Nickels Soil Lab Projects

Project No.: **HORT6.Niederholzer**

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A. Summary:

In 2019, overall almond yield at Nickels was off 40% from 2018 due to extended cold, wet weather at bloom. Yield results presented here should be filtered through this background information.

The organic trial is the same situation as past years – organic yield is approximately 66-80% of conventional yield. Generally, organic yield is closer to that of conventional in years with good bloom weather (warm and dry) and further appart in years with poor bloom weather (cool and wet). Deficient N levels are a continuing challenge in the organic block as organic N sources are extremely expensive.

The Titan peach/almond hybrid rooted block (3rd leaf) was harvested for the first time in 2019. There was no significant yield difference between trees planted at tree spacings of 12', 14', 16', or 18' (all at 21' row spacing). The Rootpac-R almond/plum hybrid trees were planted in November, 2017 and so were essentially second leaf trees in 2019. All plantings are 50% Nonpareil, 25% Aldrich and 25% Kester.

B. Objectives *(300 words max.)*

Provide support for long-term research and demonstration projects at Nickels Soil Lab in Arbuckle, CA (Colusa Co); in particular 1) organic demonstration plot and 2) new spacing trial on two different rootstocks. The objectives of those two projects are:

1. *To demonstrate certified organic almond production practices and materials in the Sacramento Valley and compare with conventionally managed trees.*
2. *Evaluate production and orchard health (tree loss, shaker damage, etc.) over time of orchard plots at 12', 14', 16', or 18' tree spacing (at 21' row spacing) using Titan (vigorous) or Rootpac-R (less vigorous) rootstocks.*

C. Annual Results and Discussion *(This is the core function of this report)*

1. In 2019, both conventional and organic shaking for Nonpareil was on August 12 (100 DD into the 3rd flight of NOW) using catchframe harvesters. Organic Nonpareil yield was approximately 2/3 that of conventional (Table 1; Figure 2), although the wet and cold bloom weather and the large 2018 crop probably contributed to the lowest yields in this block in 10

years. Non-pareil kernel size was good (nuts/oz) for conventional and organic/transitional (24-25 nuts/oz) with good quality (<1% rejects in field samples), despite no pesticides or any other NOW control practice(s) in the organic blocks besides careful winter sanitation. Winter shaking and poling was done in all blocks at Nickels.

During the fourteen seasons of this trial, organic production levels, disease management, weed control and nitrogen fertility have been the most challenging issues. Recently, nitrogen nutrition has eclipsed weed control and disease management as the largest, sustained challenge to sustainable organic production in this orchard.

- Fertility: Almonds use roughly 60-70 lbs of N per 1000 lbs of kernel crop produced – the highest N use of any tree crop commonly grown in California. Maintaining orchard N status while maximizing organic production is challenging and expensive. In 2011, the nitrogen fertility program in the organic/transitional trees was modified to include more organic fertilizer. Yard waste compost was not broadcast after 2011. Organic fertilizer (4-0-2) was applied through the irrigation system. However, the organic treatment areas are still N deficient; based on 2019 summer leaf N levels (Table 1). Dry organic fertilizer was not used this year due to challenges incomporating the material. In 2020, further efforts will be made to “shank” in dry N fertilizer.

- Weed Control: While propane flaming in the tree row has been mostly effective it is slow and expensive. Sections of the organic trees received a weed cloth barrier at planting which has prevented most weed growth in the 6 ft. wide tree line but at the considerable expense of $1500/acre plus yearly repair expenses. Weeds were hard to control along the edges of the cloth where mowers couldn’t operate without catching/pulling the cloth. The weed cloth was removed at the end of 2011 after annual maintenance became too expensive and time consuming to continue. The surface drip system was replaced in October 2007 with a dual line subsurface drip system, primarily to reduce weed growth, seed emergence and associated weed control costs. This has reduced propane flaming expenses significantly compared to previous seasons. The subsurface drip lines were replaced in spring, 2016 due to plugging issues. Vented end-caps for each line were installed with the new hoses.

- Disease control: Spring and summer disease control, especially leaf rust, has been a problem in the organic trees. Beginning in 2011, a program of one sulfur spray per month has controlled rust and suppressed spider mites, contributing to a stronger canopy at postharvest. This single practice has had the biggest impact on organic production in this demonstration block over the past six seasons.

- Navel orangeworm (NOW): No effective organic insecticides without impacts on mte predators (especially 6-spotted thrips) are known to the authors. The one exception is B.t. (Dipel®, etc.), but this material has a very short residual and requires frequent applications. Therefore, no insecticides were sprayed in the organic block at hull split.

