Topics in Subtropics Newsletter

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News from the Subtropical Tree Crop Farm Advisors in California

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Farm Advisors

Gary Bender – Subtropical Horticulture, San Diego
Phone: (760) 752-4711
Email: gsbender@ucdavis.edu
Website: http://cesandiego.ucdavis.edu

Mary Bianchi – Horticulture/Water Management, San Luis Obispo
Phone: (805) 781-5949
Email: mlbianchi@ucdavis.edu
Website: http://cesanluisobispo.ucdavis.edu

Ben Faber – Subtropical Horticulture, Ventura/ Santa Barbara
Phone: (805) 645-1462
Email: bafaber@ucanr.edu
Website: http://ceventura.ucdavis.edu

Neil O'Connell – Citrus/Avocado, Tulare
Phone: (559) 684-3312
Email : nvoconnell@ucanr.edu
Website: http://cetulare.ucdavis.edu

Craig Kallsen – Subtropical Horticulture & Pistachios, Kern
Phone: (661) 868-6221
Email : cekallsen@ucdavis.edu
Website: http://cekern.ucdavis.edu

Eta Takele – Area Ag Economics Advisor
Phone: (951) 683-6491, ext 243
Email: ettakele@ucanr.edu
Website: http://ceriverside.ucdavis.edu

Elizabeth Fichtner - Orchard Systems, Tulare
Phone: (559) 684-3310
Email to: ejfichtner@ucanr.edu
Website: http://cetulare.ucdavis.edu

Stephen Vasquez – Citrus & Nut Crops, Fresno/Madera
Phone: (559) 600-7285
Email : skvasquez@ucanr.edu
Website: http://ucanr.org/sites/Citrus/

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.

Elizabeth Fichtner
Craig Kallsen
Co-Editors

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.

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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.

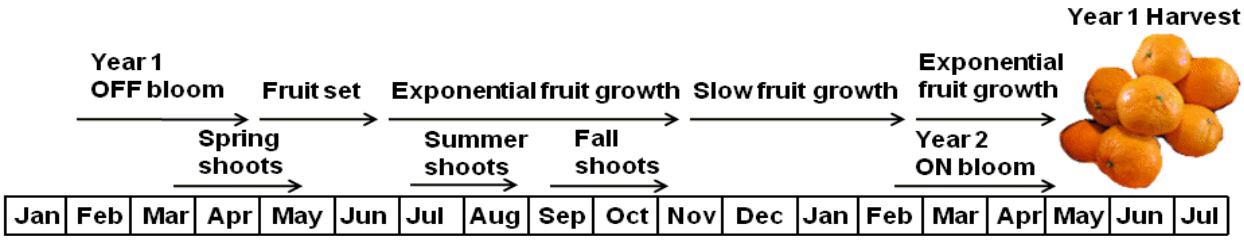

Fig. 1. An OFF-crop year starts with an OFF bloom that sets an OFF crop or is initiated by a climatic or culture event that reduces flower or fruit number during the bloom or fruit set periods. The low number of young developing fruit in Year 1 results in a significant amount of summer and fall vegetative 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.

ON-bloom/ON-crop Year. During Year 1, the ON crop of young developing fruit inhibits summer and fall vegetative shoot growth, thereby reducing the number of buds available to produce inflorescences (and vegetative shoots) the next spring, resulting in an OFF bloom (Year 2) (Fig. 2). Note that due to the inhibition of summer and fall vegetative shoot growth during the ON-crop year, only Year 1 spring shoots contribute inflorescences at return bloom.

