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January 2019 Task List for Pistachios
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Chilling and Cold Weather Update: LAST YEAR the first frost did not occur in the southern San Joaquin until December 5th. **THIS YEAR** the first frost occurred right on schedule during the second week in November. We then had ten days in which the night temperatures were 31-33^{0}F. This helped induce the early stages of dormancy, by desiccating the leaves and hardening off current season's growth. We have also had some good rains, and as I write, Ocean Beach surf in San Francisco is breaking at 12-15 feet, telling us that the "Aleutian Juice" is heading our way! Bring it on, Baby! Pray for rain to fill the reservoirs! Let's find out if they fixed the Oroville spillway correctly!

Table 1 provides the chill portions for various sites throughout the Valley between September1 and December 10 for the past five winters, as well as 2010 in which over 70 chill portions were accumulated by February 15. This exceeds the 58-60 chill portions estimated to satisfy the rest requirement of the Kerman cultivar. The Peters male may have a chill portion requirement as great as 65. The values in parentheses are the **total chill portions** accumulated by station and year, up to February 15. My study of the chill accumulation patterns the past few years suggests there have been MORE cold weather events after the traditional cut-off date than usual. Hence, trees with high Rest requirements like pistachio and walnut probably benefit from chill portions accumulated up to March 1, and possibly even March 15.

I have now reached the point in my horticultural career where I can confidently say that I know little about Rest in deciduous tree crops. Had I declared this when I was 30, my colleagues would have branded me incompetent. I have read the old and some of the new literature, and sat at the feet of Davis professors expounding on the concept of Rest, and how winter temperatures below 45^{0}F are needed to "satisfy" complex physiological processes that we still know little to nothing about. I also drank the Kool-aid about chilling hour accumulation below 45^{0}F as the best method for Rest assessment in California, and then cautiously accepted the "Dynamic Chill Portion" model as the new gold standard. However, after 40 years of trying to make sense of what REALLY happens to deciduous trees during the winter, I can only explain the obvious; trees not receiving "Adequate Rest" struggle to leaf out and bloom, and produce less crop presumably because they are depleted in carbohydrates, develop leaf area for its replenishment slowly, and have weak or poorly overlapping bloom which does not set enough fruit.

Over the years, Rest researchers generally agree on the following: (1). It is the BUD temperature that concerns us. Light, wind, fog, and shade all affect bud temperature. Clear, sunny days can elevate bud temperatures 10^{0}F above the air temperature. Wind also warms buds slightly above ambient temperature. Fog and shade make the bud temperature equal to ambient. (2). Rest satisfaction begins in the fall when the terminal buds are no longer active, and the leaves no longer functional. (3). December and January are believed to be the two most important months for Rest satisfaction. (4). Deciduous trees with high vigor and nitrogen status in the fall have a higher Rest requirement than trees with moderate vigor and nitrogen level. (5). Researchers report in the literature that periods of "non-chilling" temperatures interspersed through the winter increases the plant's chilling requirement. The increase depends on the magnitude of the elevated temperatures, and their duration.

I have gone back and reviewed the chilling observations of Dr. Julian Crane, as well as the research Dr. Louise Ferguson and I performed individually and collectively. It all clearly states that Kerman and Peters do not grow normally when winter Rest is inadequate. Our research efforts suggest Kerman requires 750 hours below

45^0 F, and Peters 850 hours in order to leaf out and bloom promptly in the spring. One experiment suggested that Peters continued to benefit from cold temperatures up to 1200 hours below 45^0F. It was also reported in these studies that a minimum of 500 hours below 45^0 F was needed to initiate much bud break from Peters. University of California Circular 179, "Deciduous Orchards in California Winters", by W.H. Chandler and D.S. Brown (1936), states that December and January are the two most critical months in California to satisfy the rest requirement. It was their belief that optimal Rest conditions occurred when EACH of these months received 400 hours below 45^0F. In recent years, we have been fortunate to get 200! During the 2013 and 2014 winters, the unusually warm temperatures in January did not provide its complement of chill hours.