  Good sanitation and early harvests have generally helped keep NOW damage in the Non-pareil under 1% in the conventional and organic section over the past few years. However, in 2019, worm damage in the organic (2%) was up compared to the conventional (0.9%) in 100 nuts/row samples. The ‘Fritz’ variety pollinizer was

harvested on Oct 1 (250 DD into 4th NOW generation) had 5.5% (conventional w/ 3 pesticide sprays!) and 4.5% (organic) damage in field samples. Growers planning an organic orchard (or any new almond orchards?) should consider earlier harvesting varieties as pollinators.

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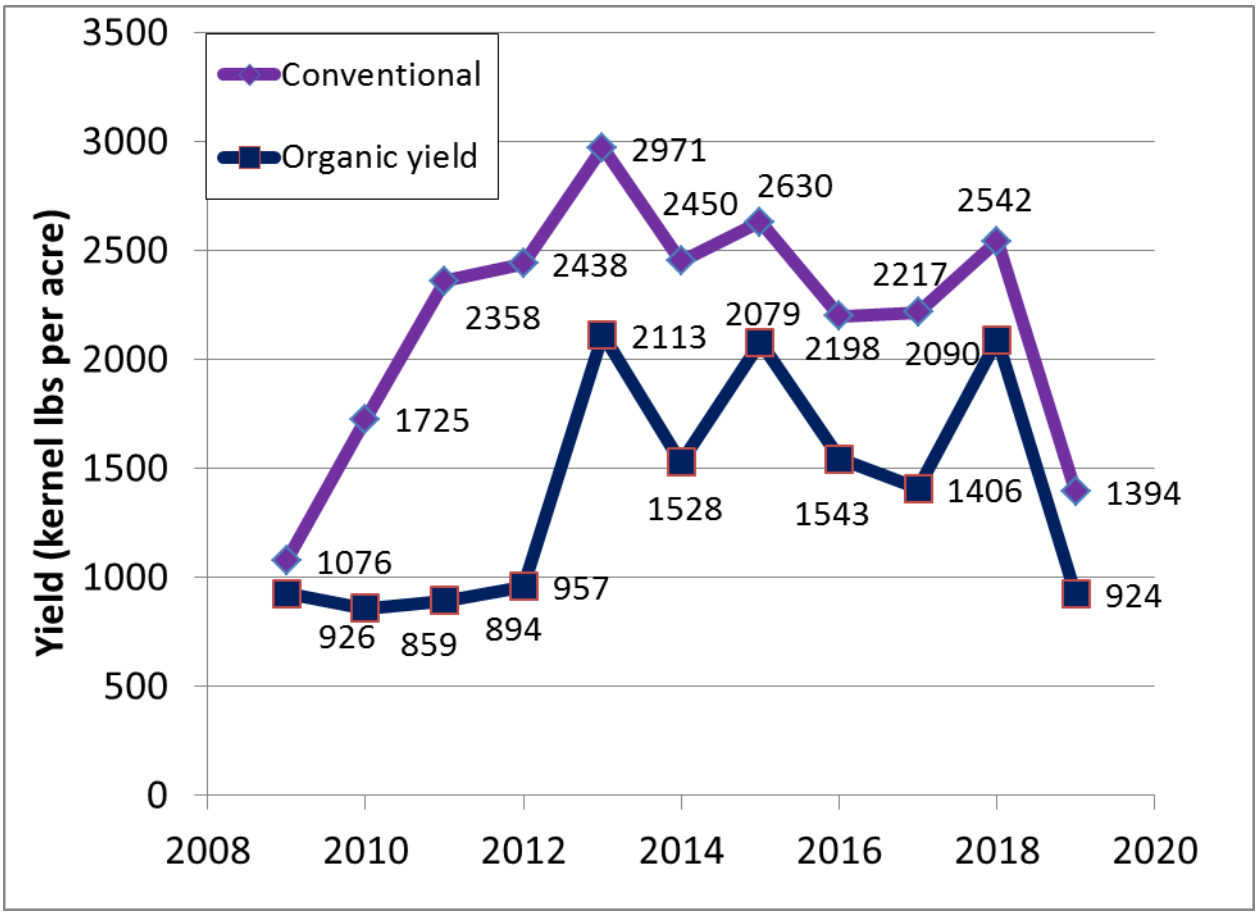
Table 1. 2019 Yield / Kernel Size / Leaf %N. Data are not adjusted to account for rocks.

System	2019 Nonpareil yield lbs/Ac	Kernels/oz	July leaf %N
Conventional	1394	**24**	**2.52**
Transitional	788	**25**	**2.20**
Organic	924	**25**	**2.11**

Figure 2. Nonpareil (NP) yields (kernel lbs/acre) for conventional and organic treatments. 2009-2019.



