

## Successful Utilization of the Area-Wide Approach for the Management of Fruit Flies in Hawaii

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### 1. Abstract

Melon fly, *Bactrocera cucurbitae* (Coquillett), Mediterranean fruit fly, *Ceratitidis capitata* (Wiedemann), oriental fruit fly *Bactrocera dorsalis* (Hendel), and the so-called Malaysian (solanaceous) fruit fly, *Bactrocera latifrons* (Hendel), have accidentally become established in Hawaii, and attack more than 400 different host fruits. These fruit flies inhibit development of a diversified tropical fruit and vegetable industry, require that commercial fruits undergo quarantine treatment prior to export, and provide a breeding reservoir for their introduction into other parts of the world. Previous fruit fly control measures in Hawaii relied heavily on the application of organophosphate insecticides to crops. In 1999 a 7 yr Area-Wide Pest Management (AWPM) program was initiated for management of fruit flies in Hawaii. The AWPM program integrated two or more control components (field sanitation, protein bait sprays, male annihilation, sterile

insects, and parasitoids) into a comprehensive package that has been economically viable, environmentally acceptable, and sustainable. The program has resulted in area-wide suppression of fruit flies, a reduction in the use of organophosphate insecticides, and the impetus for further growth and development of diversified agriculture in Hawaii.

## **2. Recent Trends and Approaches in Area-Wide Management**

In 1994 the United States Department of Agriculture (USDA) set the goal of implementing Integrated Pest Management (IPM) on 75% of the nation's farmland by the year 2000. The Agricultural Research Service (ARS) implemented fully an Area-Wide Pest Management partnership in 1995 (Faust and Chandler 1998; Chandler and Faust 1998). Components include not only sterile insects, parasites and predators, but also many cultural tactics, mating disruption, F<sub>1</sub> sterility, attracticides, and reduced risk insecticides. Key to the successful programs have been close partnerships among Federal, State and local agencies, the private sector, land grant universities, and international groups. ARS AWPM projects (fiscal year of initiation) include: 1) Codling moth on apples and pears in the Pacific Northwest (1995), 2) corn rootworms in the Midwest (1996), 3) leafy spurge in the northern plains (1997), 4) stored grain insects in the Midwest (1997), 5) tephritid fruit flies in the Hawaiian Islands (2000), 6) fire ants in the southern US (2001), 7) Russian wheat aphid and greenbug in the Great Plains (2002), 8) tarnished plant bug in Louisiana and Mississippi (2002), 9) *Melaleuca* in the Florida Everglades (2002), and 10) Methyl Bromide in California and Florida (2007). The Hawaii program was initiated by ARS in FY2000, and includes research, education and assessment components. The goal is to transfer environmentally sound sustainable technologies to the farmers and reduce the use of organophosphate insecticides. It has been funded for 7 yr and then will be carried on by cooperators, growers, and residents.

## **3. Current Economic Impact of Fruit Flies**

Four Species of exotic flies-Mediterranean fruit fly (*Ceratitidis capitata* (Wiedemann)), melon fly (*Bactrocera cucurbitae* (Coquillett)), oriental fruit fly (*Bactrocera dorsalis* (Hendel)), and Malaysian fruit fly (*Bactrocera latifrons* (Hendel))-have been devastating to Hawaiian agriculture for decades. They can

infest more than 400 different host plants-such as papaya, guava, mango, orange, persimmon, loquat, passion fruit, peach, plum, melon, watermelon, pumpkin, tomato, and zucchini. But with the decline of sugar and pineapple plantations, these fruit fly-susceptible, high-value crops are the backbone of today's Hawaiian agriculture. Growers, large and small, have had to resort to either frequent doses of insecticides or give up production entirely.

#### **4. AWPM Components Being Developed**

ARS scientists have developed technologies over the years to combat accidental fruit fly outbreaks on the U.S. mainland. But while the research was done in Hawaii, the technologies had never been packaged and transferred to Hawaiian farmers. In 1999, USDA-ARS launched the Hawaii Fruit Fly Area-Wide Pest Management (AWPM) program to suppress fruit flies below economic thresholds while reducing the use of organophosphate insecticides (Vargas et al. 2003). The program includes developing and integrating biologically-based pest technology into a comprehensive management package that will be economically viable, environmentally-friendly and sustainable. The technologies include (Fig. 1): 1) field sanitation (Klungness et al. 2005), 2) protein bait sprays (Peck and McQuate 2000; Vargas et al. 2001,2002; Prokopy et al. 2004), 3) male annihilation with male lures and attractants (Steiner et al. 1965; Koyama et al. 1984; Vargas et al., 2000, 2003), and if needed, 4) augmentative parasitoid releases (Knipling 1995; Wong et al., 1991, 1992; Vargas et al. 2004), and 5) sterile insect releases (Steiner et al. 1970; Vargas et al. 1994; 1995; Koyama 1996; Vargas et al. 2004).

