**Chilling, Cold Injury, and Dormant Oil Research in Pistachio (Kerman and Peters cv.)**

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**Chilling**: Thus far, this is a colder winter than last year. Hopefully we will have no problem in meeting the 850 hour estimated chill requirement for pistachio. Here are the 2007 chilling hours as of January 10 with last year (a poor chilling winter with a reported range from 548 to 953 hours) in parentheses: Blackwells Corner: 604(330), Shafter: 672(487), Visalia: 677(454), Parlier: 650(428), Madera: 575(511), Durham: 628(492) and Orland: 592(486) hours below $45^0$ F. As you can see, we are well ahead of last year. To check on your local chilling, reference my website, http://cekings.ucdavis.edu. From the main page, select and click on agricultural research and education, then grape, tree fruit and nuts in the blue menu box on the left. Once on my UC webpage, scroll down and select chilling hours under the "Management" heading. I report unadjusted hours (simply those below 45) beginning November 1 and ending February 15 because this is the standard used for years in the San Joaquin Valley. I am not saying it is better than the "adjusted method" where hours below 32 and above $60^0$ F. are subtracted. It is merely an accepted reference point for comparing years. This standard indicates the average chill hours between 1973 and 2006 are 1064 at the Parlier station. Out of these 33 years, 11 have been less than 900 hours. **Eight** of those low chill years have occurred since 1994!

**Freezes:** Our recent **"Artic Freeze" given the time of the season of its occurrence**, should not be a problem for **established** pistachios, providing the temperatures do not get down to around $10^0$ F. Cold injury is a function of many factors, including the degree of coldness, its duration, tree age and the degree of plant dormancy at the time cold temperatures occur. Newly planted P. *integerrima* or UCBI may suffer "burn down" on the upper part of the dormant stock, but experience has shown that buds closer to the ground usually remain alive and grow vigorously in the spring. If temperatures reach $25^0$ F in early November, damage can occur to young trees. It is best to have some moisture in the soil when unusually cold weather occurs. This stores heat during the day for later release at night and insures that the water relations within the tree are not stressed. Growers with young trees could experience some slow emergence of the vigorous one-year-old wood higher in the canopy if the Artic cold temperatures are prolonged. Remember two things: 99% of the time, the worst never happens, and farming is risky business!

**Oil**: Since 1994, the author has conducted numerous trials to document the effect of dormant-applied horticultural mineral oil on breaking rest in pistachios. **Registered for control of soft scale and *Phytocoris*** (overwinters in the egg stage), oil also assists in overcoming the delayed leafing and erratic bloom associated with insufficient winter chilling hours. University of California research and field observation suggests the pistachio cultivar, Kerman, requires about 850 hours below $45^0$F for **complete** rest satisfaction. The effect of dormant oil application on breaking pistachio rest was first documented by the author in 1993 as part of the Phytocoris research (see Ca. Pist. Ind. Ann. Rpt. 1993-94). This response was confirmed in 1994 with large scale application of oil alone and in combination with Sevin®, a carbamate pesticide highly effective against soft scale and possessing plant growth regulator activity. Dormex® (hydrogen Cyanamid) was also tested at 2% and 4% concentrations. Oil and Dormex® were equally effective. A small trial by Ferguson in 1996 also confirmed the effectiveness of Dormex® as a rest breaking agent and showed significant increases in split nut production with its use (see Ca. Pist. Ind. Ann. Rpt. 1996-97).

In 1997 the horticultural mineral oil Volck (possessing a $476^0$F 50% distillation point) was applied mid-January, February and March to eight year-old Kerman pistachio trees grown on four different rootstocks (Atlantica, PGI, PGII, UCBI). This randomized and replicated experiment was conducted over four years in which there were high and low chilling hours. Rootstock type had no significant effect on oil response. Oil applied in January and February proved highly significant in advancing bud break, flower development and kernel filling over all four rootstocks studied when compared to untreated trees. Trees sprayed with oil in mid-March were no different in these growth parameters than control trees. Oil applied in mid-February provided the greatest advancement in vegetative and flower bud growth. Yield data collected over four years showed dormant oil treatment significantly increased split nut production. **Cumulative edible split nut yield** was 84.7, 91.1, and 79.6 pounds per tree for the January, February and March oil treatments, respectively, compared to only

