WEST COAST NUT

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WEST COAST NUT

By the Industry, For the Industry

IN THIS ISSUE

SPECIAL SECTION: Biologicals

From biostimulants to biological pesticides, this month's special section takes a look at biological products, issues and strategies for nut producers in the Western United States.

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FIELD EVALUATION OF ALMOND VARIETIES

A LOOK AT REGIONAL TRIAL RESULTS THROUGH SIXTH LEAF

By **PHOEBE GORDON** | *UCCE Farm Advisor, Madera and Merced Counties,*
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UC CE | University of California
Agriculture and Natural Resources | Cooperative Extension

Variety
Self-sterile
Eddie
Supareil
Sterling
Booth
Capitola
Folsom
Bennett
Jenette
Durango
Kester
UCD18-20
UCD1-16
UCD3-40
Aldrich
Nonpareil
Wood Colony*

(University of California personnel have been involved with evaluating new fruit and nut crop varieties from public and private breeders for over 100 years. These evaluations have always been done in partnership with commercial and public operators and we want to extend a heartfelt thank you to our cooperators for hosting these trials. We also thank the Almond Board of California for funding important research into varieties for many years.)

THE MOST RECENT REGIONAL EVALUATIONS, sponsored by the Almond Board of California, were planted at three sites down the Central Valley in winter 2014. The three locations were CSU Chico University Farm in Butte County, an orchard near Salida in Stanislaus County, and an orchard near Chowchilla in Madera County. The three sites have different spacing and rootstocks **(See Table 1),** depending on grower preferences and rootstocks that are typical in that area. The trial was designed to allow statistical analyses of yield; each variety is planted in twelve-tree stretches and repeated four times at a site in a random order. In other words, each site has 44 to 48 trees of each variety, split up into groups of four and randomly planted next to other varieties, with a Nonpareil row on either side.

Trial Limitations

Before reading further, it is important to understand the limitations of these regional variety trials. This is a rigorous examination of traits like bloom timing, the initiation of hull split, and yield. However, there are limitations related to evaluating dozens of different varieties in the same field. The trees vary widely in size, shape, light interception and yield, resulting in different irrigation and fertilization needs. Smaller-statured varieties may have lower yields compared to larger trees and may look better at a site with closer spacing.

Because our cooperators cannot economically perform different bloom and hullsplit sprays to ensure optimal coverage for each variety and fertilize each variety based on its yield, the varieties cannot be perfectly managed. Traits like navel orangeworm (NOW) damage, though largely influenced by shell seal (which is a varietal trait), should be viewed with a grain of salt as the nuts of a variety may remain on a tree a week longer than is ideal if there are not enough varieties ready to justify a harvest. However, if certain issues are constant through all three sites, it is more likely to be an issue with the variety rather than the impossibility of perfectly managing all of the varieties.

We always recommend that you use as much information as possible when deciding what variety to plant. Evaluate

Location	Rootstock	Spacing	Trees per Acre
Butte	Krymsk 86	18′ x 22′	110
Stanislaus	Nemaguard	16′ x 21′	130
Madera	Hansen 536	12′ x 21′	173

Table 1. Rootstocks and spacings of the regional almond variety trials by location.

Breeder/Nursery	Variety	Breeder/Nursery
	Partially Self-fertile	
Bright's	Sweetheart	*UC Davis*
Burchell	Winters	*UC Davis*
Burchell		
Burchell	Fully self-fertile	
Burchell	UCD1-232	*UC Davis*
Dave Wilson	UCD1-271	*UC Davis*
Duarte	UCD7-159	*UC Davis*
Fowler	UCD8-160	*UC Davis*
Fowler	UCD8-201	*UC Davis*
UC Davis	UCD8-27	*UC Davis*
UC Davis	Y116-161-99	*USDA*
UC Davis	Y117-86-03	*USDA*
UC Davis	Y117-91-03	*USDA*
N/A	Y121-42-99	*USDA*
N/A		
N/A		

**Wood Colony was originally planted only at the Butte site; it was planted a year later at the Madera site.*

Table 2. Varieties in the trial. Varieties highlighted in green are standards.

Bloom overlap of self-sterile almond varieties				
Variety/Selection	Number of Days Before (-) or After (+) Nonpareil Full Bloom			
	Butte	Stanislaus	Madera	Average
UCD 3-30	-8	-8	-13	-10
Wood Colony	-2*	N/A	-3	-3
Capitola	-2	-2	-1	-2
Winters	0	0	-2	-1
UCD 1-16	1	-1	-2	-1
Supareil	0	-1	-1	-1
Eddie	-1*	+1	-2	-1
Nonpareil	-	-	-	-
Aldrich	+1	+1	-3	0
Jenette	-1	+2	-2	0
Bennet-Hickman	+2*	-1	-1	0
Booth	+1	+1	-1	0
Sterling	+2	-1	0	0
UCD 18-20	+3*	+3	-4	+1
Durango	+1	+1	+1	+1
Sweetheart	+3	+5	-3	+2
Folsom	+6*	+2	+4	+4
Kester	+5*	+3	N/A	+4
Kester on Hansen	+6*	+4	+3	+5

*An * indicates when heavy rains in 2019 prevented entering the orchard to observe bloom status and the results are an average of 2016-2018. All varieties are planted on Hansen at the Madera site. N/A indicates the variety is not present at a particular site.*

Table 3. Full bloom timing of self-incompatible or partially self-compatible varieties, as compared to Nonpareil full bloom, averaged from third through sixth leaf. The date of full bloom can vary considerably, and many varieties that have average bloom dates close to Nonpareil may fluctuate before or after Nonpareil full bloom.

UC variety trial data as well as input from nursery representatives, handlers, neighbors and your personal experience. Some issues with new varieties may not appear for many years or until they are planted on a wider scale. At this point in the trial, while we are looking for varieties that perform well, we are primarily identifying ones that have such major issues that they will not be acceptable for wide-scale planting.

Public and private breeders were invited to submit varieties they had released recently or were interested in releasing. Independence and Shasta could not be included in the variety trials. **Table 2** indicates which varieties are self-fertile or self-sterile. Self-fertility is when the flower is receptive to pollen from the same or a closely related variety, but some bees may still be needed to consistently get pollen from the anther to the stigma. Self-sterile varieties (such as Nonpareil) require pollen from a different variety to set a commercially acceptable yield and added beehives during flowering to ensure cross-pollination.

The trials were planted so that each row

Continued on Page 7

Bloom overlap of self-fertile almond varieties			
	Number of Days Before (-) or After (+) Nonpareil Full Bloom		
Variety/selection	Butte	Stanislaus	Madera
UCD 8-27	-1	-2	-5
UCD 7-159	0	-1	-1
UCD 8-160	-1	-1	1
UCD 1-271	-1	3	-3
Nonpareil	-	-	-
UCD 1-232	1*	3	2
Y 116-161-99	3	2	1
Y 117-86-03	2*	4	2
Y 117-91-03	5	2	3
UCD 8-201	3*	3	6
Y-121-42-99	N/A	4	4

*An * indicates when heavy rains in 2019 prevented entering the orchard at the Butte trial to observe bloom status and the results are an average of 2016-2018. N/A indicates the variety is not present at a particular site.*

Table 4. Full bloom timing of fully self-compatible varieties, as compared to Nonpareil full bloom averaged from third through sixth leaf. The date of full bloom can vary considerably, and many varieties that have average bloom dates close to Nonpareil may fluctuate before or after Nonpareil full bloom.

