Western Cherry Fruit Fly Control Trial:
Can Addition of Adult Attractants Enhance the Efficacy of GF-120?
USHA Research Report, 2006

Diane Alston and Thor Lindstrom, Utah State University

Objectives:

1. To evaluate the addition of two forms of ammonium (acetate and carbonate) to the attract-and-kill product, GF-120, for reducing adult trap-catch and fruit infestation by *Rhagoletis indifferens*.
2. To compare the efficacy of the GF-120 treatments to two non-organophosphate insecticides, Success and Provado, for cherry fruit fly control.
3. To assess off-target effects of the insecticide treatments on densities of mites and beneficial arthropods on cherry leaves.

Methods:

Experimental Design

The experiment was conducted in a 'Montmorency' tart cherry orchard at the USU research farm in Kaysville, UT. Plots were two rows wide by seven trees in length (12 ft x 20 ft tree spacing; 0.1 acres in size). Treatments were replicated four times in a randomized block design. The first catch of western cherry fruit fly adults (biofix) on yellow sticky traps occurred on May 26 and treatment applications were initiated five days later on May 31.

Treatments

1) GF-120 @ 20 fl oz per acre (diluted 1:4 in water; 100 fl oz dilute spray per acre) was applied with a 4-wheeler-mounted electric-pump sprayer and reapplied every seven days or immediately after a rain event for a total of eight applications (May 31; June 7, 10, 16, 23, and 30; and July 3 and 7)
2) GF-120 @ 20 fl oz per acre (diluted 1:4 in water; 100 fl oz dilute spray per acre) + 10% w/v Ammonium Carbonate (AC) was applied with 4-wheeler-mounted electric-pump sprayer and reapplied every seven days or immediately after a rain event for a total of eight applications (same dates as Trt. 1)
3) GF-120 @ 20 fl oz per acre (diluted 1:4 in water; 100 fl oz dilute spray per acre) + 10% w/v Ammonium Acetate (AA) was applied with 4-wheeler-mounted electric-pump sprayer and reapplied every seven days or immediately after a rain event for a total of eight applications (same dates as Trts. 1 and 2)
4) Success @ 6 oz per acre was applied with an orchard airblast sprayer (70 gpa) and reapplied every 7-8 days for a total of six applications (May 31; June 7, 14, 21, and 29; and July 6)
5) Provado 1.6F @ 8 oz per acre was applied with an orchard airblast sprayer (70 gpa) and reapplied every 14-15 days for a total of three applications (May 31, and June 14 and 29)
6) Untreated Control

The pH of GF-120 spray solutions was tested: 5.2 (GF-120 alone), 8.7 (GF-120 + 10% AC), and 5.9 (GF-120 + 10% AA). Addition of AC to the GF-120 and water solution caused a bubbling reaction. The GF-120 + AC solution was alkaline while than GF-120 alone or mixed with AA were acidic.

WCFF Adult Trapping

Three Pherocon AM® yellow sticky traps with additional ammonium carbonate (AC) bait were placed in the study orchard before first adults were expected to emerge based on a degree-day phenology model (traps placed 750-800 DD, first adult expected 900 DD). Once first adult catch was determined (Biofix: May 26), two traps with AC bait were placed in each subplot (8 traps per treatment plot and 48 traps total). Traps were replaced and AC bait boxes refilled as needed.

Adults were counted and removed from traps once per week. The number of adults was compared over time and cumulative trap catch was compared among treatments with analysis of variance (Proc GLM, SAS).

Fruit Injury Sampling

To assess fruit infestation, once per week from June 6 (when fruit began changing color from green to yellow-salmon) to June 30, 100 fruit were collected from center trees of each subplot and placed on wire mesh trays above aluminum cake pans (8 inch-square) to collect third-instar larvae as they emerged from fruit. When fruit were mature on July 13, two types of final harvest samples were collected: 1) 400 fruit per subplot were picked and placed on larval emergence trays as above and 2) 100 fruit per subplot were picked and dissected to count the number of 1^{st}, 2^{nd}, and 3^{rd} instar larvae and exit holes. The number of infested fruit (immature and mature) was compared among treatments with analysis of variance (Proc GLM, SAS).

Effects on Mites and Beneficial Arthropods

Twenty cherry leaves were collected from the center trees of each subplot on June 15 and August 22 to evaluate off-target effects of insecticides on mites and beneficial arthropods. Phytophagous and predaceous mites [twospotted spider mite,

brown mite, and rust mite; and western orchard predatory mite (*Typhlodromus occidentalis*), respectively] and western flower thrips were observed and counted. The density of mites and thrips were compared among treatments with analysis of variance on the two sample dates (Proc GLM, SAS).

