Almond Newsletter

Cooperative Extension Glenn County

UC CE University of California Agriculture and Natural Resources

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In this issue:

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Almond Management Considerations: Spring & Early Summer

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MAY

- ✓ **Irrigation:** Monitor stem water potential using the pressure chamber and soil moisture sensors for irrigation timing (when and how long). Information on pressure chamber use is available at: ucanr.edu/datastoreFiles/391-761.pdf. Information on soil moisture monitoring is can be found at: ucanr.edu/sites/Tehama/files/20513.pdf. Get regular irrigation water analyses to know what's in your water as the season progresses. Overall salinity, chloride, sodium, and boron can change with source (canal vs. well) and time of the year.
- ✓ **Navel orangeworm:** Track NOW populations and develop a hull split/harvest timing NOW plan. Egg traps can be used to project when egg laying is likely to begin for later generations once a biofix is obtained in spring. Pheromone traps (catch males, ineffective near mating disruption products) and bait-bag traps (catch females) can be used to track flights and relative pest levels. Additional details on NOW management at ipm.ucanr.edu/agriculture/almond/Navel-Orangeworm/ and in this newsletter.
- ✓ **Spider mites:** Monitor for spider mites and their predators (especially six-spotted thrips) at least weekly, watching hot spot areas that are often dusty or water-stressed. If you are relying more heavily on groundwater this year after our dry winter, check irrigation salinity (EC) levels. Increased water stress that may be a result from increased soil salinity from lower water quality, which could in turn increase mite pressure. Early abamectin (AgriMek®, etc.) sprays provide excellent spider mite control for roughly 60 days if carefully applied but can create mite flaring going into harvest as the abamectin wears off and predators are absent. Late mite flaring is expensive to control. Find more on treatment decisions at ipm.ucanr.edu/PMG/r3400211.html and sacvalleyorchards.com/almonds/insects-mites/approaches-to-spider-mite-management-in-almonds.
- ✓ **Nitrogen (N):** Assess your crop set and cut nuts to track nut development. Consider leaf sample results from last July and/or this spring and adjust the amount of nitrogen application needed before harvest – up or down depending on all information. Nuts use 80% of N by the first week of June, although timing varies with year and crop load.
- ✓ **Potassium (K):** Maintain leaf K levels in the adequate range (1.4%) through July to minimize spur death and reduced flower number (crop loss potential) next year.

Almonds absorb K up to hull split, so the window for K fertilization is wider than N. See article on K nutrition in this newsletter.

- ✓ **Diseases:** Monitor for Alternaria, rust, scab and anthracnose and treat if needed. Consider a follow up rust treatment before symptoms are visible if orchard history and conditions indicate high vulnerability. Rotate the material's site of action (FRAC Group) to avoid development of pesticide resistance. Be aware of changes possibly affecting propiconazole (Tilt®, etc.) use for nuts exported to the EU. See disease management details at: ipm.ucanr.edu/agriculture/almond/
- ✓ **Gophers** kill almond trees. Also, gopher mounds in the orchard with close mowing produce more dust creating more spider mite pressure. See more on gopher control at sacvalleyorchards.com/blog/almonds-blog/options-for-gopher-management/. Trapping is an excellent means of controlling gophers. Better trapping results have been measured when employees are trained to find tunnels and set traps. See great video showing steps to gopher trapping with Dr. Roger Baldwin, UC Extension Specialist at youtube.com/watch?v=iDW0l6eeG0M.
- ✓ **Weeds:** Survey to see which weeds were not controlled by fall or winter treatment. The UC Weed ID Tool at https://wric.ucdavis.edu/information/weedid.htm can help with identification. This info will be very helpful in planning for next fall/winter weed management.
- ✓ **Bugs:** Monitor for leaffooted and stink bugs. More info at: ipm.ucanr.edu/agriculture/almond/Leaffooted-Bug/ and ipm.ucanr.edu/agriculture/almond/Stink-Bugs/

JUNE

- ✓ **Irrigation:** For Rhizopus hull rot management and a shorter, cleaner shake at harvest, taper off water in orchards as kernel fill completes. Deep, heavy soil with micro-sprinkler or solid set irrigation have more soil water available and so respond more slowly to reduced irrigation compared to lighter soil with drip irrigation. See http://thealmonddoctor.com/2012/08/05/irrigating-from-hull-split-to-harvest/ for more pointers.
- ✓ **Spider mites:** Continue monitoring. Treat when populations reach thresholds. If waiting into June to use abamectin, use 1-2% narrow range 415 oil and spray at night to get the most material into the leaves (and the best control possible).
- ✓ **Navel orangeworm:** Continue monitoring NOW and prepping for hull split.
- ✓ **Hull rot:** Best control is from an integrated approach combining reduced irrigation between kernel fill and end of early hull split, moderate leaf N levels (no more than 2.6% N in summer leaf samples) and 1-2 fungicides in June or early July.
    - **Monilinia hull rot:** For best control of Monilinia hull rot, which presents as a tan lesion on the outside of the hull, spray in early June as hull split timing does not effectively control this hull rot pathogen.
    - **Rhizopus hull rot:** For orchards with a history of Rhizopus hull rot (black spores), spray a fungicide at early hull split.
    - **Timings and materials:** ipm.ucanr.edu/PMG/r3101811.html.
- ✓ **Nitrogen:** Finish up N application in early June, if not completed in May.
- ✓ **Potassium:** Continue K application(s) if needed.
- ✓ **Ants:** Monitor for protein feeding ants in June. If they are found, decide on a treatment plan with your PCA. Depending on the material, applications can start as early as 10 weeks ahead of planned harvest. Use bait materials promptly after buying and apply to dry ground (at least one day after irrigation and two days before irrigation) for best results. Info including key treatment details at: ipm.ucanr.edu/agriculture/almond/Ants/.
- ✓ **Equipment prep:** Maintenance check your harvest equipment and sprayers ahead of hull split and harvest. Equipment dealers offer pre-harvest service packages. Harvest breakdowns can cost extra time and money, especially in big crop years. Check sweeper and harvester head settings to minimize harvest dust. See dust reduction info at: almonds.com/growers/in-the-orchard/harvest/harvest-dust.

