# Nickels Soil Lab Projects

**Project No.:** **HORT6.Niederholzer**

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## A. Summary:

*In 2020, overall almond yield at Nickels was excellent due to excellent bloom weather. Yield results presented here should be filtered through this background information.*

*The organic trial productivity situation is the same as past years. Generally, organic yield is closer to that of conventional in years with good bloom weather (warm and dry like 2020) and further appart in years with poor bloom weather (cool and wet like 2019). With the good bloom weatherin 2020, organic yield was roughly 82% of conventional. Finally, in 2020 after several years of trying different application equipment, a dry organic N fertilizer was successfully "shanked" into the ground and delivered both a good crop and better leaf N levels compared with previous years. Deficient N levels are a continuing challenge in the organic block as organic N sources are extremely expensive.*

*The Titan peach/almond (P/A) hybrid rooted block (4rd leaf) was harvested for the second time in 2020 and the plum/almond hybrid (Pl/A) rootstock planting was harvested for the first time. No significant yield difference (at the 5% level) was measured between Nonpareil or Aldrich on Titan PA or Rootpac-R Pl/A rootstock for trees planted at tree spacings of 12', 14', 16', or 18' (all at 21' row spacing). Kester variety on Rootpac-R rootstock at 12' tree spacing had significantly greater yield per acre than trees at 14', 16', or 18'. Yields for Kester on P/A rootstock at different tree spacings are not presented. 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 for orchard plots at 12', 14', 16', or 18' tree spacing (at 21' row spacing)*

*using Titan peach x almond (vigorous) or Rootpac-R plum x almond (less vigorous) rootstocks.*

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

1. In 2020, organic blocks shaking for Nonpareil was on August 7 (263 DD into the 3rd flight of NOW) using catchframe harvesters and August 14 (431 DD into the 3rd flight of NOW) for conventional treatment. Organic Nonpareil yield was approximately 80% that of conventional (Table 1; Figure 2), the best production to date. Non-pareil kernel size was good (28 nuts/oz) for conventional and organic/transitional (26 nuts/oz) with good quality (<0.5% rejects in field samples), despite no pesticides (but mating disruption for the first time) in the organic blocks and careful winter sanitation. Winter shaking and poling was done in all blocks at Nickels.

During the fifteen 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.

  From 2011-2019, liquid organic fertilizer (4-0-2) was applied through the irrigation system. This was expensive and organic treatment blocks were still N deficient; based on summer leaf N levels.

  In 2020, 30 lbs N/a were injected as 4-0-2 in March. In late April, 100 lbs N/a as 12-0-0 pelletized feather meal (True Organic Products) was shanked into the ground on both sides of each row in the organic sections using a AgPro 160-D fertilizer cart (AgPro, Inc., Lewiston, ID) on loan from ICL Speciality Fertilizers. It was necessary to drive very slowly (1 MPH) to ensure that the high rate of material (800 lbs 12-0-0/acre) flowed smoothly through the machine, but it worked. Organic production was good and summer leaf levels were up compared to previous years, although right on the N deficiency threshold.

  In the conventional rows, coated urea fertilizer (Agrocote MAX 1-2M, 44-0-0; ICL Specialty Fertilizers) was applied on April 25 at rates shown in Table 2 using the AgPro 160-D machine mentioned above. Previously, 120 lbs N had been injected through the irrigation system as 10-0-12 liquid (urea and potassium carbonate) in 3 separate applications: 50 lbs N/ac on March 6, 35 lbs N/ac on April 8, and 35 lb N/a on April 18. The coated urea was applied as a demonstration to see if different N rates with the same 1-2 month release timing influenced yield or leaf N results. In this unreplicated demonstration, no major differences in July leaf N or yield were observed. The pattern of yield variability was similar to those measured in 2019 for the same rows.

- Navel orangeworm (NOW): Careful winter sanitation is practiced every year. However, while early harvesting can help reduce NOW damage in the Nonpareil, the Fritz can be hit very hard (Table 3). [No insecticides have been used in the organic orchard for 10 years and the conventional blocks are sprayed 2-3 times between initial hull split and Nonpareil harvest.]

