NEW CHERRY FRUIT FLY CONTROLS IN TART CHERRY

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EXTENSION UtahState UNIVERSITY

UTAH PESTS

WESTERN CHERRY FRUIT FLY IN UTAH *RHAGOLETIS INDIFFERENS*

- Native hosts don't play a role
- Tart & sweet cherry
- Unmanaged trees
  - Home yard trees
  - Neglected orchards
- Hostile environment & ecosystem outside of orchard & urban areas

Tart cherry orchard

Home yard sweet cherry tree

WCFF MANAGEMENT – TART CHERRY

- Primary insect pest
- Zero tolerance for larvae in fruit
- Growers struggle with control timing
  - Low populations – difficult to set biofix
  - Large orchards (10+ acres)– if minimal outside influx, does entire interior need to be treated?
  - Excessive spraying
- Growers use a low trap density (1-2 traps per 5-10 acres) & most are placed on borders

CFF-infested fruits

UTAH CFF RESEARCH

- Field-based
- Efficacy of new insecticides
  - Neonicotinoid (imidacloprid, Provado®)
  - Microbial (spinosad, GF-120®)
  - Adult & larval suppression
  - Non-target effects on mites
- Monitoring (Pherocon AM® trap)
  - Additional attractants
  - Trap placement (border & interior)
  - Trap density
  - Insecticide influences on dispersal of males & females (immature & gravid)

Pherocon AM® trap + ammonium carbonate bait

1. EFFICACY OF NEW INSECTICIDES

- 2004-07: 19 orchard trials
  - 15 trials on commercial farms
  - 4 trials on university research farm
- Objectives:
  - Evaluate, demonstrate, & encourage adoption of non-OP insecticides for CFF management
  - Test & refine strategies, technologies, & timing for alternative products
  - Develop and validate predictions of fruit injury from trap catch

Infested cherry fruits

GF-120 APPLICATION

Electric pump sprayer mounted on 4-wheeler applies a strip of spray along the mid- and upper-line of each tree row

EFFICACY OF NEW INSECTICIDES

COMMERCIAL ORCHARD TRIALS

Year	Orch #	Treatment*	# CFF larvae^
2004	1	Guthion	0
		Provado	0
	2	Dimethoate	0
		Provado	0
	3	Guthion	0
		Imidan	0
		Provado	0
2005	4	Guthion	0 c
		Provado	2.4 a
		GF-120	0.8 b
	5	Guthion	0
		GF-120	0

Year	Orch #	Treatment*	# CFF larvae^
2005	6	Guthion	0
		GF-120	0
	7	Guthion	0
		GF-120	0
2006	8	Provado/Guthion	0
	9	Provado/Imidan	0
	10	Provado/GF-120	0
	11	Provado/GF-120	0
	12	GF-120	0
	13	Provado/Guthion	0.0002
	14	Provado/GF-120	0
	15	Provado/GF-120	0.0004

*Total of 2-6 applications per season, ^Cumulative # CFF larvae per 100 fruit (2,000-5,000 fruit sampled per orchard)

EFFICACY OF NEW INSECTICIDES
RESEARCH ORCHARD TRIALS

Year	Orch #	Treatment*	# CFF larvae^
2004	16	Untreated	44.7 a
		Guthion	1.1 b
		GF-120	0.3 c
2005	17	Untreated	9.3 a
		Guthion	1.3 b
		GF-120	0.1 c
2006	18	Untreated	10.0 a
		GF-120	4.0 b
		GF-120+AC	3.3 b
		GF-120+AA	0.3 c
		Success	2.3 bc
		Provado	1.8 bc

Year	Orch #	Treatment*	# CFF larvae^
2007	19	Untreated	9.1 a
		GF-120	1.9 b
		GF-120+AA	0.8 b
		GF-120+U	1.4 b
		GF-120+TY	0.5 b
		GF-120+CCJ	0.9 b

*Total of 2-6 applications per season; AC=ammonium carbonate, AA=ammonium acetate, U=urea, TY=torula yeast, & CCJ=concentrate cherry juice (10% w/v)

^Cumulative # CFF larvae per 100 fruit (2,000-5,000 fruit sampled per orchard)

IMIDACLOPRID (PROVADO®)

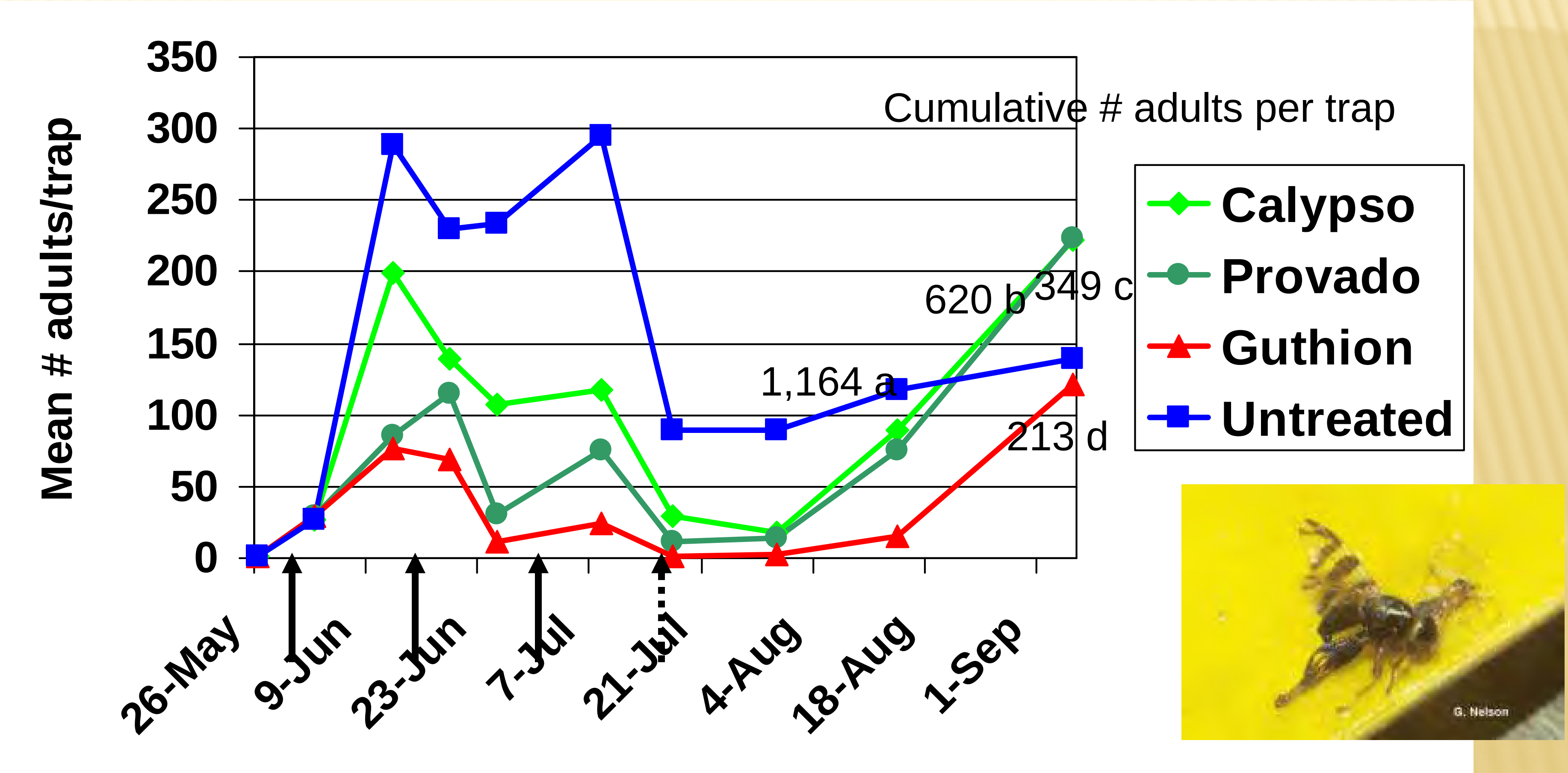
- Prevented WCFF fruit injury in 13 of 15 commercial orchard trials
- In Orchard 4 (2.4% fruit injury), crop load was small and external, home yard sources of fruit flies compromised Provado's performance
- In Orchard 13 (0.0002% fruit injury), fruit maturity was advanced
  - 16% of fruit was rosy in color on June 12 (collection date of infested fruit)

Home yard sweet cherry tree

SPINOSAD (GF-120 NF®)

