

Olive Notes

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Seasonal Development of Olive (*Olea europaea* L.)

Elizabeth Fichtner, Farm Advisor, Tulare County

Physiologically speaking, spring is a busy time of year for the olive tree. Not only are buds developing for shoot growth and flower production, but it is also the time of year when old leaves abscise and the relative production of perfect flowers (those with the potential to bear fruit) is determined. Understanding the seasonal processes of the olive tree may aid in comparison of orchard productivity between growing seasons and identification of potential stress factors during critical timings of seasonal growth and development.

Vegetative growth. Generally, terminal buds develop vegetative shoots in April, whereas lateral buds will give rise to inflorescences in May. Vegetative buds of olive exhibit little (if any) dormancy, and tend to grow when temperatures exceed 70°F. About a month prior to bud break, floral buds can be differentiated from vegetative buds by dissection and visualization under a low-powered microscope. Though olives are evergreen, an individual leaf may only live 2-3 years, and most leaves abscise in the spring. Though spring leaf abscission is a normal plant process, excessive defoliation may be a sign of another plant stress. Excess defoliation prior to bloom may adversely affect fruit set, and create natural openings for olive knot infection.

Flower production. Olive fruit is borne on 1 year old shoots. The California olive bloom is typically in May, with bloom commencing one to two weeks earlier in the southern part of the state than in northern California. Flowering in olive is not dependant on photoperiod (day length).



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Photo: Olive flowers

Submitted By

Carolyn DeBuse

Direct 707-784-1320

Cell 530-2220-2380

cjdebuse@ucdavis.edu



UCCE Solano County

501 Texas Street,

First Floor

Fairfield, CA 94533

707-784-1317

Fax - 707-429-5532

cesolano.ucdavis.edu

UCCE Yolo County

70 Cottonwood Street

Woodland, CA 95695

530-666-8143

Fax-530-666-8736

ceyolo.udavis.edu

Olive Development continued...

Flower buds form in the axils of leaves and each inflorescence contains 15-30 flowers. Flower number will vary between growing season and cultivar. The olive inflorescence is composed of both perfect and staminate (imperfect) flowers. Perfect flowers contain both female and male parts, and are therefore able to produce fruit. Staminate flowers contain only male parts. One or two perfect flowers within an inflorescence are sufficient to support a commercial crop. Approximately 10-15% of young fruit abscise 6-7 weeks after bloom, resulting in typically only 1-2% final fruit set. Additionally, leaves must be present on shoots bearing inflorescences to insure adequate fruit set.

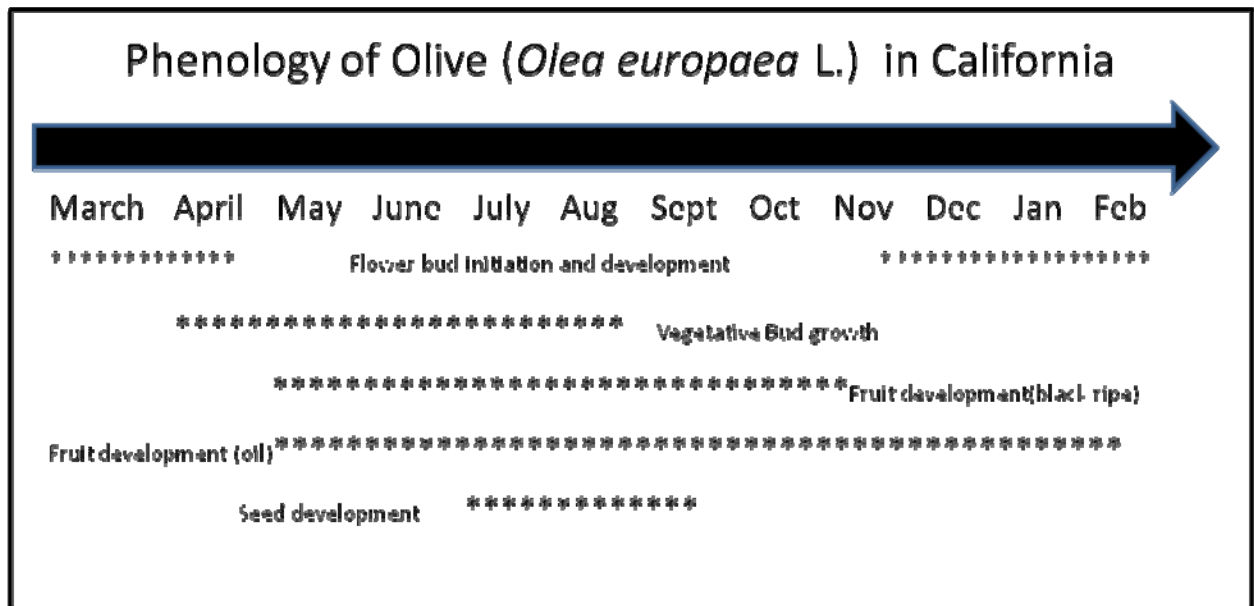
The proportion of male to perfect flowers is determined approximately 4 weeks prior to bloom. During early flower bud development, all buds are perfect. Imperfect flowers result from pistil abortion (loss of female flower part). During bloom one can visually differentiate between perfect and imperfect flowers. The perfect flowers contain a large, green pistil, whereas the imperfect flowers have a short brown, white, or greenish white style. The proportion of staminate to perfect flowers varies by inflorescence, cultivar, and environmental conditions.