#### **5. Prospect of AWPM Sustainability**

Getting the program adopted by Hawaiian farmers required a far more than just researching and developing the technology. First, partnerships were created with the Hawaii Department of Agriculture (HDOA) and the University of Hawaii (UH). ARS researchers and University personnel and extension agents are working tirelessly with growers to help them take control of the technology package. HDOA provides the impetus to register control products. Other partners were then enlisted to enhance cooperation and give the program the best chance of success, including the USDA Animal and Plant Health Inspection

Service, The IR-4 pesticide program, the U.S. Environmental Protection Agency, private industry including Dow AgroSciences Inc., and local community action groups. But the heart of the program has been the Hawaiian farmers and gardeners who have participated as cooperators to demonstrate the benefits of the program and then spread the word to others. First, the team had to overcome grower's reluctance to put themselves at economic risk by trying technologies they perceived as experimental. The team also had to get past growers' disappointment with previous unsuccessful eradication attempts during the past 25 years. Extension agents, ARS researchers, UH researchers, and HDOA officials met with growers' groups to explain the idea and procedures. Extensive educational and "how-to-do" materials have been created including videos, a website, public service announcements, pamphlets, handouts, and posters to help growers and gardeners adopt the program. But personal communication with growers has been the real basis for the successful adoption of the program. Growers were empowered to make informed decisions about adopting and continuing the program. Because home gardens can act as reservoirs for fruit fly populations, the program has also begun enlisting public participation, beginning with a senior citizens group. More than 2540 cooperating growers over five islands, representing more than 15,773 acres (Table 1), have already been able to cut organophosphate pesticide use by 75 to 90%. While using the IPM program that reduced environmental risks, growers have still cut fruit fly infestation from 30 to 40 % to less than 5 % (Vargas et al. In Press).

Table 1. Total number of cooperators, number of farms, and acreage impacted by the Hawaii Area-Wide Pest Management program.

<b><i>Island</i></b>	<b><i>Total # of Cooperators</i></b>	<b><i>Farms</i></b>	<b><i>Acres</i></b>
<b><i>Oahu</i></b>	528	108	5637
<b><i>Maui</i></b>	1074	60	2646
<b><i>Molokai</i></b>	57	26	198
<b><i>Kauai</i></b>	160	49	494
<b><i>Hawaii Island</i></b>	721	364	6798
<b><i>Over all islands</i></b>	2540	607	15773

## **6. Benefits, Impact, More Users, and Sustainability**

Strengthening Hawaii's agricultural industry, weakened by the downsizing of the pineapple and sugarcane industries, will have ripple effects throughout the state economy. New jobs will be created in areas of high unemployment and new income generated as growers expand their acreage, sometimes acres previously abandoned by growers unable to deal with fruit fly damage. The production of more high-value food crops will also help consumers in a state that now imports many fruits and vegetables that could be produced locally. Ultimately, fruit fly control could lead to new possibilities for export of high-value commodities. Adoption of the area-wide IPM program also benefits the unique, fragile Hawaiian ecology by reducing the amount of organophosphate and carbamate pesticides while still promoting an increase in agricultural production.

As a result of this program, there has been tremendous support by growers and the public in utilizing the technologies offered by the program.

- ? Grower yields have increased.
- ? Organophosphate insecticide use has decreased.

Tools are now legally available to control fruit fly in Hawaii. This project's close collaboration is being considered as a template for future agricultural research and technology transfer in Hawaii. California, Florida, and Texas have shown keen interest in the program. California alone would suffer a \$1.5 billion annual loss in export sanctions, treatment costs, lost markets, and reduced crop yields if the Mediterranean fruit fly became established there. Discussions have also been held with other countries, including Taiwan, the PRC, Australia, South Africa, French Polynesia, Fiji, Vanuatu, Guam, and the Commonwealth of the Northern Mariana Islands. Spreading the success of the fruit fly area-wide program will not only help other countries control their fruit fly problems but also help protect U.S. agriculture from fruit fly spread.

