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The 2016 Pistachio Bloom: Chilling hour accumulation, anticipated bloom time, and pollination

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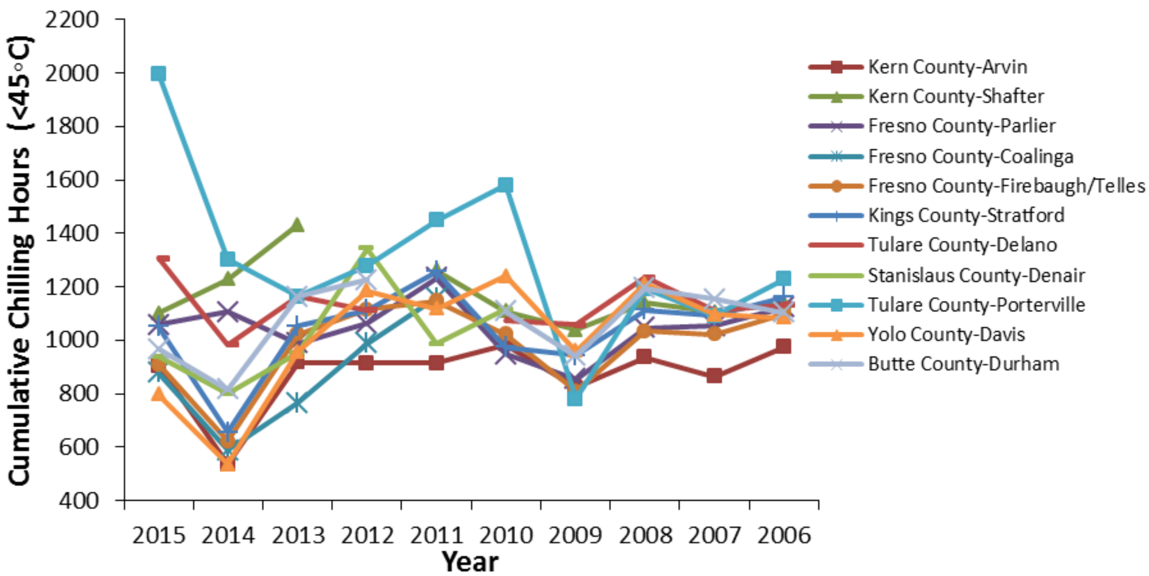
The California pistachio industry suffered the consequences of a warm 2014/2015 winter, leaving growers and allied industries pondering whether the 2015/2016 winter provided enough chill to facilitate the set of a 2016 crop. In general, the chill requirement has been met at most pistachio-growing locations in California. Looking closely at the numbers, however, it's not hard to notice that several sites fall slightly short of the target, and are below the long-term average of cumulative chilling hours in a season (Figure 1). In 1978, Davis had a record low accumulation of winter chill (670 hours); the current season accumulated only 796 chilling hours and last year's catastrophically-warm winter resulted in only 537 chilling hours in Davis. The 200-300 acres of 'Kerman' pistachios in Yolo County may fall short of the chill accumulation for pistachio in 2016. Consequently, even in a "good" year for chill accumulation, there are pockets of acreage that may still fall short of the chill requirement. The remaining question is what percent of the state's pistachio acreage is affected by these regional pockets that may not have met the chilling requirement. Additionally, chill accumulation is only one factor contributing to bloom. Other climatological factors, such as heat unit accumulation, contribute to time and uniformity of bloom. The 2006 pistachio bloom is an excellent example in that sufficient chilling hours were accumulated, but bloom was approximately 1 month delayed in NW Kern County.

Figure 1. Historic cumulative Chilling Hours were compiled from the UC Fruit and Nut Research and Information Center. Values are derived from data collected from CIMIS stations. Missing data points (ie. Shafter, 2013) are due to station failure or vandalism.



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Chill requirement for pistachio. Studies conducted by UC scientists determined that **'**Peters' males have a higher chilling requirement than their 'Kerman' female counterpart. 'Peters' males require at least 900 hours below 45˚C to achieve 50% bloom. The 'Kerman' female requires 700 hours below 45˚C to achieve 44% bloom (Ferguson et. al., 2002). The chilling requirements for new varieties such as 'Golden Hills' and 'Lost Hills' have yet to be assessed. A rough conversion of 900 chill hours converts to approximately 69 chill portions in CA's Central Valley (Pope et al, 2015). Katherine Pope, UCCE Farm Advisor and colleagues recently published a paper elucidating that historic pistachio yields did not fall below average until chill portions dropped below 57 (Pope et al, 2015). This work suggests a disparity between the amount of chill required for budbreak and attainment of yield thresholds.

What happens when the chilling requirement is not met? During the winter of 1977-1978, in the infancy of the California pistachio industry, growers experienced firsthand the effects of a low chill winter on the crop. That winter, only 670 hours of chill were recorded in Davis, as compared to the long-term average of 1,445 hours (Crane and Takeda, 1978). Low chill accumulation results in delayed and irregular bloom, late vegetative development, altered leaf morphology, poor pollen production, death of stigma, reduced fruit set, increased proportion of blanks and unsplit nuts, late maturation, and general reduction in yield (Crane and Takeda, 1978). The 2015 crop was similarly affected by low chilling hour accumulation over the 2014/2015 winter.

