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Preventing Olive Leaf Spot and Olive Knot Disease

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Olive Fruit Fly Update

As you probably have heard, there has been quite a bit of olive fruit fly activity in California this year (Table 1). Note that Table 1 is already out of date because of continuing fly activity, i.e., three flies have been trapped in Tehama County. However, at this writing, the Sacramento Valley is still considered uninfested. This is despite the fact that there have been two fly finds in Yuba County and three in Tehama County (Corning). These finds have been such that they do not constitute an infestation. No mated females have been found or the catches have been far enough apart in time or distance that they are not considered an infestation. While this is good news, it is probably not realistic to expect it to continue with the mounting fly populations in the San Joaquin Valley and coastal areas including Alameda County.

Table 1. SUMMARY - 2000 OLIVE FRUIT FLY FINDS

County	Adults Trapped	Date Last Adult Trapped	Larval Properties
Alameda	20	10/04/00	0
Fresno	79	09/18/00	0
Kern	85	09/29/00	1
Madera	18	09/29/00	0
Monterey	1	09/26/00	0
San Joaquin	1	10/06/00	0
San Luis Obispo	90	08/24/00	0
Santa Clara	8	09/27/00	0
Sutter	2	09/14/00	0
Tehama	2	10/06/00	0
Tulare	183	09/08/00	0
	489		1

Source - CDFA Detection Advisory 10-11-00

Following is some basic information about the olive fruit fly provided by Dick Rice, UC Entomologist.

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 2). 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 2. World distribution of the olive fly, *Bactrocera oleae.*

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

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 logitudinal 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.*

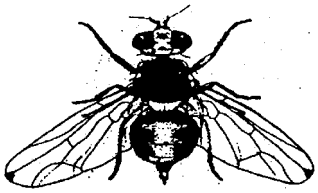

Figure 1. Adult female olive fly, *Bactrocera oleae.*

Hosts of Olive Fruit Fly

Fruits in the plant genus *Olea* are the only known natural hosts for *B. oleae*. Many cultivars of edible olives (*O. europea*) 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 cost 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 savastanoi*, the bacterial casual 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 greather 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, Myoporum 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, *Arbutus*, 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 relationship 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

Table 1 summarizes the results from our 1999-2000 trial. Similar results were obtained in 1998-99. All of the treatments were applied with a hand gun sprayer at approximately 400 gpa. The materials and rates were Kocide DF, 2.5 lbs./100 gal, Bordeaux, 10 lbs. of copper sulfate and 10 lb. hydrated lime in 100 gallons of water, Tribasic copper 3 lbs/100 gal. and Nordox 3 lbs/100 gal. In order to follow disease development throughout the trial, 5 shoots per tree with ten leaf nodes per shoot were defoliated on all trees at approximately monthly intervals from December through May. In June, the knots which developed on the defoliated shoots were counted and the data is reported as % infected leaf scars. Leaves were collected from the trees before and immediately after treatment and in June and analyzed for coper to get an idea of copper residues on the leaves.

In 1998-99 there were no differences in percent infected leaf scars for the two sprays of Kocide, Bordeaux, Nordex or TriBasic applied on the same days. However, in 1999-2000 Bordeaux, Nordox and TriBasic resulted in less infection than Kocide (Table 1).

From this work and my experience, I would make the following

recommendations:

1. Apply at least two copper treatments per year. The first should be applied in the fall before rains begin to prevent Olive Leaf Spot. The second should be applied in March or April to protect developing leaf scars from natural defoliation from olive knot infection.

2. If a freeze results in significant defoliation, apply a treatment immediately.

3. If using Kocide, you may want to use the higher label rate to insure adequate residue for longer term disease control.

4. Don't prune trees susceptible to freeze damage and/or olive knot in the fall and winter. Pruning at this time, in addition to creating wounds which can be infected with olive knot if rains follow within two weeks, opens up tree canopies and makes them more susceptible to freeze injury, which can make more wounds, which can become infected.