2. Objectives: Evaluate the economic and horticultural production of almond trees in four row spacing distances on 1) vigorous or 2) less vigorous rootstock.

Interpretive Summary: Nonpareil/Titan harvest was August 23, 2019 and pickup was September 3. Field run nut weights were reduced 25% to account for rock weight, as field checks showed 17-33% rocks by weight in the nut wagons at pickup. There was no significant yield difference between the four rows spacing treatsments (p=0.98), while block location in the long, narrow block was a significant factor in yield (p=0.045). Aldrich and Kester yields were not taken. Rootpac-R trees were essentially 2nd leaf trees in 2019 and not harvested.

Trunk circumference measurements were taken on February 13, 2020, just prior to full bloom. Measurements were taken from four, evenly distributed trees in each tree spacing treatment in each block for a total of 20 trees per spacing treatment (four trees per block, five blocks). Titan rooted trees on 12' spacings had significantly smaller trunk circumference, indicating smaller trees, compared to the other spacings (Table 2). It appears that the trees in the 12' spacing treatments are competing with each other and reducing tree size relative to growth from the other spacings, while trees in the other spacing treatments have not yet grown to the point that they compete with each other. The competition appears strongest in Blocks 1 and 5 (Figure 1). RootpacR rooted trees are less vigorous than those on Titan and showed no significant differences in tree circumference across the spacing treatments (Table 2).

There were significant differences in trunk diameter, averaged across the tree spacings in each block, between blocks (Table 3) for both Titan or Rootpac-R rooted trees. This natural pattern of tree growth potential did not appear to influence yield across the orchard this year.

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Table 1. Yield of Nonpareil trees (2019, 3rd leaf) spaced 21' across the row with differing tree spacings. Data have been reduced 25% to correct for rocks content of field weights. There is no significant difference in yield. n=5

Row Spacing (ft)	***Non-pareil pounds/acre***
12'	***403***
14'	***370***
16'	***379***
18'	***355***

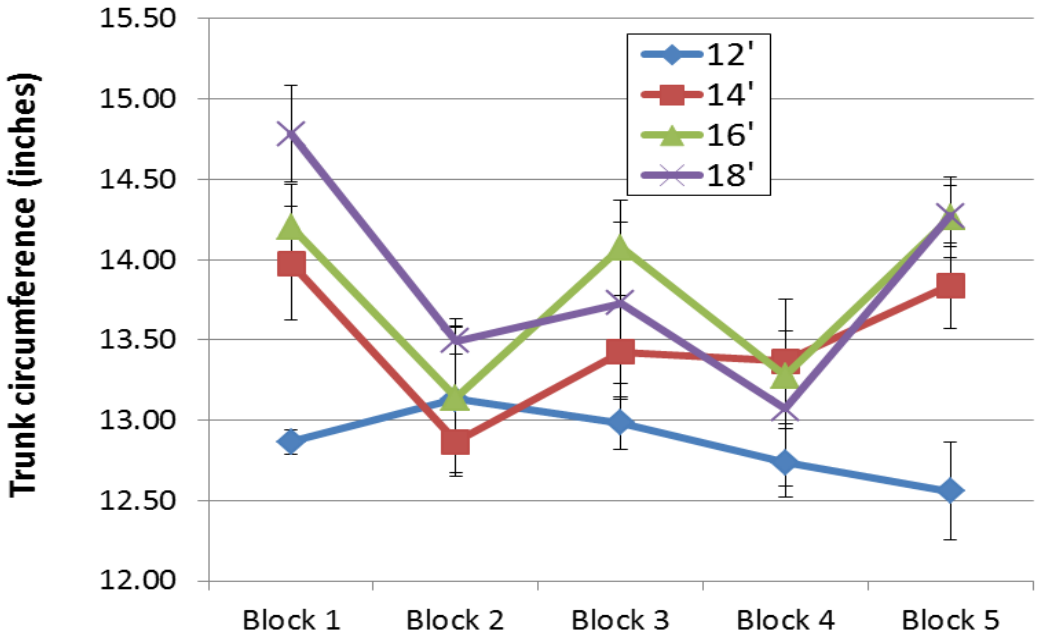
Table 2. Average Non-pareil tree trunk circumference (inches) at one foot above the graft union for Titan and RootpacR trees at different tree spacings. Data taken Feb.13, 2020. Twenty trees from each spacing distance were measured, four from each of five blocks. Titan trees were bareroot and planted in late April, 2017. RootpacR trees were potted and planted in late October, 2017. Data in each column, followed by the same letter are not significantly different with 95% confidence using Tukey HSD test.

