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Chestnut Integrated Pest Management

Erin Lizotte
Senior Statewide IPM Educator



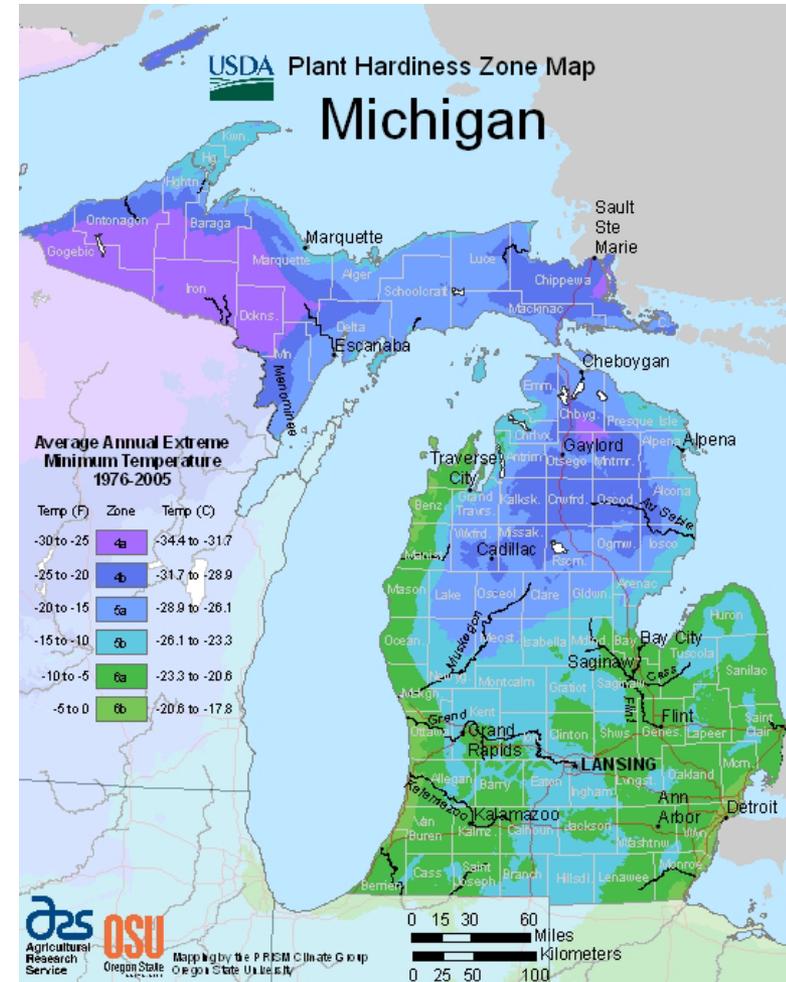
Overview

- MI/My perspective
- Scouting
- Pests of Importance
- Resources



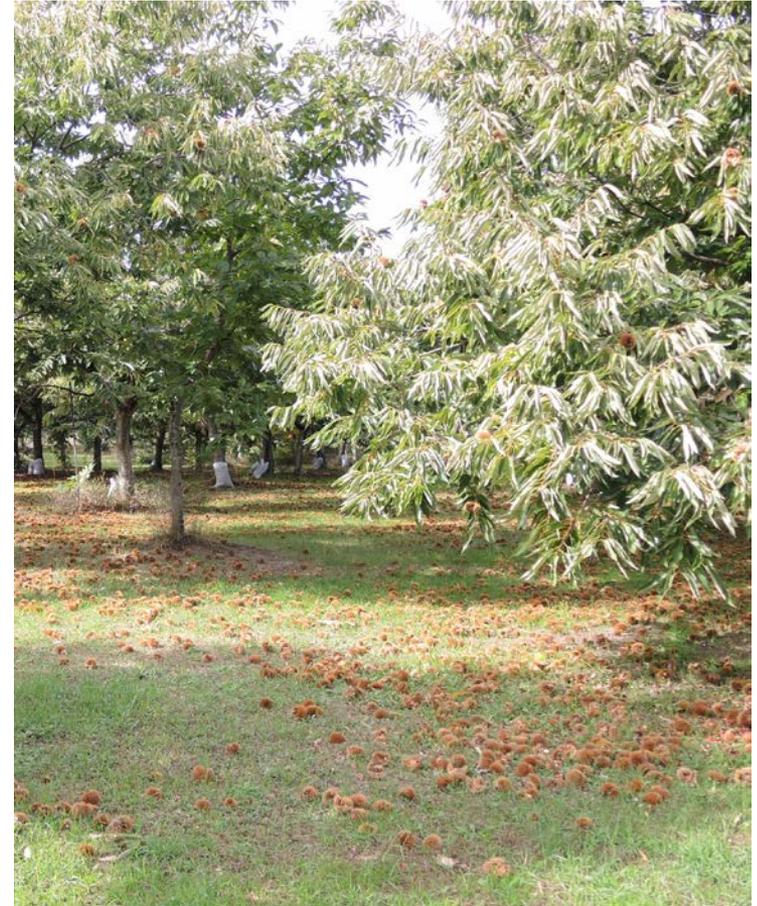
Michigan Industry

- Production concentrated in the “fruit belt”
- Michigan growing shy of 1M pounds, highest concentration of growers.
- Novelty offers growers the chance to capitalize on new and underserved markets, innovate, and diversify
- Establishing a new industry and market is also an enormous challenge
- Nationally, chestnut acreage in the U.S. has increased substantially over the past 30 years with the largest acreage increases in MI



Production

- Regional species preferences primarily due to response to chestnut blight
- Western states plant susceptible European/Japanese chestnuts
- Most eastern growers plant the naturally blight-resistant Chinese chestnut
- Michigan growers plant both Chinese and European chestnut species in orchards



Scouting

- Scouting involves monitoring the crop and cropping area for problems
- Begin as soon as trees begin to grow or pests become active
- Continue until crop is dormant or risk of the pest has passed



Scouting

- A critical step in quantifying the potential pest damage
- Aids in determining if intervention to control the pest is warranted
- Helps determine the lifestage of the pest which is critical to optimize management
- Assists in determining management efficacy



Scouting

- Scouting for diseases includes monitoring the crop for signs and symptoms of disease and quantifying incidence and severity



Scouting

- Scouting for insects includes looking for all life stages and attempting to quantify the population
- May also include inspecting for crop damage and setting traps to collect them



