Importance of Good Spray Coverage

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Northern Utah Fruit Growers Meeting

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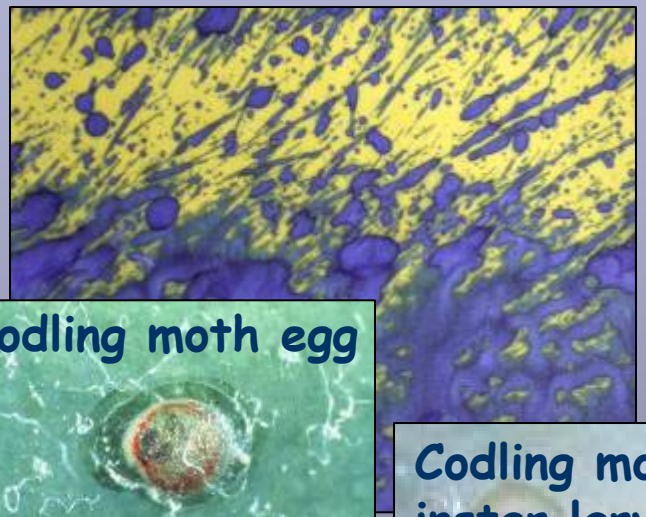
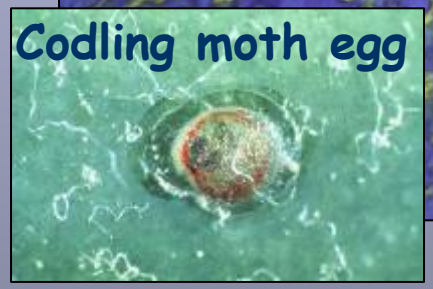
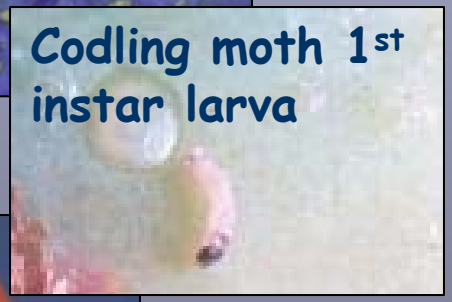
UtahState UNIVERSITY EXTENSION
extending usu to you

Heightened Importance of Canopy Coverage





Codling moth egg



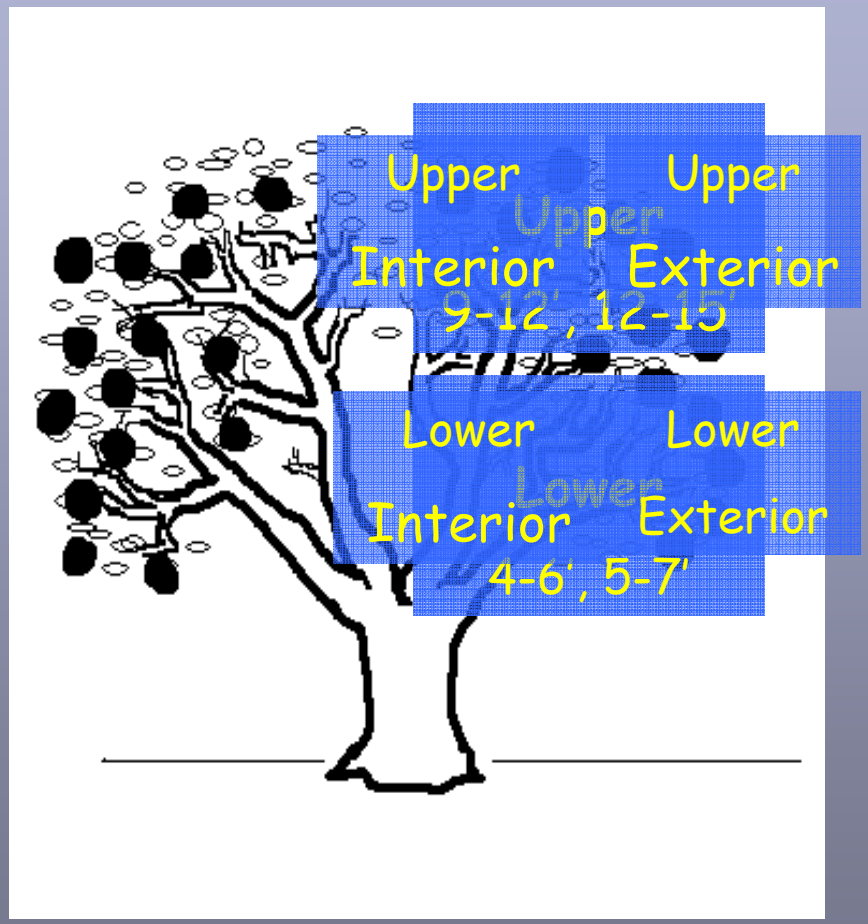
Codling moth 1st instar larva

Cherry fruit fly adult ingests bait

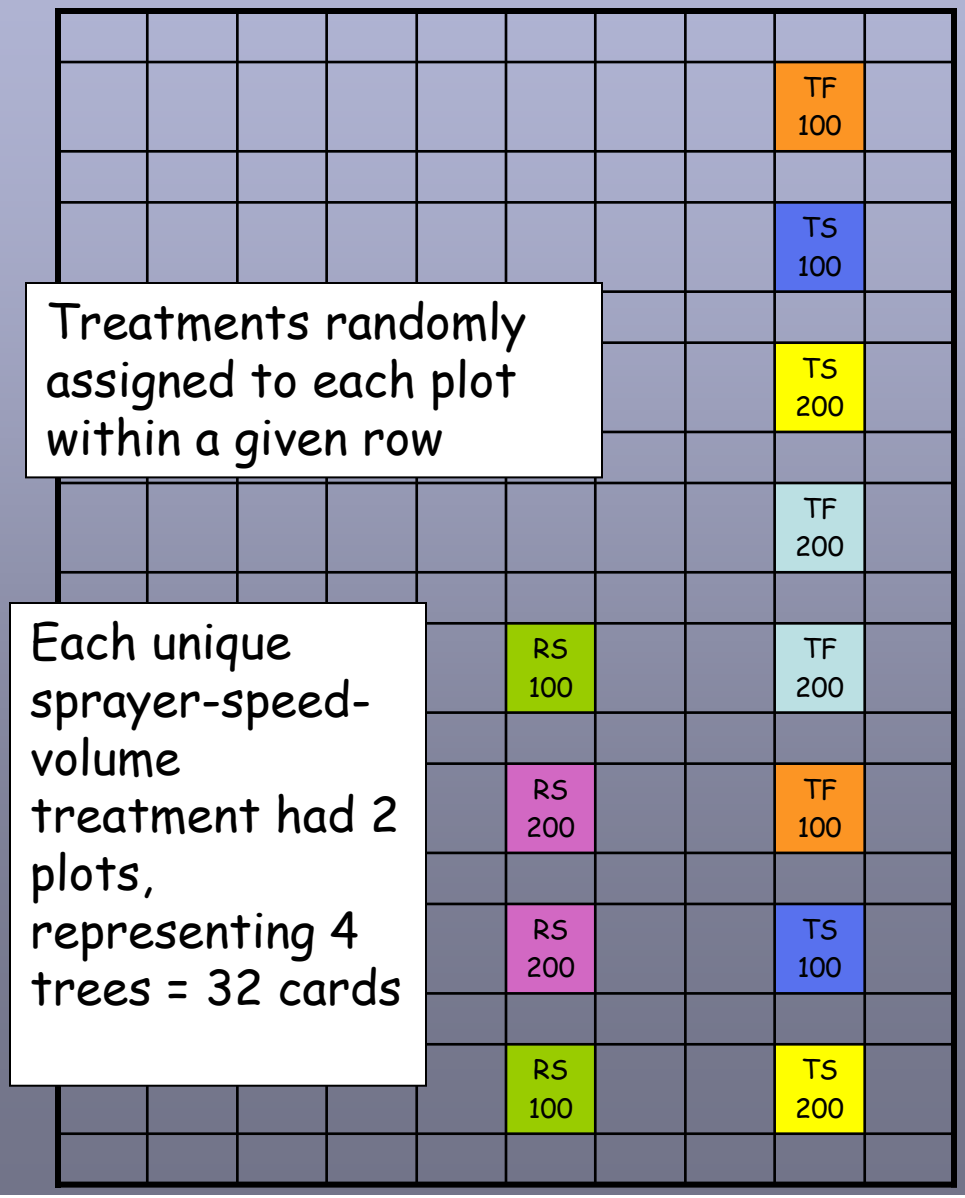
- Older insecticides are contact-killers (*Guthion, Danitol, Imidan*)
- Contact-killers can cause mortality without being ingested; effective without uniform coverage
- BUT most of the older contact-killers are less effective due to resistance
- Newer insecticides (Intrepid, Rimon, Assail, Calypso, Bt, CM virus) & oil are very effective as long as coverage is thorough
  - Ingestion
  - Contact with egg
  - Physical suffocation

