonicotinoid insecticide
  - Soil and foliar application allowed

- dinotefuran (Venom)
  - New neonicotinoid insecticide
  - Efficacy:not used

- azadiractin (Neemix, Ecozin)
  - Efficacy: not used

- spinosad (Spintor)
  - Efficacy: not used

- spinosad (Entrust)
  - Efficacy: not used

- pyrethrum (Pyganic)
  - Efficacy: not widely used, but it is used by organic growers in Iowa.

- pyrethrum (Evergreen)
  - Pyrethrum plus PBO (PBO = piperonyl butoxide which is a pesticide synergist that increases the activity of pyrethrum insecticides)
  - Efficacy: not widely used, but it is used by some growers in Iowa.

- kaolin (Surround)
  - Not used in most North Central region vineyards.
  - Requires many applications.
  - Maintaining coverage is difficult with rainfall.
  - Expensive (drive slow, high volumes needed)
  - Efficacy: Good; doesn't have the residual activity of Provado

PIPELINE:

- indoxacarb (Avaunt)
  - Reduced risk
  - Active on grape leafhopper, no data on potato leafhopper in grape
  - Registration expected for 2007 season

- thiamethoxam (Actara)
  - High efficacy expected
  - Registered for 2008 season

- thiamethoxam (Platinum)
  - High efficacy expected
  - Registered for 2008 season

- thiacloprid (Calypso)
  - Neonicotinoid
  - High efficacy expected, with wide spectrum of activity

- clothianidin (Belay)
  - Soil applied formulation
  - Neonicotinoid
  - Effective in small plot and potted vine studies

- ***Pest management aids***
  Yellow sticky traps can help detect infestation, but examining foliage is usually required too.
  Watch adjacent alfalfa field mowing for immigration of potato leafhopper

"To do" list for potato leafhopper
Research needs:
- Determine efficacy of soil-applied insecticides and foliar insecticides for potato leafhopper control
- Determine thresholds for moderately and highly susceptible cultivars
- Investigate fungal disease for control of potato leafhopper
- Collaborative research between entomologists and meteorologists in the southern U.S. to determine when potato leafhopper are likely to be carried into the North Central Region by storm fronts.

Regulatory needs:

Education needs:
- Early warning of when potato leafhopper appears based on weather

JAPANESE BEETLE (*Popillia japonica*)

Biology and management

Japanese beetle is an invasive insect pest that has been in the US for about 90 years. In that time it has spread from the site of introduction in New Jersey out to all states east of the Mississippi except Florida. It is moving further into the North Central region each year, with populations established in southwestern and eastern Missouri, Iowa and moving north in Michigan.

This pest has a single generation per year, although in the northern extremes of its distribution it may take two years to complete development. Beetles defoliate vines during the summer, with the degree of leaf removal based on population size, leaf toughness, and chemical control of the beetles. In highly infested winegrape vineyards, especially of Chardonel, Norton, Vidal, Vignoles and the table grape Reliance, vines can be heavily defoliated, reducing vine establishment and potentially harming the vine's winter hardiness.

Beetle activity is during July and August, when vines have typically completed most of their leaf growth. In established vineyards, high levels of leaf removal at this time can compromise the vines ability to ripen fruit.

- **Organophosphates**
  - azinphos-methyl (Guthion)
    - Efficacy:
    - Grapes taken off the label in 2004 (?), but still has a tolerance.
    - Not used

  - phosmet (Imidan)
    - Efficacy: Good
    - Main remaining OP used in vineyards.
    - Shorter residual control than Guthion.
    - Requires high rate and pH 6 spray water for optimal performance.
    - 7-day PHI but 14-day REI; makes use in season more challenging, especially for Japanese beetle control.
    - Not used much

- diazinon (Diazinon)
  - Not used

- malathion (Malathion)
  - Not used

- **Carbamates**
  - carbaryl (Sevin)
    - Efficacy: Good-Excellent
    - Widely used for Japanese beetle control, active on other co-occurring pests.
    - Provides good control of adults, one week of activity.
    - Compound of choice in some areas; not a restricted use pesticide
    - Directed spray at top of canopy (cuts costs)

  - methomyl (Lannate)
    - Active, but short residual control.
    - Not used much (maybe some in MI)

- **Pyrethroids**
  - fenpropathrin (Danitol)
    - Efficacy: Excellent
    - Broad activity on other pests
    - No mite outbreaks reported to date (over five years use)
    - The other main compound for Japanese beetle control (along with Sevin)
    - Northern IL not used for Japanese beetle (because it's used for phylloxera earlier in season)
    - Some allergies shown in some workers

  - bifenthrin (Capture)
    - Efficacy: Not known
    - Recently registered (2006)
    - Not tried yet

  - beta-cyfluthrin (Baythroid XL)
    - Efficacy: Not known
    - Recently registered (2006)
    - Not tried yet
    -
  - zeta-cypermethrin (Mustang Max)
    - Efficacy: Not known
    - Recently registered (2007)
    - Not tried yet

- **Other insecticides**
  - imidacloprid (Provado Pro)
    - Neonicotinoid insecticide
    - Reduced-risk, systemic insecticide
    - Efficacy: Excellent, but Sevin is cheaper

  - imidacloprid (Admire)
    - Soil formulation of Provado (imidacloprid)
    - Efficacy:
    - Slow updake and price may limit utility
    - Could be used for killing grubs if an isolated infestation
    - Could be used as a systemic soil drench (along with phylloxera control)

  - acetamiprid (Assail)
    - Neonicotinoid insecticide
    - Foliar application allowed
    - Efficacy: Not used

