



# ALMOND VARIETIES AND SELECTIONS

Sebastian Saa, *Almond Board of California*

Phoebe Gordon, *UC-ANR*







# ALMOND VARIETIES AND SELECTIONS

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## TAC: Almond Breeding Program

Sebastian Saa, Associate Director,  
Agricultural Research







# Agenda

1. Part I: ABC variety breeding strategy  
Sebastian Saa, Associate Director, ABC
2. Part II: Regional Variety Trial (RVT)  
Phoebe Gordon, UC Cooperative Extension
3. Part III: Non- RVT varieties and other milestones  
Sebastian Saa, Associate Director, ABC

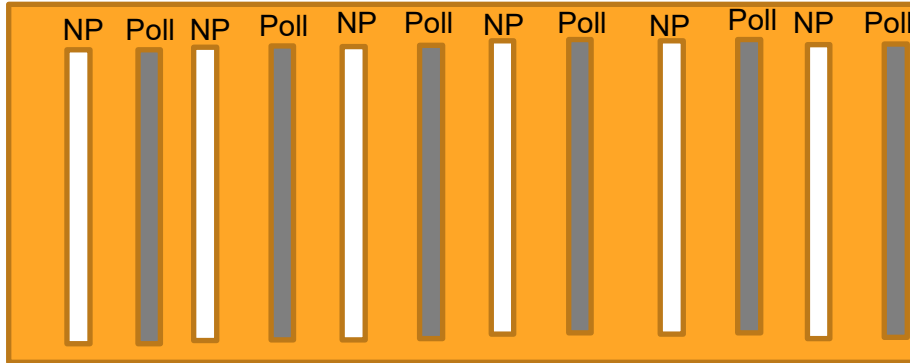




## The development of variety diversification in the supply chain

- Almond variety diversification evolved primarily due to the need for pollinizers of Nonpareil (NP):

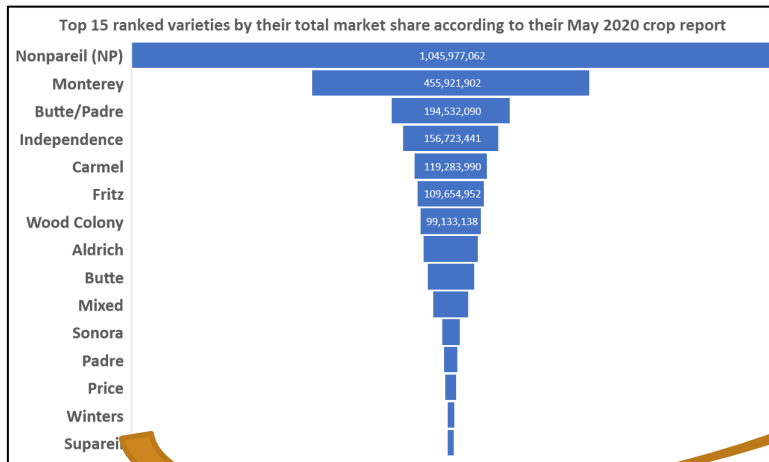
### Classic almond orchard configuration



*Other factors in diverse variety selections include leveraging equipment use, niche market opportunities, and resilience.*

## Under this classic configuration, together we developed and evaluated different pollinizers for Nonpareil that could also offer better market diversification.

- ABC supported UC breeding program and University managed Regional Variety Trials (RVT)
  - First generation 1974-1981
  - Second generation 1993-2006
  - Third generation 2014-present
- As result, all but one of the top 15 current CA almond varieties, ranked by their total market share according to 2019/20 crop receipts, have been included in past or current RVTs

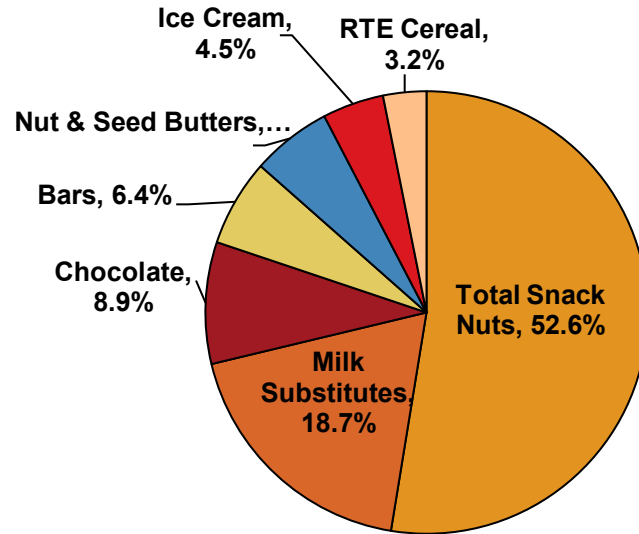


The fact that we know a lot about the performance of these varieties is mainly because they were evaluated by our UC researchers in coordination with public breeders and nurseries, and because extensionists and experts have disseminated such results across our industry.



