Western Cherry Fruit Fly Research Update

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Cherry Fruit Fly (CFF)

- Primary source of CFF infestations in managed orchards - immigration of mature females
- Must kill mature females within ~2 hr of exposure to fruit to prevent oviposition (Yee & Alston 2011, J. Pest. Sci.)
  - Adults active in orchards Jun – Jul (hard frost)
- Key management strategies:
  - prevent egg-laying
  - kill eggs & larvae inside fruits with systemics

Three Methods to Time CFF Treatments

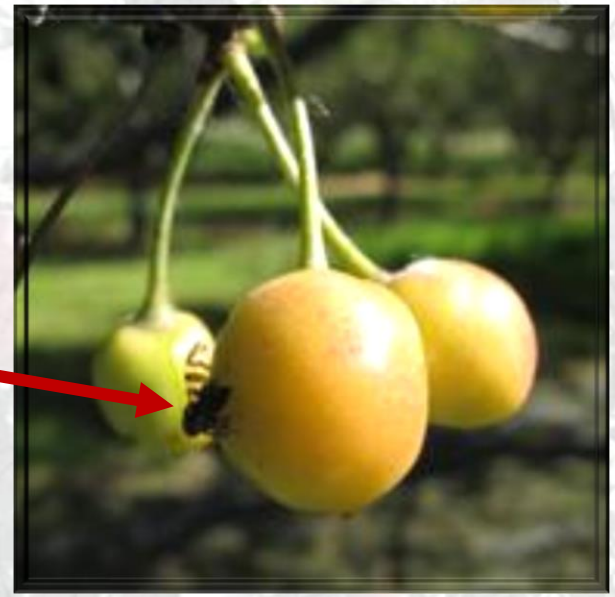
1. Fruit maturity
   - Straw-salmon color (fruit soft enough to penetrate)
2. Adult trapping
   - Yellow sticky trap + ammonium carbonate (AC) bait
   - Treat within 5-7 days (190 DD_{41})
3. Degree-day model
   - 1060 DD_{41} ~3% fly emergence, first reproductively mature female

Are Cherries Over-treated for CFF?

- Insecticides are an insurance policy
- Lessons-learned from moth mating disruption:
  - lower pest numbers
  - allow for more flexibility in mgmt.
- Key CFF attractants:
  - visual: color – bright yellow
  - food: sugars, yeasts, proteins
  - ammonium carbonate > ammonium acetate

Key CFF Management Strategies

- Maintain rapid adult mortality (5-7 days)
  - Prevent build-up of reproductively mature females
    - Consistent insecticide coverage; orchard borders are more at risk for immigrating flies
- Ways to achieve this:
  - Insecticides that quickly knock-down adults (e.g., pyrethroid, spinosyn)
  - Systemic insecticides that kill CFF/SWD within fruit (e.g., neonicotinoid, diamide)
  - Constant CFF/SWD population suppression
    - attract-and-kill (attractants + insecticide)



Insecticide Rotations
Activity on CFF Life Stages
Fruit Protection
Timing

CFF Population Management Research Results

Insecticide Rotation Trial - CFF Tart Cherry: 2012 & 2013

- USU research farm, Kaysville
- Plot size: 4 rows × 6 trees (0.12 ac)
- RCB design, 4 reps
- Different insecticide chemistries
  - spinosyns, pyrethroids, carbamates
    - kill adult flies, fast acting, contact & ingestion on fruit surface, fly grooming behavior
  - neonicotinoids & diamides
    - penetrate fruit flesh (systemic), kill eggs & larvae inside fruits, adult ingestion on fruit surface, longer residuals

