FINAL PROJECT REPORT **YEAR 3/3**
WTFRC Project # CH-04-408

Project title: Cherry Fruit Fly Control Options

PI: Timothy J. Smith
Organization: WSU Extension, North Central Washington
Address, phone, e-mail: 300 Palouse, Wenatchee, WA 98801
(509) 667-6540; smithtj@wsu.edu
Research Assistant: Esteban Gutierrez, East Wenatchee.

Introduction and Justification
Cherry fruit fly was identified as the top priority in the TFRC Cherry Research Committee yearly priority setting sessions. The objective of this project has been to develop safe and highly effective new control material options, as the carbamate and organophosphate class insecticides available at the inception of this work were (and continue to be) under regulatory pressure, and no alternative methods and chemistries were likely to be registered soon.

Significant Results Summary:

Objective 1: Identify new conventional and organic cherry fruit fly control products and methods.

- Twelve products have been included in the trials.
- Several other promising products remain to be tested.

Objective 2: Assess efficacy of new insecticides and control methods for cherry fruit fly.

- Most of the candidate products were quite effective, especially when applied at "moderate" or "full" proposed label rates and at 7 or 10 day spray intervals. Rate and interval data will be used for future label directions.
- This project first recognized and demonstrated the efficacy of GF-120 Bait as a Cherry Fruit Fly control. Early adoption of this control method is **saving the PNW Cherry growers about $1 million each year** in labor, application and material costs.
- Three products were identified as alternatives to dimethoate as post-harvest "clean-up" sprays.
- Organic growers are now fully able to control this pest with the GF-120 bait and/or Entrust. One commonly recommended organic product, azadirachtin (neem) was proven ineffective.

Objective 3: Work with industry toward the registration of effective new CFF control products.

- This project has added eight products shown to be effective cherry fruit fly control materials.
- Impending registration of the new products tested in this project will lead to availability of new chemistries that are highly effective and have fewer negative effects on the foliage, environmental concerns, and labor issues than many current material choices.

Results and Discussion:

Objective 1, Identification of Candidate Products: Products included in this project during the 2003-05 trials included Assail, Calypso, Azadirachtin, Provado, Success, Entrust, GF-120NF Bait,, Pyganic, an unmentionable insect growth regulator, and three very promising numbered products. Eight of the products tested had not been tested in the field for effect on cherry fruit fly when first included in this project. Some interesting products remain untested, usually due to lack of current interest on the part of the registrant. New options are being included each year.

Objective 2, Efficacy Trials: Most tested products controlled CFF very well at moderate or full rates applied at 7 to 10 day intervals. Lower rates often showed some slight failure rate at ten day intervals, and most products became less effective when applied at 14 day intervals, even with full standard rates. This interval and rate information will be used during the development of use directions for these products, and during educational programs.

Spinosad was proven as an effective CFF control active ingredient during earlier work first by the PI and then by others. Entrust, an organically acceptable formula of sprayable spinosad was shown effective during this project. The GF-120 NF bait was first (2002) shown to be an option as a cherry fruit fly control material and method through this project. Application of insecticidal bait is a new practice to Pacific Northwest tree fruit producers, so research and educational efforts were closely linked. Numerous presentations and publications gave the cherry growers opportunity to become aware of this material and its' potential. ***Use in the first two years of registration has saved Washington cherry growers about $1,160,000*** in labor, machinery and material costs, and economic benefits will continue at about $1 million per season at current use levels. Adoption of this new technology has essentially eliminated a serious and increasing problem with cherry fruit fly in organic orchards. It has also enhanced the conventional growers' ability to treat their orchards in a timely manner, despite wind. Use of the product increased by 360 percent in 2005 vs. 2004, and acceptance of this technology is expected to increase at a slower rate as the more skeptical growers gain confidence in its efficacy. Applicator exposure to products with potential to inhibit cholinesterase was reduced by about 6,600 hours during May, June and July of 2005

Three control materials were tested for effect on cherry fruit fly larvae inside the fruit, for possible alternatives for post-harvest dimethoate. Sections of a single most-highly infested tree were sprayed at the time that the third instar larvae were starting to cut emergence holes in the fruit skin. The fruit was harvested 24 hours after treatment, and then suspended at room temperature over sand. The number of larvae that emerged were counted. All three alternatives appeared quite effective, though further research is required. See table 4.