Research Trial to Assess Spray Coverage - 2004

- Compare coverage in sections of the tree canopy
- Compare apple and tart cherry canopies
- Apply a high volume (200 gpa) and low volume (100 gpa) of water
- Use tower and rears sprayers, applying water to both sides of tree canopy
- Drive at low (~2 mph) and high (~2.5 mph) speeds



Layout of Apple and Cherry Orchards



Treatments randomly assigned to each plot within a given row

Each unique sprayer-speed-volume treatment had 2 plots, representing 4 trees = 32 cards

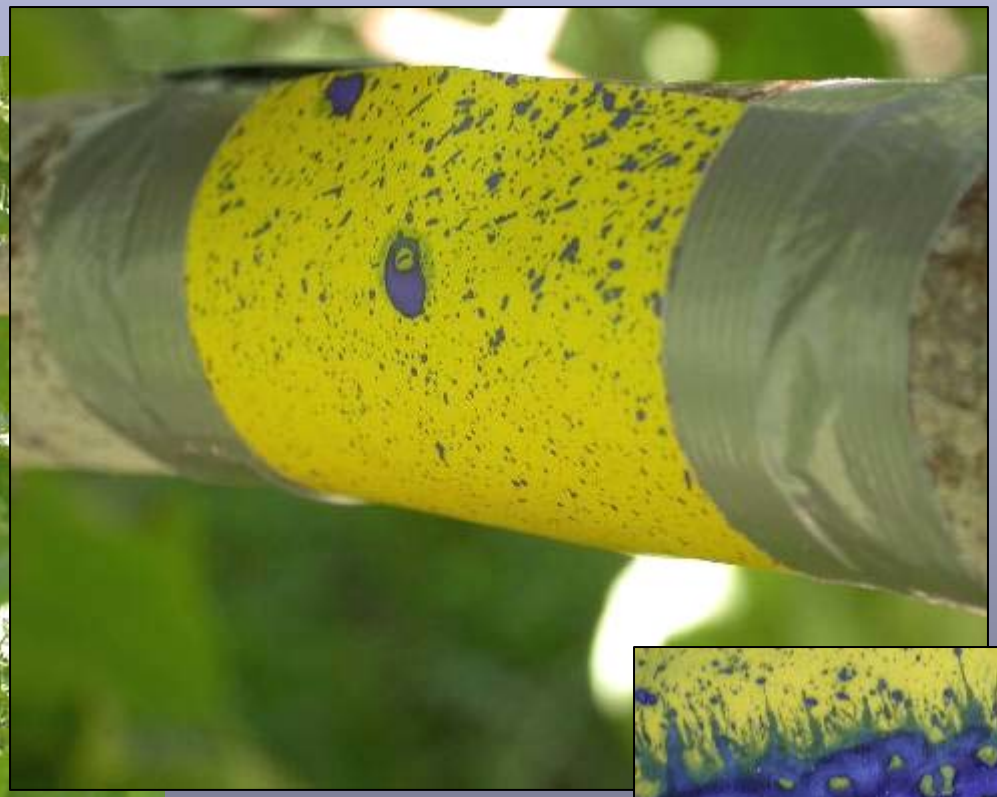
- Three sprayer-speed combinations:
  - Rears-Slow (RS)
  - Tower-Slow (TS)
  - Tower-Fast (TF)
- For each sprayer-speed, applications were made @ 100 and 200 gpa (6 unique combinations)
- For each sprayer-speed-volume combination, two plots each in apple and cherry blocks were treated
- 24 plots total (12 in apple, 12 in cherry); 2 trees/plot = 48 trees; 8 cards/tree = 384 cards)

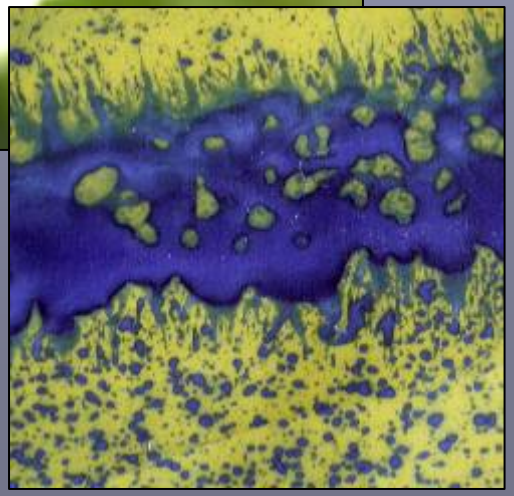
Card Set-Up

Selected limbs perpendicular
to row or parallel to spray direction – worst case scenario