Potassium Deficiency

Joseph Connell, UC Farm Advisor Emeritus, Butte County
Franz Niederholzer, UCCE Farm Advisor, Colusa and Sutter/Yuba Counties

It looks like 2020 is going to be a big almond crop year in the Sacramento Valley. A big crop means, among other things, paying careful attention to potassium (K) nutrition in the orchard. Almonds remove more K per acre in the crop than any other nutrient, which can lead to K deficiency if adequate K nutrition is not maintained through fertilization. K deficiency in July leaf samples can lower yields next year. By the time you have time to read/respond to summer leaf analyses reports, it's too late to "fix" deficiency for next year and yields can suffer. Don't fall behind on K nutrition.

Potassium (K) deficiency. When first leafing out, potassium deficient trees appear pale in color and have small leaves with little new growth. These symptoms are more prevalent where soils are wet, cold, and saturated since root activity and nutrient uptake are reduced. Later, trees show rolled leaves with tip and marginal leaf burning. This symptom is classic when it occurs in the treetop on leaves in the middle of new shoot growth. The tip and margins of leaves become necrotic and this causes the leaf to roll and the tip to curl upward, a condition referred to as "Viking's prow" (see Figure 1). The Butte and Aldrich varieties are good indicators of this deficiency because they exhibit leaf scorching before Nonpareil and other varieties show symptoms.

Figure 1. Potassium deficient leaves show tip and marginal leaf scorching. First symptoms appear in the middle of new shoots in the tree top. More leaves are affected as the deficiency becomes more severe.

When thinking about fertility in your orchard, the first step is to review tree nutrient status by re-examining your leaf tissue analysis from last July to determine if any nutrients are borderline or deficient. Root activity increases when soils warm and dry out, hence, deficiency symptoms may correct themselves as spring progresses. For every 1000 pounds of almond kernels hauled to the huller (hulls, shells and kernels), 80 lbs. of potassium (equal to 96 lbs. K_2O) are exported with the crop. Fertilizing with potassium is often required to avoid deficiency, particularly in heavy crop years.

Leaf nutrient levels change through the growing season. Heavy nut set creates significant competition for trees' potassium resources between shoots and the rapidly developing nuts. Normally, potassium leaf levels start the season high, decrease to a plateau by mid-summer, and then drop off again from September to leaf fall. Leaf samples I once collected in March in a symptomless orchard had 1.84% potassium--a good level that might be expected for that time of year. In an orchard showing deficiency symptoms, leaf potassium was 0.65%----a figure that would be low even in mid-summer but is especially low early in the season. This illustrates that taking an early season leaf sample can be incredibly instructive. Agricultural laboratories offer this testing and have developed critical nutrient levels for early leaf sampling although rapid changes in leaf levels occur early in the season.

Critical values for July leaf samples are shown in Table 1. These published values established for almond by U.C. researchers can help guide you in your fertilization practice or can alert you to developing trends when results are compared from one year to another. Visual observation is an excellent complement to any lab analysis.

Foliar nutrient sprays can provide quick correction of deficiency and improve tree color and vigor. Fortunately, potassium deficiency can be corrected at this time of the year by foliar sprays of potassium nitrate when sufficient material is applied. The U.C. researched approach using dilute sprays (400 gal/ac) called for application of 10 pounds of potassium nitrate per 100 gallons of water. This spray was applied at least three times at seven to ten day intervals between each application to achieve deficiency correction for the season. This meant 40 pounds of potassium nitrate was applied per acre with each of the three 400 gallon dilute applications for a total of 120 pounds of potassium nitrate per acre. This approach effectively corrected potassium deficiency in the past.

Table 1. Critical nutrient levels for almond leaves*sampled in July (Almond Production Manual; UC ANR Pub. 3364).

Nutrient	Deficient	Adequate	Excessive over
Nitrogen (N)	< 2.0%	2.2-2.5%	> 2.7%
Phosphorous (P)		0.1-0.3%	
Potassium (K)	< 1.0%	> 1.4%	
Calcium (Ca)		> 2.0%	
Zinc (Zn)	< 15 ppm		
Manganese (Mn)		> 20 ppm	
Copper (Cu)		> 4 ppm	
Magnesium (Mg)		> 0.25%	
Sodium (Na)			> 0.25%
Chlorine (Cl)			> 0.3%
Boron (B)	< 30 ppm	30-65 ppm	> 300 ppm
**B Hull levels		>80 ppm	

* Fully expanded leaves from non-bearing spurs.
** Use analysis results of hulls sampled at harvest to best assess almond boron status.

Today, concentrate sprays applied at 100 gallons water per acre with 20-30 pounds of potassium nitrate per acre can be safely applied to almonds to provide a spring boost. Three sprays alone at this rate may not be enough to provide complete lasting correction if you already have a deficiency showing.