With this diverse supply our industry has flourished for decades

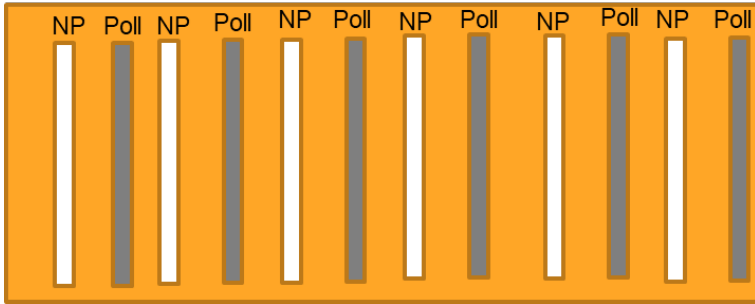
### 2018: Category Share of Pure Almond Volume Estimated at 257 MM Lbs (Nielsen)



2018  
Pure Almond Volume: 77.1% (Snack nuts, butters, milk substitutes)  
Ingredient Volume: 22.9%

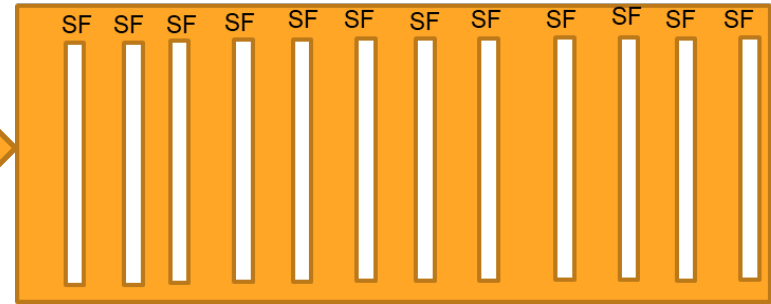
## Development of self-compatible varieties (varieties that do not require cross pollination to set fruit)

### Classic almond orchard configuration



Transition  
that started  
in 2010s

### New almond orchard configuration



**“Self-Compatible varieties are here to stay and for good reasons”**

- Do not require a pollinizer such as Monterrey, Carmel, Fritz, and Butte/Padre.
- No need for cross-pollination, which results in less horticultural risks and less hives per acre during bloom.
- Brings uniformity to the management unit and thus increases the efficiency of most horticultural practices:
  - Increased efficiency of sprays to the canopy (i.e. NOW, Hull Rot control).
  - Fertigate and irrigate accordingly to one variety.
  - One shake, one harvest.
  - Etc.



## Independence: The first self-compatible variety highly adopted in CA

- Independence received huge marketing attention and rapid adoption in less than ten years.

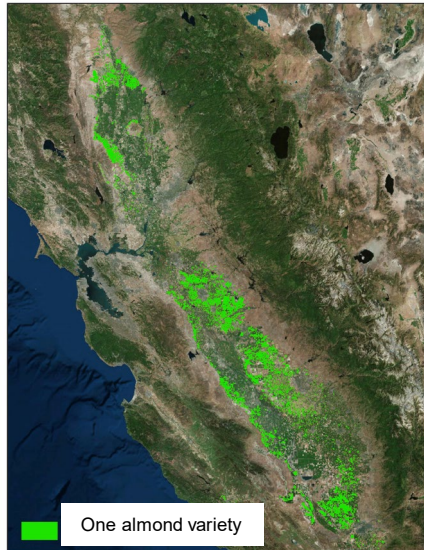
2019/20 Receipts By variety	Kernels (lbs)
Nonpareil (NP)	1,045,977,062
Monterey	455,921,902
Butte/Padre	194,532,090
Independence	156,723,441
Carmel	119,283,990
Fritz	109,654,952