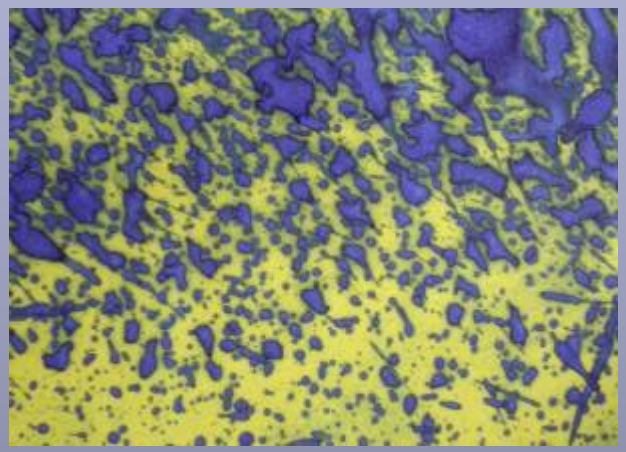
Water Applications

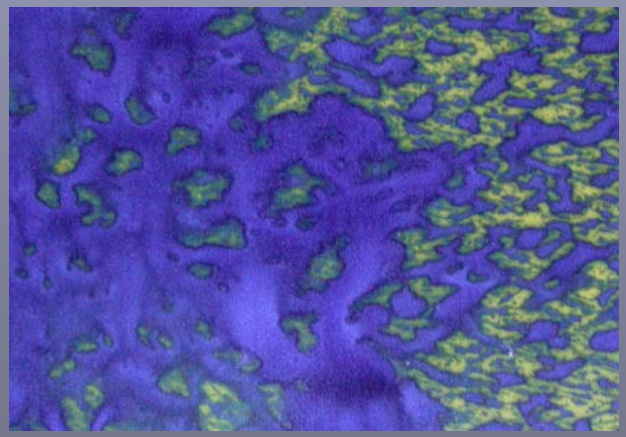
“Capturing” the Coverage





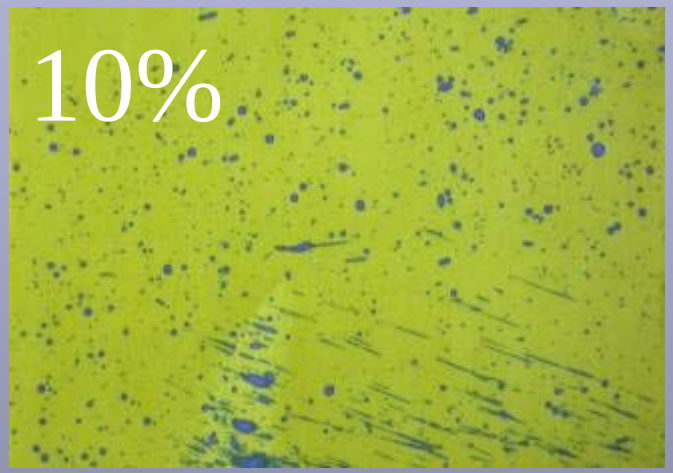
Digital Image Analysis

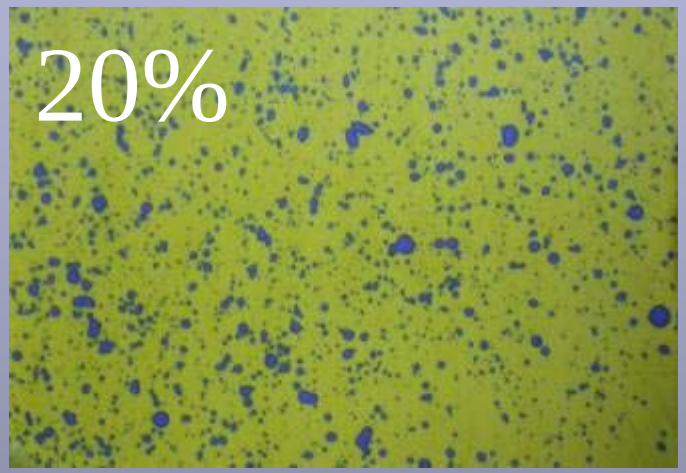


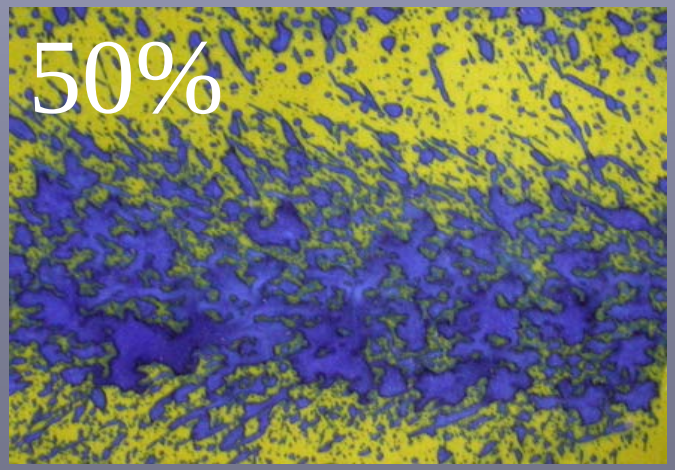


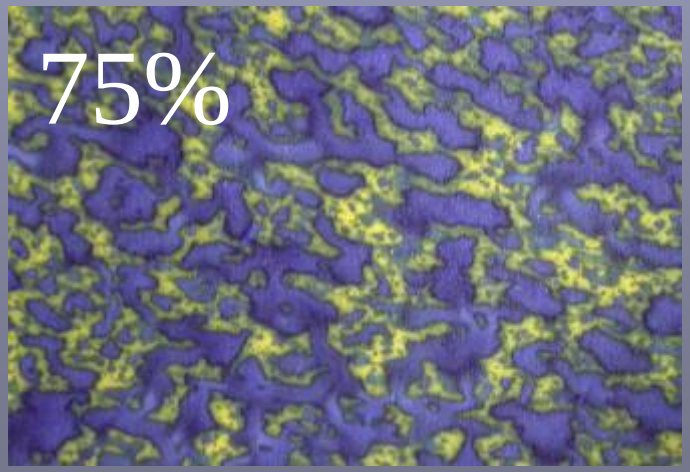
- Captured images of "water marks" (4 x 4 cm) – digital camera
- Processed images to increase contrast - Photoshop™
- Used ArcView GIS™ to categorize the image, pixel-by-pixel
- Entered pixel totals in a spreadsheet to determine % coverage