Potassium in the soil is found in one of three forms: fixed K, exchangeable K, and K in solution. Fixed K is tightly held within soil particles or is part of potassium-bearing minerals and may only be very slowly released through weathering. Potassium ions (K^+) have a one plus charge and are readily adsorbed by negatively charged soil clay and organic matter particles. Exchangeable K is attached by weak electrostatic charges to soil particles and is in equilibrium with potassium ions in the soil solution. Soluble K consists of ions moving freely within the soil solution constituting a readily available form of K. At any given time, a soil will contain a unique balance of fixed, exchangeable, and soluble potassium characteristic of that soil type. Potassium is thus in equilibrium and moves back and forth between these states as the supply of K^+ and other cations varies. Soil with higher clay and organic matter content have a larger capacity to hold K on the exchange sites, while soils with lower cation exchange capacity (CEC) will hold less K.

Most soils in the Sacramento Valley tend to have higher clay contents, high CEC levels and higher capacity to hold added K on exchange sites. Thus, many soils in the region hold fertilizer potassium so that it is slowly available to plants. Concentrated applications are necessary to overcome the soils ability to hold K as fixed or exchangeable potassium. Traditional banding or micro fertigation saturates the K holding capacity of the soil in the relatively small application zone leaving plant available K in the root zone. Avoid an application that broadcasts potassium over a large soil area because more of the K becomes fixed**.** Targeted broadcasting in micro-sprinkler irrigated zones is often used in many orchards.

Fertigated applications of potassium sulfate, potassium thiosulfate (KTS), potassium carbonate or potassium nitrate injected through drip or micro-sprinkler irrigation is an effective approach when applied regularly with irrigation between mid-April and July. Injecting K through in-season drip irrigation is effective because the amount of K is very high in the wetted area thus saturating the K holding capacity of the soil making K available to be picked up by active roots. Depending on the rate applied and soil texture, KTS use tends to acidify soil pH and potassium carbonate use tends to increase soil pH. Potassium chloride is an effective K fertilizer and the least expensive form of K. However, concerns with chloride build up in the soil and trees, especially under drought conditions, should limit the use of this material, especially with chloride-sensitive Lovell, Nemaguard or Krymsk 86 rootstocks.

The choice of K fertigation products depends on the cost of materials and convenience. Although often cheaper, dry fertilizer must be dissolved first so more labor is usually involved compared with delivered liquid materials (liquid potassium sulfate 1-0-8, KTS). Potassium fertigation is more efficient than banded soil applications, produces faster results, and requires less actual potassium than fall banded soil applications. A common fertigation rate for potassium sulfate is 300 pounds (0-0-50)/acre over the irrigation season, while 400-500 pounds of potassium sulfate is the recommended annual maintenance rate for band applications applied to the soil.

In a heavy crop year like this, pay attention to potassium. Foliar sprays and/or fertigation are viable alternatives to meet this season's K demands compared to traditional fall banded soil applications. Assess current crop demands, material costs, and additional labor required when deciding on your most cost-effective potassium fertilizer program!

Rootstock Trial for Boron Tolerance – 2019 Update

Katherine Jarvis-Shean, UCCE Orchard Advisor Yolo, Solano, & Sacramento Cos.

Excessive boron in soil or irrigation water is not widespread in the Central Valley, but where present, it can be a substantial obstacle to almond production. A rootstock trial in Yolo County was designed to find which almond rootstocks do better or worse under high boron conditions. What follows is a summary of findings to date.

In 2011, Carolyn Debuse, former Yolo-Solano UCCE tree crop advisor, started a trial to measure the impact of heavy, clay soils and high boron water on different almond rootstocks. 'Nonpareil' nursery grafted trees on eight rootstocks were planted February 2011, at 18'x22' (110 trees per acre). Twelve Titan SG1s were added that April but not in the replicated trial. The trees have a variety of genetic backgrounds (Table 1) with different levels of boron tolerance. The trial is located in Yolo County north of Cache Creek. Boron in the irrigation water ranges from <1mg/l to 3.1 mg/l, depending on year and month.

Table 1. Almond boron rootstock trial tree genetic backgrounds

Rootstock	Origin
Titan SG1	Peach-Almond
Nickels	Peach-Almond
Brights 5	Peach-Almond
FxA	Peach-Bitter Almond
Hansen 536	Peach-Almond
Viking	Peach-Almond-Myro Plum-Apricot
Krymsk 86	Myro Plum-Peach
Rootpac-R	Myro Plum-Almond
Lovell	Peach

Yield. Peach-Almond (P-A) hybrids (except Hansen 536) consistently yield highest at the trial, while Krymsk 86 and Lovell consistently yield lowest, as can be seen looking at cumulative yields over the course of the trial (Figure 1). Hansen 536, despite showing no significant difference in terms of size, continues to be lower yielding than other P-A hybrids. In 2019, the orchard was in its 9th leaf. 2019 is the first year that Rootpac-R yields have grouped with Krymsk-86 and Lovell. Viking has consistently been in the middle of the pack, yield-wise.

P-A hybrid yields in 2019 were unusually high for Yolo County, but the scale, data sheets and calculations were repeatedly checked for errors and none were found. Low yields following freeze damage in 2018 likely played a role in the high yields of 2019. Growers should not expect to consistently achieve 2019 yields under high boron conditions.

Note: Different letters indicate groupings of statistically significantly different yields. Because there are not as many later planted Titan trees, we cannot make statistical comparisons with other rootstocks.

