Infestation of Olive Fruit Fly, *Bactrocera oleae*, in California and Taxonomy of its Host Trees

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SUMMARY

The results of the trapping survey were analyzed to determine the taxonomy of various tree species infested by the olive fruit fly (*Bactrocera oleae*) in California. Since its first appearance in California in 1998, the olive fruit fly has spread from Los Angeles to 37 counties, including all of the state's commercial olive growing areas. Olive fruit flies were trapped from 19 tree species belonging to nine genera distributed in seven families of angiosperms. Olives (Family Oleaceae) were the preferred host of the olive fruit fly. Family Rosaceae had nine host tree species followed by Rutaceae (five host tree species). Other host tree species were distributed in Anacardiaceae, Fabaceae (Leguminosae), Lythraceae and Malpigiaceae families. These hosts were mostly fruit trees with the exceptions of Brazilian pepper tree, carob, crape myrtle and ornamental plum. The host list reflects typical hosts and is not comprehensive. It is unknown if different olive cultivars are more attractive to the fly or more susceptible to fly damage. The pest directly attacks olive fruits and can devastate entire harvests. Adults feed on nectar, honeydew and other opportunistic sources of liquid or semi-liquid food. University of California scientists are now developing specific information about the olive fruit fly in California and have synthesized useful findings from Europe, where the pest has long been established.

KEY WORDS

olive fruit fly; host plants; taxonomy; California

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INTRODUCTION

The olive fruit fly (*Bactrocera oleae* (Gmelin1788)) (formerly *Dacus oleae*) is a serious pest of olives in most of the countries around the Mediterranean Sea. The olive fruit fly is found in many olive-producing areas in the world (Economopoulos 2002, Ramos et al. 1982, Van Steenwyk 2002). The larvae are monophagous and feed exclusively on olive fruits. The larvae cause premature fruit drop and yield reduction. Adults feed on nectar, honeydew, and other opportunistic sources of liquid or semi-liquid food. While feeding, they tunnel throughout the fruit, destroying the pulp and allowing entry of secondary infestation of bacteria and fungi that rot the fruit and greatly increase the free fatty acid level (acidity) of the olive oil. Feeding damage by adults may also cause premature dropping of olive fruit. Oviposition stings caused by the female laying eggs inside the fruit lower the value of table fruit. An infestation seriously affects oil volume, alters its color and increases acidity. The larger, earlier-maturing olive varieties, such as those grown in California, are preferred for egg laying.

The damage caused by tunneling of larvae in the fruit results in about 30 % loss of the olive crop in Mediterranean countries, especially in Greece and Italy where large commercial production occurs (Economopoulos et al. 1982, Michelakis 1990). The olive fruit fly is generally a serious pest of cultivated olives throughout its range. It was detected in California in October 1998 in the Los Angeles area and has since spread to the rest of southern California (1999), the Central Valley (2000) and to Marin, Napa, Sonoma, Solano (2001), Shasta, El Dorado and Lake (2002) counties (Rice et al. 2003, Van Steenwyk et al. 2002, Vossen and Varela 2003). Athar and Nasir (2004) described the host range of olive fruit fly in California. In this paper the results of the trapping surveys are analyzed to determine the taxonomy of various tree species infested by olive fruit fly (*B. oleae*) in California. Information developed by federal, state and university scientists about the olive fruit fly in California is also discussed.

MATERIALS AND METHODS

Various traps (Champ, Jackson, McPhail, GWSS traps) were used to capture adult flies from various counties of California (Gill 2001). Traps were baited with a male sex lure (Spiroketal capsule) and a feeding attractant (ammonium bicarbonate). Traps were placed in producing olive trees at the density of one per 16 hectares (40 acres) or one per block when planting is less than 16 hectares (Rice 2000). Traps were placed in large, well-foliated trees that have an abundance of fruit. Dusty trees were avoided when possible. In commercial orchards, traps were placed two to three rows in from the edge of the planting (Rice 2000). Edges of roads within the orchards were also avoided because vehicles may create dusty conditions during trapping season. Traps were also placed on other selected tree species in a similar way to trap the olive fruit fly from these trees. The nomenclature and classification of the host trees was described following Bailey and Bailey (1976). Common names of trees were checked from Sunset Western Garden Book (Brenzel 2001).

RESULTS AND DISCUSSION

Infestation of the olive fruit fly was observed on 19 tree species in California (Table 1). These trees belonged to nine genera distributed in seven families of angiosperms. Olives (Family Oleaceae) were the preferred host of the olive fruit fly. Family Rosaceae had nine tree species followed by Rutaceae (five tree species) as host of olive fruit fly. Other host tree species were distributed in Anacardiaceae, Fabaceae (Leguminosae), Lythraceae and Malpigiaceae families (Table 1). Mostly these hosts comprised of the fruit trees with the exception of Brazilian pepper tree, carob, crape myrtle and ornamental plum (Athar and Nasir 2004, Gill 2001). The host list reflects typical hosts and is not comprehensive. It is unknown if different olive cultivars are more attractive to the fly or more susceptible to fly damage. Olives are the only breeding host plants. The larger table olive varieties are preferred for oviposition by the female. However, smaller oil olive cultivars are excellent hosts. Flies have been trapped in other plants or crop orchards where the adults search for food or refuge (Eskafi 1987, Rice 2000, Vossen and Verala 2003). In addition to cultivated olives, the olive fruit fly is also known to attack several species of wild olives (Rice 2000). 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, the olive fruit fly has very specific and restrictive nutritional requirements. It has been shown that *Pseudomonas savastanoi*, the bacterial causal agent of olive knot disease, is a symbiont required in the gut of olive fruit fly larvae and adults (Rice 2000). The bacteria help flies break down chemicals in olive fruit into essential amino acids and proteins required for growth and reproduction.