Table 1. EFFICACY AND TMIING

Material	Treatment Date					Copper Residue in ppm 30 June	Infected Scars (%) 24 July
	2 Dec	3 Feb	3 Mar	3 Apr	5 May		
Kocide	X					54 AB	10.1 CD
Kocide		X				62 ABC	12.4 BC
Kocide			X			60 AB	7.3 D
Kocide				X		77 BC	8.8 CD
Kocide	X	X				79 BC	4.8 EF
Kocide	X		X			121 CD	6.5 DE
Kocide	X			X		153 DE	4.6 EFG
Kocide	X	X		X		185 E	3.2 FG
Kocide	X		X		X	318 G	1.7 FG
Kocide	X		X			121 CD	6.5 DE
Nordox	X		X			168 DE	2.5 FG
TriBasic	X		X			165 DE	4.1 FG

Bordeaux	X		X			258 F	1.9 G
CONTROL						11 A	19.0 A

Infected leaf scar data are the means for all defoliation dates. Values followed by the same letter are not significantly different.

year. Olive fruit remaining on trees through the winter into early summer and presence of mated female flies contribute to this development.

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

Stage	Lower	Upper
Egg	43°- 46°F	95°- 100°F
Larva	39°- 46°F	95°F
Pupa	41°- 48°F	86°F
Adult	40°F	102°F

The adult activity threshold for olive fly is approximately 15.5° C (60° F). In summer olive flies can complete a generation in as little as 30 to 35 days at optimum temperatues. 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 the 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 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 (2.4 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.

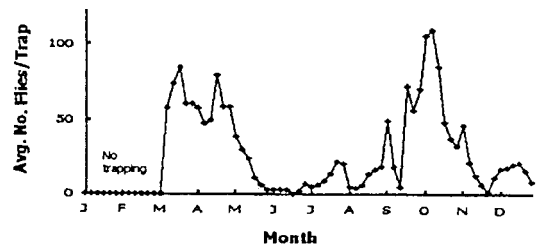

Figure 2. Phenology of the Olive Fly *Bactrocera oleae*, Mochos, Crete, 1981. Haniotakis et al., 1986.

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 season 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 infestation 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 (sdpiroketal) 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 1/4 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.

Preventing Olive Leaf Spot and Olive Knot Disease

Olive Leaf Spot, also known as Peacock Spot, is caused by the fungus *Spilocaea oleaginea*. Wind and rain move spores from holdover lesions to new infection sites. Symptoms, dark green to black spots sometimes surrounded by a yellow halo, defoliation and twig death, develop in the spring. Of the common varieties in the Sacramento Valley, Mission is the most susceptible. Olive leaf spot is controlled by the application of copper fungicide before heavy rains begin in the fall. Research by UC Researchers Beth Teviotdale and Steve Sibbett during the eighties and early nineties showed the following. All of the fungicides tested (Bordeaux, Kocide, Nordox, Microcop and Copper Count N) performed equally. In any one year one copper treatment applied prior to winter rans (Nov.) was as effective as two sprays (Nov. and Jan.). However, where the double spray was used consistently year after year, long term disease infection was suppressed. Treatment differences were still apparent three years after all of the trees were returned to the same treatment indicating the role of consistent control programs in disease suppression.

Olive Knot disease is caused by *Pseudomonas savastonoi* bacteria which are spread about by wind and rain and get into trees through openings such as leaf scars, pruning wounds and frost cracks. The "knots" which are disorganized tissue, which can girdle and kill twigs and branches, develop in the spring. Of the varieties commonly grown here, Manzanillo is the most susceptible. Research that UC Plant Pathologist Beth Teviotdale and I have been conducting the last several years has shown the following. Copper resistance by the bacteria is limited. The majority of infection occurs in the spring, coinciding with the period of natural leaf drop. Efficacy of fall-applied copper treatments declines by March or April. Multiple treatments are more effective than single treatments. In our studies, two sprays were more effective than one and three were more effective than two.