Abiotic issues

- Unexplained by pests
 - Cold
 - Lack of water
 - Lack of nutrient
 - pH
 - Mechanical damage
 - Excessive water



Vertebrate pests



Scouting protocol

- Section your planting off into manageable portions based on acreage, age, species, etc.
- Review the list of known pests and beneficials known to be active at that time



Michigan Chestnut Pest Scouting Calendar

	Dormancy	Bud swell	Bud break	Leaf expansion	Shoot elongation and catkin initials	Catkin maturity and pollen shed	Bur formation and catkin senescence	Kernel development	Bur splitting	Nut drop	Leaf senescence	Dormancy
												

Insects

Asian chestnut gall wasp	+	+	+	+	+	+	+	+	+	+	+	+
Potato leafhopper		+	+	+	+	+	+	+	+	+	+	
Chestnut weevil					+	+	+	+	+	+		
European rose chafer				+	+	+	+					
Japanese beetle						+	+	+	+			
European red mite	+	+	+	+	+	+	+	+	+	+	+	+
Lecanium Scale	+	+	+	+	+	+	+	+	+	+	+	+

Disease

Chestnut blight	+	+	+	+	+	+	+	+	+	+	+	+
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High risk, monitoring and control may be required

Less risk, monitoring or control may be required

+ Potential pest activity or visibility, monitoring should occur



Wait-- What am I looking for?

- Consider the following as a starting point:
 - Cupped, chlorotic, spotted or malformed foliage
 - Discolored, damaged, swollen or sunken areas of bark
 - A large number of insects—identify them!
 - Pockets of less vigorous or dying trees
 - **Anything out of the ordinary**



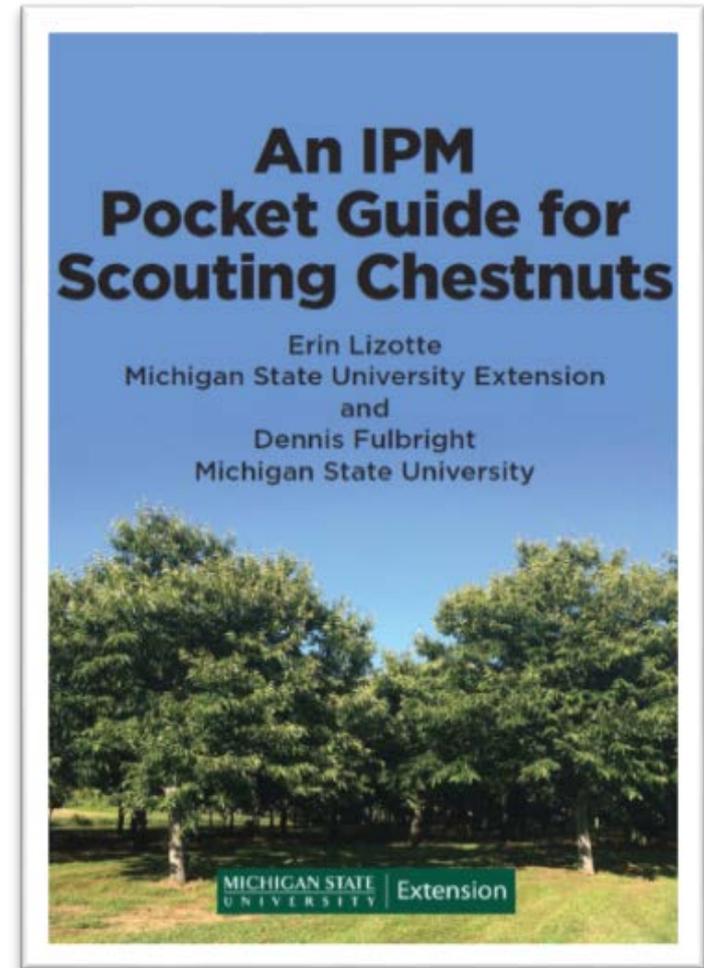
General Protocol

- Interior and edge
- Check new area each time
- Gently ruffle foliage as you walk looking for a flush of activity
- Remove leaves as you move through the orchard, flip them over and give a close inspection using a hand lens
- Check leaves from all reachable heights
- The more you look, the more you see.....



Scouting Resources

- Check out the pest management section of chestnuts.msu.edu
- Email me at taylo548@msu.edu
- Send a sample to Plant and Pest Diagnostics (pestID.msu.edu)
- Refer to the scouting guide





Notable Pests

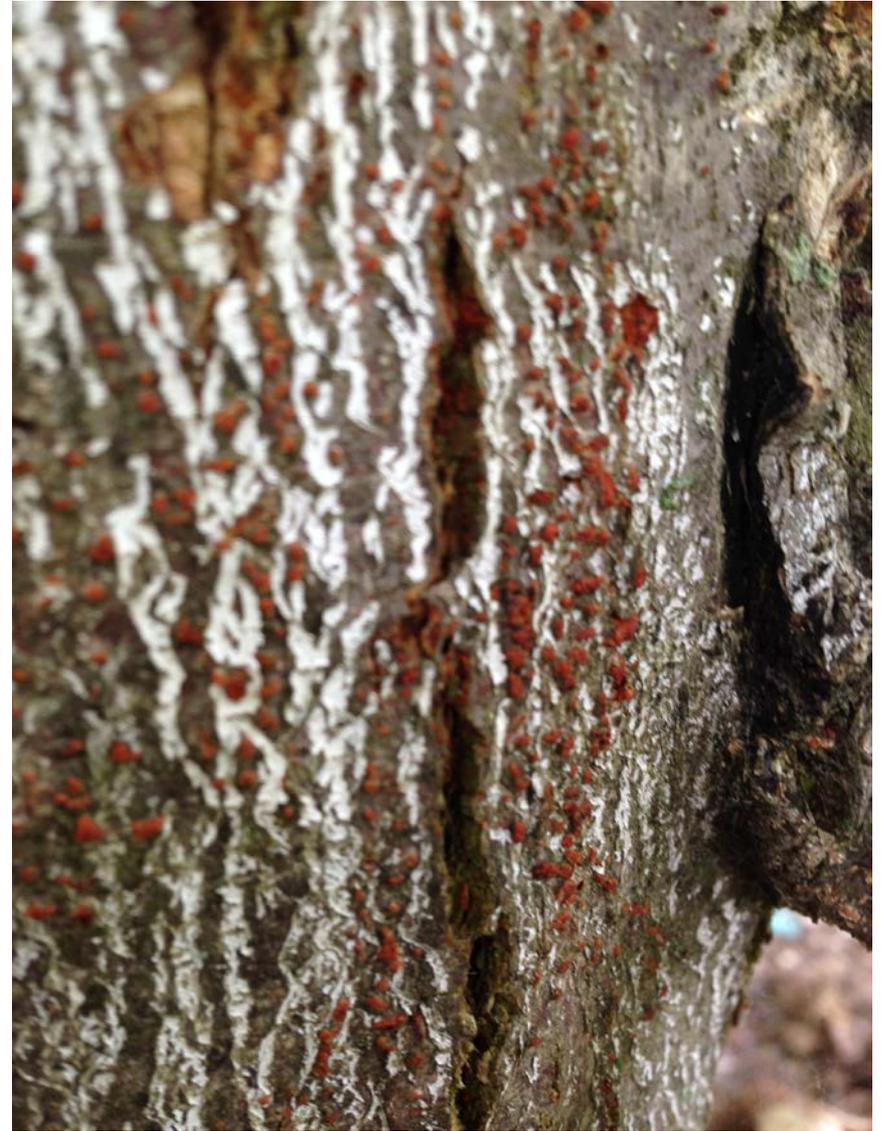
- **Chestnut Blight**
- **Asian Chestnut Gall Wasp**
- **Chestnut Weevil**
- **Nut rots**
- Potato leafhopper
- Mites
- Rose chafer
- Japanese beetle