### Main drivers for adoption:

- Strong marketing program
- First self-compatible variety that retains many of the desired CA almond qualities such as:
  - Low % of doubles
  - High crack-out percentage
  - Similar appearance to NP variety
  - Early and high yielding
- Practically no competition in CA at the time it was released

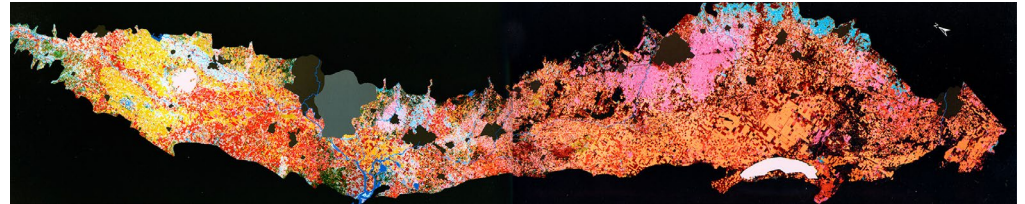
## Contrasting scenarios of the future of our industry

**Undesired scenario:** Our industry reduces its diversification because it adopts only one or few self-compatible varieties.



**Desired scenario:** Our industry retains diversification by adopting different self-compatible almond **varieties** that respond to different market demands

Multiple colors = Multiple varieties



- We retain self-compatibility at the management unit level (orchard level)
- We retain diversification at the multi-orchard level



## Almond Breeding Program

**Overall goal:** To enhance variety diversification for the CA almond industry by adopting better almond **varieties** that respond to different market demands as well as provide enhanced traits such as self-compatibility.

S.O.1: Accelerate the development and evaluation of better varieties with traits such as self-compatibility.

S.O. 2: Guide the CA industry in a more comprehensive and strategic approach to keep CA almonds as the crop of choice.



S.O.3: Integrate almond quality and sensory characteristics as part of a stepwise process to detect the best varieties.

S.O.4: Implement a strategic outreach plan among the different stakeholders in the supply and demand chains.

## Actions under this strategic plan: The almond crack-out event

- Held November 13, 2019, this event brought together public and private breeders, growers and handlers, hullers/shellers, UCCE researchers and farm advisors, and nursery representatives for an opportunity to sample more than 60 varieties of almonds.





Actions under this strategic plan: A comprehensive industry resource

## ***Almond varieties: A blend of perspectives***



### Almond Varieties and Selections

Evaluation of National and International  
Varieties or Selections Under  
Development

August 25<sup>th</sup>, 2020

## Actions under this strategic plan: Current generation of Regional Variety Trials

- Accelerate the outputs and dissemination of the results obtained in our current Regional Variety Trials.
- Increase the level of outreach in our Regional variety trials and overall information collected in other breeding projects.



Picture credits: Luke Milliron



## » PART II: Regional Variety Trial (RVT)



Picture credits: Luke Milliron







# ALMOND VARIETIES AND SELECTIONS

Phoebe Gordon, *UC-ANR*



# Regional Almond Variety Trial Results through Hullsplit 2020

Phoebe Gordon, Roger Duncan, Luke Milliron, Bruce Lampinen,  
Sam Metcalf, Tom Gradziel

## This is a large project with many collaborators

- Three sites are managed by Roger Duncan, Luke Milliron, and me, along with our grower-cooperators, Salida School District, Chico State University, and Creekside Farming Company
- Funded by the Almond Board of California

# Trial Design

Location	Rootstock	Spacing	Trees per Acre
CSU Chico	Krymsk 86	18' x 22'	110
Salida	Nemagard	16' x 21'	130
Chowchilla	Hansen 536	12' x 21'	173

- All sites were planted in the winter of 2014
- Rows of pollinator rows alternate with Nonpareil rows
- Pollinator rows contain several different varieties planted in groups



# Data collected

- Bloom time (effective bloom, full bloom, end of petal fall)
- Bloom density
- Hullsplit (1% split to 100% split)
- Yield and PAR
- Ease of shaking
- Observations of disease and other issues



Madera site during early bloom 2017, Nonpareil on the left, UCD 3-40 on the right