Tree Size. Canopy light interception (PAR%) measurements is a measure of canopy size, telling us what percent of the ground was covered in shadow at mid-day by trees on different rootstocks. The bigger the tree, the bigger the shadow. Examining average PAR by rootstock over multiple years (Figure 2) shows that over by 7th leaf (2017), trees on all rootstocks had plateaued in terms of their size, as well as a clear separation of larger trees on P-A hybrid rootstocks, and smaller trees on all other rootstocks.

Figure 1. Boron rootstock trial cumulative yield for 3rd through 9th leaf (2013-2019). Scaled from the 5-tree sample average to per acre yields based on the 110 trees per acre spacing.

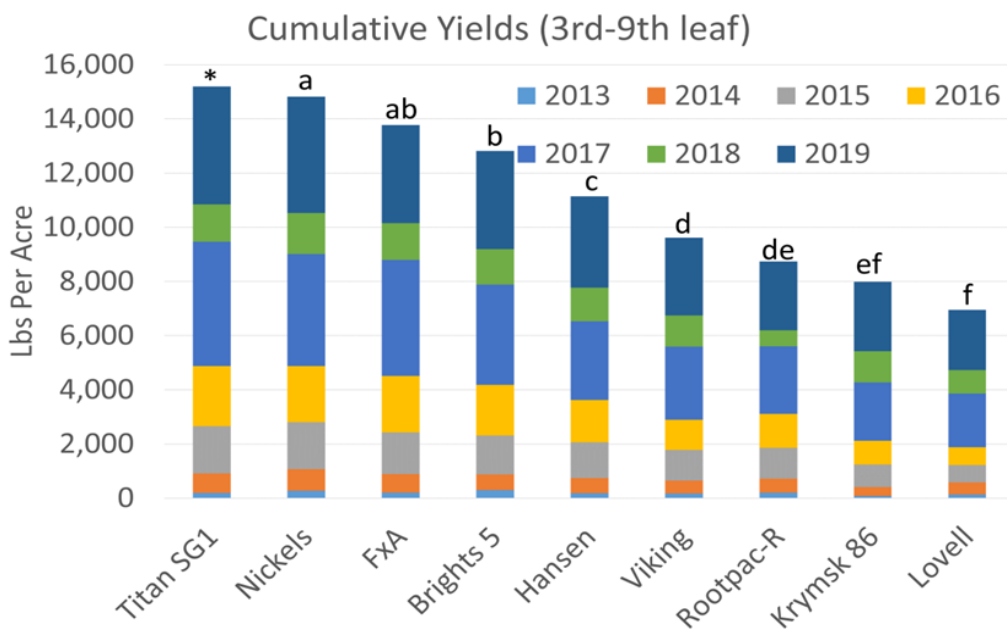
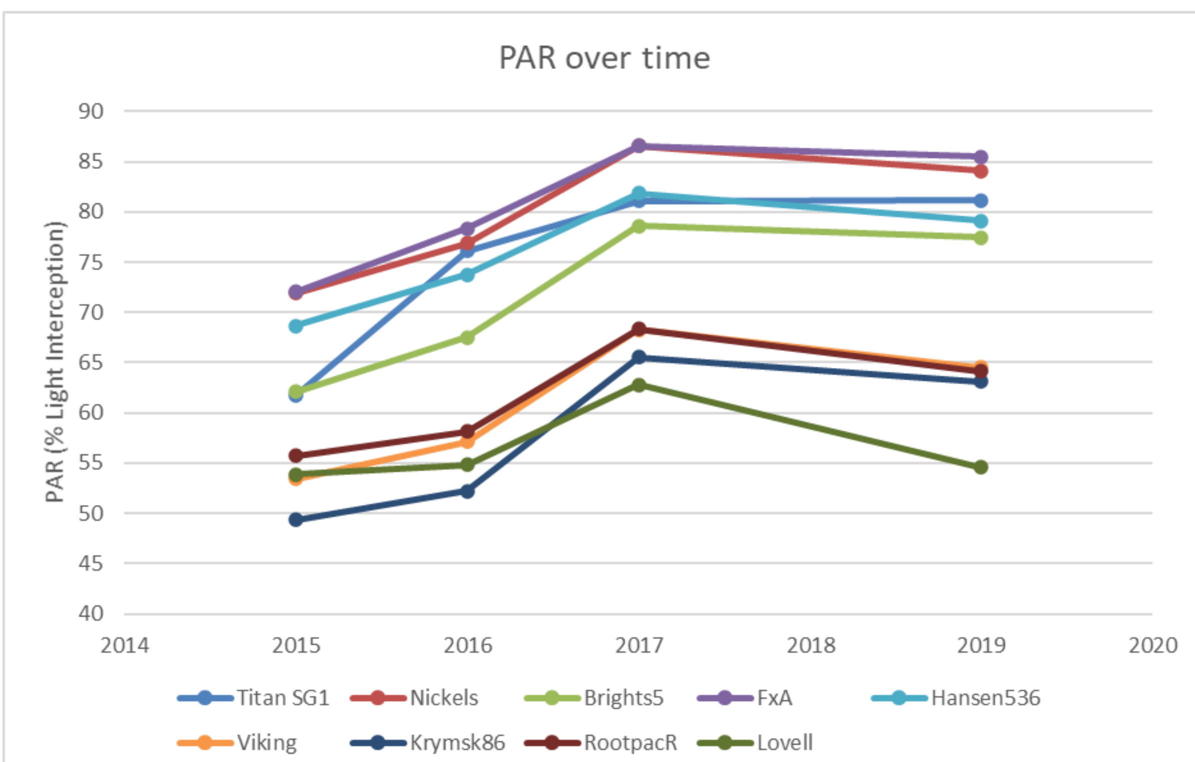