  In 2020, mating disruption (Trece Cidetrack NOW MESO) was used in the entire block (organic and conventional) beginning in May. No hull split insecticides were used in the organic block at hull split in 2020, while the conventional blocks received 3 hull split sprays (2x in July and 1x in early August). While 2020 was generally a light NOW damage year and an adjacent hard shell block was removed the year before (reducing pressure in the organic trial), the low NOW damage levels in the organic block are encouraging. The plan is to continue to use mating disruption in 2021.

- 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 management: Spring and summer disease control, especially leaf rust, was 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 eight seasons (Figure 1).

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**Table 1. 2020 Yield / Kernel Size / Leaf %N. Data are adjusted down 10% to account for rocks.**

| System | 2020 Nonpareil yield lbs/Ac | Kernel ct/oz | July leaf %N |
|---|---|---|---|
| Conventional | 2697 | **26** | **2.52** |
| Transitional | 2307 | **28** | **2.20** |
| Organic | 2116 | **28** | **2.20** |

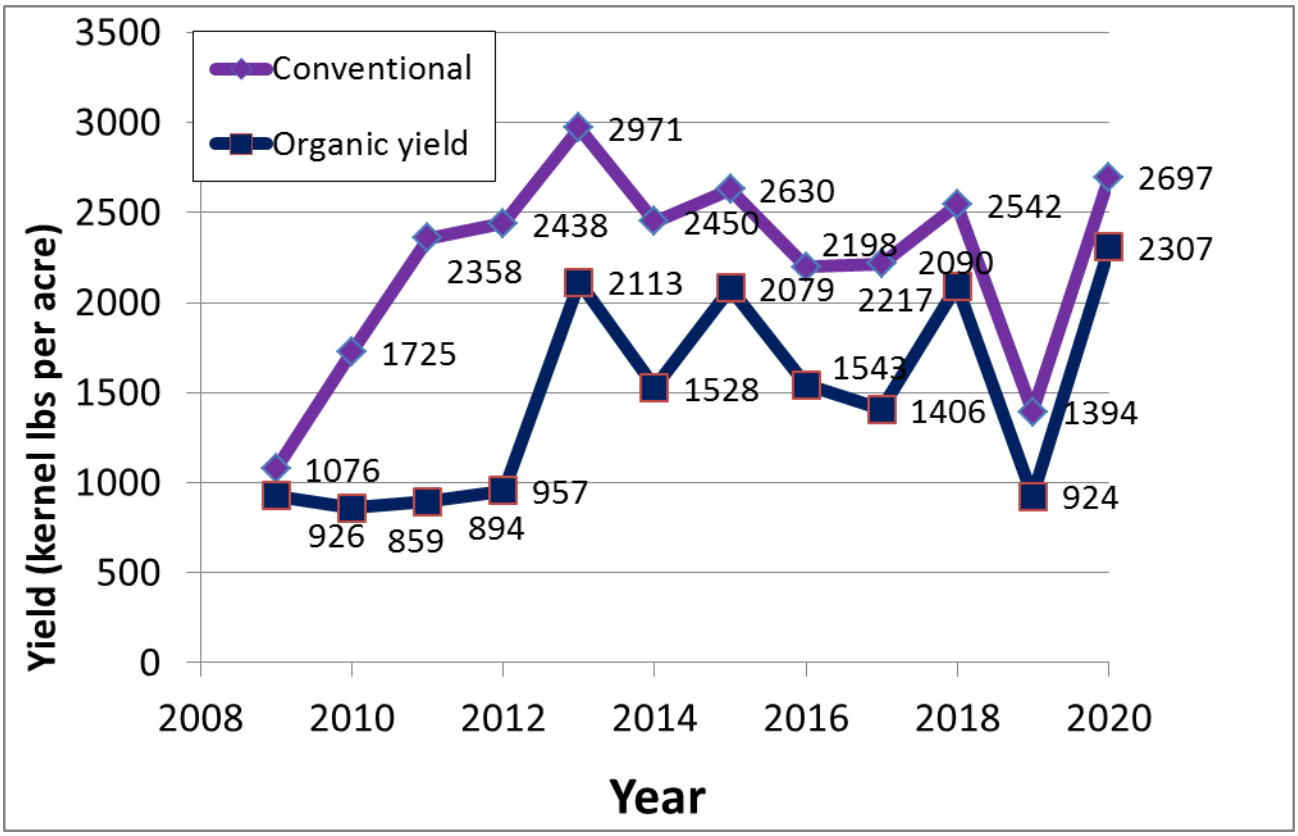
Table 2. Rates of nitrogen (N) as slow release fertilizer (Agrocote MAX 1-2M, 44-0-0, coated urea) applied to the conventional rows on April 25, spring and summer leaf N levels and final yield results. All treatments received 120 lbs N/acre in March and April as liquid urea. The slow release material was buried at 3-4" depth using an AgPro 160-D fertilizer cart. Kernel weights were reduced 10% to correct for weight of rocks in field weights used to determine yield values.