Provado, Assail and Calypso controlled black cherry aphid (Myzus cerasi) when used at rates and application timings intended for cherry fruit fly control.

Azadirachtin (neem) was proven not effective as a cff control. It has been recommended to organic growers for this purpose for many years. Data could be interpreted that the product had some suppressive effect, as the degree of fruit infestation on treated trees was lower than would be expected on untreated trees supporting similar high numbers of adults.

A previously untested insect growth regulator was very suppressive of larval infestation. Adults were apparently unaffected by the product, and a trap captured over 100 adults during the four weeks of treatment. This level of adult infestation would normally lead to 60 -100% fruit infestation.

Table 1. Details of 2005 Trials (Not reported in previous project updates):

Treatment	Trees / Sites	Days Interval Spray	Flies / Trap 2005	Fruit Sample Number	Larvae Found in Fruit
Calypso SC 480, 3 oz/A 1st treatment, Carbaryl 4 pints/A second, Calypso 3 oz/A third treatment, Success 4 oz 4th. Treatment, and GF-120 BAIT weekly during and after harvest	3 / 3	3 @ 10 3 @ 7	3 11 55	1000 1000 1000	0 0 0
Calypso SC 480, 4 oz/A 1st treatment, Carbaryl 4 pints/A second, Calypso 4 oz/A third treatment, Success 4 oz 4th. Treatment, and GF-120 BAIT weekly during and after harvest	3 / 3	3 @ 10 3 @ 7	3 55 27	1000 1000 1000	0 0 0
Calypso SC 480, 6 oz/A 1st treatment, Carbaryl 4 pints/A second, Calypso 6 oz/A third treatment, Success 4 oz/A 4th treatment + GF-120 BAIT weekly during and after harvest	3 / 3	3 @ 10 3 @ 7	3 55 27	1000 1000 1000	0 0 5*
Provado 1.6F, 6 oz/A 1st. Treatment, Carbaryl 4 pints/A second, Provado 6 oz/A third treatment, Success 4 oz/A 4th treatment + GF-120 BAIT weekly during and after harvest.	18 / 4	3 @ 10 3 @ 7	55 27 11 35	1000 1000 1000 1000	0 0 0 0
An Insect Growth Regulator	1 / 1	10	101	1000	11**
Assail 30SG, 2.5 oz / A 10 day	3 / 3	10	21 5 55	1000 1000 1000	0 0 0
Assail 30SG, 2.5 oz / A 14 day	2 / 2	14	34 18	1000 1000	5 1
Assail 30SG, 4.0 oz / A 14-day	3 / 3	14	31 31 18	1000 1000 1000	3 4 3
Numbered Product X 4.5 oz. / A	4 / 4	7	3 5 55 34	1000 1000 1000 1000	0 0 0 0
Numbered Product X 6.0 oz. / A	4 / 4	7	3 5 55 34	1000 1000 1000 1000	0 0 0 0

Table 1, Continued. **Treatment**	**Trees / Sites**	**Days Interval Spray**	**Flies / Trap 2005**	**Fruit Sample Number**	**Larvae Found in Fruit**
Numbered Product Y 1 oz / A + 0.5% Oil	3 / 3	10	89 5 55	1000 1000 1000	0 0 0
Numbered Product Y 2 oz / A + 0.5% Oil	3 / 3	10	55 74 34	1000 1000 1000	0 0 0
Numbered Product Y 3 oz / A + 0.5% Oil	3 / 3	10	117 55 10	1000 1000 1000	5** 1 0
Numbered Product Y 4 oz / A + 0.5% Oil	3 / 3	10	3 55 74	1000 1000 1000	0 0 0
Numbered Product Y 2 oz / A No Oil	3 / 3	10	55 26 61	1000 1000 1000	2 4 4
Numbered Product Z 10 fl oz/ A	3 / 3	10	55 74 34	1000 1000 1000	0 0 0
Entrust 1.9 oz / A	5 / 5	7	3 5 55 26 34	1000 1000 1000 1000 1000	0 0 0 0 0
Untreated Check Trees	5 / 5	na	265 565 87 238 150	1000 1000 1000 1000 250	447 497 303 540 339

Notes:

* One interval of 12 days between sprays may have caused control difficulty.