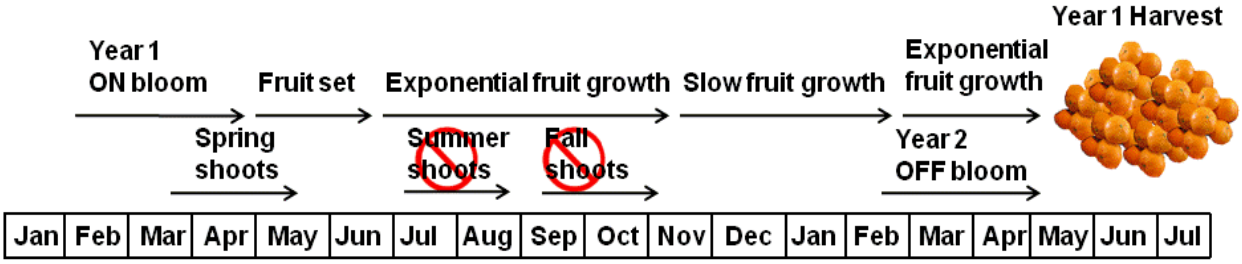

Fig. 2. An ON-crop year starts with an ON bloom that sets an ON crop or is initiated by climatic or culture events that are optimal for flowering and fruit set such that natural fruit thinning fails to take place. The large number of young developing fruit inhibits summer and fall vegetative shoot growth. The loss of summer and fall shoots means there are fewer sites that can bear inflorescences in spring of Year 2, especially leafless inflorescences, which develop predominantly on summer shoots. The result is an OFF bloom in Year 2 that is produced predominantly by the Year 1 spring shoots. Note that there are many small size mature fruit in the ON crop.

The setting ON crop of fruit has a localized and a whole tree effect on return bloom.

On both ON- and OFF-crop mandarin trees, some Year 1 spring shoots set fruit (with fruit) and others fail to set fruit (without fruit). Clearly ON-crop trees have more shoots that set fruit than OFF-crop trees. In Year 1, shoots with and without fruit were tagged on ON- and OFF-crop 'Pixie' mandarin trees. At bloom the following year, the number of inflorescences produced by the spring shoots and summer + fall shoots for each original tagged shoot was counted. Year 1 shoots without fruit on OFF trees produced the most inflorescences on both spring and summer + fall shoots at return bloom (Verreynne and Lovatt 2009). In contrast, Year 1 shoots that set fruit (with fruit) on ON-crop trees produced the least inflorescences. Year 1 spring shoots without fruit on ON trees and Year 1 shoots with fruit on OFF trees produced intermediate numbers of inflorescences.

Fruit exert a localized effect and a whole tree effect on the contribution of spring, summer and fall shoots to return bloom of mandarin trees.

	Year 1 Spring shoots		Year 1 S + F shoots		
	Bud Break (%)	Inflores. (no.)	Nodes (no.)	Bud Break (%)	Inflores. (no.)
Shoots without Fruit					
OFF	31.4 a	9.8 a	10.0 a	33.0 a	7.0 a
ON	15.5 b	2.5 b	2.7 bc	5.0 c	0.8 c
Shoots with Fruit					
OFF	10.8 bc	5.8 bc	4.2 bc	8.4 b	2.1 bc
ON	2.1 d[z]	0.2 c	1.1 c	1.0 c	0.1 c
P-value	0.0001	0.0001	0.0001	0.0001	0.0001

[z] Values in a vertical column followed by different letters are significantly different at the *P*-value specified by Duncan's multiple range test.

The number of shoots that do not set fruit during the ON-crop year is important.

The data above illustrate the interaction between the localized effect of fruit present on a shoot and the effect of crop load. The interactions are strongest for buds on Year 1 spring shoots without fruit on OFF trees and Year 1 spring shoots with fruit on ON-crop trees. The full negative effect of fruit on return bloom in alternate bearing is expressed on spring shoots that set fruit (with fruit) on ON-crop trees. Thus, for ON- or OFF-crop trees, the intensity of the return bloom and yield in Year 2 is proportional to the number of shoots that do not set fruit (without fruit) in Year 1. This is an important concept for managing alternate bearing. ***Example:*** Both Growers A and B have 1,500 fruit per tree. Grower A's crop will be followed by an OFF bloom and OFF crop but Grower B's crop will be followed by another crop of 1,500

or more fruit per tree. *Why?* ***Answer:*** Grower A has very few shoots without fruit that can produce vegetative shoots in summer and inflorescences the next spring, whereas Grower B has more than 1,500 shoots without fruit that will produce summer and fall vegetative shoots and a strong return bloom.

The effect of the ON crop on return bloom is cumulative.