Craig Kallsen, UC Farm Advisor for Pistachios and Subtropicals, Kern County, recently published a refereed journal paper summarizing thirty years of pistachio yield data from three Kerman/Peters orchards in Kern County. Armed with CIMIS weather data proximal to each orchard, Craig studied the relationships between yield the previous year and a number of calendar periods including fall and winter temperatures preceding the next crop year. This data set showed a positive correlation between yield and hourly air temperatures greater than or equal to 45^0F and less than 60^0F. The accumulation of chill portions or hours **did not** correlate as well with yield as the hours accumulated at temperatures between 45-60^0F. Modeling fall and winter air temperatures above 65 and bloom temperatures above 80^0F both resulted in negative correlations (reduced) with yield. This data makes me think there is a LOT of pistachio physiology that I do not know, and hence my earlier statement that I question my knowledge about Rest! Those interested in fully understanding Craig's study and entering your own data for yield prediction can do so at: http://cekern.ucanr.edu/files/260681.pdf.

The effect of high winter temperatures is **thought** to elevate the bud respiration rate which consumes the limited amount of stored carbohydrates critical for spring growth. UC Davis Plant Sciences Associate Professor Maciej Zwieniecki (Dr. Z), and his Reseach Associate, Anna Davidson, have joined our pistachio industry research team to study this important aspect of tree biology. Dr. Z suggests there may be a critical amount of carbohydrates and other growth substances needed to produce normal growth in the spring. This may explain why oiled trees performed so poorly in 2015. Oil is **thought** to enhance rest breaking by causing a slight stress to the tree which is not phytotoxic. In the process of metabolizing the oil, the tree **may** increase its respiration rate, which renders it more responsive to favorable spring temperatures for growth. Thus, high January temperatures and oil treatment possibly have a compound effect on carbohydrate depletion from elevated respiration. When the time comes for bud break, the deficiencies in both chilling and available sugars create the perfect storm for poor leaf out and fruit set. There could also be detrimental effects to male and female flower development and receptivity.

To check on your local chilling, go to the "Weather-Related Models and Services" section of the UC Fruits and Nuts Center. Select "chilling accumulation models" from the menu, and then "Cumulative Chilling Portions". This site allows you to see the chill portion accumulation for every CIMIS station in the state. You can also click on a given station to get historical data. I find this helpful in estimating where we are relative to other years. You can also compare chill portions to chill hours at this webpage. Keep in mind that these stations were designed to accurately estimate water use, NOT chill accumulation. The data is collected in an open grass-covered area which may influence the temperatures compared to those within the orchard environment. The absence of fog also causes temperature differences up to 20^0F between ambient (air) and the buds. Obviously, we are concerned with the bud temperatures, so it would be helpful to make note of those warm, fog-less winter days.

Table 1. Chill portion accumulation for various CIMIS stations statewide from 9/1-12/10 for selected years. Numbers in parentheses are the total chill portions accumulated at each station by year from 9/1- 2/15.

Year	2018-19	2017-18	2016-17	2015-16	2014-15	2013-14	2010-11
Durham	27	21(62)	23(64)	25 (66)	22 (55)	20 (54)	28 (70)

Patterson	na	19(na)	16(54)	20 (59)	23 (63)	22 (63)	26 (73)
Madera II	na	20(na)	22(68)	25 (66)	25 (52)	15 (57)	23 (na)
Parlier	21	16(52)	14(56)	26 (67)	27 (64)	22 (53)	27 (74)
Five Points	21	15(52)	15(56)	24 (65)	15 (52)	20 (55)	24 (69)
Coalinga	21	14(50)	16(60)	25 (62)	13 (48)	20 (53)	28 (70)
Shafter	22	17(51)	12(49)	24 (59)	25 (61)	24 (63)	23 (70)
Delano	20	na	15(56)	25 (65)	16 (58)	22 (56)	24 (73)
Blackwell's	21	16(58)	18(60)	24 (67)	15 (52)	21 (50)	27 (75)
Arvin/Edison	19	13(48)	15(54)	23 (61)	10 (44)	21 (55)	22 (66)
Porterville	24	16(na)	14(49)	30 (76)	20 (63)	22 (59)	27 (63)

