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Managing Fruit Flies on Farms in Hawaii

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Fruit flies have become serious pests in Hawaii since the first species was found here in about 1895. They are widespread, occurring from sea level to above 7000 ft elevation, and feed on hundreds of host plant species, many of which are economic crops.

Four species of fruit flies in the family Tephritidae are now known in Hawaii. The melon fly is commonly found in commercial and backyard vegetable gardens at low elevations. The Mediterranean fruit fly ("medfly") moved away from most lowland areas (except low-elevation coffee fields) when the oriental fruit fly arrived in 1945, and it is now found more frequently in upper elevations. The oriental fruit fly is found in most elevations and climates. The solanaceous fruit fly survives in both cool and hot climates but so far has been found only in dry areas of Hawaii (<100 inches of rain per year).

This publication provides information to help farmers and gardeners identify pest fruit flies, learn about their habits and life cycles, and implement strategies to manage them and reduce crop damage. A glossary defining some of the terms used is on page 7.

Most control strategies use a combination of techniques—no single, "one-answer" solution to the fruit fly problem is available. The postharvest treatments required for export of commodities affected by fruit flies are not covered in this publication.

Damage caused by fruit flies

Plant injury. Fruit fly adults most often lay their eggs in the fresh flesh of fruits and vegetables. The eggs hatch into larvae (maggots), which most often feed on the inside of the fruit, resulting in a soft, mushy mess. Look for wiggling white larvae the next time you pick a very ripe guava or other fruit.

Economic injury. Fruit flies can often be present at low levels without causing significant economic problems, so control may not be necessary. If high fruit fly populations are causing more severe damage, management practices may need to be implemented.

Key steps in managing fruit flies

- Prevention—practice sanitation techniques.
- Monitor the levels of pests; determine if you have economic injury; evaluate and use the best strategies.
- Identify the fruit fly species and become familiar with its life cycle and host plants.
- Determine which other plants in the area are fruit fly hosts, and determine when these plants are fruiting.
- If possible, rotate your crops so they do not fruit when other hosts are fruiting and pest populations are peaking.
- Harvest fruits under-ripe when possible (e.g., papayas are usually fruit fly–free if picked when less than ¼ ripe).
- If fruit flies cause economic injury, apply appropriate controls.
- Divert pests with poisoned border plants, baits, or lures.
- Monitor pests again and reevaluate your strategies.

Life cycles of fruit flies

Fruit fly development (life cycle) depends on temperature. Cool temperatures slow the development cycle, while warm temperatures speed it up. Information on life cycles given here is derived from laboratory-raised fruit flies grown at 77°F at 50% relative humidity, except for the solanaceous fruit fly (80°F at 60% RH); wild flies will most likely be different. Traits common to all four species include

- eggs are white, up to 1⁄16 inch long
- larvae range from 1⁄16 to 3⁄8 inch long (just before pupating, the larvae often "pop" and flip to leave the fruit)
- pupation normally occurs 1–2 inches under the soil
- adults usually rest in shady locations unless feeding, mating, or laying eggs; most feed at dawn and mate at dusk.

This publication replaces HITAHR Brief no. 114, 1995, *Introduction to managing fruit flies in Hawai'i*, by Laurel Dekker and Russell Messing.

Melon fly

Mediterraneanfruit fly

Four species of tephrited fruit fly are found in Hawaii. Wing pattern is the best distinguishing characteristic; color is inconsistent and not always reliable. See "key characteristics" in the descriptions below for distinguishing features.

Melon fly

Scientific name: *Bactrocera cucurbitae*; native to Asia; detected in Hawaii around 1907.

Key characteristics: Wing pattern has stripes and a large black spot at the wing tip. Abdomen is usually brown with a gold to brown horizontal band and a faint black "T". Ovipositor (egg-laying tube) has a plump, straight sheath (outer covering) and is about 1/16 inch long.

Distribution: parts of Africa, Burma, Sri Lanka, China, Guam, Hawaii, New Guinea, Rota, Commonwealth of the Northern Marianas, Southeast Asia, and South Asia; sea level to 4500 ft.

Hosts: Over 100 known. Preferred hosts are cucurbits (squash, melon, etc.). Other hosts include solanaceous plants (tomato, eggplant, pepper, etc.) and papaya.