A fruit removal experiment was conducted to determine when the ON crop is exerting its effect on the return bloom (Verreynne and Lovatt 2009). The results demonstrated that the effect of the ON crop on return bloom is cumulative. This basic information is necessary for timing treatments to mitigate alternate bearing. In this experiment, all fruit were removed from sets of ON-crop trees in progressively later months and the intensity of the return bloom on these trees was compared to OFF- and ON-crop control trees. Removing all Year 1 young fruit from ON-crop trees in June, July or August significantly increased the number of summer and fall vegetative shoots that developed and the intensity of the Year 2 bloom and yield to values greater than or equal to the return bloom and yield of Year 1 OFF-crop control trees, which were ON-crop trees in Year 2. Removing fruit progressively later (Sept through Dec), reduced the number of summer and fall vegetative shoots that developed and their contribution to return bloom and yield compared to OFF-crop control trees or ON-crop trees with all fruit removed in June, July or August. Removing fruit as late as December increased the number of inflorescences contributed by the Year 1 spring shoots during bloom in Year 2 compared to ON-crop control trees with no fruit removed, demonstrating that Year 1 spring shoots had viable floral buds through December. However, the number of floral shoots that developed on ON-crop trees with the fruit removed in December was significantly less than OFF-crop control trees and ON-crop trees with their fruit removed earlier in the year, because these trees produced summer and/or fall vegetative shoots that contributed to return bloom. Subsequent research by Arbona and Lovatt demonstrated that the number of inflorescences produced by Year 1 spring shoots decreased incrementally for each month the ON crop remained on the trees past December compared to OFF-crop control trees and ON-crop trees with all fruit removed in December or earlier.

Reducing crop load (i.e., creating more shoots without fruit) mitigates alternate bearing.

The incremental decrease in inflorescence number due to the presence of the ON-crop past December is a problem for 'Pixie' mandarin, 'Valencia' and other late-maturing cultivars. For these cultivars, it is important that ON-crop trees be harvested as soon as possible after the fruit reach legal maturity. In addition, having two crops on the trees into early summer should be avoided to reduce the risk of inhibiting summer vegetative shoot growth and creating a second OFF-crop year in Year 3 (Verreynne and Lovatt 2009). Similarly, alternate bearing is exacerbated by the cultural practice of holding the ON-crop on the tree to extend the commercial harvest period.

Thinning (fruit removal by hand, by chemical or by pruning) the ON crop prior to summer vegetative shoot growth is the most effective time for increasing return bloom and yield (Fig.3A). Summer fruit thinning is also optimal for increasing size of the young, developing fruit. Thinning the ON crop prior to fall shoot growth will increase return bloom and yield to a lesser degree than summer thinning (Fig. 3B). Note that December of Year 1 is the latest time to thin and still obtain a positive effect on Year 2 bloom and yield (Fig. 3C). The goal is to reduce the number of fruit in the ON crop uniformly over the tree sufficiently early to promote summer vegetative shoot growth. Research in a commercial 'Nules' Clementine mandarin orchard in Grapevine provided evidence that fruit drop of the young fruit is minimal by the third week of August in both ON- and OFF-crop years (Chao and Lovatt 2012). It is possible to wait until this time to thin the crop, which will reduce the risk associated with high temperatures that can occur during the June drop period (mid-June through the end of July) but still increase return bloom to a greater degree than fall fruit thinning would accomplish. If the crop is to be thinned by pruning, prune with caution. The goal is a light pruning to promote summer vegetative shoot growth. It must be done sufficiently early (spring or early summer) so the new vegetative shoots have time to mature and develop floral buds. Shoots that develop in response to fall pruning will contribute marginally to return bloom in spring of Year 2, but will provide shoots that will flower in Year 3. Removing summer shoots from spring shoots that did not set fruit (shoots without fruit) defeats the

purpose. Avoid over-pruning, which will interfere with floral bud development. When deciding how many fruit to remove or how much to prune from ON-crop trees, keep in mind that next year's crop will be produced predominantly on Year 1 (current season) spring and summer shoots that did not set fruit (without fruit) or from which fruit have been removed by hand or pruning early in the season. In addition to pruning to reduce crop load, pruning should be done at other times of the year to increase shoot number (fruiting wood) and branching (tree complexity), which contribute to increased floral shoot number and yield the following year and the next.