Year	Site	Disease	Cultivars
2017	Butte	Bacterial spot	Booth , UCD 1-271, UCD 18-20
	Butte	Bacterial blast	Bennett-Hickman, Wood Colony, Y116-161-99
	Madera	Bacterial blast	not recorded
	Stanislaus	Band Canker	Nonpareil, Sterling, Kester on Hansen, Y121-42-99
2018	Butte	Bacterial spot	UCD 1-271
	Butte	Bacterial blast	not recorded
	Stanislaus	Hull rot caused by *Rhizopus stolonifer*	Supareil, UCD 1-232, UCD 8-201, UCD 1-271, UCD 3-40
	Stanislaus	Scab	Winters, UCD 1-271
2019	Butte	Bacterial blast + *Botrytis cinerera* (pathogen that causes jacket rot)	Bennett-Hickman, Booth, UCD 1-271
	Stanislaus	Bacterial blast	Bennett-Hickman, UCD 1-271, Booth, Capitola, UCD 8-27, Y116-161-99, UDC 1-16, Eddie, Supareil, UCD 3-40, Aldrich
	Madera	Bacterial blast + *Botrytis cinerera* (pathogen that causes jacket rot)	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
	Madera	Hull rot (*Rhizopus stolonifer* and *Aspergillus niger* isolated in 2018)	UCD1-232, Eddie, Nonpareil, Sterling, Folsom. Observed in past years to also be severe on UCD8-201 and Bennett-Hickman

Table 5. Observed diseases by year.

Continued from Page 5

of pollinizers was adjacent to a row of Nonpareil. Because of this, these variety trials cannot fully assess the yield potential of the partially or fully self-fertile varieties as if they were planted in solid blocks.
Due to the enormous amount of data this trial generates, we will present the accumulated data and note when a year may have had an exception.

Bloom Data

We measure bloom progression by recording the dates of 1% bloom, full bloom (when 80% of the flowers are open) and the end of petal fall. Varieties that are good pollinators for Nonpareil should overlap closely with it **(See Tables 3 and 4, on pages 5 and 6)**, though many growers will plant other varieties that may bloom a bit before or after to account for unusual bloom conditions. In most years, UCD 3-40 blooms much earlier than all other possible pollinators so yield data does not reflect the yield potential of this variety.

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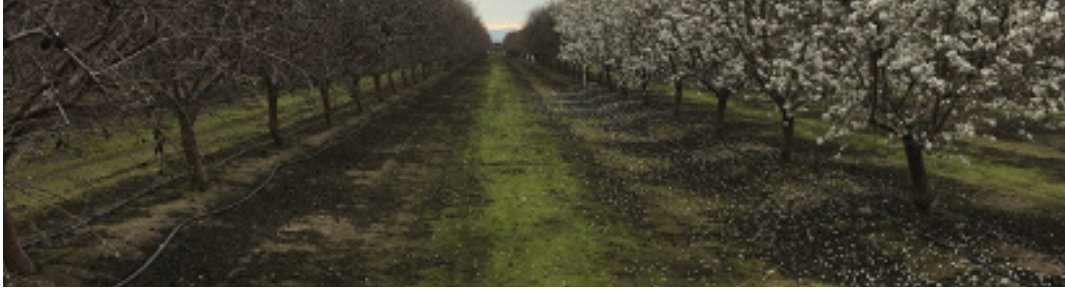
We always recommend that you use as much information as possible when deciding what variety to plant.



Nonpareil (left) and UCD3-40 (right) at the Madera site in 2017. In most years, UCD 3-40 blooms much earlier than other possible pollinators so yield data does not reflect the yield potential of this variety (all photos courtesy P. Gordon, UCCE.)

Hullsplit Timing

	Butte			Stanislaus			Madera		
	Average start	Average +/- NP	Average duration	Average start	Average +/- NP	Average length	Average start	Average +/- NP	Average length
Y117-91-03	7/13	-6	15	7/12	-7	13	7/10	-19	17
Y116-161-99	7/17	5	21	7/12	-3	16	7/9	-12	25
Eddie	7/15	-2	16	7/12	0	19	7/11	-7	27
Nonpareil	7/19	0	14	7/11	0	20	7/11	-1	33
Y121-42-99	N/A			7/17	-1	13	7/22	10	34
Kester	7/25	5	13	7/20	5	17	N/A		
Folsom	7/21	7	20	7/19	8	20	7/19	4	30
Capitola	7/25	10	18	7/22	8	17	7/22	7	30
UCD8-201	7/24	9	18	7/22	11	20	7/24	6	28
Sterling	7/26	6	14	7/23	12	20	8/5	9	30
Wood colony	7/30	13	17	N/A			7/24	5	27
Sweetheart	7/28	15	21	7/24	10	17	7/28	3	21
Y117-86-03	7/29	12	16	7/28	12	16	7/27	7	25
UCD1-16	7/29	16	21	7/22	13	22	7/27	5	25
UCD1-271	7/29	10	15	7/23	13	20	7/14	14	43
Booth	7/23	8	18	7/25	12	19	7/25	20	40
Jeanette	7/29	24	29	7/30	20	21	7/20	-1	24
Bennett	7/28	11	16	7/30	21	22	7/24	12	33
Kester on Hansen	7/29	15	19	7/27	20	24	7/21	10	34
UCD7-159	7/31	19	22	7/30	17	18	7/27	14	32
UCD8-27	7/30	18	22	7/28	23	27	7/21	9	33
Aldrich	8/7	24	19	8/4	21	18	7/31	14	29
Durango	8/9	25	19	8/5	21	17	7/26	15	34
[1]Supareil	8/3	24	23	8/9	28	19	8/3	20	36
[1]UCD8-160	8/4	26	24	8/1	23	22	7/28	27	50
[1,3]Winters	8/4	33	31	8/5	27	22	8/9	25	33
UCD18-20	8/14	33	22	8/14	31	17	8/2	21	33
[1]UCD1-232	8/7	32	27	8/16	31	15	8/8	25	25
UCD3-40	8/11	37	28	8/17	32	15	8/12	24	29

[1]varieties were knocked before hullsplit was completed in Madera in 2018 [2]varieties were knocked before hullsplit was completed in 2018 and 2019 [3]variety never entered hullsplit in Butte county. All varieties were planted on the Hansen 536 rootstock in Madera county.

Table 6. Average hullsplit start (1% of the nuts have entered hullsplit), end (last nut on the variety has split), and number of days in hullsplit. Average duration spent in hullsplit is an average of all years and may not match the start and end dates listed.

