UTAH PESTS fact sheet

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Western Cherry Fruit Fly (*Rhagoletis indifferens*)

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Do You Know?

- Western cherry fruit fly is the primary insect pest of sweet and tart cherries in Utah
- Damage occurs from the larva developing inside fruit
- Females lay eggs under the skin of fruit, so target adult flies for control
- Insecticides are currently the most effective control method
- A new insecticide technology–attract-and-kill (bait plus insecticide)–can be effective for control in commercial and home cherry trees
- Use of ground barriers (mulch, fabrics) can reduce pupation and fly emergence
- Post-harvest sanitation can reduce populations

The western cherry fruit fly (Rhagoletis indifferens) is the most important pest of tart and sweet cherries in Utah. Once the skin of fruits becomes soft enough to penetrate, adult females (Fig. 1) insert eggs with their ovipositor, and larvae develop inside the fruits (Fig. 2). The result is "wormy" fruit that is unmarketable. It is difficult to determine whether a fruit is infested until the larva exits through a hole that it chews (Fig. 3) or the fruit is cut open to reveal the larva inside. For processed cherries, detection of one larva by the processor can result in rejection of the entire crop from that orchard and/or farm. Therefore, the best management strategy is to prevent fruit infestation.

Adult flies will migrate only short distances (< 40 m) if host fruit is available. This causes infestations to be spotty in a region; however, once established in an orchard, the western cherry fruit fly can spread rapidly and require annual control. Protective insecticide sprays are currently the major tactic for preventing infestation. A new insecticide technology called "attract-and-kill," where adults are enticed to feed on a sticky bait droplet containing an ultra low concentration of insecticide, has proven effective in experiments in Utah orchards.

There is one generation per year; however, adults can emerge from the soil over a period of 12 weeks or more. Cherry fruits are susceptible to infestation from when they first ripen to a salmon-blush color (Fig. 4) until they become too soft or fall from the tree.

Figure 1. Adult fly caught on trap.[1]

Figure 2. Larvae feeding inside a cherry fruit.[2]

Figure 3. Damaged cherries with larval exit holes.[3]

Figure 4. Cherry fruits are not susceptible to attack until they have a blush of salmon color.[2]

HOSTS

Sweet, tart, and wild species of cherries

LIFE HISTORY

Pupa – Overwintering Stage

- **Size**: about 3/16 inch (5 mm) long
- **Color**: light to dark brown and shaped like a large grain of wheat
- **Where**: overwinters in the soil of the orchard floor, 1 - 4 inches (2.5 - 10 cm) deep
- Rate of pupal development and adult emergence affected by soil temperature and moisture

Adult – Monitoring Stage

- **Size**: about 1/5 inch (5 mm) long
- **Color**: black body with white bands on abdomen (posterior body region); wings are transparent with a distinctive pattern of dark bands (Figs. 1 and 6)
- **When**: adults begin emerging from soil in late May to early June (Table 1 and Fig. 5) depending on soil temperature and moisture and continue to emerge

throughout the summer and into early fall
- After emerging, females require about 5 - 7 days (190 degree-days) to become sexually mature, after which they can begin laying eggs
- Females lay eggs under the skin of fruit without leaving visible marks, over a period of about 30 days

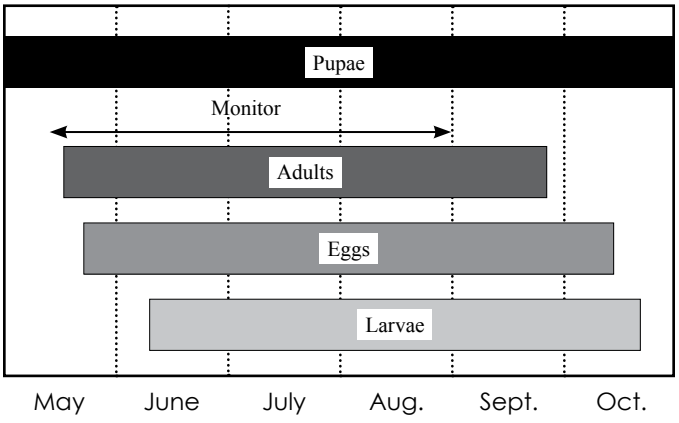
Egg

- **Size**: about 1/30 inch (0.8 mm) long
- **Color and shape**: yellowish and elongated with a stalk at one end
- **Where**: deposited beneath the skin of cherry fruits
- Eggs hatch in 5 - 8 days