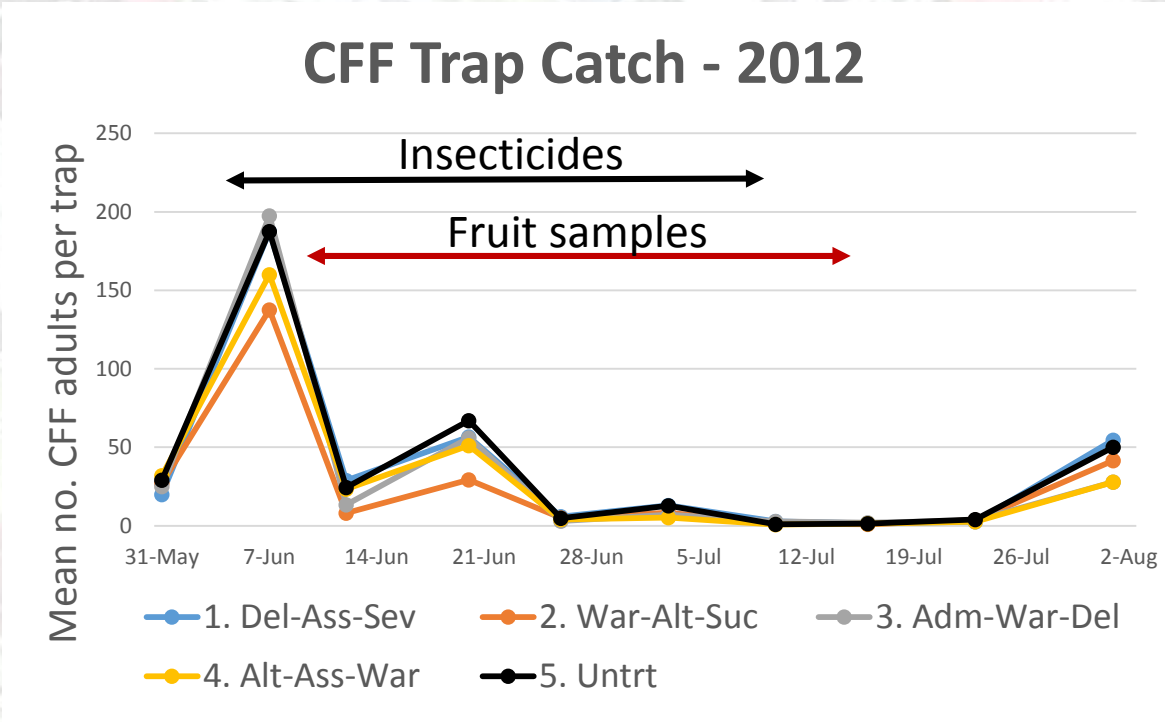
Insecticide Rotation Treatments

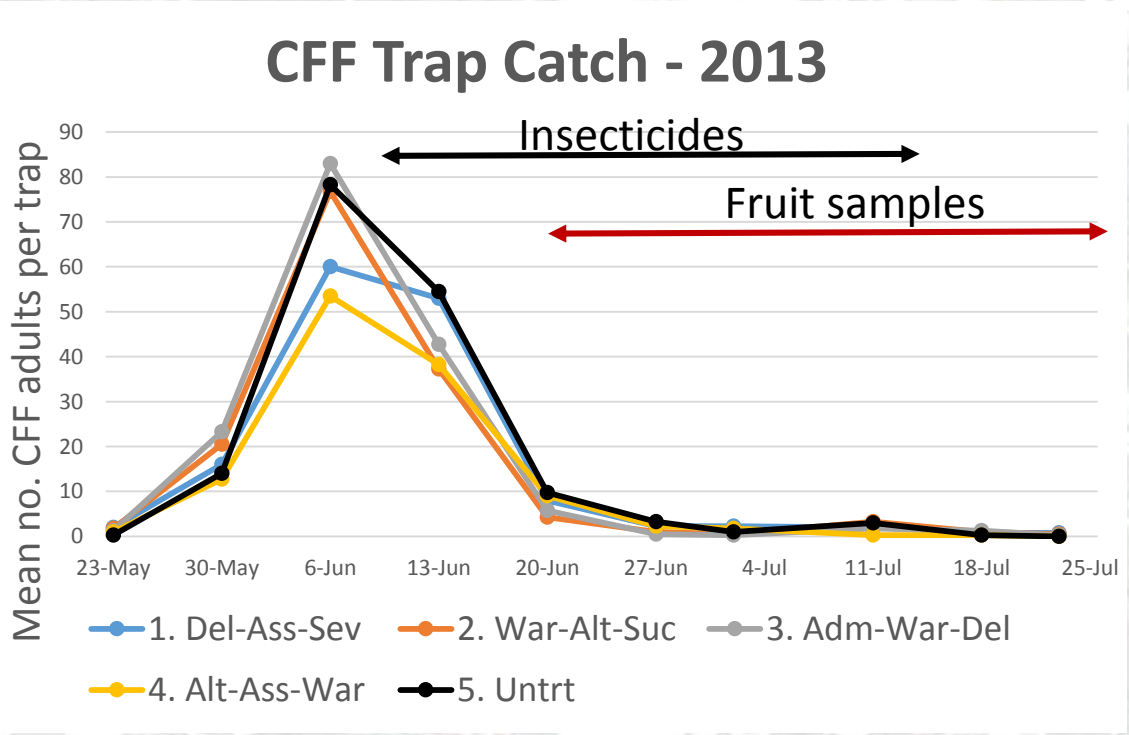
Treatment No.	Jun 4 or 10^	Jun 19 or 22	Jul 2 or 5 (9 or 12-Success)
1	Delegate 6 oz (Spinosyn, 5*)	Assail 30SG 6 oz (Neonic, 4A)	Sevin 4F 2.5 qt (Carbamate, 1A)
2	Warrior 3 oz (Pyrethroid, 3A)	Altacor 4 oz (Diamide, 28)	Success 6 oz X 2 app. (Spinosyn, 5)
3	Admire Pro 2.5 oz (Neonic, 4A)	Warrior 3 oz (Pyrethroid, 3A)	Delegate 6 oz (Spinosyn, 5)
4	Altacor 4 oz (Diamide, 28)	Assail 30SG 6 oz (Neonic, 4A)	Warrior 3 oz (Pyrethroid, 3A)
5	Untreated	Untreated	Untreated

^Application dates for 2012 and 2013
*Insecticide resistance action committee (IRAC) classification

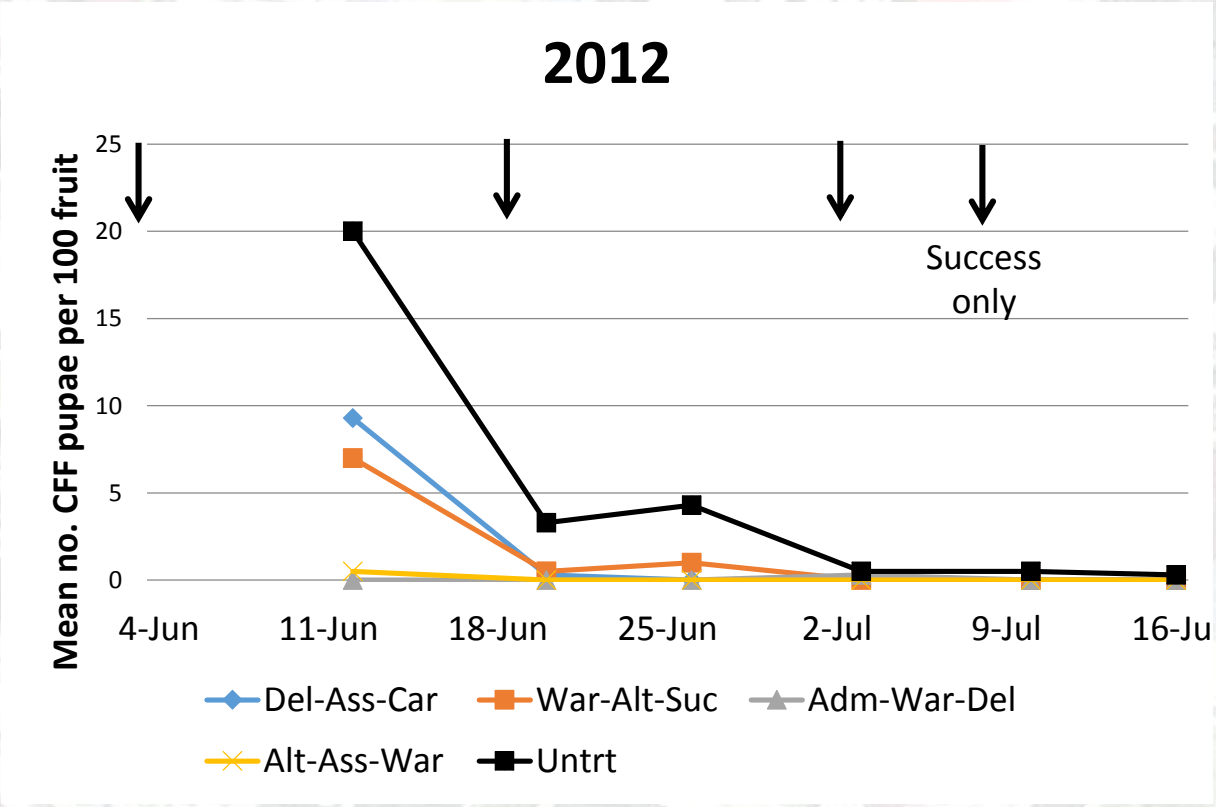
PHIs – 3 d: Sevin; 7 d: Admire, Assail, Delegate, Success; 10 d: Altacor; 14 d: Warrior