Chestnut blight

- Caused by a fungi called *Cryphonectria parasitica*
- Introduced into the United States in the early 1900s and has spread throughout the range of the American chestnut
- The disease causes a canker disease on stems and branches
- On the highly susceptible American chestnut, cankers quickly girdle the stem and as a result the aerial portions of the tree die back
- Cannot infect the roots, which retain the ability to produce stump sprouts







Blight considerations

- Chinese and Japanese trees are tolerant but carriers.
- European chestnut is susceptible.
- American chestnut are very sensitive.
- Select least susceptible species that appropriate for goals.
- Source planting stock carefully.



Blight management

- Destroy infected trees in an effort to eradicate the disease
 - Growers suffer significant costs
- Currently no known chemical treatments
- Efforts underway at MSU to identify systemic fungicide treatments with currently labeled products
- Hypovirulence efficacy and implementation



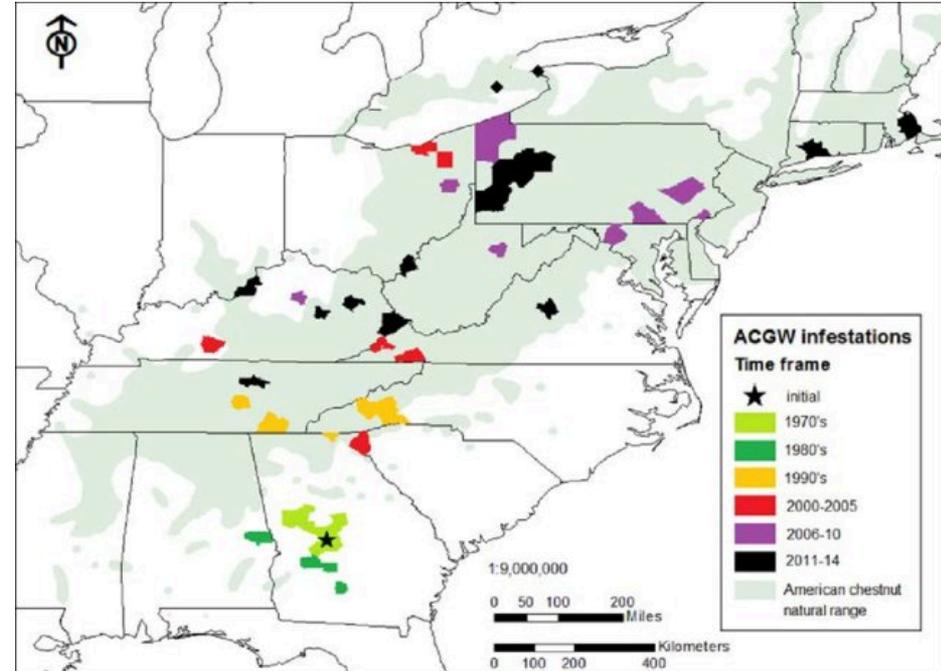
Asian chestnut gall wasp

- Asian chestnut gall wasp (*Dryocosmus kuriphilus*), is an invasive pest that can infest all species in the genus *Castanea*.
- Native to Asia, first reported in the U.S. in 1974.



ACGW distribution

- Introduced on imported plant material.
- From Georgia, the geographic range expanded reaching Virginia, Ohio, Kentucky, Maryland, Pennsylvania, Connecticut, Massachusetts, Ontario and finally Michigan.
- ACGW will likely continue to spread across eastern North America through natural dispersal and via infested plant material.



Distribution and spread of the Asian chestnut gall wasp in North America since its introduction in 1974 (updated December 2014). Credit: Ignazio Graziosi.



ACGW lifecycle

- Produces one generation per year via asexual reproduction, all female
- Adult females lay eggs inside buds in early summer and eggs hatch soon after
- After egg hatch, the larvae remain inactive until the following spring—they are undetectable at this time
- Accidental movement of infested plant material is a major concern



ACGW lifecycle

- Larvae induce the formation of galls at bud break the following spring
- Galls can form on stems, petioles, or leaves and protect the larvae and pupae
- Adults emerge from galls in early summer and begin laying eggs



Adult in dissected gall. Fulbright.



ACGW damage

- After the adult wasps emerge, galls become woody and dry out, but can persist on the tree for several years
- Galling reduces fruiting and nut yield, suppresses shoot elongation, reduces tree vigor, slows wood production, and can even kill trees
- Infested shoots do not produce new growth or flowers, thereby reducing or eliminating future nut production









Scouting for ACGW

- The easiest way to scout for the ACGW is to visually inspect for galls and hang yellow sticky traps at the end of June.
- Walk an edge and a transect in each 10 acre section, switching the route to cover new ground each week
- Scouting can take place at any time of the year as the galls persist on the tree even after the wasps emerge in early summer
- Leaves often remain attached to the galls during the winter making them highly visible at that time



The good news....