**With this number of adults on the trap, would normally expect near 100% infestation.

Table 2. Summary of Previous Trials:

	Year	Trees / sites	Flies / Trap Prior Year*	Flies / Trap Treated Year	Total Fruit Inspected	Total Larvae Found
Untreated Checks	**na**	**12**	**< 20**	**144**	**8065**	**2428**
Provado	**1999**	**8/1**	**150+**	**14**	**800**	**0**
Provado	**2003**	**4/1**	**21**	**1**	**800**	**0**
Provado	**2004**	**6/2**	**50+**	**40**	**1000**	**0**
Calypso	**2003**	**21/6**	**25**	**4**	**4600**	**0**
Calypso	**2004**	**29/11**	**150+**	**93**	**5050**	**9 ****
Assail	**2002**	**7/1**	**50+**	**4**	**900**	**0**
Assail	**2003**	**24/6**	**39**	**28**	**3600**	**0**
Assail	**2004**	**24/9**	**100+**	**59**	**5200**	**1 ****
Product Y	**2002**	**5/1**	**30**	**3**	**800**	**0**
Stylet Oil	**1999**	**4/1**	**100+**	**16**	**800**	**6**

* ”Failures”are due to research intentions. The rate was too low, or interval too long, or both.

Table 3. Organic CFF Control Product Summary:

	Year	Trees / sites	Flies / Trap Prior Year*	Flies / Trap Treated Year	Total Fruit Inspected	Total Larvae Found
Untreated Checks	**na**	**12**	**< 20**	**144**	**8065**	**2428**
Aza-Direct	**2004**	**12/6**	**50+**	**55**	**2000**	**102**
GF-120NF	**2002**	**4/1**	**50+**	**4**	**500**	**0**
GF-120NF	**2003**	**22/6**	**59**	**11**	**2500**	**1 ****
GF-120NF	**2004**	**29/10**	**73**	**16**	**6400**	**1 ****
GF-120NF	**2005**	**32/13**	**57**	**3**	**12,000**	**0**
Success	**1997**	**1/1**	**50+**	**7**	**500**	**0**
Success	**1998**	**9/1**	**100+**	**14**	**3200**	**13 *****
Success	**1999**	**25/2**	**150+**	**13**	**2500**	**0**
Success	**2002**	**2/1**	**50+**	**4**	**500**	**0**
Entrust	**2003**	**10/3**	**29**	**5**	**2400**	**0**
Entrust	**2005**	**5/5**	**110**	**25**	**5000**	**0**

* Average trap catch year prior to first treatment, if data available.

** Note: The single larva was found in fruit sample taken from multiple tree, highly infested sites. (Example: 200 cherry fruit fly adults where captured on one trap, 15 trees). No larvae were found in fruit in second year or third year of treatment on these bait-treated sites.

***Control failures in this replicated plot were probably due to treatment contamination by mature females from heavily infested untreated "check" trees within 50 feet. Some treatments were low rates at 10 day intervals.

Post-harvest Treatments:

Provado, Assail and Calypso applied on a date that would have been "post-harvest," led to excellent control of large 3rd instar CFF larvae in fruit that had an average of 136 percent larvae emergence from fruit in the non-treated check. All products tested appear to be very acceptable replacements for dimethoate, the only product currently recommended for controlling larvae in fruit remaining on harvested trees. This may give products with this chemistry a great advantage as a pre-harvest product, as application may control newly hatching eggs or larvae that may have slipped through earlier control programs. At this time, dimethoate is not a popular choice, as it sometimes causes leaf marking and drop. While this post-infestation effect seems relatively certain, it is so significant that more extensive trials to document this effect on larvae inside the fruit should be carried out.

