

Fall Juvenile Pistachio Freeze Damage

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The Problem

Fall freeze damage, is most likely to occur during the period from late October through to the end of December in 1st through 8th-leaf trees.

Kerman, Peters, Kalehghouchi and Golden Hills cultivars growing on PG1 and UCB1 seedling rootstocks and UCB1and PGII-clonal material have been affected.

Frost damage is not new. I have a newsletter of Joseph Maranto's, my predecessor as pistachio farm advisor in Kern County, that he published in the early 1980s of a tree he suspected of being damaged by cold temperatures.



At one time the cause of these symptoms was unknown, but it did not appear to be caused by disease or heavy metal in soils.

Additional Observations related to pistachio juvenile freeze damage.

- a) trees go into dormancy apparently vigorous and healthy;
- b) topographically low-elevation orchards have most, but by no means, all of the frost damage. Frozen trees are often not in the lowest areas of a given orchard;
- d) high sodium levels in the soil and water, and soil characteristics such as presence of hardpans, appear to increase freeze damage;
- e.) the scion (nut producing part of the tree) is usually more adversely affected than the rootstock, but the entire tree may be killed;
- f) A frozen tree is often immediately adjacent to an unaffected tree, although typically, affected trees appear in clumps;
- g) Trees uninjured the previous year may be injured the subsequent year.
- h.) juvenile trees are much more susceptible to freezing than are bearing trees, and usually third, fourth, and fifth leaf trees appear most at risk.
- i.) the most vigorous rootstocks, cultivars and growth stages of the pistachio tree appear most susceptible to freezing.

Juvenile Pistachio Fall Freeze Damage can be lumped into two broad categories:

1. Mild
2. Severe

Mild Damage

First through 8th leaf pistachio trees on *P. integerrima*-type rootstocks, such as UCB1 and PG1, can show freeze damage at temperatures of about 31°F in late October or early November if growing vigorously, even in geographical areas where salt is not a problem.

Mild Symptoms

Reported incidences of mild freeze damage symptoms increase greatly soon after mild freeze events in late October and November before trees show much dormancy.

The current hypothesis is that temperatures sufficient to cause mild symptoms on vigorous trees may be in the range of 27 to 31 degrees F. Even in the coldest areas of Kern County, temperatures lower than this are rare in late October through mid-November.

Symptoms of Mild Freeze Damage

Leaves on branches frozen before the trees begin to defoliate in the fall remain attached to the branch delaying leaf drop. Usually pruning crews find this type of damage.

Attached leaves





Gumming bark



Black mold may grow on damaged bark on areas of the trunk that appear wet, especially on the trunk between the lower portions of the scaffold branches and the graft union. Bark 'wetness' appears to originate from the scion not the rootstock.

Often white beads or small ribbons of dried sap, apparently originating fairly shallowly in the bark, are visible on the outside of the tree in the moldy areas.

Initially, in the moldy areas of the tree, there appears to be little if any damage to the bark and cambium layer below the outer skin of the bark.

Trees showing mold growth and gumming in the fall may leaf out earlier than unaffected trees. Later, in early spring, dieback of the branches occurs on some trees that showed the most pronounced of these early symptoms. The dieback begins at the branch tips and affected areas of the scion and rootstock.



Early leaf out in the spring.

This mild damage is usually not a problem, and the trees recover normally by the end of summer.

Severe Freeze Symptoms

The worst freeze damage occurs in trees showing none of the early symptoms described above.

Damage to these trees is not obvious until May, when pistachio trees begin to leaf-out in the spring. In severely affected trees, third-leaf or older, the new growth, typically may push only from the lower scion or rootstock and this growth occurs later than in unaffected trees.



Trees show different levels of dieback in the spring. Generally, trees are frozen later in the fall, after the leaves have fallen.

