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In a Nutshell
Tulare and Kings Counties

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Winter Chilling of Pistachio: Consequences of Low Chill and Implementation of Online Chill Calculators

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The pistachio industry has thrived in the southern San Joaquin Valley (SSJV) of California due to the unique climate that historically contributes adequately to the accumulation of heat units in the summer to promote crop development and chill units in the winter to break dormancy for production of the successive crop. Climate anomalies are not uncommon, with the recent 2021 summer characterized by excessive heat throughout California's main pistachio-growing regions (Figure 1). The abnormally hot summer, characterized by over 40 days with high temperatures at or above 100°F in the SSJV. (Figure 1B), may now be followed by an unusually warm winter, as predicted by the National Oceanic and Atmospheric

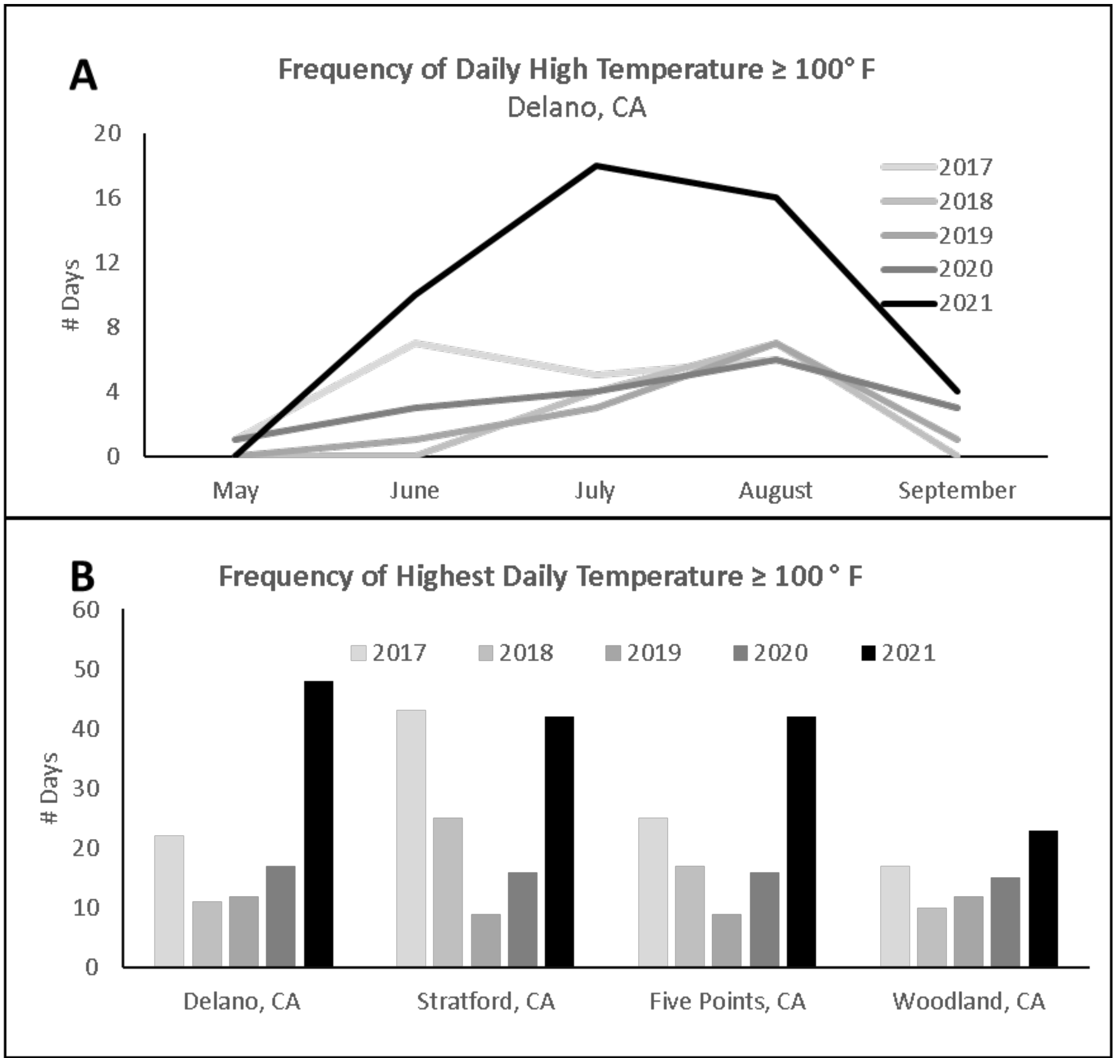

Figure 1. The summer of 2021 was characterized by excessive heat in pistachio-growing regions in California. Focusing on Delano, CA (**A**), there were more days with temperatures ≥ 100°F in June through September in 2021 than in the prior four years. Similarly, across four regions (**B**) the cumulative number of days with high temperatures ≥ 100°F was generally higher in 2021 than the prior four years. Data Source: CIMIS

Administration's (NOAA) Climate Prediction Center (Figure 2). Insufficient chill this winter may challenge pistachio production in 2022.