# Varieties under observation

Variety	Breeder/Nurser y	Variety	Breeder/Nurser y
Self-sterile		Partially Self-fertile	
Eddie	Bright's	Sweetheart	UC Davis
Supareil	Burchell	Winters	UC Davis
Sterling	Burchell		
Wood Colony*	N/A	Fully self-fertile	
Booth	Burchell	UCD1-232	UC Davis
Capitola	Burchell	UCD8-160	UC Davis
Folsom	Dave Wilson	UCD1-271	UC Davis
Bennett	Duarte	UCD8-201	UC Davis
Jenette	Fowler	UCD8-27	UC Davis
Durango	Fowler	Y117-86-03	USDA
Kester	UC Davis	Y116-161-99	USDA
UCD18-20	UC Davis	Y117-91-03	USDA
UCD1-16	UC Davis	Y121-42-99	USDA
UCD7-159	UC Davis		
UCD3-40	UC Davis		
Aldrich	N/A		
Nonpareil	N/A		

- Conditions not conducive to fully evaluate self-fertile variety performance
- Impossible to time hullsplit sprays, harvests perfectly
- Varieties differ in size and light interception (and therefore irrigation needs), however everything is managed the same
- Three varieties have already been dropped

# DISCLAIMER:

We are only reporting four years of yields

Canopy closure has not occurred at all sites or varieties

We are collecting data so that you can make your own decisions,  
once the trial is complete

## Bloom timing – averages from 2016-2020

### Self incompatible and partially self compatible

	Butte	Stanislaus	Madera	Grand average
UCD 3-40	-10	-8	-12	-10
Capitola	-4	-1	-1	-2
Eddie	-1	-1	-2	-1
UCD 7-159	-2	0	-1	-1
Winters	-1	0	-2	-1
UCD 1-16	0	0	-2	-1
Supareil	-1	-1	0	-1
Aldrich	0	1	-2	0
Bennett	1	-1	-1	0
Jenette	-2	2	-1	0
Sterling	-1	0	0	0
Nonpareil	0	0	0	0
Booth	0	1	-1	0
Wood Colony	2	N/A	-2	0
Durango	0	1	0	0
UCD 18-20	2	2	-3	0
Sweetheart	1	3	-2	1
Kester/Hanse				
n	5	4	-3	2
Folsom	5	2	3	3
Kester	4	3	N/A	4

### Fully self compatible

	Butte	Stanislaus	Madera	Grand average
UCD 8-27	-2	-2	-5	-3
UCD 8-160	-1	0	1	0
UCD 1-271	0	3	-2	0
Y 116-161-99	-1	2	0	0
UCD 1-232	1	2	2	2
Y 117-91-03	1	1	3	2
UCD 8-201	3	2	5	3
Y 117-86-03	4	4	2	3



Variety	Butte	Stanislaus	Madera
Aldrich	5	4	4
Bennett	5	4	4
Booth	5	4	4
Capitola	4	3	2
Durango	3	2	3
Eddie	5	5	4
Folsom	4	2	2
Jenette	5	4	3
Kester/Hansen	3	3	3
Kester	4	3	N/A
Nonpareil	4	3	3
Sterling	3	3	2
Supareil	3	3	3
Sweetheart	5	3	3
UCD 1-16	4	2	2
UCD 1-232	3	1	2
UCD 1-271	4	4	4
UCD 18-20	4	2	3
UCD 3-40	4	5	Missed
UCD 7-159	5	3	3
UCD 8-160	3	2	2
UCD 8-201	4	2	2
UCD 8-27	4	4	Missed
Winters	3	3	2
Wood Colony	5	N/A	4
Y 116-161-99	4	3	3
Y 117-86-03	3	3	4
Y 117-91-03	4	3	3
Y 121-42-99	3	3	2

## 2020 Bloom Profusion

- Good pollinators have a lot of flowers to provide pollen
- Bloom profusion measures can also help determine whether poor yield was related to poor bloom
- Subjective measurement that is based on the researchers' judgement
  - 5s are obvious, as are 1s