  - dinotefuran (Venom)
    - New (2006) neonicotinoid insecticide
    - Soil and foliar application allowed
    - Efficacy: Not used not labeled for Japanese beetle

  - azadiractin (Neemix, Ecozin)
    - Efficacy: Not used

  - pyrethrum (Pyganic)
    - Efficacy: Not used

  - pyrethrum (Evergreen)
    - Pyrethrum plus PBO (PBO = piperonyl butoxide which is a pesticide synergist that increases the activity of pyrethrum insecticides)
    - short residual activity
    - Efficacy: Not used

  - kaolin (Surround)
    - Not used in most North Central region vineyards, but it was shown to reduce Concord foliar in Arkansas
    - Requires many applications.
    - Maintaining coverage is difficult with rainfall.
    - Expensive
    - Efficacy: Works well with application after every rainfall

PIPELINE:

- thiamethoxam (Actara)
  - High efficacy expected

- thiamethoxam (Platinum)
  - High efficacy expected
  - Soil application needs correct timing

- thiacloprid (Calypso)
  - Neonicotinoid
  - High efficacy expected, with wide spectrum of activity

- clothianidin (Belay)
  - Soil applied formulation
  - Neonicotinoid
  - Efficacy:

- metaflumizone (Alverde)

- spirotetramat (Movento)

- indoxacarb (Avaunt)

- ***Pest management aids***

  Japanese beetle traps may draw beetles to the vineyard. However, modified Japanese beetle traps funneling beetles into a 3 gal. capture bucket are highly effective to mass trap Japanese beetles when several traps are placed 100' away from the vineyard.

  Beetles and their damage are easy to see so monitoring traps are not necessary.

"To do" list for Japanese beetle

Research needs:

- Determine efficacy of soil-applied and foliar insecticides
- Determine percentage foliar loss thresholds for different types of grape cultivars, under various crop loads
- Demonstrate usefulness of Surround to prevent foliar damage

Regulatory needs:

- Better monitoring for infestation by United States Department of Agriculture

Education needs:

- Information on cultivar tolerance, pesticide efficacy, biology
- Threshold education
- Trap placement in relation to vineyard and adjacent habitats for mass trapping

GRAPE ROOT BORER (*Vitacea polistiformis*)

The grape root borer is a clearwing moth with a dark brown body with yellow-orange bands on the abdomen. Adult moths are active during the day, and are seen on vines in July. The female moths lay up to 300 eggs on or near the vine, and newly hatched larvae find their way into the soil and then to a root. Larvae feed on the roots for up to two years (perhaps longer), moving to larger roots as they grow. Damaged vines have reduced vigor and may eventually die. This species is found throughout the eastern US, but is more damaging in southeastern states.

- **Control measures**
  - chlorpyriphos (Lorsban) application timing is an issue because the PHI is 35 days which restricts effective use on early maturing cultivars harvested in July and August
  - Mating disruption works
  - Cultural controls (good weed control) to reduce populations
  - Mass trapping males to reduce mating and subsequent population level

PIPELINE:
  - Nematodes for control of larvae
  - Need to test new chemistries for efficacy on grape root borer

"To do" list for grape root borer
Research needs:
- Test new chemicals for root borer control
- Determine efficacy of soil-applied neonicotinoids

Education needs:
- Proper identification of adults
- How to check for larvae in roots to assess extent of infestation

GRAPE PHYLLOXERA (*Daktulosphaira vitifoliae*)


Biology and management

Phylloxera are small, yellow aphid-like insects that live on vine roots and leaves. The root form of this pest prefers heavy, clay soils that crack during dry weather allowing pest to move to other vines. Phylloxera damages the root systems of grapevines by feeding on growing rootlets, which then swell and turn yellowish, or on mature hardened roots where the swellings are often hard to see. Necrotic spots (areas of dead tissue) develop at the feeding sites and become infected with secondary fungal pathogens that kill the vines. Labrusca grapes can tolerate phylloxera feeding on roots, particularly in well-watered vineyards. This form is effectively managed by using resistant or tolerant rootstocks. In the eastern US, the foliar form of phylloxera can be seen on wild grape, labrusca, and several hybrid varieties as raised galls on the undersides of leaves. Grape varieties from crosses of *V. vinifera* and various American *Vitis* species when grown in the NorthCentral Region were highly susceptible to leaf galling including: Aurora, Cascade, Cayuga White, Chambourcin, Chancellor, Chelois, DeChaunac, Delaware, Himrod, Lakemont, Norton/Cynthiana, Rayon D'Or, Reliance (table grape), Rougeon, Seibel, Seyval, Vidal, Vidal Blanc and Vignoles. Well timed insecticide sprays control the foliar form on susceptible varieties.

Registered insecticide efficacy

- **Products for control of the aerial form**
  - endosulfan (thiodan)
    - Efficacy: Good (not as good as Danitol)
    - Used more before Danitol came out; not restricted; cheaper than Danitol; the liquid formulation (EC) can cause phytotoxicity on some varieties

  - fenpropathrin (Danitol)
    - Efficacy: Excellent
    - Product of choice; timing is important in different areas (spray when leaf galls appear; spray around bloom can knock down populations for the season; timing by crawler emergence from galls)

  - acetamiprid (Assail)
    - Efficacy: Good-Excellent
    - Starting to use; not as effective as Danitol (shorter residual); not restricted use pesticide

- dinotefuran (Venom)
  - Efficacy: Not used but high efficacy expected

- imidacloprid (Admire)
  - Efficacy: Good
  - Learning how to use it, timing (needs to be applied before crawler activity); systemic

- bifenthrin (Capture)
  - Efficacy: Good-Excellent in recent trials in Ohio

- beta-cyfluthrin (Baythroid XL)
  - Efficacy: Good-Excellent in recent trials in Ohio

PIPELINE
Neonicotinoids and other systemic insecticide under development for grape (thiamethoxam, spirotetramat, etc.) may have a good fit. Development of soil-applied formulations has promise.