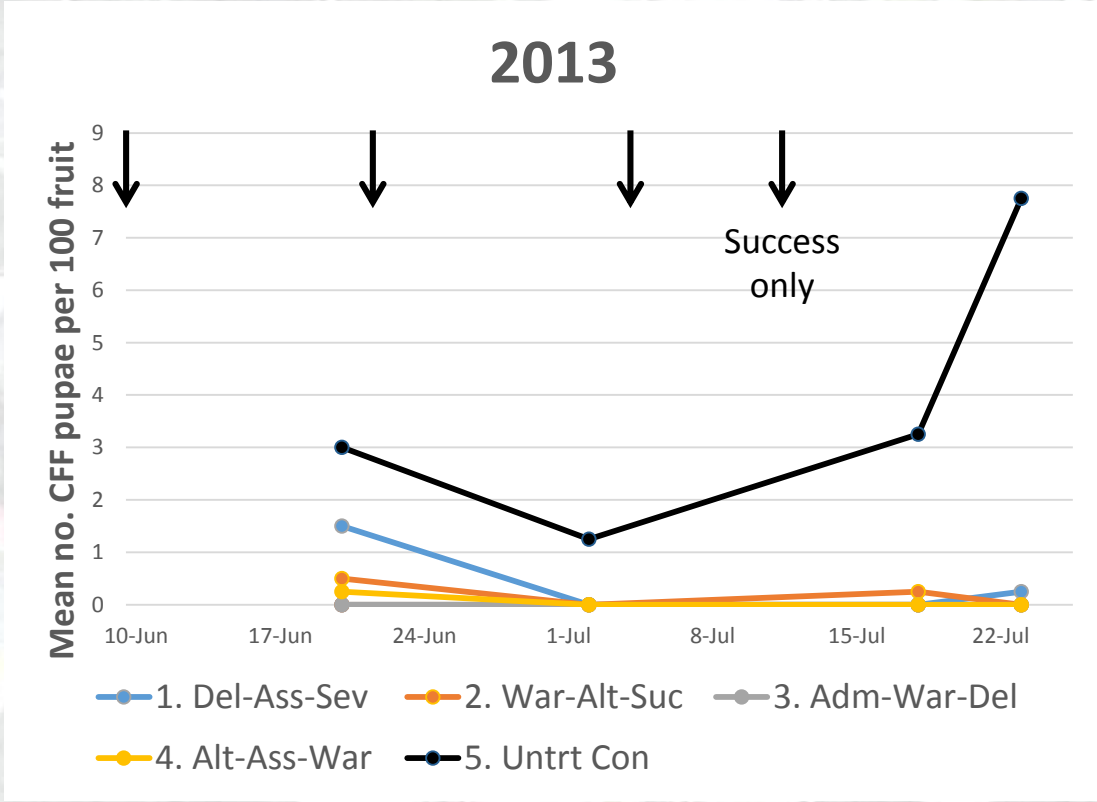
CFF Adult Pressure: 2012 and 2013





Fruit Infestation





Insecticide Rotation Study Conclusions

- High CFF pressure in both years, especially 2012
  - much higher than typical commercial tart cherry orchards
- Systemics applied first (Admire & Altacor) performed best
  - systemics killed early CFF eggs & larvae within fruit
  - Admire-Warrior-Delegate: 0%
  - Altacor-Assail-Warrior: $\leq$ 0.25%
- Pyrethroid or spinosyn applied first: some early infestation
  - Warrior-Altacor-Success: 7% in 2012 & 0.5% in 2013
  - Delegate-Assail-Sevin: 9% in 2012 & 1.5% in 2013
- Under high CFF pressure, killing CFF adults and eggs/larvae within fruit are both important strategies

Food Baits + Insecticide

GF-120 (spinosad + ammonia acetate + sugar) – attract and kill

Corn sugars – Nu Lure, Monterey Insect Bait

Sugar (sucrose)

Yee 2009, 2010, 2011, and Yee & Alston, 2012, Crop Protection 41: 17-23

Sugar Baits can Enhance Insecticides – CFF Kill

- Sugar (sucrose) - stimulate CFF feeding, enhance speed of kill, & reduce oviposition
  - lab studies
    - best: Actara, Provado, Success/GF-120
    - moderate: Assail, Avaunt, Guthion
  - field studies
    - Actara, Success/GF-120

WCFF female on tart cherry fruit

Two Goals:

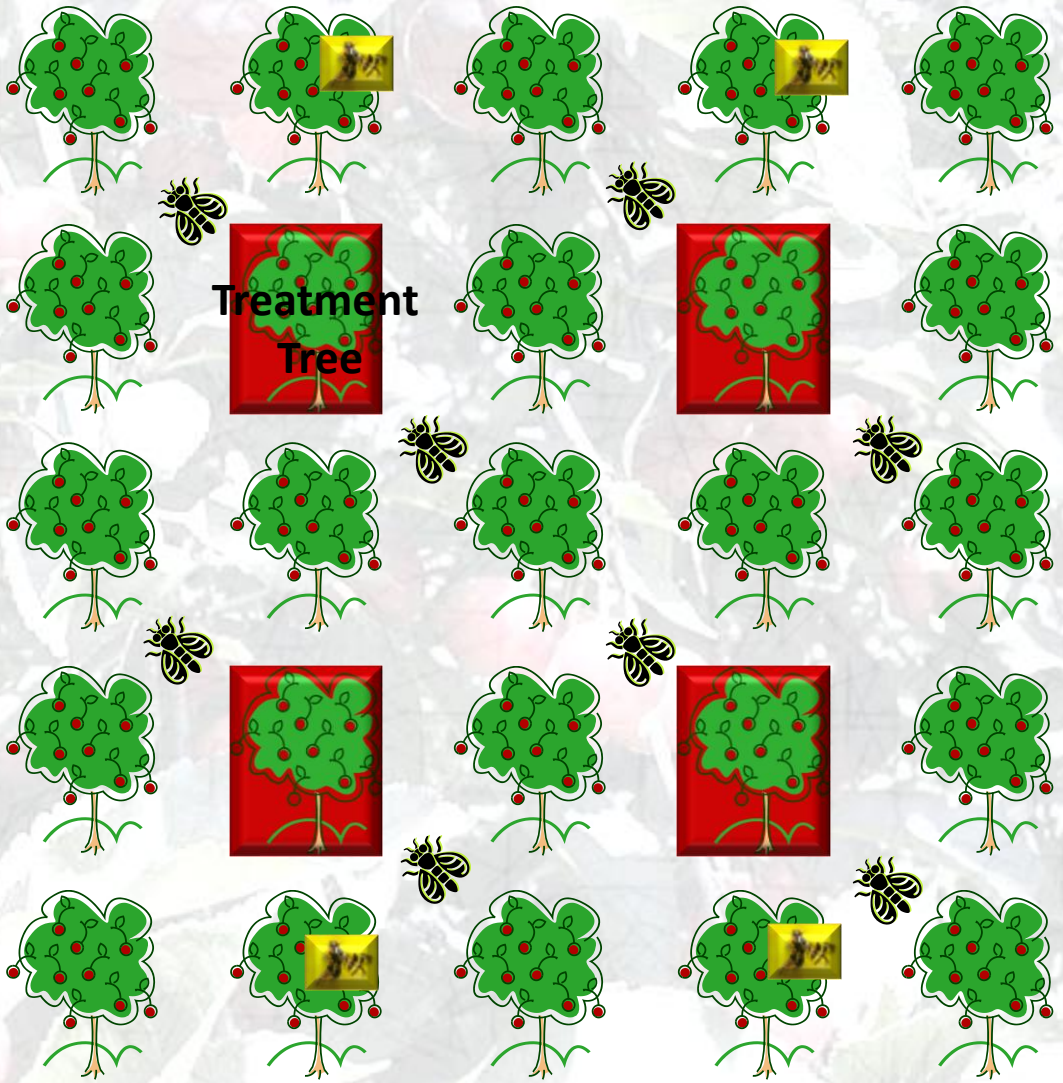
1) Kill CFF adults quickly with sugar bait sprays
2) Evaluate insecticides also effective for SWD

Insecticide + Sugar Experimental Design
Tart Cherry, Kaysville, UT

2012 and 2013
9 treatments (4 reps; RCBD):

1. **untreated control**
2. **zeta-cypermethrin (4 oz Mustang Max)**
3. **zeta-cypermethrin + 1% sugar (by wt)**
4. **lambda-cyhalothrin (2.56 oz Warrior)**
5. **lambda-cyhalothrin + 1% sugar**
6. **thiamethoxam (5.5 oz Actara)**
7. **thiamethoxam + 1% sugar**
8. **spinetoram (7 oz Delegate)**
9. **spinetoram + 1% sugar**

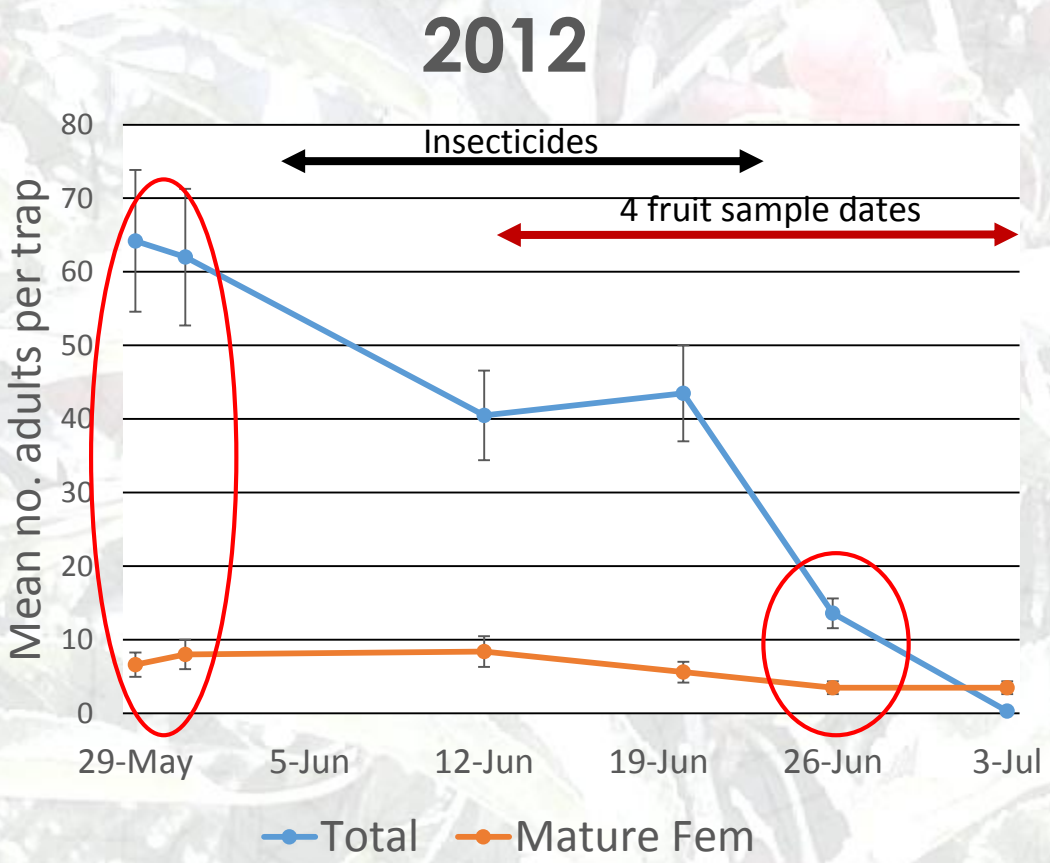
-label rates & allowable limits not exceeded
-first sprays within 7 days of first fly capture
-pyrethroids applied 3 or 4 times (weekly)
-thiamethoxam applied twice (biweekly)
-spinetoram applied three times (weekly)