Larva – Damaging Stage

- **Size**: mature larvae are about 5/16 inch (8 mm) long
- **Color and shape**: creamy white, legless maggot; tapered at the head and rounded at the tail (Fig. 2)
- **Where**: lives and feeds in the fruit
- After approximately 14 - 21 days, full-grown larvae exit from the fruit, drop to the ground, burrow into the soil, and pupate

Figure 5. Life history of western cherry fruit fly. There is one generation per year.



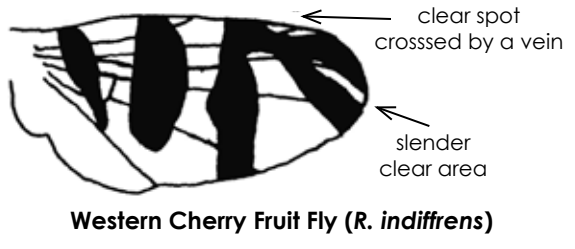
HOST INJURY

Larvae feed within the fruit on the flesh, rendering the fruit unmarketable (Fig. 2). There is no noticeable evidence on the outside of a fruit indicating infestation until after larvae emerge through exit holes (Fig. 3). Large populations can infest a high percentage of the fruit on a tree. Peak emergence of adults and infestation of fruit occurs from mid-June to mid-July.

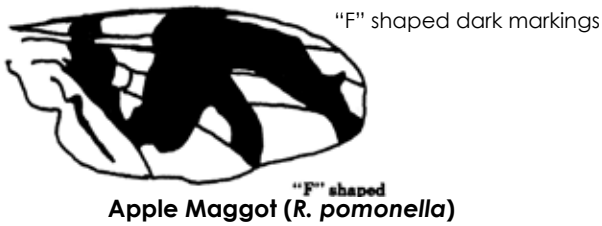
TIMING CONTROL

Insecticide treatments should be timed to prevent adult mating and/or female fruit flies from laying eggs in developing fruit. There are three methods to determine proper timing of sprays. Method 1 should be used in combination with Methods 2 or 3.

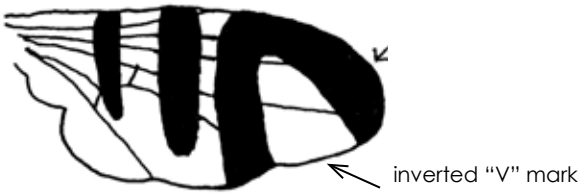
Figure 6. Illustration of fruit fly wing banding patterns.



Western Cherry Fruit Fly (*R. indiffrens*)



Apple Maggot (*R. pomonella*)



Walnut Husk Fly (*R. completa*)

Method 1: Fruit Maturity

Cherry fruits are not susceptible to egg-laying by adult females until they ripen to a salmon blush in color (Fig. 4). Green fruits will not be attacked. Consider the maturity of the ripest fruit in an orchard, not the average.

Method 2: Adult Trapping

Adult flies do not use sexual pheromones, but are attracted to certain colors and odors. Yellow sticky panel traps (Pherocon AM®) with an external bait of ammonium carbonate (AC) are a moderately effective monitoring tool (Fig. 7); unbaited traps should not be used. Place traps in cherry orchards before the first fly is expected [750-800 degree-days (DD)], or by mid-May (Tables 1 and 2). Apply the first insecticide treatment 5 - 7 days (190 DD) after first catch (females require 5 - 7 days for ovaries to mature after emergence).

