UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION TULARE COUNTY

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Olive Notes

Bionomics of the Olive Fruit Fly
Bactrocera (Dacus) Oleae

Richard E. Rice, U.C. Kearney Agricultural Center

The olive fruit fly (olive fly) *Bactrocera oleae* (Gmelin) (Diptera: Tephritidae) is the most serious insect pest of olive fruit in the world. It is known primarily from the Mediterranean area of southern Europe, and is also found in North Africa, the Middle East, and along the east coast of Africa to South Africa (Table 1). There are records of olive fly infestations in fruit three centuries B.C. in the eastern Mediterranean area. It is generally agreed among olive fly researchers that this insect can survive and develop in any area of the world where olive trees are grown.

Table 1. World distribution of the olive fly, *Bactrocera oleae*.

Albania	Israel	Sardinia
Algeria	Italy	South Africa
Canary Islands	Jordan	Spain
Corsica	Lebanon	Syria
Cyprus	Libya	Tunisia
Egypt	Mexico	Turkey
Eritrea	Morocco	United States
France	Pakistan	Yugoslavia
Greece	Portugal	

Distribution of Olive Fly in California

The olive fly was first detected in California on October 19, 1998 in a McPhail trap placed in an orange tree in west Los Angeles, CA. This trap was part of the monitoring and detection trapping program for Mexican fruit fly and other fruit flies that do not respond to specific lures. Following the initial detection, delimitation trapping showed all of the coastal counties from Santa Barbara south to San Diego and inland to Riverside and San Bernardino counties to be generally infested with olive fly. Trapping in the coastal counties was terminated in early 1999 due to the widespread infestations present in these areas.

The first olive fly in the San Joaquin Valley was trapped in a commercial grove on September 14, 1999 near Plainview in southern Tulare County. Intensive trapping around this single fly find through the remainder of 1999 failed to detect any additional flies in this area, or elsewhere in the San Joaquin Valley. However, on May 5, 2000 a sexually mature female fly was trapped in the Mayfair area east of Bakersfield, Kern County. As with the initial find in west Los Angeles, this fly was trapped in an orange tree in a McPhail trap. A second fly was trapped near Bakersfield on May 16, 2000, this time a male in a ChamP yellow panel sticky trap specific for olive flies. Another olive fly was detected in Reedley, Fresno County, on May 17, 2000. On May 22, 2000 the first olive fly on the California coast north of Santa Barbara County was trapped in Arroyo Grande, San Luis Obispo County. A second fly was trapped in Tulare County on May 23, 2000 near Terra Bella. Following these additional detections in the San Joaquin Valley and in San Luis Obispo County, olive fly collections increased rapidly in all of these areas. Numbers of olive flies collected in counties north of Los Angeles are shown from July 12, 1999 through July 10, 2000 (Table 2).

Table 2. Collections of olive fly in California north of Los Angeles County[1/].

County	First Collection		Trap 2/	Host	No. Flies ♂♂	No. Flies ♀♀	Trapping Terminated
Ventura	7/12/99	♀	Ch.	Olive	71	36	3/9/00
Santa Barbara	7/23/99	♂	Ch.	Olive	122	90	12/11/99
San Luis Obispo	5/22/00	♂	Ch.	Olive	72	17	
Kern	5/5/00	♀	McPh.	Orange	22	8	
Tulare	9/14/99	♂	Ch.	Olive	143	34	
Fresno	5/17/00	♂	Ch.	Olive	9	5	
Madera	6/19/00	♂	McPh.	Loquat	3	0	
					412	183	

[1/] Through July 10, 2000.
[2/] Ch. = ChamP; McPh. = McPhail.

Survey and detection trapping in Ventura and Santa Barbara counties has now terminated due to the generally invested nature of those two areas. Detection trapping is continuing in San Luis Obispo County although fly numbers are increasing rapidly in that area as well, primarily in urban ornamental trees. The first fly detection in Madera County was noted on June 19, 2000. As of the publication date of this issue of the UC PPQ, however, numbers shown in Table 2 are already out of date because of the rapidly increasing detections of flies throughout the southern San Joaquin Valley. (Addendum: On July 5 and July 7, singe male olive flies were trapped in Fremont, Alameda County, and San Jose, Santa Clara County, respectively.) Two additional flies were trapped in Alameda County on July 19, 2000.

In addition to the expanding infested areas of California, detection trapping in the summer and fall of 1999 in Baja California, Mexico, showed the presence of olive fly as far south as the San Vicente region of western Baja.