Figure 2. PAR from 2015-2019 (5th to 9th leaf) shows trees reaching their greatest canopy size at 7th leaf, as well as a grouping of P-A hybrids and non-P-A hybrids. Note this this graph only shows means, not statistical



Yield/Size Efficiency. Broadly speaking, it's not surprising that smaller trees produce lower yields. So it's worth wondering, if those smaller trees were at a tighter spacing, could they achieve the same per-acre yield as their larger P-A competitors? Dividing kernel pounds produced by PAR gives a yield/size efficiency number that can help answer this question. In 2019, the Yield/Size efficiency was much lower for trees on Krymsk 86, Rootpac-R and Lovell (around 40 lbs/1% PAR) compared to the most size efficient P-A hybrids, Titan and Nickels (greater than 50 lbs/1% PAR). This indicates that even if small trees were planted more closely, trees on non-P-A rootstocks would not catch up to P-A yields on a per-acre basis.

Given their comparable size, it is somewhat surprising that trees on Hansen 536 yielded lower than those on Titan and Nickels. It seems from the data so far that not all P-A hybrids are equally suitable for high boron conditions. Similarly, though trees on Rootpac-R, Viking, Krymsk 86 and Lovell were of comparable size, trees on Viking produced notably higher yields per unit PAR than the other small trees.

Hull Boron. Unlike most plant species, plants in the Prunus genus (almond and other stone fruit) accumulate boron in the fruit. Leaf boron levels are not a good indicator of toxicity in almond. Instead, boron in the hulls at harvest is used. In 2019, hull B was below the toxic threshold (300 ppm) in all cases, with no significant differences in hull boron content by rootstock. This is surprising given the yield differences by rootstock, and difference in hull content found in the past. It may be that low yields this year in some rootstock are a result of damage by boron to tree structure in previous years, reducing flowers per unit canopy. Given low rainfall this past winter and thus low soil leaching, I suspect we will see hull differences again in 2020.

My program will spend a few more years closely monitoring this experiment to see if yields are sustained in trees on high performing rootstocks and if we can find any more clarity on "middle of the pack" rootstocks like Viking and Rootpac-R. But for those who need to make decisions now, based on the results we have so far, it looks like Krymsk 86 and Lovell are inadvisable for high boron conditions. Consistently lower yields from trees on Hansen 536 indicates caution is warranted in thinking all P-A hybrids will perform equally well under high boron stress. Cumulative yields indicate that Titan, Nickels, and FxA are the safest bet for a productive orchard under high boron conditions.

Observations on Butte County Rootstock Trials

Joseph Connell, UC Cooperative Extension Advisor Emeritus, Butte County

Over a dozen different rootstocks have been observed in various orchard situations with local growers in Butte County over the past twenty two years. The complete results of these trials can be found in past Annual Rootstock Project Reports to the Almond Board of California. The following article summarizes what I believe are the most useful results and conclusions.

Following removal of an almond orchard on 'Lovell' rootstock and the partial failure of an initial new planting, the next year a **replant disease fumigation trial was planted in 2004.** Twenty single tree replicates of 'Krymsk 86', 'Lovell', 'Marianna 2624', and 'Ishtara' rootstocks were planted in both fumigated and non-fumigated tree sites. By 2011, 'Krymsk 86' trunk circumference was largest while 'Lovell' benefited most from fumigation. After eight years, 47 percent of the 'Ishtara' trees and 8 percent of the 'Lovell' rooted trees were leaning. There were no leaning trees on the 'Krymsk 86' rootstock. Both 'Ishtara' and the 'Krymsk 86' rootstocks had 5 percent of the trees missing mostly due to band canker, while 'Lovell' rootstock had 10 percent missing. Poor anchorage made 'Ishtara' unacceptable for almonds.

I planted nine trees of 'Nonpareil' on 'Krymsk 86' in spring 2010 spread between three different oak root fungus spots in commercial orchards. The growth on 'Krymsk 86' was good and seemed similar to growth on 'Lovell'. None of these 9 trees were killed by the fungus although a 'Lovell' rooted replant of similar age died in one of the fungus spots. 'Krymsk 86' is not immune but appears relatively resistant or tolerant. So far, I've only seen one tree on this rootstock killed by oak root fungus in a commercial orchard. As you know, 'Krymsk 86' has since become a dominant rootstock for new almond orchards in the Sacramento Valley.

A rootstock trial was planted bare root in March 2010 at 24x16 feet on Farwell Loam soil in Durham following the removal of a previous 'Lovell' peach rooted orchard containing some Marianna 2624 plum rooted replants. The grower's current orchard is on 'Krymsk 86' rootstock and is solid set irrigated and managed for those trees. 'Nonpareil' trees on 'Rootpac-R', 'Atlas', 'Krymsk 86', and 'Empyrean 1' rootstocks are compared to trees on the standard rootstocks 'Nickels' and 'Lovell'. Four of the six rootstocks established well in the first growing season with no tree losses.

'Atlas' suffered 10% mortality at planting and 'Nickels' lost 16% of the new trees. This trial is nearly complete and much has been learned.

Nutrient levels. Certain rootstocks forage better for some mineral nutrients and are better at excluding other elements. This knowledge will help select rootstocks with the best fit for orchards where there are site challenges. Rootstocks defend against specific challenges and some stocks are more tolerant of high pH, salt, and alkali than others. In this trial all trees were sufficient in N, K, Ca, Mg, Mn, Zn, and none were toxic in Cl, Na or B. Although not dealing with a particular nutritional problem, leaf levels for trees on each rootstock were relative to one another and the differences between rootstocks over three years of nutrient analysis were statistically significant.