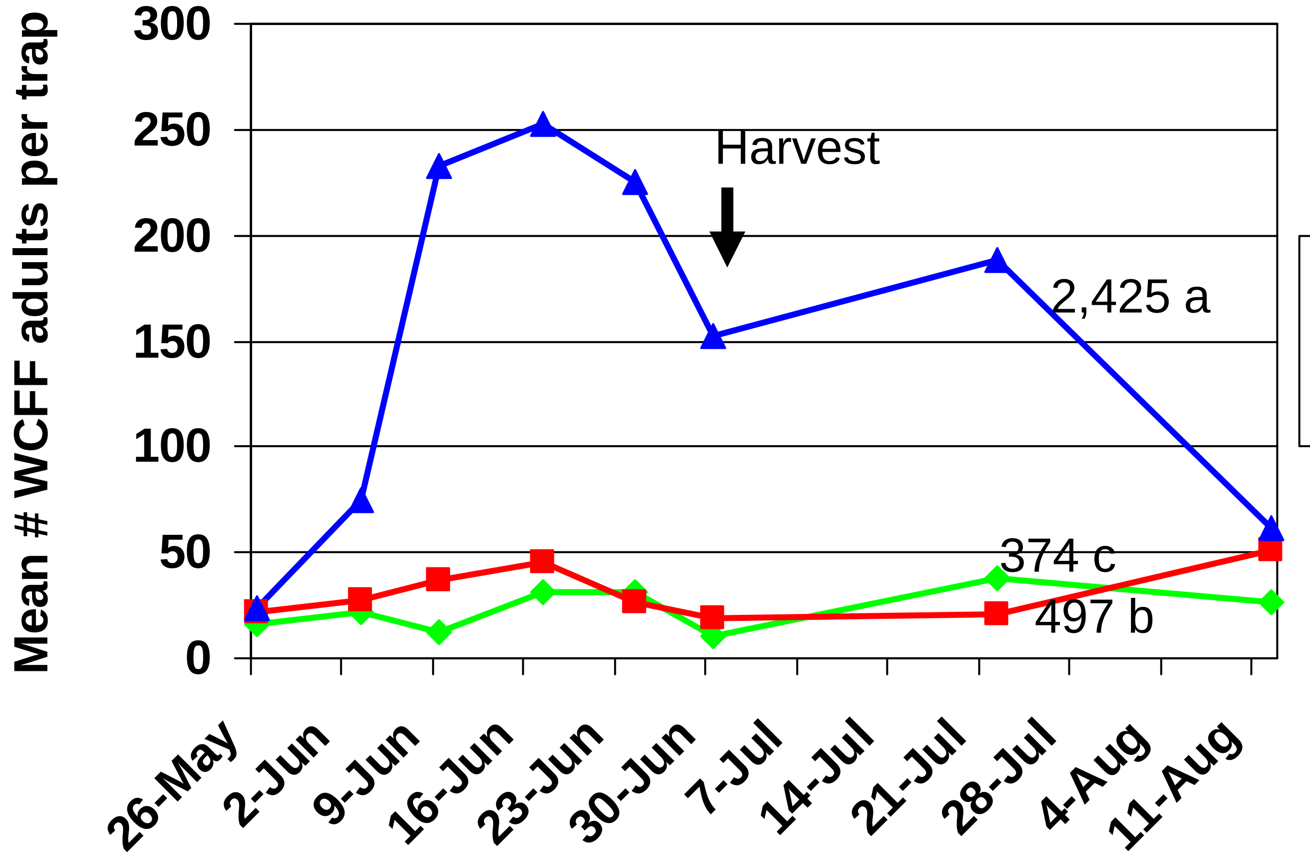
- Similar to Provado, GF-120 prevented WCFF fruit injury in 13 of 15 commercial orchard trials
- GF-120 did not completely protect fruit in any of the 4 research orchard trials
- Fruit fly densities were 2-100× times higher in research orchards (21-1211 cumulative adults per trap) than in commercial orchards (0-12 cumulative adults per trap)
  - High CFF densities & close proximity of untreated plots were major reasons for the inability of GF-120 to prevent fruit injury in research trials
  - Despite high CFF densities & influx of gravid females, GF-120 kept fruit injury $\leq$ 4.0 larvae per 100 fruit
- 10% AA (w/v) improved performance of GF-120 in 2006 trial, but no added attractants enhanced GF-120 in 2007 trial

Life Stage Suppression –
Neonicotinoid insecticides are moderate adulticides



Solid arrows indicate insecticide spray timings; broken arrow indicates cherry harvest date

Life Stage Suppression – Spinosad is a good adulticide



GF-120 Bait and Guthion dramatically suppressed WCFF pops.
Guthion: 76% flies caught next to Untreated
GF-120 Bait & Guthion suppressed populations post-harvest

GF-120 MODE OF ACTION

- Bait in GF-120 must be <u>arresting</u> adults reasonably well, but it doesn't appear to be attractive
- Bait droplets encountered during routine adult foraging
- Adult fruit flies that feed on GF-120 are killed quickly
- 0.02% a.i. spinosad is highly toxic to adults when <u>ingested</u>
- Need to keep enough GF-120 available for adult population size
- Not rain-fast
- Reapply every 5-7 d & after rain

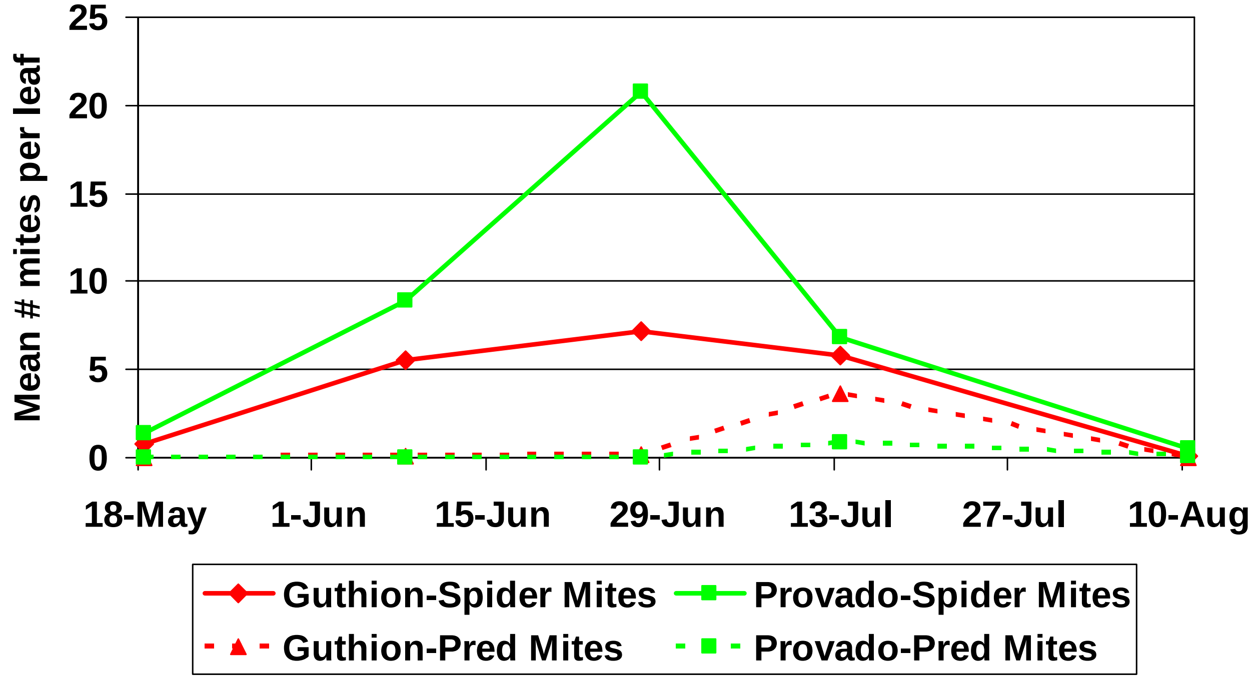
PROVADO MODE OF ACTION

- Contact – only moderate adulticide
- Systemic – kills larvae (eggs) inside fruit
- Under high populations in research orchard trials – 14 d of fruit protection

NON-TARGET EFFECTS ON MITES EXAMPLE

- Stimulation of spider mites
- Follows 2-3 applications of Provado
- Predaceous mite densities lowered none or moderately
- Primary mechanism: Hormoligosis
- No non-target effects of spinosad detected