Description

The adult olive fly is normally 4-5 mm long with large reddish eyes and small antennae. The thorax is dark brown with 2-4 gray or black longitudinal stripes. The scutellum is yellow to white; there are also several yellow-white patches on each side of the thorax. The abdomen is brown with darker areas on the sides of each segment (this character is quite variable). The wings of olive fly are clear except for a small distinct black spot at the tips; wing veins may also be slightly dark. Olive fly does not have colored wing bands or patterns typical of many other species of fruit flies such as the Mediterranean fruit fly, *Ceratitis capitata*.

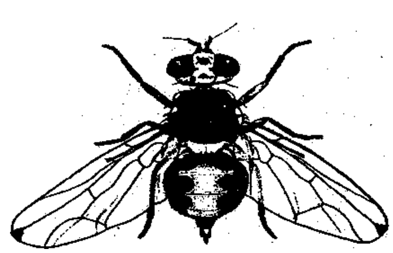

Figure 1. Adult female olive fly, *Bactrocera oleae*.

Hosts of Olive Fruit Fly

Fruits in the plant genus *Olea* are the only known natural hosts for *B. olea*e. Many cultivars of edible olives *(O. europe*a) can be infested. In general the larger table olive varieties are preferred for oviposition by female flies; these fruits tend to allow better survival and produce greater numbers of olive fly larvae. However, even the smaller oil olive cultivars are excellent hosts for olive fly wherever these cultivars are grown.

In addition to cultivated olives, olive fly is known to attack several species of wild olives. Infestation in these hosts has allowed the fly to spread along the east coast of Africa as far as central South Africa where wild olives occur along with a few plantings of commercial olives. As might be suspected from such a narrow host range, olive fly has very specific and restrictive nutritional requirements. It has been shown that *Pseudomonas savastano*i, the bacterial causal agent of olive knot disease, is a symbiont required in the gut of olive fly larvae and adults. The bacteria help flies break down chemicals in olive fruit into essential amino acids and proteins required for growth and reproduction. Olive flies can be reared on artificial diets, but with greater difficulty than many other tephritids.

Although *O. europea* or other species of olives are the only natural breeding host for olive fly, flies have been trapped in other plants where they search for food, or for protection and refuge. In addition to olive, adult fly collection hosts in California include orange, grapefruit, tangerine, calamondin, cherry, plum, lemon, avocado, loquat, nectarine, *Myoporu*m, and Surinam cherry. Flies trapped in these nonbreeding hosts are often caught in McPhail traps, rather than in the yellow ChamP traps that are normally placed specifically in olives. Trapping and migration studies from Crete list additional nonbreeding hosts such as walnut, apple, sycamore, chestnut, vines, fig, *Arbutu*s, and persimmon. Tomato and *Ligustrum* (privet) are reported as laboratory hosts supporting olive fly larval development.

As indicated earlier, olive cultivars in Mediterranean countries show varying susceptibility to infestation by olive fly. In general, larger sizes of olives and olives with higher water content (e.g., table cultivars) are more susceptible than small olives with lower water content (oil cultivars). In Greece, the smaller oil cultivar Koroneiki is less susceptible to olive fly infestation than is the larger table olive cultivar Tsounati.

Olive Fly Phenology and Biology

Temperature relationships and developmental thresholds for olive fly are similar to other tephritid fruit fly species (Table 3). In California it is believed that at least three and perhaps as many as five or six generations of olive fly can develop in the olive production areas of the San Joaquin and Sacramento valleys. It appears that in mild southern areas of the state such as San Diego County, olive fly development can be continuous throughout the year. Olive fruit remaining on trees through the winter into early summer and presence of mated female flies contribute to this development.

Table 3. Developmental thresholds for *Bactrocera oleae* at constant temperatures.

Stage	**Lower**	**Upper**
Egg	43º – 46º F	95º – 100º F
Larva	39º – 46º F	95º F
Pupa	41º – 48º F	86º F
Adult	40º F	102º F

The adult activity threshold for olive fly is approximately 15.5º C (60º F). In summer olive flies can complete a generation in as little as 30 to 35 days at optimum temperatures. The eggs hatch in 2 to 3 days and larvae will develop in approximately 20 days during the summer and fall. Pupal development requires approximately 8 to 10 days during the summer but may last for six months in winter. Unlike other tephritid species, olive flies pupate within the host fruit during warmer months, but leave the fruit to pupate in the ground or in any protected niche during winter. Adult flies can live from 2 to 6 months depending upon food (honey dew, bird feces) availability and temperatures of their environment. Male flies are polygamous; females are normally monogamous. Some authors report olive fly females laying from 200 to 500 or more eggs, thus the reproductive potential for olive flies is extremely high if host fruit is available for oviposition.