| Rate of N/acre | April 30, 2020 leaf N | July 28, 2020 leaf N | Yield (kernel lbs/a) |
|---|---|---|---|
| 88 | 3.04 | 2.39 | 2,809 |
| 115 | 3.13 | 2.53 | 2,740 |
| 147 | 3.11 | 2.54 | 2,394 |
| 147 | 3.12 | 2.49 | 2,553 |

Table 3. NOW damage (%) in Nonpareil and Fritz varieties, sampled from the nut cart at harvest (prior to hulling). All organic acres used mating disruption (Trece Cidetrack NOW MESO) in 2020, but not in previous years. The conventional rows are treated with 2-3 pesticide sprays at hull split (July and August). The organic blocks receive no insecticide sprays. All rows are carefully winter sanitized.

| Year | Nonpareil (conventional) | Nonpareil (organic) | Fritz (conventional) | Fritz (organic) |
|---|---|---|---|---|
| 2017 | 1 | 0.7 | 5.0 | 16.1 |
| 2018 | 0.375 | 0.5 | 1.5 | 2.5 |
| 2019 | 0.875 | 2.0 | 2.0 | 2.0 |
| 2020 | 0.375 | 0.5 | 0.125 | 0.5 |

**Figure 2. Nonpareil (NP) yields (kernel lbs/acre) for conventional and organic treatments. Fourth leaf through fifteenth leaf: 2009-2020.**




**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 harvest was August 15, 2020 and pickup was August 31. Aldrich and Kester were harvested on September 3 and pick up was September 21. 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 in 2019.

Orchard location: Soils in this orchard are highly variable, based on preplanting soil mapping, and yields for Titan rooted trees tended to decrease from west to east. These yield differences across the planting were almost significant (p=0.12) for Nonpariel and very significant for Aldrich (p=0.01). There were no significant yield differences based on orchard location on Rootpac-R® for Nonpareil (p=0.91), Aldrich (p=0.53) or Kester (p=0.62). Because the different rootstocks were planted in different sections of the field (not randomized together) no comparison between the rootstocks can objectively be made. We will continue to track the orchard location impact on yield, separately, for Titan and Rootpac-R.

Tree size, measured by trunk circumference at 12" above the graft union, also decreased significantly across the orchard in a general pattern from west to east for both Titan (p=0.001) or Rootpac-R (p=0.01).

Tree Spacing: In 2020, closer tree spacing generally increased yield, particularly for the 12' spacing, but the differences were not the same across varities and rootstocks. For Titan, yield of closer plantings was almost statistically different for Nonpareil (p=0.09) but not for Aldrich (p=0.22). The threshold for statistically significance is usually p=0.05). For Rootpac-R, Nonpareil again showed differences very close to statistically significant (p=0.07), while Aldrich was not influenced by spacing (p=0.17). Only Kester on Rootpac-R showed a significantly greater yield at 12' (p=0.01) compared to all other spacings. Average yields per spacing are shown in Table 1 for Titan and Table 2 for Rootpac-R rooted trees.