Yield Summary of varieties planted on Krymsk 86, Butte County										
Varieties	**2016 Yield (lbs/ ac)**	**2017 Yield (lbs/ ac)**	**2018 Yield (lbs/ ac)**	**2019 yield (lbs/ ac)**	**Cum. Yield (lbs/ ac)**	**Classification**	**$ 2016 - 2019 Payout, high**	**$ 2016 - 2019 payout, low**	**2019 Canopy PAR (%)**	**2017-2019 yield/PAR average**
UCD 1-271	159	405	1037	870	2472	CA	$5,838.30		54	16.9
Supareil	308	773	676	2071	3810	Nonpareil	$10,297.99		79	16.8
Sweetheart	315	526	1486	1801	4128	CA	$9,758.84		74	18.8
UCD 3-40	342	284	504	2816	4396	Carmel	$9,705.48		72	18.2
UCD 7-159	211	1019	1121	2114	4464	CA	$10,521.05		61	24.9
Sterling	336	1005	1645	1828	4732	Sonora / CA	$12,282.47	$11,333.50	68	24.0
UCD 8-27	507	1105	1677	1790	5079	CA	$11,913.75		67	26.3
Kester/Hansen	609	1060	1763	1785	5217	Padre / Carmel	$12,701.10	$12,207.24	65	23.4
UCD 1-232	712	1941	881	1819	5281	CA	$12,404.51		58	29.9
UCD 1-16	556	964	1854	1947	5300	Sonora or Carmel	$13,555.75	$12,914.86	66	26.8
Eddie	447	1090	2028	1748	5314	Nonpareil / Sonora	$14,297.57	$13,564.38	63	27.7
Wood Colony	419	1382	1548	1989	5338	Wood Colony	$12,517.92		53	34.5
Bennett	291	902	2278	1958	5391	Nonpareil / CA	$14,563.23	$12,832.65	67	31.4
Y117-86-03	460	932	2264	1846	5503	Carmel	$13,465.29		67	28.3
Capitola	455	1500	1315	2461	5611	CA	$13,434.89		79	23.8
Kester (2-19e)	649	1114	1892	2006	5662	Padre / Carmel	$13,792.48	$13,256.96	72	25.3
Folsom	523	1583	1605	2016	5785	CA	$13,396.72		73	26.9
Y116-161-99	529	823	2669	1811	5833	Nonpareil	$15,623.14		56	34.8
UCD 8-201	517	1405	2168	1842	5933	Nonpareil / CA	$15,998.62	$13,917.37	62	33.5
UCD 8-160	670	1604	1941	1808	6127	Wood Colony	$14,070.20		49	42.8
Winters	469	1902	657	3002	6168	Carmel	$14,639.60		71	29.2
Durango	390	1271	2440	2086	6188	CA	$14,579.84		69	31.3
Aldrich	316	1031	3265	2024	6636	CA	$15,705.97		65	37.2
Y117-91-03	481	1500	2779	1878	6638	CA	$15,604.76		74	30.9
Jenette	271	1524	2555	2505	6855	Mission / CA	$16,172.41	$15,504.91	57	43.1
UCD 18-20	717	1904	2648	2368	7666	Monterey	$17,895.61		71	35.3
Booth	796	1982	2344	2613	7736	CA	$18,097.49		71	35.8
Nonpareil	447	2085	2846	2999	8376	Nonpareil	$22,601.10		74	38.8

Table 7. Yield data from 2016 to 2019. Cumulative payout based on yearly prices for estimated classification of kernels. At the time of writing this article, 2019 prices were not available, thus 2018 prices were used.

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Disease, Death and Other General Observations

Gopher damage has been present at both the Butte and Madera sites. At the Butte site, gophers have particularly targeted the Hansen rooted trees (Kester on Hansen rootstock) and there have been many tree deaths. Gopher girdling has killed several trees at the Madera site, where all trees have been planted on the Hansen rootstock, but deaths have been scattered across varieties and likely do not significantly affect yields. Some diseases, such as bacterial blast, have occurred at several sites over several years **(Table 5, see page 6).**

A more significant concern at the Madera site is a spot with poor drainage that has resulted in several tree deaths and poor establishment of replants, affecting Winters, UCD8-160 and Wood Colony. The Madera site also has three different soil types that are resulting in vigor and hullsplit and harvest timing differences; trees in one soil type (a Class II soil) have the highest vigor and complete hullsplit several weeks after trees growing in a Class I and Class IV soil. Trees growing in the Class I have intermediate vigor, and those in the Class IV have the lowest. Hullsplit ratings are mostly relegated to trees in a single soil type, but the differences in hullsplit timing result in harvest delays for trees growing in the Class I and Class IV soil types.

In both 2017 and 2018, low hive strength likely reduced yields at the Butte site. There was also a frost event in 2018 that affected both Madera and Butte. At the Madera site, low temperatures on the 20th, 21st and 24th reached 25, 28 and 24 degrees F, respectively. At the Butte site, low temperatures on the 19th, 20th, 22nd, 23rd and 24th reached 26, 28, 29, 28 and 26 degrees F, respectively.

Hull split

Knowing when a variety enters hullsplit is important for timing NOW sprays **(Table 6, see page 7)**. The end of hullsplit (when the suture of all nuts has split open) indicates when the variety can be harvested. The nuts must be protected from NOW between the initiation of hullsplit and harvest; varieties that are in hullsplit for more than 14 days may require a second spray, depending on the residual protection time of the product used. It is wise to select pollinators for Nonpareil that have a hullsplit end date that does not overlap with Nonpareil. Most processors offer lower prices for mixed nuts, and close harvest dates may increase the risk for mixing. In 2018, the later maturing varieties at the Madera site were shaken earlier than desired. This did not affect yield but did result in a loss of hullsplit data.