- In China, ACGW is kept in check by natural enemies, including *Torymus sinensis*.
- *T. sinensis* was introduced for ACGW control in the 1970's and is now well established in the eastern US.
- Two management options:
 - *T. sinensis*
 - Insecticides



T. sinensis larvae in gall wasp gall. Fulbright.



Chestnut Weevil

- Most important insect pest of chestnut in the central-eastern U.S.

is lesser chestnut weevil (*Curculio sayi*).

- Large chestnut weevil (*C. caryatrypes*) is also an important pest but is less prevalent.
- Episodic but highly destructive pest.
- Large and lesser chestnut weevil are native weevils and are host-specific, only infesting tree species in the genus *Castanea* (American chestnut, Chinese chestnut, European chestnut and chinquapin).



Lesser chestnut weevil Jennifer C. Giron Duque,
University of Puerto Rico, Bugwood.org



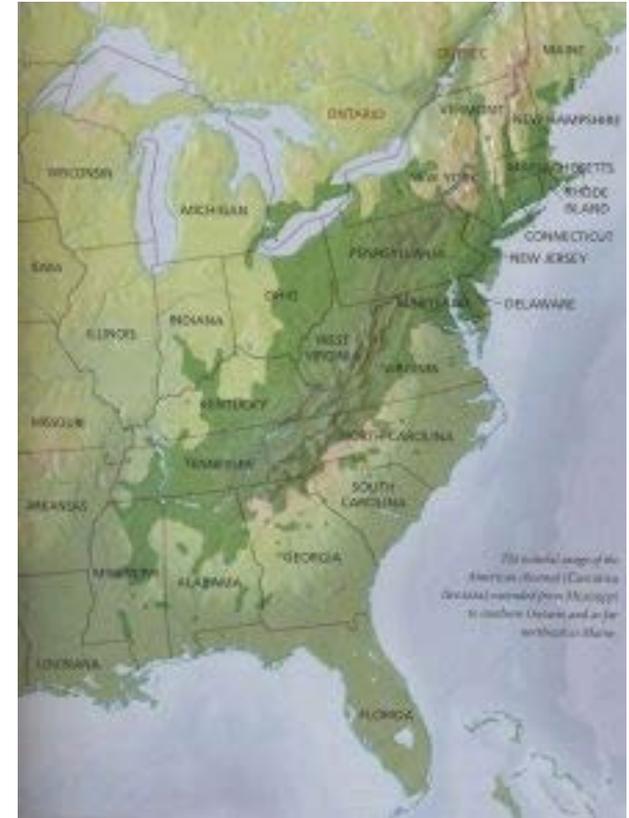
Chestnut Weevil

- Both species lay eggs on developing nuts, the larvae feed within the nut, compromising the kernel.
- If left unchecked, can infest and destroy nuts.
- Larvae can be present at harvest creating consumer issues.



Chestnut Weevil

- Weevil range mirrors that of American chestnut and extends into some areas of commercial production.
- When native chestnut stands collapsed from blight, weevil populations shrunk to pockets where chestnuts are present.



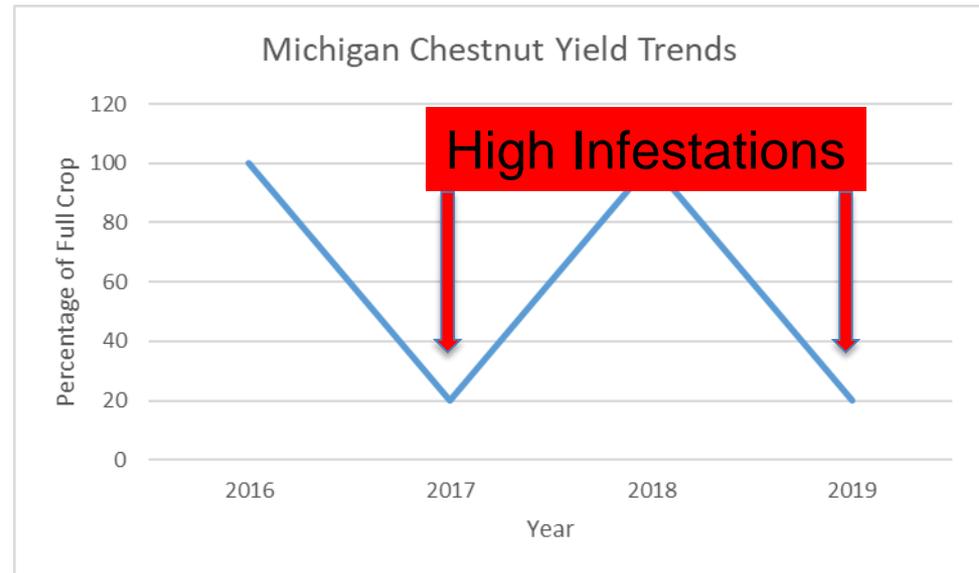
Native range of American Chestnut.
Photo credit: American Chestnut Foundation Media.



Chestnut Weevil Outbreaks

2017 and 2019,
some farms
experienced high
levels of weevil
infestation at harvest.

- Bumper 2016/18 crops (tons of egg-laying sites).
- Low crop in 2017/19 (very few egg-laying sites).



Lesser Chestnut Weevil Lifecycle

- Adults likely emerge during two separate periods around bloom and early fall before burrs open.
- Spring populations feed on catkins while available, it is unknown if they return to the soil or feed on other plants.
- Eggs are deposited in the downy lining surrounding the nut as burrs open and hatch in approximately 10d at which time the larvae feeds on the kernel and develops within the shell.
- After 2-3 weeks, larvae exit and drop to the soil.
- Most overwinter as larvae, pupate in the soil the following fall and overwinter as adults.
- The total lifecycle is completed in 2-3 years.



Large Chestnut Weevil Lifecycle

- Adults likely emerge as pollen shed ends and immature burrs form, laying eggs almost immediately.
- Eggs hatch in 5-7d and the larvae feed and develop within the nut for 2-3 weeks.
- The larvae usually exit the chestnut before the nuts drop to the ground, overwintering in the soil.
- Pupation and adult emergence takes place the following summer, a small population of larva may overwinter a second winter before pupation.
- The total lifecycle is completed in 1-2 years.