Spring leaf out in 2011



Spring leaf out

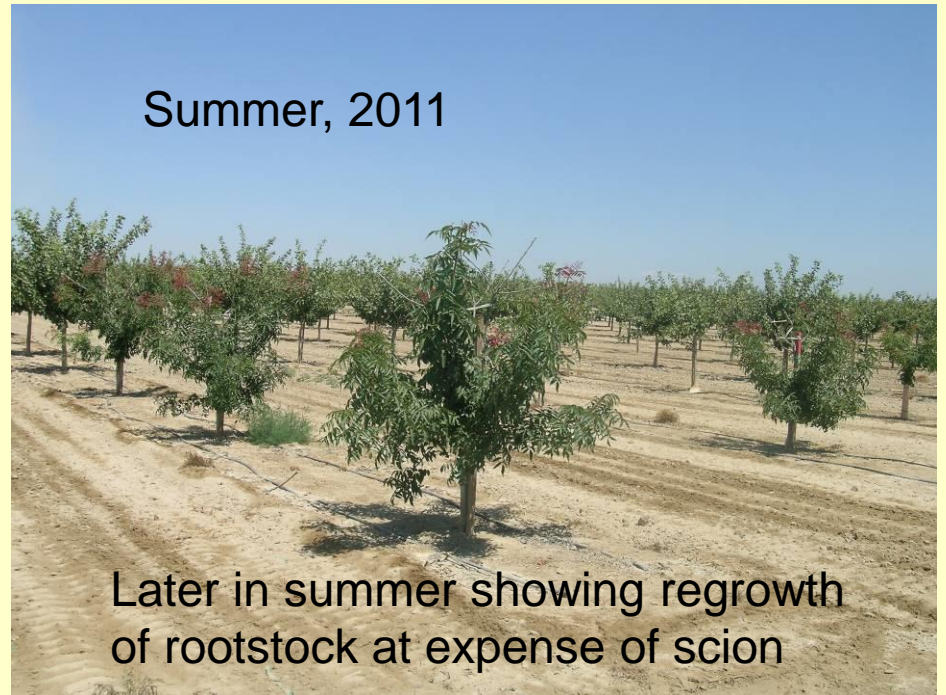


Spring leaf out



Spring leaf out

Summer, 2011



Later in summer showing regrowth of rootstock at expense of scion

BABY TREES.

Affected 1st and 2nd leaf trees may die without pushing any new growth or the new growth begins to fade quickly with the first warm temperatures. Often in the very young trees, the rootstock appears to die first and this damage is hard to detect until spring.