NOAA Climate Prediction for Winter 2021-2022

On October 21, 2021, the NOAA reported that predicted winter conditions, consistent with La Niña, are likely to be warmer than usual in the SSJV (Figure 2). Additionally, precipitation in the SSJV is likely to be lower than average and drought conditions may continue to worsen (Figure 2). Based on the same model, the Sacramento Valley may expect normal winter temperatures, but is not exempt from the probability of below average precipitation (Figure 2).

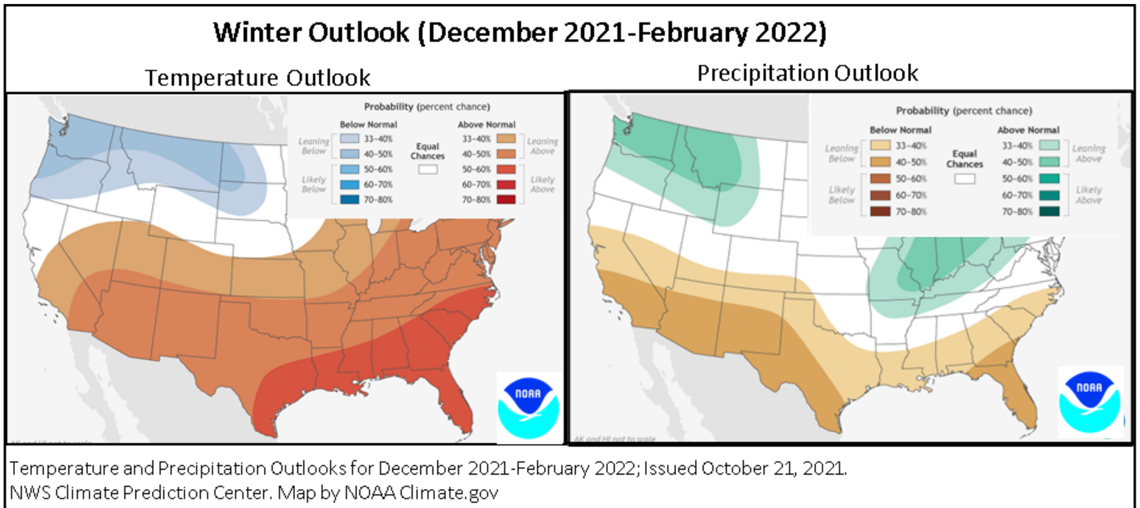

Figure 2. Predictive modeling conducted by NOAA suggests the probability that the winter of 2021-2022 may be warmer than normal and characterized by lower precipitation than normal.

Consequences of Low Chill on Pistachio

Many temperate crops, including pistachio, require a cumulative amount of chilling to exit dormancy in the spring. The chilling requirement is a physiological mechanism that protects buds from the winter cold. Without a chilling requirement, budbreak could occur during intermittent winter warming events, thus exposing open buds, flowers, or shoots to cold conditions that may limit survival of the structure. Chill hours are not calculated on a continuous basis, but rather accumulate in a cumulative fashion throughout the winter.

Figure 3. Low chill accumulation is associated with delayed, protracted bud break, bud abscission, bare zones on branches, and poor nut set. Photo: David Doll

When the chilling requirement for pistachio is not fulfilled, vegetative and reproductive abnormalities may be observed in the spring. Bud break may be delayed or irregular (Figure 3), often resulting in multiple phenological stages present on the same branch. Insufficient chill may result in protracted progression of bud break, whereas sufficient chill is correlated with a more condensed duration of bud break (Afshari, et al. 2009). Lack of adequate chill has also been associated with abscission of floral buds as well as altered flower morphology and reduced fruit set. Pollination rates may be reduced due to asynchronous bloom of male and female trees, as well as poor pollen production and death of the stigma (Crane and Takeda, 1978). The resulting reduction in fruit set is associated with an increased proportion of blanks, unsplit nuts, late maturation, and a general reduction in yield (Crane and Takeda, 1978). As a pollination management strategy, some growers have opted to plant multiple male genotypes in orchards to extend the duration of pollen availability.

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.

