Topics in Subtropics Newsletter

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News from the Subtropical Tree Crop Farm Advisors in California

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In This Issue

Editor's Note:

Topics in Subtropics is also available as an online blog. Visit our blog for up-to-date information that may be available prior to receipt of this newsletter: **http://ucanr.org/blogs/Topics/**

Has your mailing address changed? Would you like to add someone to our mailing list? Simply call or e-mail the farm advisor in your county to make additions or changes to our mailing list.

We strive to extend to you the most recent information pertaining to topics in subtropics. We enourage you to contact your local farm advisor to suggest topics of import to your commodity or industry for inclusion in future editions of this newsletter.

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U.S. Department of Agriculture, University of California, and Tulare County Cooperating

Research Advances on Mitigation of Alternate Bearing in Olive

Elizabeth Fichtner, UCCE Tulare County & Carol Lovatt, UC Riverside

Alternate or biennial bearing is a phenomenon where fruit production alternates between large crops consisting of smaller, lower value fruit during an "ON" year and smaller crops consisting of larger, higher value fruit during an "OFF" year. Alternate bearing is not unique to olive, but also affects other perennial California crops including (but not limited to) pecan, pistachio, apple, avocado and citrus, especially mandarins. The large swings in biennial fruit production impact the overall industry, from growers to harvesters, to processors. The 2009-2011 seasons exemplify the magnitude of the affect of alternate bearing on olive production and crop value in Tulare County (Table 1).

Table 1. Tulare County Olive Production

	Yield (Tons/Acre)	Value (Dollars)
2009 OFF	0.40	5,750,000
2010 ON	7.23	74,128,000
2011 OFF	1.82	23,278,000

Causes of alternate bearing in olive

In olive, the current year's fruit is borne on the prior year's vegetative growth. The current year's fruit, and specifically the pit, inhibits the vegetative growth that supports flower buds for the following year (Sibbett 2000). Consequently, during an ON year, fruit production directly inhibits vegetative growth. A recent Israeli study (Dag et al. 2010) demonstrated the inhibitory effect of fruit on vegetative shoot growth and return bloom in the oil cultivar 'Coratina'. Similarly, in 2011 and 2012 we investigated the relationship between fruit load and vegetative growth on 'Manzanillo' olives in Tulare County. In our study, we assessed the influence of fruit on vegetative growth on ON trees in comparison to OFF trees. Additionally, within ON trees, we assessed vegetative growth on branches bearing fruit and branches not bearing fruit. Our study demonstrated the inhibitory effect of fruit number (crop load) on vegetative growth (Table 2). Vegetative shoot growth was lower for shoots that did not set fruit (-fruit) on ON trees than shoots without fruit on OFF trees indicating a whole-tree effect of crop load in alternate bearing. Additionally, our data demonstrate that fruit-bearing branches exhibit even less vegetative growth than non-fruit-bearing branches on ON trees, providing evidence of a strong localized effect of fruit on shoot growth (Table 2).

Our studies also demonstrated that the bearing status of a shoot influences the following year’s percent bud break of floral buds. For example, shoots bearing fruit in 2011 exhibited over 90% fewer inflorescences than did shoots without fruit, regardless of whether non-bearing shoots were on an ON- or OFF-crop tree.

Alternate bearing is typically initiated by adverse climate. Once initiated, in the absence of additional environmental constraints affecting crop load, the bearing status of an orchard alternates between ON and OFF years, with ON years exhibiting less vegetative growth than OFF years. This biennial cycle, however, can be reset by adverse environmental conditions affecting bloom and fruit set. Adverse conditions 8-10 weeks prior to bloom may cause abortion of female flower parts, resulting in a high proportion of staminate (male) flowers that do not give rise to fruit. Additionally, adverse weather conditions at bloom may impact pollination and subsequent fruit set. Any conditions resulting in loss of crop during an anticipated ON year may render the season an OFF year.

Table 2. Effect of ON- and OFF-crop tree status and the presence (+fruit) or absence (-fruit) of fruit set on a shoot on shoot extension growth. (Orchard 2, Exeter, CA, 2011).

Tree status	No. fruit per shoot	Net shoot growth (mm) and no. of nodes per shoot			
		15 July - 17 Aug		18 Aug - 4 Oct	
ON-crop tree		-- mm --	-- no. --	-- mm --	-- no. --
shoot +fruit	22.8 a[z]	0.0 c	0.1 c	0.0 a	0.1 a
shoot -fruit	0.0 b	9.0 b	0.6 b	1.0 a	0.1 a
OFF-crop tree					
shoot -fruit	0.0 b	24.0 a	1.3 a	1.0 a	0.1 a
P-value	<0.0001	<0.0001	<0.0001	0.4004	0.6024

[z] Values in a vertical column followed by different letters are significantly different at specified *P* levels by Fisher's LSD Test.

Mitigation of Alternate Bearing

Reduction of fruit load prior to the major period of vegetative shoot growth during an ON year may mitigate alternate bearing. Chemical thinning with NAA at bloom may result in a smaller crop with larger sized fruit during an ON year, and allow for more vegetative growth to support the following year's crop.

