A Pest Management Strategic Plan for Olive Production in California

The California Olive Committee (COC)

The California Minor Crops Council (CMCC)

The California Minor Crops Council received major funding for this project from the EPA Region 9 Agricultural Initiative and the USDA Cooperative States Research, Education, and Extension Service (CSREES) Pest Management Alternatives Program (PMAP). CMCC received additional support from the California Olive Committee and the California Pest Management Center at UC Davis. We gratefully acknowledge the contributions of all of these organizations and their participation in this process.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The new safety standards set forth by the 1996 Food Quality Protection Act (FQPA) will impact many crop protection tools used by the agricultural community. To facilitate a transition to "Reduced Risk" pest management, the USDA has requested that all commodities develop Pest Management Strategic Plans (PMSPs) to identify the critical research, registration, and educational needs of the growers. The term "Reduced Risk" broadly describes pest management techniques and tools that have low inherent toxicities and minimal impact on the environment. In other words, pest management practices and products should be safe for both consumers and field workers, and crop protection activities should have little or no negative impact on air, soil, or water quality.

California olive production has a history of very little pesticide use; biological and cultural controls have been effectively used in an integrated pest management (IPM) system for several decades. The *Crop Profile for California Olives* (http://pestdata.ncsu.edu/cropprofiles/docs/Caolives.html) and the *Olive Production Manual* (UC Publication 3353, http://anrcatalog.ucdavis.edu/merchant) provide useful references for a comprehensive review of olive pests and management techniques.

The discovery in California of the olive fruit fly (*Bactrocera oleae)* in 1998 has presented a serious challenge for California olive production. This event marked the beginning of a new era of pest management for our growers and this insect is now considered the most important insect threat to the industry worldwide. The fact that olive trees also are widely grown in the urban landscape complicates the development of a statewide integrated pest management system for this pest, as these trees serve as a reservoir for continual fly invasion.

The following pest management strategic plan includes an overview of olive production, seasonal pest occurrences, and management techniques for insect, disease, weed, and vertebrate pests throughout California for both table and oil cultivars; current and emerging pest management needs are addressed in the document. Cultural practices and efficacy ratings of various pest control techniques (chemical and non-chemical) used in olive production have been summarized from input made by growers, pest control advisors, and other experts involved in field and processing activities from all production areas of the state.

This strategic plan will receive periodic updates and will serve principally as a pest management resource for those seeking information about the production of olives in California. A comprehensive list of individual growers, pest control advisors, industry representatives, and university research and extension personnel is located in the back of this document; this reference will be helpful for those seeking more detailed information on olive production and pest management in California.

Stakeholder Recommendations

As a result of the Pest Management Strategic Planning meeting held in January 2003, the Olive Work Group identified the following research, regulatory, and educational priorities. These critical areas must be addressed to maintain the economic viability of the olive industry in California.

Research Priorities

Developing pest management techniques that control the olive fruit fly in both table and oil cultivars is critical. This will be accomplished primarily through basic research on the biology and distribution of this pest in California. Monitoring techniques, economic thresholds, and phenological models to relate tree biology to fly infestations and damage are all key areas of research which need to be addressed. Biological and chemical controls for this pest should be evaluated and developed as rapidly as possible, followed by timely registration of effective insecticides. Other pest management tools needed by olive growers are organophosphate alternatives, carbamate alternatives, and pre-emergence herbicides.

- Study olive fruit fly biology and develop effective pest management techniques
- Determine the relationship between olive tree phenology and olive fruit fly biology and management
- Evaluate currently registered insecticides for olive fruit fly efficacy
- Evaluate activity of neonicotinoid insecticides against olive fruit fly and scales
- Develop reliable monitoring techniques and economic thresholds for the olive fruit fly
- Evaluate effectiveness of mass olive fruit fly trapping techniques in oil production regions
- Develop methods to properly handle olive fruit fly infested fruit
- Evaluate the impact of glassy-winged sharpshooters and *Xyllela* on olives
- Evaluate alternatives to organophosphate and carbamate insecticides for control of scale insects and glassy-winged sharpshooter
- Evaluate pre-emergence herbicides for weed control (especially flax leaf fleabane)
- Determine optimal timing for copper applications to minimize residues in oil crops

Regulatory Priorities

Effective olive fruit fly materials and trapping devices should be registered as soon as possible to provide management tools for both conventional and organic olive growers. Growers need reduced risk alternatives to organophosphate and carbamate insecticides for control of scale insects and glassy-winged sharpshooters. New pre-emergence herbicides are needed and label language should be altered to allow for less restrictive use of the contact herbicide Goal®.

- Obtain a full registration for spinosad GF-120 Naturalyte® and an attract-and-kill device
- Obtain an organic approval for spinosad GF-120 Naturalyte® and an attract-and-kill device
- Expedite the registration of additional insecticides for olive fruit fly control
- Establish abatement districts to manage ornamental sources of olive fruit flies
- Register alternatives for organophosphate and carbamate insecticides used for control of scale and glassy-winged sharpshooter
- Expedite registrations for new pre-emergence herbicides and for materials which control flax leaf fleabane
- Remove timing restrictions on Goal® herbicide use

Educational Priorities

The public, including regulators and consumer groups, must be educated about the use of Integrated Pest Management (IPM) in California olive production, and how this system optimizes food production while minimizing risks to workers and the environment. A statewide effort is critically needed to educate the public about the potential impact of the olive fruit fly on the local community (growers, workers, processors, etc.); this program should focus not only on growers and PCAs, but also on outreach to homeowners who use olive trees as a part of the urban landscape. Growers, PCAs, and applicators need timely updates on pest biologies and the proper selection, application, and timing of pesticides for all olive pests. Growers need information on the proper handling of olive fruit fly infested fruit so that their fruit may be acceptable to processors. The general public and the regulatory community need to be educated about unfavorable trade positions which arise from policies and practices related to labor availability and the importation of olive products. Finally, all consumers should be reminded that eating California olives is an important part of a healthy lifestyle and that this product is grown under the highest standards of safety and quality in the world.

- Educate the urban public on the olive fruit fly issue and the significant impact this pest can have on the local economy and well-being of the community; develop outreach and educational materials targeted at homeowners, gardeners, and landscapers
- Educate growers, PCAs, and applicators on proper use of pesticides, application methods, and timing
- Continue education on olive fruit fly biology and management of all olive pests
- Educate growers on the proper handling of olive fruit fly infested fruit
- Inform the public and the regulatory community on labor issues (e.g., labor and imports) which present significant and unfair trade disadvantages for producers of California olive products

The California olive industry appreciates the support of EPA, USDA, CDPR, and the University of California Land Grant system in the development of this pest management strategic plan. We look forward to the valuable assistance provided by these agencies and institutions as we develop solutions for the many issues facing our growers.

Major funding for this project was accomplished through grants to the California Minor Crops Council from the EPA Region 9 Agricultural Initiative and the USDA Cooperative States Research, Education, and Extension Service (CSREES) Pest Management Alternatives Program (PMAP). Additional support was provided through the California Pest Management Center at UC Davis. We are extremely grateful for the contributions of all of these organizations and their participation in this process.

The California Olive Committee (COC)

The California Minor Crops Council (CMCC)

August, 2003

A PEST MANAGEMENT STRATEGIC PLAN FOR CALIFORNIA OLIVES

1. CALIFORNIA OLIVE PRODUCTION OVERVIEW: TABLE AND OIL CULTIVARS

Olives are grown throughout the world. The European Union produces over 70% of the world's olive oil. Main production areas are in Spain (28%), Italy (24%), Greece (16%) and Portugal (2%). About 50% of the world's supply of olives comes from Spain and Italy, with another 30% from Greece and Tunisia. The United States produces about 11% of the world's olives, and about 0.1% of the olive oil.

In the United States, California produces virtually the entire U.S. commercial olive crop.

The following information provides a summary of the California olive industry in terms of size, scope, and key pest management issues:

- Over 99% of the olives grown in the United States are grown in California
- There are approximately 36,000 acres of olives in California
- Both table and oil cultivars are produced in California, but table olives (whole, processed fruits sold in cans) are the predominant product
- The major markets for table olives are the food service industry (for use in pizzas and salad bars) and retail grocery sales
- There are two major table olive production areas in California: the Central San Joaquin Valley and the Sacramento Valley. Oil cultivars are produced throughout the state, including in coastal areas
- Competition from foreign markets is extremely fierce; countries which export olive products to the U.S. include Spain, Morocco, Italy, and Greece
- California olives have had relatively few agricultural pests in the past compared to other orchard crops and, historically speaking, have had little pesticide use
- The olive fruit fly, *Bactrocera oleae*, discovered in 1998 in California, is the most serious pest of olives in the world; this pest has the potential to completely destroy the processing olive industry in California
- An intensive monitoring and research effort has been established to determine the distribution and abundance of the olive fruit fly throughout the state and to develop effective management techniques

The two main olive production areas for table varieties in California are shown below in Figure 1. Cultivars grown for oil are dispersed throughout the state in both inland and coastal areas. Seasonal calendars for cultural activities and IPM activities in olives are provided in Appendix 2.