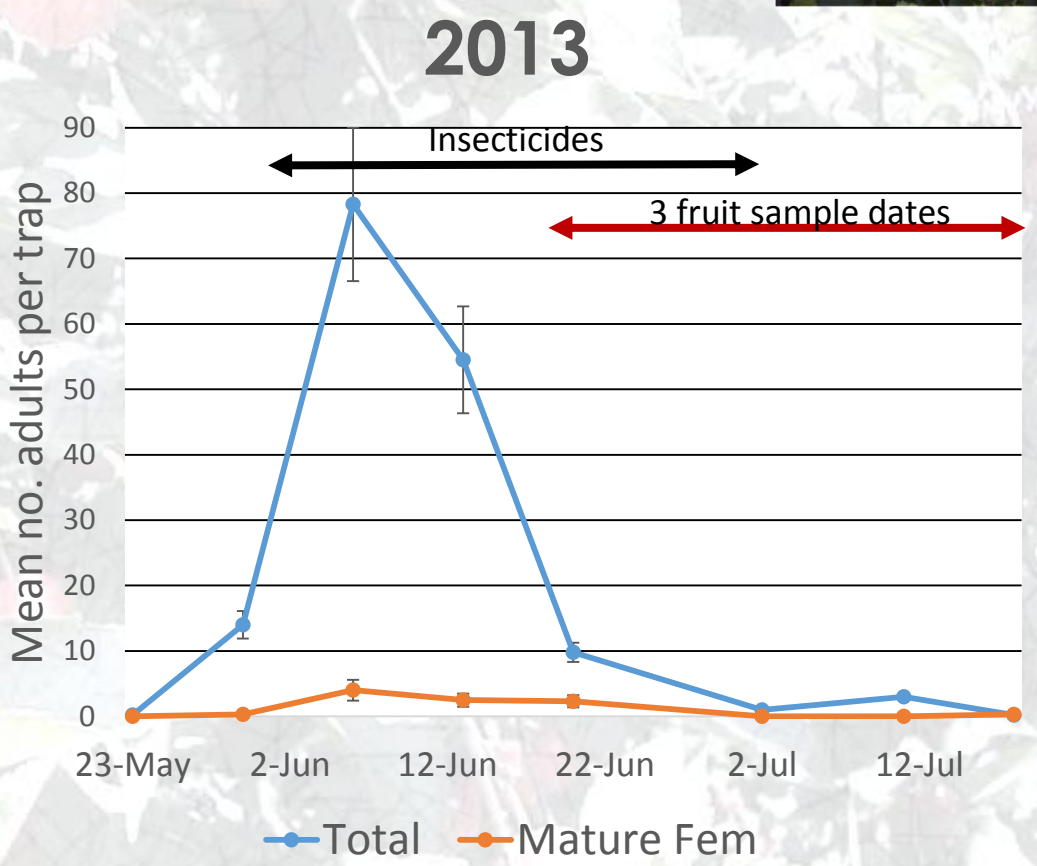


High CFF pressure

Low spray volume (100 gpa)