- ***Pest management aids***
  - Resistant rootstock is the main cultural control

"To do" list for grape phylloxera
Research needs:
- Determine relative resistance of varieties grown in North Central Region to both foliar form and root form of grape phylloxera
- Describe basic seasonal biology of root and foliar phylloxera in the North Central Region
- Develop damage thresholds for varieties that are moderately to highly susceptible to foliar phylloxera
- Compare vigor and yields of susceptible varieties grafted to regionally adapted phylloxera resistance rootstocks
- Evaluate various soil amendments (vermicompost, compost tea, compost, fungi, nematodes) as to suppression of root grape phylloxera and/or antagonistic interactions of introduced soil microbes in reducing root pathogenic fungi associated with grape phylloxera attack.
- Evaluate soil-applied insecticides and other new pesticide options for efficacy at controlling infestations

Regulatory needs:
- Registration of effective insecticides for phylloxera control

Education needs
- Learn to detect the crawler emergence period near bloom to time sprays to control crawlers on varieties known to be suffer yield or vigor loss by foliar phylloxera leaf galling.
- Do not spray varieties resistant to foliar phylloxera
- Necessity to graft resistant rootstocks to varieties moderately to highly susceptible to root phylloxera

MULTICOLORED ASIAN LADYBEETLE (*Harmonia axyridis*)

Biology and management

A biological control agent, the multi-colored Asian ladybeetle was introduced into the US for control of various aphid pests in crops. It is now well-established and is likely to be present in the northcentral region for many years, particularly because it is beneficial to some crops. However, the grape industry and other fruit crops have had some severe problems with juice quality in recent years caused by this insect.

During the summer, multi-colored Asian ladybeetle provides suppression of soft-bodied insects, but in the fall (during grape harvest time), the beetles change behavior and search for sources of carbohydrate, and also search for tight spaces for overwintering. This results in beetles infesting grape clusters during harvest in states north of Missouri. When crushed, beetles in clusters release defense secretions that taint the wine or juice. Such products may be unmarketable, and in recent years there have been some massive losses of potential wine sales because tainted juice had to be dumped.

This is a relatively new pest and there are active research programs learning about its biology and control. Because of the timing of multi-colored Asian ladybeetle infestation, products with short PHIs are most valuable for control.

Registered insecticide efficacy

- dinotefuran (Venom)
  - Effectiveness: Good-Excellent
  - Specifically labeled for Asian ladybeetle
  - 1-day PHI; not used much yet (just got label this year) but expected to be used
  - The 2ee label for multicolored Asian ladybeetle does not include IA, MO, SD, ND, NE and KS of the North Central Region

- imidacloprid (Provado)
  - Effectiveness: Good-Excellent
  - Not always the most effective treatment (from side by side trials)
  - 0-day PHI
  - Sublethal paralysis could be a concern for wine-making since the insect could still be in the cluster

- acetamiprid (Assail)
  - Efficacy:
  - 7-day PHI; not widely used; some use in Iowa because it is shows good to excellent efficacy against multicolored Asian ladybeetle, is not a restricted use pesticide and can also be used against phylloxera

- Bifenthrin (Capture / Brigade)
  - Efficacy: Applications 7 days before harvest have been highly effective in vineyard trials (in MN)
  - Pyrethroid. Potential concerns of residue on grapes?

- beta-cyfluthrin (Baythroid XL)
  - Efficacy: Low rates have been highly effective in vineyard and laboratory trials
  - Pyrethroid. Potential concerns of residue on grapes?
  - 3-day PHI
  - Not used, may have potential for use due to efficacy and relatively short PHI

- zeta-cypermethrin (Mustang Max)
  - Efficacy: Excellent
  - Supplemental label with MALB
  - 1-day PHI
  - Not used, due to registration during 2007. Short PHI provides flexibility for growers.

- pyrethrum (Evergreen)
  - Pyrethrum plus PBO (PBO = piperonyl butoxide which is a pesticide synergist that increases the activity of pyrethrum insecticides)
  - Most effective biological insecticide tested in recent trials
  - Provides one day of beetle control in lab and field studies
  - 12 h PHI
  - Not used due to low MALB populations recently

- pyrethrum (Pyganic)
  - Pyrethrum only
  - Active, but short residual control
  - Organic registration
  - 12 h PHI
  - Not used

- neem (Aza-Direct, Ecozin, Neemix etc.)
  - Organic option
  - Efficacy: Good-Excellent, but only knockdown for 24-36 hours
  - Has a potent odor and can be oily, which could potentially be a problem for wine makers if applied too close to harvest

PIPELINE
Neonicotinoids and pyrethroids should all be active, but PHI is most important issue when labeling due to the timing of infestation near harvest

- ***Pest management aids***
  - Floating row covers have been found to reduce MALB numbers in clusters
  - Traps in development, but not commercialized for agriculture
  - Binomial sampling scheme developed by Bill Hutchison at U. Minnesota predicts need to spray based on thresholds
  - Thresholds developed for juice and some winegrapes, for number of beetles in a volume/weight of grapes that can cause detectable residues in the juice or wine. However, there is wide variability in the human perception threshold
  - Studies underway at Brock University, Ontario and elsewhere to strip the beetle taint from wine and juice