67.6 pounds for the untreated trees. Although no yield improvement was observed in the unusually cold and wet 1998 El Nino season, a five-pound average increase in edible split nuts was recorded for the January and February treatments in 1997. Oil treatment in 1999 resulted in an average increase of 4.7 pounds edible split nuts. In 2000, the oil treated trees averaged 10 pounds more edible split nuts. **The increase over the untreated trees was significant for only the mid-February treatment which had 15.6 pounds more edible split nuts per tree.**

In addition, an orchard trial was established in western Kings County with Nichols Farms in 1997. This compared trees treated annually with Volck® dormant oil to untreated trees under commercial conditions for six years (1997-2002). A uniform block of 10-year-old trees was selected and eight, 20-tree plots were established in a randomized complete-block experimental design for each of the two treatments. Oil treatment was performed in mid-February from 1997 to 2002 at the rate of six gallons per acre in 200 gallons of water.

In addition to repeated shoot growth measurements and bloom rating, a timed flower bud drop survey was performed. It indicated significantly fewer buds fell off the oil treated trees compared to the untreated (5.1 versus 8.2 per 2 minute count). Similar counts performed in 2002 at the Kettleman Pistachio orchard where Volck® and 415 oils were applied in mid-January and February showed only about 7 flower buds lost in the mid-February treatments compared to about 17 in the January treated and untreated trees.

After six years, the cumulative yield improvement from dormant oil treatment is 602 split nut pounds per acre and 695 less edible closed shell pounds. Most of the edible closed shell occurred in the 2002 season (540 pounds). This was believed to be due to water stress associated with poor water infiltration. The greatest split nut yield increase of 700 pounds per acre was recorded in 1999. **In addition to the yield variability inherent with alternate bearing, the fluctuations in yield improvement from oil application may be associated with pruning severity, deficit irrigation, insufficient winter chilling hours and its effect on bloom overlap, unfavorable weather during bloom, and the absolute number of flower buds per tree. Of these, pollination efficiency, water stress and flower bud number are probably of greatest importance**. In the researcher's opinion, the absence of a yield response from oil during the 1998 El Niño weather phenomenon supports this statement. During this bloom period, nine out of 13 days had measurable rainfall, which totaled 1.95 inches.

The Nichols trial also suggested that repeated dormant oil treatment reduces the severity of alternate bearing in pistachio. Calculation of the alternate bearing index shows a reduction of 21.4% from oil use. This could be very useful to the industry in mitigating large production fluctuations within individual orchards and between seasons. This trial indicates oil advances nut maturity by four to five days which can be valuable to larger growers wishing to initiate harvest sooner. It is also a reported advantage to processors needing new product to fill pending orders.

A three year oil spray timing trial was performed on mature trees with Chris Wylie, Agri-World Cooperative Ranch Manager, Madera. Beginning in mid-January, Chris applied Volck® oil weekly to individual rows up until the first week in March. Weekly ratings of vegetative and floral development were then performed until the nutlet stage. Summary of these evaluations supported the recommendation that the most advanced and uniform leafout and bloom resulted from oil treatment during the first two weeks in February. Earlier treatment resulted in more advanced leafing, but slightly slower bloom. Treatment after mid-February was not as consistent or advanced. March applications were only slightly different from the untreated trees. No yield data was taken.

**Oil on young pistachios:** No phytotoxicity from properly applied oil has been observed in trials on one to seven year-old trees. **It is essential that oil be stored in clean, dry containers to avoid degradation of the emulsifier. Sprayer speed of travel must also not exceed 2 mph to prevent poor coverage and erratic response!** In 2002, a "good" chill winter (976 hours at Parlier), a replicated trial was performed with Clark Farms using seven year-old trees. Volck® and 415 oils were each commercially applied on the 15$^{th}$ of January and February at 6 gpa. In addition to weekly monitoring of shoot and flower development, four trees were hand harvested to obtain the total field weight. Samples were then submitted to a processor for assessment of nut quality. These results are shown in Table 1.