The majority of olive acreage in California (65%) is located in the San Joaquin Valley, primarily in Tulare County (53% of the total). The other main production area is the Sacramento Valley, primarily Glenn and Tehama counties. There is small but developing acreage in the coastal areas of California to produce exclusively gourmet olives and oil. The following table helps to characterize the olive industry in California:

Number of olive growers	>1,200
Average holdings of CA growers	67% of growers have < 20 acres; 5% have >500 acres
Total CA acreage in olives	~36,000 in 2000
Value of California olive crop	~ $75 million
California Olive Usage	90-95% table olives; 5-10% oil

Figure 1. Primary Olive Production Regions in California

The California Olive Industry

Two principal growing regions, the Sacramento Valley and the Southern San Joaquin Valley (SJV), represented on the map by solid lines, accounted for most of the $75,000,000 produced from olives harvested in 2001. Several other counties, mainly Marin and north coastal areas, produced additional smaller oil olive harvests. The four SJV counties of Madera, Fresno, Tulare, and Kern accounted for 70% of the total harvest value.

California's San Joaquin Valley

The San Joaquin Valley (SJV) is part of the larger Central Valley (represented by the dotted line). The SJV covers two-thirds of the Central Valley's 450-mile length and 50-mile width. This particular region produces over 250 different crops worth more than $14 billion annually; nearly six million people live in this area.

The olive tree is a long-lived evergreen and is very well-adapted to the Mediterranean type climate of California. Irrigation management is especially critical for tree uniformity and high yields in the warmer, dryer San Joaquin Valley. Most olive orchards use surface irrigation to meet the water demands of the crop (basin, furrow, and border strip methods), but sprinkler and low volume and drip systems are becoming more widely used. The crop is harvested primarily by hand, but mechanical harvest (currently under development) would greatly assist the California olive industry in remaining competitive in world markets.

Differences in Production of Table Versus Oil Cultivars in California

	Table Cultivars	Oil Cultivars
Relative size of industry	~32,000 acres	~4,000 acres
Areas of production	San Joaquin and Sacramento Valleys	Statewide, including coastal areas
Harvest period	September – November	September – January

Olive oil is obtained by crushing the flesh of the fresh fruit; no oil is pressed out of seeds alone. In some cases, culls from the table olive industry are pressed for oil. Culls may be either brine or fresh-pressed into oil.

Olive Varieties in California

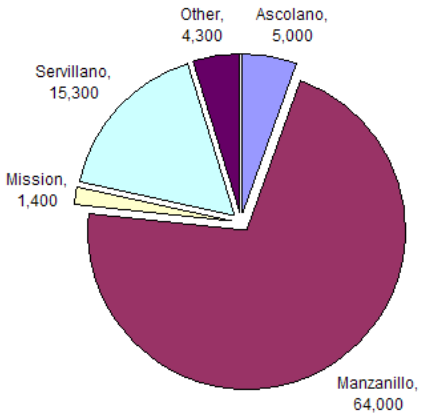

Figure 2. 2002 California Olive Crop Estimated Tonnage by Variety

The table olive industry includes four commercially grown olive (*Olea europea* L.) cultivars: Manzanillo (the most common – about 70%), Sevillano (about 17%), Ascolano, and Mission, which account for over 96% of the total olive acreage in the State (see Figure 2 above). In the southern districts, Manzanillo is by far the dominant variety. In Northern California, Manzanillo, Sevillano, Ascolano, and Mission are commonly grown. About 95 % of the total production will be used for black-ripe or green-ripe canning. The remaining 5 % will be used for olive oil and other specialty products.

Stages and Approximate Length of Time for California Olive Development*

Flower Development thru Bloom	Pollination	Fruit Development	Pit Hardening	Harvest	Post-Harvest	Storage
2-4 mo.	2-4 wks.	3-7 mo.	3-4 wks.	2-5 mo.	1-2 mo.	1-12 mo.

* Extremely variable according to variety, location, and season

Harvest Timing in Olive Growing Areas

San Joaquin Valley	Sacramento Valley	Marin County	North Coast
Sep. – Nov.	Sep. – Nov.	Nov.	Nov. – Dec.

Important Pests in the Major Olive Production Areas of California

Several insect, disease, nematode, and weed pests attack California-grown olives, although relatively speaking, until 1998, olives have experienced significantly fewer pest problems than most orchard trees. This is reflected in the number of pesticides registered in olives and the actual amount of material applied each year (see Appendix 8). However, in 1998 the olive fruit fly, *Bactrocera oleae,* was discovered in California and this one pest has the potential of destroying the entire industry in the state. It is considered to be the most important insect pest of olives worldwide. This pest is extremely damaging in the larval stage to olives, and entire truckloads of olives destined for the processing plant can be rejected at very low levels of infestation. Growers can potentially lose entire crops if they do not meet strict inspection requirements.

Other important pests of olives include black scale, armoured scales (olive scale), oleander scale, and California red scale. Glassy-winged sharpshooters (GWSS) can be found in olives, but the impact of feeding, or the importance of this species in *Xylella* transmission, is not well understood. V*erticillium* wilt fungus is a serious fungal disease for which there is no effective treatment other than avoiding planting on infested soils and removing damaged trees and branches. Olive leaf spot and olive knot bacteria may be spread by pruning with infected tools or by rain. Severity of damage is dependent upon year, culture, and region.

Additional minor pest problems (e.g. *Phytophthora* disease or bud mites) occur on a very sporadic and site specific basis.

The pests that cause the most significant losses to California olive growers are listed below:

Pests	S. San Joaquin Valley	Sacramento Valley	Marin and N. Coast
Insects	Olive fruit fly Olive scale Black scale California red scale	Olive fruit fly Olive scale Black scale Oleander scale Western flower thrips Branch & twig borer American plum borer	Olive fruit fly Black scale Black vine weevil Western flower thrips Branch & twig borer
Diseases	Olive leaf spot Olive knot *Verticillium* wilt *Phytophthora* root & crown rots	Olive leaf spot Olive knot *Verticillium* wilt *Phytophthora* root & crown rots *Armillaria* root rot	Olive leaf spot, *Verticillium* wilt *Phytophthora* root & crown rots
Weeds	Grasses & broadleaves, especially flaxleaf fleabane	Grasses & broadleaves, especially flaxleaf fleabane	Grasses & broadleaves, especially flaxleaf fleabane
Rodents & Vertebrates	Ground squirrels Gophers Meadow mice	Ground squirrels Gophers	Meadow mice Gophers

2. PEST MANAGEMENT FOR OLIVE ORCHARDS

INTRODUCTION

This document is an analysis of pests, regional and seasonal occurrences, agronomic practices, and pest management tools used during the various stages of olive production in California. The major sections will be divided by season, and within those by major category of pests (i.e., Insects, Weeds, Diseases and Vertebrates as applicable); each pest subsection will end with specific Work Group Recommendations for that pest category. In some cases, certain sections will be divided by area, season, or cultivar to describe differences. Calendars of seasonal pest occurrence, pest management field activities, and cultural practices for the major olive production areas in California are provided in the Appendices.

The critical issues of the olive industry will be summarized at the end of this report. In order to address these work group recommendations and pest management issues in the most systematic manner, these topics will be categorized by research, regulatory, and educational needs as identified by the industry.

Of particular note in the development of a pest management strategic plan for olives is the relatively recent discovery of the olive fruit fly, *Bactrocera oleae*, in California in 1998. This species is the most serious pest of olives in the world; it has devastated olives in the major olive growing countries around the Mediterranean. In areas of the world where olive fruit fly is endemic and uncontrolled, its damage has been responsible for up to 100% loss of the table olive crop and 80% of the oil crop.

Olive fruit flies have been found throughout most of California and state officials have concluded that it is impossible to eradicate this pest. As a result, commercial growers face a continual threat of re-infestation from the unknown number of ornamental olive trees in the state. If olive fruit fly populations are not effectively suppressed, the entire olive industry in California could be lost to this one insect pest alone. It is therefore critical to learn as much as possible about this pest, since management efforts will impact any previously established integrated pest management programs.

Economic thresholds for the olive fruit fly are very low in table olives, as processors demand infestation levels of 1% or less. Olives intended for oil production can tolerate slightly higher infestation levels (5 -10%), but the increased acidity associated with the presence of larvae will eventually result in rejection for this use. Growers face the possibility of being unable to deliver their entire crop for processing. In cultivars produced for oil, significant reductions in oil quality result from the increased acidity brought about by the presence of larvae in the fruit. Therefore, this pest concerns both the table and oil industries. Management of olive fruit flies is essential because of the low threshold for damage.

Since this is a new pest in California, very little information on effective chemical controls is available. Very few materials are registered for use in olives compared to other orchard crops; a well-researched arsenal of control tools is not available, and the impact of new materials on natural enemies in olives is unknown. Biological controls for the fruit fly are not currently available.