According to European literature, olive flies survive best in more humid coastal climates but are also known to heavily infest olives that are grown in interior dry regions of Greece, Italy, and Spain. One report from 1929 describes infestations approaching 100% in olives from Cordoba and Jaen, Spain. High temperatures in the 38-41° C (100-105° F) range are detrimental to adult flies and to immature stages in fruit. However, adult flies are very mobile and have the ability to seek out more humid areas within olive groves, particularly those that are heavily irrigated, or in more humid urban environments. Various authors have reported adult fly movements from 200 m (656 ft) in the presence of olive hosts, to as much as 4000 m (2.5 mi) to find hosts.

Dispersals up to 10 km (6.2 mi) have been reported over open water in the Mediterranean. Presence or absence of fruit modulates fly dispersal in groves.

The seasonal phenology of olive fly varies considerably depending upon the area and climate of the world that it is infesting. In general, olive flies overwinter as pupae or in the adult stage. Females can lay eggs in fruit in warmer climates throughout the winter. Overwintered adult populations decline to generally low levels by February or March, however, new adults from overwintered larvae and pupae begin to emerge in March and April in many Mediterranean climates (Fig. 2). These adult populations then also begin to decline during May and June. The next generation of adults appears in July and August at the time that new crop olive fruits become susceptible to infestation. Fruit susceptibility begins at the time of pit hardening, usually in July in the Mediterranean areas. In California, however, pit hardening was observed in olives in Tulare County (along with many trapped flies) in early June 2000. Mature female flies were being collected in mid-June; mature eggs in mated females were present in late June.

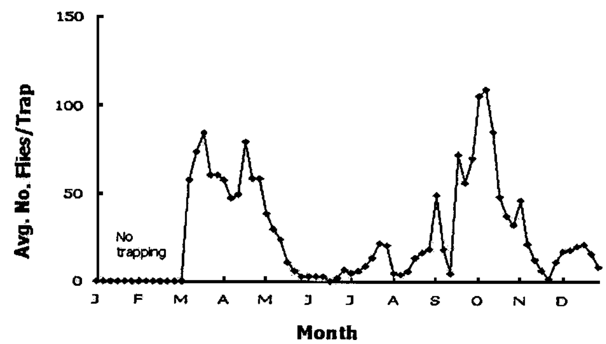

Figure 2. Phenology of the Olive Fly, *Bactrocera oleae*, Mochos, Crete, 1981. Haniotakis et al., 1986.

Additional generations of flies are produced through the late summer and fall months and into December, depending upon fruit maturity and availability on the trees. Olives that are left on trees can produce high numbers of flies from late fall to early spring if these fruits are unharvested, or are allowed to simply mature and drop naturally from the trees before being collected for oil pressing. There will undoubtedly be significant differences in the seasonal phenology and biology of olive fly in California due to the numerous microclimates found within our coastal and interior regions.

Economic Impact

The economic impact and monetary losses due to infestations by olive fly vary considerably and depend primarily on the end use of the fruit. Economic thresholds for *B. olea* in table olives are extremely low. In many countries infestation levels of 1% or less are required for high quality production of table olives. This would certainly be true for California growers. Oviposition stings alone, without eggs or larval feeding, will lower the value of table fruit. Oil cultivars can sustain higher infestations as long as the fruit is harvested within a relatively short period of time (3 to 4 weeks) after the larvae begin feeding in the fruit. A decline in oil quality occurs due to secondary infestations of bacteria and fungi that greatly increase the acidity of the oil. European authors have indicated economic losses of table olive crops as high as 100% from infestations that are not controlled. Oil losses can range as high as 80% from combined fruit drop, pulp destruction, and increased acidity of oil if fruit is not harvested in a timely fashion. A general example of the variation in olive fly impact on table olive and oil production in the Mediterranean area is shown in Table 4, primarily for olive oil cultivars. The potential for extreme economic losses to the California olive industry is great because the majority of our olives are produced for table consumption rather than for oil production.

Table 4. Economic impact of the olive fly, *Bactrocera oleae* (olive production loss).[1/]

Spain	1962	5%
Italy	1962	25%
Greece	1962	30-35%
Israel	1962	20-60%
Cyprus	1962	15-20%
Yugoslavia	1962	20-40%
Libya	1980	27-72% (avg. 50%)
	1981	7-14%
Portugal	1994-96	4-8%, table; 17-19%, oil

[1/]Primarily oil cultivars.