Chill Models. Various chill models used by physiologists are not laws of nature, but statistical models used to represent plant response to chill-related variables. 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. The simplest model, the Chilling Hour Model, is a summation of the hours below 45˚F. It is this model that was used to establish the 900- and 700-hour chilling requirement for 'Peters' and 'Kerman,' respectively. A modified model accounts only for chilling hours accumulated between 32˚F and 45˚F; these are called 'Modified Chill Hours'. Two other models, the Utah Model and the Dynamic Model, attempt to characterize the influence of intermittent warmer temperatures on chill accumulation and are represented by 'Chill Units' and 'Chill Portions,' respectively. When comparing the Chilling Hour Model and the Dynamic Model, 900 chill hours converts to approximately 69 chill portions in CA's Central Valley (Pope et al, 2015).

Access to Chill Models. Online chill model calculation tools are available online at the UC ANR Fruit and Nut Research and Information Center (FNRIC) website (www.fruitsandnuts.ucanr.edu). To utilize these models, a grower can click on the model of interest and choose the CIMIS (California Irrigation Management Information Center) station nearest their orchard. Data from CIMIS stations are available for four locations in each of Tulare and Kern Counties, two locations in each of Kings and Madera Counties, and 9 locations in Fresno County. One limitation of these calculators is the reliance on information from CIMIS stations and not from individual orchards and microclimates; however, the online calculators do allow for comparisons over successive years by providing access to historic, archived CIMIS data.

Chill is not everything. Adequate chill is not the sole determinant of orchard productivity. A recent study of historic yield records demonstrated that pistachio yields did not fall below average until chill portions dropped below 57 (Pope et al, 2015). Recalling that the 900 chill hours required for 'Peters' converts to approximately 69 chill portions in the Central Valley, one can conclude that it takes more than a reduction of chill portions below 69 to affect the yield at a state level.

Another study utilizing 30 years of production data from three 'Kerman' orchards identified four main factors responsible for over 65% of the variability in yield (Kallsen, 2017). In this study, the main factors influencing yield included 1) yield in the prior year, 2) warm spring temperatures (>80°F) prior to bloom, 3) cool temperatures (<45°F) from mid-November through mid-February, and 4) warm temperatures (>65°F) from mid-November through mid-February. If four variables accounted for 65% of the variability in yield in the Kallsen (2017) study, then the other 35% of yield may be influenced by the many other orchard management practices throughout the year.

In summary, the chill calculators are tools that may be utilized to make comparisons of chill accumulation between years and assess the progress of chill accumulation during a given season. The model outputs are limited by the input data sourced from CIMIS stations at discreet locations that might not adequately reflect the environmental parameters of a given orchard. In addition to chill accumulation, growers should consider other mitigating factors such as microclimates, propensity for inversions, and historical yield data to assess the future orchard productivity potential.

Gills Mealybug Control

Phoebe Gordon, UCCE Madera and Merced Counties

Gill's Mealybug (*Ferrisia gilli)* (Figure 1), first identified on pistachios in 1997, has become a major pest of this crop. It's most noticeable around harvest, however the effective treatment times are much earlier in the season so close monitoring of populations is essential to ensure its treated at the right time. While Gills Mealybug has been documented attacking almonds, beneficial insects seem to keep this pest in check, most likely because early season pyrethroid use in almonds is becoming less common, preserving insects that can attack mealybugs.

Gills Mealybug Impacts

Gills mealybugs directly impact the pistachio crop by reducing yields and split percentage and increasing shell staining. They may cause increased sticktights and adhering hulls, though this has not been conclusively shown in research studies. Mealybugs cause this damage by feeding on the phloem, consuming carbohydrates that the pistachio would otherwise use to fill the nuts or develop new growth. They also produce honeydew that can harbor growth for sooty mold. This is not considered detrimental to pistachios, though it does look dramatic at harvest time.

Figure 1: Gills mealybug adults feeding on a pistachio rachis. Photographer: David Haviland.

Gills Mealybug Lifecycle

Gills mealybug has three generations in a year. It overwinters as a nymph, and early season populations are low due to extremely high winter mortality. Close to bud break (mid-March to early April), the nymphs leave their hiding places and move to pistachio buds to feed. It is thought that this may be triggered by the remobilization of carbohydrates from permanent woody structures during dormancy to expanding buds in the spring. The nymphs complete development by late May/early June and produce the first generation of crawlers (the name given to the first of the three nymph stages of mealybugs). These crawlers move to the developing nuts and rachis to feed, passing through the other nymph stages, and becoming adults in late July. These adults produce the second generation of crawlers, which also feeds on the pistachio fruit. As pistachio nuts finish developing in September, the mealybugs leave the fruit and move to branches, where they subsequently produce the third generation of crawlers. It is this generation that overwinters in cracks and crevices. By this time the mealybug population is at its highest, increasing exponentially with each generation.

Gills Mealybug vs. Grape Mealybug

Gill's mealybug can be confused with another mealybug, Grape Mealybug, that can occasionally be found in pistachio orchards. It is critical to distinguish between the two, as the grape mealybug does not cause economic damage in pistachios and should not be treated. Luckily, there are a few key indicators that will help distinguish the two.