Genola, UT – <u>Economic mite populations</u>



<u>Provado increased spider mite densities</u> vs. Guthion

Pred mites increased in mid July – too late

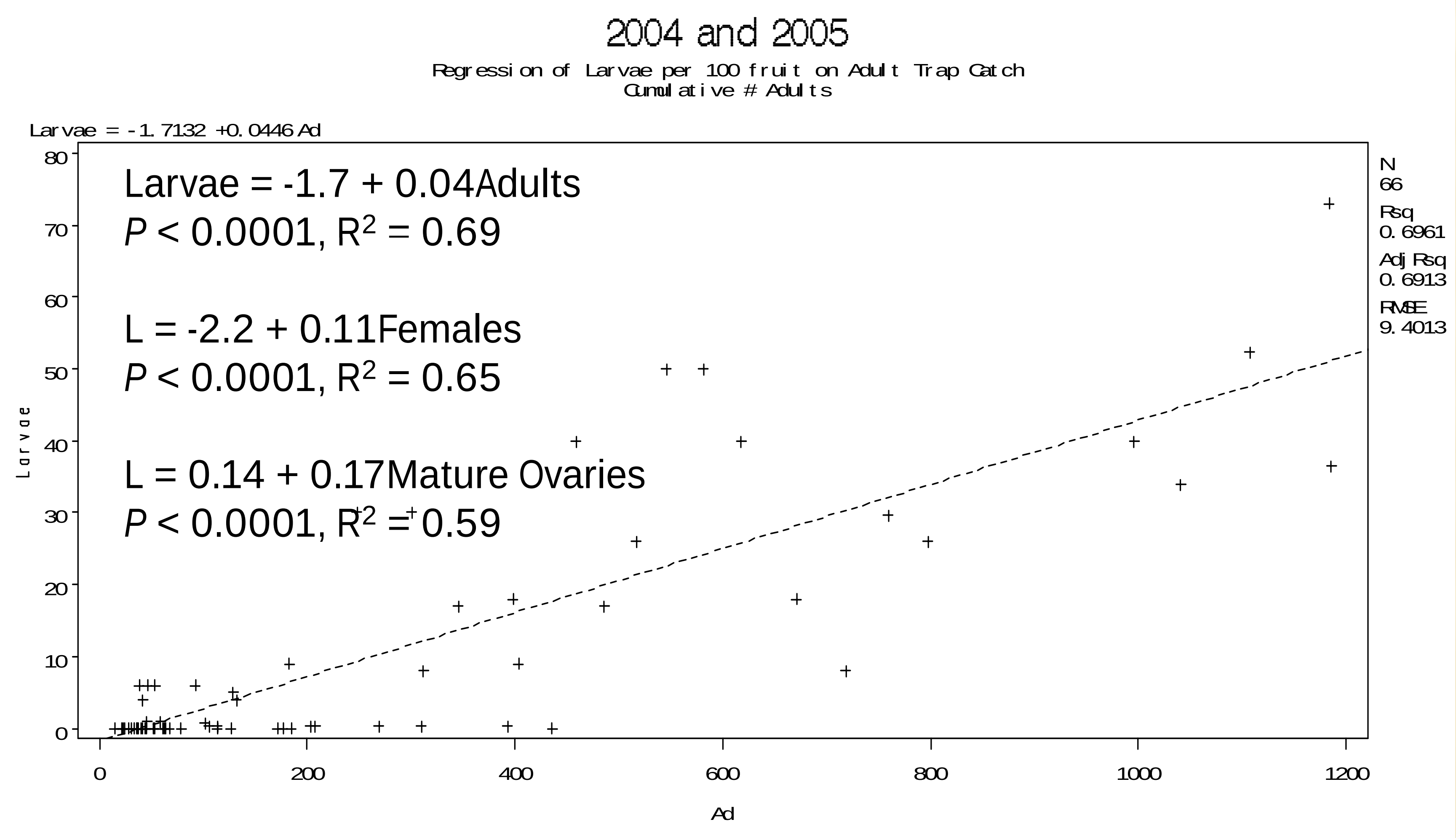
COMPARISON OF INSECTICIDE LABELS

- GF-120
  - 4 h REI
  - 0 d PHI
  - 10-20 fl oz/acre
  - Coarse spray droplet size (4-6 mm)
  - 1:4 or 1:5 dilution with water
  - Strip application
  - PPE:
    - Coveralls, gloves, shoes
- Provado
  - 12 h REI
  - 7 d PHI
  - 6-8 fl oz/acre
  - Minimum of 10 days between sprays
  - Post-bloom only
  - Toxic to bees
  - Full cover spray
  - PPE:
    - Coveralls, gloves, shoes

INSECTICIDE EFFICACY SUMMARY

- Spinosad (GF-120 and Success) and imidacloprid (Provado) offer greater flexibility in REIs and PHIs than organophosphate insecticides
- GF-120 offers an alternative application method
- The two products differ in pest target stage
  - Provado: larvicide (ovicide), moderate adulticide
  - Spinosad: adulticide
- GF-120 cannot protect fruit against migrating females that contain mature eggs
  - Prevented fruit injury for orchards ≤ ~ 20 cumulative CFF on traps
- Important to rotate applications of neonicotinoid (Provado) with other insecticide classes
  - Stimulation of spider mites

RELATIONSHIP BETWEEN LARVAL INFESTATION AND ADULT DENSITIES



PREDICTION OF FRUIT INJURY FROM ADULT TRAP CATCH

- For untreated & treated cherries combined
  - 100 adults ⟹ 4 larvae
  - 100 females ⟹ 11 larvae
  - 100 females with mature ovaries ⟹ 17 larvae
- >0.14 gravid females corresponded to infested fruit
- Need to analyze with larger data set & refine predictions

2. MONITORING CFF WITH TRAPS

A. ADDITIONAL ATTRACTANTS

- Pherocon AM® yellow sticky trap – standard
  - Visual attractant – yellow color
  - Host/Food attractant – yeast
- Objective:
  - Evaluate additional attractants to enhance "sphere of influence" of trap
    - Ammonia-containing compounds
    - Cherry fruit juice and extracts
    - Yeasts
    - Sugars

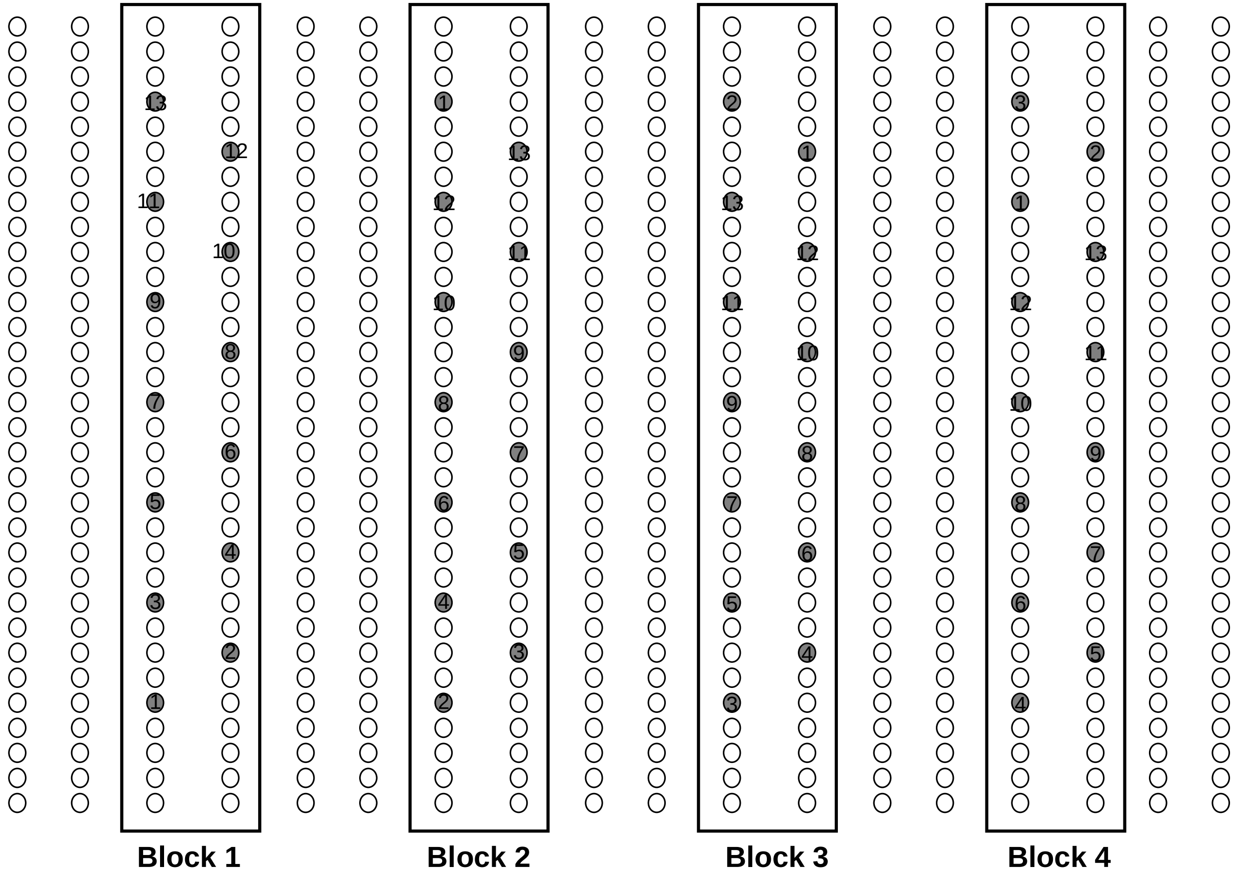
Pherocon AM® trap + ammonium carbonate bait