Results

Adult Densities

Trap catch peaked in mid June, declined during July, and then increased slightly in August before trapping was discontinued (Fig. 1). Weekly trap catch numbers followed the same trend among treatments, but was highest in untreated control and Success plots on dates of highest catch. Cumulative catch from late May to mid August was significantly greater in untreated control plots than in all insecticide-treated plots (Fig. 2). Cumulative catch in Success plots was higher than in GF-120 and GF-120+AA plots.

Figure 1. Influence of insecticide treatments on adult trap catch during the season. GF=GF-120 alone, GFAC=GF-120+10% ammonium carbonate, GFAA=GF-120+10% ammonium acetate, SU=Success, PR=Provado, and UC=untreated control.

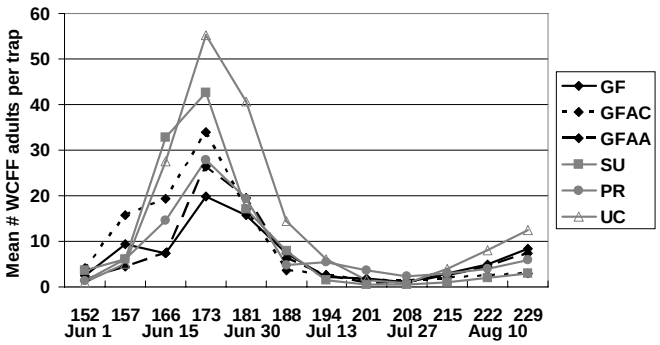
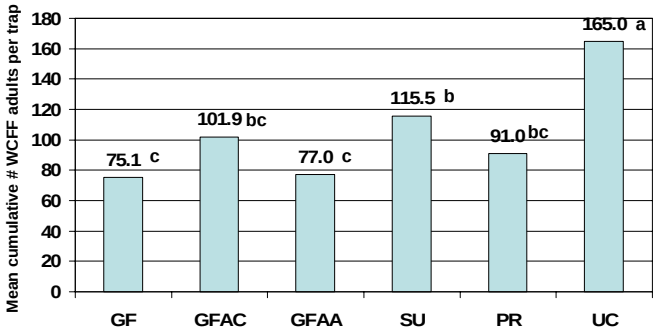


Figure 2. Mean cumulative number of adults per trap (Jun 1 – Aug 17) as influenced by insecticide treatments. GF=GF-120, GFAC=GF-120+10% ammonium carbonate, GFAA=GF-120+10% ammonium acetate, SU=Success, PR=Provado, and UC=untreated control.



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

Fruit Injury

Cherry fruit fly larvae first emerged from fruit collected on June 15. On this date, very few fruit were green, a few were yellow, most were rosy, and a few were red. For immature and mature fruits placed on larval emergence trays, a low number were found to be infested in all treatments (Table 1). Significant differences among treatments were found on July 7 and 13 only. On both these dates more fruit were infested in the untreated control than in insecticide-treated plots (Table 1).

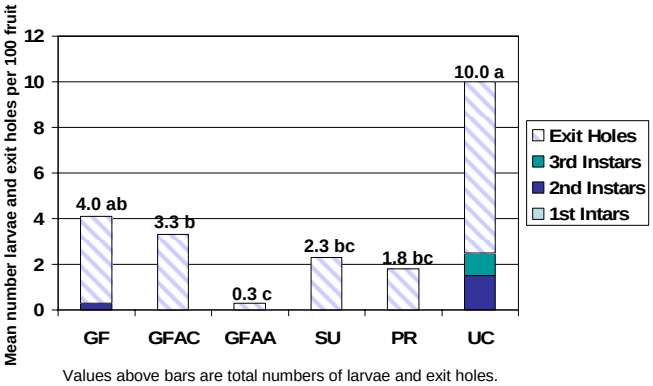
For mature fruits collected on July 13 and dissected to determine numbers of larvae and exit holes, significantly fewer infested fruit were found in the GF-120 + AA treatment than in other treatments except Provado and Success (Fig. 3). No first instar larvae were found in dissected fruits and later instar larvae and exit holes were most common suggesting that most fruits were infested 2-4 weeks before the harvest date coinciding with peak adult trap catch in mid to late June.

Table 1. Influence of insecticide treatments on fruit infestation by western cherry fruit fly. Fruit were placed on larval emergence trays and data are presented by date of collection from the orchard.

Treatment	Mean number of fruit fly emerged per 100 fruit				
	15-Jun	22-Jun	30-Jun	7-Jul	13-Jul
GF-120	0.1	0.8	0.1	0.1 b	0.1 b
GF-120 + AC	0.3	0	0	0.3 b	0.1 b
GF-120 + AA	0	0.6	0.5	0.1 b	0.1 b
Success	0.1	0.1	0.1	0 b	0 b
Provado	0	0	0.1	0 b	0 b
Untreated Control	0.1	1	0.6	0.9 a	1.3 a
P>F	0.83	0.11	0.07	0.02	0.0001

Data were square root (x + 0.1) transformed before analysis to meet normality assumptions.
Means within a column followed by different letters are significantly different (LSD test, $p \leq 0.05$).