The three most obvious traits are seen in the adults:

- Gills mealybug produces glassy rods (Figure 2, top), whereas grape mealybug does not (Figure 2, bottom).
- Gills mealybugs have two tails coming from the end of their bodies, the grape mealybug has four.
- When poked, the grape mealybug will produce two dots of red fluid near their tails, the Gills will not.

If you monitor around their reproductive times (late May/early June, late July, October), you will see that Gill's mealybug produces live young (Figure 3), whereas the grape mealybug produces eggs, from which the crawlers hatch.

Figure 2: Top: Gill's mealybug. Bottom, Grape mealybug. Photographer: David Haviland.

Figure 3: Gill's mealybug adults with first instar nymphs (crawlers). Photographer: David Haviland.

Treatment Options

Gill's mealybug is best treated at the crawler stage; the waxy covering they create will protect older nymphs and adults from insecticides. Traditionally, Gill's mealybug was controlled with a single insecticide application during the emergence of the first generation of crawlers in late May/early June. UC guidelines suggest that you treat when you find 1 mealybug per 10 rachises at this time, however the economic threshold may change depending on the projected price of the crop and the projected yield. Treating when there are fewer than 1 in 10 rachises with mealybugs may be warranted if the price of pistachios is high and the cost of an application is low. However, if you are using an expensive product and nut prices are low, you may decide you can tolerate a higher mealybug infestation. Be sure to check with your processor to see if there are any potential MRL issues with the product you plan on using, as some products have been causing export issues. You can find suggested products through the UC IPM link at the bottom of this article.

Recent reports from 2019 and 2020 have indicated that a single treatment in late May or early June may no longer give adequate control. The reasons why have not yet been determined. It is possible that the mealybug may be developing resistance to insecticides, however the reduced efficacy has been observed across several classes insecticides, making this explanation unlikely but still possible. In order to improve insecticide control, it is suggested you:

- Monitor populations closely to ensure sprays are timed to the crawler stage
- Follow the application best practices
    - Drive slowly to ensure good coverage
    - Use enough gallons of mixed solution to ensure the spray gets to the top of the canopy and penetrates the canopy
    - Consider spraying when ambient humidity is higher to ensure droplets do not evaporate before they reach their target

A spray during the emergence of the second generation of crawlers (late July) may be needed. While there is a third generation of crawlers late in the season, it is currently unknown if this is an effective spray time.

Female insects cannot fly, so the way this pest is spread is by moving contaminated plant material or machinery. Harvest activities can move Gill's mealybug within an orchard, and equipment carrying infested plant material can move this pest between orchards. Ensure that you clean your own equipment before moving between orchards and if possible, harvest infested orchards last. Ensure that custom harvesters have cleaned their equipment before entering your orchard.

For more information on Gill's mealybug, you can visit: https://www2.ipm.ucanr.edu/agriculture/pistachio/Mealybugs/

https://www.sjvtandv.com/blog/pistachio-short-course-videos (Listen to David Haviland talk about scale pests and mealybugs on Day 4. His talk begins approximately 40 minutes in)

2021 Field Day: Nematode Management in Walnut and Almond

Host: Andreas Westphal UC Riverside, Nematology




Where? Kearney Agricultural Research and Extension Center, 9240 S. Riverbend Ave, Parlier, CA 93648, ph.: (559) 646-6555

When? Nematode management in WALNUT Nov. 30, 12:00 noon – 4:00 PM
Nematode management in ALMOND Dec. 1, 8:00 AM – 12:00 noon

Who? Field research representatives, farm advisor, PCAs, growers, consultants (CEU other(O): 4.0 for each day)

What? Rootstock development; pre-plant soil treatments; post-plant treatments …



Grantors and cooperators making the activities possible include: CDFA-IAB, DPR, SCBGP, chemical companies, nurseries, TriCal, NIFA-Hatch 1010599, and…

NIFA-SCRI 2018-03397

REGISTRATION for this event at https://surveys.ucanr.edu/survey.cfm?surveynumber=35743
Early registration is encouraged because the event is limited to 100 participants per day.

2022 Statewide Pistachio is going Virtual!
January 19-20, 2022, 8am-12pm PT

Pistachio Day delivers the latest research-based production practices to prospective or current growers, production managers, and pest control consultants so they are better able to achieve their pistachio growing goals.

The diverse program will include an industry overview as well as sessions on various important topics within the areas of Food Safety and Regulations, Horticulture Science, and Integrated Pest Management.

2022's Pistachio Day will be held in a webinar format online as a two-day event.
View the detailed agenda here.

The $40 registration fee includes access to the live two-day webinar, online access to presentation PDFs, and post-course online access to recordings.