Row Spacing (ft)	***Non-pareil/Titan***	***Non-pareil/Rootpac-R®***
12'	**12.85 a**	**10.60 a**
14'	**13.49 b**	**10.46 a**
16'	**13.79 b**	**10.51 a**
18'	**13.88 b**	**10.95 a**

Table 3. Block affect on Non-pareil tree trunk circumference (inches) at one foot above the graft union for Titan and RootpacR trees averaged across tree spacing at bloom, 2020. Order of blocks is from West (1) to East (5). Data in each column, followed by the same letter are not significantly different with 95% confidence using Tukey HSD test.

Block	*Non-pareil/Titan*	*Non-pareil/Rootpac-R®*
1	**13.96 a**	**11.08 a**
2	**13.16 b**	**10.78 ab**
3	**13.55 ab**	**10.54 ab**
4	**13.11 b**	**10.61 ab**
5	**13.73 ab**	**10.28 b**

Figure 1. Average trunk circumference (inches) for Non-pareil on Titan peach/almond hybrid trees at one foot above the graft union in each of the five blocks (West to east) at bloom. Bars indicate ± 1 standard error. Order of blocks is from West (1) to East (5).



D. Outreach Activities

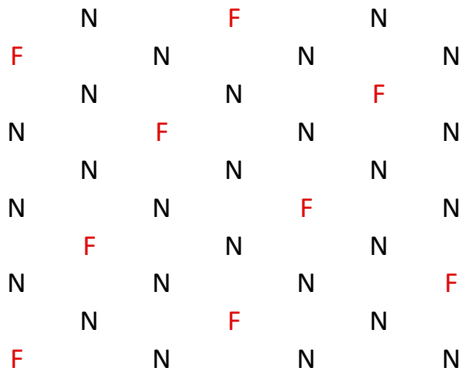
1. The annual Nickels Field Day was May 7, 2019. There were at least 110 people in the audience.

E. Materials and Methods *(500 word max.)*:

1. For the past 14 years, organic vs conventional almond orchard management practices have been compared in a 7-acre almond planting of Nonpareil/Fritz (75/25) at the Nickels Soil Lab (see Figure 1 for tree layout). Three production systems; conventional, transitional and organic were initially compared, but currently conventionaland organic practices are compared. The transitional trees were grown conventionally for 3 seasons

and then converted to organic practices in September, 2008. All trees are planted 22' across the row and 16' down the row and irrigated with subsurface drip irrigation (SDI). Tree sizes across the different treatments are similar. The conventionaltrees are managed using practices typical for almond production in the area. The organic trees are grown using practices approved for organic production by the USDA and CCOF. Certified organic pesticides and fertilzers are used. This trial is not replicated due to the limited space available. However, this side-by-side comparison is intended to be a valid case study of differing almond management systems. Outline materials used and methods to conduct experiment(s)

Figure 1. Trial Planting Design
75% Nonpareil/25% Fritz



2. In 2017, a randomized complete block designed, 16 acre trial was planted to compare the economic sustainability of four row spacings (12', 14', 16', or 18') on two almond rootstocks of different vigor. Row spacing was held constant (21'). Irrigation is by double-lined drip hose with half-gallon emitters at 30" intervals. Trees were doubled staked at planting. In the first dormant season, scaffolds were selected and then headed back to 36-42", which is common practice on the westside of the Sacramento Valley out of concern for wind damage.

   Two rootstocks of differing vigor – Titan peach/almond hybrid and Rootpac-R® almond/plum hybrid – were used. These two rootstocks were selected for their different tolerance to excessive soil moisture and good/better performance under elevated boron and/or chloride levels in UC trials in other districts. Peach/almond hybrids are much less tolerant of saturated soils and Rootpac-R is reported to be more tolerant of "wet feet" than peach or peach/almond hybrid.

   Bareroot Titan trees and potted Rootpac-R trees were planted in late April and early November, 2017, respectively. All plantings were 50% Nonpareil, 25% Aldrich and 25% Kester. There are 5 replicates of each rootstock x row spacing. The rootstocks are planted in different areas of the same field due to soil type and drainage differences, so direct statistical comparison of the one rootstock performance against the other is not possible.

F. Publications that emerged from this work

Niederholzer, F.J.A. 2019. Nickels Soil Lab research review. West Coast Nut. April pp. 42-46.

Objectives: Evaluate the economic and horticultural production of almond trees grown in four row spacing distances on 1) vigorous or 2) less vigorous rootstock on Class 2-3 soils in the Arbuckle District of Colusa County.