"To do" list for multicolored Asian ladybeetle
Research needs
- Determine link between soybean aphid and multi-colored Asian ladybeetle populations – predicting risk of infestation
- Test new products with short PHI for removing infestations
- Identify deterrents for preventing infestation or attractants for mass trapping
- Weather based prediction of risk
- Tank mixing repellants or attractants with contact insecticides
- Oxidate as a repellant just before harvest
- Interference of insecticides with fermentation, overall wine quality
- Control of soybean aphid to decrease multi-colored Asian ladybeetle populations
- Remediation of taint in wine during/after wine production
- Spray timing for multi-colored Asian ladybeetle (suppress overall population when they first show up or just spray the day before harvest)
- What triggers Fall aggregation and feeding behavior (temperature, kairomone, etc.)?
- Role of grape damage (cracking, bird damage, etc.) on feeding and aggregation behavior
- Development of physical methods (washing the conveyor system, floating, etc.) that wineries can use to remove multicolored Asian ladybeetle from grapes.
- Testing to show there are no off flavors in wine made from grapes that have been sprayed to control multicolored Asian ladybeetle close to harvest

Regulatory needs
- Stop importing biocontrol agents!
- Getting multi-colored Asian ladybeetle on label of effective insecticides in different chemical classes, with short PHIs
- Reduce 30-day PHI in Capture/Brigade (this is a research priority as well)

Education needs
- Grower/winemaker training on sampling plan, thresholds, and control options

GRAPE FLEA BEETLE (A*ltica chalybea*)

Biology and management

Beetles feed on swelling buds, and larvae can be active feeding on clusters and leaves up to bloom. Damage is usually worse on the edge of vineyards, adjacent to woods. Pest can move to the vineyard quickly. The grape flea beetle (or steely beetle) is 4-5mm long and a shiny metallic dark blue. It is capable of jumping when disturbed. The insect overwinters as an adult, and this stage causes damage when conditions warm in the spring by direct feeding on young buds. The borders of vineyards adjacent to woods or other protected areas are most affected. Adults damage swelling buds, hollowing them out. Their damage can easily be confused with cutworm damage, and both species feed during bud swell. The level of injury varies between years, and is worse when bud development is slowed by cool temperatures.

Registered insecticide efficacy

- carbaryl (Sevin)
  - Efficacy: Good-Excellent; preferred product

- danitol
  - Efficacy: Good-Excellent

- pyrethrum (Pyganic)
  - Efficacy: Not used

- pyrethrum (Evergreen)
  - Pyrethrum plus PBO (PBO = piperonyl butoxide which is a pesticide synergist that increases the activity of pyrethrum insecticides)
  - Efficacy: Not used

- beta-cyfluthrin (Baythroid XL)
  - Efficacy: Not used

- zeta-cypermethrin (Mustang Max))
  - Efficacy: Not used, because it was just labeled in May of 2007.
  - Has grape flea beetle on the label

- ***Pest management aids***
  - Scouting for cutworms and for flea beetles can detect risk of bud damage.

"To do" list for grape flea beetle

Research needs

- Determine weather conditions that bring beetles into vineyards
- Information on what pesticides are effective on this insect
- Damage thresholds (how much damage can buds handle before their fruiting and growth potential are compromised?)

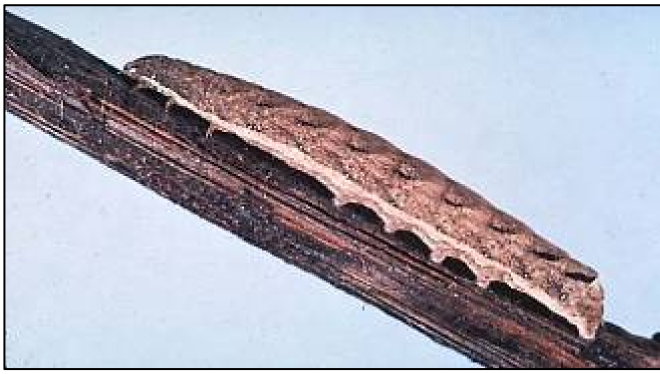
Regulatory needs

- Short REI products (to get workers back in the vineyard quickly)
- Information on what pesticides are effective on this insect

Education needs

- Identifying beetle damage compared with cutworm damage

CLIMBING CUTWORM (Family Noctuidae, multiple species)




Biology and management

The larvae of climbing cutworms are large, smooth caterpillars, measuring 1.2-1.6 inches (30-40 mm) when fully grown. The head capsule is usually dark, and the body is a dull gray-brown color marked with dots or stripes. Climbing cutworm larvae overwinter in the soil of the vineyard floor, and first become active in the spring when vine buds begin to expand. Larvae feed on young buds at night, hiding beneath the vines in topsoil beneath leaf litter during the day. Buds may be removed completely by feeding, or an area of chewing damage may remain. Cutworms are mainly a pest in areas with sandy soils, and in vineyards with weeds under the vines. Vineyards with a history of cutworm damage should be scouted regularly during bud expansion, particularly after warmer nights. Once shoot expansion begins, vines are no longer at risk. The level of injury varies depending on growing conditions in the spring and is worse when bud development and shoot growth are slowed by cool temperatures.