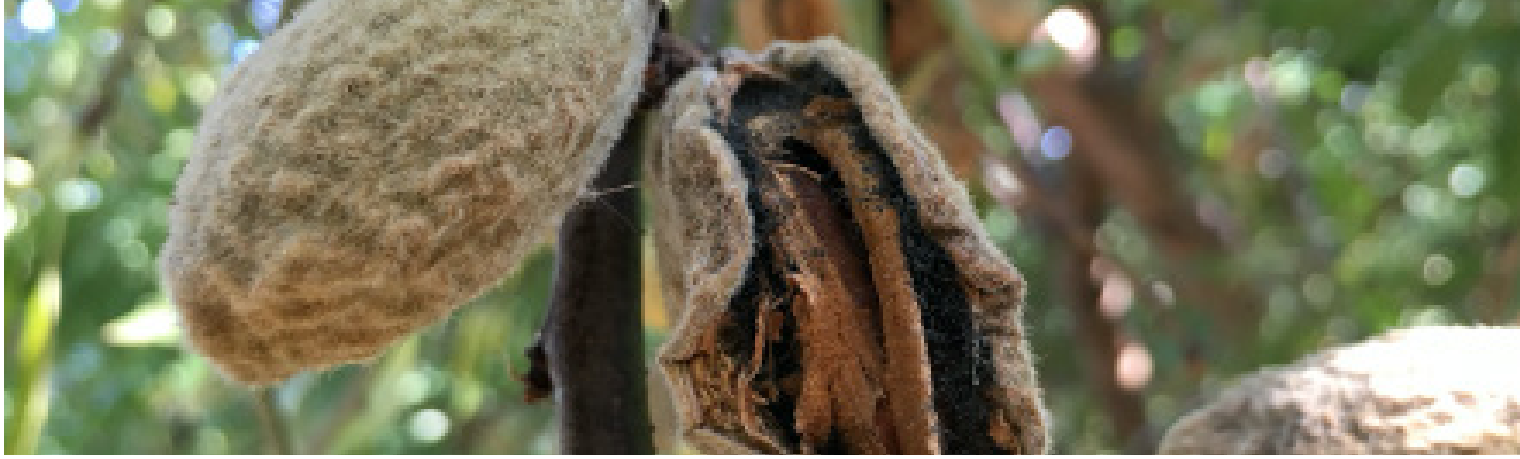
Continued on Page 13

Yield summary of varieties planted on Nemagard rootstock, Stanislaus County										
Varieties	**2016 Yield (lbs/ ac)**	**2017 Yield (lbs/ ac)**	**2018 Yield (lbs/ ac)**	**2019 yield (lbs/ ac)**	**Cum. Yield (lbs/ ac)**	**Classification**	**$ 2016 - 2019 Payout, high**	**$ 2016 - 2019 payout, low**	**2019 Canopy PAR (%)**	**2017-2019 yield/PAR average**
UCD 8-27	178	907	1601	1062	3748	CA	$8,825.23		51	25
UCD 3-40	133	1016	1365	1341	3856	Carmel	$9,426.95		55	24
Supareil	53	1042	1130	1968	4047	Nonpareil	$11,310.10		60	25
UCD 1-16	357	1223	1354	1295	4228	Sonora or Carmel	$10,807.78	$10,228.96	45	31
Sweetheart	178	936	1612	1554	4281	CA	$10,100.87		62	24
Jenette	120	1396	1458	1322	4296	Mission / CA	$10,086.35	$9,671.90	46	31
Eddie	309	1285	1827	964	4385	Nonpareil/ Sonora	$11,871.88	$11,222.86	55	27
Folsom	281	1241	1316	1573	4411	CA	$10,345.47		49	28
UCD 1-271	86	1234	1613	1630	4562	CA	$10,755.46		50	31
UCD 1-232	225	1404	1498	1646	4773	CA	$11,204.56		46	33
UCD 8-201	123	1569	1549	1660	4900	Nonpareil / CA	$13,286.45	$11,511.79	43	38
Nonpareil	175	1408	2043	1377	4999	Nonpareil	$13,528.39		45	40
Capitola	123	1365	2262	1284	5034	CA	$11,860.85		55	32
Durango	159	1467	1825	1495	5046	CA	$11,625.92		47	36
Sterling	54	1465	2003	1447	5062	Sonora / CA	$12,720.81	$11,707.24	52	33
Aldrich	162	1675	2331	1480	5064	CA	$13,278.99		46	42
Winters	195	1544	2136	1341	5216	Carmel	$12,726.31		42	37
Y117-86-03	213	1536	2033	1465	5247	Carmel	$12,801.27		43	39
Booth	128	1550	2226	1498	5402	CA	$12,716.15		57	32
Y121-42-99	373	1411	2336	1356	5476	CA	$12,855.82		43	37
UCD 7-159	40	1417	2246	1780	5483	CA	$12,950.86		44	41
Bennett	334	1473	2321	1442	5570	Nonpareil / CA	$15,047.47	$13,081.85	50	37
Y116-161-99	325	1437	2107	1739	5608	Nonpareil	$15,141.16		43	41
Kester	321	1648	1818	1618	5612	Padre / Carmel	$13,153.64	$12,654.37	50	36
UCD 8-160	224	2058	2006	1992	6280	Wood Colony	$14,729.46		40	50
Y117-91-03	218	1918	2172	1763	6419	CA	$14,248.85		60	34
UCD 18-20	262	1971	2368	2121	6722	Monterey	$15,781.76		52	44
Kester/Hansen	345	1600	2614	2630	7287	Padre / Carmel	$17,596.01	$16,935.24	66	37

Table 8. Yield data from 2016 to 2019. Cumulative payout based on yearly prices for estimated classification of kernels. At the time of writing this article, 2019 prices were not available, thus 2018 prices were used.

Yield summary of varieties planted on Hansen 536 rootstock, Madera County										
Varieties	**2016 Yield (lbs/ ac)**	**2017 Yield (lbs/ ac)**	**2018 Yield (lbs/ ac)**	**2019 yield (lbs/ ac)**	**Cum. Yield (lbs/ ac)**	**Classification**	**$ 2016 - 2019 Payout, high**	**$ 2016 - 2019 payout, low**	**2019 Canopy PAR (%)**	**2017-2019 yield/PAR average**
UCD 3-40	577	708	236	507	1923	Carmel	$4,816.14		77	7
UCD 1-271	409	1137	1268	462	3176	CA	$7,605.02		80	13
Wood Colony	49	675	1527	2088	3262	Wood Colony	$10,305.51		67	25
UCD 1-232	954	1490	1051	1890	5035	CA	$12,487.82		69	24
UCD 7-159	775	1465	1490	2306	6036	CA	$14,094.26		72	27
Supareil	1010	1791	800	2468	6069	Nonpareil	$16,442.49		88	22
UCD 8-27	1145	1022	2059	1846	6072	CA	$14,154.91		74	24
Durango	1415	1827	1570	1406	6218	CA	$14,327.11		77	25
Sterling	1112	1889	1479	2285	6764	Sonora / CA	$17,258.49	$15,703.44	88	25
Aldrich	1724	1413	1907	1819	6863	CA	$15,859.67		79	25
Folsom	1052	1818	1437	2668	6974	CA	$16,231.33		91	24
UCD 1-16	1469	1647	1275	2741	7132	Sonora or Carmel	$18,156.39	$16,998.58	69	32
UCD 8-160	964	1596	2362	2280	7201	Wood Colony	$16,828.25		60	39
Winters	1369	2066	340	3521	7295	Carmel	$17,560.03		71	32
UCD 8-201	1310	1671	2644	1770	7395	Nonpareil / CA	$19,939.69	$17,198.89	64	35
Eddie	1262	2167	2156	1824	7409	Nonpareil/Sonora	$20,070.23	$18,944.78	84	29
Sweetheart	1429	1210	1997	2833	7468	CA	$17,411.43		79	27
Bennett	1770	1977	2800	1021	7568	Nonpareil / CA	$20,467.06	$17,462.36	72	31
Booth	1857	2247	1137	2536	7776	CA	$17,901.75		89	25
Y-121-42-99	1533	1758	2675	1981	7946	CA	$18,457.43		83	30
Capitola	1781	2190	1124	2925	8020	CA	$18,513.66		89	26
Jenette	1644	1783	2481	2200	8107	Mission / CA	$18,813.36	$18,036.90	67	36
Nonpareil	1349	2379	2327	2429	8442	Nonpareil	$22,961.35		87	34
Y-117-91-03	1427	2042	2872	2124	8465	CA	$19,687.13		68	37
Kester/Hansen	1783	1840	2407	2467	8497	Padre / Carmel	$20,490.38	$19,654.31	78	32
Y-117-86-03	1995	1807	3483	1896	9180	Carmel	$22,147.73		65	40
UCD 18-20	1680	2226	3227	2434	9566	Monterey	$22,294.29		68	43
Y-116-161-99	1804	2604	3056	2716	10278	Nonpareil	$27,508.56		70	44

Table 9. Yield data from 2016 to 2019. Cumulative payout based on yearly prices for estimated classification of kernels. At the time of writing this article, 2019 prices were not available, thus 2018 prices were used.