Distribution and Coverage



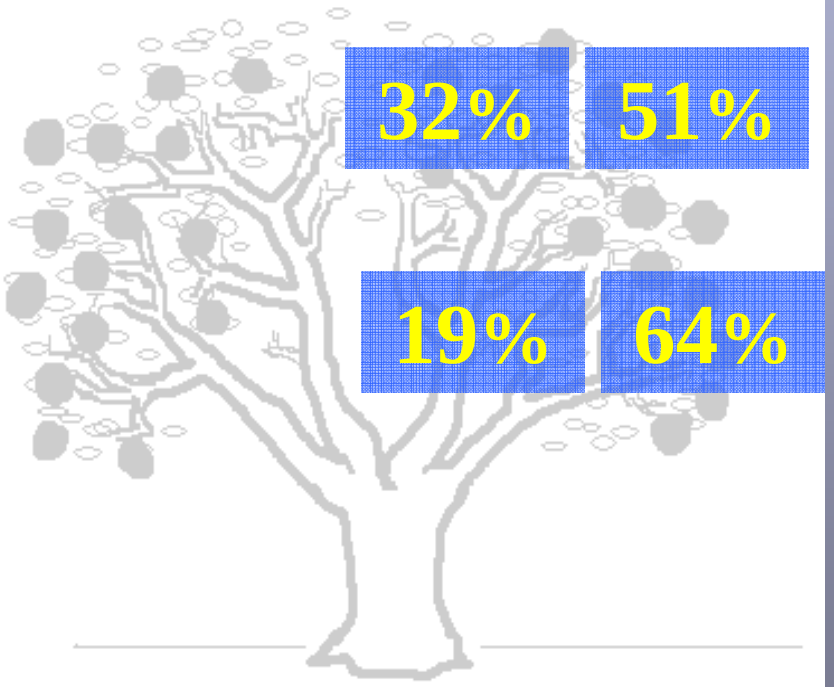




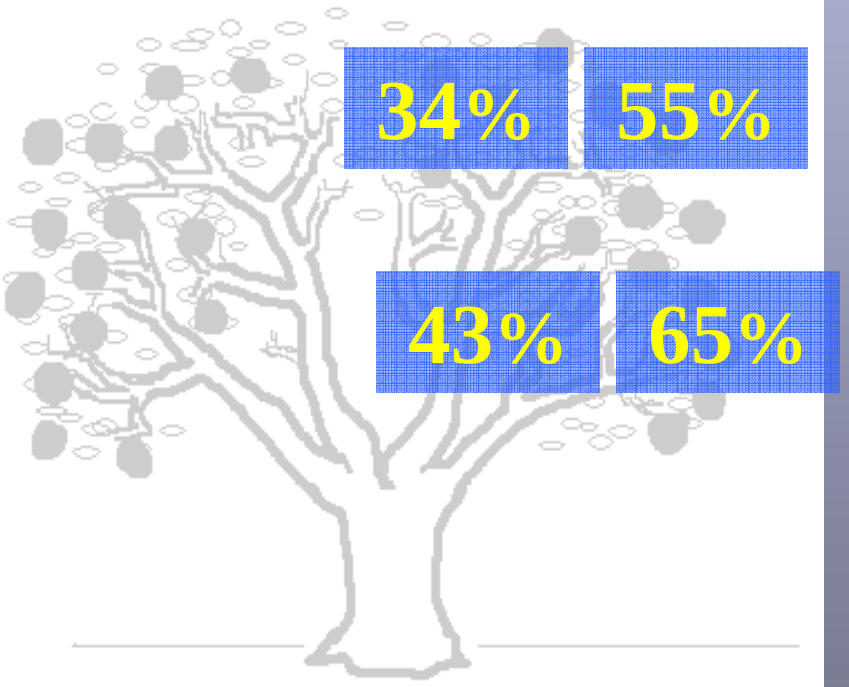


Effect of Volume in Apple: *Rears-Slow*

100 gpa



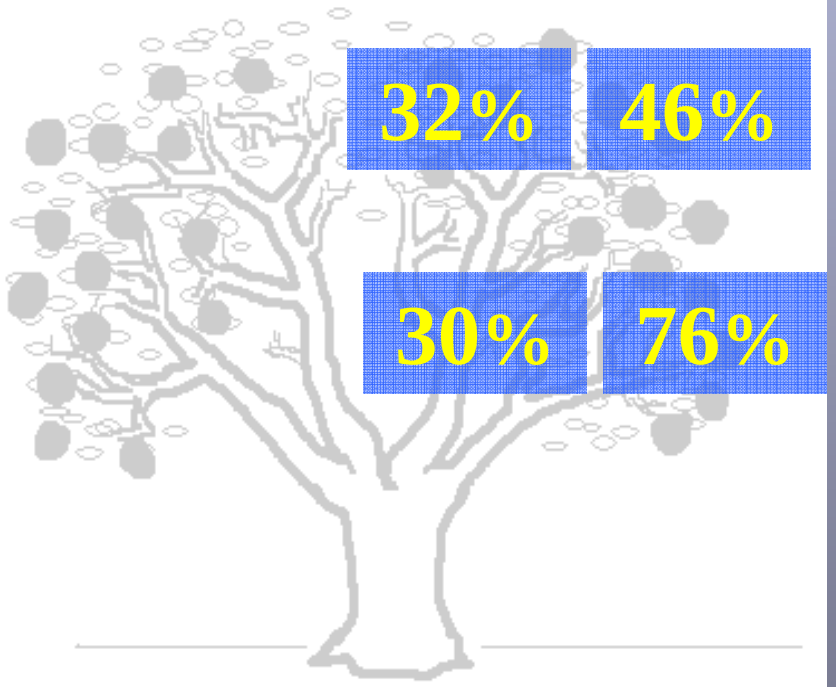
200 gpa



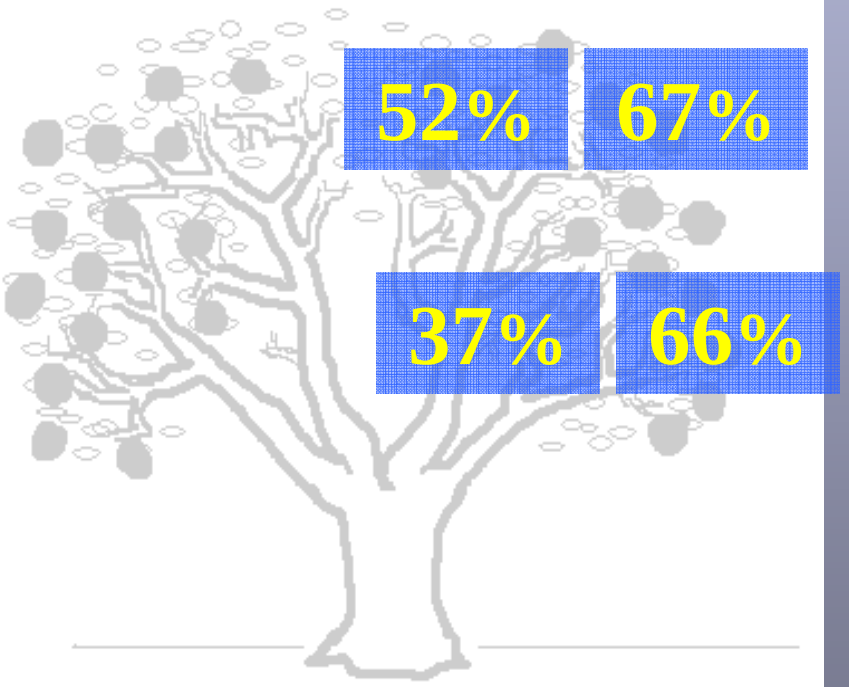
- Doubling the spray volume did little for upper and exterior coverage
- Greater volume did improve lower, interior penetration
- Rears sprayer, at 100 gpa, averaged 41.5%. At 200 gpa: 49.1%
- Apple scaffolds appear to create "spray shadows" at interior positions