	Butte		Stanislaus		Madera	
Variety	Average start	average length	Average Start	Average length	average start	average length
Y 117-91-03	7/13	15	7/12	15	7/10	16
Eddie	7/15	16	7/12	20	7/11	25
Y 116-161-99	7/17	21	7/12	17	7/9	24
Nonpareil	7/19	13	7/11	21	7/11	32
Folsom	7/21	19	7/19	21	7/19	33
Booth	7/23	16	7/25	19	7/25	38
UCD 8-201	7/24	18	7/22	21	7/24	26
Capitola	7/25	15	7/22	17	7/22	29
Kester	7/25	11	7/20	17	7/21	35
Sterling	7/26	14	7/23	21	8/5	25
Sweetheart	7/28	13	7/24	20	7/28	21
Bennett	7/28	14	7/30	25	7/24	32
Y 117-86-03	7/29	15	7/28	16	7/27	27
Kester/Hansen	7/29	21	7/27	26	N/A	N/A
Jenette	7/29	28	7/30	20	7/20	24
UCD 1-16	7/29	22	7/22	23	7/27	28
UCD 1-271	7/29	16	7/23	20	7/14	41
Wood Colony	7/30	21	N/A	N/A	7/24	24
UCD 8-27	7/30	23	7/28	28	7/21	33
UCD 7-159	7/31	25	7/30	18	7/27	33
Supareil	8/3	25	8/9	20	8/3	38
Winters	8/4	31	8/5	23	8/9	35
UCD 8-160	8/4	23	8/1	22	7/28	47
Aldrich	8/7	18	8/4	17	7/31	30
UCD 1-232	8/7	29	8/16	17	8/8	31
Durango	8/9	21	8/5	20	7/26	34
UCD 3-40	8/11	28	8/17	16	8/12	29
UCD 18-20	8/14	22	8/14	19	8/2	33

## Hullsplit



Varieties	2019 yields			Madera Classification	Ave. cumulative yield 2016-2019
	Butte	Stan.			
UCD 18-20	2368	2121	2434	Monterey	7985
Y116-161-99	1811	1739	2716	California*	7240
Y117-91-03	1878	1763	2124	CA	7174
Kester/Hansen	1785	2630	2467	Padre / Carmel	7000
Booth	2613	1498	2536	CA	6971
Y121-42-99	N/A	1356	1981	CA	6711
Y117-86-03	1846	1465	1896	Carmel	6643
UCD 8-160	1808	1992	2280	Wood Colony	6536
Jenette	2505	1322	2200	Mission / CA	6419
Nonpareil	2999	1377	2429	Nonpareil	6379
Capitola	2461	1284	2925	CA	6221
Aldrich	2024	1480	1819	CA	6188
Bennett	1958	1442	1021	Nonpareil / CA	6177
UCD 8-201	1842	1660	1770	Nonpareil / CA	6076
Winters	3002	1341	3521	Carmel	5986
Durango	2086	1495	1406	CA	5817
Folsom	2016	1573	2668	CA	5723
Eddie	1748	964	1824	Nonpareil / Sonora	5703
Kester	2006	1618	N/A	Padre / Carmel	5637
UCD 1-16	1947	1295	2741	Sonora or Carmel	5553
Sterling	1828	1447	2285	Sonora / CA	5519
UCD 7-159	2114	1780	2306	CA	5328
Sweetheart	1801	1554	2833	CA	5291
UCD 8-27	1790	1062	1846	CA	4821
UCD 1-232	1819	1646	1890	CA	4792
Supareil	2071	1968	2468	Nonpareil	4642
Wood Colony	1989		2088	Wood Colony	4300
UCD 1-271	870	1630	462	CA	3403
UCD 3-40	2816	1341	507	Carmel	3305

## Yields

- Wood Colony is one year younger than other varieties
- Bennett, Booth, UCD 1-271 hit with bacterial blast in Butte
- Aldrich, Bennet, Capitola, Durango, Eddie, Folsom, Jennette, Nonpareil, Supareil, UCD 18-20, UCD 1-271, UCD 7-159 Winters, Wood Colony, Y117-86-03, Y121-42-99 hit with bacterial blast in Madera
- Y116-161-99 previously reported as Nonpareil type, is actually a California type



Varieties	2019 % canopy light interception (PAR)		
	Butte	Stanislaus	Madera
Supareil	79	60	88
Capitola	79	55	89
Booth	71	57	89
Sweetheart	74	62	79
Folsom	73	49	91
Kester/Hansen	65	66	78
Sterling	68	52	88
Nonpareil	74	45	87
UCD 3-40	72	55	77
Eddie	63	55	84
Y117-91-03	74	60	68
Durango	69	47	77
UCD 8-27	67	51	74
UCD 18-20	71	52	68
Y121-42-99	N/A	43	83
Aldrich	65	46	79
Bennett	67	50	72
Winters	71	42	71
UCD 1-271	54	50	80
Kester	72	50	N/A
UCD 1-16	66	45	69
Wood Colony	53	N/A	67
UCD 7-159	61	44	72
Y117-86-03	67	43	65
UCD 1-232	58	46	69
Jenette	57	46	67
Y116-161-99	56	43	70
UCD 8-201	62	43	64
UCD 8-160	49	40	60