Current Research on Mitigation of Alternate Bearing using Plant Growth Regulators (PGRs)

During the 2012 growing season, we investigated the potential for applications of PGR treatments to mitigate alternate bearing in olive. The specific goal of PGR treatments was to enhance spring bud break, summer vegetative shoot growth, and return bloom. In the first phase of this project, individual scaffolds of mature 'Manzanillo' olives were injected with a suite of PGR treatments. PGR treatments were injected at two times during the growing season, with winter/spring (pre-bloom) treatments targeting floral bud break, and summer treatments targeting vegetative shoot growth. Additionally, the winter/spring injections were made over a four-month timeframe (January-April) to assess the optimal timing of injections for enhanced floral bud break. Scaffold injection treatments resulting in desired growth responses will be carried forward in future studies focused on determining the efficacy of foliar applications. Treatments included either of two auxin transport inhibitors (tri-iodobenzoic acid and a proprietary auxin-transport inhibitor) injected alone, or in combination with two cytokinins (6-benzyladenine, and a proprietary cytokinin).

In the 2012 growing season, PGR treatments had encouraging results. Cytokinin treatments injected in February resulted in over 60% more floral bud break on non-bearing shoots of ON- trees, as compared to the untreated control. Similar treatments also increased floral bud break over 6 fold on bearing shoots on ON-trees; however, due to the variability in floral bud break, there was no significant difference between treated trees and controls on bearing shoots on ON-trees. All summer PGR treatments (either auxin transport inhibitors or cytokinins, alone or in combination) increased vegetative shoot growth on both bearing and non-bearing branches by over four fold; however, the influence of PGR-induced enhancement of summer vegetative growth on return bloom is not yet known. Return bloom and fruit set will be quantified during the 2013 season to determine the efficacy of PGR treatments on mitigation of alternate bearing on olive.

Selected Literature

Dag, A., Bustan, A., Avni, A., Tzipori, I, Lavee, S., Riov, J. 2010. Timing of fruit removal affects concurrent vegetative growth and subsequent return bloom and yield in olive (*Olea europaea* L.). Scientia Horticulturae 123:469-472.

Sibbett, S. 2000. Alternate bearing in olive trees. California Olive Oil News. Vol. 3, Issue 12.

Alternate Bearing in Mandarin – The basics

Carol J. Lovatt, Professor of Plant Physiology Department of Botany and Plant Sciences, University of California-Riverside

Fruit influence mandarin tree phenology and return bloom and yield.

Effects of the OFF crop, ON crop and removing the entire ON crop on 'Pixie' mandarin tree phenology, vegetative shoot growth, floral development and the next year's yield under California growing conditions have been quantified (Verreynne and Lovatt 2009). Results of this research provide insight into solutions to alternate bearing that can be used now. In addition, the results identified the best time for taking action and established the consequences of delaying action or doing nothing.

For the sake of this discussion, Year 1 starts with bloom. The ON crop (ON year) is initiated with an intense ON bloom, followed by the setting of the ON crop of fruit. We will follow the Year 1 ON crop from fruit set through development to harvest to discuss how and when the ON crop of fruit at each stage of development impacts mandarin tree phenology and return bloom and yield the following year (Year 2). To facilitate comparison of the effects of ON and OFF mandarin crops, we will similarly discuss the effects of the OFF crop of fruit on mandarin tree phenology starting with the Year 1 light OFF bloom, which sets the OFF crop. The phenology models included herein are for 'Pixie' mandarin but apply to other mandarins and sweet oranges, with the exception, in some cases, of the late harvest varieties.

Summer vegetative shoot growth is key to a good return bloom and yield.

OFF-bloom/OFF-crop Year. When the mandarin tree sets and develops an OFF crop, a significant number of vegetative shoots develop during the summer and to a lesser degree during the fall of Year 1 (Fig. 1). The following spring, in addition to the contribution of Year 1 spring shoots to return bloom, the Year 1 summer shoots contribute inflorescences to bloom, resulting in the ON bloom and ON crop in Year 2. For OFF-crop 'Pixie' mandarin trees in California, ~60% of the Year 2 floral shoots are produced by the Year 1 spring vegetative shoots, ~32% by the Year 1 summer vegetative shoots and ~8% by Year 1 fall vegetative shoots (Verreynne and Lovatt 2009). Thus, 40% of the return bloom is contributed by summer + fall shoots. Summer vegetative shoot growth is key to a good return bloom; the more summer vegetative shoots, the greater the return bloom and yield.

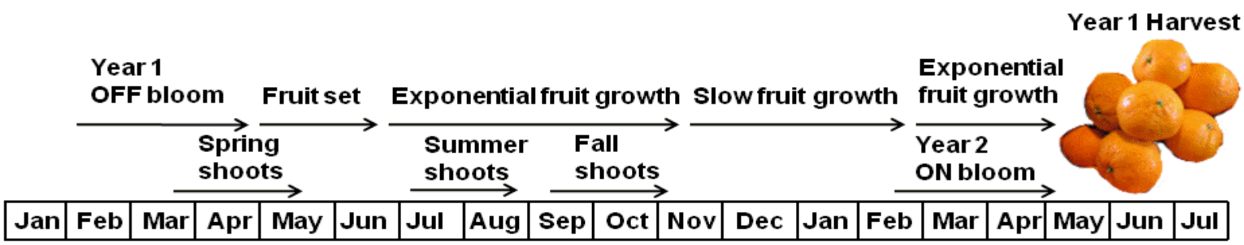

Fig. 1. An OFF-crop year starts with an OFF bloom that sets an OFF crop or is initiated by a climatic or culture event that reduces flower or fruit number during the bloom or fruit set periods. The low number of young developing fruit in Year 1 results in a significant amount of summer and fall vegetative shoot growth that contributes inflorescences to the ON bloom in Year 2, ~32% and ~8% by summer and fall shoots, respectively. Summer vegetative shoots also contribute the majority of leafless inflorescences, which are present in large numbers in an ON bloom. Note that the mature fruit of the OFF crop are fewer in number but large in size.

The setting ON crop of fruit inhibits summer vegetative shoot growth.