Identification

- Lesser and large chestnut weevil both have robust bodies and are dark brown or tan with brown mottling or stripes.
- Lesser chestnut weevil is $\frac{1}{4}$ inch in length, with a snout of equal or greater length.
- The body of the large chestnut weevil is $\frac{3}{8}$ inch long, the snout is $\frac{3}{8}$ - $\frac{5}{8}$ inch long.



*Lesser chestnut weevil Jennifer C. Giron Duque,
University of Puerto Rico, Bugwood.org*



Large chestnut weevil, Todd Luety OMAFRA



Scouting

Scouting for weevils using a limb-tapping.

- Place a light colored sheet under the limb you are sampling and tap the branch with a padded pole or stick.
- Jarring the branch causes the weevils to drop from the tree onto the sheet.
- Weevils “play dead” when disturbed so don’t be fooled.
- Chestnut weevils are substantial in size and should be easily visible if present.
- Growers should sample at least 30 branches per acre.
- Scouting locations should include both the edges and interior of orchards as well as any hotspots that are identified.



Management

- #1 goal: Prevent larvae in nuts at harvest.
- #2 goal: Prevent nut damage from feeding.
 - The 4 weeks prior to harvest are the most critical.
- There are chemical, cultural and postharvest treatments available to control chestnut weevils.
- Ideally, a combination of cultural and chemical management would control the pest and eliminate the need for postharvest treatment which can diminish quality and the marketable yield.



Management

- Sanitation is an important part of the management of these pests.
- Collecting and destroying fallen nuts may help remove developing larva from the orchard.



Chemical Management

- Insecticides should target the later windows of potential adult activity:
 - August-September for large chestnut weevil adult emergence.
 - September-October for lesser chestnut weevil fall adult emergence.
 - With limited biological data, the goal is to protect kernels
- Avoid applying pesticides during May-June as bees are often foraging at that time.



Best Candidates?

Selected Pesticides for Chestnut Weevil Management, 2020

Active Ingredient (Mode of Action Code)	Products Labeled	Pesticide Efficacy ¹			Beneficial Insect Toxicity ²			Fruit rate per acre	Chestnut Rate per acre	Seasonal Max per acre	Max Applications per Season	Application Interval Minimum	Days of Control	PHI	Notes
		PLH	Scarabs	Plum Curculio	Bees	Mite predators	Insect predators								
Phosmet (1B)	Imidan 70W	G-E	E	E	T	S	M	2.125 lb	4.3-8.5 lbs	17.14lbs	2-3		3-10 days	28 days	Imidan is an organophosphate insecticide and provides good broad-spectrum control of many pests in Michigan.
Carbaryl (1A)	Sevin 4F	E	G-E	G	T	T	T	2-3 qts.	4-5 qts.	15 qts.	4	7	3-10 days	14 days	Sevin is an organophosphate insecticide and provides good broad-spectrum control of many pests in Michigan.
Acetamiprid(4A)	Assail 30SG	E	E	E	M	S	M	2.3-3.4 ounces	4.1 ounces	16.4 ounces	4	14	7 days	14 days	Targets aphids, leafhoppers, leafminers, Japanese beetle, plum curculio, as well as some lepidopteran pests. This translaminar (locally systemic) material has a long residual inside the plant.
Clothianidin(4A)	Belay	E	E	E	M	S	M	6 fl.oz.	3-6 fl.oz.	12 fl.oz.	2	10 days	7 days	21 days	Targets aphids, leafhoppers, leafminers, curculio, Japanese beetle and lepidopteran pests. As a foliar spray Belay is a translaminar (locally systemic) material, and has long residual inside the plant.

1. Pesticide efficacy ratings; E-excellent, G-good, F-fair, P-poor, U-unknown, N-pest not included on label. 2. Beneficial insect toxicity; S-safe, M-moderate, T-toxic, U-unknown, not evaluated by MSU.

* OMRI approved for organic production.** Products containing these active ingredients are classified as a restricted use pesticides and require the applicator to retain a pesticide applicator license.

Pesticide efficacy and beneficial insect toxicity is based on trials in fruit crops with products containing the same active ingredient, as reported in the E154 Fruit Management Guide, Michigan State University Extension.

- Active on potato leafhopper
- Multiple applications available
- Knockdown (Imidan and Sevin), longevity (Assail and Belay)
- Somewhat less toxic to beneficials
- Chestnut rates are higher than, or equal to effective rates on fruit beetle/weevil pests



Management

- Applications should only be made in response to positive identification of the weevil with regular scouting.
 - Carbaryl and Sevin are toxic to beneficial natural enemies including predatory mites.
- Thorough and frequent scouting is essential for optimal management, particularly with the lack of information regarding chestnut weevil behavior and prevalence in Michigan.
- Well timed applications, good sanitation practices and scouting will be the key to successful chestnut weevil management in Michigan.



Weevil Research

- Research into chestnut weevil is getting a big boost in 2020, led by the McCullough lab at MSU.
- As we learn about the biology of this pest and the efficacy of various insecticides we can improve management recommendations.