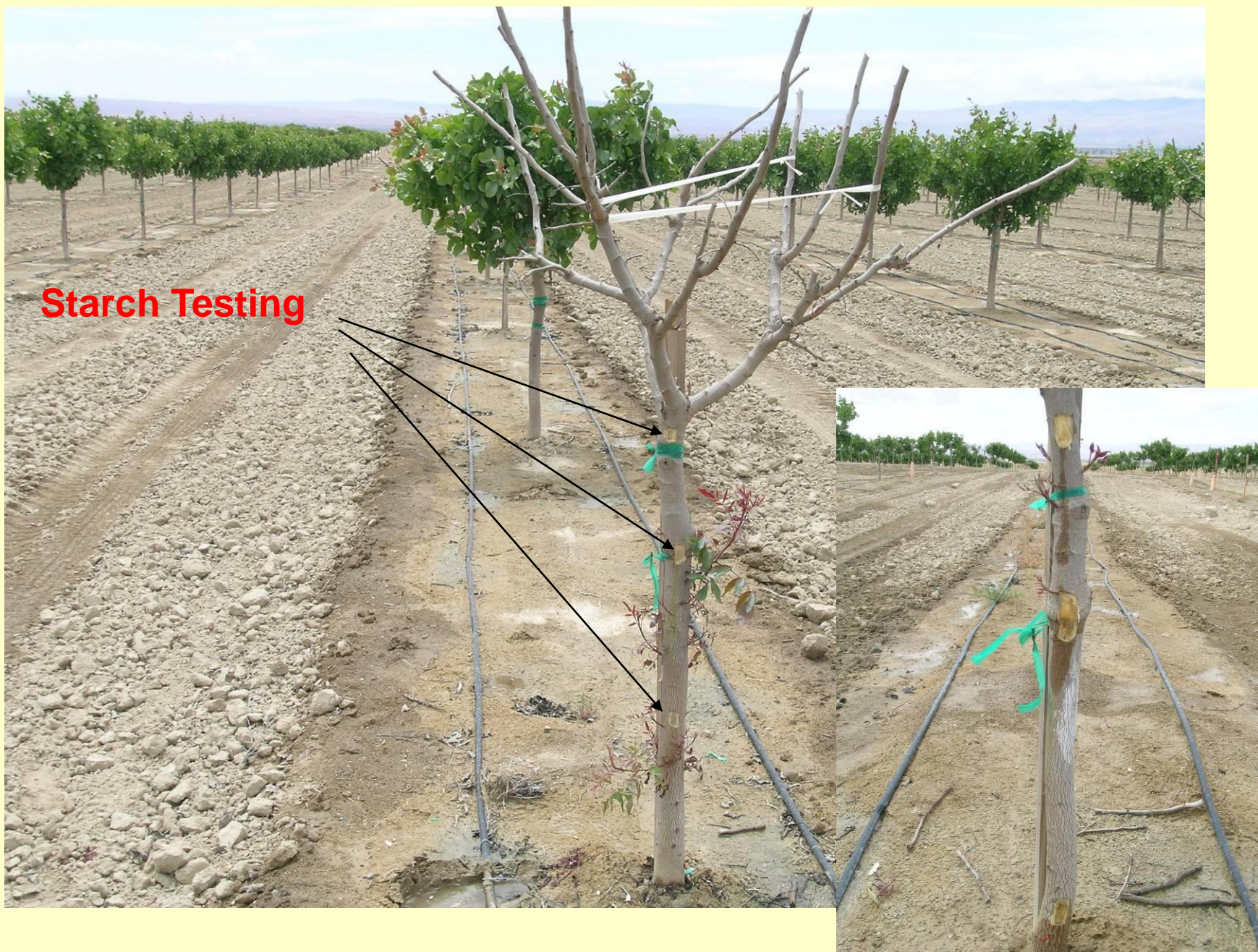


This is not spray or fertigation damage!

Bark samples from the trunk of severely injured trees show elevated levels of sodium and magnesium, perhaps indicating that the conducting tissues (xylem and phloem) were severely damaged and leakage occurred. This leakage is not present in trees with mild symptoms.