Quarantines and Control

Management of *Bactrocera oleae* in California will depend on a combination of early detection and delimitation trapping, limited interior quarantines, effective bait sprays or attract and kill trapping of adult flies, cultural practices (e.g., timely harvest), and fruit sanitation. As of July 2000 specific details on olive fly management in production areas are still being developed. In general, however, control of olive fly for the immediate future will rely upon protein hydrolysate bait sprays containing spinosad insecticide, and perhaps a mass trapping or attract and kill strategy based on insecticide-treated traps containing both ammonium bicarbonate and pheromone (spiroketal) lures. Restrictions and transporting requirements will also be placed on movement of harvested fruit from infested San Joaquin Valley counties to the processing facilities in northern California where olives are also grown. In addition, there are plans for mass trapping in olive trees within ¼ mile of known infested commercial groves. Olive trees in urban or noncultivated areas near commercial groves will be trapped in an attempt to reduce fly populations and migrations of adult flies back to production groves.

Prognosis for Olive Fly in California

Although there is a tremendous amount of literature from Mediterranean researchers on olive fly biology and control, the ultimate impact of olive fly and management of this pest in California is still undetermined. Although our climate is very similar in many respects to areas of the world that grow olives and are infested with olive fly, we will still need to develop our own specific phenology and biology data for this pest. Hopefully this will lead to development of IPM programs for olives that will allow California growers to continue economical production of high quality table and oil olives while at the same time not disrupting the current very effective IPM programs for other olive pests such as scale insects.

Fall Copper Sprays

Probably the most important spray an olive grower can apply is copper immediately following harvest. Copper applied then and dissolved in subsequent rainfall protects the tree against both the “Peacock Spot" fungus (AKA “Olive Leaf Spot”) and the “Olive Knot” bacterium. Here are some things to know about each disease and copper application.

Peacock Spot: For best effect, copper needs to be applied prior to winter rains - rain disseminates the fungus spores for subsequent new infections of leaves. No difference in control exists between the following copper products: Bordeaux (copper sulfate and lime), COCS, Kocide, Nordox, Micro-cop, and Copper Count N (we did not test all fixed coppers); the important point is to have copper on the trees prior to winter rains, and not as much what copper is selected.

In any one year, one copper treatment prior to winter rains (November) is as effective as two applications (November and January). However, where the double treatment is consistently used year after year, long term disease infection is suppressed.

Olive Knot: Copper, in ionized form, kills the Olive Knot bacterium. Recent research has shown that, in addition to the fall spray, an additional application in mid-March is very important in preventing knot (gall) development. This new strategy is suggested each year. If freezing temperatures occur, sufficient to cause splitting bark, an additional treatment following the freeze event is recommended in the interim.

Black Scale: An excellent time to control black scale is following harvest, as the insect is in an extremely susceptible stage for chemical treatment. In fall, there are also more chemical choices than when fruit are on the tree. Further, the orchard is accessible prior to winter rains.

If populations are heavy at harvest, we suggest a fall application be made. Also, remember that pruning to "thin out" olive trees next spring will maintain excellent control of this pest; black scale suffers substantial mortality in a dry, summer heat. Avoid dense trees.

Remember: Black scale treatments and fall applied copper can, in some cases, be combined after harvest. Check compatibility with your manufacturer first before combining these treatments.

Fall Weed Control

Residual, preemergence herbicides need to be applied to olives in October and November before winter weeds germinate. If applied late, following weed germination and growth, a contact herbicide needs to be included as a "knock-down." The 1999 Herbicide Label Status for Olives is located below.

1999 Herbicide Label Status for Olive

Preemergence		**Postemergence**	
Devrinol	R	Gramoxone	R
Karmex	R	Fusilade	NB
Simazine	R	Poast	NB
Surflan	R		

R = registered; NB = registered in nonbearing orchards and vineyards only.

NOTE, THIS IS INTENDED AS A GENERAL GUIDE ONLY! BEFORE USE OF ANY HERBICIDE CONSULT THE LABEL CAREFULLY. LABELS CHANGE FREQUENTLY AND OFTEN CONTAIN SPECIAL RESTRICTIONS REGARDING SPECIFIC USE OF A COMPANY'S PRODUCT.

G. Steven Sibbett
Farm Advisor
(559) 733-6486