Orchard sanitation may be a fairly effective cultural practice to reduce over-wintering populations of olive fruit fly in agricultural plantings of olives. Mass trapping to reduce populations is under evaluation. Biological controls are currently being researched; however, nothing is currently available. Note that there have been releases and recoveries of one parasite, but it is expected to have only limited impact on pest populations.

Clearly, the management of the olive fruit fly will require not just an area-wide approach to pest management, but a statewide effort on the part of the research, UC Cooperative Extension, grower, regulatory, and PCA community to learn more about the biology and management of this pest in both table and oil cultivars. CDFA and the county Agricultural Commissioners have been very helpful in this effort. All integrated pest management systems currently in place will be influenced by the need to manage the olive fruit fly.

WINTER
(Harvest through February)

Cultural Activities

• Cultivation • Pre-emergence herbicide applications • Mowing • Grazing	• Pruning – (Coastal regions) • Gopher control • Herbicide applications • Insecticide applications • Copper applications	• Harvesting oil varieties • Fertilizing • Irrigation • Monitoring • Clean up

INSECTS

Orchard sanitation might be fairly effective in reducing over-wintering populations of olive fruit fly in agricultural plantings of olives. Biological controls are currently being researched; no commercially available parasite or predator species are currently available.

Because the olive fruit fly is such a new pest, there are few materials for which efficacy information is available. At the present time spinosad GF-120 bait is available and provides fair to good levels of control. Under heavy pest pressure, spinosad requires the maximum number of applications and rates; this is obviously a concern in terms of resistance management, not to mention cost. Spinosad may not provide adequate control for canning olives in high pest populations.

On April 21, 2003, the Department of Pesticide Regulation reissued the Section 18 for GF-120 (spinosad) bait spray to remove the restriction on the number of applications allowed in a year. The exemption is valid until Dec 5, 2005. Presently, GF-120 Naturalyte® fruit fly bait (spinosad) is registered and provides fair to good control of olive fruit flies, but requires the maximum number of applications and rates; the overuse of this new product may lead to the development of resistance. Under heavy fly pressure, this product may not provide adequate control for canning olives in high populations. Attract-and-kill traps (which use lambda cyhalothrin) have been shown to be effective in Europe, and need to be evaluated here. Note that the California Department of Pesticide Regulation (DPR) revised the Section 18 expiration date for the AgriSense/Certis Attract & Kill Device for Olive Fly. The expiration date occured February 28, 2003.

Of the scale pests (including black, olive, oleander, California red, greedy, and lantania scales), black scale is the major scale pest of olives, but other scale species are also damaging on occasion. Black scales damage olive trees by direct feeding and by secreting honeydew which inhibits photosynthesis. Several species of natural enemies have been introduced for control of scale insects. Supracide® provides very good control of scales, but is an expensive insecticide. Sevin® and Sevin® plus oil provide fair to good control of scales. Dormant oils are not currently used because they cannot be used with copper, which is needed for disease management, and there are concerns about increased frost susceptibility when oil is applied.

Branch and twig borer, occasional pests, are most common near plantings of grapes and oaks. Adults lay eggs and larvae bore into the heartwood of the trees. Infestation in olive groves is minimized by burning all infested wood around orchards to destroy developing larvae. There are no known biological or chemical controls for these pests.

Glassy-winged sharpshooter, although not known to cause economic damage through feeding on olive trees, generates significant concern that it may cause damage to olive trees by spreading disease, particularly *Xylella*. Currently, no control measures are used to treat sharpshooters in olives.

Work Group Recommendations for Insect Management in Winter

Research	• Evaluate the relationship between *Xyllela* disease incidence and glassy-winged sharpshooter feeding • Develop effective orchard floor management tactics for olive fruit fly management • Develop biological control for olive fruit fly • Continue evaluation of attract-and-kill traps for olive fruit fly • Determine the over-wintering biology of the olive fruit fly throughout the state • Evaluate the role of sanitation in the trees as an olive fruit fly management tool (e.g., removal and disposal of infested fruit) • Determine what the ornamental urban contribution is to olive fruit fly populations in agricultural areas • Evaluate new trap types (e.g., bottle trap) for control of olive fruit fly • Evaluate chemical control measures for olive fruit fly control • Evaluate the residual control of spinosad for olive fruit fly
Regulatory	• Create abatement districts throughout the state for area-wide pest management and eradication efforts • Continue state-wide monitoring program and cooperation with researchers • Maintain Supracide® and Sevin® registrations for control of scales and other insect pests
Education	• Provide training on the value of orchard sanitation for pest management • Bring growers, applicators, and PCAs up to date on the proper use of spinosad • Educate PCAs on monitoring and treatment of olive fruit fly • Provide timely updates for growers on current status of pest problems in orchards • Recommend planting of non-fruit-bearing olive trees in urban areas • Educate homeowners about olive fruit flies and the relationship between trees in the urban landscape and the potential impact on commercial plantings • Provide information on plant growth regulators (PGRs) for homeowners to use to prevent fruit set (to remove refugia for olive fruit flies)

WEEDS

Cultural weed management in olives during the winter includes mowing, disking, and grazing, all of which provide good control of most winter weeds. Several herbicides are available; however, many of these have limitations due to environmental concerns. Simazine® provides excellent broad spectrum residual control of weeds; however, there are ground water concerns with this material. Diuron® also works well; however, this product has ground and surface water issues associated with it. Roundup® and Goal® are good contact herbicides; however, there is resistance developing to Roundup® and it is expensive to use. Goal® can be used only in winter due to label restrictions. A weed efficacy chart is provided in the Appendix; most weeds are effectively controlled with the available products with the exception of flaxleaf fleabane, which is extremely difficult to control.

Work Group Recommendations for Weed Management in Winter

Research	• Develop non-chemical weed control methods • Evaluate new and established chemistries to expand herbicide availability for olives, especially for flaxleaf fleabane
Regulatory	• Register alternative pre-emergence herbicides (through IR-4) • Remove label restriction on Goal® to allow use year-round
Education	• Educate registrants on the need for new herbicides in olives

DISEASES

Olive leaf spot, a fungal disease also called peacock spot, occurs in all olive growing regions of the state. Infected trees may take years to develop disease levels of concern. Lesions on leaves cause leaf drop that weakens and kills small wood, reducing the tree's productivity. No effective biological or cultural controls are available; copper provides good chemical control, but concern exists about residues on fruit which is used in production of olive oil.

Olive knot is caused by a bacterium and affects olives throughout California. It does not kill trees, but weakens them and reduces their productivity. Bordeaux mix and copper provides good preventative chemical control of olive knot, but with the same concern mentioned above.

Verticillium wilt is a very serious disease of olives that kills many young trees every year. No treatments are made during the winter; however, tree removal and fumigation is done during the winter months to manage soil-borne populations.

Phytophthora rot, crown rot, and *Armillaria* root rot are managed mainly through proper drainage in orchards.

Work Group Recommendations for Disease Management in Winter

Research	• Evaluate alternate fumigants for replant situations • Evaluate alternate chemical/non-chemical controls for disease management (especially *Verticillium* and olive knot) • Determine proper timing of copper and how residues on fruit can be reduced or eliminated (especially for oil cultivars)
Regulatory	• Expedite registration of new fumigants for control of soil-borne diseases
Education	• Educate growers on proper timing of copper applications

VERTEBRATE PESTS

Gophers, squirrels, deer, and coyotes can damage trees and interfere with orchard management in the winter months. No one technique works consistently. Gophers can be controlled using gopher blasters and traps. Poison baits are also very effective and use aluminum phosphide or anticoagulants. Strychnine is very effective; however, this material is increasingly difficult to obtain, and can be used only underground for gophers. Squirrels are controlled with anticoagulant baits, and deer can be kept out of orchards using fencing.

Work Group Recommendations for Vertebrate Pest Management in Winter

Research	• Evaluate new control measures for squirrels

SPRING
(March through May)

Cultural Activities

• Annual weed control	• Thinning – chemical
• Pruning	• Shred prunings
• Frost protection	• Grazing
• Herbicide applications	• Pest monitoring
• Irrigation	• Supplemental pollen with blowers
• Mowing and disking	• Vertebrate pest control activities
• Fertilizing	

INSECTS

Olive fruit fly populations are being constantly monitored during spring to learn more about the distribution and abundance of this species throughout the state. Chemical controls include use of spinosad GF-120 bait and use of attract-and-kill devices (for which the Section 18 permit expired February 28, 2003). No biological controls are commercially available. Mass trapping, a technique to reduce populations, is being used under evaluation. Mass trapping involves using increased numbers of yellow sticky traps per acre as compared to fewer traps used to monitor populations.

Pruning during the spring months is a good management tool for branch and twig borer.