- Trees on 'Lovell' are intermediate in some nutrient levels but are among the highest in chloride and among the lowest in potassium, calcium, and boron.
- 'Krymsk 86' rooted trees are highest in leaf nitrogen, among the highest in potassium, chloride, and boron, but were among the lowest in leaf calcium and magnesium.
- 'Atlas' rooted trees are among the highest in boron and potassium, intermediate for most other nutrients, but among the lowest in chloride.
- 'Empyrean 1' rooted trees are highest in magnesium, among the highest in manganese, zinc, and boron, but among the lowest in nitrogen, potassium, and chloride.
- 'Nickels' rooted trees are highest in calcium and among the lowest in leaf nitrogen and chloride.

Trees on 'Rootpac-R' are among the highest in leaf potassium and manganese, among the lowest in boron, calcium, and magnesium, and are intermediate in nitrogen and chloride.

Hullsplit timing. The approximate order of 'Nonpareil' hullsplit as influenced by rootstock in both 2018 and 2019 from earliest to latest was 'Rootpac-R', 'Lovell', 'Atlas' and 'Krymsk 86', and finally 'Empyrean1' and 'Nickels'. While the least vigorous rootstock 'Rootpac-R' was ready to shake by the end of July 2019, the much more vigorous 'Empyrean1' and 'Nickels' rooted trees weren't ready to shake until roughly August 16th, over two weeks later. Different orchards with the same variety will vary in hullsplit timing and harvest maturity depending on rootstock. 'Krymsk 86' was ready to shake in the 2nd week of August possibly avoiding the 3rd generation of NOW egg laying in some years.

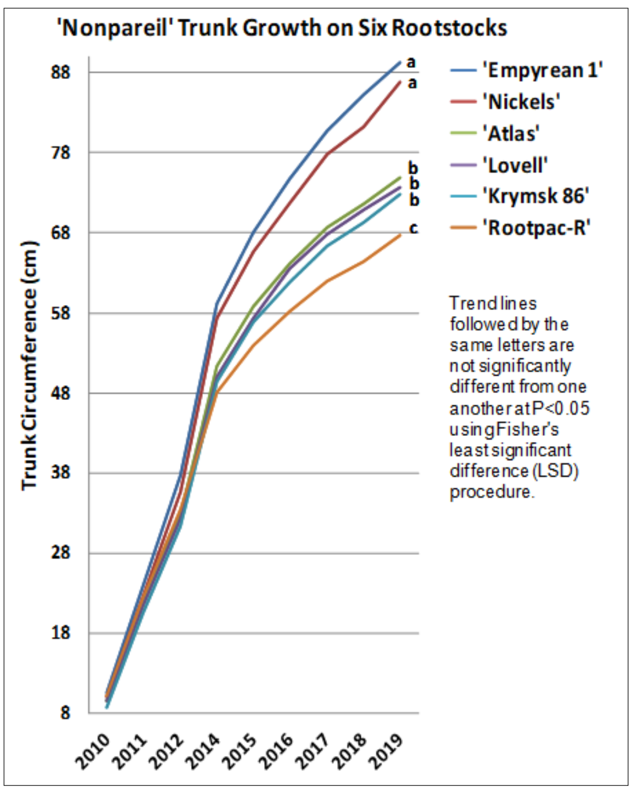


Figure 1. 'Nonpareil' trunk circumference on six rootstocks after ten growing seasons.

Tree size. After ten growing seasons, trees on 'Empyrean 1', a peach hybrid, are largest in circumference followed by trees on the 'Nickels' peach/almond hybrid. Trees growing on 'Atlas', an interspecific hybrid (peach/almond x apricot/plum), 'Lovell' peach, and the peach/plum hybrid, 'Krymsk 86' are similar in trunk circumference. Trees on 'Rootpac-R', a plum/almond hybrid, are the smallest in circumference and are the weakest growing trees in the trial (Figure 1). Once trees came into bearing the most vigorous rootstocks continued to increase tree size while tree size on less vigorous rootstocks began to fall behind (Fig.1). Canopy width (Table 1) gives an indication of how well the trees have filled their space across the 24 foot wide orchard middle.

Table 1. Tree canopy width measured from the east side drip line to the west side drip line.

Rootstock	Average Canopy Width East to West drip line (feet)
'Lovell'	19
'Krymsk 86'	20
'Atlas'	22
'Empyrean 1'	23
'Nickels'	23
'Rootpac-R'	15

Nut size and yield. 'Nonpareil' kernels from trees on 'Rootpac-R' were significantly smaller in two of the last four years than kernels from trees on all other rootstocks (Table 2); despite setting a smaller crop. Kernels from trees on 'Krymsk 86' and 'Lovell' were often of similar size while trees on 'Empyrean 1', 'Nickels', and 'Atlas' mostly produced kernels significantly larger than those produced on the other rootstocks. Thus, the significantly lower yield noted on 'Rootpac-R' rooted trees (Table 3) is a function of both smaller trees and small kernels even though they have a larger volume of irrigated soil with less competition.

Table 2. Rootstock effects on 'Nonpareil' kernel size, Durham, CA

	Weight in Grams/Kernel			
Rootstock	2016	2017	2018	2019
'Lovell'	1.22 bc	1.27 b	1.15 d	1.16 b
'Krymsk 86'	1.18 c	1.27 b	1.17 cd	1.24 a
'Atlas'	1.24 ab	1.32 a	1.19 bc	1.23 a
'Empyrean 1'	1.29 a	1.33 a	1.24 a	1.26 a
'Nickels'	1.25 ab	1.35 a	1.23 ab	1.27 a
'Rootpac-R'	1.07 d	1.22 c	1.14 d	1.16 b

Values followed by the same letters are not significantly different at P< 0.05 using Fisher's least significant difference (LSD) procedure.