Registered insecticide efficacy

- chlorpyriphos (Lorsban)
  - Efficacy: Excellent
  - Labeled as a 24c Special Local Needs label in Michigan for use on cutworms
  - 24c SLN label expires in early 2009

- fenpropathrin (Danitol)
  - Efficacy: Good-Excellent
  - Some usage

- bifenthrin (Capture)
  - Efficacy: Good-Excellent
  - Newly registered, not widely used yet

- beta-cyfluthrin (Baythroid XL)
  - Efficacy: Not known in grapes, excellent control of cutworms observed in corn.
  - Newly registered, not widely used yet

- zeta-cypermethrin (Mustang Max)
  - Efficacy: Not known in grapes, excellent control of cutworms observed in corn.

- carbaryl (Sevin)
  - Efficacy: Good
  - Sometimes used in order to save Danitol sprays for later in the season; usually used in conjunction with flea beetle spray

- spinetoram (Delegate)
  - Efficacy: Good, but little experience so far
  - Registered in late 2007

"To do" list for climbing cutworm

Research needs

- Identify local habitat factors (weed species, soil types, etc.) in and around vineyards that contribute to cutworm outbreaks so scouting can be concentrated in those locales
- Determine species of cutworm causing damage

Education needs

- Weed control to reduce cutworms

ROSE CHAFER (*Macrodactylus subspinosus*)


Biology and management

The rose chafer is a light tan beetle with a darker brown head. It has long legs, and is about 12 mm long. There is one generation per year. It emerges from the ground in late May or June, near the time of grape bloom, and lives for three weeks. The adults feed on leaves and flowers of grapes. Females lay groups of eggs just below the surface in grassy areas of sandy, well drained soils. The larvae (grubs) spend the winter underground, and move up in the soil to feed on grass roots, followed by pupation in the spring. A few weeks later they emerge from the soil and disperse by flight. Male beetles are attracted to females and they congregate on plants to mate and feed. Rose chafer adults are strongly attracted to the blossom buds and can destroy a crop in June if not controlled.

- **Organophosphates**
  - azinphos-methyl (Guthion)
    - Efficacy: Good
    - Grapes taken off the label in 2005, but still has a tolerance.
  - phosmet (Imidan)
    - Efficacy: Good - excellent
    - Main remaining OP used in vineyards.
    - Shorter residual control than Guthion.
    - Requires high rate and pH 6 spray water for optimal performance.
    - 7-day PHI but 14-day REI; makes use in season more challenging, especially for Japanese beetle control.
  - diazinon (Diazinon)
    - Not used
  - malathion (Malathion)
    - Not used
- **Carbamates**
  - carbaryl (Sevin)
    - Efficacy:
    - Widely used for Japanese beetle control, active on other co-occurring pests.
    - Provides good control of adults, one week of activity.

- methomyl (Lannate)
  - Active, but short residual control.

- **Pyrethroids**
  - fenpropathrin (Danitol)
    - Efficacy: Very good in Ohio and should be very good else as well
    - Broad activity on other pests
    - No mite outbreaks reported to date (over five years use)

  - bifenthrin (Capture)
    - Efficacy:
    - Recently registered (2006)

  - beta-cyfluthrin (Baythroid XL)
    - Efficacy:
    - Recently registered (2006)

  - zeta-cypermethrin (Mustang Max)
    - Efficacy:
    - Recently registered (2007).

- **Other insecticides**
  - imidacloprid (Provado Pro)
    - Neonicotinoid insecticide
    - Reduced-risk, systemic insecticide
    - Efficacy: Not known

  - imidacloprid (Admire)
    - Soil formulation of Provado (imidacloprid)
    - Efficacy: Not known
    - Slow updake and price may limit utility
    - Could be used for killing grubs if an isolated infestation

  - acetamiprid (Assail)
    - Neonicotinoid insecticide
    - Foliar application allowed
    - Efficacy: Not known

  - dinotefuran (Venom)
    - New (2006) neonicotinoid insecticide
    - Soil and foliar application allowed
    - Efficacy: Not known

  - azadiractin (Neemix, Ecozin)
    - Efficacy: Not known
    - Not used

- pyrethrum (Pyganic)
  - Efficacy: Not known
  - Not used

- pyrethrum (Evergreen)
  - Pyrethrum plus PBO (PBO = piperonyl butoxide which is a pesticide synergist that increases the activity of pyrethrum insecticides)
  - Short residual activity
  - Efficacy: Not known
  - Not used

- kaolin (Surround)
  - Not used in most North Central region vineyards.
  - Requires many applications.
  - Maintaining coverage is difficult with rainfall.
  - Expensive

- thiamethoxam (Actara)
  - High efficacy expected
  - Registered in late 2007

PIPELINE

- thiacloprid (Calypso)
  - Neonicotinoid
  - High efficacy expected, with wide spectrum of activity

- clothianidin (Belay)
  - Soil applied formulation
  - Neonicotinoid
  - Efficacy: Not known

- metaflumizone (Alverde)

- spirotetramat (Movento)

- ***Pest management aids***
  - Traps are highly effective, but may draw beetles to the vineyard.
  - Beetles and their damage are easy to see.

"To do" list for rose chafer

Research needs:

- Determine efficacy of soil-applied and foliar insecticides
- Determine thresholds for different types of grape cultivars, under various crop loads

Education needs:

- Information on vine tolerance, pesticide efficacy, biology

MITES (European red mite, *Panonychus ulmi*; two spotted spider mite; *Tetranychus urticae*; Grape Erineum mite, *Colomerus vitis*)



Biology and management

Mites are generally not a primary pest management concern of grape growers in the northcentral region. However, in some sites and in some years, conditions conducive to their growth occur and high populations can be found that cause leaf bronzing. For this reason, mites and their symptoms are monitored during regular vineyard scouting and growers aim to minimize the risk of flaring their populations through selection of insecticides that minimize toxicity to predatory mites.