Effect of Volume in Apple: *Tower*-Slow

100 gpa



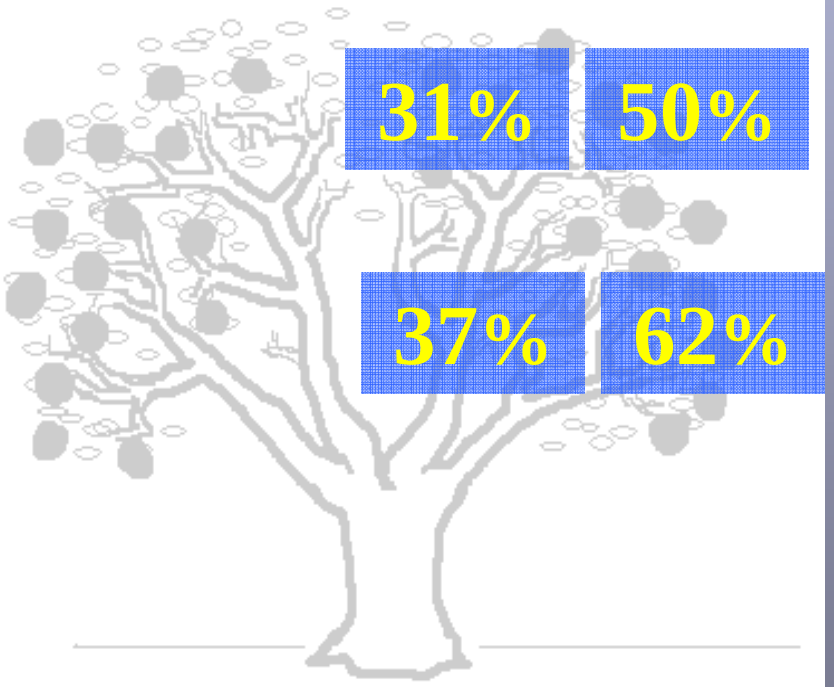
200 gpa



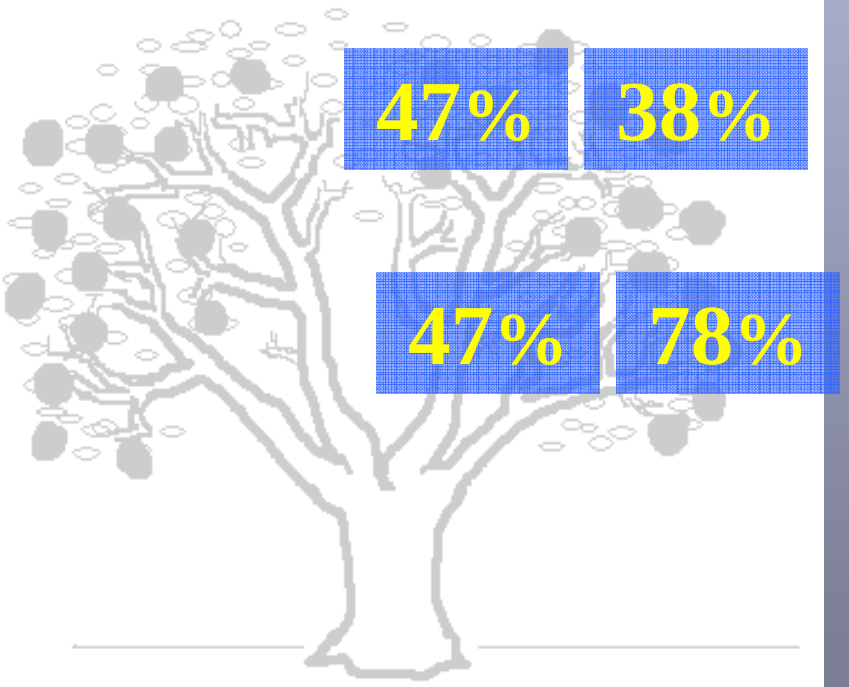
- 200 gpa provided marked improvement at upper and interior positions
- Tower sprayer, at 100 gpa, averaged 45.8% coverage. At 200 gpa: 55.4%
- At both spray volumes, "spray shadows" still apparent at lower interior position

Effect of Volume in Apple: *Tower*-Fast

100 gpa



200 gpa



- Tower driven fast appears to penetrate canopy as well as tower-slow
- Greater volume improved coverage markedly, except at upper exterior
- At 100 gpa, averaged 45.1% coverage. At 200 gpa: 52.5%
- "Spray shadows" still apparent, but much less at interior positions

Broad Effects: Apple % Coverage

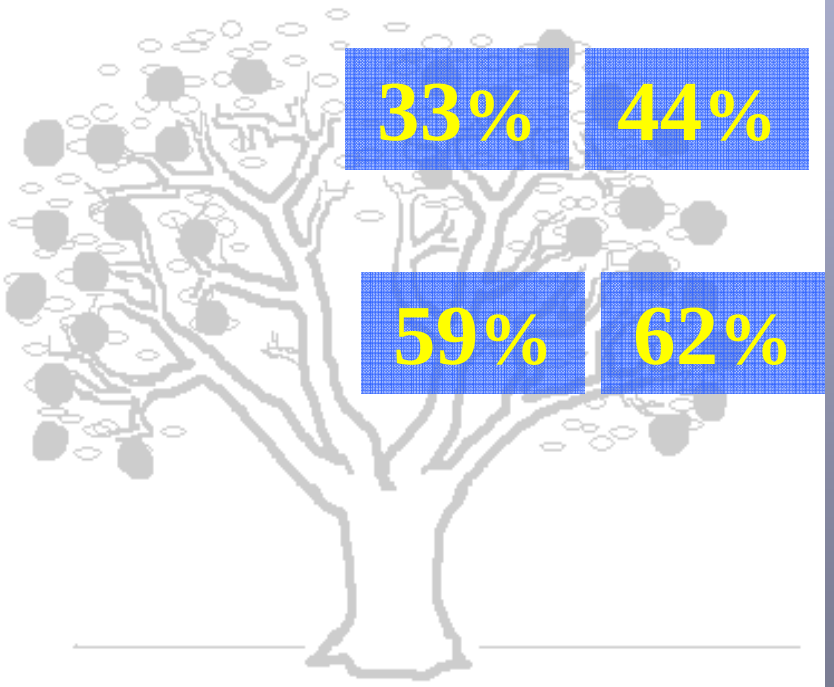
Apple Sprayer -Speed	Volume		Position		Height		Overall Effects
	100	200	Int	Ext	Hi	Lo	
Rears-S	41.5	49.1	31.9	58.7	42.9	47.7	45.3
Tower-S	45.8	55.4	37.7	63.5	49.0	52.2	50.6
Tower-F	45.1	52.5	40.6	57.1	41.4	56.2	48.8
Overall	44.1	52.4	36.7	59.8	44.4	52.0	48.2

Summary of Coverage Trends in Apple

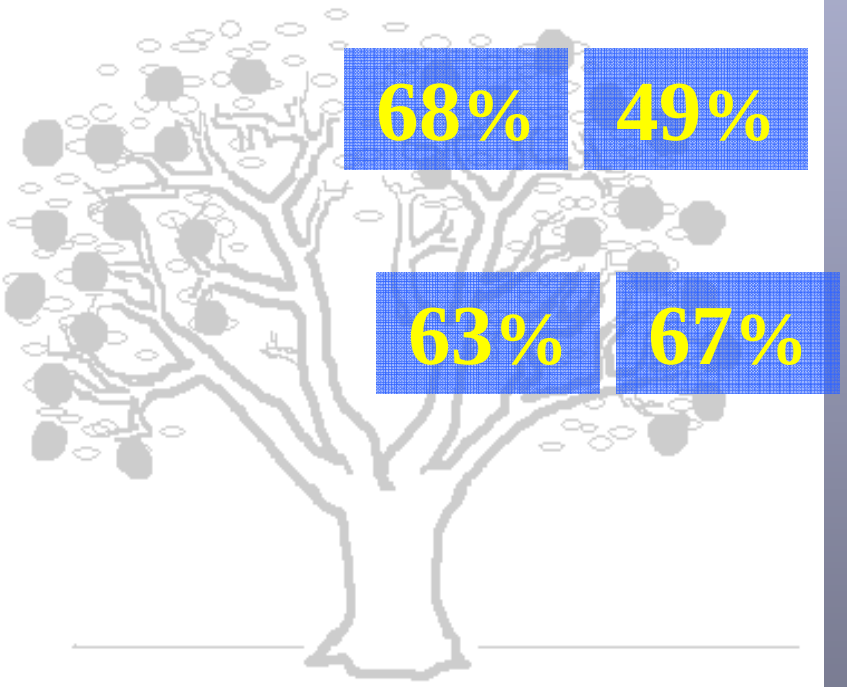
- Coverage on the cards was far below what was anticipated (44% @ 100 gpa; 52% @ 200 gpa)
- Coverage on the interior of the canopy is consistently and *significantly less* than exterior—likely a "spray shadow"
- Higher volume per acre (200 gpa) allowed greater canopy penetration and thus better coverage for all sprayers; however, increases were not dramatic
- Tower sprayer provided slightly better coverage than rears, but difference was not statistically significant
- Tractor speed did not significantly affect coverage with the tower sprayers—may suggest that 2.5 mph doesn't sacrifice coverage