The intermediate yield noted on 'Lovell' and on 'Krymsk 86' rooted trees appears to be related to tree size and nut set since both trees and kernels on these rootstocks are similar in size. Although similar in trunk circumference to trees on both 'Lovell' and 'Krymsk 86', the larger canopy of trees on the 'Atlas' rootstock often produced both larger nut size and a significantly greater yield (Fig.1 and Tables 2 & 3). Accumulated 'Nonpareil' yield through the 10th leaf is greatest on the 'Nickels' and 'Empyrean 1' rootstocks (Table 3) as these are the largest trees in the trial.

Table 3. Accumulated 'Nonpareil' yield, kernel pounds per acre @ 113 trees/ac.

Rootstock	3rd Leaf	4th Leaf	5th Leaf	6th Leaf	7th Leaf	8th Leaf	9th Leaf	10th Leaf	Accumulated Total Yield
'Lovell'	74	1,042	1,426	2,208	1,978	3,211	3,572	2,083	15,595
'Krymsk 86'	105	1,018	1,524	2,435	2,923	3,279	3,786	2,459	17,529
'Atlas'	113	1,190	2,060	2,826	3,252	4,111	4,486	2,722	20,759
'Empyrean 1'	69	1,321	2,183	3,378	3,289	4,231	4,425	3,758	22,654
'Nickels'	96	1,162	2,157	3,332	3,642	4,019	4,602	3,645	22,655
'Rootpac-R'	90	1,025	1,553	1,714	1,526	2,434	2,818	1,381	12,541

Summary. Although rootstock behavior and characteristics can be documented in rootstock trials it should be recognized that results are always going to be somewhat site specific. For instance, we know from other work that the 'Krymsk 86' rootstock is very susceptible to root knot nematodes. If your site had this limiting factor 'Krymsk 86' would not be the rootstock for you. Tree canopy size is the greatest factor in yield as the accumulated total yield of trees on these six rootstocks closely follows the same pattern as canopy width shown in table 1. Yield of the smaller trees on 'Lovell' and 'Krymsk 86' could be improved if the orchard tree spacing was ideal for each rootstock. This work shows that it's critical to get the spacing right when planting if optimum yields are to be produced.

Beyond yield, when choosing a rootstock, attention to other limiting factors such as salinity, drought tolerance, and drainage issues must be considered. If excess chloride is a limiting factor on your site, the 'Krymsk 86' or 'Lovell' rootstocks would not be a good choice for you. 'Atlas', 'Empyrean', and 'Nickels' are better at limiting the uptake of harmful chloride salt. Other essential nutrients such as potassium are taken up more effectively by 'Krymsk 86', 'Atlas', and 'Rootpac-R' while 'Empyrean 1' and 'Lovell' tend to pick up less potassium. 'Rootpac-R' and 'Lovell' had the lowest boron leaf tissue levels in this trial. This might be good if your orchard site is in a high boron area but may be not so good if your site is known for boron deficiency.

Overall, for new plantings, rootstocks should be selected to help overcome the greatest challenges that your particular orchard site faces .

Hull Split Timing and Sprayer Practices for Best Pest Control Results

Franz Niederholzer, UCCE Farm Advisor, Colusa and Sutter/Yuba Counties

"If your first hull spray went out after July 5 last year, you weren't happy with your reject sheets."

An experienced PCA in the Arbuckle area said that to me last fall. The exact date in 2019 isn't important as we look to hull split, 2020; every year is different. The key point is: waiting too long to start hull split spraying will cost you. So will a poor spray job. There are two take home messages from this article:

1) If you wait too long to put on the first hull split spray, it doesn't matter if it's done by air, ground or robot, what's in the tank, how slow you drive or what spray volume you use – you are too late to get the best control possible and it will cost you in both lost crop and quality incentives.

2) Once you get the timing right, you have to get excellent coverage when you spray or you will not get the best control possible and the best net return.

Early hull split, when the hull begins to open at the suture, is a can't-miss timing in almond pest management. The splitting hull does two things; releases nut volatiles so the navel orangeworm (NOW) female can find the nut (and lay eggs), and gives wound pathogens like *Rhizopus stolonifera* and *Aspergillus niger* an opening to infect the hull. Spraying at the right time (Stage 2c, see photo below) when hull split first begins (in the upper, southwest side of the tree) is critical to effective NOW and *Rhizopus* hull rot management throughout the orchard.* To get the timing right, get up in the tree in a pruning tower or bring the tree top nuts down to ground level by cutting tree top shoots with extension pruners so you can really see what's going on. Splitting usually starts on the SW side of the tree tops.

Because getting the timing right for the first hull split spray is critical and it takes time to get across orchards spraying by ground, consider 1) going by air to get across the orchard(s) before Stage 2c ends in the tree tops and/or 2) starting spraying by ground a couple of days before nuts get to Stage 2c so you can finish quickly (in a week or less). A second application may be needed within 7-14 days based on trap counts and orchard damage history, with the interval depending on the material. Finally, since outside nuts on the trees on the outside trees in a block split first, consider an "edge spray" by ground, driving around the whole orchard, spraying in from the outside, when the sound nuts start to split on those edge trees. The edges can be ready several days before the rest of the orchard.