TRAP ATTRACTANT TRIAL

- 2007
- 5 'Montmorency' tart cherry orchards (4 commercial, 1 research)
  - 13 potential attractants:
    - Ammonium acetate (AA) – volatile powder
    - Ammonium carbonate (AC) – volatile powder
    - Ammonium hydroxide (AH) – volatile liquid
    - Urea (U) – volatile granular
    - Sweet cherry essence (SWCE) – volatile liquid
    - Sour cherry essence (SOCE) – volatile liquid
    - Single strength cherry juice (20-25 brix) (SSCJ) – liquid
    - Concentrate cherry juice (65 brix) (CCJ) – liquid
    - Torula yeast (TY) – powder dissolved in water
    - Brewer's yeast (BY) – powder dissolved in water
    - Molasses (M) – 10 drops per trap
    - Sucrose (S) – crystals dissolved in water, 10 drops per trap
    - No bait

TRAP ATTRACTANT TRIAL DESIGN

Map of Utah County Tart Cherry Orchards
2007 Western Cherry Fruit Fly Attraction to Traps
(Need at least 16-18 rows X ca. 30 trees; skip 1-2 edge rows and 2-4 end trees per row)

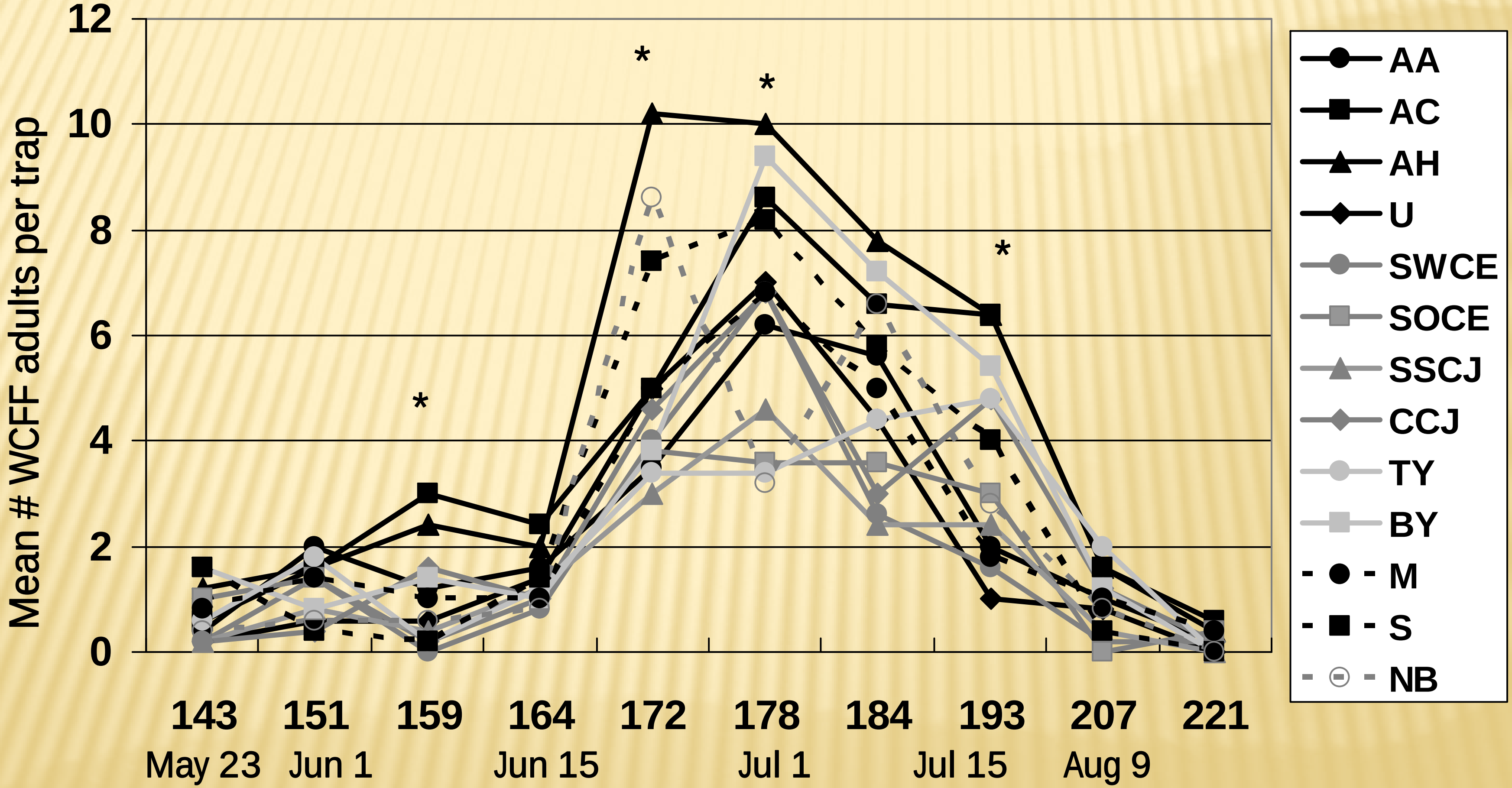


Treatments:
1. Amm. Acetate (AA)
2. Amm. Carbonate (AC
3. Amm. Hydroxide (AH)
4. Urea (U)
5. Sweet Cherry Essence (SWCE)
6. Sour Cherry Essence (SOCE)
7. Single Strength Cherry Juice (SSCJ)
8. Concentrate Cherry Juice (CCJ)
9. Torula Yeast (TY)
10. Brewer's Yeast (BY)
11. Molasses (M)
12. Sucrose (S)
13. No Bait (NB)

● = tree with trap

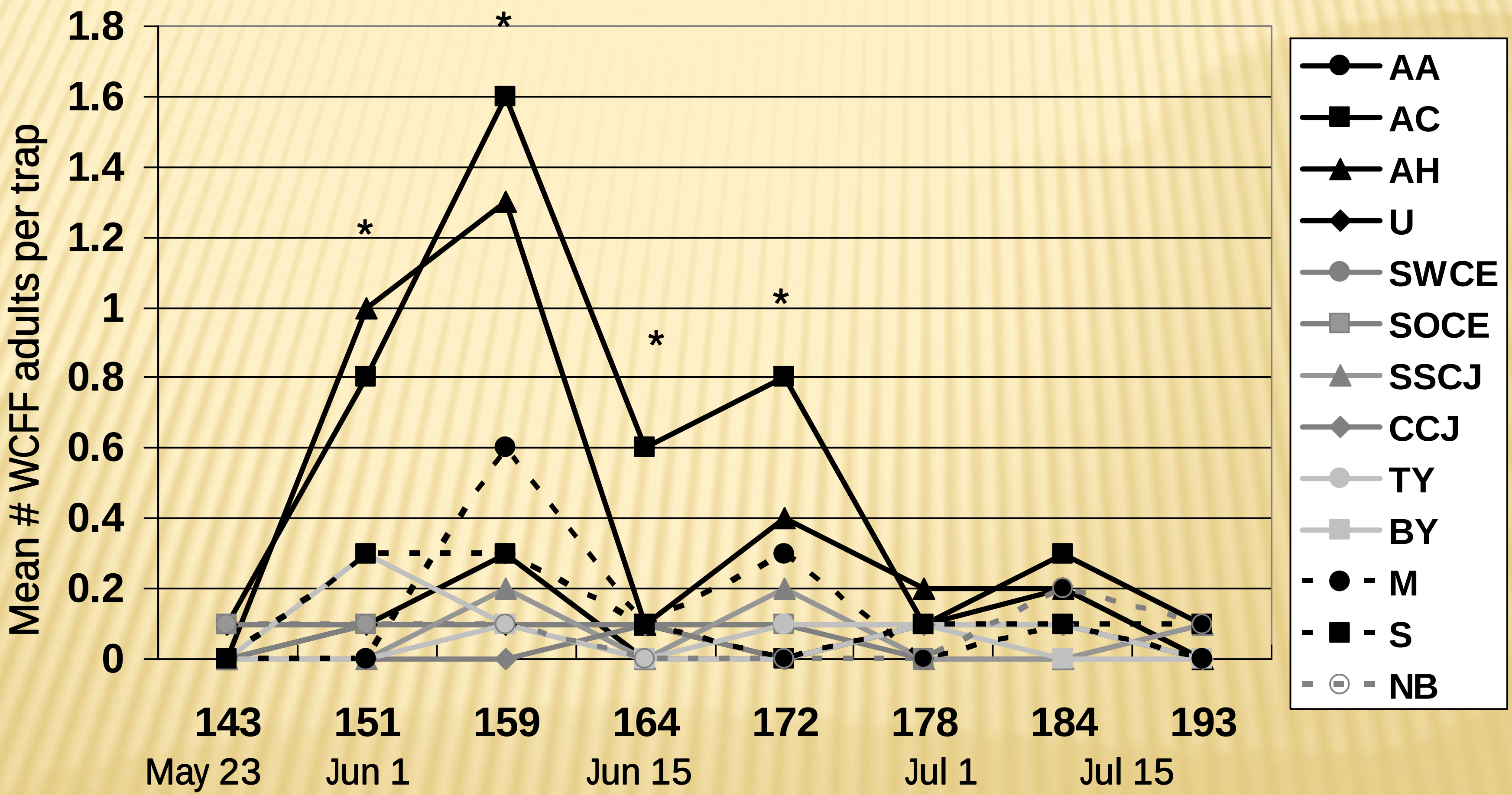
Position of treatments upon initial placement of traps indicated by numbers. Traps will be rotated weekly to the next position from front to back.