Trap Placement and Servicing

- Place AC-baited Pherocon AM® traps on the southern side of trees (flies emerge first and are more active on the warmer side of trees).
- Place traps at least 6 ft high, preferably in the upper 1/3 of the tree canopy.
- Remove fruit, leaves, and twigs within 6 inches of the trap.
- A minimum of two traps should be placed in each orchard. Research conducted in Utah commercial cherry orchards ≥ 10 acres in size has shown that 1 - 2 traps per acre catches significantly more flies than

four traps per orchard. Differences in fly activity on orchard borders versus interiors can be determined by placing traps in representative locations. Suspected "hot spots" within an orchard should be monitored separately.

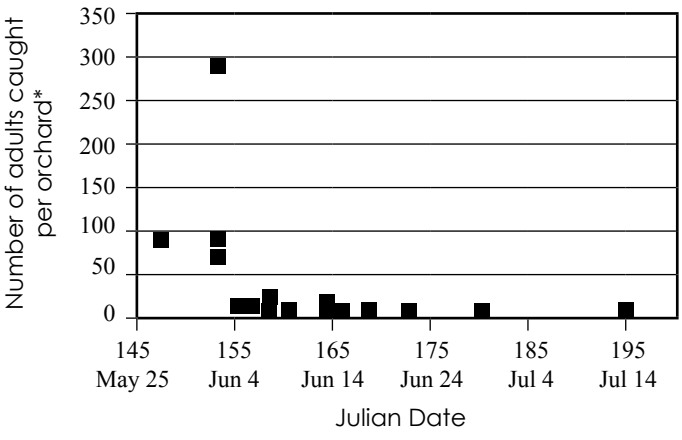
- Maintain and check traps weekly throughout the fruit development period. Change traps every 3 - 4 weeks or when they become covered with debris.
- Refill or replace AC bait containers as needed.
- Keep a record of trap catches for each location within an orchard and for each orchard. This information can be used to determine first fly emergence, timing of first cover spray, relative fly activity across orchards, and help in evaluating success of your fruit fly management program.
- More than one species of fruit fly may be caught on traps. Inspect the banding pattern on wings to determine the species (Fig. 6).

Method 3: Degree-Day Model

Use 1060 DD as a guideline (41° F lower threshold for development, Tables 2 and 3) to initiate cover sprays if you don't have fly trapping information. This timing corresponds to 3% fly emergence and 1% of females with mature ovaries. In order to use a DD method, daily air temperature data must be available. Table 3 is a look-up table that can be used if you have access to maximum and minimum temperatures in or near your orchards. The Utah Integrated Pest Management (IPM) Project provides DD information for representative orchards in northern Utah on their Web page (http://utahpests.usu.edu/ipm/htm/advisories).

Also consider the history of fruit fly populations and fruit infestation in an orchard to help guide initiation of insecticide sprays. First adult emergence will tend to be earlier in orchards with higher fruit fly densities (Fig. 8).

Figure 8. Relationship between fruit fly density and date of first adult emergence.



*Total adults caught from first catch to ~ July 31; missing data point: JD 151 (May 31), 1600 adults

Figure 7. Yellow sticky trap with external bait of ammonium carbonate.[3]

Table 1. Date of first catch of western cherry fruit fly in northern Utah from 1995-2006*.

Year	Date of first catch
1995	June 8
1996	May 29
1997	May 19
1998	June 2
1999	May 30
2000	May 25
2001	May 26
2002	May 27
2003	May 26
2004	May 16
2005	May 22
2006	May 22

*Flies were monitored with yellow sticky traps (Pherocon AM®) plus external ammonium carbonate bait.

Table 2. Major events in western cherry fruit fly management. Timing of events is based on degree-day accumulations* and first activity of adults.

Degree-Days (DD)	Management Event
750-800	Place traps in orchards
900-950	First adult flies expected on traps; Treat 5-7 days or 190 DD after first fly is caught if cherries have developed a salmon-colored blush; otherwise wait for fruit to turn color
1060	3% of flies emerged, 1% of flies sexually mature; If you don't have trap catch information, use 1060 DD and fruit maturity guidelines (above) to time the first spray. Re-apply cover sprays based on insecticide protection interval and anticipated harvest date of crop.

*The western cherry fruit fly model is based on a 41° F lower threshold and no upper threshold for development. Begin accumulating DD after temperatures exceed 41° F, or Jan. 1.