Life cycle: One generation takes around 37 days; egg to adult in 15–18 d; eggs hatch in about 30 hr; larvae develop in 7–8 d; adults emerge in 9–10 d; pre-oviposition period is 7–8 d; females lay an average of 15 eggs /day, singly or in clusters.

Special notes: Known to feed on stem shoots and buds of squashes and melons.

Mediterranean fruit fly

Scientific name: *Ceratitis capitata;* native to sub-Saharan Africa; first reported in Hawaii in 1895.

Key characteristics: Wing pattern is very complex and multicolored (gold and black) with black stripes and detailed markings. Black spots are on the back or thorax. Abdomen is usually brown. Adult is about 2/3 the size of the other fruit flies.

Distribution: Africa, Mediterranean countries, Hawaii, western Australia, Central and South America; the dominant fruit-fly pest in Hawaii above 3000 ft and in low-elevation coffee; prefers dry regions.

Hosts: Over 300 hosts. Preferred hosts include coffee, peach, plum, loquat, orange, guava, rose apple, solanaceous plants (pepper, Jerusalem cherry), and the sapote family, among others.

Life cycle: One generation takes around 18–31 days; egg to adult in l9 d; eggs hatch in about 2–3 d; larvae develop in 7–8 d; adults emerge in 9–10 d; the pre-oviposition period is about 3 d; females lay an average of 10 eggs/day, singly or in clusters of up to 10.

Oriental fruit fly

Solanaceous fruit fly

Photographs are from the website of the USDA Agricultural Research Service's Tropical Fruit, Vegetable, and Ornamental Crops Laboratory, Hilo, Hawaii.

Oriental fruit fly

Scientific name: *Bactrocera dorsalis*; native to Asia; introduced to Hawaii in 1945.

Key characteristics: Wing pattern has two solid black lines stemming from the point of attachment, without a black spot at the tip as in the solanaceous fruit fly. Abdomen is gold to brown with gold to brown horizontal band and prominent black "T". Ovipositor has a slender, straight sheath.

Distribution: Asia, Australia, Surinam, and islands of the Pacific; the major fruit fly pest in Hawaii at low elevations, except for coffee fields.

Hosts: Over 200 wild and cultivated hosts. Preferred hosts include guava, mango, papaya, starfruit, passion fruit, citrus, fig, rose apple, tomato, and many more.

Life cycle: One generation takes around 37 days; egg to adult in 19 d; eggs hatch in about 38 hr; larvae develop in 7–8 d; adults emerge in 10–11 d; the pre-oviposition period is 6–7 d; females lay over 130 eggs /day, usually in groups of 10 but as many as 100 or more.

Solanaceous fruit fly

Scientific name: *Bactrocera latifrons* (also known as Malaysian fruit fly); native to South and Southeast Asia; first detected in Hawaii in 1983.

Key characteristics: Wing pattern has two solid black lines stemming from the point of attachment, plus a black spot at the wing tip that differentiates it from the oriental fruit fly. Abdomen is usually brown, without a prominent "T". Ovipositor is tri-lobed, to 1/16 inch long.

Distribution: China, Taiwan, Malaysia, Thailand, Laos, India, Pakistan, and Hawaii.

Hosts: 33 reported hosts, mostly solanaceous (pepper, tomato, eggplant, apple of sodom), and occasionally cucurbits.

Life cycle: One generation takes around 48 days; egg to adult in 21 d; eggs hatch in about 2 d; larvae develop in 8–9 d; adults emerge in 10 d; the pre-oviposition period is 10–11 d; females lay an average of 10 eggs/day, one at a time.

Special notes: Occurrence is generally in low numbers with a patchy distribution.

Prevention strategies

Exclosure. Crop damage can be prevented by keeping fruits out of reach of female fruit flies. Screen-houses can produce fruit-fly–free crops. Local research has found that an economical structure (~$1.20/sq ft) was cost-effective within the first harvest for tomato production. Netting (floating row covers or lightweight netting from a fabric store) can be placed directly on plants or on a frame of PVC tubes for temporary cover of crops like zucchini. Tomatoes and self-pollinating cucumbers are pollinated by the wind, but some other crops may need hand pollination if plants are covered by screen. A possibility that has not been fully explored is to add bee hives to large screenhouses to provide ample pollination. (Note: secondary insect or weed problems may arise from reduced air circulation and lack of beneficial insect populations in enclosed areas.)