Clays and Calcium for Dormancy Improvement? Tests of winter applied kaolin clay or calcium carbonate-based materials intended to either reflect solar radiation or diffuse have been performed, but I am not sure they will be continued. Results from David Doll, former UCCE Farm Advisor, Merced County, and Valley Orchard Management, showed a 200 to 250 pound increase in APC yield over untreated trees when Surround (kaolin-clay) was applied prior to the 2015 season. In 2016, trees treated with dormant oil yielded more than either the untreated or Surround treated trees. In 2017, the untreated, Surround, and Surround plus oil treatments yielded more than the oil alone treatment, but not the Surround plus oil treatment. Thus, the Surround plus oil treatment has yielded the most over two years. However, there is insufficient data to recommend any of the treatments. David believes the test results are partly associated with differences in rest satisfaction, since Surround application provided approximately 10 percent greater chill portion accumulation from lower flower bud temperatures. The 2014 winter was well below the chill portions required for adequate pistachio rest; hence the kaolin treatment was more valuable. High chilling during the 2015 winter rendered the kaolin treatment less valuable in 2016, and the reduced yield in 2017 from the winter oil treatment could simply be an alternate bearing effect. Our lack of understanding the physiological effects of oil, reflective, and diffusion materials makes this research very difficult.

Calcium carbonate-based diffusion materials work differently than kaolin-based clay materials. Kaolin clays reflect light to reduce the absorption of solar radiation by plant tissue such as flower buds. It is also marketed as a finely ground powder, which growers report to be more difficult to apply than liquids. In contrast, calcium carbonate crystals modify the incoming light through a process called double refraction. This essentially divides the light rays as they intercept the crystals, and thus reduces their energy. Incoming light can also hit the crystals whose size matches the incoming wavelength, resulting in a so-called "sparkler effect" in which light is dispersed in multiple directions. Both light division and the sparkler effect reduce energy absorption by the plant, resulting in lower temperature. My intent in describing the methodology of calcium carbonate is NOT to suggest it is better than kaolin-clay. It is simply to inform the reader that kaolin-clay and calcium carbonate are distinctively different in their mode of action.

We cannot tell you if kaolin-clay or calcium carbonate provides statistical improvement in chill accumulation and subsequent yield benefit, because this research is slow to progress, due to the complexity of its performance. The weather also cannot be controlled to secure the needed temperature differences.

Field reports indicate some growers have begun treatment of these products in early December as a precaution. The use rates of the various kaolin-clay products vary from 25 to 40 pounds per acre. The liquid calcium carbonate is typically applied at four gallons per acre. Re-application is recommended after significant rainfall. Applications are not presently advised in February, unless one desires to delay bud break and bloom due to the risk of spring frost in your growing area. The cost per application is estimated at $80-90 per acre.

Rain? Bring It ON! Growers wishing to periodically check on reservoir and snowpack status can do so my website: http://cekings.ucanr.edu/Agriculture/Grapes_Tree_Fruits_Nut_Crops/. Select "Management" in the main menu, then "Water and Weather". Select "Snowpack Status" from the menu, which will link you to the state water resources webpage. This page converts snowpack into water content and plots it for three major sections of the state. It also compares this year to wet and dry seasons and the 30-year average. These plots really provide a visual picture of where we stand in water availability. Statewide reservoir conditions can be accessed by selecting "Reservoirs Status" from my webpage menu. This takes you to a DWR web site that lets you click on the reservoir of interest. It then brings up information about current and historic water status, and allows you to select what years you would like to compare in graphic form. It is pretty neat, and gives you lots of sound data to spread around at the coffee shop! Keep rain in your prayers!

Happy New Year, Farming, and see you at Pistachio Day, Wednesday, January 16, 2019, at the Visalia Convention Center!