Starch Testing



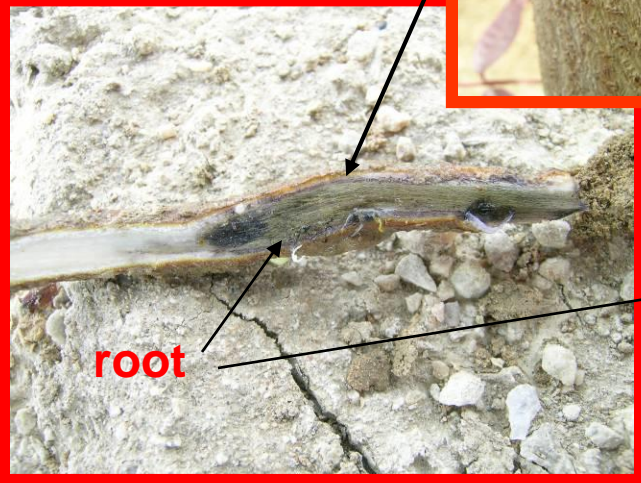
Frozen tree

May Starch Tests at graft union and roots

Unaffected tree



Positive
dark starch
test



root



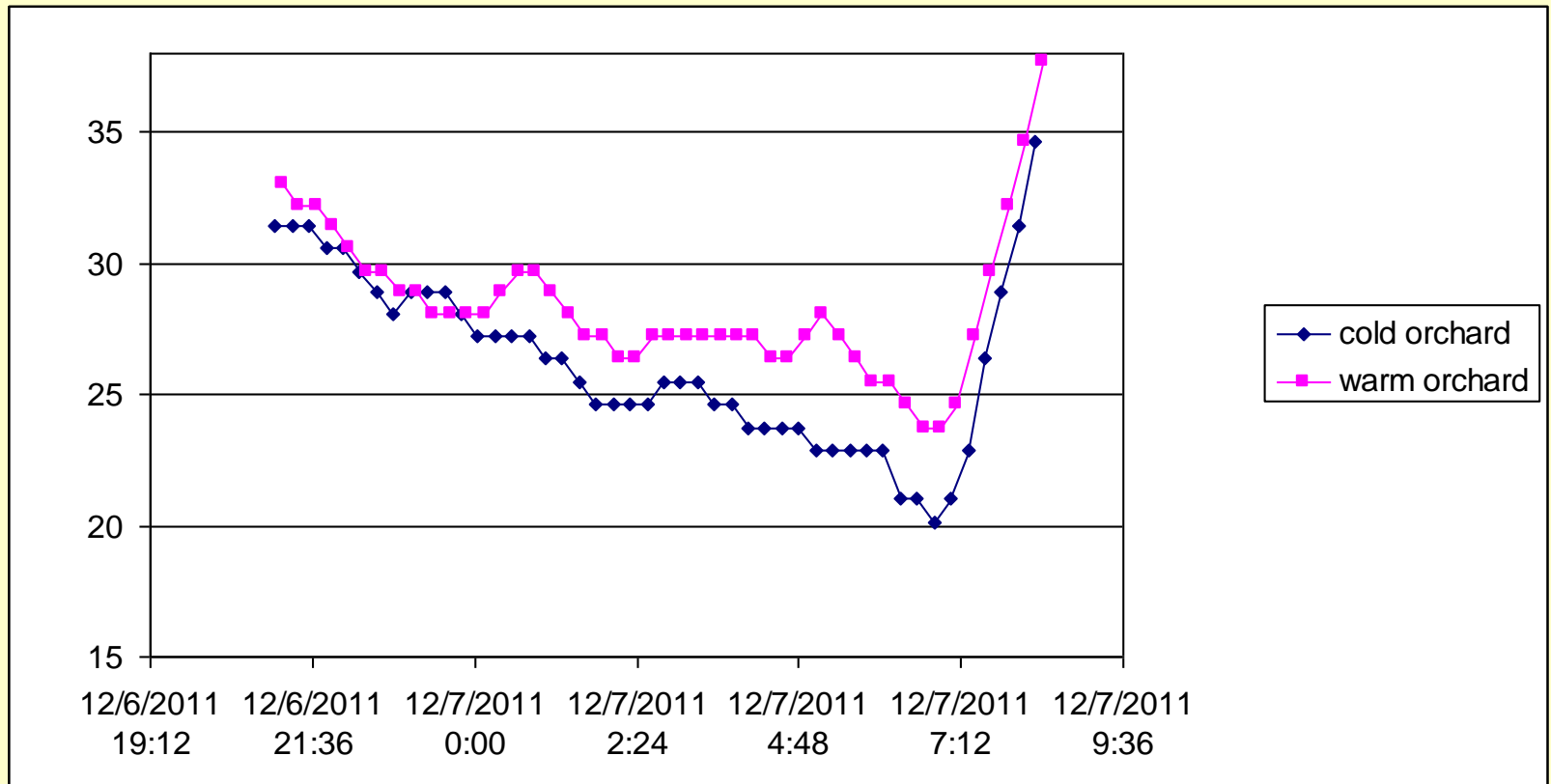
Healthy juvenile pistachio trees use almost all of the starch produced the previous year to push new leaves in the spring. In May, in the San Joaquin Valley, very little starch remains in the tree. In frozen trees, the buds are killed, no new leaves are produced, and the starch remains in the trunk and roots.

During the winter of 2011-2012, Freeze damage was present in a number of orchards in Kern and Fresno Counties with tree loss near 20% in a few blocks. To my knowledge in Kern County, affected orchards ranged from 1st leaf through 5th leaf in the spring of 2012, although damage can occur to 7th or 8th leaf trees as well.