Another method of exclosure is bagging individual fruits with newspaper, paper bags, or other barriers. This method works well but is labor-intensive.

Sanitation. Remove fruits as they ripen. If they fall to the ground, be sure to kill any larvae in them by burying the fruit deeply or putting them in an air-tight container for four days or until no movement is found. Check for pupae (and destroy them) before adding fruit to compost piles. Sanitation by itself will not be effective in many situations, because fruit flies can fly in from outside areas. Melon fly pupae buried as deep as 2 ft have managed to emerge as adults from dry sand, wet sand, and soil. When composting, the pile must achieve internal temperatures of at least 120°F. Mowing or shredding ground fruit can provide sanitation by killing the larvae or exposing them to other predators.

Harvest early. By harvesting early, you can sometimes prevent infestation (e.g., fruit flies do not usually sting papayas or 'Sharwil' avocados that are less than ¼ ripe). However, some fruits lose flavor when harvested too early, as they will not ripen fully.

Reduce populations. If fruit flies are present in your field prior to crop ripening, you can try to reduce their population by attracting the adults to a poisoned bait. This can be done by spraying a protein-bait–insecticide mixture onto nearby non-crop plants, windbreaks, or a border of corn plants. Farmers and researchers have observed reduction of melon flies in zucchini, cucumber, and watermelon fields when using bait sprays on border crops. Suppression sprays have also been used in Australia, Israel, Mexico, Florida, and California. Mass trapping with protein baits (for male and female fruit flies) or with chemical lures (for males) is being researched as a method of fruit fly reduction.

Create an "isolated" area. Planting between other crops or rotating to opposite ends of a field has been tried for a few crops (melon fly hosts). Often, fruit flies do not find the crop during the first half of the harvest. This strategy should not be repeated in consecutive plantings in the same place.

Plant resistance can help. High levels of citrus oil in immature citrus peels can be toxic to larvae, so researchers are investigating the use of plant growth hormone (giberellic acid) to delay peel ripening and reduce susceptibility to fruit flies. Mango cultivars are being developed to have flesh that is harder and crisper when ripe. Small tomatoes (Roma and cherry) *can* be infested by fruit flies, contrary to popular belief; however, many growers have found that small tomato varieties can be harvested with less infestation than large varieties.

Don't confuse fruit flies with vinegar flies. Note that the fresh-fruit–eating fruit flies discussed here (tephritid family) are not the same as the tiny "fruit flies" that feed on yeasts and decaying fruit. These tiny flies called vinegar flies belong to the drosophilid family and can often by found on soggy fruits on the ground or overripe, fermenting fruits.

Control of fruit flies

Note on using pesticides: Read the pesticide label completely. Apply according to manufacturer's recommendations only to crops specified on the label. If in doubt, contact your local Cooperative Extension Service office or the Hawaii Dept. of Agriculture, Pesticides Branch. If information given in this publication is different from the label directions, follow the label directions.

Cultural and chemical controls

Bait spray. In fruit-fly–infested areas, a protein hydrolysate compound, such as Nu-lure® or Staley's® bait, can be combined with insecticide and applied to plants that are associated with the resting and feeding areas of the adults, rather than on the crop to be protected. Bait sprays use small amounts of chemical and are not generally attractive to beneficial insects that may be natural enemies of fruit flies and other pests.

To apply with a knapsack sprayer, find a malathion product cleared for use on the target site. Follow the directions for fruit-fly control on the pesticide label. For example, mix the appropriate amount of malathion 25% WP with 1 qt Nu-lure and 3 gal water; or 1 part malathion 57% EC with 3 parts Nu-lure. To apply with a conventional

power sprayer of 20–100-gal capacity, mix 1 qt Nu-lure with the appropriate amount of malathion. Agitate during application. Spray with concentrated, coarse droplets on border plants that are listed on the pesticide label. Apply weekly (for high populations) to bi-weekly (for low populations). Reapply after rain. Researchers and farmers have observed good control of melon flies with this technique. The Hawaii Department of Agriculture's Pesticides Branch has allowed application of pesticide bait sprays to other border plants and windbreaks under certain conditions. Note that this policy may change—contact your HDOA Pesticides Branch district office for current information. Note also that the mixtures described above have a pH of 4.7; recent research indicates that a pH of 9.2 is more attractive to the flies, so researchers are looking at ways to raise the pH.