Table 1. Yield and nut quality from seven year-old pistachios treated with 415 and 476 oil on the 15th of January and February, 2002. Data an average of four trees. Values represent pounds. Numbers followed by the same letter are not statistically different at p=0.05.

| Treatment | Total Dry Wt. | Edible Splits | Edible Closed | Blank Nuts |
|---|---|---|---|---|
| 415 Jan 15 | 15.0 c | 11.3 c | 0.75 a | 1.75 c |
| Volck Jan 15 | 31.3 a | 25.0 a | 1.5 a | 3.0 bc |
| 415 Feb 15 | 30.7 ab | 22.0 ab | 1.75 a | 5.25 a |
| Volck Feb 15 | 29.5 ab | 21.3 ab | 2.0 a | 4.0 ab |
| Untreated | 23.3 b | 17.3 b | 1.5 a | 3.25 b |
| C.V. (%) | 18.5 | 19.6 | 62.4 | 27.6 |
| LSD (lbs.) | 7.4 | 5.8 | 1.4 | 1.5 |

In 2003, the same oil test was performed with David Demkey (Tejon Farming) in a seven year-old orchard with only 550 chilling hours. This amount of chilling is considered to be near the threshold of severe inadequacy. Oil applied in mid-February resulted in 50% bloom on April 10 compared to May 1 for the untreated trees, a difference of 21 days. Unfortunately, yield data could not be collected.

With 2006 appearing to be another insufficient chilling winter, two replicated trials were established with Munger Farms in Burrel, California. One was in six year-old pistachios, and the other was in seven year-old trees on heavier soil. In both trials, four-tree plots were used and each contained its own male. Britz 415 and 470 oils were applied January 13 and February 13 by speed sprayer and randomly replicated down the row five or six times. Shoot growth, bloom development, and yield data was then collected on the inside two trees of each plot. A twenty pound sample was taken from each plot following commercial shaking and analyzed at the Monarch plant. Weather recorders on-site indicated 800 unadjusted hours were obtained by February 15.

Table 2 shows the yield and nut quality data from the trial on the six year-old trees. Application of 415 oil in mid-January provided less rest breaking response in terms of bud and floral development. The January timing was improved with the use of the heavier 470 oil. Applying the 470 oil in mid-February provided the earliest and most uniform leafout and bloom. Mid-February treatment with 415 oil was very similar. The yield data shows oil treatment increased the total amount of nuts harvested from the two-tree plots. Total split nut production (edible + shelling stock) was increased with all oil applications. The shelling stock was primarily dark stained nuts from delayed harvest. The calculated difference between the untreated total split nut production and the average of all four oil treatments is 6.7 pounds, or 3.3 pounds per tree. The total split nut percentage was greater in the untreated trees (77.5%) than the oil treated (71.6%), and suggests that oil application so early in the tree's bearing life may be taxing its production capacity.

It is the author's opinion that the **lack of statistical significance** between treatments is a reflection of the large yield variability encountered between pistachio trees. Performing field trials with sufficient tree numbers to reduce the coefficient of variation (CV) becomes logistically impossible without a major investment of resources by the grower and industry. In order to obtain 12 data trees for each treatment (six reps x 2 trees/rep), each of these trials involved over 155 trees in one row a half mile in length. This was also not an industry-funded project. The author is grateful to Munger Investments for their generous support.

Table 2. Yield and nut quality for six year-old Kerman pistachios treated with 415 and 470 oil in mid-January and February compared to untreated trees. Based on five, two-tree replications per treatment. Values represent pounds. Values followed by the same letter are not statistically significant at p= 0.05.