Work Group Recommendations for Insect Management in Spring

Research	• Determine level of *Xylella* disease transmitted by glassy-winged sharpshooters • Evaluate neonicotinoid alternatives for control of olive fruit fly • Continue statewide monitoring programs to learn more about the population biology of olive fruit fly • Determine when olive fruit is most susceptible to olive fruit flies
Regulatory	• Register imidacloprid (IR-4)
Education	• Provide training to growers, PCAs, and applicators on proper application of spinosad (GF-120 Naturalyte® fruit fly bait) sprays

WEEDS

During spring, contact herbicides are applied and several cultural techniques are used for weed management. Mowing, grazing, and cultivation are all used to effectively control weeds.

Work Group Recommendations for Weed Management in Spring

Research	• Develop non-chemical weed control methods • Evaluate new and established chemistry to expand herbicide availability for olives
Regulatory	• Register alternative pre-emergence herbicides (through IR-4) • Remove label restriction on Goal® to allow use year-round

DISEASES

Olive leaf spot and olive knot severity are dependent on year, culture, and region. Copper is used for olive leaf spot in northern coastal production areas and in the northern San Joaquin Valley as needed. *Armillaria*, *Phytophthora,* and crown rot are all managed by removing dead trees in the spring.

Work Group Recommendations for Disease Management in Spring

Research	• Evaluate new alternate fumigants for replant situations • Evaluate alternate chemical/non chemical controls for disease management • Determine proper timing of copper applications and how residues on fruit can be reduced or eliminated (especially for oil cultivars)
Regulatory	• Expedite registration of alternative fumigants
Education	• Educate growers on proper timing of copper applications

VERTEBRATE PESTS

Vertebrate pests are the same as mentioned earlier; however, management is more critical at this time as pest pressure is significantly greater in the spring. Gophers can be controlled using gopher blasters and traps. Poison baits are also very effective and use aluminum phosphide or anticoagulants. Strychnine is very effective; however, this material is difficult to obtain, and can be used only underground for gophers. Squirrels are controlled with anticoagulant baits and deer can be excluded from orchards by using fencing.

Work Group Recommendations for Vertebrate Pest Management in Spring

Research	• Evaluate new control measures for squirrels.

SUMMER
(June to mid-September)

Cultural Activities

• Irrigation • Petiole analysis • Fertilizer application • Chemical thinning – north or south with late bloom • Cultivation	• Herbicide applications • Insecticide applications – spinosad, scale control in August • Pruning and brush disposal • Mowing • Pest monitoring

INSECTS

Spinosad (GF-120 Naturalyte® fruit fly bait) spray is currently being used with good to moderate success for control of olive fruit fly. Attract-and-kill traps placed right after harvest (when registered) may be efficacious for control of adult flies for four to six months. Control of olive fruit fly in urban settings is important to prevent re-invasion of commercial orchards.

Black scale control is achieved by pruning during summer to open up canopies and to expose scale to natural enemies. Sevin® plus oil provides good control of scale, but pre-harvest intervals (PHIs) may be limiting; oil alone is not as effective as it is when used with Sevin®; therefore, good coverage and timing is critical, especially in organic orchards.

Mass trapping, a technique to reduce populations, is also being used and remains under evaluation. Mass trapping involves using increased numbers of yellow sticky traps per acre as compared to fewer traps used to monitor populations.

Work Group Recommendations for Insect Management in Summer

Research	• Evaluate alternatives to Sevin® (carbaryl), possibly neonicotinoids • Evaluate efficacy of Surround® (kaolin clay) as an insect management tool • Improve application technology for spinosad (GF-120 Naturalyte®) • Evaluate various trap designs for olive fruit fly monitoring • Evaluate rotenone plus pyrethrum for olive fruit fly (used in Europe, not registered in CA)
Regulatory	• Obtain full Section 3 registration of attract-and-kill traps and eliminate timing restrictions • Obtain full Section 3 registration of spinosad (GF-120 Naturalyte®). • Obtain approval of spinosad (GF-120 Naturalyte®) bait spray for use in organic production • Obtain approval of attract-and-kill devices for organic production
Education	• Educate growers on need for good coverage and timing for oil applications

WEEDS

Good weed control during the summer months is accomplished by using cultivation and using spot treatments with contact herbicides for both annuals and perennials.

Work Group Recommendations Weed Management in Summer

Research	• Develop non-chemical weed control methods • Evaluate new and established chemistries to expand herbicide availability for olives
Regulatory	• Register alternative pre-emergence herbicides (through IR-4) • Remove label restriction on Goal® to allow use throughout the year
Education	• Educate growers on the horticultural benefits of good irrigation management

DISEASES

Pruning is a good cultural technique to reduce and manage olive knot.

Although not commonly practiced, tree holes are occasionally solarized to reduce the incidence and severity of *Verticillium* wilt with fair to good results.

There are no work group recommendations for disease management issues during the summer.

VERTEBRATE PESTS

The vertebrate pests found at this time of the year are the same as indicated in previous sections of the strategic plan. It should be noted, however, that vertebrate pests are more difficult to manage in summer because they are larger and more numerous.

Gophers can be controlled using gopher blasters and traps. Poison baits are very effective as is use of aluminum phosphide or anticoagulants; strychnine is very effective, difficult to obtain, and can be used only underground for gophers. Squirrels are controlled with anticoagulant baits and deer can be kept out of orchards using fencing.

Work Group Recommendations for Vertebrate Pest Management in Summer

Research	• Evaluate new control techniques for squirrels

FALL
(Mid-September through harvest)

Cultural Activities

• Irrigation • Pre-emergence herbicide applications • Cultivation • Fertilizer application • Harvest	• Insecticide applications • Disease control applications (leaf spot) • Sanitation • Seeding cover crops • Mowing

INSECTS

To control olive fruit fly, GF-120 (spinosad bait spray) is used during the fall with good to moderate success. Attract-and-kill traps (when registered) would be used for mass trapping to reduce overall populations of olive fruit flies.

For scale pests (including black, olive, oleander, California red, greedy, lantania scale), post-harvest applications of Supracide® and Sevin® plus oil provide good control of all scales during the fall.

Work Group Recommendations for Insect Management in Fall

Research	• Determine how and if kaolin clay residues will affect processors • Determine varietal susceptibility to olive fruit fly • Develop economic thresholds for olive fruit fly • Develop effective post-harvest control of scales • Evaluate impact of post-harvest cover sprays on olive fly populations • Evaluate effect of olive fruit fly damage on oil quality • Determine best way to dispose of infested fruit • Determine the impact of mechanical harvesting on fruit damage
Regulatory	• Reduce worker compensation costs • Register an alternative post-harvest cover spray material for scales and olive fly • Develop guidelines for disposal of olive fly infested fruit • Continue state-wide monitoring of olive fly populations • Develop guidelines for disposal of attract-and-kill device cardboard
Education	• Update growers on current issues such as harvest maturity effects on oil quality

WEEDS

Cultural weed management for olives during the fall includes mowing, disking and grazing, all of which provide good control of most winter weeds. Several good herbicides are available (Simazine® and Diuron®), however, many of these have environmental issues (as mentioned above in the Winter Weed section). Roundup® and Goal® are good contact herbicides; however, there is resistance developing to Roundup® and it is expensive to use. Most weeds in olive orchards are effectively controlled with the available products with the exception of flaxleaf fleabane, which is very difficult to control.

Work Group Recommendations for Weed Management in Fall

Research	• Develop non-chemical weed control methods • Evaluate new and established chemistries to expand herbicide availability for olives
Regulatory	• Register alternative pre-emergence herbicides (through IR-4) • Remove label restriction on Goal® to allow its use year-round
Education	• Educate registrants on the need for new herbicides for olives

DISEASES

Olive leaf spot and olive knot are well controlled by post-harvest copper treatments; timing is critical to obtain maximum efficacy.

Work Group Recommendations for Disease Management in Fall

Research	• Evaluate alternate fumigants for replant situations • Evaluate alternate chemical and non-chemical controls for disease management • Determine proper timing of copper applications and how residues on fruit can be reduced or eliminated (especially for oil cultivars)
Regulatory	• Expedite registration of alternative fumigants
Education	• Educate growers on the importance of proper timing of post-harvest copper applications to improve efficacy

VERTEBRATE PESTS

Vertebrate pests tend to be less of an issue during the fall months; there are no work group recommendations specified for this particular season.

HARVEST and POST- HARVEST

HARVEST

Table olive harvest usually begins in mid-September and can extend through November. Cultivars grown for oil, however, are harvested much later so that the maximum amount of oil can accumulate in the fruit.

Harvesting of olives is usually done by hand, but labor is expensive and often scarce. Harvesting accounts for up to 65% of the total cash production costs for the olive crop. Due to these factors, there continues to be great interest in developing reliable mechanical devices to safely remove the fruit from olive trees; currently there are two types of machines used for harvesting olives (grabber and shaker type devices).

Work Group Recommendations for Harvest Management

Research	• Evaluate the nature and extent of fruit damage by mechanical harvesting • Develop efficient olive harvesting equipment which is safe to both fruit and trees

POST-HARVEST

After olives are harvested, several activities take place in the orchards; most of these activities are related to sanitation for scale and disease control. Herbicides and fertilizer applications are common at this time.