## Light interception

- The close spacing at the Madera site allowed for early canopy closure in some areas
- Many trees have been lost to band canker at the Stanislaus site

## Yield Efficiency

	2017-2019 yield efficiency		
	Butte	Stanislaus	Madera
UCD 3-40	18.2	24	7
UCD 1-271	16.9	31	13
Supareil	16.8	25	22
Sweetheart	18.8	24	27
UCD 8-27	26.3	25	24
Folsom	26.9	28	24
Capitola	23.8	32	26
Sterling	24.0	33	25
Eddie	27.7	27	29
UCD 1-232	29.9	33	24
Wood Colony	34.5	N/A	25
UCD 1-16	26.8	31	32
Kester	25.3	36	N/A
Kester/Hansen	23.4	37	32
Durango	31.3	36	25
UCD 7-159	24.9	41	27
Booth	35.8	32	25
Winters	29.2	37	32
Bennett	31.4	37	31
Y121-42-99	N/A	37	30
Y117-91-03	30.9	34	37
Aldrich	37.2	42	25
UCD 8-201	33.5	38	35
Y117-86-03	28.3	39	40
Jenette	43.1	31	36
Nonpareil	38.8	40	34
Y116-161-99	34.8	41	44
UCD 18-20	35.3	44	43
UCD 8-160	42.8	50	39

- Yield efficiency is a measure of how much crop is produced per % canopy cover
- Could indicate there's an issue with bloom (UCD 3-40?)
- As well as identify trees that produce heavily despite their small size

## Disease observations

Year	Site	Disease	Cultivars
2017	Butte	Xanthomonas arboricola pv. pruni	Booth , UCD 1-271, UCD 18-20
	Butte	Pseudomonas syringae	Bennett, Wood Colony, Y 116-161-99
	Madera	Pseudomonas syringae	not recorded
2018	Butte	Xanthomonas arboricola pv. pruni	UCD 1-271
	Butte	Pseudomonas syringae	not recorded
2019	Butte	Pseudomonas syringae + Botrytis cinerera	Bennett, Booth, UCD 1-271
	Madera	Pseudomonas syringae + Botrytis cinerera	Aldrich, Bennet, Capitola, Durango, Eddie, Folsom, Jennette, Nonpariel, Supareil, UCD 18-20, UCD 1-271, UCD 7-159 Winters, Wood Colony, Y117-86-03, Y121-42-99



# 2020 General observations – Butte County

- Bloom conditions were excellent at the Butte County site in 2020
- Consistent with past years, honeybee stocking appeared low.
- The UCD 18-20 variety, like Monterey in 2020 (not in the trial) showed leafing failure symptoms.
- **ALS symptoms were observed to varying severity and frequency on every variety/selection in the trial.**
- No water was applied from before nonpareil shake on August 10<sup>th</sup>, until the last varieties were picked up on September 11<sup>th</sup>.
- As a result of the severe water stress and subsequent hull-tights, eight varieties never reached 100% hull split and three others never entered hullsplit
- Severe re-greening/leaf out was observed across the trial in early October 2020.



Almond leaf scorch symptoms, in addition to postharvest dust and mite infestation.

## 2020 General observations – Stanislaus County

- Bloom weather was dry and mild with no rain
- No significant bloom or spring diseases apparent
- Severe hull rot (Rhizopus) Y121-42-99, Folsom, Kester on Hansen, UCDB-201, moderate on UCDB-160, Nonpareil, UCDB-232, UCDB-27, Eddie
- *A. niger* hull rot on UCDB-232
- Possible Phomopsis hull rot (unconfirmed) on Sweetheart
- Widespread but moderate leaf chlorosis / mottling from alkaline irrigation water and Nemaguard rootstock. Trees on Hansen much better.
- Signs of moderate zinc and potassium deficiency in some areas / varieties. Leaf samples indicate elevated levels of chloride.
- Overall, growth of trees better than in past years