Environmental stresses during flower bud differentiation (8-10 weeks prior to bloom) may adversely affect orchard productivity. Stressed flower buds are unable to compete with leaves for water; consequently, inadequate water supply during floral bud development may result in malformed or imperfect flowers.

Pollination. Though some olive cultivars may be self-compatible, fertilization and subsequent fruit set are often enhanced by cross pollination. For example, Manzanillo may be self-compatible during optimal weather conditions at bloom; however, pollen germination of Manzanillo may be inhibited during hot temperatures at bloom. Consequently, it is recommended that pollinating cultivars (ie. Sevillano in a Manzanillo orchard) are included in commercial orchards for enhanced fruit set, particularly in geographic areas where excessive heat, dry, or cold conditions may occur at bloom. Note that Mission and Ascolano pollen do not improve fruit set in the Manzanillo cultivar.

Seed and fruit development. Seed development generally occurs from July-September. Though physiologically immature, fruit grown for production of black ripe olives is generally harvested in September-October. When left on the tree, the fruit matures physiologically by January/February of the following year. Because oil levels in the fruit increase into the fall, olives grown for oil are typically harvested later than those grown for black ripe table olive processing.

Flower bud induction and development. The exact timing of flower bud induction is not known; however, most reports suggest that induction occurs between July and February, depending on cultivar and environmental conditions. Consequently, flowers buds are developed one year before they set a crop. Floral bud differentiation occurs from February-May. Many olive cultivars, including those originating in Crete, southern Greece, Egypt, Israel, and Tunisia, require little chilling to induce floral bud development. Cultivars originating in California, Italy and Spain tend to require winter chilling. Extensive warm daytime temperatures during the chilling phase may inhibit chilling and proper floral bud development.



Verticillium Wilt in Olives

Carolyn DeBuse, UCCE Farm Advisor, Solano and Yolo Counties
Elizabeth Fichtner, UCCE Farm Advisor, Tulare County

Verticillium wilt in olives can be devastating to an orchard. The disease can wipe out entire orchards under severe disease pressure. The first symptom of disease is the yellowing, curling, and wilting of all the leaves on a branch or scaffold with the leaves dropping or desiccating on the limb. The leaves may drop without even yellowing in some sensitive varieties. As the summer progresses the disease symptoms move through the tree with more branches and scaffolds succumbing to wilt. In olives, there are two types of Verticillium, defoliating and non-defoliating. The defoliating Verticillium is more aggressive to olive than the non-defoliating form of the pathogen. If the leaves fall off (defoliate) then the tree has been attacked by the more aggressive type of verticillium and will most likely die. If the leaves adhere after desiccation (non-defoliating) then the tree may survive. Both young and mature trees can be killed by Verticillium.