Although *Olea europaea* or other species of olives are the only natural breeding host for the olive fruit fly, flies have been trapped in other plants where they search for food or for protection and refuge. Results of quantitative fly collection in various traps are not reported here and will be provided elsewhere. In additions to olives, adult fly collection hosts

Table 1. Information about host trees of olive fruit fly in California

Tree Species	Family	Common Name	Tree Habit
Ceratonia siliqua L.	Fabaceae (Leguminosae)	Carob	Tall tree to 17 m
Citrus aurantium L.	Rutaceae	Citrus	Spiny tree to 7-10 m
Citrus limon (L.) Burm.	Rutaceae	Lemon	Spiny tree to 6-9 m
Citrus x paradisi Macfady	Rutaceae	Grapefruit	Tree to 10-17 m
Citrus reticulata Blanco.	Rutaceae	Tangerine	Small spiny tree
Citrus sinensis (L.) Osbeck.	Rutaceae	Orange	Compact tree to 14 m
Ficus carica L.	Malpighiaceae	Fig	Broad irregular deciduous tree to 10 m
Lagerstroemia indica L.	Lythraceae	Crape myrtle	Deciduous shrub or tree to 7 m or more
Malus sylvestris Mill.	Rosaceae	Apple	Small tree with dense round crown or shrub to 2-14 m
Malus prunifolia (Willd.). Borkh.	Rosaceae	Crabapple	Shrub or small tree
Olea europaea L.	Oleaceae	Olive	Tree to 8 m or more
Prunus armeniaca L.	Rosaceae	Apricot	Small round-crowned tree
Prunus avium (L.) L.	Rosaceae	Cherry	Large deciduous tree to 10 m or more
Prunus domestica L.	Rosaceae	Plum	Coarse shrub or tree
Prunus persica (L.) Batsch.	Rosaceae	Peach	Small glabrous tree
Prunus salicina Lindl.	Rosaceae	Ornamental plum	Small tree to 8 m
Pyrus communis L.	Rosaceae	Pear	Broad-crown tree
Pyrus pyrifolia (Burm. f.) Nakai	Rosaceae	Asian pear	Tall tree to 8-10 m and about half as wide
Schinus terebinthifolius Raddi	Anacardiaceae	Brazilian pepper tree	Shrub or tree to 7 m tall and wide

have been reported to include orange, grapefruit, tangerine, calamondin, cherry, plum, lemon, avocado, loquat, nectarine, *Myoporum* and Surinam cherry (Rice 2000). Flies trapped in these nonbreeding hosts are often caught in the yellow Champ traps that are normally placed specifically in olive trees. Trapping and migration studies from Crete list additional nonbreeding hosts such as walnut, apple, sycamore, chestnut, vine, fig, *Arbustus* and persimmon. Tomato and *Ligustrum* (privet) are reported as laboratory hosts supporting olive fly larval development (Rice 2000).

Management tools are desperately needed for the olive fruit fly in California because few chemical tools are currently registered in this crop and their efficacy for olive fruit fly control appears to be very limited. Studies began in 2002 to fully evaluate chemical controls for this pest and to determine which insecticides would be the least disruptive to other pests of olives (*e.g.*, black scale). A section 18 registration for GF-120™ insecticide (a spinosad bait spray) was initially granted in 1999 and other reduced risk controls are currently being evaluated by the US-EPA. Mass trapping is the only option available at this time for organic growers in the state and this technique is extremely labor intensive and only marginally effective. The potential role of natural and biological controls is unknown at this time (Haniotakis et al. 1987, Konstantopoulos et al. 1999). The low infestation threshold (<1%) required by processors, retailers and consumers will require highly efficacious pest control techniques and products. The cost of using any control measure will be critical as California growers are currently experiencing intense pressure in the marketplace from imports and low profit margins (Rice 2000, Rice et al. 2003).

The development of any effective control technique will rely heavily on a thorough knowledge of both the pest biology and that of its host (Gaouar and Debouzie 1995, Haniotakis et al. 1987). Due to the recent establishment of this pest, we currently have limited data on the seasonal distribution and abundance of the olive fruit fly in California. It is unknown if different olive cultivars are more attractive to the fly or more susceptible to fly damage. It is also unknown if the fly will establish better in specific climatic zones. The use of biological models to link insect and plant developmental data has been effectively used as a tool to address these questions in other crops (Vargas et al. 2002). In particular, the use of "degree day" models is a method of tracking the development of an insect species throughout a season using accumulated units.

Olives are grown commercially in California for the fruit on a limited scale and are grown also as ornamentals (Rice 2000, Rice et al. 2003). In Florida, olive trees are slow-growing evergreens that may be grown as ornamentals, but have no commercial application in relation to the fruit. Use of olive trees as ornamentals is increasing in Florida, and fruit from these trees probably could support olive fruit fly development. Thus, state and federal regulatory agencies should continue to maintain vigilance against introduction of the olive fruit fly. Larvae and pupae are intercepted frequently in olives from the

Mediterranean region, and occasionally adults have been taken along with larvae and pupae.

Since its first appearance in California in 1998, the olive fruit fly has spread from Los Angeles to 37 counties, including all of the state's commercial olive growing areas (Rice et al. 2003). The pest directly attacks olive fruit and can devastate entire harvests. In California, management depends on bait sprays, trapping of adult flies, harvest timing, fruit sanitation after harvest, and biological control (Van Steenwky et al. 2003). University of California scientists are now developing specific information about the olive fruit fly in California, and have synthesized useful findings from Europe, where the pest has long been established.

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