Volume Effects in Cherry: *Rears*-Slow

100 gpa



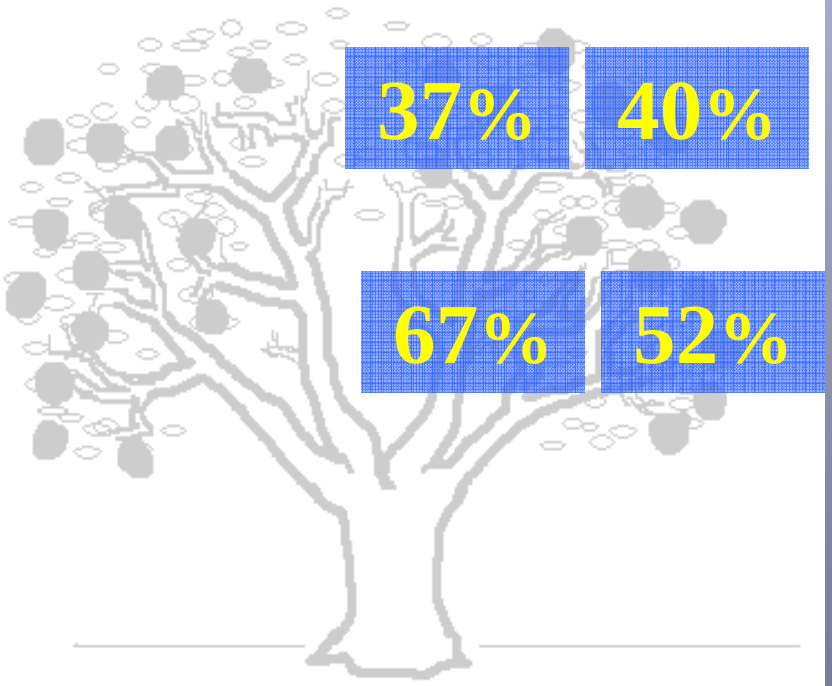
200 gpa



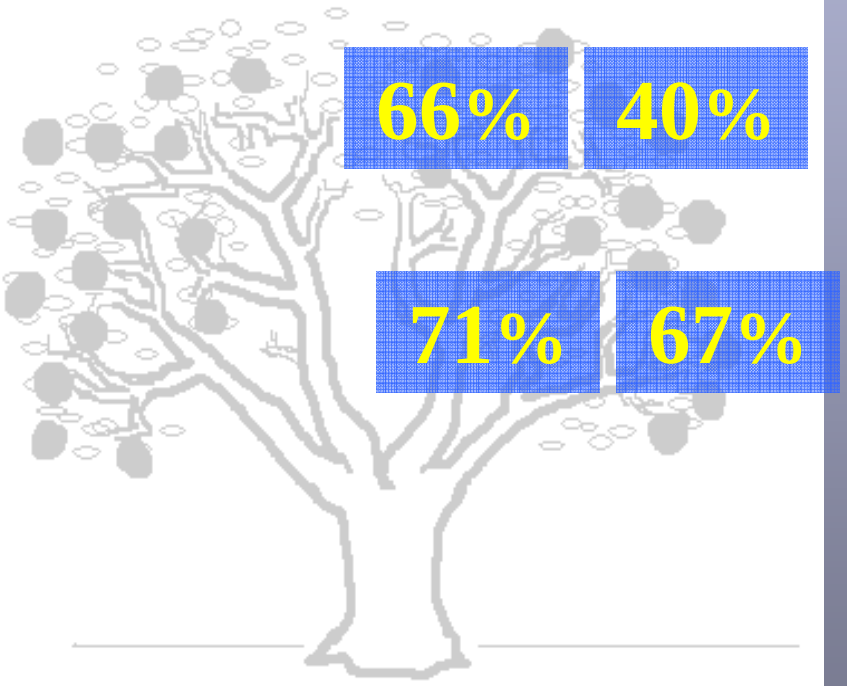
- Doubling the spray volume improved coverage, esp. the upper interior
- Upper exterior coverage relatively low for both spray volumes
- Different kind of spray shadow: upper exterior canopy

Volume Effects in Cherry: *Tower*-Slow

100 gpa



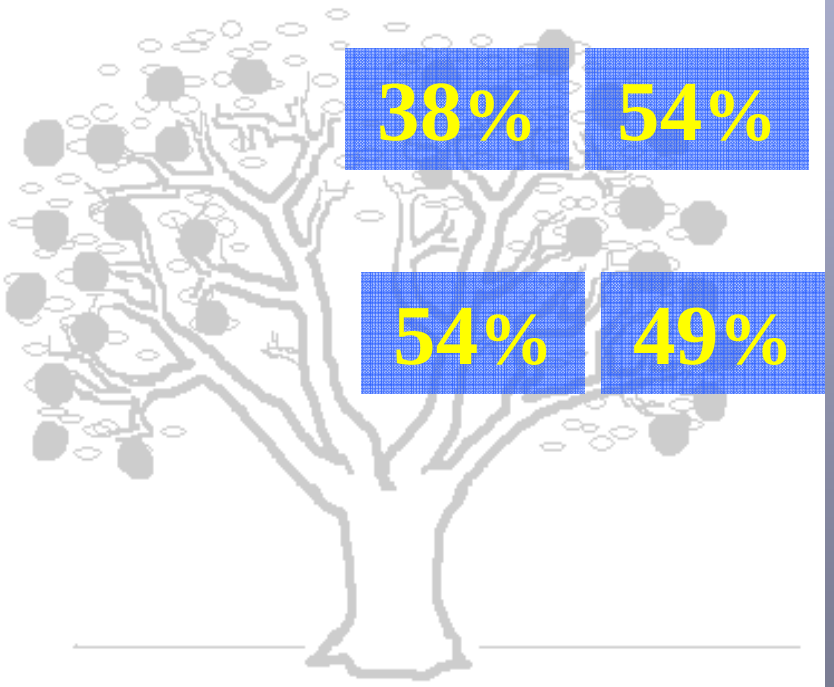
200 gpa



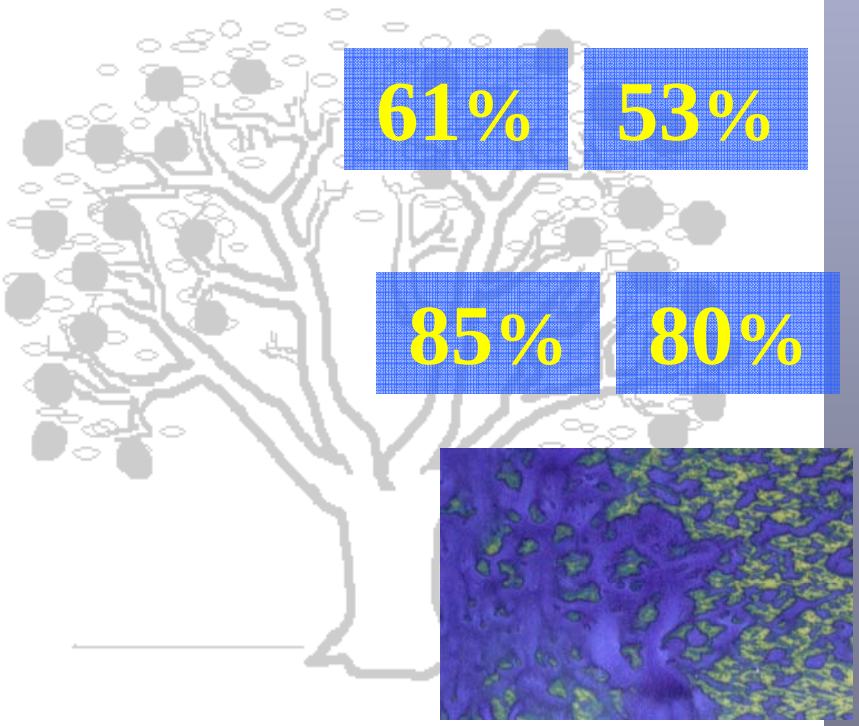
- Doubling the spray volume did little for the upper and exterior coverage
- Greater volume did improve interior penetration
- Exterior positions with lower coverage—reverse of apples