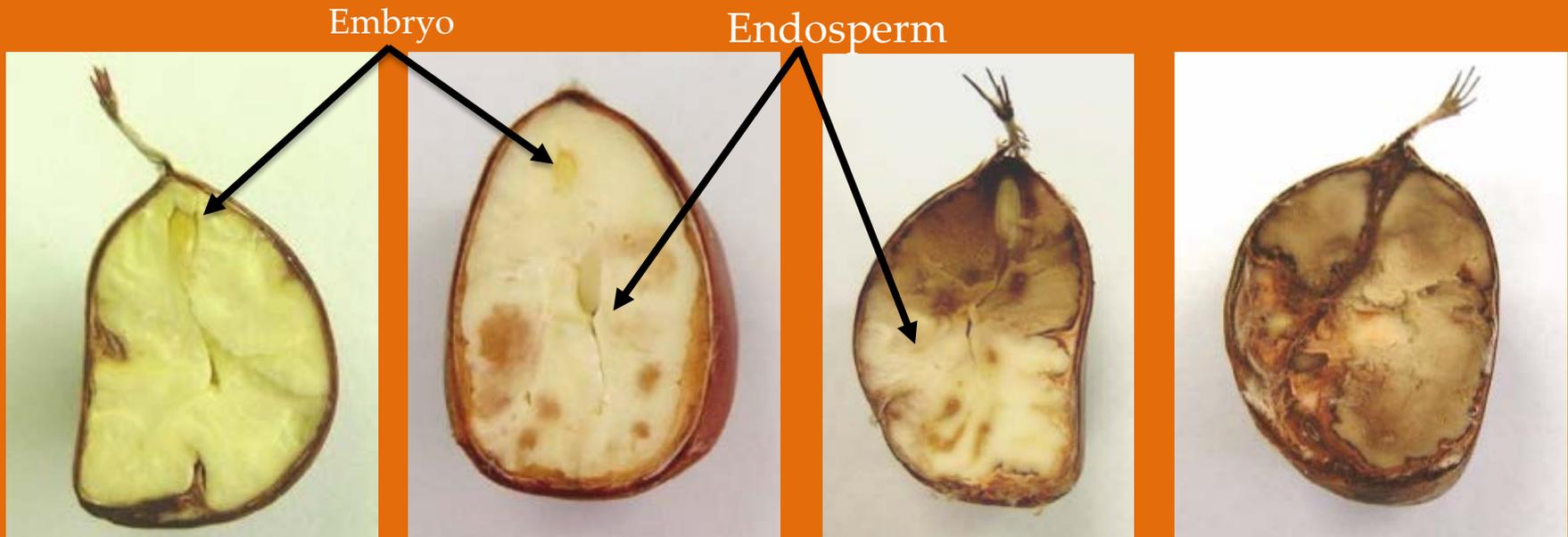




Brown Rot Of Chestnut

- Caused by *Gnomoniopsis smithogilvyi*
- Global distribution- Italy, Switzerland, France, India, Australia, and New Zealand
- Results in an internal rotting of nuts, that increases post-harvest.
- Also associated with cankers
- High levels of rot incidence have been reported
 - 60-90% in Italy
 - 70% in Australia
 - 20% in Switzerland
- Effort led by Dr. Monique Sakalidis





Healthy nut

Symptoms

Light, medium and dark brown lesions on the endosperm and embryo of the nuts



Range of rot symptoms observed

Brown rot



Brown wet,
spongy
lesions

Other symptoms



IKB



Other
fungi/bacte
ria/ insect
damage



Nut Rotting Pathogens Collected



Fusarium spp.



Gnomoniopsis spp.



Fusarium spp.



Botryosphaeria spp.



Rhizoctonia spp.

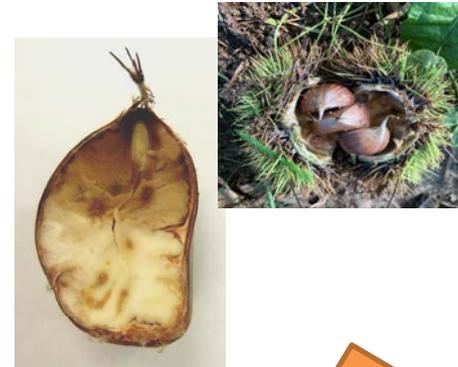


Penicillium spp.



Disease/Life Cycle

Summer
Secondary infection: transported by rain splash, wind and insects



Fall
 Symptoms at nut maturity: increase over time

Primary infection: spores are transported up to flowers, leaves, and branches



Spring



Overwintering: on debris on the orchard floor

Winter



Disease Management In the Field

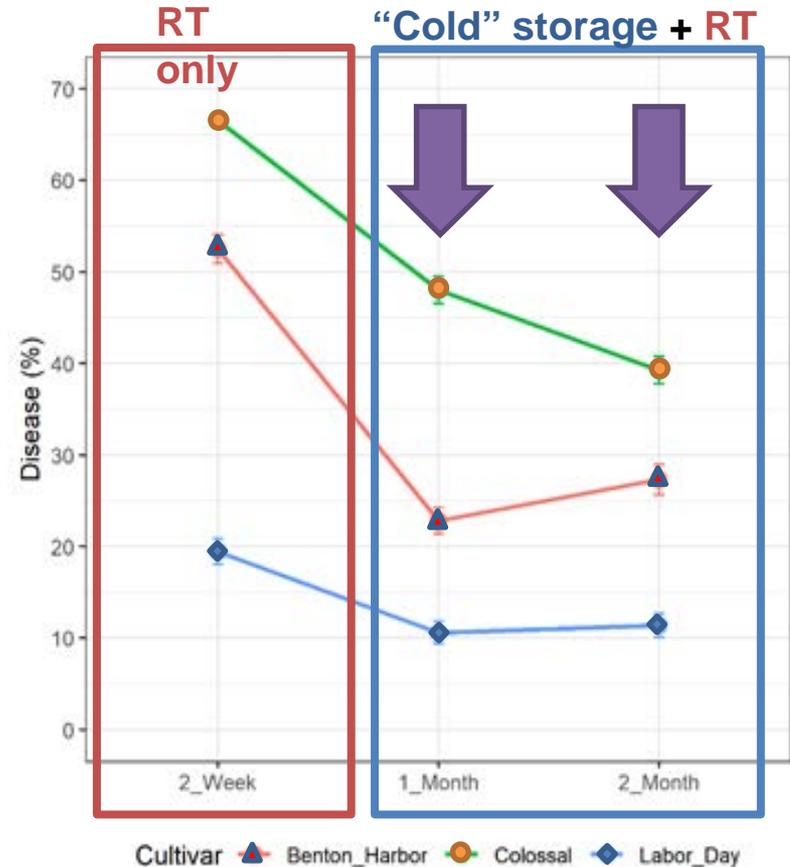
- Target infected litter (burrs, branches, leaves) on the orchard floor – hygiene
- Thick groundcover before and during flowering may provide a physical barrier between spores and flowers
- Grow several varieties to stagger the flowering period and reduce potential for floral infection
- Efficient harvest of chestnuts



Postharvest Management Preliminary Findings

- Immediate placement into cold storage leads to less rot.
 - Cold storage recommended -2 to 0°C (28.4°F to 32°F)
- Multiple points in supply chain for disruption of cold storage: Harvest, Post-Harvest, Consumer
- Current exploration of post harvest sterilization options
- Lower disease severity occurs after cold storage