Closer tree spacing (down the row) reduced tree size. This was first established for almonds, to our knowledge, in a larger rootstock/spacing trial in Stanislaus County planted almost 20 years ago by Roger Duncan, UCCE Advisor. We have found similar results. Nonpareil on Titan or Rootpac-R rootstocks at 12' spacings had significantly smaller trunk circumference, indicating smaller trees, than trees at the widest spacing of 18' (Table 3). There were significant differences in trunk circumference, averaged across the tree spacings in each block, between blocks (Table 3) for both Titan or Rootpac-R rooted trees.

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Table 1. Yield of Nonpareil/Titan trees (2020, 4th leaf) planted with 21' row spacings and differing tree spacings resulting in differing number of trees per acre. Data have been reduced 25% to correct for rocks content of field weights. Data in each column, followed by the same letter are not significantly different with *90%* confidence using Tukey HSD test.

| | | ----kernel lb/acre---- | |
|---|---|---|---|
| ***Row Spacing (ft)*** | ***Trees /acre*** | ***Non-pareil*** | ***Aldrich*** |
| ***12'*** | ***173*** | ***1407 a*** | ***1580 a*** |
| ***14'*** | ***148*** | ***1446 a*** | ***1415 a*** |
| ***16'*** | ***130*** | ***1316 a*** | ***1361 a*** |
| ***18'*** | ***115*** | ***1205 a*** | ***1423 a*** |

Table 2. Yield of Nonpareil/Rootpac-R trees (2020, 3rd leaf) planted with 21' row spacings and differing tree spacings resulting in differing number of trees per acre. Data have been reduced 25% to correct for rocks content of field weights. Data in each column, followed by the same letter are not significantly different with *95%* confidence using Tukey HSD test.

| | | ----------kernel lb/acre---------- | | |
|---|---|---|---|---|
| ***Row Spacing (ft)*** | ***Trees /acre*** | ***Non-pareil*** | ***Aldrich*** | ***Kester*** |
| ***12'*** | ***173*** | ***918 a*** | ***816 a*** | ***823 a*** |
| ***14'*** | ***148*** | ***775 a*** | ***772 a*** | ***660 b*** |
| ***16'*** | ***130*** | ***750 a*** | ***698 a*** | ***647 b*** |

| | | | | |
|---|---|---|---|---|
| *18'* | *115* | *762 a* | *634 a* | *669 b* |

Table 3. Average Non-pareil tree trunk circumference (inches) at one foot above the graft union for Titan and RootpacR trees at different tree spacings. January 12, 2021. Twenty trees from each spacing distance were measured, four from each of five blocks. Titan trees were bareroot and planted in late April, 2017. Rootpac-R® 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.

| | *Trunk circumference (inches)* | |
|---|---|---|
| *Row Spacing (ft)* | *Non-pareil/Titan* | *Non-pareil/Rootpac-R®* |
| *12'* | ***16.04 a*** | ***14.22 a*** |
| *14'* | ***17.14 b*** | ***14.50 ab*** |
| *16'* | ***17.50 bc*** | ***14.51 ab*** |
| *18'* | ***17.92 c*** | ***15.07 b*** |

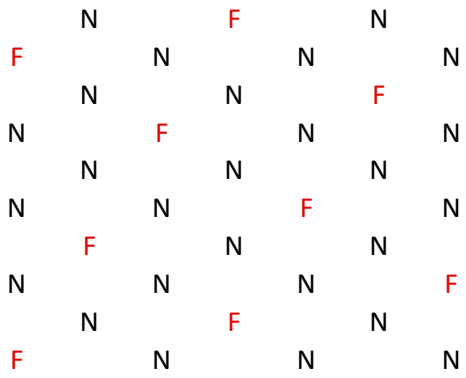
## D. Outreach Activities

1. Given the pandemic, no program has focused on these results.

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

1. For the past 15 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 Lalb (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: none to date

**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.