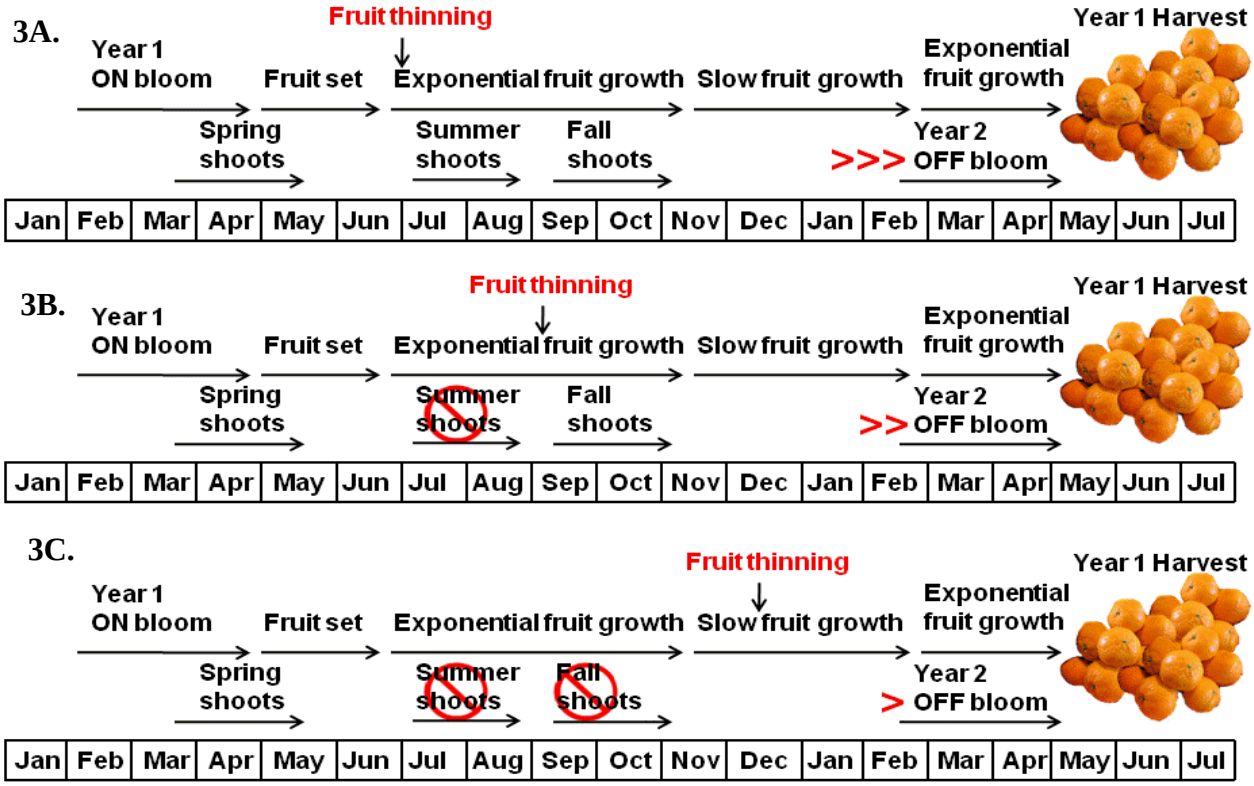

Fig. 3. A, B and C. A. Thinning (fruit removal by hand or chemical) the ON crop in early summer has the greatest potential to increase the number of summer and fall vegetative shoots that develop and thus, the greatest potential to significantly increase floral intensity and yield above that of the expected Year 2 OFF bloom and OFF crop. Early fruit removal also increases the contribution of the Year 1 spring shoots to return bloom. Summer fruit thinning is also the optimal time for increasing the size of the young developing fruit. B. Thinning the ON crop in fall will reduce the number of summer vegetative shoots that develop and their contribution to return bloom and yield, but will increase the growth of fall vegetative shoots and their contribution to increasing Year 2 bloom and yield above the anticipated OFF bloom. Removing fruit at this time will also increase the contribution of the Year 1 spring shoots to return bloom. C. Waiting until December to thin the ON crop will eliminate the contribution that summer and fall vegetative shoots could make to the Year 2 bloom, but will increase the contribution made by the Year 1 spring vegetative shoots so that bloom and yield in Year 2 will be slightly greater than the putative OFF bloom and OFF crop. There is an incremental decrease in return bloom for each month the ON crop of fruit remains on the tree past December.

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