TRAP CATCH IN KAYSVILLE RESEARCH ORCHARD



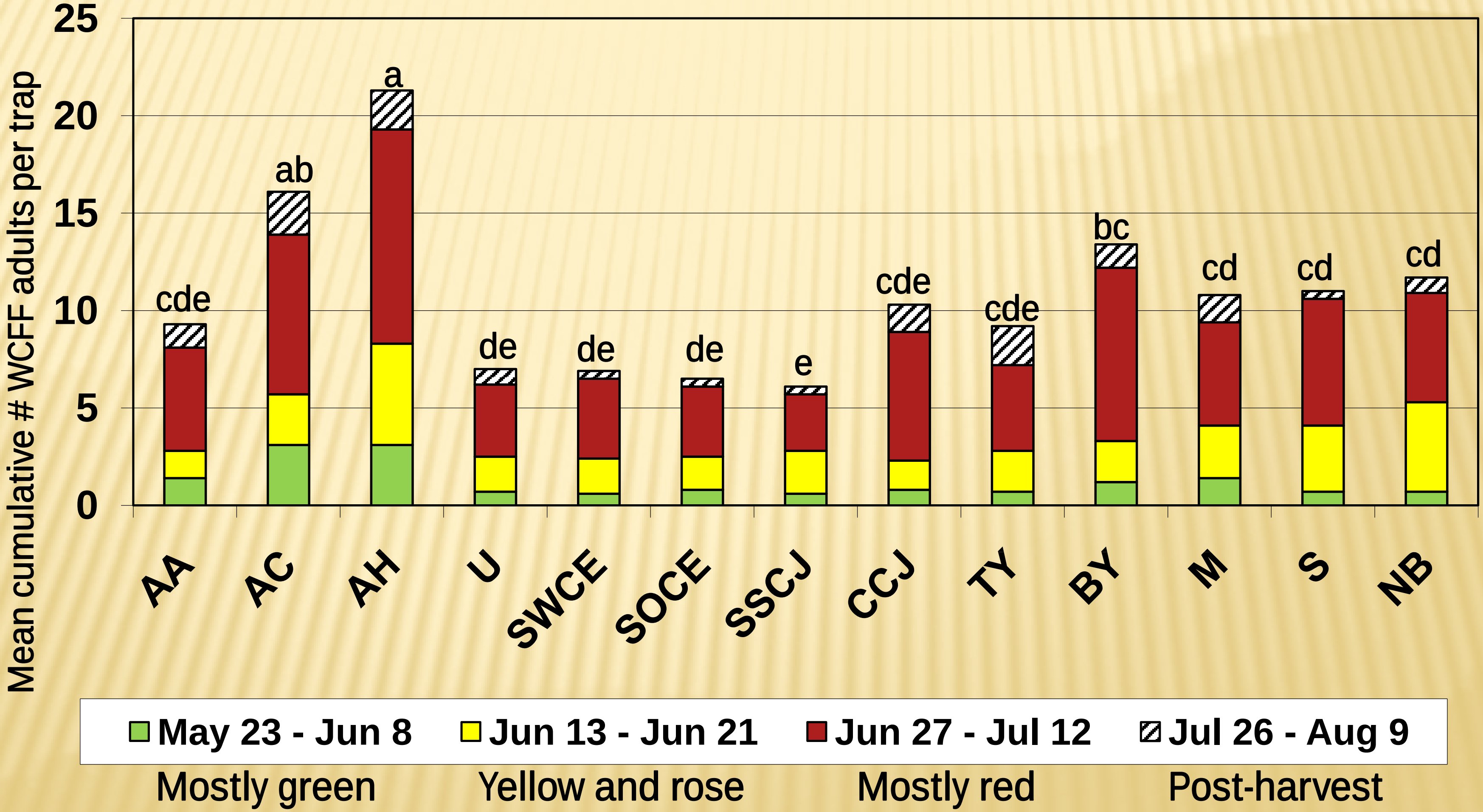
* indicates treatment means were significantly different (Tukey-Kramer test; $p \geq 0.05$) on indicated dates.

TRAP CATCH IN FOUR COMMERCIAL ORCHARDS



* indicates treatment means were significantly different (Tukey-Kramer test; $p \geq 0.05$) on indicated dates.

CUMULATIVE ADULTS FOR FOUR FRUIT MATURITY PERIODS – ALL 5 ORCHARDS



Means followed by the same letter are not significantly different (Tukey-Kramer test, $p \geq 0.05$)

TRAP ATTRACTANTS SUMMARY

- AH & AC increased adult trap catch by 1.5-2× over NB traps
  - AH releases the most ammonia, AC also releases CO_2
- BY enhanced catch over NB on dates when fruits were mature or nearly mature
- Overall, more adults were caught when fruits were mostly red in color (June 27 – July 12), but more were caught in commercial orchards during June (fruits mostly yellow and rose in color)
- More work needed on release rates & formulations, & enhancement of compound volatility

TRAP ATTRACTANT RECOMMENDATIONS

- Use of commercial AC bait recommended (~2× increase in trap catch over no bait)
- "Sphere of influence" of trap small
- Greater accuracy in CFF detection depends on higher trap densities
- Further work on CFF attractants is needed!!

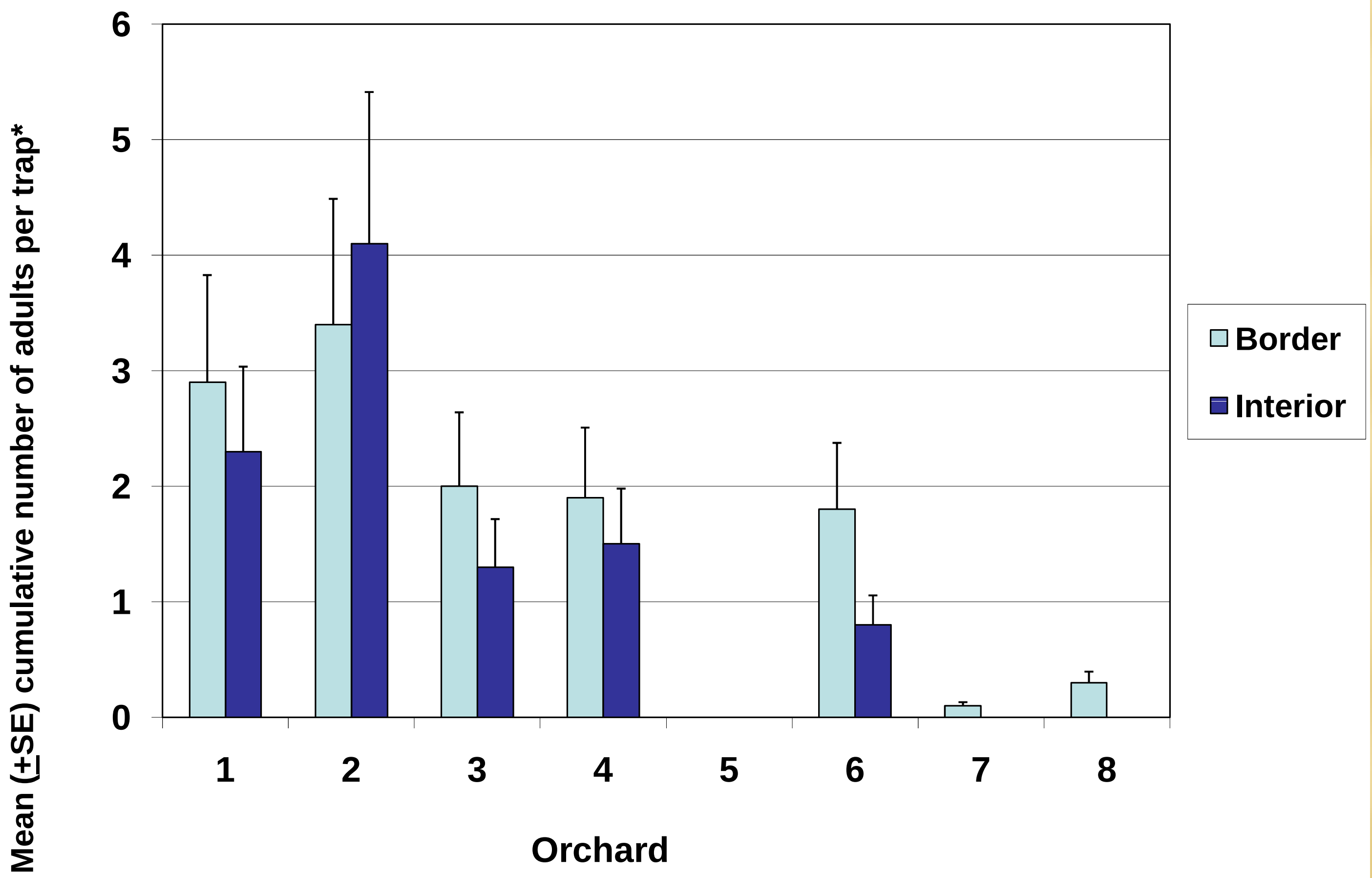
Pherocon AM® trap + ammonium carbonate bait