Hull rot (induced by *Rhizopus stolonifera*) at the Madera variety trial site.

Continued from Page 10

Yields

Yields for the first four years are presented (**Tables 7, 8 and 9, see pages 8, 11, and 12**). We emphatically do not recommend basing variety selection on four years of yields. Some varieties do not start bearing heavily until maturity, while others do not show fatal flaws until maturity. While the sites also have different spacings, this should not be used as a referendum on spacing, as there have been events that have negatively affected yields at certain sites. The Butte site, for instance, has had low beehive strength, particularly in 2017 and 2018, likely reducing yields. In 2017, the Stanislaus site suffered from a springtime drift injury of glyphosate and glufosinate which damaged trees and reduced yields. Many trees of some varieties have been killed from band canker as well (**Table 5, see page 6**). Early yields are unreliable when determining ultimate yield potential, so we have not yet dropped varieties based on low yields.

Photosynthetically active radiation (PAR) is the percentage of light interception a variety captures. It has been found to correlate with yield potential, especially at sites that do not have other significant disease or management issues. PAR can be taken as an indication of vigor during establishment years, however as discussed below, high vigor and high PAR interception do not necessarily translate to higher yields.

We are using yield/PAR as an

Continued on Page 14

Continued from Page 13

indicator of tree efficiency, or how many pounds of nuts trees produce per percent canopy cover. We are presenting the 2017-2019 average for this variable as another indicator of a variety's yield potential. A tree that is naturally small but yields well for its size may look worse than a larger tree when looking at yearly or cumulative yield, but may have similar yield/PAR values. That small tree may perform better when spaced more closely. Additionally, the industry is exploring off-ground harvest technologies to reduce dust. Orchards that already use off-ground harvesting technology perform better when trees are smaller. In these systems, small trees with high yield/PAR values may be valuable. Low yield/PAR can also indicate an issue during bloom, such as excessively wet conditions, severe bacterial blast or frost events, thus it is important to examine several years of data.

Defects

Defect data includes horticultural (double kernels, twin kernels) and insect issues (NOW damage) (**Table 10, see page 15**). Due to the difficulty in adequately protecting all the varieties with different hullsplit dates, issues such as NOW damage should be viewed with a grain of salt, though those that have consistently high damage across a site may be of concern. Three UCD selections, 18-20, 8-201 and 1-16, have high rates of double kernels across all sites, and UCD 3-40 and 8-27 had high rates of doubles across all three sites.

The threshold of reporting varieties with defects greater than 6% has no significance; this threshold was chosen to simplify the results.

Conclusions

These trials are ongoing and will continue for a few more years. At this point, we can eliminate some new selections with issues that make them unsuitable for commercial production. On the other hand, there are some commercial and experimental varieties that appear to be high performers and are worth exploring further. New regional trials will be established in the future to continue the search for high quality, high yielding varieties, with a special emphasis for those that are self-fertile.

Comments about this article? We want to hear from you. Feel free to email us at article@jcsmarketinginc.com

Varieties with defect	Trial					
	Butte	(%)	Stanislaus	(%)	Madera	(%)
6% or more double kernels	UCD18-20	29	UCD 18-20	20	UCD 18-20	19
	UCD 8-201	18	UCD 1-16	13	UCD 8-27	15
	Wood Colony	18	UCD 8-201	13	UCD 8-201	13
	Durango	13	UCD 8-27	12	Booth	10
	Aldrich	10	Capitola	6	P16.013	8
	UCD 8-27	10				
	Booth	9				
	UCD 1-16	9				
	UCD 8-160	8				
	UCD 3-40	8				
6% or more twin kernels (two kernels within the same pellicle)	Nonpareil	15	UCD 3-40	14	UCD 3-40	17
	Folsom	13	Sweetheart	13	UCD 8-27	13
	UCD 3-40	13	UCD 8-27	11	Jennette	7
	Sweetheart	12	Folsom	9	UCD 8-201	7
	UCD 8-27	12	UCD 1-232	7		
	Jenette	12				
	UCD 7-159	10				
	UCD 8-201	6				
6% or more chipped/broken	UCD18-20	8				
6% or more crease	Y117-86-03	15	Sterling	8	UCD 8-160	15
	UCD 8-160	13	Jenette	6	Sterling	10
	Sterling	12	Durango	6	Sweetheart	8
	Capitola	11			Jennette	8
	Jenette	10			Capitola	7
	Folsom	9			UCD 1-232	6
	UCD1-232	8			Folsom	6
	Wood Colony	7				
	Durango	7				
	Eddie	6				
6% or more shrivel	UCD 8-201	7			Folsom	8
	Capitola	7				
	Y117-86-03	6				
6% or more NOW damage	UCD 8-27	6		0		0

Table 10. 2019 defects by site. The 6% threshold only serves as a cutoff point to make viewing the data easier and has no horticultural significance.

GETTING STARTED WITH COVER CROPS IN ALMOND SYSTEMS

By **AMÉLIE GAUDIN** | *Associate Professor, UC Davis Department of Plant Sciences*
KATHERINE JARVIS-SHEAN | *UCCE Orchard Systems Advisor, Sacramento and Yolo Counties,*
MOHAMMAD YAGHMOUR | *UCCE Orchard Systems Advisor, Kern and Kings County,*
and **VIVIAN WAUTERS** | *Post Doctoral Fellow, UC Davis Department of Plant Sciences*

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Agriculture and Natural Resources | Cooperative Extension

ALMOND ORCHARD MIDDLES ARE FIRST and foremost considered working surfaces in the orchard. It's obvious from the language we use to talk about them: the orchard floor, the drive row, etc. But years of keeping middles free of any vegetation can lead to the development of problems in orchard soils, and sacrifices the many benefits that can be gained by having winter vegetation in orchard alleyways.

Winter cover crops hold promise to help growers address multiple production challenges associated with poor soil health and uncertainties in water resources while fostering bee health and sustainability. Despite its potential, this practice is not widely implemented mostly due to concerns regarding water usage, residues at harvest and frost risks in some regions. Successful growers' experience, and research[1] by the University of California, with support from the Almond Board and the California Department of Food and Agriculture, point toward winter cover crops being clearly compatible with large-scale almond production in California. Renewed interest in bee health, incentive programs and widespread soil-related management issues across the Valley have increased demand for information on cover crops. Here, we detail how to get started and considerations to minimize potential production and management constraints.