The adult female of the **European red mite** (*Panonychus ulmi)* is about 1/50 inch long and is dark red with eight legs. Adult male mites are smaller than females and have a pointed abdomen; they are usually dull green to brown. Mites hatch in the spring from tiny spherical eggs that are laid around cane nodes. These eggs can be detected by scouting in early spring. Although several generations can occur each season, populations rarely increase enough to cause significant damage, as predatory mites prevent their growth. If predatory mite suppression is reduced by weather or pesticides, red mites can increase and cause bronzing that reduces vine photosynthesis. Red mites can be pests on juice and wine grape varieties.

The **two spotted spider mite** (*Tetranychus urticae*) can cause severe damage to wine grapes if pest mite populations reach high densities. Leaf tissue is removed by the mite's feeding, causing yellowing, and then bronzing, with thin-leaved varieties most susceptible. These mites overwinter in leaf litter, develop on weeds in spring, and move onto the vine as the ground cover dries in the summer. Water-stressed vines are most at risk. Protection of predatory mites is the most effective method of control, with biological control achieved with an average of one predatory mite per 10 two-spotted mites.

Erineum mites are very small and a microscope is needed to see this species. It overwinters beneath bark of one-year old canes and in spring the mites move to leaves where they cause an "erineum" (a mite-induced growth of high density of leaf surface hairs). The the lower surface, beneath the erineum, has a dense, white growth of abnormally curled plant hairs and the mites feed and reproduce in this patch of hairs. The best time for control is when shoots are growing or when erinea are just starting to form.

Registered insecticide efficacy

- Fenbutatin-oxide (Vendex)
  - Efficacy: Excellent on two-spotted mite and red mite.

- abamectin (Agri-mek)
  - Efficacy: Good on two-spotted, poor on grape erinium mite

- dicifol (Kelthane)
  - Efficacy: Good on European red mite

- JMS Stylet Oil
  - Efficacy: Fair-Good
  - Used in vineyards with history of mites

- fenpropathrin (Danitol)
  - Efficacy: Good-Excellent
  - Danger of killing predatory mites, so not used for mite control

- pyridaben (Nexter)
  - Efficacy: Fair-Good
  - Not used by growers

- bifenazate (Acramite)
  - Recently registered
  - High activity expected

- etoxazole (Zeal)
  - Efficacy: Excellent
  - Performs well on TSSM and ERM
  - Can be slow acting but long residual control

- spirodiclofen (Envidor)
  - Efficacy: Excellent
  - Performs well on TSSM, ERM, and rust mite species such as Erinium Mite
  - New mode of action, registered in 2007

- fenpyroximate (Fujimite)
  - Efficacy: Fair-Good
  - Broad activity on different mite species

- ***Pest management aids***
  - Predatory mites

"To do" list for mites

Research needs:

- Effective spray timing and products for grape erinium mite control
- Side-by-side comparison of new miticides; need data from vineyards not apple
- Species composition of predatory mites in NC region vineyards

Education needs:

- Grower education on pest and predatory mite identification
- Importance of predatory mite conservation through ground cover management and pesticide selection

OTHER INSECT/MITE PESTS

GRAPE ROOTWORM (*Fidia viticida*)
This beetle is light brown with yellow hairs, and is 6 mm long. It feeds on grape foliage as an adult, making a chain-like damage pattern. Immature stages feed on grape roots and can lead to vineyard decline over many years if left untreated. Grape rootworm adults begin appearing in vineyards in mid-to late-May, and then lay eggs on the vine trunk. Larvae later crawl into the soil and attach themselves to grape roots, developing there for one to two years while completing their development. Larvae eat small roots and bore into larger ones. Adult beetles and their foliage feeding have been found statewide in IA recently, but no economic root damage has been documented to date. This insect can be hard to eliminate once established.

Control Measures:
- carbaryl (Sevin)
  - Efficacy: Good

Research needs:
- Basic biology and timing of development
- Varietal susceptibility
- Damage thresholds

GRAPE CANE GIRDLER (*Ampeloglypter ater*)
The grape cane girdler is common in central and eastern United States but it rarely causes economic damage to vineyards. Adults girdle current-season canes with a row of punctures that causes canes to break off above the girdled areas. The adult is a black snouted beetle about 1/8 inch (4mm) long. The legless grub is slightly larger when full grown, and is white with a brown head. It is very similar in appearance to the closely related grape cane gall maker. Eggs are laid in late spring in a series of holes encircling the cane made by the female using its mouthparts. After eggs are laid, the female continues to make another series of punctures a few inches below the first girdle until the cane is encircled, but eggs are placed only in the holes of the first girdle. Grubs feed in the cane pith between the girdles. After larval development is completed, pupation occurs. Adults appear in late summer, go into hibernation, and reappear in late spring.

GRAPE CANE GALLMAKER (*Ampeloglypter sesostris*)
Grape cane gallmaker is a sporadic pest of grapes in the eastern US. Its damage is rarely abundant enough to cause economic injury, but young vineyards can be at risk because its damage can delay development of the trunk or cordon. This insect produces noticeable red galls on new shoot growth just above nodes. The majority of galls are beyond the fruit clusters and usually cause no serious yield loss. Canes with galls are capable of producing a crop the following year. The adult is a dark brown snout beetle about 1/8 inch (4mm) long and is very similar in appearance to the grape cane girdler. The legless grub is slightly larger when full grown, and is white with a brown head.