2. MONITORING CFF WITH TRAPS

B. TRAP PLACEMENT

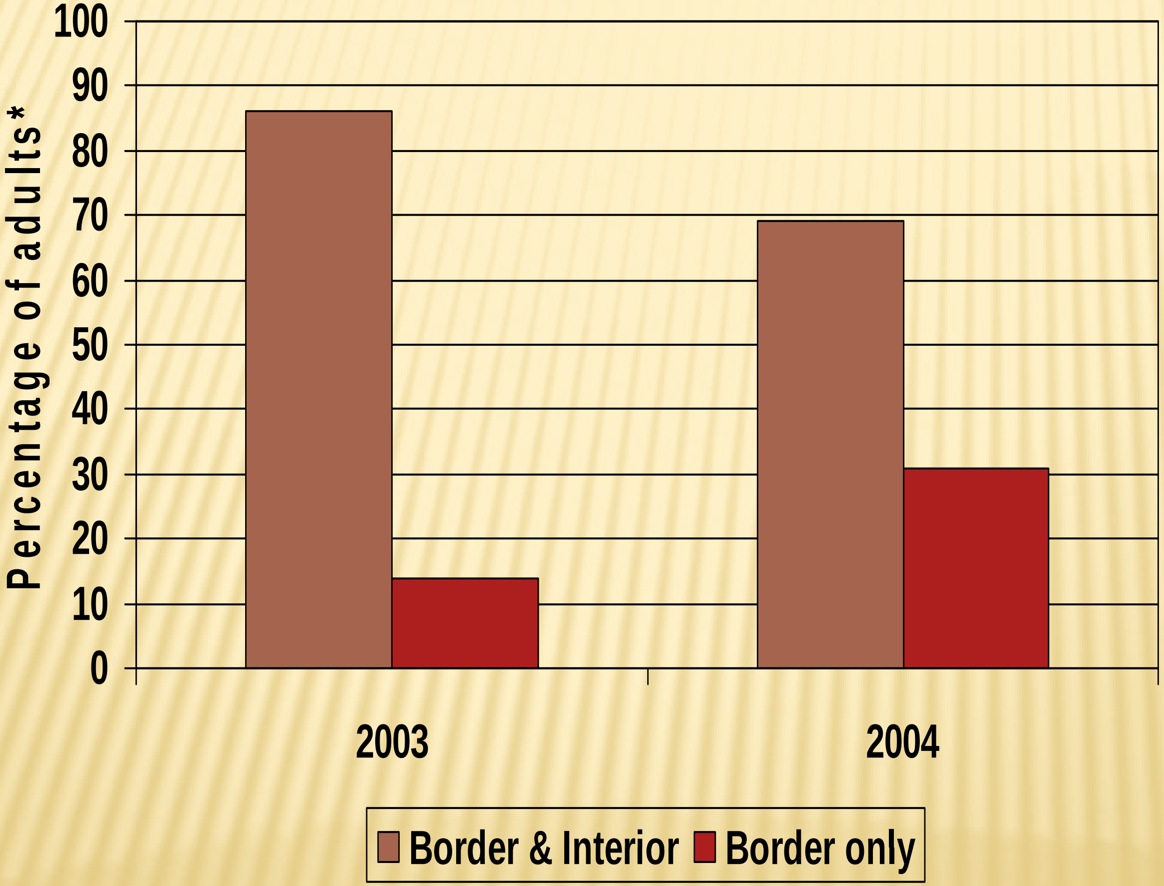
- Most Utah tart cherry growers place 1-2 traps per orchard (10+ acres), on border trees
- Growers most concerned about detection of external sources of flies
- Objective:
  - To compare adult catch on borders vs. interiors of orchards
    - 2005 & 06: 11 orchards (compared border (B) vs. interior (I) trap catch within orchards)
    - 2003 & 04: 32 orchards (compared orchards with B & I traps vs. B only)

INFLUENCE OF TRAP PLACEMENT ON WCFF CATCH - 2006



*Cumulative catch from early June to early August

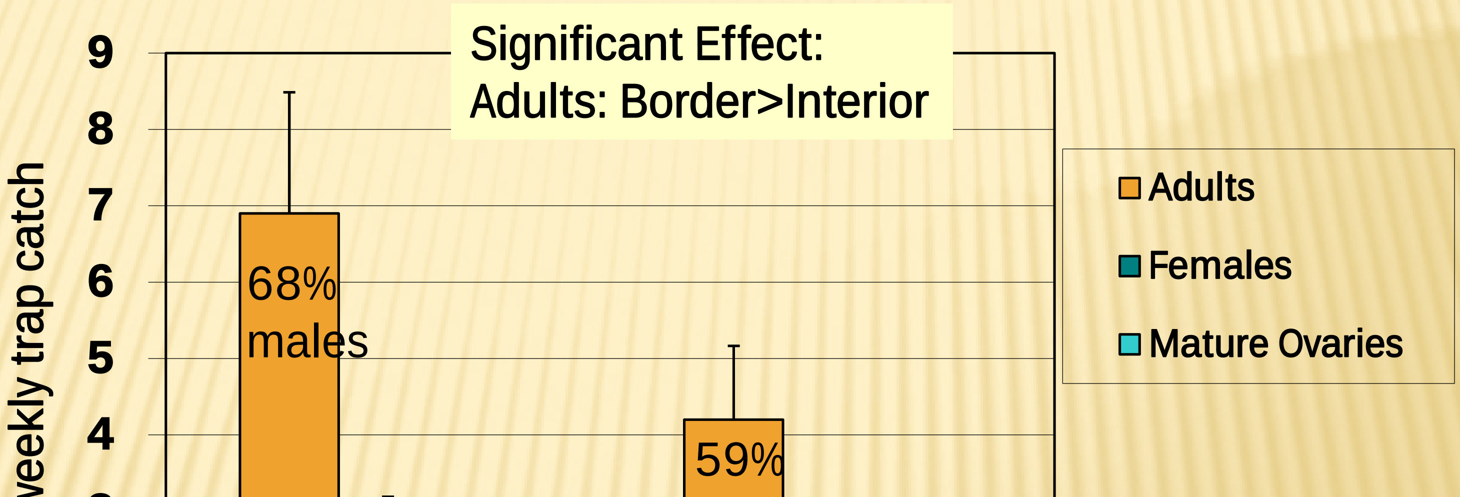
INFLUENCE OF TRAP PLACEMENT ON WCFF CATCH – 2003 & 04

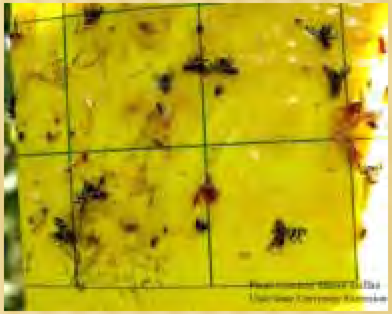


- First adult catch was an average of 2.4 days earlier in orchards with both border and interior traps vs. border traps only
- 2003 & 2004:
  B & I > B (p<0.05)

*Caught on traps from biofix to Jul 31

INFLUENCE OF TRAP PLACEMENT ON TRAP CATCH – 2004 & 05





*For 8 border & 8 interior traps in each treatment of 6 cherry orchards from late May to Mid Aug, 2004 & 2005

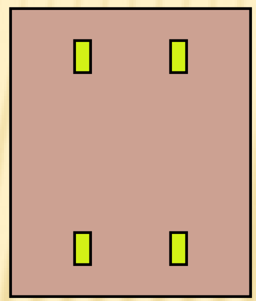
2. MONITORING CFF WITH TRAPS

C. TRAP DENSITY

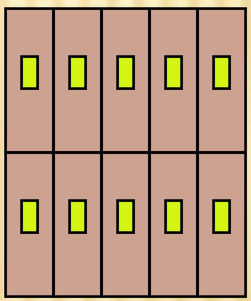
Trece® Pherocon AM + Ammonium carbonate

2003:	2004:
6 Treatments	2 Treatments
Factorial design	1 trap/acre
Reps.: 3X (18 orchards)	7X (14 orchards)
Orchard size: 10-14 acres	10-14 acres

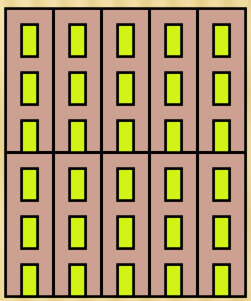
4 traps/orch.