Why Consider Cover Crops

Cover crops have the potential to tackle multiple management goals. Impacts vary with cover crop mixtures and growth, and a seeded cover crop will likely provide more benefits than resident vegetation. Potential benefits include: **1)** improved soil physical properties like infiltration and water holding capacity; **2)** increased bee health from improved floral resources; **3)** decrease in winter weed pressure; **4)** improved orchard access; and **5)** increased biological activity and nutrient retention and cycling in the system.

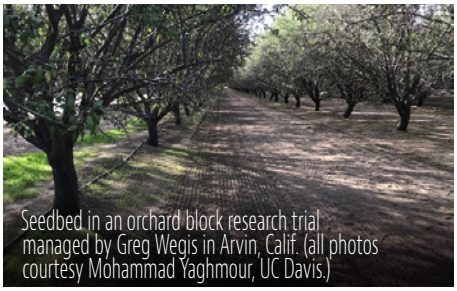
Improvements in soil physical properties are a primary objective for many almond growers. This was a main driver for grower Greg Wegis, who is collaborating with our research in Kern County (see related sidebar.)

"Wegis and Young Property Management considered growing cover crops as a solution to water penetration issues in Arvin," Wegis said.

So far, he's been happy with the results, noting, "We definitely notice improved infiltration."

Cover crop residues and root structures can lower compaction and improve aggregation of soil particles, which, in combination with better infiltration and water holding, could allow for more water storage. Improved infiltration helps with salt leaching to reduce salinity, enables better orchard access and improves efficiency of compost and gypsum applications. Considerable improvements in water infiltration and sodicity can be found after as few as two years of cover crops. Some growers using cover crops

Continued on Page 18


Seedbed in an orchard block research trial managed by Greg Wegis in Arvin, Calif. (all photos courtesy Mohammad Yaghmour, UC Davis.)

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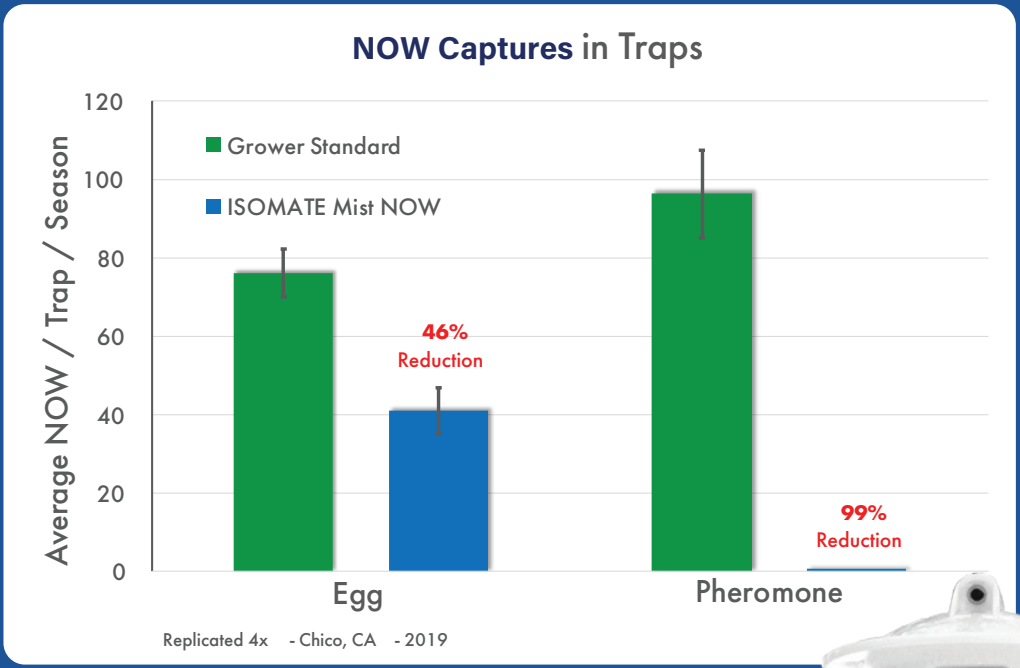

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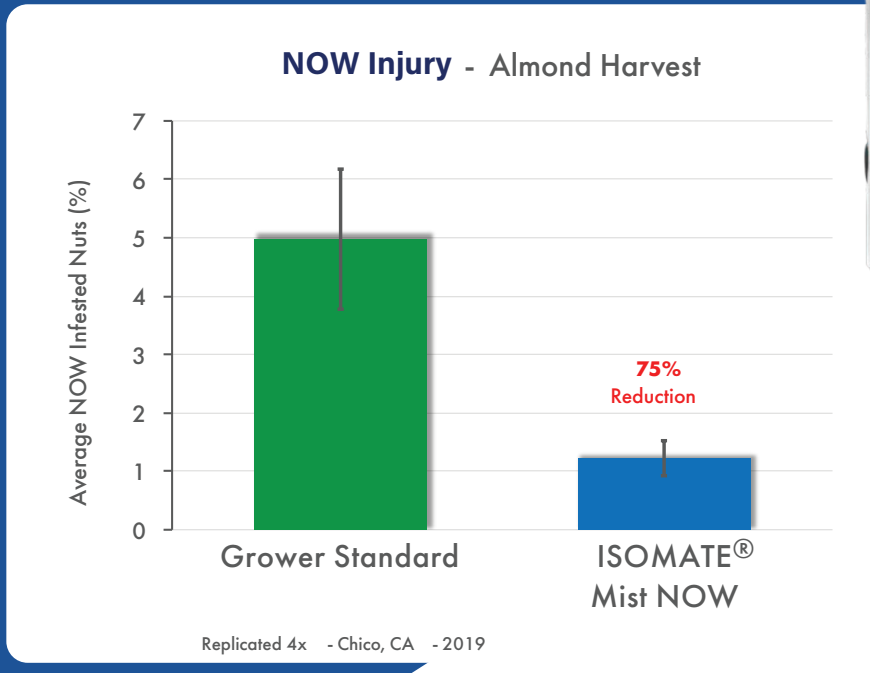

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Heavy cover crop growth in an orchard. Orchard soil conditions at harvest.

have also noticed decreased dust and particle emissions at harvest, but linkages between soil health improvement and air quality remain anecdotal.

Research has also shown that flowering cover crops can support bees by providing habitat and nutrient resources before and during almond bloom. Planting abundant and diverse flowering plants provide pollen and nectar early in the season to mitigate honey bee nutritional stress while providing critical support for wild bee populations preceding and immediately following almond bloom.

Controllable plant covers can compete with and displace weedy vegetation. Fast establishment and growth are critical determinants of weed suppression in the winter and, potentially, later-emerging summer weeds after the cover crop is terminated. Numerous cover crop mixes effectively reduce winter weed populations compared to standard bare soil and herbicide practices.

Cover crops also add organic nutrients to the systems which can broadly and quickly influence soil fertility. Organic sources of nutrients, especially nitrogen, can offset synthetic fertilizer inputs in the spring if release from the cover crop is synchronized with tree demand and residues are placed near the tree roots. Cover crops also provide organic carbon for storage in soil. Yet, increasing soil organic carbon, the building block of healthy soils, is particularly challenging in our climate and soils. Medium- to long-term use of cover crop is necessary to see improvements in soil organic matter levels.