Disease development

Verticillium wilt is caused by the fungus *Verticillium dahliae*. This soilborne fungus can survive as microsclerotia in bare soil or in plant debris that remains in the field. Microsclerotia are hard coated compacted fragments of fungus that can withstand harsh environmental conditions staying quiescent in the soil for years until roots of a host plant are in the vicinity. When a host plant is near, the microsclerotia germinate and infect the roots and the pathogen proceeds to colonize the xylem (water conducting tissue) of the plant. The xylem becomes plugged with the fungus making it nonfunctional for water transport causing the plant to wilt. Cool wet springs are favorable for the growth of the fungus and promote disease development.

Many plants are hosts for Verticillium including all of the stone fruit tree species, many row crops commonly grown in California (cotton, tomatoes, potatoes, eggplant, peppers, safflower, strawberry, melons, watermelon, cabbage, lettuce) and many weed species (nightshade, groundsel, lambsquarter, dandelion, pigweed). Verticillium microsclerotia numbers can increase up to 60 per gram of soil where host plants have been grown. Yet, the disease can be a problem in new olive orchards planted where only one microsclerotia per gram of soil is found. The majority of the microsclerotia are found in the top layer of soil.

Diagnosing the disease

Verticillium-infected olives do not have the characteristic black streaking in xylem that is commonly associated with Verticillium infection in other crops. Consequently, the disease in olive cannot be diagnosed in the field, but requires confirmation of pathogen presence by a plant disease diagnostic laboratory.

To collect a plant tissue specimen for disease diagnosis, cut a sample of tissue at the intersection of healthy and symptomatic tissues and place the sample in a plastic bag. Keep the sample cool while transporting or mailing it to a diagnostic lab. Labs can also evaluate your soil samples for presence and quantity of microsclerotia.

How to avoid the disease prior to orchard establishment

Avoid planting new orchards following cultivation of susceptible host crops or weed infestations. The microsclerotia can remain viable for up to 30 years but the number of viable microsclerotia decreases with the passage of time. If cotton, tomatoes, or other host crop or weed species historically was grown in the field, mitigation methods should be implemented before planting. Take soil samples to determine amount of microsclerotia. Remember even 1 microsclerotia per gram of soil is too many.

Mitigation methods:

- Flooding during summer months
- Planting a non-host interim crop over several years like Sudan grass, crucifer, bean, barley, corn, oat, sorghum, sweet potato, and wheat. Incorporation of the cover crop (grass or crucifer) in the soil has shown an even higher reduction in microsclerotia.
- Fumigation with chloropicrin or a combination that contains chloropicrin.
- Solarization of soil the year before planting during the summer months with clear plastic tarps

Verticillium continued...

Post-plant soil solarization to treat Verticillium

The sterilization effect of soil solarization for management of Verticillium has been studied in several agricultural systems. Soil solarization for management of Verticillium in mature olive orchards has had varied results. A recent study conducted in Turkey demonstrated that solarization over a 45 day period between July 15 and Sept 1 reduced soil pathogen population levels to undetectable levels, resulting in reduced disease incidence and severity and increased plant recovery and symptom remission. Pathogen populations in solarized plots were lower than those in unsolarized plots two years after treatment. The positive results of solarization in this study are likely due to the amount and duration of increased soil temperatures in solarized plots.

Conversely, a recent study conducted in Spain demonstrated that solarization in mature orchards did not affect disease incidence and severity, but did improve recovery of trees from infection in orchards with low inoculum levels.

Variety resistance and susceptibility

When planting olives in Verticillium-infested fields, one may consider choosing varieties that exhibit less susceptibility to the disease. Cultivars of olive exhibit different levels of susceptibility to Verticillium, and growers of olives for oil may choose from a wider range in cultivars than table olive growers who rely mainly on Manzanillo, the industry standard. Research conducted in California, Italy, Turkey and Spain demonstrate that cultivars Frantoio, Coratina, Frangivento, Oblonga, Koroneiki, Arbequina, and Kalamon exhibit some resistance or tolerance to *V. dahlia*. The cultivars Manzanillo, Cellina, Leccino, Manzanillo, Chemlaie, Konservolia, Mission and Picual are susceptible to infection. No resistant rootstock has been found. When resistant varieties are used as a rootstock, the scion may still succumb to the disease.