Table 4. Post harvest "Clean-up" Spray Options:

Product	Rate	Fruit Sample	Larvae Emerged
Dimethoate 267	64 oz./400 gal./A	250	1
Provado 1.6F	8 oz./400 gal./A	250	0
Calypso SC 480	8 oz./400 gal./A	250	20
Assail 30 SG	8 oz./400 gal./A	250	8
Untreated	0	250	339

Objective 3, New Registrations: There are four relatively new, effective products available for management of cherry fruit fly. (Success, Provado, Entrust and GF-120 NF Bait). It is likely that an additional two will be labeled in 2006 or 2007 (Assail and Calypso), greatly aided by this project. Two numbered products included in this research program (unique chemistries) are projected to be registered by 2008 - 2010; another two promising new materials (a numbered product and an insect growth regulator) will require continued research prior to adoption.

Organic growers now have organically acceptable, effective material choices for management of cherry fruit fly, a pest that was nearly out of control in 2003. Other organic options are being considered.

Methods and materials:

Several small cff infested sweet cherry orchards were used as sites for replicated trials. In total, 275 infested cherry trees on 83 sites have been included in this project over the past three seasons. Each of these sites consisted of sweet cherry trees that were documented or reported as infested with fruit fly, and volunteered by the owners as test subjects, with a signed agreement that the fruit could not be consumed if treated with unregistered products. In return, the cherry tree owner was assured a "clean" tree the next year, and often had trees treated with registered products available for immediate consumption.

Isolated abandoned cherry trees were left as unsprayed "checks" to document the relationship between prior season trap count and current season trap catch and fruit infestation. One of the unsprayed trees developed 136 percent infestation in 2005, a new local record. (Three hundred thirty-nine cff larvae were taken from 250 fruit.)

All test sites were monitored with the standard Trece baited AM yellow sticky 9 x 11 inch traps to document adult presence on the trial trees and potential infestation of fruit. Spraying usually greatly reduced trap catch, but did not eliminate adults until the second year of effective treatment. This was expected, as some CFF pupae remain in the soil for two seasons.

The trial applications began in mid- to late May, when the first adult was trapped in the area. Sprays were applied at 7, 10 or 14 day intervals from that date until the normal harvest maturity, which occurred during the last ten days of June. Usually, a total of six 7-day, four 10-day, or three 14-day treatments were applied during this time. At harvest-time, a 250 – 1000 cherry sample was collected from each replicate and placed into cold storage. At the suggestion of professional entomologists, all replicates were sampled at the 1000 fruit level in 2005, to better insure an accurate assessment of infestation level. The sites were usually treated with GF-120 Bait for 2 -3 weeks after harvest.

The test fruit was checked for larva with the Washington State Department of Agriculture standard brown sugar solution method for the detection of CFF larvae in large batches of fruit. In this extraction technique, cherries are crushed carefully, then place in a solution of seven pounds of brown sugar dissolved in five gallons of water. The specific gravity of CFF larvae is less than that of the solution, which causes them to float to the surface of the cherry/syrup mixture. The light colored larvae are relatively easy to observe floating on the dark surface, even when they are in their first instar. This method assured that large numbers of fruit could be sampled, assuring detection of even low numbers of small larvae. Larvae were easily detected in fruit taken from untreated check trees. Some samples of fruit were also suspended on a grate over sand to check for naturally emerging larvae. This larva detection method did not appear significantly more accurate than a carefully run brown sugar solution larval extraction technique.