Although the potential of cover crops to improve soil structure and fertility is well known, harnessing shifts in soil communities and their activity to build soil health and control pests remains a challenge. Albeit hard to manage, broadly restoring life into soils is key to enhance soil health, and experiments show that soil communities respond rapidly to cover crops in almond orchards. Live roots in the system can increase the amount and activity of microbes and enrichment of soil food webs. Some cover crops, especially brassicas, can also reduce pest nematode populations.

How to Minimize Potential Problems

The two biggest concerns we hear about using cover crops is competition for water and debris at harvest. Knowledge gathered from a growing community of growers and researchers shows that sound cover crop management can help mitigate water competition and potential interference with harvest.

Water use was certainly on the mind of Wegis. The site where we worked together historically receives about 7 inches of rainfall a year.

"Water was a prime concern," Wegis recounted. "With help from universities, we documented that there was almost no increase in ET from the overall orchard with winter cover crop vs bare soil. This was the biggest surprise for sure."

Our research is finding that there is no large or significant difference in water use by the cover crop and water lost to evaporation from bare soil, particularly when increased water infiltration decreases run-off. Fall water use can be minimized by planting just ahead of fall rains. Spring water use can be decreased by earlier termination by mowing and/or herbicide after almond bloom.

To avoid harvest debris, the right species mix and timely termination are critical. In general, legumes decompose faster than grasses and brassicas, and are a useful addition to mixes to lower risks of residues at harvest. In young, bearing orchards that are still filling in, grasses can dominate and get out of hand. Orchards that receive precipitation well into spring, or with micro-sprinklers, have more flexibility to terminate into May, because this water can help with the biomass breakdown. Orchards in drier regions and/or on drip are better suited for April termination timing.

If frost is a risk in your region, consider a low-growing but fast-recovering species (i.e. sub-clover). In general, cover crops buffer heat flow and storage[2] in the soil without major impact on temperatures 5 feet above ground, but winter mowing and choosing low stature species can further help reduce risk.

How to Get Started

Cover crop management decisions are guided by the specific features of your orchard and management goals. The following list walks through the steps to getting started with cover crops.

Identify management goals and orchard features: Diagnose

your orchard and prioritize your main objectives. How old is your orchard? What are the main challenges you experience that cover crops may help alleviate (e.g. compaction, weed pressure, sodicity?) Answering these questions will help you pick a mix of species based on your goals. The article mentioned in references[3] and species selection tool[4] can help you think through different cover crop goals and how to best achieve them.

Plan and start small: Gather information, make cover crop management choices and implement a small trial. Fellow growers and managers, seed suppliers, UCCE farm advisors and UCCE Healthy Soils specialists, and NRCS and RCD staff offer lessons and experience. Investment in seedbed preparation, which creates an even surface and good seed-soil contact, is an important step to obtain good stands and harvest conditions. Consider your seeding and mowing equipment in establishing row width to minimize effort and complexities when you get started. Grain drills and no-till drills are usually best at establishing a stand without disturbing the rest of the orchard floor. Some working of the soil ahead of the seeder may be necessary to get started, especially in highly compacted soils. Time your planting to help prevent competition for water while giving the cover crop time for robust growth, and have a plan for termination and potential in-season growth control before you plant the cover crops: will you mow them, or terminate with herbicides? These choices will affect species selection and the magnitude of benefits you might obtain from your ground cover.

Scaling up: Seek incentives programs and map out costs, logistics and systems changes. Look to programs like Seeds for Bees, the CDFA Healthy Soils grants and NRCS EQIP for financial assistance.

A growing body of research indicates that significant challenges lie ahead for agriculture in terms of input use efficiency and resilience to environmental stressors. Winter cover crop remains one of the most accessible strategies for almond growers to withstand and thrive through these stressors by improving soil properties, increasing bee health, decreasing weed pressure, improving nutrient cycling and shifting soil microbial communities. Renewed interest and experimentation are finding these benefits can be gained without sacrificing precious water or causing problems at harvest.

Resources

A summary of research can be found on the Almond Doctor website article: "Cover crop research review: How can it help almonds?"

http://www.sacvalleyorchards.com/almonds/horticulture/cover-crops-in-almonds-research-updates/

http://www.sacvalleyorchards.com/almonds/horticulture/cover-crop-seed-selection/

http://cekern.ucanr.edu/CDFA_Grants/HSP_Grants/Cover_Crop_Selection_Tool/

Comments about this article? We want to hear from you. Feel free to email us at article@jcsmarketinginc.com

Grower Perspective and Advice when Considering Cover Crops

Q&A with Greg Wegis, Wegis and Young

Q What is your experience with cover crops?

Wegis and Young Property Management considered growing cover crops as a solution to water penetration issues in Arvin, Calif. Our hesitations and concerns were associated with costs of additional management, water consumption and the changes needed to the overall system. We started with a 30-acre trial testing two different mixes for two years, scaled up to 80 acres, and now plan on planting about 400 acres in mostly organic almonds next season. Given the added costs (about $80/acre), we are only targeting blocks with water infiltration issues. We are using a biodiverse seed mix (from Cal Ag Solutions) with diverse root systems to open up the ground after termination in April/May. Planting with a little heat in the fall helps with germination, and the first week of November seems like a good time for us.

Q How is it turning out for you?

We definitely notice improved infiltration and lower weed pressure, reducing our need to spray and mow weeds during the season. This particular orchard is located in a zone historically receiving low winter precipitation, mostly late winter (7.1 inches of rain per year), so water was a prime concern. We are on Fanjet sprinklers on these blocks so less worried about catching the first rain, but the cover crop was largely rainfed. With help from universities, we documented that there was almost no increase in ET from the overall orchard with winter cover crop compared to bare soil. Although I feel we need other technologies to back up these findings, this was this biggest surprise for sure. This is a big deal if this proves to be true as we move further into SGMA compliance.

We were also worried about winter sanitation but were able to shake, sweep and mow on our same schedule as we do without the cover crop. We ran the blowers to push mummies off of berms and into the middles where the cover crop was actively growing. We couldn't windrow the mummies, which we feel aids in breaking the mummies, and had to wait until April or May to mow the cover crop and eventually break down the mummies. The majority of the nuts were destroyed but a few mummies remained due to some unevenness of the orchard floor on occasion. We haven't seen a difference in NOW damage yet after three years of cover crop but will be watching out for potential increased damage due to this issue.

Q What recommendations do you have for farmers getting started? What to watch out for?

Make sure you prepare and level your orchard floor before planting as this will be your last opportunity to float out your floors before the following year's harvest. It also helps establish a good stand. We didn't have much success just drilling into a hard orchard floor with a grain drill, and running a mulcher in front of the planter about 1 inch deep worked for us.

Leaf samples pulled following proper protocols in May can predict with high accuracy how much nitrogen leaves will contain in July (photo courtesy UCCE.)