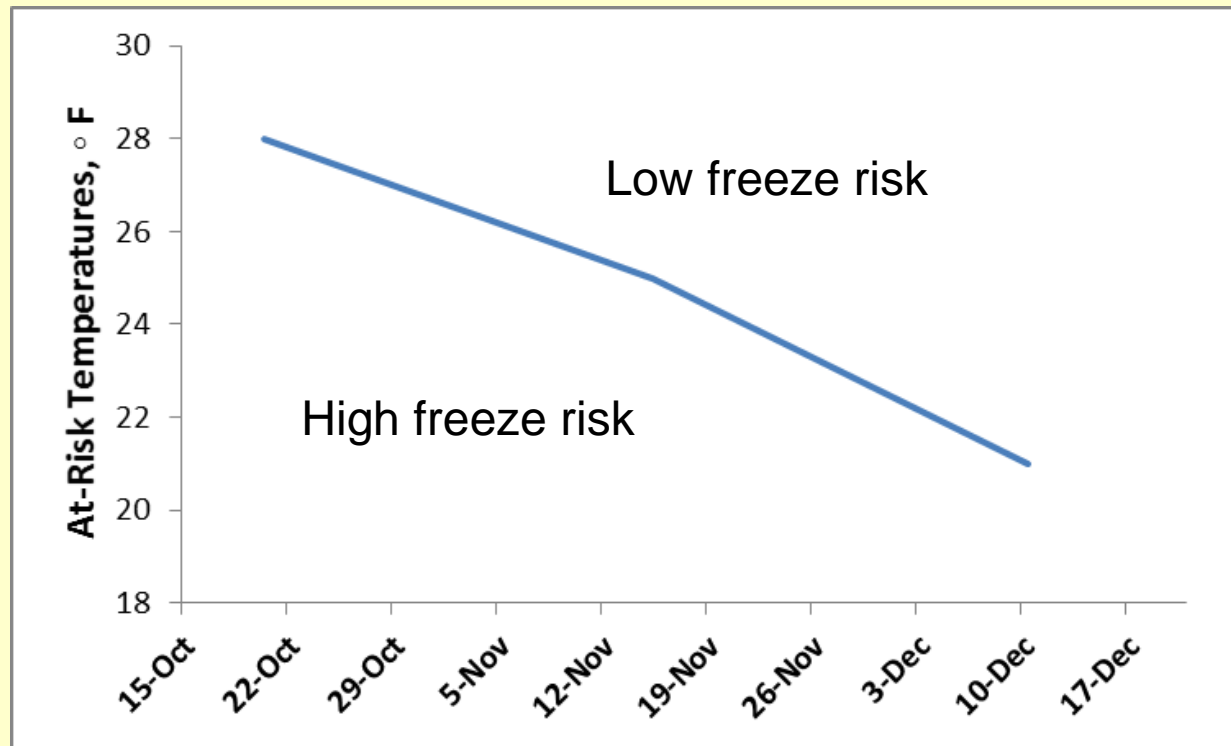
Spring, 2012

Severe frost damage is thought to occur after the trees have begun to go dormant, but before they are fully dormant, probably in the period from late November to late December.



The chart above was prepared from temperature data measured 4 to 5 feet above ground level in two 5th-leaf orchards during the night of December 6-7, 2011. On several other nights in early December, temperatures fell to similar levels. The trees in the warmer orchard showed no freeze damage, while those in the colder orchard had approximately 20% severe frost damage.

The data below is tentative, but susceptibility to freeze appears to decrease with time, probably as a result of the trees becoming increasingly dormant.



Low temperatures (measured at a height of 4 ft. above the ground) on progressive dates late into the fall where severe WJTD occurred to moderately hardened-off juvenile pistachio trees in various low-elevation, salt-affected orchards in the southern San Joaquin Valley. This figure should be considered very preliminary and data are taken from freeze events from 2010 to 2013. Trees in many orchards experiencing similar cold temperatures did not suffer show WJTD symptoms. Note that the temperatures required to freeze trees were lower later in the year.

Junvenile frost damage is proposed to be a function of the following factors:

- **winter air and tree temperature, (low temperature - more damage)**
- **tree age at freeze event, (juvenile trees – more damage)**
- **tree vigor at freeze event, (more vigor – more damage)**

Temperature ~ Temperature factors:

fall and/or winter minimum temperatures, duration of cold temperature, winter cold air ponding, dew point, fog,

Tree age ~ Tree age factors:

Trees 0 to 7 years old most susceptible

Is this related to bearing or non-bearing, or perhaps, bark thickness? (older trees and bearing trees have thicker bark). Our commonly used rootstock have thinner bark than the scion.

Tree vigor ~ Tree vigor in the fall is (or could be) related to:

- how much time tree had to adjust to sudden cold snaps
- degree of dormancy when freezing occurs,
- soil-water status** during the season and **in the late summer and fall**,
- early defoliation probably reduces vigor (easier if trees water stressed)
- Cultivar?
- rootstock,
- tree health (poor tree health decreases vigor but increases risk of freezing),
- soil fertility, late nitrogen applications
- late pruning issues
- soil sodium/boron levels?
- presence of hardpans ?

Winter Juvenile Freeze Damage has been more obvious in drought years and appears worse in low elevation areas of the San Joaquin Valley more subject to low fall and winter temperatures.

Because of the higher salinity, growers have only more recently planted in these salt-impacted old lake beds, as their comfort level with planting pistachio in high salt areas has increased.

- 1. The problem is that air temperature in the San Joaquin Valley can change abruptly from warm to cold, and cold air flows downhill.**
- 2. Drought (due to drier air and less soil evaporation) also reduces the dew point of the atmosphere and reduces fog development. With drier air, night time temperatures can fall quickly and durations of cold temperature can increase dramatically.**

INTERESTING FINDING (2014) FROM HISTORICAL FREEZE EVENTS:

Table 1. Rootstock identification in 29 orchards where the total tree population suffered more than 1% severe cold damage at least one winter during the time interval from the winter of 2009/10 through 2013/14 in Kern County, CA .