Spot treatments with bait spray–insecticide mixtures have been used successfully elsewhere, but these methods may not be included on current labels in Hawaii. In Mexico, bait spray has been applied to orchard tree trunks with good results. Israeli producers have found spot treatments effective for medflies in or around fields when applied at 2 oz per spot, spaced at 40–80 spots per acre, with 16–33 feet between spots.

Insecticide sprays. Insecticides applied to kill fruit flies directly should be used only as a last resort and only on crops allowed on the pesticide label. At least 40 pesticides have been found toxic to fruit flies, including malathion and naled. Pyrethrum is not as toxic to fruit flies as malathion. Most pesticides, including permethrin, are *more toxic* to beneficial insects (such as parasites of pest insects) than to fruit flies.

Approved organic controls

Neem. In research tests, neem-treated sand was found to be toxic to oriental fruit flies and medflies but not to several beneficials. This suggests potential for soil treatment to inhibit fruit fly development in fields (however, adults may still invade from outside areas). Azatin® is a neem product registered for use in Hawaii as a soil treatment against fruit fly larvae. The National Organic Standards Board has approved use of neem in certified fields, but it is still investigating the inert ingredients in Azatin.

Biological controls

Chickens and guinea hens may eat some fruit-fly larvae found at the top of the soil. Wild birds have also been seen digging through infested fruits for larvae. Birds and fowl may also help with sanitizing infested fruits.

Ants are known to feed on most life stages of fruit flies (research reports up to 40% kill), and earwigs have been reported to feed on fruit fly larvae.

Nematodes are among the soil-borne organisms that feed on insect pests in the soil. Nematodes are microscopic roundworms with a broad host range, including fruit fly larvae. Currently, commercial use of the nematode *Steinernema carpocapsae* is not permitted in Hawaii, but in the future this may become a viable control for areas heavily infested with fruit flies.

Fruit fly parasites are tiny wasps that attack only fruit flies. Parasites can lay their eggs in the egg, larva, or pupa of a developing fruit fly. The parasite develops within the immature stages until the fruit fly pupa is consumed, and then the adult parasite emerges from the soil. Parasites can be very effective in controlling fruit flies—reports have indicated up to 90% kill of oriental fruit flies in unsprayed guava.

Species that parasitize tephritid fruit flies have become established in the state of Hawaii after being introduced for biological control. All evidence indicates that these reported parasites do not harm any other species besides fruit flies. Many additional parasites exist in Africa, Asia, and South America. Do not attempt to bring in beneficial insects yourself; to do so violates stringent import regulations that protect Hawaii from alien species.

Rearing for identification—Get to know your pests

Raising larvae to adulthood is the best way to identify the fruit fly species attacking your crops. An easy home method uses a wide-mouth plastic container with a lid. Make some small air holes in the top. Place a small amount of infested fruit with wriggling larvae inside the clean container. Observe regularly, making sure there is no liquid collecting on the bottom. Soil or sand can be added to prevent drowning. As the larvae age, they will leave the fruit to pupate. You can remove the fruit after the pupae are formed. The adults will emerge after 9–11 days. Compare them with the descriptions given on pages 2–3.

Beneficial wasps that are parasites of fruit flies can be reared in the same way. Because the wasps are small, make the holes in the top smaller than $\frac{1}{16}$ of an inch, or put a tissue or small-mesh screen between the top and bottom of the cup. Adults will emerge in 2–10 days from ripe fruit.

Trapping strategies

Monitoring with traps

Monitoring helps identify fruit fly pests, keeps track of changes in their population levels, and indicates when or whether to use controls. The best way to detect the presence of fruit flies and evaluate the effectiveness of control measures is to monitor fruit infestation.

Liquid traps with food bait attract males and females. Put 1–2 inches of bait mix into the trap, and check weekly. *Yeast tablets:* mix five Torula® yeast tablets in 2–2½ cups water; stir to dissolve tablets. *Protein hydrolysate:* mix 11 fluid oz Nu-lure® or Staley's Fly Bait®, 7 fluid oz borax, and 3½ qt water. *Fruit:* blend cucumber or other primary host with water; place small amount in trap; change often.