WCFF Trap Catch

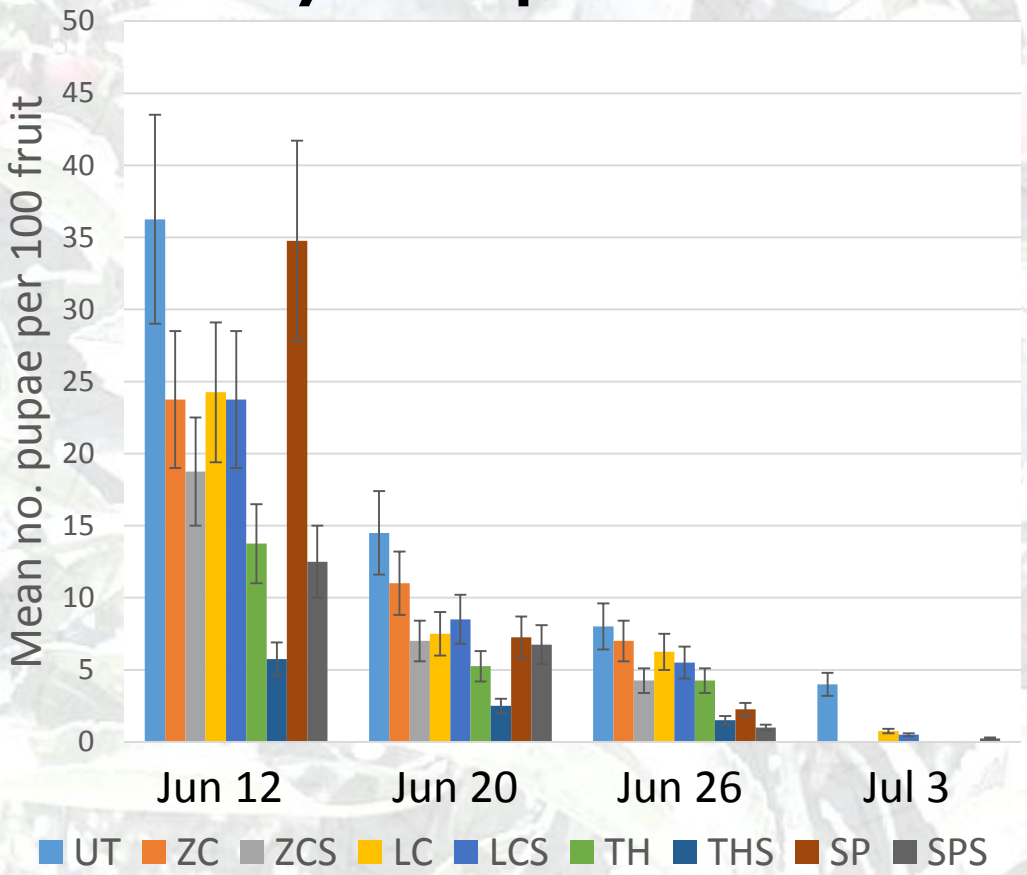




Mean of 8 traps placed in bordering, untreated trees in 2012; 4 traps in 2013

Fruit Infestation: 2012

By Sample Date



Sample Dates Combined

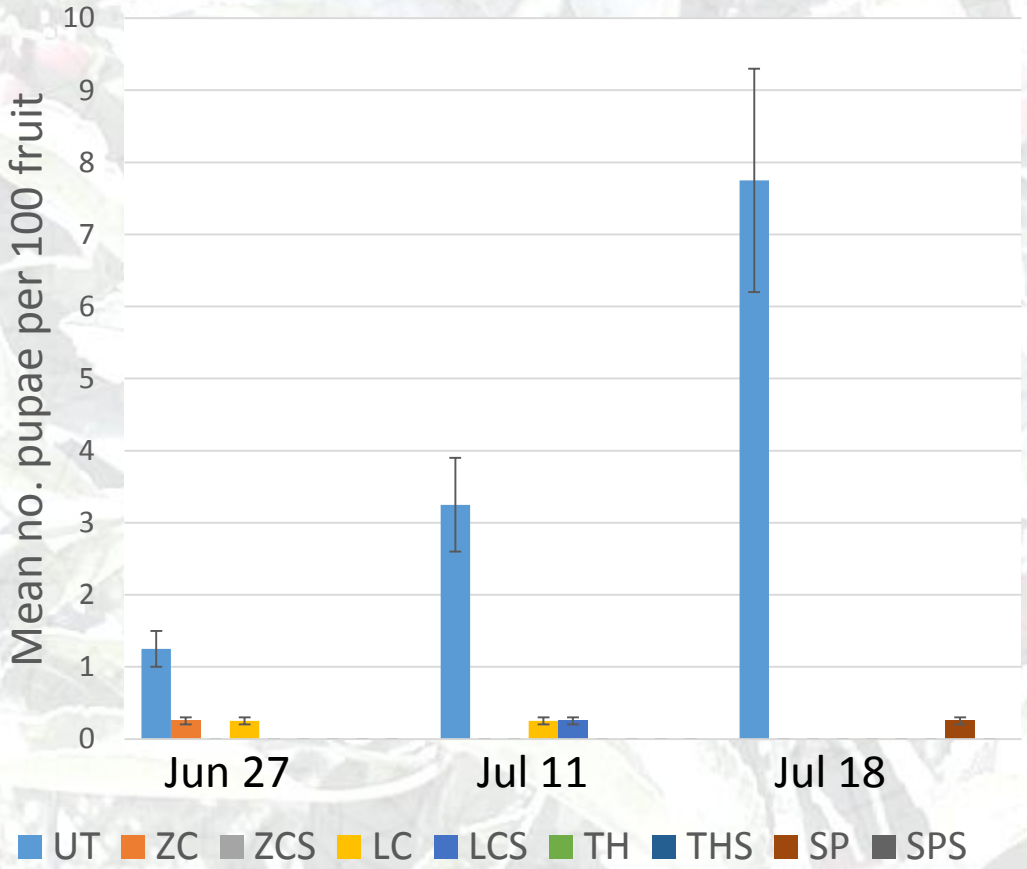
Insecticide treatment	Mean no. pupae/100 fruit*	% less than control
Untrt control	15.7 a	--
Zeta-cyper	10.4 ab	33.8%
Zeta-cyper + sugar	7.5 bcd	52.2%
Lambda-cyhal	9.7 bc	38.2%
Lambda-cyh + sugar	9.6 bc	38.8%
Thiamethoxam	5.8 cd	63.1%
Thiamethox + sugar	2.4 e	84.7%
Spinetoram	11.4 ab	27.4%
Spinetoram + sugar	5.2 de	66.9%

*Data square-root transformed; ANOVA & lsd tests; $p<0.0001$.

Comparisons within insecticides: sugar reduced infestation for thiamethoxam & spinetoram.

Fruit Infestation: 2013

By Sample Date



Sample Dates Combined

Insecticide treatment	Mean no. pupae/100 fruit*	% less than control
Untrt control	4.1 a	--
Zeta-cyper	0.1 b	97.6%
Zeta-cyper + sugar	0 b	100%
Lambda-cyhal	0.2 b	95.1%
Lambda-cyh + sugar	0.1 b	97.6%
Thiamethoxam	0 b	100%
Thiamethox + sugar	0 b	100%
Spinetoram	0.1 b	97.6%
Spinetoram + sugar	0 b	100%

*Data square-root transformed; Friedman rank & lsd tests; p=0.005.

No differences within insecticide comparisons.