Cultural Activities

• Clean up branches	• Pre-emergence herbicide applications
• Grind bark	• Black scale insecticide applications
• Removal of sucker trees	• Copper sprays for disease management
• Fertilizer applications	

FOOD SAFETY AND SECURITY ISSUES

The U.S. olive industry has several concerns regarding imported olive products that present potential food security issues and also disrupt the market for U.S. growers and processors. The work group strongly recommends that level playing fields be developed and enforced to prevent foreign product from entering U.S. channels of trade without proper monitoring and enforcement.

A specific issue concerning microbial contamination exists for oil products which are packaged with fresh herbs (basil, oregano, etc.); this practice might introduce botulism or other microorganisms to be introduced into the oil.

Work Group Recommendations for Food Safety and Security Issues

Research	• Determine if herbs introduce botulism or other microbes of concern into olive oil
Regulatory	• Establish a testing program for imported olives and oil to monitor for pesticides, microbial contamination, and adulteration
Education	• Educate the public and the regulatory community on issues related to imported olive products • Educate producers and the public on botulism issues with high moisture content products added to oil

INTERNATIONAL ISSUES

U.S. olive growers face fierce competition from product brought into the country from overseas markets. Foreign olives are produced without the same regulations regarding pesticide usage or food safety as enforced in the U.S. The work group had several action items regarding this issue.

Work Group Recommendations for International Issues

Regulatory	• Insure that the U.S. accepts and enforces internationally recognized standards of safety and quality • Enforce truth in labeling for olive oil to prevent adulteration • Update U.S. standards for olive oil to comply with international standards • Develop consistent production and marketing regulations for all olive producing regions of the world
Education	• Educate consumers on the nutritive value, safety, and importance of buying California olive products • Educate regulatory agencies on the need to update and enforce standards for oil • Educate state and federal officials on the problem that a level playing field does not exist for U.S. olive growers and processors

LABOR ISSUES

The work group also had several concerns regarding labor as outlined below.

Work Group Recommendations for Labor Issues

Research	• Determine the costs and benefits of worker compensation reform • Evaluate, develop, and improve mechanical harvesting techniques to reduce labor inputs and associated costs
Regulatory	• INS checks should be conducted prior to harvest (not during the harvest season) • Bring back guest worker availability
Education	• Educate state and federal officials on the costs of worker compensation • Educate state and federal officials on the relationship between minimum wage and the cost of harvesting • Educate state and federal officials on the cost of providing housing • Educate federal officials on the need for INS checks prior to the harvest season so as to minimize disruptions in harvest

IR-4 PROJECT ISSUES

The California Olive Committee is currently supporting several research projects related to olive fruit fly management, including screening of insecticides. Once any good candidates are identified, IR-4 will serve as the initial means to obtain new product registrations. Areas of focus include screening of new neonicotinoids and establishing field trials to determine the best methods and timing of spinosad treatments.

The Western Regional IR-4 Center at UC Davis should be kept informed of the needs of the olive industry and priorities should be presented at the annual Food Use Workshop to insure that projects are being established within the IR-4 priority system.

Work Group Recommendations for the IR-4 Project Issues

Research	• Evaluate new chemistries for control of olive fruit fly; submit best product candidates for prioritization within IR-4 system • Prepare proposal to determine most effective method and timing of spinosad applications for control of olive fruit fly • Evaluate contact and pre-emergence herbicides to expand product availability for olive growers (especially products which control flaxleaf fleabane)
Regulatory	• Harmonize registration efforts between CDPR, IR-4, and EPA to facilitate timely registrations of olive fruit fly materials • Register imidacloprid for olive fruit fly control

3. CRITICAL ISSUES FOR THE CALIFORNIA OLIVE INDUSTRY

The following list summarizes the California olive industry's critical issues identified by the 0live Work Group:.

Research	• Study olive fruit fly biology and develop effective pest management techniques • Determine the relationship between olive tree phenology and olive fruit fly biology and management • Evaluate currently registered insecticides for olive fruit fly efficacy • Evaluate activity of neonicotinoid insecticides against olive fruit fly and scales • Develop reliable monitoring techniques and economic thresholds for the olive fruit fly • Evaluate effectiveness of mass olive fruit fly trapping techniques in oil production regions • Develop methods to properly handle olive fruit fly infested fruit • Evaluate the impact of glassy-winged sharpshooters and *Xyllela* on olives • Evaluate alternatives to organophosphate and carbamate insecticides for control of scale insects and glassy-winged sharpshooter • Evaluate pre-emergence herbicides for weed control (especially flaxleaf fleabane) • Determine optimal timing for copper applications to minimize residues in oil crops
Regulatory	• Obtain a full registration for spinosad GF-120 Naturalyte® and an attract-and-kill device • Obtain an organic approval for spinosad GF-120 Naturalyte® and an attract-and-kill device • Expedite the registration of additional insecticides for olive fruit fly control • Establish abatement districts to manage ornamental sources of olive fruit flies • Register alternatives for organophosphate and carbamate insecticides used for control of scale and glassy-winged sharpshooter • Expedite registrations for new pre-emergence herbicides and for materials which control flaxleaf fleabane • Remove timing restrictions on Goal® herbicide use
Education	• Educate growers, PCAs, and applicators on proper use of pesticides, application methods, and timing • Continue education on olive fruit fly biology and management of all olive pests • Educate growers on how to properly handle olive fruit fly infested fruit • Educate the public and the regulatory community on international import and labor issues which present significant and unfair trade disadvantages to producers of California olive products • Educate the public on the safety and quality aspects of consuming olive oil and table olives which have been produced in the U.S.; teach the public that these products help to maintain a healthy lifestyle

REFERENCES

Crop Profile for California Olives, May 1999, at website http://pestdata.ncsu.edu/cropprofiles/docs/Caolives.html

Olive Production Manual, 1994 - UC Publication 3353 (http://anrcatalog.ucdavis.edu/merchant)

Hartmann, H.T. and K. W. Opitz. 1974. *Olive Production in California*. ANR Press Leaflet 2474.

Seibert, J. 2000. *Economic Impact of Olive Fruit Fly on the California Olive Industry* - Report to the California Olive Committee.

UC IPM Pest Management Guidelines: Olives, November 2002, at website http://www.ipm.ucdavis.edu/PMG/selectnewpest.olives.html

USDA National Agricultural Statistics Service, August 2002, *Agricultural Chemical Usage 2001 Fruit Summary*, *CDFA Resource Directory – 2002* at their website http://www.cdfa.ca.gov/publications.htm

http://rics.ucdavis.edu/fnric2/crops/olive_factsheet.shtml

The California Olive Committee website www.calolive.org/

APPENDICES

1. 2001 California Olive Production Statistics

COUNTY	HARVEST ACREAGE	YIELD (Tons/Ac.)	PRODUCTION (Tons)	TOTAL VALUE ($)
Butte	1,300	0.9	1,105	608,000
Calaveras	200	1	200	80,000
Fresno	954	3.7	3,480	2,401,000
Glenn	4,787	3.9	18,909	11,534,000
Kern	584	3.8	2,250	1,538,000
Madera	1,730	4.9	8,442	6,146,000
Tehama	5,551	2.9	16,098	10,302,700
Tulare	15,973	4.1	65,500	42,248,000
State Totals	31,079	**Average** 3.7	115,984	74,857,700

Source: County Agricultural Commissioners' Data

Note that the *CDFA Resource Directory – 2002* contains additional production statistics which may be seen at their website http://www.cdfa.ca.gov/publications.htm

2. Crop Development, Cultural Practices, and Pest Management Activities in California Olives

North Coast

Crop Development	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bloom Development												
Bloom												
Pollination												
Fruit Development												
Pit Hardening												
Harvest												
Post-harvest												
Storage (Oil Olives)												
Cultural Practices	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Cultivation												
Irrigation												
Pruning												
Thinning												
Frost Protection												
Brush Removal												
Fertilizer Application												
Shredding Brush												
Pest Management Activities	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Soil Sampling												
Scouting												
Insecticide Applications												
Dormant Applications												
Fungicide Applications												
Use of Pheromones												
Herbicide Applications												
Nematicide Applications												
Vertebrate Control												
PGR Application												

Data based on collective field observations and experiments

2. Crop Development, Cultural Practices, and Pest Management Activities in California Olives (continued)

Marin County

Crop Development	J	F	M	A	M	J	J	A	S	O	N	D
Bloom Development												
Bloom												
Pollination												
Fruit Development												
Pit Hardening												
Harvest												
Post-harvest												
Storage												
Cultural Practices	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Cultivation												
Irrigation												
Pruning												
Thinning												
Frost Protection												
Brush Removal												
Fertilizer Application												
Shredding Brush												
Pest Management Activities	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Soil Sampling												
Scouting												
Insecticide Applications												
Dormant Applications												
Fungicide Applications												
Use of Pheromones												
Herbicide Applications												
Nematicide Applications												
Vertebrate Control												
PGR Application												