Rootstock identification	Percent of all damaged orchards examined*
PG1 (<i>P. integerrima</i> x <i>P. integerrima</i>)	65.5
Clonal UCB-1 (<i>P. atlantica</i> x <i>P. integerrima</i>)	34.5
UCB-1 seedlings	0.0

*Note: These are all and only the orchards brought to the author's attention in this time period. Freeze damage likely occurred in other orchards. This is not a scientific sampling and may be biased based on the number of acres of each rootstock actually present in low-elevation, salty orchards. Rootstock selection should be based on many criteria depending upon the conditions present in the orchard. High vigor may be a problem (related to dormancy) in orchards located in areas subject to sudden drops in temperature in early fall.

Rootstocks with *P. integerrima* heritage do not go dormant very early in the fall.



Scion (Kerman)
dormant but
rootstock still green
in early December

What is happening at the
rootstock/scion graft union when
cold temperatures hit at this time?

From the above observations and discussion, it would appear that a useful way to reduce freeze damage might be to encourage earlier tree dormancy.

Based on observations made over the past four years, it appears that shutting off irrigation water to juvenile trees encourages earlier dormancy and reduces the incidence of WJTD. (this suggestion is supported by the lab work of Dr. Maciej Zwieniecki at UC Davis)

Where growers had had severe problems with freezing in 2009-2010 and 2010-2011, and shut off the water in August of 2011, problems with freezing did not occur in 2011-2012, even though low temperatures appeared to be comparable.

Whether shutting off the water in August actually was the reason for less frost damage is not proven.

Early canopy defoliation has also been reported to encourage earlier dormancy. Again, however, the effectiveness of early defoliation has not been proven.



Foliar sprays with zinc sulfate or other materials to defoliate trees to encourage earlier dormancy.

The tree on the left was sprayed with high rates of copper chelate to knock off leaves.

Caution: Shutting off irrigation water in August may reduce young tree growth and might cause premature canopy defoliation (especially in shallow or sandy soils).

However;

Results from a water-shutoff experiment conducted in Kern County showed that turning off the irrigation in late August in a heavy soil did not reduce the growth of the trees.

For trees planted in 2012, no significant differences in average rootstock diameter was measured in October of 2015, between Treatment 1, in which irrigation continued without interruption at least until after January 1 and Treatment 2, where irrigation ceased in late August of each year.

On October 22, 2015 rootstock diameter averaged 37.2 mm in Treatment 1 and 34.8 mm in Treatment 2.

Avoid late and/or excessive nitrogen applications to further reduce fall tree vigor.

Also, do not train the trees in late August or September which could push out new, tender growth in the fall.

Before planting, leaching salt in low-elevation areas may decrease the incidence of freeze damage, as may breaking up shallow hard pans.



So how do we minimize the risk of juvenile tree freezing in low-elevation areas of the southern San Joaquin Valley? Suggestions:

Use UCB-1 seedling rootstock

Plant on a low salt soil with no hard pans (i.e. good drainage)

Shut water off at the end of August in deep soils

Defoliate trees at the end of October.

Do not apply nitrogen after July 1.

Do not train 2nd leaf trees after mid-August or earlier.

What to hope for:

Plenty of rain to create fog.

No sudden cold snaps from October through mid-December.

What to do if the trees do suffer freeze damage?



Don't rebud high on the trunk – wait to see extent of damage



Trees older than three years that lose their canopy appear to be more susceptible to sunburn in May and June. White washing the trunks of trees with no canopy in early May, may retard further damage by sunburn.





For severely injured trees, rebud onto suckers growing from ground or very low on the trunk.



Should we be using tree wraps in cold areas?

Data from this trial showed temperatures 4 degree F. higher inside wrap one foot above ground level (Golden Hills scion on UCB-1 clonal rootstock).

Freeze – damaged trees may continue to die years after the freeze event.

Trees will appear fine but will collapse suddenly during the first hot days of late spring or early summer.

Picture showing the crown of 4-year old pistachio tree that suddenly collapsed in June. The scion was still alive. Note discolored wood of crown area and below.

The trunk may appear unaffected, but usually the below-ground portion of the tree, the crown, will appear dark and the wood dry and discolored. If dug up early enough, there may be substantial gumming.

The diseased tissue (the canker) will probably test positive for *Fusarium* or other secondary fungal invader. These secondary invaders gain entrance in freeze-damaged tissue and continue to grow deep in to the wood.

If you take out one of these trees, it is OK to replant into the same hole soon after tree removal.



Pistachio twigs, leaves and flowers can also freeze in the spring. The Iranians and growers at higher elevations in Kern County (above 2000 ft. above sea level) can lose their entire crop to a late spring freeze.

Affect of a late spring frost
on new leaves.



Late spring frosts can freeze
flower buds resulting in
complete loss of yield for that
season.