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

Project title: Cherry Fruit Fly Control Options

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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 bait and/or Entrust. One commonly recommended organic product was proven ineffective.

Objective 3, ***To 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 environmental 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, Azadirect, Provado, Success, Entrust, GF-120NF Bait,, Pyganic, an insect growth regulator, and three numbered products. Eight of the products tested had never 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 10 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. See table 1 for 2005 season result details and table 2 for the results summaries of previously reported project results.

Spinosad was proven as an effective CFF control active ingredient during earlier work by the PI and others. Entrust, an organically acceptable formula of sprayable spinosad was shown effective during this project. The GF-120 NF bait was first shown to be an option as a cherry fruit fly control material and method through this project. As application of an insecticidal bait is a new practice to Pacific Northwest tree fruit producers, 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 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. See table 3 for an organic material control results summary.

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, 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 on a single highly infested cherry tree. 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. Further research on this and other fruit fly species may now be expected.

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 1 @ 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 1 @ 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 1 @ 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 1 @ 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
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 Previously Reported 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"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 likely 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.

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 three effective products available for management of cherry fruit fly. (Provado, Entrust and GF-120 NF Bait). It is likely that an additional two will be labeled in 2006 or 2007 (Assail and Calypso), aided by the research funded through this project. Two numbered products (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 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. Nineteen cherry tree owners turned their non-infested trees over to our care, apparently hoping for free spraying service. These trees are not included in the data.

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. (339 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 (see tables 1, 2, 3 and 4 above) 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.
In 2003-2005, the GF -120 Bait was the only CFF control product applied to a total of twenty-six sites. In both 2003 and 2004, one larva was found in fruit from one extremely infested site. Trap catch on the 2004 "failure" site fell from 205/trap to 3/trap in 2005. No larvae were found in this site this second season of treatment. In 2005 no larvae were found in 12,000 fruit sampled from twelve bait treated sites. All five remaining treatment sites from the 2003 plots have been maintained larvae-free for three seasons, treated only with bait. The 22 trees that were first treated during the 2004 plots have been treated weekly during the CFF season to date and have been maintained larva free. Similar untreated check trees have developed larva counts ranging from 22 to 136 percent.

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