Data based on collective field observations and experiments

2. Crop Development, Cultural Practices, and Pest Management Activities in California Olives (continued)

Sacramento Valley

Crop Development	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bloom Development												
Bloom												
Pollination												
Fruit Development												
Pit Hardening												
Harvest												
Post-harvest												
Storage												
Cultural Practices	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Cultivation												
Irrigation												
Pruning												
Thinning												
Frost Protection												
Brush Removal												
Fertilizer Application												
Shredding Brush												
Pest Management Activities	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Soil Sampling												
Scouting												
Insecticide Applications												
Dormant Applications												
Fungicide Applications												
Use of Pheromones												
Herbicide Applications												
Nematicide Applications												
Vertebrate Control												
PGR Application												

Data based on collective field observations and experiments

2. Crop Development, Cultural Practices and Pest Management Activities in California Olives (continued)

San Joaquin Valley

Crop Development	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bloom Development												
Bloom												
Pollination												
Fruit Development												
Pit Hardening												
Harvest												
Post Harvest												
Storage												
Cultural Practices	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Cultivation												
Irrigation												
Pruning												
Thinning												
Frost Protection												
Brush Removal												
Fertilizer Application												
Shredding Brush												
Pest Management Activities	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Soil Sampling												
Scouting												
Insecticide Applications												
Dormant Applications												
Fungicide Applications												
Use of Pheromones												
Herbicide Applications												
Nematicide Applications												
Vertebrate Control												
PGR Application												

Data based on collective field observations and experiments

3. Seasonal Pest Occurrence in California Olives

North Coast (Oil Cultivars)

Insects and Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Black Scale												
Olive Scale												
Oleander Scale												
Black Vine Weevil												
Greedy Scale												
Lantania Scale												
Western Flower Thrips												
Branch and Twig Borer												
American Plum Borer												
Olive Bud Mite												
Olive Fruit Fly												
Weeds	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
All												
Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Olive Leaf Spot												
Olive Knot												
Verticillium Wilt												
Phytophthora Root & Crown Rots												
Armillaria Root Rot												
Nematodes	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Root Knot Nematode												
Citrus Nematode												
Lesion Nematode												
Vertebrates	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Meadow Mice												
Moles												
Pocket Gophers												
Ground Squirrels												
Birds												

Data based on collective field observations and experiments

3. Seasonal Pest Occurrence in California Olives (continued)

Marin County (Oil Cultivars)

Insects and Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Black Scale												
Olive Fruit Fly												
Olive Scale												
Oleander Scale												
Black Vine Weevil												
Greedy Scale												
Lantania Scale												
Western Flower Thrips												
Branch and Twig Borer												
American Plum Borer												
Olive Bud Mite												
Weeds	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
All												
Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Olive Leaf Spot												
Olive Knot												
Verticillium Wilt												
Phytophthora Root/Crown Rot												
Armillaria Root Rot												
Nematodes	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Root Knot Nematode												
Citrus Nematode												
Lesion Nematode												
Vertebrates	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Meadow Mice												
Moles												
Pocket Gophers												
Ground Squirrels												
Birds												

Data based on collective field observations and experiments

3. Seasonal Pest Occurrence in California Olives (continued)

Sacramento Valley (Table and Oil Cultivars)

Insects and Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Black Scale												
Olive Fruit Fly												
Olive Scale												
Oleander Scale												
Black Vine Weevil												
Greedy Scale												
Lantania Scale												
Western Flower Thrips												
Branch and Twig Borer												
American Plum Borer												
Olive Bud Mite												
Weeds	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
All												
Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Olive Leaf Spot												
Olive Knot												
Verticillium Wilt												
Phytophthora Root/Crown Rot												
Armillaria Root Rot												
Nematodes	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Root Knot Nematode												
Citrus Nematode												
Lesion Nematode												
Vertebrates	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Meadow Mice												
Moles												
Pocket Gophers												
Ground Squirrels												
Birds												

Data based on collective field observations and experiments

3. Seasonal Pest Occurrence in California Olives (continued)

San Joaquin Valley (Table Cultivars)

Insects and Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Black Scale												
Olive Fruit Fly												
Olive Scale												
Oleander Scale												
Black Vine Weevil												
Greedy Scale												
Lantania Scale												
Western Flower Thrips												
Branch and Twig Borer												
American Plum Borer												
Olive Bud Mite												
Weeds	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
All												
Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Olive Leaf Spot												
Olive Knot												
Verticillium Wilt												
Phytophthora Root/Crown Rot												
Armillaria Root Rot												
Nematodes	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Root Knot Nematode												
Citrus Nematode												
Lesion Nematode												
Vertebrates	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Meadow Mice												
Moles												
Pocket Gophers												
Ground Squirrels												
Birds												

Data based on collective field observations and experiments

4. Efficacy of Insect Management Tools Used in California Olives

Efficacy Ratings: E = Excellent, G = Good, F = Fair, P = Poor/None, R = Known Resistance

MANAGEMENT TOOLS	INSECTS									
	Black Scale	Olive Scale	Oleander Scale	Greedy Scale	Lantania Scale	CA Red Scale	W. Flower Thrips	Branch & Twig Borers	American Plum Borer	Olive Fruit Fly
Chemical										
Methidathion (Supracide®)	F-G	F-G	F-G	F-G	F-G	F-G				P
Sevin®	F	F	F	F	F	F		F	G	P
Spinosad (GF-120 Naturalyte®)							G			F-G
Lambda-cyhalothrin (Karate®, Force®)										N-R
Sevin®+Oil	F-G	F-G	F-G	F-G	F-G	F-G				P
Attract-and-Kill Devices										?
Non-Chemical										
Biological Controls	P-G		P-G			G				
Oils	F-G	F-G	F-G	F-G	F-G	F-G				
Pruning	G-E	P	P	P	P	P		G	G	
Sanitation								G	G	
Cover Crops										
Irrigation Management									G	

Data based on collective field observations and experiments

5. Efficacy of Weed Management Tools Used in California Olives

Susceptibility of Winter Weeds to Herbicide Control

Efficacy Ratings: C = Control Provided, P = Partial Control Provided, N = No Control Provided

WINTER WEEDS	PRE-EMERGENCE					POST-EMERGENCE							COMBINATIONS				
	NAP	OXY	ORY	DIU	SIM	OXY	PAR*	FLU	GLY	SUL	CLE	SET	OXY, ORY	GLY, OXY	PAR*, OXY	GLY, ORY	GLY, SIM, ORY
Annual Grasses																	
Hare (wild) Barley	C	P	C	C	C	P	C	C	C	C	C	C	P	C	C	C	C
Bluegrass	C	P	C	C	C	P	C	N	C	C	P	N	C	C	C	C	C
Bromegrasses	C	P	C	C	C	N	C	C	C	C	C	C	P	C	C	C	C
Canarygrass	C	P	C	C	-	N	C	C	C	C	C	C	N	C	C	C	C
Wild Oat	C	P	P	P	C	N	C	C	C	C	C	C	P	C	C	C	C
Rabbitfoot Polypogon	C	P	C	C	-	-	C	C	C	C	C	C	N	C	C	C	C
Italian Ryegrass	C	P	C	C	C	N	C	C	C	C	C	C	N	C	C	C	C
Annual Broadleaves																	
Common Chickweed	C	P	C	C	C	P	C	N	C	C	N	N	P	C	C	C	C
Clovers	P	P	N	P	P	P	P	N	C	C	N	N	P	P	C	P	P
Fiddlenecks	C	C	C	C	C	C	C	N	C	C	N	N	C	C	C	C	C
Filarees	C	C	N	C	C	C	C	N	P	P	N	N	P	C	C	P	C
Common Groundsel	P	C	P	N	C	C	C	N	C	C	N	N	C	C	C	C	C
Henbit	P	C	P	C	C	C	C	N	C	C	N	N	C	C	C	C	C
Miner's Lettuce	C	C	C	C	C	C	C	N	C	C	N	N	C	C	C	C	C
Mustards	P	C	N	C	C	P	C	N	C	C	N	N	P	C	C	C	C
Nettles	P	C	P	C	C	C	P	N	P	P	N	N	P	C	C	C	C
Pineapple-weed	C	C	N	P	C	P	P	N	C	C	N	N	P	C	C	C	C
Wild Radish	P	C	N	C	C	P	P	N	C	C	N	N	P	C	C	C	C
Redmiads (Desert Rockpurslane)	N	C	C	C	C	C	C	N	C	C	N	N	C	C	C	C	C
London Rocket	C	C	P	C	C	C	C	N	C	C	N	N	P	C	C	C	C
Shepherd's-purse	P	C	N	C	C	P	C	N	C	C	N	N	P	C	C	C	C
Sowthistles	C	C	P	C	C	C	C	N	C	C	N	N	P	C	C	C	C

Data from *UC IPM Pest Management Guidelines: Olives*

Comments: * Permit required from county agricultural commissioner for purchase or use

Chemical Legend:

CLE = clethodim (Prism®)
DIU = diuron (Karmex®, etc.)
FLU = fluazifop-P-butyl (Fusilade® DK)
GLY = glyphosate (Roundup®, etc.)
ORY = oryzalin (Surflan®)
OXY = oxyfluorfen (Goal®)
PAR = paraquat* (Gramoxone® Extra)
SET = sethoxydim (Poast®)
SIM = simazine (Princep®, etc.)
NAP = napropamide (Devrinol®)
SUL= sulfosate (Touchdown®)

5. Efficacy of Weed Management Tools Used in California Olives (continued)

Susceptibility of Spring/Summer Weeds to Herbicide Controls

Efficacy Ratings: C = Control Provided, P = Partial Control Provided, N = No Control Provided

SPRING/SUMMER WEEDS	PRE-EMERGENCE						POST-EMERGENCE					COMBINATIONS					
	NAP	OXY	ORY	DIU	SIM	OXY	PAR*	FLU	GLY	SUL	CLE	SET	OXY, ORY	GLY, OXY	PAR*, OXY	GLY, ORY	GLY, SIM, ORY
Annual Grasses																	
Barnyardgrass	C	P	C	C	P	N	P	C	C	C	C	C	N	C	C	C	C
Crabgrasses	C	P	C	C	N	P	C	C	C	C	C	C	P	C	C	C	C
Fescues	C	P	C	C	C	N	C	N	C	C	N	N	N	C	C	C	C
Foxtails	C	N	C	C	C	N	C	C	C	C	C	C	P	C	C	C	C
Lovegrasses	C	P	C	C	-	N	C	C	C	C	C	C	P	C	C	C	C
Sandburs	C	N	C	C	P	N	P	C	C	C	C	C	P	C	C	C	C
Spangletops	C	P	C	N	N	N	C	C	C	C	C	C	N	C	C	C	C
Witchgrass	C	P	C	P	C	N	C	C	C	C	C	C	N	C	C	C	C
Annual Broadleaves																	
Cockleburs	C	C	N	C	C	C	C	N	C	C	N	N	C	C	C	C	C
Cudweeds	C	N	N	C	C	P	N	N	C	C	N	N	P	C	P	C	C
Hairy Fleabane	N	P	N	C	C	P	C	N	C	C	N	N	P	C	C	P	C
Fluvellins	N	P	N	P	P	P	P	N	P	P	N	N	P	C	C	P	P
Goosefoot, Nettleleaf	C	C	C	C	C	C	C	N	C	C	N	N	C	C	C	C	C
Groundcherries	N	C	C	C	C	C	C	N	C	C	N	N	C	C	C	C	C
Knotweeds	C	C	C	C	C	P	P	N	C	C	N	N	P	C	P	P	C
Common Lambsquarters	C	C	C	C	C	C	P	N	C	C	N	N	C	C	C	C	C
Prickly Lettuce	C	C	N	C	C	C	C	N	C	C	N	N	C	C	C	C	C
Little Mallow (Cheeseweed)	P	C	P	C	N	C	N	N	P	P	N	N	C	C	C	P	C
Nightshades	N	C	N	C	C	C	C	N	C	C	N	N	C	C	C	C	C
Pigweeds	C	C	C	C	C	C	C	N	C	C	N	N	C	C	C	C	C
Puncturevine	P	C	P	C	P	C	C	N	C	C	N	N	P	C	C	C	C
Common Purslane	C	C	C	C	C	C	C	N	C	C	N	N	P	C	C	C	C
Speedwells	C	C	P	P	C	P	C	N	C	C	N	N	P	C	C	C	C
Yellow Starthistle	P	C	N	C	C	C	P	N	C	C	N	N	P	C	C	C	C
Russian Thistle	P	P	P	P	P	P	C	N	C	C	N	N	P	C	P	C	C
Velvetleaf	N	C	P	C	C	N	P	N	C	C	N	N	N	C	C	C	C
Panicle-leaf Willowherb	-	C	C	C	C	-	P	N	C	C	N	N	C	C	C	C	C

Data from *UC IPM Pest Management Guidelines: Olives*

Comments: * Permit required from county agricultural commissioner for purchase or use

Chemical Legend:

CLE = clethodim (Prism®)
DIU = diuron (Karmex®, etc.)
FLU = fluazifop-P-butyl (Fusilade® DK)
GLY = glyphosate (Roundup®, etc.)
ORY = oryzalin (Surflan®)
OXY = oxyfluorfen (Goal®)
PAR = paraquat* (Gramoxone® Extra)
SET = sethoxydim (Poast®)
SIM = simazine (Princep®, etc.)
NAP = napropamide (Devrinol®)
SUL= sulfosate (Touchdown®)

5. Efficacy of Weed Management Tools Used in California Olives (continued)

Susceptibility of Spring/Summer Weeds to Herbicide Controls (continued)

Rating System: C = Control Provided, P = Partial Control Provided, N = No Control Provided

SPRING/SUMMER WEEDS	PRE-EMERGENCE						POST-EMERGENCE						COMBINATIONS				
	NAP	OXY	ORY	DIU	SIM	OXY	PAR*	FLU	GLY	SUL	CLE	SET	OXY, ORY	GLY, OXY	PAR*, OXY	GLY, ORY	GLY, SIM, ORY
Perennials(seedlings)																	
Bermudagrass	C	N	C	C	P	N	C	P	P	P	P	N	C	C	C	P	N
Field Bindweed	P	C	P	P	C	C	C	C	C	P	P	C	N	C	C	N	N
Dallisgrass	C	C	C	C	C	N	C	C	C	C	C	N	C	C	C	C	C
Johnsongrass	C	C	C	C	C	C	C	P	C	C	C	C	P	C	C	C	C
Established Perennials																	
Asparagus	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	N	N
Bermudagrass	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Field Bindweed	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Blackberries	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Common Catsear	N	N	N	P	N	P	P	N	N	N	N	N	P	N	N	P	P
Clovers	N	N	N	N	N	N	P	N	N	N	N	N	P	P	N	N	N
Dallisgrass	N	P	N	N	P	N	N	N	N	P	N	N	N	N	N	N	N
Dandelion	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	N	N
Curly Dock	P	N	N	N	N	N	N	P	P	N	N	N	P	P	C	C	P
Johnsongrass	P	N	P	N	P	P	N	N	N	N	N	C	C	N	N	N	N
Yellow Nutsedge	N	P	P	N	N	N	N	N	P	P	N	N	N	N	P	C	C
Pacific Poison-oak	N	N	N	N	N	C	C	N	N	N	N	N	P	P	N	N	N
Smartweeds	N	P	C	C	N	N	N	N	N	P	P	N	N	N	N	N	C
Red Sorrel	C	N	N	N	N	N	C	C	N	N	N	N	N	P	P	N	N

Data from *UC IPM Pest Management Guidelines: Olives*

Comments: * Permit required from county agricultural commissioner for purchase or use

Chemical Legend:

CLE = clethodim (Prism®)
DIU = diuron (Karmex®, etc.)
FLU = fluazifop-P-butyl (Fusilade® DK)
GLY = glyphosate (Roundup®, etc.)
ORY = oryzalin (Surflan®)
OXY = oxyfluorfen (Goal®)
PAR = paraquat* (Gramoxone® Extra)
SET = sethoxydim (Poast®)
SIM = simazine (Princep®, etc.)
NAP = napropamide (Devrinol®)
SUL= sulfosate (Touchdown®)

6. Efficacy of Disease Management Tools Used in California Olives

Efficacy Ratings: E = Excellent, G = Good, F = Fair, P = Poor/None, R = Known Resistance

MANAGEMENT TOOLS	DISEASES					
	Olive Leaf Spot	Olive Knot	*Verticillium*	*Phytophthora*	*Armillaria*	Crown Gall
Chemical						
Pre-plant fumigation			P	P	F	
M-cresol (Gallex®)						F-G
Copper	G-E	G				
Non-Chemical						
Site Selection			E	E	E	
Root Stock Selection			P			
Solarization			F-G		P	
Pruning		G-E				
Sanitation					F	G
Cover Crops						
Fertilizer Management						
Skirt Management						
Irrigation Management			G	G	P	

Data based on collective field observations and experiments

7. Efficacy of Vertebrate Management Tools Used in California Olives

Efficacy Ratings: E = Excellent, G = Good, F = Fair, P = Poor/None, R = Known Resistance

MANAGEMENT TOOLS	Squirrels	Gophers	Voles	Rabbits	Deer	Birds
Chemical/Non-Chemical						
Trapping	F	F				
Anti-coagulants	P-G	P-G				
Strychnine	G					
Blasters	P-G	P-G				
Cover Crops	P					
Aluminum Phosphide	G	G				
Owls	P	P				
PGRs						
NAA	G	G				

Data based on collective field observations and experiments

8. Chemical Use on California Olives 1999 and 2001 (data not available for 2000)

(% of Acreage Involved and Pounds of Active Ingredient Used)

CHEMICAL	ACREAGE APPLIED (%)		TOTAL APPLIED (Lbs.)	
	1999	2001	1999	2001
Herbicides				
Diuron®	26	31	16,500	13,164
Glyphosate	53	<1	24,300	15
Oxyfluorfen	8	19	1,900	1,234
Paraquat	11	6	3,600	1,559
Simazine	30	29	27,500	17,250
Insecticides				
Carbaryl	6	3	13,400	4,580
Petroleum Distillate	10	2	187,900	21,407
Spinosad	0	63	0	13
Fungicides				
Basic Copper Sulfate	19	19	52,600	45,074
Copper Hydroxide	21	39	48,800	83,847

1999 Fertilizer Use on Olives

Nitrogen		Phosphate		Potash	
% Ac. Treated	Total Lbs.	% Ac. Treated	Total Lbs.	% Ac. Treated	Total Lbs.
80 %	1,850,000 lbs.	9 %	93,000 lbs.	7 %	53,000 lbs.