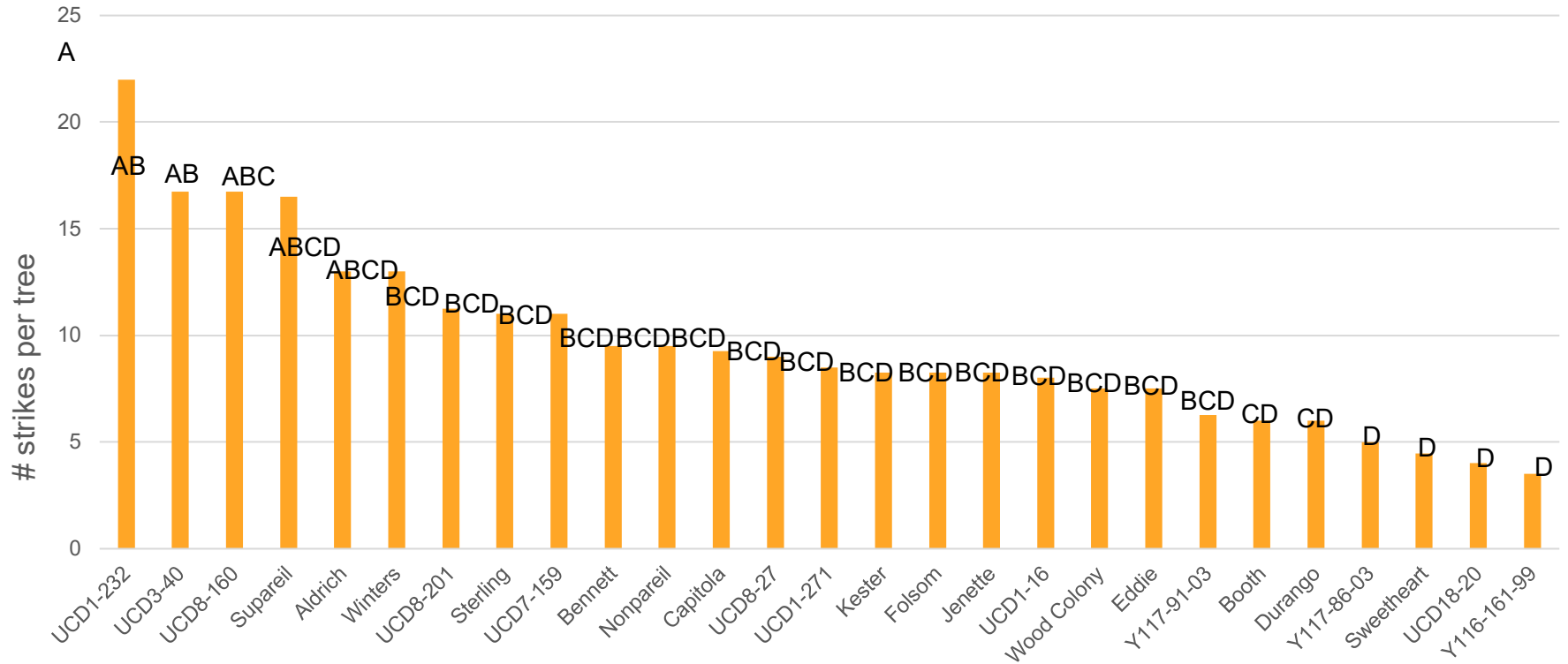


## 2020 General observations – Madera county

- Bloom conditions were good in 2020
- A handful of trees have been killed by gophers every year, some were killed by shothole borer attacking stressed trees
- Canopy closure and hull rot are resulting in a large amount of lower limb dieback
- Hullrot heavily affected UCD1-232, UCD8-160, Supareil, and UCD3-40
- Hullrot was primarily *Aspergillus niger*, though in one section of the field where vigor is very high, *Rhizopus* seems to be more common
- Spider mite populations were fairly high, leading to minor re-leafing



# Timed hull rot strike count results - Madera





Want to look things over more carefully? You can find reports at [www.sjvtandv.com](http://www.sjvtandv.com) and [www.almonds.com](http://www.almonds.com)

October 8, 2020

## Field Evaluation of Almond Varieties - Results Through 6th Leaf

*Phoebe Gordon, University of California Cooperative Extension (UCCE) Madera and Merced*

*Roger Duncan UCCE Stanislaus*

*Luke Milliron UCCE Butte, Glenn, and Tehama*

*Bruce Lampinen UC Davis*

*Tom Gradziel UC Davis*

This article is also published in the September 2020 issue of West Coast Nut



### Almond Varieties and Selections

Evaluation of National and International Varieties or Selections Under Development

Kester has been released



And Y-116-161-99 has recently been released as 'Yorizane'







# Thank You!

THE ALMOND CONFERENCE  
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20  
JOIN THE JOURNEY