| Treatment | Total Dry Wt. | Edible Splits | Shelling Stock | Edible Closed | Blank Nuts |
|---|---|---|---|---|---|
| 415 Jan 15 | 46.2 b | 30.4 b | 4.2 b | 0.6 ab | 4.4 b |
| 470 Jan 15 | 45.8 b | 26.2 a | 7.4 a | 0.8 ab | 3.8 a |
| 415 Feb 15 | 40.6 b | 22.6 a | 4.6 b | 1.2 bc | 4.0 a |
| 470 Feb 15 | 44.2 b | 25.8 a | 6.4 a | 1.8 c | 4.0 a |
| Untreated | 33.2 a | 23.8 a | 2.0 c | 0.4 a | 2.8 a |
| C.V. (%) | 18.0 | 22.9 | 37.7 | 58.0 | 34.6 |
| LSD (lbs.) | 6.0 | 5.9 | 1.8 | 0.7 | 1.6 |

Table 3 shows the yield and nut quality data from the trial on the seven year-old trees. Like the six year-olds, the oiled trees were about seven days advanced in leafout and bloom over the untreated trees. There was good overlap between the Peters male and the oiled Kerman females. The seven year-olds responded more consistently than the six year-old trees. Trees treated in February produced the more total dry weight than the two January treatments. The January treatments were very similar in yield and nut quality to the untreated trees. The February 470 treatment performed the best. The two trees harvested per plot averaged 4.8 pounds more clean open splits and 2.5 pounds shelling stock than the untreated trees. This equals 3.65 pounds of total split nuts per tree, or 482 pounds per acre (132 females/ac). The February treatments also produced slightly more edible closed nuts than the untreated trees. However, the large degree of variability in tree performance prevented much statistical separation of the means within any nut quality category. Seven year-old pistachios treated with oil also showed less affect on total split nut percentage compared to the six year-old trees. The average total split nut percentage for the seven year-old trees with oil was 80.5% compared to 84% for the untreated, a difference of only 3.5%. The difference in the six year-olds was almost 6%.

Table 3. Yield and nut quality for seven year-old Kerman pistachios treated with 415 and 470 oil in mid-January and February compared to untreated trees. Based on five, two-tree replications per treatment. Values represent pounds. Values followed by the same letter are not statistically significant at p= 0.05

| Treatment | Total Dry Wt. | Edible Splits | Shelling Stock | Edible Closed | Blank Nuts |
|---|---|---|---|---|---|
| 415 Jan 15 | 51.7 ab | 39.2 a | 4.2 a | 1.5 a | 3.3 b |
| 470 Jan 15 | 51.0 bc | 38.5 a | 3.5 a | 0.8 a | 3.3 b |
| 415 Feb 15 | 57.0 ab | 39.7 a | 4.3 a | 2.7 b | 5.2 ac |
| 470 Feb 15 | 65.0 a | 46.5 a | 5.0 a | 2.2 a | 4.2 bc |
| Untreated | 52.5 ac | 41.7 a | 2.5 a | 1.0 a | 3.3 b |
| C.V. | 20.0 | 21.2 | 61.3 | 77.4 | 28.9 |
| LSD (lbs.) | 13.3 | 10.5 | 2.9 | 1.5 | 1.3 |

These trials suggest that young trees with adequate chilling and high potential crop benefit somewhat from oil treatment. However, the additional nut set may exceed the capacity of some six year-old trees, depending on tree vigor, irrigation, and seasonal weather. The split nut percentages in the seven year-old trees were less affected by oil application than the six year-old trees. It is not known whether this was associated with tree capacity or the heavier soil present at the seven year-old site. The heavier 470 oil applied in mid-February also appeared to break rest the best without any signs of phytotoxicity when properly stored and applied. Application of 415 or 470 oil in January has not been as consistent in its response in the trials conducted by the author. This is not to say that it will not work at this time in certain years and under certain conditions. The consistency of January treatments may be more dependent on the amount of chilling received at the time of application. The data collected thus far indicates that January applications should be made with a 470 oil, rather than a 415.

Oil is not for everyone. Oil is a tool with many factors affecting its performance. It can not put buds on trees. It can not overcome deficit (NOT regulated!) irrigation, which significantly limits the tree's productive capacity from low carbohydrates and insufficient fruitwood. Oil applied at sprayer speeds too fast for optimal coverage, improperly timed, applied to stressed trees, used at too low a concentration, applied by tractor drivers who miss rows, or used in an area with potential spring frost can easily negate any benefits of use.