Volume Effects in Cherry: *Tower*-Fast

100 gpa



200 gpa



- Doubling the spray volume greatly increased coverage, except upper exterior
- Tremendous improvement at interior positions
- Again, "spray shadow" at the upper exterior

Broad Effects: Cherry % Coverage

Cherry Sprayer -Speed	Volume		Position		Height		Overall Effects
	100	200	Int	Ext	Hi	Lo	
Rears-S	49.5	61.9	55.8	55.6	48.6	62.8	55.7
Tower-S	49.1	60.9	60.3	49.8	45.6	64.4	55.0
Tower-F	48.6	69.7	59.4	58.9	51.4	66.9	59.1
Overall	49.1	64.2	58.5	54.7	48.6	64.7	56.6

Summary of Coverage Trends in Cherry

- Coverage on the cards was far below what was anticipated
- At 100 gpa, coverage at the upper height was particularly low with all the sprayers
- The 200 gpa dramatically increased coverage at all interior positions
- Tower sprayer did not appear to provide better coverage (RS vs. TS)
- For the tower sprayer, the faster speed provided equal (or better) coverage than the slow speed

Take Home Points on Spray Coverage in Apple vs. Tart Cherry

Apple: 48%

- Interior: spray shadow from large scaffolding limbs, especially for lower interior
- Sprayer, speed, & volume: mild effects

Tart Cherry: 57%

- Upper: less coverage, not pushing the spray thru the canopy
- 200 gpa provided sig. better coverage than 100 gpa

The Silver Lining

- The information on canopy coverage forms the basis for future improvements in IPM
- Helps explain pest "break out" situations
- Coverage is something that *can* be improved
- Increased water volume/acre and better pruning are obvious first-steps
- Better coverage will help manage almost all orchard pests

Acknowledgements

- Curtis Rowley
- Dale Rowley
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- Guy Banner
- Susan Durham
- Ray Rowley
- Dustin Rowley
- Chris Garrard

New Insecticides for Tree Fruit Pest Management

Guthion Registration Update

- Group 3 uses – Time limited reg.:
  - Apple, pear
  - Sweet & tart cherry
  - Walnuts, almonds, pistachios
- April 3, 2006 – EPA decision on continuation
- Group 2 uses – Phase out reg.:
  - Peach, nectarine
  - Caneberries
- Group 2 uses terminated in 2005

Insecticides Registered for WCFF in Utah

Product	REI	PHI
Imidan*	24 h	7 d
Lorsban*	4 d	14 d
Asana	12 h	14 d
Warrior	24 h	14 d
Guthion	15 d	15 d
Diazinon	24 h	21 d
Dimethoate	Post-harvest	

*for tarts only

Product	REI	PHI
Sevin	12 h	3 d
Malathion	12 h	1or3 d
Diatect	12 h	12 h
Provado	12 h	7 d
Actara	12 h	14 d
Spinosad		
Success	4 h	7 d
Entrust	4 h	7 d
GF-120	4 h	4 h

GF-120 Mode of Action

- Bait in GF-120 is a weak attractant, but a strong arrestant
- Adult fruit flies that feed on GF-120 are killed quickly
- 0.02% a.i. spinosad is highly toxic to adults when ingested
- Need to keep enough GF-120 available for adult population size
- Not rain-fast
- Reapply every 5-7 d & after rain

Provado Mode of Action

- Systemic – uptake by fruit kills eggs & small larvae
- Contact – weak to moderate adulticide
- Under high populations in Kaysville research orchard – 14 d of fruit protection

Take Home Points on New WCFF Insecticides

- New insecticides offer greater flexibility in REIs & PHIs
- GF-120 offers an alternative application method
- Differ in target stage efficacy
  - Provado – larvicide, kill eggs/larvae inside fruit
  - Success / GF-120 – adulticide
- Cannot protect fruit against migrating, mature adults – in Utah, ff sources are within & outside orchards
- Rotate neonicotinoid insecticide applications – mite stimulation

Codling Moth Management

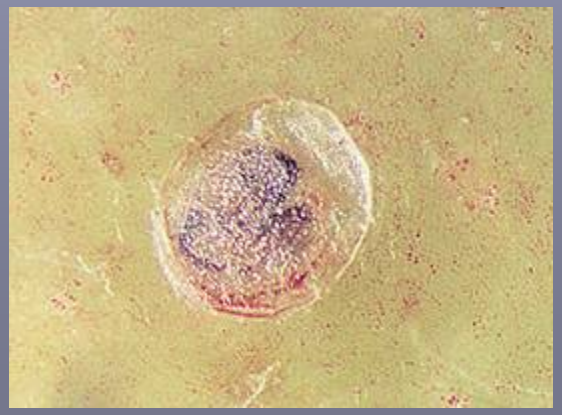
- Critical factors:
  - Reduce population size to manageable level
    - Mating disruption
  - Time sprays for peak egg hatch (& peak egg laying) periods
  - Use a diverse management program
    - Avoid insecticide resistance
    - Target eggs & hatching larvae

Codling moth adults in trap

New Insecticides: Target Eggs & Larvae

- Larvicides, Ovicides, or Both (Intrepid, Esteem)
- Larvicides
  - Contact (most)
  - Ingestion (biologicals)
- Ovicides
  - Topical (oil, Assail, Calypso)
  - Residual (Esteem)
  - Both (Intrepid, Rimon)