Parapheromone lure traps use highly volatile lures which attract male flies; these traps need to be checked frequently. The amount of lure determines how attractive and long-lasting these traps will be. Lures catch only males, leaving the females in the field to infest the fruit. At present, only methyl eugenol for oriental fruit fly is available in Hawaii.

To attract male fruit flies, initially use 3–5 drops of lure in a trap. Adding an insecticide to the lure provides a better catch than traps without insecticide. Use 1 drop of an insecticide approved for use on your crop for every 20 drops of lure used. Replenish the lure as needed, using more lure to attract males over longer distances and for longer time periods. Only insecticides that are EPA-registered and labeled for use on that crop may be used. The Hawaii Department of Agriculture Pesticides Branch has agreed that parapheromone lures with insecticide may also be used in fields with non-approved crops to collect fruit flies *for survey purposes only* in properly labeled traps (this policy may change).

Yellow spheres or sticky panels are also used to monitor fruit flies in crop fields. Check them regularly, and change them when the trapping surface is full or becomes dusty.

Mass trapping

High-density trapping is being explored to reduce or suppress populations of fruit flies. USDA researchers have not produced evidence that small-scale trapping helps reduce infestation. However, mass trapping is used in other areas. In Crete, it resulted in substantial reduction of insecticides used against a fruit fly. Local research is needed to determine if small-scale suppression of fruit flies can be effective.

Types of attractants

Food baits are effective, mild attractants for males and females of all four fruit fly species. Food baits are not very volatile, so bait traps typically have lower catches than the parapheromone lure traps, but food baits can be used directly in the field.

Torula® yeast tablets are more effective than Nu-lure over time, because the pH is stable at 9.2. The level of pH in the mix plays an important role in attracting fruit flies. Fewer fruit flies are attracted to the mix as the pH becomes more acidic. USDA researchers are testing a combination of Torula® yeast and dyes commonly used in cosmetics and drugs to improve population reduction of medflies and oriental fruit flies.

Nu-lure® (a yeast extract) and Staley's Fly Bait® (a corn extract) are hydrolyzed proteins. They are not effective over time as the pH drops from its initial state of 8.5. Promar®, an experimental hydrolyzed protein developed in Australia, has been very effective against a species similar to the oriental fruit fly in Malaysia, where starfruit orchards with Promar® spray applications rather than insecticidal cover sprays have doubled yields, mostly due to more bees being available for pollination.

Farmers report that homemade baits (cucumber or zucchini blended with water, or vinegar plus yeast) have attracted both males and females of the melon fly.

Parapheromone lures are very volatile and longer lasting than protein baits. They attract only males, and each fruit fly species in Hawaii is attracted to a different kind. The amount of lure used depends on whether the trapping is for monitoring or for mass trapping. A few drops may be effective to sample the population over a short period of time, but more is needed for mass trapping over a longer period. The kind of lure also affects the amount needed. In California, detection traps with methyl eugenol are set at two per square mile, whereas with tremedlure 10 traps are needed for the same area (6 ml of lure per trap in both cases). In Hawaii, three to five drops of methyl eugenol have been used in within-field traps.

Parapheromone lures for male fruit flies

Type of lure	Strength	Fly attracted
methyl eugenol	very volatile and persistent	oriental
Cue-lure	moderately persistent	melon
Ceralure	persistent	medfly
Trimedlure	moderately persistent	medfly
Latilure	mildly persistent	solanaceous

The effectiveness of traps varies with their color and shape. Yellow is the most attractive color to males and females of oriental fruit fly, melon fly, and medfly. They are attracted to yellow and white flat panels as well as spheres. In field tests, researchers collected both females and males from the colored traps.

Types of traps

All traps used for catching fruit flies must be properly labeled with the name of the bait or lure and date the trap was set. Keep traps out of reach of children.

Commercial traps

- Protein bait—glass or plastic McPhail traps can be used; flies enter from below and cannot get out.
- Lure—the waxed cardboard Jackson trap, or tent trap, is popular; it has a removable, sticky insert floor to catch flies and a cotton wick for the lure.
- Yellow sticky board—rectangular, yellow, sticky boards are used with or without other attractants.

Home-made

- Protein bait—use a clear plastic bottle with several 1-inch holes; add a liquid bait mix.
- Lure—use a clear plastic bottle with a few ¼-inch holes; put cotton inside to absorb the lure.
- Harris trap—a tall container with a clear, wide cover and 1-inch diameter holes; can be used with any attractant; easier to use than sticky traps, but when used with lures, it must have insecticide to kill the flies before they escape.
- Sticky panels—paint cardboard or wood panels bright yellow; cover with Tanglefoot®.