How does the winter of 2015-2016 compare with that of 2014-2015? Using the chilling hours calculator on the UC Fruit and Nut Research and Information Center (FNRIC) website, www.fruitandnuts.ucdavis.edu, it is possible to look up the cumulative chilling hours for both the current year as well as historical data. More chilling hours were accumulated during the 2015-2016 winter than during the winter of 2014-2015, which fell short of sufficient chill for pistachio (Figure 1). If we use 900 hours as a 'benchmark' amount of desired chill for CA pistachios, and specifically for 'Peters,' then most pistachio-growing regions attained enough chill during the 2015/2016 winter (Figure 1). Davis, CA and Coalinga, CA, however, both fell short of sufficient chill for pistachio this winter, at 796 and 878 chilling hours, respectively. Let's look at a couple of sites to best conceptualize the difference in chill hour accumulation between the 2014/2015 and 2015/2016 winters. In Arvin, the 2014/2015 winter was characterized by 535 chilling hours; the same site accumulated 904 chilling hours in 2015/2016. In Delano, 983 and 1307 chilling hours accumulated 2014/2015 and 2015/2016, respectively. To summarize, although the past winter felt warm, there were generally sufficient chilling hours below 45˚C to fulfill the chilling requirement for pistachio.

Chill Models: Chilling Hour Model is a summation of the hours below 45˚F. A modified model accounts only for chilling hours accumulated between 32˚F and 45˚F; these are called 'Modified Chill Hours'. Another model, The Utah Model, was designed in the 1970s to accommodate for the fact that warm temperatures may have a negative effect on chill accumulation; the Utah Model represents chill in 'Chill Units' (Table1). The Dynamic Model is a newer model developed in the 1980s, that defined a new concept for the process by which warm temperatures negate chill. The Dynamic Model is represented by 'Chill Portions.' The Chilling Hour and Utah Models have historically been utilized to study the chill requirements of pistachio; however, Zhang and Taylor (2011) recently found the Dynamic Model best for determining fulfillment of chilling requirements on 'Sirora' pistachio in Australia.

Table 1. The Utah Model, a weighted Chilling Hour Model	
Temperature Range	**Units Accumulated or Detracted**
<34˚F	0 units
35-36˚F	0.5 units
37-48˚F	1.0 unit
49-54˚F	0.5 units
55-60˚F	0 units
61-65˚F	-0.5 units
>65˚F	-1.0 units

Limitations of Chill Models. The various chill models used by physiologists are not laws of nature, but statistical models used to represent plant response to a chill-related variable. In short, each model simply calculates the chill-related variable slightly differently. The model achieving the "best fit" may vary from year to year simply because no two years have identical temperature fluctuation profiles from November through February. Second, chill accumulation data is generally derived from CIMIS (California Irrigation Management Information System) stations. CIMIS station-derived data may have gaps due to station malfunction (ie. vandalism). Because the purpose of CIMIS stations is to provide data for irrigation management, maintenance may be delayed in the winter months when the stations are not utilized for their intended purpose. Last, CIMIS stations capture data in specific locations, and data does not capture the variance of chill accumulation over regions or in microclimates.

Figure 2. Male pistachio flower (Photo: G. Brar).

What to expect during bloom. 'Kerman' represents approximately 90% of the current bearing California pistachio acreage with an estimated bloom time for the first week in April in NW Kern Co (Kallsen, et al. 2009). Two new female cultivars developed and released by University of California, 'Golden Hills' and 'Lost Hills,' preceed 'Kerman' bloom by 5-7 and 4-7 days, respectively (Kallsen, et al. 2009). In seasons or locations with low chilling hour accumulation, flowering may be more uniform for 'Lost Hills' and 'Golden Hills' than 'Kerman.' The male pollinator 'Randy' flowers 1-3 weeks earlier than 'Peters,' but has a long bloom period, similar to 'Peters.' 'Randy' may be of benefit as a pollinizer for 'Kerman' in low chill seasons, but generally blooms too early to pollinate 'Kerman' and is more suited to 'Golden Hills' and 'Lost Hills.'

Pollination. Pistachio is a dioecious, wind-pollinated crop; neither the male (Figure 2) nor female (Figure 3) flowers have petals or nectaries. For ideal pollination, the male pollinizer should be at peak bloom during the first 2-3 days of female bloom. The earliest pollinated flowers result in higher nut set (ie. nuts per cluser) then later pollinated flowers (Crane and Iwakiri, 1982). Supplemental, topical application of pollen has not been found effective in enhancing nut set in the 'Kerman'/'Peters' system

(Crane and Iwakiri, 1985, Sibbett and Weinberger, 1994). To date there is no published data on the potential benefit of supplemental pollination of other varieties (ie. 'Golden Hills' or 'Lost Hills'), or the potential benefit of supplemental pollination during low chill seasons where male and female bloom may not be temporally compatible.