HORNWORMS (Family Sphingidae)
Sphingid larvae or "hornworms" are more commonly found in winegrape vineyards, where they feed on leaves. Larvae may be brown or green, with spots on the sides of the body, and a distinctive 'horn' on their posterior. The larvae can grow to 5 inches (12 cm) long, and feed voraciously during development. Because of this, hornworms are more of a concern in young vineyards with limited leaf area. Larger vines can usually tolerate some leaf area loss from their feeding. These insects are often parasitized by wasps that lay their eggs on the hornworms.

Control measures:

- carbaryl (Sevin)
  - Efficacy: Excellent
- *Bacillus thuringiensis* = *B. t.* (Dipel)
  - Efficacy: Excellent if high coverage is achieved and applications are made when larvae are young
- methoxyfenozide (Intrepid)
  - Efficacy: Excellent if high coverage is achieved and applications are made when larvae are young
- parasitic wasps
  - Not used commercially, but natural populations of wasps parasitize these larvae and kill them.

YELLOWJACKETS (*Vespula* spp. *or Dolichovespula* spp.)
Yellowjacket and other wasps may break open the skins of grape berries during late summer. In the early part of the growing season, wasps are mainly predatory, but toward the end of the season their behavior changes to searching for sugar, such as that found in ripe fruit. Control measures can be directed against the overwintering yellowjacket queens by establishing bait stations containing an attractant and a pesticide in early spring. Destruction of nearby nests is effective but difficult, because nests are often located underground.

Control measures:

- carbaryl (Sevin)
  - Efficacy: Excellent
  - 7 day PHI can be an issue

- phosmet (Imidan)
  - Efficacy: Fair-Good
  - 14 day REI makes use difficult for winegrape growers, or if insects are found close to harvest

- malathion (Malathion)
  - Efficacy: Good-Excellent
  - Lower rate used (as a repellent)

- zeta-cypermethrin (Mustang Max)
  - Efficacy: Good to Excellent – several growers in IA are using against multicolored Asian ladybeetle and are also repelling yellowjackets.

- imidacloprid (Provado)
  - Efficacy: Good-Excellent
  - Can be used also to control multicolored Asian ladybeetle control

- dinotefuran (Venom)
  - Efficacy: Not used enough yet to know possible use for control

Pest management aids

- Elimination of nests using directed insecticides (if you can find the nests)
- Minimize suitability of the farm for yellowjackets.
- Implement control measures early and maintain program to attract and kill wasps

Research Needs:

- Baited poisons in traps targeted at wasps, yellowjackets

Education Needs:

- Biology of native and invasive yellowjackets
- Role in biocontrol
- Effective methods for nest control

FRUIT FLIES (*Drosophila* spp.)

Drosophila females lay eggs near the surface of fermenting fruits. Eggs take only 30 hours to hatch, and the larvae develop in fermenting material. They feed near the surface, mostly on yeast, for 5-6 days and go to drier places to pupate. The life cycle may be completed within 8-10 days at 85 F (29 C). Timely harvesting can help prevent outbreaks of fruit flies in the vineyard, though management in processing facilities can be challenging.

Research Needs:

- Relationship between fruit flies and sour rot (Are fruit flies a carrier or do they just come in later)
- What will control them?
- Useful products that have a short PHI (so they can be used close to harvest)

ANTS (Formicidae)

A column of ants on a vine during the summer may be tending mealybugs, since they feed on the secreted honeydew. Ants can become a pest during harvest, when ripe berries are a source of sugar, and they can become a hazard for hand-pickers. They rarely require control and typically affect a small area of a vineyard.

Control:

- Keeping fruit rots in check could decrease ant populations

Research Needs:

- Baits for control (Esteem, for example)

GREEN JUNE BEETLES (*Cotinis nitida*)
Direct pest on ripening fruit in southern region of the Midwest, especially cultivars maturing in July and early August during adult flight
Zero tolerance in table grapes

Control Measures:
- o carbaryl (Sevin)
    - 7-day PHI is an issue since beetle attack ripe fruit near harvest

Research Needs:
- Need effective control measures close to harvest
- Work on identifying sex pheromone and kairomones that elicit feeding aggregations in order to develop baited trap or an attract and kill system

FALL ARMYWORM (*Spodoptera frugiperda*)
Seen in 2006 in very high numbers in northern MI
Erratic population cycles

Control Measures:
- o Trap for adults to keep an eye on populations
- o Expected to be controlled by many Lepidoptera-specific insecticides.
- o Beneficial Insects
    - Hard to make direct links between natural enemy presence and pest control
    - Make insecticide choices that will minimize natural enemy loss wherever possible

Education Needs:
- Educating growers on natural enemy preservation

PLANTHOPPERS
Potential issue in IA because it is common for planthoppers to move into vineyards in late summer when adjacent grasslands and borders are mowed. Species not known.