9. Members of the California Olive Work Group

(UC=University of California, KAC=Kearney Agricultural Center)

Growers, Packers, Processors and Shippers

1. Mike Denny, CA Olive, Oroville, CA (Oil Olives)
2. Gene Welch, Bell-Carter Olive Co., Orange Cove, CA (Table Olives)
3. Dan Dreyer, Grower/COC, Lindsay, CA (Table Olives)
4. Cody McCoy, Bell-Carter Olive Co., Corning, CA (Table Olives)
5. Nick Sciabica, Nick Sciabica & Sons, Modesto, CA (Oil Olives)
6. Jeffrey Creque, McEvoy Ranch, Petaluma, CA (Oil Olives)
7. Alan Reynolds, S&J Ranch, Madera, CA (Table Olives)
8. Dennis Burreson, Musco Family Olive Co., Orland, CA (Table Olives)

Pest Control Advisors

9. Mark Keenan, John Taylor Fertilizers, Chico, CA (Table Olives)
10. Judy Stewart-Leslie, Pest Management Assoc., Exeter, CA (Table Olives)
11. Tim Ksander, Research Director/PCA, Yuba City, CA (Table Olives)
12. Michael Marshall, Agricultural Advisors, Inc., Live Oak, CA (Table Olives)
13. James Bettiga, S&J Ranch, Coarsegold, CA (Table Olives)

Commodity Group Representatives

14. Jan Nelson, California Olive Committee, Fresno, CA (Table Olives)
15. Jamie Johanson, Board Member/Owner-Farmer, Oroville, CA (Oil Olives)
16. Lori Berger, California Minor Crops Council, Tulare, CA
17. Christi Darling, California Olive Committee, Fresno, CA
18. John Erickson, COC Research Subcommittee, Orland, CA (Table Olives)

Land Grant University Research and Extension Personnel

19. Paul Vossen, Farm Advisor Sonoma County, Santa Rosa, CA (Oil Olives)
20. Marshall W. Johnson, UCR Entomologist, UC KAC Parlier, CA (Table & Oil Olives)
21. Frank Zalom, UCD Entomologist, Davis, CA (Table & Oil Olives)
22. Louise Ferguson, Extension Specialist, UC KAC, Parlier, CA (Table & Oil Olives)
23. Steve Sibbett, Farm Advisor Tulare County, Visalia, CA (Table & Oil Olives)

California Pest Management Center

24. Rick Melnicoe, California & Western Region Pest Management Center, UC Davis, CA
25. Linda Herbst, California & Western Region Pest Management Center, UC Davis, CA

10. California Olive Industry – Contact Information

Lori Berger
Director of Technical Affairs
CA Minor Crops Council
4500 S. Laspina, Suite 214
Tulare, CA 93274
Ph: (559) 688 5700
Fax: (559) 688 5527
E-mail: lori@minorcrops.org

James Bettiga
S&J Ranch
29925 Stetson Dr.
Coarsegold, CA 93614
Ph: (559) 706 1913

Dennis Burreson
Director of Field Operations
Musco Family Olive Co.
5th and Swift Street
Orland, CA 95963
Ph: (530) 865 4111
Fax: (530) 865 5204
E-mail: dennisb@olives.com

Jeffrey Creque
McEvoy Ranch
5935 Red Hill Rd.
Petaluma, CA 94952
Ph: (707) 769 4117
Fax: (415) 868 9574
E-mail1: jacreque@aol.com
E-mail2: info@mcevoyranch.com

Christi Darling
California Olive Committee
1903 N. Fine, #102
Fresno, CA 93727
Ph: (559) 456 9096
Fax: (559) 456 9099
E-mail: calolive@psnw.com

Mike Denny
Vice President
California Olive Committee
2675 Lone Tree Road
Oroville, CA 95965
Ph: (530 846 8000
Fax: (530) 846 8003
E-mail: mdenny@cal-olive.com

Dan Dryer
California Olive Committee
PO Box 548
Lindsay, CA 93274-0548
Ph: (559 562 4297
Fax: (559) 562 3227
E-mail: dan@ag-services.net

John Erickson
Cal. Research Subcommittee Chair
6849 Road 25
Orland, CA 95963
Ph: (530) 865 3814
Fax: (530) 865 2199
E-mail: ericksonorchards@msn.com

Louise Ferguson
UCCE Extension Specialist
9248 South Riverbend Ave.
Parlier, CA 93648
KAC Ph: (559) 646 6541, 737 3061
UC Ph: (530) 752 0507
KAC Fax: (559) 646 6593
UC Fax: (530) 752 8502
E-mail: louise@uckac.edu

Linda Herbst
Assistant Director
Western Region Pest Management Center
One Shields Ave.
University of California
Davis, CA 95616
Ph: (530) 752 7010
Fax: (530) 754 8379
E-mail: llherbst@ucdavis.edu

Jamie Johanson
California Olive Oil Council
3723 Foothill Blvd.
Oroville, CA 95966
Ph: (530) 534 6548
Fax: (530) 534 6645
E-mail: Jamie@lodestarfarms.com

Marshall W. Johnson
UCR Associate Entomology Specialist
Kearney Ag. Center
9240 South Riverbend Ave.
Parlier, CA 93648
Ph: (559) 646 6519
Fax: (559) 646 6593
E-mail: mjohnson@uckac.edu

Mark Keenan
John Taylor Fertilizers
13834 Winesap Court
Chico, CA 95973
Ph: (530) 570 6294
Fax: (530) 934 9606
E-mail: markkeen@aol.com

Tim Ksander
Agricultural Advisors, Inc.
3995 E. Butte Road
Yuba City, CA 95953
Ph: (530) 674 1255
Fax: (530) 674 1907
E-mail: agadvise@jps.net

Michael Marshall
Agricultural Advisors, Inc.
3995 E. Butte Road
Live Oak (Yuba City), CA 95953
Ph: (530) 674 1255
Fax: (530) 674 1907
E-mail: agadvise@jps.net

Cody McCoy
Northern Field Manager
Bell-Carter Olive Co.
1012 Second Street
Corning, CA 96012
Ph: (530) 824 7165
Fax: (530) 824 7178
E-mail: cmvvoy@bellcarter.com

Rick Melnicoe
Director
Western Region Pest Management Center
One Shields Ave.
University of California
Davis, CA 95616
Ph: (530) 754 8378
Fax: (530) 754 8379
E-mail: rsmelnicoe@ucdavis.edu

Jan Nelson
Manager
California Olive Committee
1903 N. Fine, #102
Fresno, CA 93727
Ph: (559) 456 9096
Fax: (559) 456 9099
E-mail: jnelson@calolive.org

Alan Reynolds
Vice President
S&J Ranch
39639 Avenue 10
Madera, CA 93639
Ph: (559 437 2628
Fax: (559) 437 2606
E-mail: areynolds@paramountcitrus.com

Nick Sciabica
Production Manager
Nick Sciabica & Sons
2150 Yosemite Blvd.
Modesto, CA 95354
Ph: (209) 577 5067
Fax: (209) 524 5367
E-mail: nick@sciabica.com

Steve Sibbett
U.C. Farm Advisor, Emeritus
Agriculture Building
4437 S. Laspina St., Ste. B
Tulare, CA 93274
Ph: (559) 734 4607
Fax: (559) 734 2708
Cell: (559) 280 0666
E-mail: sibbett@lightspeed.net

Judy Stewart-Leslie
Pest Management Associates, Inc.
PO Box 712
Exeter, CA 93221
Ph: (559) 592 9461
Fax: (559) 592 3373
E-mail: jsleslie@pestmgmt.net

Paul Vossen
UCCE Farm Advisor
2604 Ventura Avenue
Santa Rosa, CA 95402
Ph: (707) 565 2621
Fax: (707) 565 2623
E-mail: pmvossen@ucdavis.edu

Gene Welch
Southern Field Manager
Bell-Carter Olive Co.
630 9th Street
Orange Cove, CA 93646
Ph: (559) 626 4411
Fax: (559) 626 7588
E-mail: gwelch@bellcarter.com

Frank Zalom
UC Davis
Department of Entomology
Davis, CA 95616
Ph: (530) 752 3687
Fax: (530) 752 1537
E-mail: fgzalom@ucdavis.edu