1st instar larva



CM egg with dead larva

CM Integrated Insecticide Program – Disrupt more than one stage

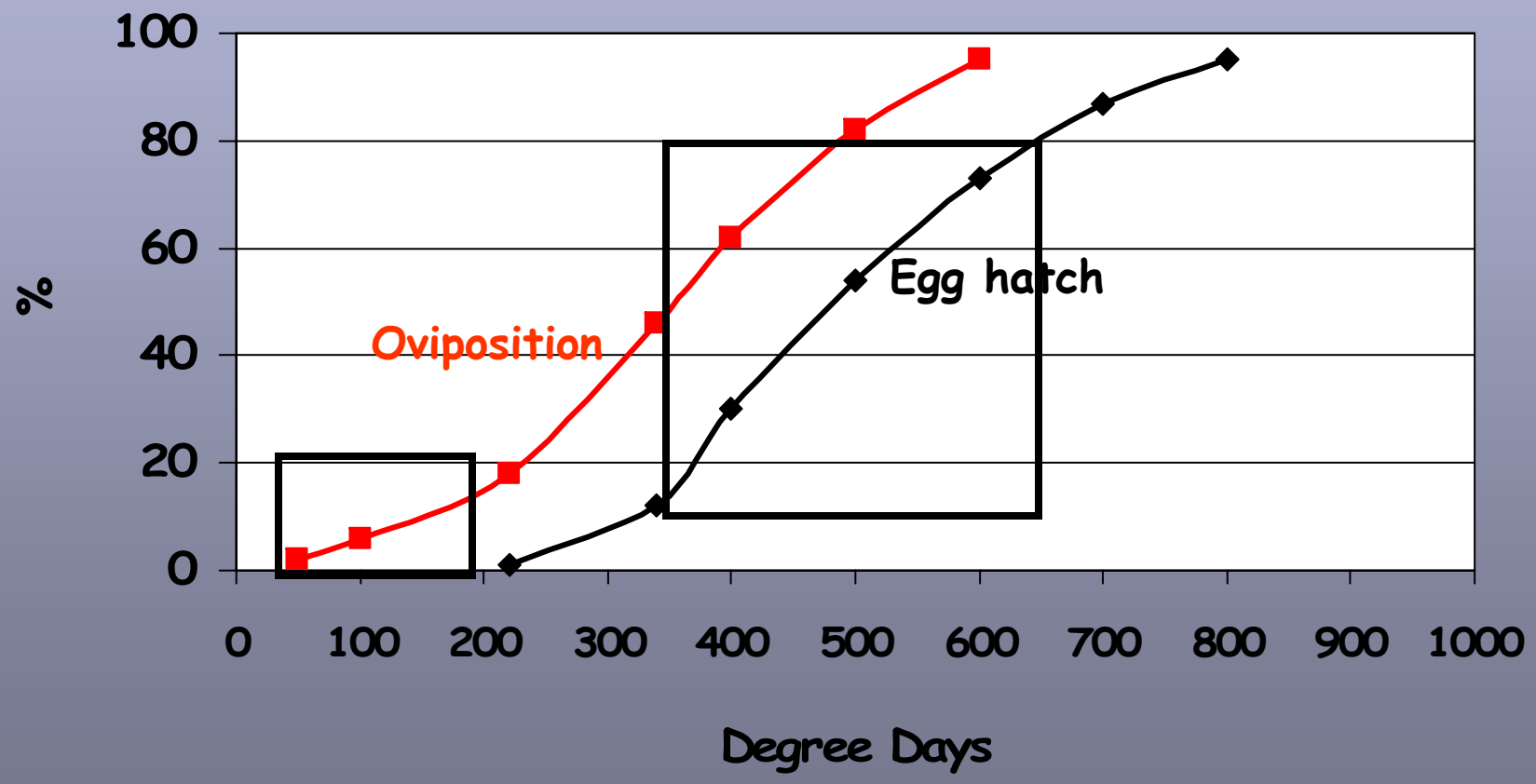
- Ovicide: 50-200 DD
  - Control first ~12% of egg hatch
  - Kill eggs before they hatch, delay larval control
- Larvicide/Ovicide: 350 DD
  - Optimizes residues for ~70% of egg hatch (340 – 660 DD)

For 1st generation:

#1
50-100 DD: Rimon, Intrepid or Esteem
350 DD: Assail
21 d later: Calypso

#2
100-200 DD: Oil or IGR
350 DD: Assail or Calypso + Rimon or Intrepid

Codling Moth Development



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350 DD: Assail
21 d later: Calypso

#2
100-200 DD: Oil or IGR
350 DD: Assail or Calypso + Rimon or Intrepid

New CM Insecticides Diverse Rotation Program

April → CM egg laying periods September

50 DD 350 DD

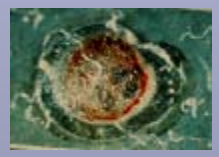
Rimon
Intrepid
Esteem
Oil

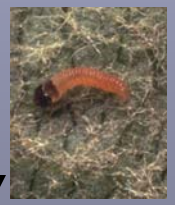
Assail
Calypso

1050 DD 1350 DD

Rimon
Intrepid
Esteem
Oil

Intrepid
CM virus
Bt





CM egg hatch periods

250 DD

1200 DD

Good timing
Target different life stages
Rotate within & between CM generations
Mixtures

From Brunner et al. Managing Apple Pests without OPs

CM Adult Monitoring

- Lure options:
  - 1X, 10X, DA (pear ester), Combo
- Trap options:
  - Delta (large, orange) – catch fewer bees, more males
  - Wing – not recommended
- Trap position in tree – upper 1/3 canopy
- Trap density – 1 trap per 2-3 acres
- Trap placement – borders & interior
- Thresholds – vary with lure & time of season (2-4 moths)

Long-term, sustainable CM Mgmt. Program

- MD allows population reduction, if needed
- More options & flexibility for insecticide program
- Target both eggs & larvae
- Use only as many sprays as needed to maintain low CM population
- Monitor moths!

Nicotinoids

- Derived from nicotine
- Broad-spectrum pest activity
- Most have systemic activity; if applied to soil or injected can last for a season
- Neurotoxin – interfere with nerve impulses
  - Apple:
    - Provado, Assail, Calypso
  - Cherry:
    - Provado, Actara

Spinosad

- Bacterial fermentation product
- *Saccharopolyspora spinosa* discovered in soil of abandoned rum distillery in the Caribbean
- Broad-spectrum pest activity
- Neurotoxin – novel binding site in nerve transmission
  - Success & Entrust (organic)
  - GF-120 – fruit fly bait

Novaluron

- IGR: chitin synthesis inhibitor, prevents proper formation of exoskeleton after molting
  - Rimon – Pome fruits
    - Codling moth, Pear psylla

Diacylhydrazines

- IGR: Disrupts/mimics molting hormone, induces premature molting
  - Confirm – Fruits
    - Leafrollers
  - Intrepid – Fruits
    - Codling moth, Leafrollers

"New" Miticides

Twospotted Spider Mite

Leaf Blister Mite

Clofentezine & Hexythiazox


Twospotted spider mite

- Mite growth inhibitor
- Acts primarily as an ovicide (kills eggs) with some effect on early instars (first stages of young)
- Need to apply "early" in development of a mite population
- Translaminar activity (local systemic uptake)
  - Apollo, Onager & Savey – Tree Fruits & Raspberry (Savey only)

Etoxazole

European red mite

- Mite growth inhibitor
- Acts primarily as an ovicide (kills eggs) with some effect on early instars (first stages of young)
  - Zeal – Fruit & Nut Trees, Strawberries

Pyridazinones

Spider mites

- Inhibits mitochondrial electron transport, affects respiration
- Same mode of action as rotenone
  - Fujimite, Pyramite, Nexter – Fruits
    - Spider mites, Leafhoppers, Aphids, Pear psylla

Acequinocyl

- Inhibits mitochondrial electron transport, affects respiration
- Different site of action than other METI compounds
  - Kanemite & Shuttle – Pome Fruits & Strawberries
    - Twospotted spider mite, European red mite

Bifenazate

- Carbazate (related to carbamates)
- Neurotoxic, but exact MOA unknown
  - Acramite – Stone & Pome Fruits, Grapes, Vegs.

Spider mites

IR-4 Project for a New Cherry Miticide - 2006

- Michigan State U., Rutgers U., & Utah State U.
- Acequinocyl (Kanemite 15SC)
- Cherry (Tart & Sweet)
- Two spotted spider mite, European red mite
- 7 d PHI; 2 applications per season
- Suppresses respiration; mitochondrial electron transport inhibitor (METI)
- Registered on pome fruits, strawberries, ornamentals