Figure 3. Female pistachio flower (Photo: G. Brar).

Acknowledgements. The professional contributions of Craig Kallsen, Louise Ferguson, Dan Parfitt, and Katherine Pope are greatly appreciated, as is the maintenance of the online archived Pistachio Research Reports by the California Pistachio Research Board. For more information on any given topic, readers may visit www.calpistachioresearch.org. Photos were graciously provided by Gurreet Brar.

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Planning for your summer tree nut weed control

Kurt Hembree, UCCE Farm Advisor, Fresno County

Winter weeds were abundant this year, thanks to the high amount of rainfall we had. Hopefully you found time between storms and were able to get into your orchards and treat for weeds. Given moist soil conditions and warming temperatures close at hand, summer weed growth is also expected to be high. So, are you ready to go with your summer weed control program?

Hopefully you already know what weeds you'll be up against. If not, look to see if there are new ones emerging in recently-watered orchards or after the last rainfall. Note specific weeds so herbicide(s) can be selected accordingly. When it comes to herbicide selection, make sure you're using products that are effective against your specific weeds, which often vary from field to field. Also, select herbicides and rates that are appropriate for the soil type; lower rates of preemergent products are often needed on sandier soils than heavier soils. Consider using sequential treatments where appropriate if rainfall occurs in April, which can help extend control through summer.

Remember to add postemergent products to the tank if weeds are already up and growing when you treat. If glyphosate-resistant horseweed, hairy fleabane, junglerice, or ryegrass are present, and you still want to use Roundup or a similar material, be sure to add another burn-down material that is effective on those weeds. Combining Treevix or Rely 280, Lifeline, or similar product with Roundup has worked well on these and a wide variety of weeds. Be sure to treat when the weeds are small for optimum control. Don't wait to spray when weeds are large, droughty, or dense, or herbicide coverage and performance may suffer. Use spray tips, a spray volume, and spray pressure that adequately wets the weeds, while minimizes spray drift.

To make your tree nut weed control efforts the most effective and efficient they can be, consider these important measures before treating:

- ✓ Make sure spray equipment is functioning properly and has been recently calibrated. You should have ample spray equipment and labor available to ensure treatments are timely.
- ✓ Select herbicides and rates based on the specific weeds present or expected. Each orchard may have different weeds, so adjust herbicide mixes accordingly.
- ✓ Use spray nozzle tips, a spray pressure, and a travel speed that is adequate for the desired coverage of the herbicide type(s) (contact, systemic, and preemergent) being used. Use drift-reducing spray tips and/or spray shields where possible to help mitigate spray drift concerns.
- ✓ Make sure postemergent materials are applied to small, succulent weeds within two to three weeks after emergence. Preemergent materials need to be applied within 14-21 days of rainfall or irrigation.
- ✓ Evaluate the performance of each treatment and adjust the next treatments accordingly.

It's also very important to rotate and/or tank-mix herbicides with different mode of actions (MOA) whenever possible to reduce the risk of herbicide-resistant weed development and preserve herbicide effectiveness. Following is a list of registered herbicides in California perennial tree nut crops, along with their specific MOA group numbers and sites of action. To rotate and/or tank-mix herbicides effectively, simply select specific herbicide products for your specific nut crop type with different active ingredient MOA group numbers.

Herbicides and their mode of actions registered in tree nuts in California

MOA (group)	MOA (site of activity)	Herbicide (active ingredient)	Herbicide (product example)
1	Acetyl CoA carboxylase	fluazifop clethodim sethoxydim	Fusilade DX Select Max Poast
2	Acetolactate synthase	flazasulfuron rimsulfuron penoxsulam (2) + oxyfluorfen (14)	Mission Matrix FNV Pindar GT
3	Microtubule assembly	oryzalin pendimethalin trifluralin	Surflan A.S. Prowl H2O Treflan HFP
4	Synthetic auxin	2,4-D amine	Orchard Master
5	Photosystem II	simazine	Princep
7	Photosystem II	diuron	Direx
8	Lipid synthesis	EPTC	Eptam
9	EPSP synthase	glyphosate	Roundup
10	Glutamine synthase	glufosinate	Rely 280, Lifeline
12	Carotenoid biosynthesis	norflurazon	Solicam
14	Protoporphyrinogen oxidase	carfentrazone flumioxazin oxyfluorfen pyraflufen saflufenacil	Shark Chateau Goal Venue Treevix
21	Cellulose biosynthesis	isoxaben	Trellis
22	Photosystem-I-electron diversion	paraquat	Gramoxone Inteon
27	Hydroxyphenylpyruvate dioxygenase	mesotrione	Broadworks
29	Cellulose biosynthesis	indaziflam	Alion
This is not an endorsement for any of the trade names listed, nor does the omission of specific trade names reflect the view of the author. Refer to your local chemical dealer or manufacturer for specific herbicide products available. Consult the manufacturer's labels for specific crop and treatment recommendations. *Kurt Hembree, UCCE, Fresno County. November 2015.* (*http://cefresno.ucanr.edu/sites/Weed_Management*)			

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