GRAPE CANE BORER (_Amphicerus bicaudatus_)
Wood boring buprestid beetle that enters one year old canes and kills the wood distal to the entry point. Also called the apple twig borer. Populations tend to be very localized and it is more of a problem near abandoned vineyards or orchards. More of an economic problem in young vineyards where growers are trying to establish a training system and young shoots are killed.
- Imidan lists this pest on the label
- Best timing for control is not clear
- Some work underway at Cornell University

Research Needs:
- Effective controls to minimize entry or survival
- Natural enemies for this pest

Education Needs:
- Identifying the damage
- Potential for cutting out infestations during pruning

Table 3. Efficacy Ratings[1] of Broad Spectrum Insecticides for the Major Insect Pests of North Central Region Vineyards †

Management Tools	Vineyard insect and mite pests[2]										
	GFB	CC	GBM	RC	GP	GLH	PLH	JB	MALB	TSSM	ERM
Organophosphates											
Diazinon			G			G	F	F		-	-
Imidan	G		E	G		G	F	G		-	-
Guthion	G		E	G		G	F	G		-	-
Lorsban[3]		E								-	-
Organochlorine											
Thiodan					E					-	-
Carbamates											
Sevin	G		E	E		G	G	G-E		-	-
Lannate	G		G	F		G	G	F		-	-
Pyrethroids											
Danitol	E	E	G-E	G	E	E	G	G-E		G	G
Baythroid XL		E	G-E			E	E	G	E	F	F
Capture/Brigade		E	G-E			E		G	E	F	F
Mustang (Max)		E				E	E		E	F	F

1. Efficacy rating symbols: E = excellent, G = good, F = fair, P = poor, NC = not controlled, NU = not used

2. Insect/mite abbreviations: GFB = grape flea beetle, CC = climbing cutworm, GBM = grape berry moth, RC = rosechafer, GP = grape phylloxera, GLH = grape leafhopper, PLH = potato leafhopper, JB = Japanese beetle, MALB = multicolored Asian lady beetle, TSSM = two spotted spider mite, ERM = European red mite.

3. Registered under 24c Special Local Needs label in Michigan

† *From Michigan State University 2007 Fruit Management Guide (Bulletin E-154).*

Table 3 (con't). Efficacy Ratings[1] of Other Insecticides for Control of the Major Insect and Mite Pests of North Central Region Vineyards†

Other registered alternatives	GFB	CC	GBM	RC	GP	GLH	PLH	JB	MALB	TSSM	ERM
Neonicotinoids											
Provado			-	G		E	G	G	G		
Admire						G		F			
Assail			-	G	E	E	G	G	E		
Venom			F	G	G	E	G	G	E		
Biologicals											
Bacillus thuringiensis	---	---	F	---	---	---	---	---	---	----	-----
Surround			F	F		F	P	F-E	P	----	----
Neemix, Ecozin			F	F				F		----	-----
Spintor			F			F		F		----	----
Entrust			F			F		F		----	-----
Pyganic				F				F		----	----
Evergreen				F				F	F	----	-----
Pheromone mating disruption			F								
Miticides											
Agri-Mek										G	
Vendex										G	
Kelthane										G	
Acramite										G	
Nexter										F	
Zeal										G	
Envidor										E	
FujiMite										F	
Oberon										G	

1. Efficacy rating symbols: E = excellent, G = good, F = fair, P = poor, NC = not controlled, NU = not used

2. Insect/mite abbreviations: GFB = grape flea beetle, CC = climbing cutworm, GBM = grape berry moth, RC = rosechafer, GP = grape phylloxera, GLH = grape leafhopper, PLH = potato leafhopper, JB = Japanese beetle, MALB = multicolored Asian lady beetle, TSSM = two spotted spider mite, ERM = European red mite.

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Table 3 (con't). Efficacy Ratings[1] of Other Insecticides for Control of the Major Insect and Mite Pests of North Central Region Vineyards†

New Chemistries (PIPELINE)	**GFB**	**CC**	**GBM**	**RC**	**GP**	**GLH**	**PLH**	**JB**	**MALB**	**TSSM**	**ERM**	
rynaxypyr (Altacor)			G									
emamectin benzoate (Proclaim)												
indoxacarb (Avaunt)			G	G		G	G	G				
flubendiamide (Belt)			G									
metaflumizone (Alverde)			G									
clothianidin (Clutch/Belay)				G	G							
buprofezin (for scale)												
spinetoram (Delegate)			G			G	G					
Cultural Controls												
Resistant rootstocks					E							
Remove wild grape			NC									

1. Efficacy rating symbols: E = excellent, G = good, F = fair, P = poor, NC = not controlled, NU = not used

2. Insect/mite abbreviations: GFB = grape flea beetle, CC = climbing cutworm, GBM = grape berry moth, RC = rosechafer, GP = grape phylloxera, GLH = grape leafhopper, PLH = potato leafhopper, JB = Japanese beetle, MALB = multicolored Asian lady beetle, TSSM = two spotted spider mite, ERM = European red mite.

1. Registered under 24c Special Local Needs label in Michigan

† *From Michigan State University 2007 Fruit Management Guide (Bulletin E-154).*

Table 4. Compounds under Evaluation in the IR-4 Program:

Chemical Name	Trade Name	Chemical Class	Registrant	Mode of Action (MOA)	Pest Complex	Registration Status
Rynaxypyr	Altacor	Phthalic Acid Diamides	DuPont	Ryanodine receptor modulators	Lepidoptera, Diptera	IR-4 trials in 07, EPA registration 2009
Flubendiamide	BELT	Phthalic Acid Diamides	Bayer	Ryanodine receptor modulators	Lepidoptera, Diptera	EPA registration 2009
Spinetoram	Delegate	Spinosyns	DOW	Nicotinic acetylcholine receptor agonists	Lepidoptera, Coleoptera, Diptera	EPA may allow bridging data with SpinTor for fast track registration 2009
Metaflumizone	Alverde	Semicarbizone	BASF	Sodium Channel Blocker	Lepidoptera, Coleoptera, Diptera	
Flonicamid	Beleaf	Pyridinecarboxamide	FMC	Not known	Aphids, Plantbugs	EPA registration 2007

For more information about IR-4 please see: www.cook.rutgers.edu/~ir4