Application: All materials except the bait were applied with a backpack air-blast/mist sprayer in about 100 gallons water per acre. Post harvest treatments were applied at about 400 gallons per acre (drip). The GF-120NF bait was applied in orchards with a 12 volt, electric pump, auxiliary sprayer strapped to a "four-wheel" All Terrain Vehicle. Two adjustable-angle D2 disc nozzles (no cores) were used to direct streams of the bait/water mix across the upper 1/3 of the tree. Calibration trials proved that 20 fluid ounces of the bait could be mixed 1:4 with water, and then applied to one side of each tree (on alternate row middles) at 6.5 to 7 mph through D2 nozzles. Application took about 2.5 to 3 minutes per acre. The side of the trees treated was alternated weekly, but the row ends and outside rows were treated every week. The "backyard" tree bait sites were treated with a 1:3 bait to water mix applied with hand-held "window washer" squirt bottles adjusted to apply a solid stream of mixture. Rate per acre was adjusted by varying the amount of mixture that was applied relative to the size of each test tree. Bait was re-applied after significant rainfalls. Heavy dew would likely dissolve the bait speckles, possibly leading to control failures, but heavy dew is rare in North Central Washington, so was not monitored.

Discussion:

All products, rates and timings were tested under pest population conditions far in excess of what would be expected in commercial orchards. As adults emerge daily during the season, spraying usually greatly reduces, but does not prevent adult trap catch on infested trees. However,

effective control products protect the fruit from larval infestation by controlling adults prior to their maturation and egg deposition. Most of the treatments greatly reduced or eliminated infestation.

Full rates were used at seven day intervals in the first year of efficacy trials. If the product appeared promising, the subsequent seasons work included rate and interval assessment, in search of the "failure point." Under the severe test conditions, some rates and intervals failed to completely control cherry fruit fly. The fact that a few larvae were found in these sub-optimal treatments should be considered results of a successful research effort, rather than an indication that the product will not be effective when used as directed.

Low numbers of larvae were more often found when rates were dropped to 0.33 to 0.5 of proposed full label rates and spray intervals were increased to 10 or 14 days. Lower or moderate rates seem to work well with 7 day spray intervals. Moderate rates appeared to be effective at 7 or 10 day intervals. However, even highest rates of an otherwise effective product failed to fully prevent larval infestation when spray intervals were increased to 14 days.

Under the severe test conditions, GF-120 bait treatment "failed" twice out of the 35 site treatment years. (Treatment year = one site treated for one season.) The fact that two larvae were found out of 18,750 cherries crushed from these 35 treatment sites might be considered incidental results of a successful research effort under highly unusual infestation pressures, rather than an indication that the product will not be effective when used as directed under normal pest pressure situations. In both cases that larvae were found after bait treatment, the treatment sites can only be described as abnormal. The treatment trees were very tall, interwoven, and the fruit was infested at 50 - 100% the year prior to first treatment. In one case, the trees were removed after the first season, but the other, site 04-9, provides a great case study. On this "failure site," the three infested trees are 45-55 feet tall, and 100% of the fruit was infested and unharvested in 2003. Evaluation of 2003 trap catch by the local pest board was suspended after over 50 adults were captured the first week of trap deployment. During 2004, the first season of bait treatment, 205 adults were captured on a single trap, despite a 40 oz./A rate of GF-120, applied weekly. However, after one season of treatment, the larval infestation fell from the reported 100 percent to 0.25 percent (1 larva in 250 fruit). In 2005, the second season of treatment, the trees were treated at the 20 oz./A rate weekly. Adult capture fell from 205 to 2 for the season, and no larvae were found in a 1000 fruit sample.

In 2005 no larvae were found in 12,000 fruit sampled from twelve bait-treated sites. The only control product applied to these previously highly infested sites was GF-120 bait. Similar untreated check trees developed larva counts ranging from 30 to 136 percent.

Other effects:

Despite as many as five weekly applications at higher than necessary rates, no treatment in this project has resulted in leaf marking, yellowing or shedding, fruit marking, or excessive mite flare-ups leading to significant leaf damage. Some moderate leaf symptoms induced by mite feeding were observable by late summer on some of the trees treated with up to five weekly applications of Provado, Assail, and Calypso.

Many of the candidate products have not yet been tested on all common sweet cherry varieties, so potential for leaf drop sensitivity in some varieties, or marking of light colored cherries is unknown.