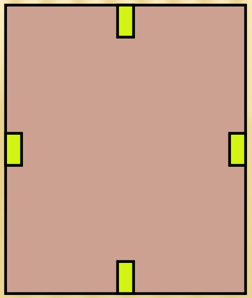
1 trap/acre



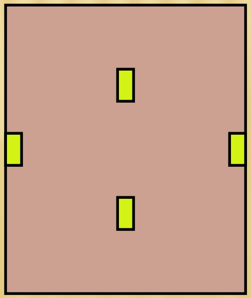
3 traps/acre



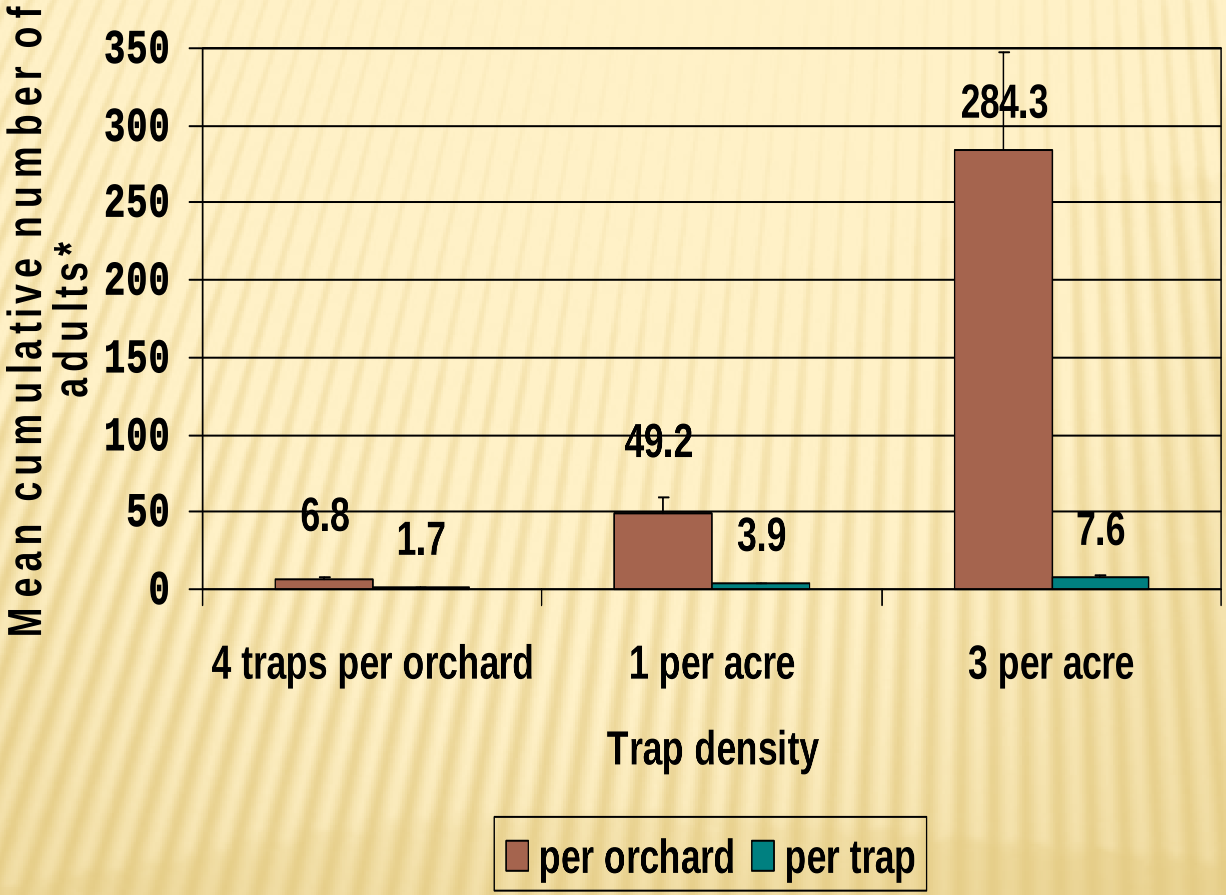
Borders only



Borders & Interior



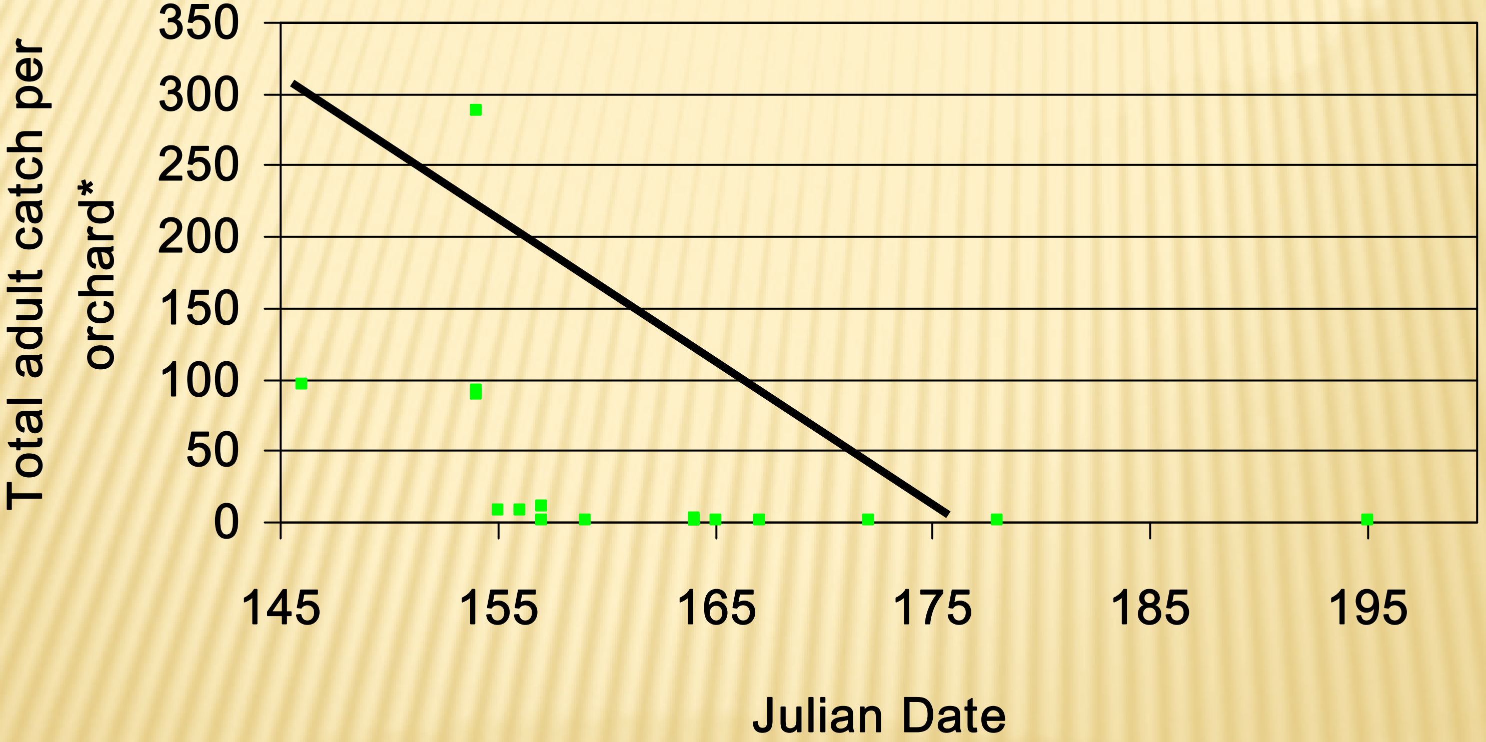
INFLUENCE OF TRAP DENSITY ON WCFF CATCH



- Adults were caught in 19/32 orchards (59%)
- Mean number per orchard:
  3 per acre >
  1 per acre >
  4 traps per orch.
  ($p<0.05$)

*From biofix to Jul 31

INFLUENCE OF CFF DENSITY ON DATE OF FIRST TRAP CATCH – 2003 & 04



- NS
- Negative relationship
- ≥9 adults May 25-Jun 5
- ≤3 adults Jun 7-Jul 13

*Biofix to Jul 31; missing data point: JD 151, 1600 adults

SUMMARY OF TRAP DENSITY AND PLACEMENT

- Adult trap catch was markedly increased by increasing trap density
  - 3 traps per acre > 1 trap per acre > 4 traps per orchard
- Adult catch on border vs. interior traps varied between years
  - More adults caught on border than interior traps in some years and orchards
  - Varied with primary source of fruit fly population
  - In one study, greater proportion on border traps were males
  - Males may disperse differently than females
- Percentage of adults caught was greater in orchards with traps on both borders and within interiors
  - First catch was an average of 2.4 days earlier
- Although NS relationship, adults were caught earlier in orchards with higher fruit fly densities