Inoculated nuts over time



Potato leafhopper

- Adult is pale to bright green and about 1/8 inch long
- Adults are very active, jumping, flying when disturbed
- The immature forms, or nymphs, are green and wingless
- Only survive year round in Southeast US











Don't be tricked by "boating"

Damage

- PLH feed near the edges of the leaves with piercing-sucking mouthparts
- Heavily damaged leaves have necrotic and chlorotic edges and abscise from the tree
- Severely infested shoots produce small, bunched leaves
- In many crops leafhopper can reduce plant vigor, reduce cropload and crop quality—impact unknown in chestnut



Scouting for PLH

- Scouting should be performed weekly to ensure detection early and prevent injury
- More frequent spot checks should be done immediately following rain storms in spring
- For every acre of orchard, select 5 trees to inspect and inspect the leaves on 3 shoots per tree (a total of 15 per acre)
- Russel foliage as you scout
- Flip the shoot over and look for adults and nymphs on the underside of leaves



PLH management

- The most common classes of insecticides for control include the pyrethroids, carbamates, neonicotinoids and organophosphates
- Carbamates and organophosphates are broad spectrum and can disrupt natural enemies so only use when necessary (like targeting another pest at the same time)
- Pyrethroids can cause mite flaring but are less expensive
- Neonicotinoids are longer lasting and narrow spectrum making them a solid choice for management



Mites

- European red mite and two-spotted spider mites are pests for many growers
- Both species can be found in the orchard season long and can do considerable damage to the trees, particularly when in high numbers or on young trees
- No established threshold, but 100% control is likely not necessary



Two-spotted Spider Mite



David Cappaert, MSU

UGA5371008



ERM



Symptoms of mite damage

- Injury is cumulative
- Leaves appear mottled, stippled, and in more severe cases bronzed
- Injured leaves have reduced photosynthetic activity potentially leading to reduced nut size, and return crop load potential as well as increased sensitivity to winter injury



Scouting for mites

- ERM: Begin scouting early for eggs
- TSSM: Take a soil sample and look for overwintering females
- During the season, inspect leaves on inner shoots of at least 10 trees per acre
- Look on the upper and lower leaf surfaces of the leaves



Don't hurt the good guys!



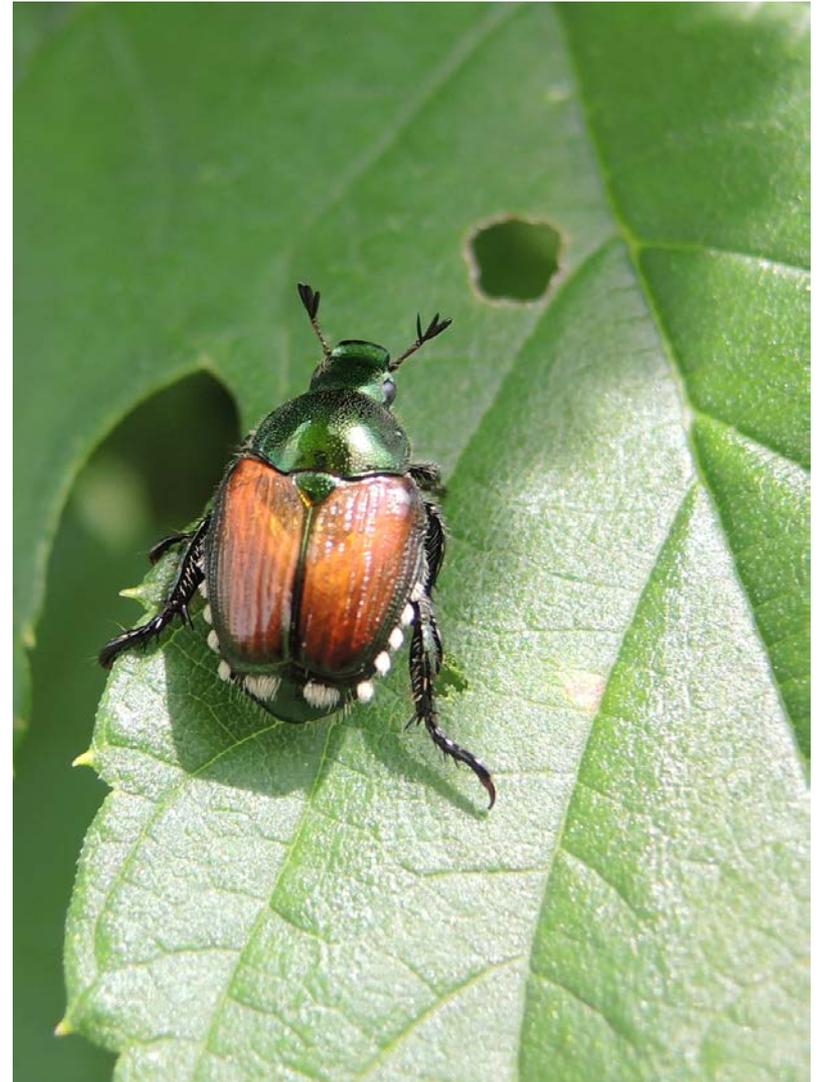
Mite management

- Dormant Superior oil applications are effective for ERM
- There are a number of miticides that have shown excellent efficacy against TSSM and ERM and are relatively soft on predatory mites
 - Avermectins (8-12 weeks residual control)
 - Hexythiazox (8-12 weeks residual control)
 - Bifenezate (6-8 weeks residual control)
 - Etoxazole (8-10 weeks residual control)
 - Spirodiclofen (8-10 weeks residual control)
- Consider spot treatments



Japanese beetle

- Adult Japanese beetles are 3/8-inch long, metallic green beetles with copper-brown wing covers
- Adults emerge from the ground and begin feeding on plants in June
- Individual beetles live about 30-45d
- Activity is concentrated over a four to six week period, after which the beetles gradually die
- Large, well established trees can likely tolerate considerable feeding damage