Table 3. Degree Day Look-Up for Western Cherry Fruit Fly*

Lower threshold: 41° F Upper threshold: None

Maximum Temperature \ Minimum Temperature	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81
40	0	0	0	0	0	0	0	0	0														
43	0	0	0	0	0	0	0	0	1	2													
46	1	1	1	1	1	1	1	2	2	3	5												
49	2	2	2	2	2	2	3	3	3	5	6	8											
52	3	3	3	3	3	4	4	4	5	6	8	9	11										
55	4	4	4	4	4	5	5	6	6	8	9	11	12	14									
58	5	5	5	5	6	6	6	7	8	9	11	12	14	15	17								
61	6	6	6	7	7	7	8	8	9	11	12	14	15	17	18	20							
64	7	7	8	8	8	9	9	10	11	12	14	15	17	18	20	21	23						
67	8	9	9	9	10	10	11	11	12	14	15	17	18	20	21	23	24	26					
70	10	10	10	11	11	12	12	13	14	15	17	18	20	21	23	24	26	27	29				
73	11	11	11	12	12	13	14	14	15	17	18	20	21	23	24	26	27	29	30	32			
76	12	12	13	13	14	14	15	16	17	18	20	21	23	24	26	27	29	30	32	33	35		
79	13	14	14	15	15	16	16	17	18	20	21	23	24	26	27	29	30	32	33	35	36	38	
82	15	15	16	16	17	17	18	19	20	21	23	24	26	27	29	30	32	33	35	36	38	39	41
85	16	16	17	17	18	19	19	20	21	23	24	26	27	29	30	32	33	35	36	38	39	41	41
88	17	18	18	19	19	20	21	22	23	24	26	27	29	30	32	33	35	36	38	39	41	42	44
91	19	19	20	20	21	22	22	23	24	26	27	29	30	32	33	35	36	38	39	41	42	44	45
94	20	21	21	22	22	23	24	25	26	27	29	30	32	33	35	36	38	39	41	42	44	45	47
97	21	22	22	23	24	24	25	26	27	29	30	32	33	35	36	38	39	41	42	44	45	47	48
100	23	23	24	24	25	26	27	28	29	30	32	33	35	36	38	39	41	42	44	45	47	48	50
103	24	25	25	26	27	27	28	29	30	32	33	35	36	38	39	41	42	44	45	47	48	50	51
106	26	26	27	27	28	29	30	31	32	33	35	36	38	39	41	42	44	45	47	48	50	51	53
109	27	28	28	29	29	30	31	32	33	35	36	38	39	41	42	44	45	47	48	50	51	53	54
112	28	29	30	30	31	32	33	34	35	36	38	39	41	42	44	45	47	48	50	51	53	54	56
115	30	30	31	32	32	33	34	35	36	38	39	41	42	44	45	47	48	50	51	53	54	56	57

To find the total degree days for a day, locate the low and high temperatures and follow the rows to where they intersect. For temperatures between those listed, use the nearest shown.

*Adapted from: Beers, E.H, J. F. Brunner, M. J. Willett, and G. M. Warner. 1993. **Orchard Pest Management: A Resource Book for the Pacific Northwest**. Good Fruit Grower. 276 pp.

MANAGEMENT

Insecticides

Insecticide sprays targeting the adult are the primary tactic for controlling this pest. Larvae of the fruit fly develop within the fruit where they are protected from most insecticides. Recent research on penetration of insecticides into fruit has shown that at least some of the neonicotinoid insecticides (e.g., Provado®) and perhaps even some of the organophosphates (e.g., Guthion®) do move through the skin of fruit and can kill insect eggs and larvae within the fruit. Despite this new information, the main target for control is still prevention of females laying eggs in fruit.

The zero-tolerance level of fruit flies in commercial orchards has made perfect control a necessity. Home growers can help by maintaining fruit fly control in backyard orchards. Once control treatments begin based on timing information described above, maintain protection of fruit through harvest. Reapply insecticides based on the protection interval stated on the label. It is best to rotate the type of insecticide applied between applications to reduce development of resistance and negative effects on beneficial insects and mites. For example, insecticides such as carbaryl, malathion, and the synthetic pyrethroids are especially toxic to predatory mites.