Placement of traps

The location and placement of monitoring traps may be more critical for medflies than other fruit flies. Research has shown that medflies can effectively be trapped in their mating areas, such as the upwind side of crowns of trees receiving some light. Traps for the other fruit flies should be placed in their resting or feeding areas.

Protein traps and other mild attractants should be placed in a shady area close to the host plants. Lure traps should be placed at the borders, corners, and outside of the field before flies move into the field. Color attractants should be placed in the open for best effectiveness.

Trap density (number per area) and spacing depends on the type and amount of attractant used. Traps for monitoring do not need to cover the entire area evenly. Protein bait traps have been used at 15–30 ft in-field spacing, and lure traps have been spaced 100 ft apart outside the field.

The visual range of fruit flies is about 15–20 ft. Yellow traps should be placed within that distance from the host plants and at greater density than lure traps. Monitoring programs on the U.S. mainland recommend that traps be placed 4–6 ft above the ground.

Glossary

Bait An attractant and food source (sometimes mixed with insecticide) for treating fruit-fly–infested areas.

Beneficial organisms Birds, insects, nematodes or other organisms that aid in controlling pests.

Development Growth through life stages or life cycle. Fruit flies have four life stages: egg, larva, pupa, and adult.

Generation The time it takes to complete all stages of development, including the pre-oviposition period.

Host A plant or animal that provides food for larval growth and development.

Infestation The presence of a fruit fly in a host.

Integrated pest management A control strategy that integrates cultural, biological, and chemical techniques to manage pests.

Larva Maggot; juvenile stage of fly development; plural: larvae.

Nu-lure® A commercial formulation of corn protein that acts as a broad-spectrum food attractant for male and female fruit flies.

Ovipositor Egg-laying tube.

Parapheromone lure Mild to very strong attractants that attract only male fruit flies; many are produced by plants.

Persistent Relates to how long-lasting a lure is.

Pre-oviposition period Time period after adults emerge, before egglaying begins.

Protein hydrolysate Extracts of yeasts or grains that act as a broad-spectrum food attractant for male and female fruit flies (and many other protein-feeding insects).

Pupa The transformation stage of fly development, after larva and before adult; a hard, brittle case covers the pupa; plural: pupae; pupation: the act of transformation.

Sheath Outer covering of ovipositor.

Staley's® Fly Bait No. 7 A commercial formulation of corn protein that acts as a broad-spectrum food attractant to male and female fruit flies.

Thorax Back or top of the mid-body.

Torula® yeast tablets A commercial formulation of yeast protein that acts as a broad-spectrum food attractant for male and female fruit flies.

Volatile Readily vaporized; refers to lures, affects how well they can be carried on the wind.

References

Liquido, N. 1993. Reduction of oriental fruitfly (Diptera: Tephritidae) populations in papaya orchards by field sanitation. J. Agric. Entomol.10(2):163–170.

Liquido, N., E. Harris, and L. Dekker. 1994. Ecology of *Bactrocera latifrons* (Diptera: Tephritidae) populations: host plants. natural enemies. distribution. and abundance. Ann. Entomol. Soc. Am. 87(1):71–84.

Mau, R. F. L. 1983. Watermelon insecticide guide for commercial producers. Univ. of Hawaii, HITAHR Brief No. 044.

Robinson, A. S., and G. Hooper (eds). 1989. World crop pests: Fruit flies—their biology, natural enemies and control. vol. 3A and 3B.

Steiner, L., W. C. Mitchell, and K. Ohinata. 1959. USDA recommends poisoned-bait sprays for fruit flies. Hawaii Agriculture. March, 1959. p. 25–30.

United States Department of Agriculture, Animal and Plant Health Inspection Service. Emergency programs manuals. Mediterranean fruit fly action plan (l982); Melonfly action plan (1984); Oriental fruit fly action plan (1989); Malaysian fruit fly action plan (1993).

A list of additional references is available upon request.

Trap sources

Great Lakes IPM, 10220 Church Rd., NE, Vestaburg, MI 48891.

Pest Management Supply Inc., 311 River Drive, MA 01035.

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