Japanese beetle damage

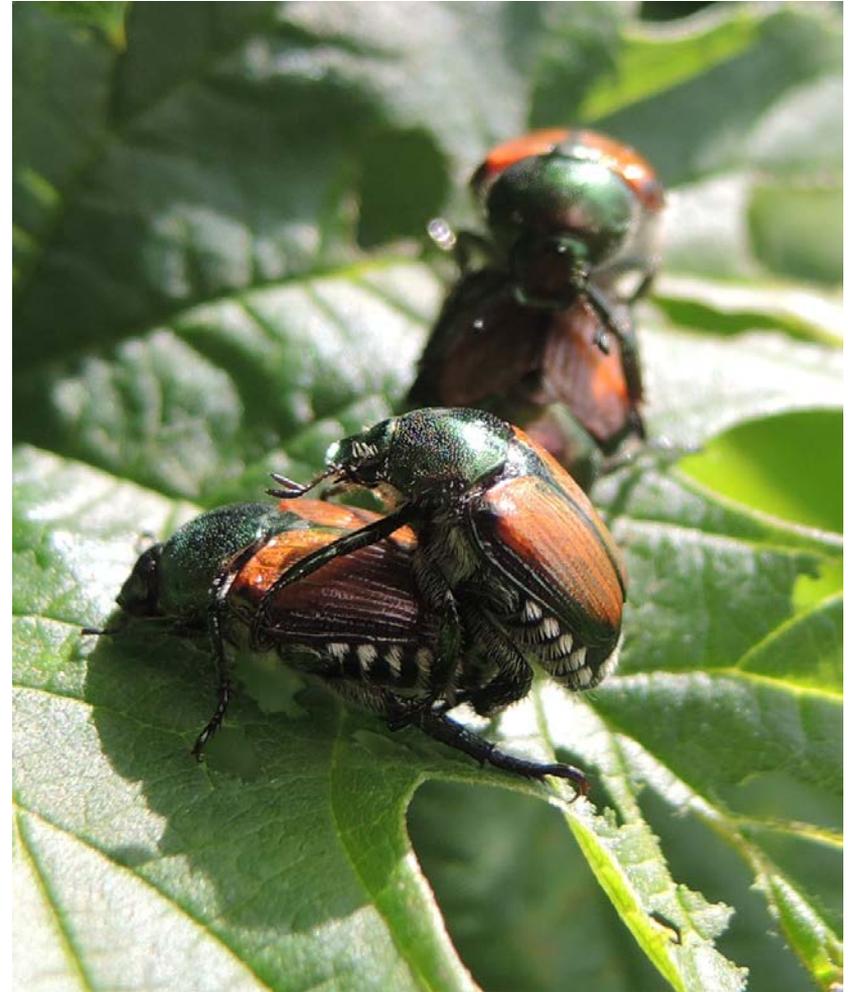


- JB skeletonize leaves and feed in large groups
- Can be particularly destructive to young trees with limited leaf area



Scouting for JB

- Take a walk—they aggregate so they are highly visible!
- Check preferred hosts in the vicinity (apples are a favorite)
- Wild raspberry, blackberry, Virginia creeper, wild grape or sassafras are highly attractive and beetles will aggregate on these plants



Managing Japanese beetle

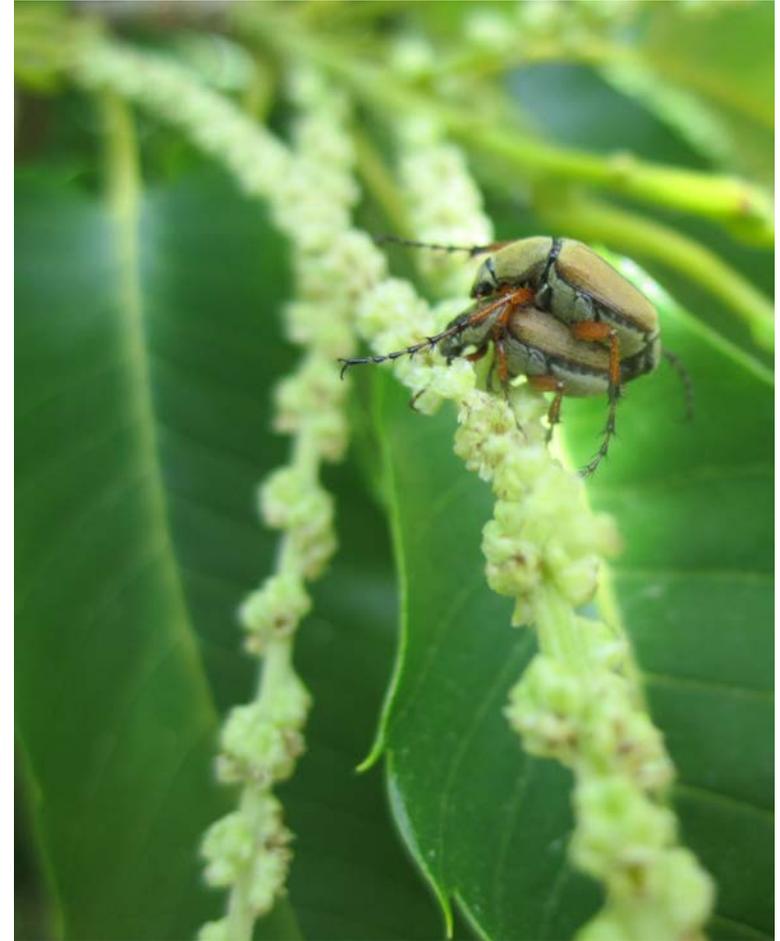
Difficult to control because of their aggregating behavior

- Carbamates-immediate knockdown and 7d residual
- Organophosphates-takes 3 days for effect, 10-14d residual
- Pyrethroids-good knockdown, 7-10d residual, may flare mites
- Neonicotinoids-2-5d contact poison, then must be ingested, long residual
- OMRI approved, Azadirachtin (neem) products 1-2d residual, good knockdown
- OMRI approved, Surround (kaolin clay) has had good results in blueberry and grape



Rose chafer

- Feed on many crops grown on sandy soils
- There is a single generation per year with the adults showing up in June
- The activity of adults typically lasts for only two to three weeks
- Particularly damaging on young trees with limited leaf area



Scouting for RC

- They are often found in mating pairs and fly during daylight hours
- Visual observation via transect is the best method for locating them



RC management

- Difficult to control due to reinfestation
- Carbamates, organophosphates, pyrethroids and neonicotinoids can provide some control
- Organic options including azadactrin (neem) products and surround are marginally effective
- It is likely that large, established trees can tolerate a fair amount of feeding



Thanks!

- Check out www.chestnuts.msu.edu
- Subscribe the MSUE News Fruit and Nut Report!
- Email me at taylo548@msu.edu
- Carefully check your local pesticide regulations



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