Sugar Bait Trial Conclusions

- 2012: Very high WCFF pressure (early & late)
  - thiamethoxam & spinetoram + 1% sugar reduced fruit infestation the most; thiamethox + sugar was the best (85%)
  - control was poorer with 2 pyrethroids; sugar did not enhance
  - thiamethoxam may have had an advantage from systemic activity in killing eggs & larvae within fruit
- 2013: Lower WCFF pressure (peaked early June)
  - all insecticides + & - sugar were effective
  - only thiamethoxam (+,-), spinetoram (+), & zeta-cypermethrin (+) eliminated infestation (100%)

Commercial tart cherry orchards:

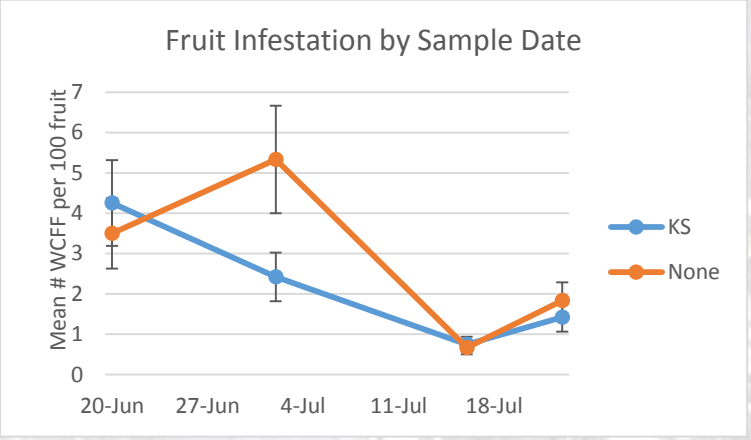
-Insecticide program/CFF pressure low

-No difference in adult fly capture on traps (trees with and without KS)

-Very low fruit damage (no difference)

Research tart cherry orchard:

-No insecticides applied/CFF pressure moderate



CFF Killing Station Trial - 2013

Placed KS on border row trees

Target immigrating mature female flies

Treated with GF-120

Apple Maggot in Utah - 2013

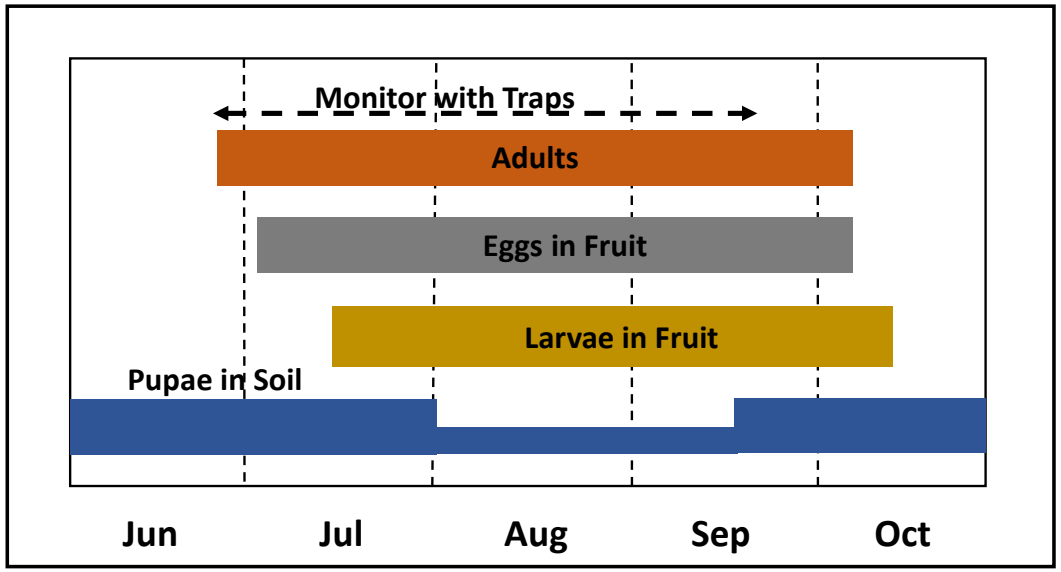
Home Yard Plum Fruits
Quarantine Pest

AM larva inside
plum fruit

Apple maggot adult fly
on domestic plum fruit,
Salt Lake City, 2013

Breakdown of plum flesh
from AM feeding

Apple Maggot Life History

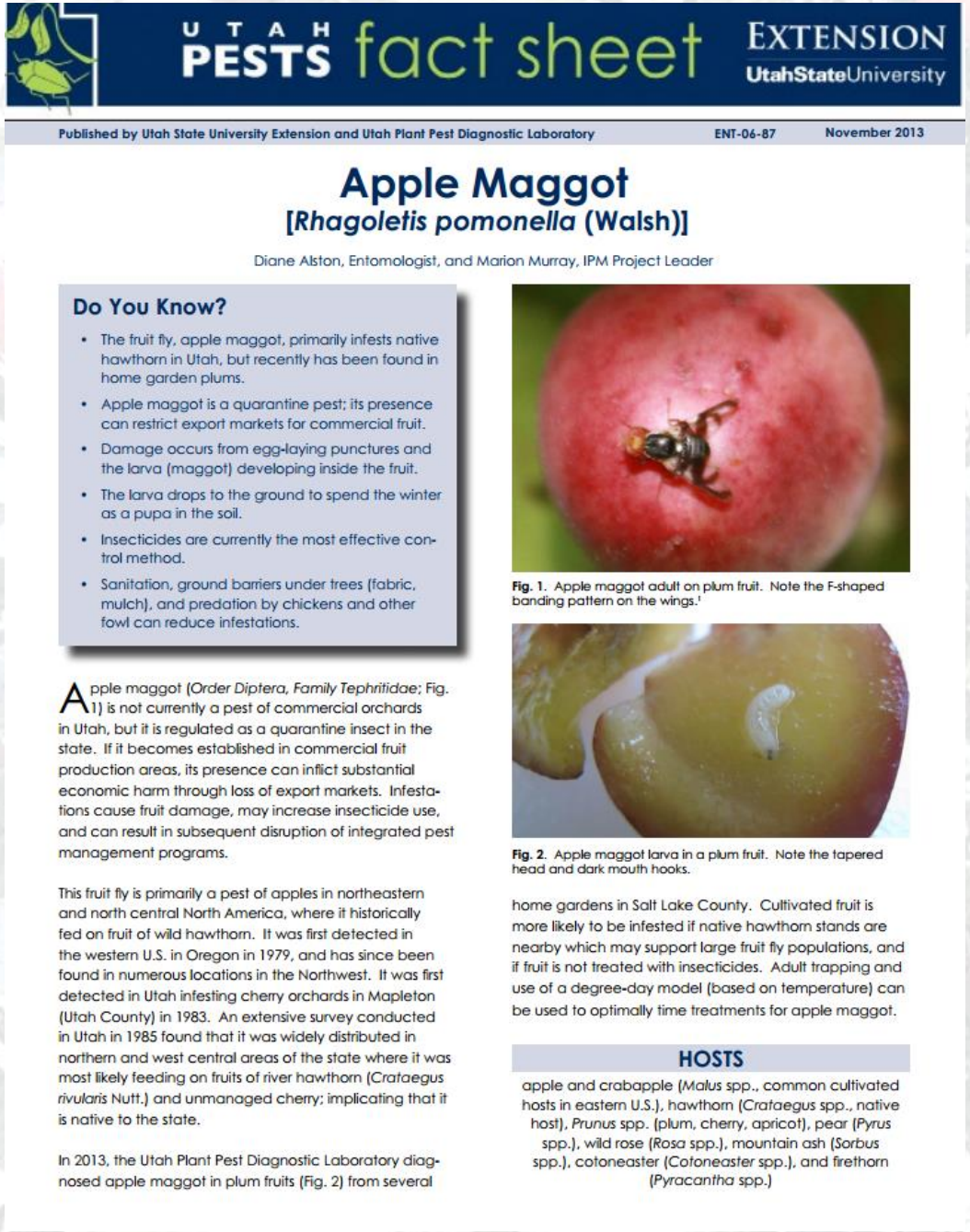


Native hawthorn shrub: River hawthorn

Broad host range: hawthorn, apple, crabapple, pear, plum, cherry, apricot, wild rose, mountain ash, cotoneaster, firethorn (*Pyracantha*)

New Fact Sheet
www.utahpests.usu.edu

- Educate home gardeners
  - Master Gardener Program
  - IPM Tree Fruit Advisory
  - Online resources
  - County Extension Offices



UTAH PESTS fact sheet — EXTENSION UtahStateUniversity

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Apple Maggot
[*Rhagoletis pomonella* (Walsh)]

Diane Alston, Entomologist, and Marion Murray, IPM Project Leader

Do You Know?

- The fruit fly, apple maggot, primarily infests native hawthorn in Utah, but recently has been found in home garden plums.
- Apple maggot is a quarantine pest; its presence can restrict export markets for commercial fruit.
- Damage occurs from egg-laying punctures and the larva (maggot) developing inside the fruit.
- The larva drops to the ground to spend the winter as a pupa in the soil.
- Insecticides are currently the most effective control method.
- Sanitation, ground barriers under trees (fabric, mulch), and predation by chickens and other fowl can reduce infestations.

Apple maggot (*Order Diptera, Family Tephritidae*; Fig. 1) is not currently a pest of commercial orchards in Utah, but it is regulated as a quarantine insect in the state. If it becomes established in commercial fruit production areas, its presence can inflict substantial economic harm through loss of export markets. Infestations cause fruit damage, may increase insecticide use, and can result in subsequent disruption of integrated pest management programs.

This fruit fly is primarily a pest of apples in northeastern and north central North America, where it historically fed on fruit of wild hawthorn. It was first detected in the western U.S. in Oregon in 1979, and has since been found in numerous locations in the Northwest. It was first detected in Utah infesting cherry orchards in Mapleton (Utah County) in 1983. An extensive survey conducted in Utah in 1985 found that it was widely distributed in northern and west central areas of the state where it was most likely feeding on fruits of river hawthorn (*Crataegus rivularis* Nutt.) and unmanaged cherry; implicating that it is native to the state.

In 2013, the Utah Plant Pest Diagnostic Laboratory diagnosed apple maggot in plum fruits (Fig. 2) from several home gardens in Salt Lake County. Cultivated fruit is more likely to be infested if native hawthorn stands are nearby which may support large fruit fly populations, and if fruit is not treated with insecticides. Adult trapping and use of a degree-day model (based on temperature) can be used to optimally time treatments for apple maggot.

Fig. 1. Apple maggot adult on plum fruit. Note the F-shaped banding pattern on the wings.[1]

Fig. 2. Apple maggot larva in a plum fruit. Note the tapered head and dark mouth hooks.

HOSTS

apple and crabapple (*Malus* spp., common cultivated hosts in eastern U.S.), hawthorn (*Crataegus* spp., native host), *Prunus* spp. (plum, cherry, apricot), pear (*Pyrus* spp.), wild rose (*Rosa* spp.), mountain ash (*Sorbus* spp.), cotoneaster (*Cotoneaster* spp.), and firethorn (*Pyracantha* spp.)

New Project – 2014 & 2015
Tree Fruit Leafroller Study

Species Complex & Biology
Phenology – Degree-Day Model
TRAPs Online Tools for Management
Survey Orchard Insecticide Management Programs

Obliqebanded Leafroller

Looking for Orchards with Leafrollers

Cherry, Apple, Other Fruits

New Project - 2014
Evaluate New Insecticide for CFF & SWD

- Exirel (cyantraniliprole; diamide; IRAC group 28; DuPont)
- With and without corn sugar (Monterey Insect Bait) and yeast baits
- USU Farm, Kaysville
- 2014 registration

Pesticide Updates

- Lannate (carbamate; DuPont): 2(ee) label
  - allows use of a registered product in a manner for which it isn't currently registered
  - Brown Marmorated Stink Bug
    - UT tree fruit crops: apple & peach
    - 1.5 to 3 pints per acre, ground application only
    - Apple: 14 d PHI, 15 pints per acre/5 apps per season limit
    - Peach: 4 d PHI, 18 pints per acre/6 apps per season limit
- New bee protection icons on labels
  - commercially pollinated crops & those attractive to bees
  - Bee Advisory Box on the label
  - on all neonicotinoid insecticide labels for sure

Pesticide Updates

- New insecticide/fungicide for stone fruits:
  - Bexar (tolfenpyrad; Nichino America)
    - METI (IRAC group 21A; energy metabolism); fungicidal activity (FRAC group 29)
    - contact activity, quick knock-down, anti-feedant
    - 2 apps/season; 14-27 oz/acre
  - Target insect pests:
    - western cherry fruit fly, obliquebanded leafroller, spotted wing drosophila (suppressant)
  - Target fungus disease:
    - cherry powdery mildew
- Available in 2014