For the first hull split spray, air application is effective and fast. Research by Dr. Joel Siegel, USDA-ARS Researcher at Parlier, CA, has documented good NOW control with careful aerial applications (fixed wing or helicopter) with spray volumes as low as 15 gallons per acre (GPA). He reports spray coverage by air is 20% to 25% less than a good ground spray job (150 to 200 GPA, 2 MPH), but control in the tree tops — where the nuts split first — is very good. Dr. Siegel's research showed 90% NOW control in tree tops by air, though careful ground application (150-200 GPA at 2 MPH) was still superior, with 100% control. (Don't expect 100% NOW control with hull split sprays. Dr. Siegel's results were from field sprayed targets exposed to NOW in the lab. The point is that aerial application can do a very good job, compared to ground sprays, in controlling NOW in tree tops.)

If you are going to spray by ground, it pays to do a careful job. To deliver good results, ground rigs must be carefully calibrated and set up for excellent coverage in each orchard you spray. It is a lot like painting a large house. For good weather protection of house siding, even paint coverage (no gaps), is needed. In almonds at hull split, the whole canopy, leaves and all, must be evenly sprayed to protect the nuts —to leave no gaps you have to "paint the whole house". There are 4-8 acres of leaf surface area in an acre of mature, vigorous almond trees. Multiple studies in almonds from Colusa to Fresno have shown that 150-200 gallons per acre (GPA) spray volume from a ground application delivers better NOW control than 100 GPA.

In big, dense trees, drive slowly. Slow tractor speed -- 2 MPH – gives the sprayer fan time to move the spray material throughout the canopy. Check your ground speed using flagging tied to a PVC pole or window-washing extendable pole. If the flagging doesn't move as the sprayer drives by with the fan on, slow down until you find a speed where the flagging just flutters out 45-90^{o} off vertical.

Watch when you spray. Spraying in dry, warm air (relative humidity below 40% and temperatures above 80^{o}F) can reduce spray coverage due to droplet evaporation. Losses of 50% spray deposition have been measured in treetops using a ground rig at 11:30 AM vs 6:30 AM in June in the Sacramento Valley. Dusk to mid-morning is a good target window.

Some aerial applicators are set up for night spraying.

Finally, Dr. Joel Siegel recommends alternating insecticide chemistries between NOW generations to slow pesticide resistance development in the pest. For example, if you use Altacor® or Minecto® Pro at spring ("mummy") spray timing against the first NOW generation, change chemistry group and use Intrepid® or Intrepid Edge® in late June into July against the second generation.

Hull split is a critical timing for pest control in almonds. NOW and hull rot pressure have increased the last few years. Proper spray timing and delivery will help make reject sheet reading less painful and almond growing more profitable.

Stage 2c of early hull split; target timing for first NOW spray.
The nut can be squeezed from the ends and the entire suture will pop open.
(photo credit: UC IPM program; ucipm.ucanr.edu)

*Work by Drs. Mohammad Yaghmour, UCCE Farm Advisor in Kern County, and Themis Michalidies, UC Plant Pathologist based at UC Kearney in Parlier, shows that *Aspergillus niger* infested more nuts and spurs (through the hull sutures) about a week after Stage 2c of hull split, when the suture is about a third of an inch wide (Stage 3), than at or before Stage 2c.

Advisor Farewell

Emily J. Symmes

As of April 2020, I have decided to make a career change and enter the private sector. It has been a true pleasure and honor serving as the UC Cooperative Extension Area IPM Advisor in the Sacramento Valley and Associate Director of Agriculture for the Statewide IPM Program. Over the past 5+ years with UCCE, I have been privileged to work alongside growers, PCAs, and others in the orchard industry to address pest management issues and share advancements with all of you.

I have now joined the team at Suterra as a Technical Field Manager. In this role, I look forward to continuing my relationships with the agricultural industry in California, as well as the University, to bring effective, economic, and sustainable pest management solutions to our industry. I can be reached at emily.symmes@suterra.com and (530) 227-0189.

Many thanks to all of you for your dedication to agriculture and best wishes for health and prosperity!

Propiconazole (Tilt®, Bumper®, etc.) use Cancelled in the EU.

Franz Niederholzer, UCCE Farm Advisor, Colusa and Sutter/Yuba Counties

Propiconazole is an inexpensive and highly effective fungicide (FRAC 3) commonly used in almond production. While most commonly used during bloom against brown rot and anthracnose, it is also effective against some spring/summer diseases particularly anthracnose and rust, although it is only moderately effective against alternaria, scab and hull rot. It is off patent and marketed under many brand names including Tilt®, Bumper®, Propi star®, etc and is an ingredient in Quilt Xcel®.

Propiconazole use in the European Union (EU), a major market for California almonds, was cancelled in March, 2020. When EU cancellations occur, the MRL is automatically lowered to a default of 0.01 ppm. However, the MRL for propiconazole was 0.01 ppm prior to cancellation and California growers used propiconazole without exceeding this MRL for many years. Again, this use was primarily during bloom.

While not commonly used much after bloom, propiconazole could be of interest to growers looking for inexpensive rust control, for example, in a year where possible lower nut prices are rumored. This would be a significant change in use pattern and a potential concern for exceeding the MRL in the EU.

Before using a product containing propiconazole on almonds, growers should check with their processor. I have seen a letter from at least one processor advising growers to consider alternative fungicides.

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Thanks to Dr. Gabriele Ludwig, Director, Sustainability & Environmental Affairs, Almond Board of California, for information used in this article.

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