Photo: Verticillium wilt in olive; P. Vossen

Developing Mechanical Harvesting for California Black Ripe Processed Table Olives: 2006-2010

Louise Ferguson, UCCE Specialist Pomology, Plant Sciences Davis

When we began developing mechanical harvesting for California black ripe table olives, the most limiting factors, in order of import, were as follows: 1) fruit damage, 2) effective fruit removal technology, 3) developing an economically viable harvester and defining its operating parameters.

To address these limitations we focused our investigation on evaluating prototype canopy contact and commercially available trunk shaking harvest technologies, evaluating the processed product, developing hedgerow orchards with young tree training and mature tree mechanical pruning, and evaluating potential abscission agents to assist with fruit removal.

The major cumulative research results thus far are:

- 1) Canopy contact and trunk shaking harvesting technology produced processed 'Manzanillo' olives that neither trained sensory or consumer panels could distinguish.
- 2) Canopy contact harvesting is over 90% efficient if the olives are accessible.
- 3) With unprepared trees both canopy contact and trunk shaking harvesting technologies remove 64% or less of the olives. At least 80% removal efficiency is needed for economically feasible mechanical harvesting.

Mechanical harvest continued...

- 3) Mechanically hedged and topped trees were harvested significantly more efficiently by a canopy contact head than hand pruned trees.
- 4) Ten year old 'Manzanillo' orchards trained with or without a trellis, in a 12x18 foot spacing, (204 trees /a) into a 12 foot tall, 6 foot wide tree skirted at 3 feet had statistically the same yields as conventionally trained trees.
- 5) Sixteen year old 'Manzanillo' trees spaced 13 X 26 feet (139 trees/a) and mechanically hedged 6 feet from the trunk on one side in 2008, the other side in 2009, and topped 12 feet and skirted at 3 feet both years, and not mechanically pruned in 2010, had significantly lower yields in 2010 than hand pruned control trees, but not in 2008 and 2009.
- 6) Evaluating the most viable potential abscission compounds has produced insignificant and inconsistent results.

At this point, fruit damage has largely been eliminated and both canopy contact and trunk shaking technologies have been demonstrated to be effective fruit removal technologies. However, in practice, efficiency of both harvesting technologies is still limited by tree canopy shape

The overall conclusion that can be synthesized from these results is that both canopy contact and trunk shaking harvesting technologies can achieve economically viable mechanical harvesting if the fruit is accessible to the harvester. To demonstrate this, the canopy contact and trunk shaking technologies must be improved through engineering, tested on effective platforms, and evaluated on properly trained trees. This is the research that we will be doing in 2011.

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Industry Cooperators:

Ranch Cooperators

Rocky Hill Ranch
Erick Nielsen Ranch

Harvester Cooperators

DSE
Erick Nielsen Inc.

Processor Cooperators

Bell Carter Olives
Musco Family Olive Company

Project Leaders:

Louise Ferguson, Jean-Xavier Guinard, and Uriel Rosa: University of California Davis

Jacqueline Burns: University of Florida

Project Cooperators

Soh Min Lee, Graduate Student, Food Science and Technology

Sergio Castro Garcia, Visiting Scientist from University of Cordoba, Spain

Kitren Glozer, Associate Project Scientist, UC Davis

William H. Krueger, UCCE Farm Advisor, Glenn County

Elizabeth J. Fichner, UCCE Farm Advisor, Tulare County

Neil O'Connell, UCCE Farm Advisor, Tulare County

Mari-Paz Suarez, Visiting Scientist, University of Seville, Spain

John Ferguson, Volunteer

Peter Kaleko, Volunteer

Skander Slama, Volunteer