Figure 3. Fruit infestation at harvest (Jul 13) presented by age of larvae and exit holes per 100 fruit. GF=GF-120, GFAC=GF-120+10% ammonium carbonate, GFAA=Gf-120+10% ammonium acetate, SU=Success, PR=Provado, and UC=untreated control.



Values above bars are total numbers of larvae and exit holes.
Means followed by different letters are significantly different (LSD test; $p \geq 0.05$).

Non-Target Effects

Counts of twospotted spider mites on cherry leaves collected on June 15 suggested that Provado applications may be increasing densities, but treatment differences were not significant (Table 2). However, in the August 22 leaf sample, significantly more spider mites, brown mites, and the predatory mite *Typhlodromus* were found in plots treated with Provado than in other treatments.

Conclusions

No insecticide treatments tested completely prevented fruit infestation by western cherry fruit fly. Addition of 10% ammonium acetate enhanced the efficacy of GF-120 in reducing numbers of larvae in mature fruit. Addition of 10% ammonium carbonate to GF-120 was less effective than addition of ammonium acetate or GF-120 alone. Fruit injury at harvest on July 13 in Success and Provado treatments was similar to GF-120 plus ammonium acetate.

Fruit were infested as early as June 15 when most fruit had a rosy-colored blush on a dark yellow-colored background. By July 13 when most fruit were mature, the majority of injury was due to exit holes where larvae had already completed development and emerged. Therefore, peak fruit infestation occurred in late June to early July, one to two weeks after peak adult catch on traps in mid June.

Although adult trap catch was related to the performance of insecticide treatments, it was not a strong predictor of control levels. Fewest adults were caught in plots treated with GF-120 alone and mixed with ammonium acetate. GF-120's mode of action is adult mortality upon ingestion of spinosad-laced droplets. Several rain storms in early and mid June caused the need for reapplication of GF-120 treatments at 3-6-day rather than 7-day intervals. Despite the rain, GF-120 treatments reduced adult densities more than Success and untreated control treatments. Success acts by contact mortality for adults and repels or prevents egg-laying, whereas the neonicotinoid Provado has been found to penetrate fruit and kill insect eggs and larvae inside.

Similar to observations in numerous other trials, Provado elevated phytophagous mite densities likely due to stimulation of feeding and reproduction. *Typhlodromus* densities were also increased in Provado-treated plots, probably in response to greater availability of spider mite prey.

In conclusion, further study of enhancing the efficacy of GF-120 for cherry fruit fly control by adding adult feeding attractants such as ammonium acetate is warranted.

Table 2. Effect of cherry fruit fly insecticide treatments on mite and thrips densities on leaves on June 15 and August 22, 2006.

Date	Treatment	Mean number of arthropods per 20 leaves							
		Spider Mites	Sp Mite Eggs	Brown Mites	Brn Mite Eggs	Rust Mites	Typhs	Typh Eggs	W Flwr Thrips
15-Jun	GF-120	6.8	3	0.3	0	10	1	2.3	2.8
	GF-120 + AC	7.3	5	0.3	1.5	5.8	0.5	1.3	1
	GF-120 + AA	3.8	1	1.3	1.3	3	0.8	0.3	1.8
	Success	6.3	5.5	2.5	1.3	9.5	0	0.3	0
	Provado	7	17.3	1	3.3	1	1.8	0.8	1
	Untreated Control	2.3	5	1.5	4	0.3	0	1	0.3
	P>F	0.37	0.14	0.31	0.12	0.16	0.45	0.42	0.15
22-Aug	GF-120	0.3 b	0	1.5 b	0	0.5	2.3 b	0	0.8
	GF-120 + AC	0 b	0	1 bc	0	0	1.8 b	0	0
	GF-120 + AA	3.3 b	4	0 d	0	9.3	0.8 b	0.8	0.3
	Success	0.5 b	0	0.3 cd	0	0.5	0.8 b	0.5	0
	Provado	22.5 a	13	3.5 a	0	0	10.5 a	1.8	1.3
	Untreated Control	1.3 b	0.5	0.3 cd	0	1.8	1 b	1	0.5
	P>F	0.01	0.15	0.001	.	0.07	0.002	0.16	0.56

Data were square root (x + 0.1) transformed before analysis to meet normality assumptions.
Means within a column followed by different letters are significantly different (LSD test, $p \leq 0.05$).