*Recommended Insecticides**

For home and commercial orchards:

- spinosad (GF-120, Success, Entrust) – reapply every 7 days
- carbaryl (Sevin) – reapply every 7 days
- malathion (Malathion) – best when used just before harvest as it lasts approximately 3 days
- synthetic pyrethroid insecticides – reapply every 7-14 days
  - cyfluthrin (Baythroid) – commercial use only
  - esfenvalerate (Asana, Ortho products)
  - lambda-cyhalothrin (Warrior) – commercial use only
  - permethrin (Ambush, Pounce, Ortho products)

For commercial orchards only:

- imidacloprid (Provado) – reapply every 14 days
- azinphosmethyl (Guthion) – reapply every 14 days (scheduled for phase-out by 2012 by the U.S. Environmental Protection Agency)
- phosmet (Imidan) – reapply every 14 days; do not use on sweet cherry
- chlorpyrifos (Lorsban) – reapply every 14 days; do not use on sweet cherry
- diazinon (Diazinon) – reapply every 10-14 days

*All brand names are registered trademarks. Examples of brands may not be all-inclusive, but are meant to provide examples of insecticides registered on cherry trees in Utah. The availability of insecticides is changing rapidly. Always check the label for registered uses, application and safety information, and protection and pre-harvest intervals.

Recent research has evaluated control of larvae, pupae, and adults in and on the soil with soil applied insecticides. No insecticides are currently registered for soil application for control of cherry fruit fly, but they may be in the future.

Attract-and-Kill Technology

GF-120 is a mixture of an adult attractant or arrestant and an ultra low concentration of spinosad® insecticide. In commercial orchards it is applied with a 4-wheeler-mounted, electric-pump sprayer (Fig. 9). In home cherry trees, it can be applied with a hand-pump sprayer. Full coverage of foliage and fruit is not required as adults are enticed to feed on small droplets of sticky bait and insecticide. Research in Utah orchards has shown it to be as effective as most traditional insecticides. It is not rain-fast and must be reapplied at least every 7 days.

It is critical to keep an adequate number of bait/insecticide droplets available to kill adults soon after they emerge and before they mate and/or females lay eggs. Currently it is only sold in larger volumes; larger than is practical for most home orchards.

Figure 9. Application of GF-120 attract-and-kill product with a 4-wheeler-mounted sprayer.[2]

Cultural Controls

Ground Cover and Mulches

It has been demonstrated that ground cover around the base of trees can prevent larvae from burrowing into the soil to complete development into the pupal stage. Successful vegetation covers include grasses and other plants with extensive, dense root systems (e.g., clover) that physically impede fruit fly larvae. Landscape fabric has been shown to prevent larval burrowing and emergence of adults from pupae in the soil (Fig. 10). Mulches of other dense materials may also interfere with their life cycle.

Sanitation

Maintaining a "clean" orchard wherein the fruit fly population is kept at low levels from one year to the next is important because high populations are more difficult to control, even with insecticides. In years when the crop is not harvested or not all fruit is removed from trees, fruit fly populations can increase and cause greater pest pressure the following year. Therefore, it is important to remove dropped fruit from the orchard floor as they may contain larvae. In addition, remove any nearby abandoned or wild cherry trees to prevent them from serving as unmanaged hosts that contribute to the local fruit fly population.

Biological Control

There are some natural enemies that will attack fruit fly life stages, such as parasitic wasps that lay eggs on larvae within fruit, but control has not been shown to be significant. Birds and rodents take a larger toll on fruit fly larvae, but they generally also consume the fruit and so are not considered beneficial. Chicken and other fowl have been shown to eat fruit fly larvae and pupae in the soil and may provide some benefit.

Figure 10. Landscape fabric under the trees can prevent larvae from burrowing into the soil to pupate.[3]

[1]Image courtesy of Shawn Steffan, Utah State University Extension
[2]Images courtesy of Washington State University Extension
[3]Images courtesy of Diane Alston, Utah State Universtiy Extension