Future plans for 2007 include expansion of area-wide survey activities in the Puna and Kona areas where papaya and avocado are cultivated, extension of the oriental fruit fly and melon fly program to include 800 acres of papaya orchards in the Puna district, training of commercial avocado growers in Kona in the "1-2-3-4" approach for fruit fly suppression, continued research to address problems which inhibit implementation of the IPM program such as non-target and economic issues, expansion into other agricultural areas not part of the present AWPM demonstration sites, and promotion of sustainability through

registration of lures with EPA. Manufacturer's use permits (MUP's) have been obtained in 2005 and 2006 for cue-lure and methyl eugenol, respectively. Major research and development efforts are presently underway by ARS, UH, and industry to provide methyl eugenol and cue-lure end products for use in male annihilation treatments, when USDA funding of the program ends.

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Figure 1. Six components of the Hawaii AWPM program.

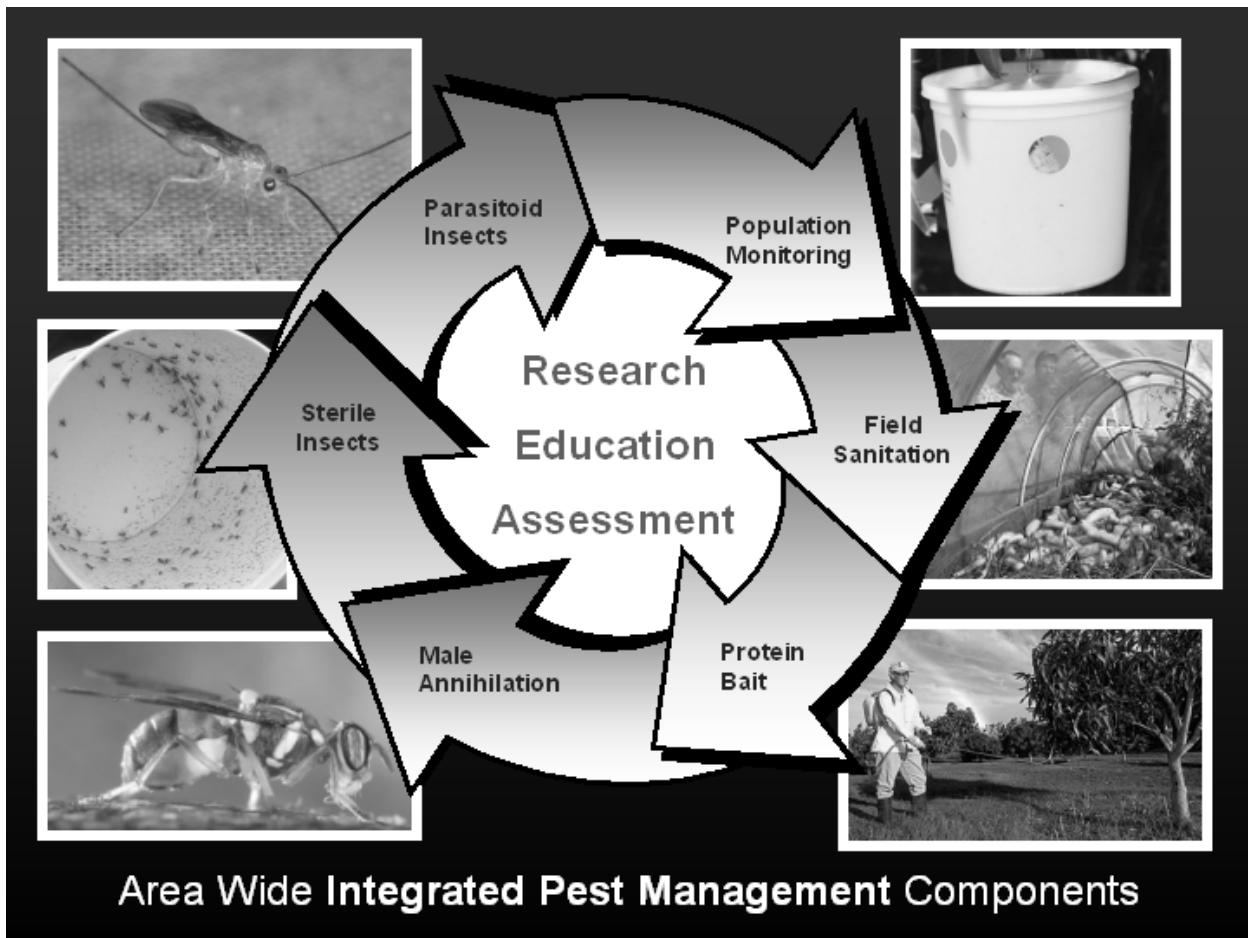


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