Female WCFF with ovipositor

2. MONITORING CFF WITH TRAPS
D. UNDERSTANDING MALE & FEMALE DISPERSAL

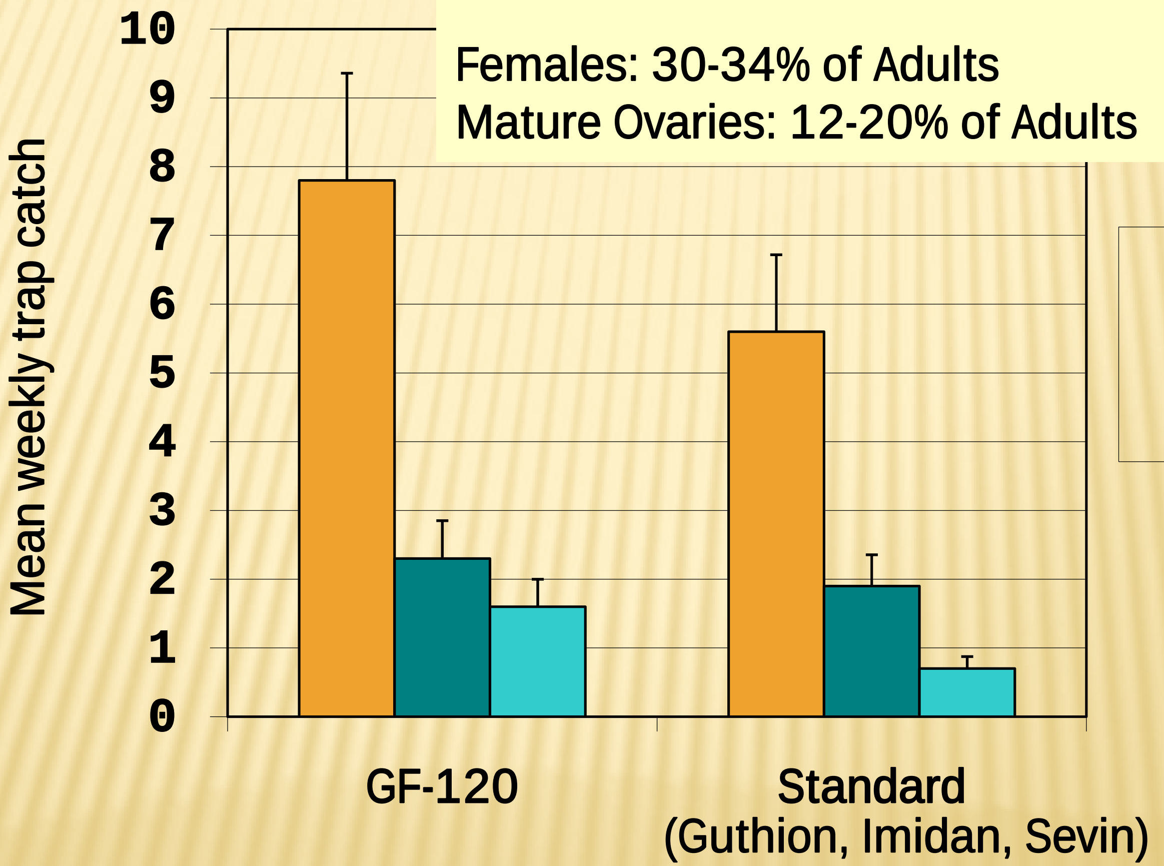
- Objective:
  - To assess the influence of different insecticides on dispersal of male & female flies in orchards

WCFF adults on sticky trap

INSECTICIDE EFFECTS ON TRAP CATCH

Significant Effect:
Mature Ovaries: GF-120>Standard

Females: 30-34% of Adults
Mature Ovaries: 12-20% of Adults



*For 16 traps in each treatment of 6 cherry orchards
from late May to mid Aug, 2004 & 2005

GF-120 EFFECTS ON TRAP CATCH

- GF-120 plots retained more females with mature ovaries
  - Ammonium acetate bait in GF-120 influenced gravid and non-gravid adults differently
- Evaluation of how attract-and-kill products and insecticides influence adult activity / movement should sort out effects on gravid females

EXTENSION / OUTREACH PRODUCTS

UTAH PESTS WEB PAGE

RESEARCH PUBLICATION

Effects of Spinosad, Spinosad Bait, and Chloronicotinyl Insecticides on Mortality and Control of Adult and Larval Western Cherry Fruit Fly (Diptera: Tephritidae)

WEE L. YEE[1] AND DIANE G. ALSTON[2]

J. Econ. Entomol. 99(5): 1722–1732 (2006)

ABSTRACT Effects of spinosad, spinosad bait, and the chloronicotinyl insecticides imidacloprid and thiacloprid on mortality of the adults and larvae of western cherry fruit fly, *Rhagoletis indifferens* Curran (Diptera: Tephritidae), were determined in the laboratory and the field. Spinosad and spinosad bait caused higher adult mortality than imidacloprid, which caused higher mortality than thiacloprid. Only spinosad bait prevented oviposition. All materials were more toxic to adults when ingested than when topically applied. Spinosad bait had the greatest residual toxicity on leaves, killing 100% of adults when aged for 14 d in the field. When materials were sprayed on infested cherries, numbers of live larvae in fruit after 8 d were lower in imidacloprid and thiacloprid than in spinosad and spinosad bait treatments, which did not differ from the control, but all materials reduced larval emergence over 30 d. In the field, spinosad and spinosad bait were as effective in suppressing larval infestations as azinphos-methyl and carbaryl, whereas imidacloprid was effective in most cases and thiacloprid was generally less effective than azinphos-methyl and carbaryl. Overall, results in the laboratory and field show that spinosad and chloronicotinyl insecticides differed significantly in their effectiveness against adults and larvae of *R. indifferens* but that spinosad, spinosad bait, and imidacloprid seem to be acceptable substitutes for organophosphate and carbamate insecticides for controlling this fruit fly.

KEY WORDS *Rhagoletis indifferens*, spinosad, imidacloprid, thiacloprid, control

Insecticides continue to be vital in efforts to control the western cherry fruit fly, *Rhagoletis indifferens* Curran (Diptera: Tephritidae), the most serious insect pest of commercial sweet and sour cherries, *Prunus avium* (L.) L., and *Prunus cerasus* L., respectively, in the western United States. Organophosphate and carbamate insecticides have been used for many years to successfully control this fly in Washington (Eide et al. 1949, Johansen et al. 1954, Frick et al. 1954, Frick 1957), Oregon (Zwick et al. 1970, 1975), Utah and other western states, and in British Columbia (Raine and Andison 1958). The zero tolerance for fly larvae in cherries (Anonymous 1988) has necessitated the use of these highly toxic insecticides in commercial orchards. Isolated homeowner or abandoned trees can be heavily infested and also need to be treated with these insecticides to reduce chances of flies dispersing to commercial orchards. However, because of their impending loss or restricted use in the future due to the Food Quality and Protection Act (1996), newer insecticides are increasingly important in efforts to control the fly. These insecticides include various formulations of a macrocyclic lactone, spinosad, which is derived from the soil bacterium *Saccharopolyspora spinosa* Mertz and Yao, and two chloronicotinyl insecticides, imidacloprid and thiacloprid (Hu et al. 1998, 2000; Liburd et al. 2003; Reissig 2003; Barry and Polavarapu 2005). Spinosad is also used as the toxin in bait sprays (Reissig 2003, Yee and Chapman 2005). These insecticides have been tested against adult apple maggot, *Rhagoletis pomonella* (Walsh) (Reissig 2003), and adult blueberry maggot, *R. mendax* Curran (Liburd et al. 2003, Barry and Polavarapu 2005, Barry et al. 2005). In *R. pomonella*, spinosad was effective in the laboratory, although it performed inconsistently in the field, whereas spinosad bait was ineffective in the field. Imidacloprid was effective in the laboratory and not effective in the field. Thiacloprid was ineffective in the laboratory, but it was effective in the field (Reissig 2003). In *R. mendax*, spinosad, imidacloprid, or thiacloprid were equally effective (Liburd et al. 2003, Barry and Polavarapu 2005, Barry et al. 2005). In the walnut husk fly, *R. completa* Cresson, spinosad bait was also effective, but it did not eliminate infestations (Van Steenwyk et al. 2003), which was also true in *R. indifferens* (Yee and Chapman 2005).

In addition to killing the adult fly and therefore reducing oviposition, imidacloprid and thiacloprid may kill larvae inside fruit to some extent because both materials are absorbed by plant tissue (Elbert et al. 1991, 2001). Controlling eggs and larvae is important

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