NEW TOOL FOR PREDICTING NITROGEN NEEDS IN WALNUTS

EARLY-SEASON LEAF SAMPLING PROTOCOL HELPS GUIDE IN-SEASON NITROGEN ADJUSTMENTS

By **VICKY BOYD** | *Contributing Writer*

WITH THE RECENT ROLLOUT OF AN early-season walnut leaf sampling program and nitrogen prediction model, walnut growers now have a tool to help make in-season nitrogen adjustments that will affect the current season's crop.

Laboratory results of leaf samples pulled following proper protocols in May can predict with high accuracy how much nitrogen leaves will contain in July, said Katherine Jarvis-Shean, a UCCE orchard systems advisor for Sacramento, Solano and Yolo counties.

In most cases, the predictive results confirm growers are on the right path as far as nitrogen fertility. Should they show a predicted deficiency or oversupply, growers still have time to adjust their fertility plans during the season.

That compares to the traditional July sample timing, which was used because walnut leaves were fully expanded and nutrient levels were fairly stable. But it also meant "the story was largely written at that point for the growing season and for nitrogen management," she said.

Developed by a UC Davis research group led by plant nutrition professor Patrick H. Brown, the early sampling and walnut nitrogen prediction model join similar ones already used by almond and pistachio producers.

Not only do the models help growers make more efficient use of nitrogen, but they also help steward a nutrient that has come under increasing regulatory scrutiny, said Jarvis-Shean, who worked with Brown on the walnut model and earlier walnut nutritional research.

Michael Cahn, a UCCE Monterey County farm advisor focused on irrigation and water resources, has incorporated the nitrogen prediction model into CropManage. A free web-based application found at www.cropmanage.ucanr.edu, CropManage provides real-time recommendations for efficient and sustainable irrigation and fertilization applications while maintaining or improving overall yield.

The first version, designed for Sacramento Valley walnuts, features the nitrogen recommendation model and an evapotranspiration-based irrigation scheduling tool. UCCE Farm Advisor Emeritus Allan Fulton, based in Tehama County, is helping set up the parameters for the irrigation model. A version for San Joaquin Valley walnuts is expected to follow.

Early, Actionable Information

Paul Wenger, who grows walnuts and almonds with his sons near Modesto, said having the nitrogen information earlier for walnuts, as they have for almonds, would be welcomed as long as the results provided a high confidence level.

"Sampling in June or July just tells you what you have," he said about walnuts. "But to the degree that walnuts can adapt and you know what crop load you have, it's helpful having that information earlier."

Depending on the year, Wenger typically makes three nitrogen applications beginning sometime in May and ending in August.

"Doing a May sample will help you know what residual nitrogen you have and what you might need to do to help the trees out," Wenger said.

Unlike almonds, which require 68 pounds N per acre for every 1,000 pounds of kernel yield, walnuts require much less, making the nutrient less of a concern in that crop, said Matthew Efird, president of Efird Ag Enterprises Inc. and vice president of Double E Farms Inc. He grows walnuts, almonds, raisins, peaches and pistachios with his family between Caruthers and Kingsburg.

"In almonds, you want to focus your nitrogen applications early in the growing season due to hull rot and nut removal concerns come late July and early August," he said. "So, monitoring early nitrogen levels is much more critical in almonds than in walnuts. With the nitrate levels in our water and the efficiency of walnuts with nitrogen, early sampling or forecasting is not as crucial as it is with almonds."

Nevertheless, Efird said having early results that would predict July walnut N leaf levels would help.

"Any tool in the toolbox is going to be beneficial," he said.

Walnut Nitrogen Requirements

The early season sampling program and prediction model complement a multi-year study trying to quantify the timing and nutrient requirements of

The early walnut nitrogen sampling protocol allows growers to factor in predictive results as well as crop load when deciding how much of the nutrient to supply the trees (photo by V. Boyd.)

Katherine Jarvis-Shean, UCCE orchard systems advisor for Sacramento, Solano and Yolo counties, said May sampling can provide early information as a complement to traditional July sampling protocols (photo courtesy UCCE.)

newer, high-yielding walnut varieties. The research, funded by the California Walnut Board and the California Department of Food and Agriculture's Fertilizer Research and Education Program, involved three Chandler and three Tulare orchards scattered from Hanford to Red Bluff.

Over three years, the researchers found a mature walnut orchard required about 29 pounds N per acre for every 1 ton of in-shell crop harvested when measured at 8% moisture. The amount of nitrogen accumulated varied little between varieties, Jarvis-Shean said.

They also looked at how walnut trees take up nitrogen throughout the growing season. Earlier UC research found that during the first month of growth – roughly March or April, depending on the region and variety – trees draw mostly from nitrogen stored within plant tissue. Any nitrogen applied during that time will likely go unused by the trees and be vulnerable to leaching loss, she said.

For the next four months, walnut trees use nitrogen fairly evenly until about a month before harvest, when their nitrogen needs essentially shut down.

Even before the start of the season, Jarvis-Shean said, growers typically begin nutrient planning by reviewing historical yields and those from last year. If, for example, an orchard yielded 3 tons per acre the previous year and appears

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healthy without significant tree losses, growers could expect it to require 3 × 29 pounds for a total of 87 pounds per acre if trees were 100% efficient. A reasonable starting goal for tree N uptake is 70% efficiency, so divide 87 pounds by 0.7 for a total of 124 pounds N per acre.

"Apply nitrogen to meet the demand," she said. "Steady applications in May, June, July and August is the way to go to get the best nitrogen efficiency. Just divide the applications evenly.

"It's not quite as tricky as almonds, where we're worried about hull rot, so you want to apply all of your nitrogen before hull split."

Early Sampling of 29 Trees

As part of the nutritional research, the researchers also looked at whether earlier sampling in May could yield predictions that would give growers time to adjust N applications for the current year's crop.

The sampling program involved 30 trees each spaced 100 feet from the next. They pulled one terminal leaflet within arm's reach from each of a tree's four corners. Altogether, they had 116 leaflets. They strived for leaves mostly in the sun and avoided those in the shaded, interior portion of the trees. They also avoided sampling trees that are stressed, diseased or otherwise not representative of the orchard.

During their research, Jarvis-Shean said they found a sample size of 29 trees yielded results with a 95% confidence level.

"If you do that, you can be guaranteed 95% of the time your numbers will be within 0.1% of the true situation in your orchard," she said. "We tried to figure out how many we needed to be sampling to get the whole story of what was going on in his orchard."

Although Jarvis-Shean admitted that may seem like a large number of leaves to pull, she said smaller sample sizes could potentially skew the results and provide added levels of uncertainty.

"You can take one leaf in the orchard and send it into the lab and they can put it in a test tube and tell you a number," she said. "But you want to make sure you're collecting leaves in such a way that the number you get back is not just a number but is actually a reflection of the situation in the orchard."

Applying the nutrient through fertigation allows growers to spoon feed the trees (photo by V. Boyd.)

Research has found the optimal July N target range for walnuts to be between 2.3% and 2.7%, Jarvis-Shean said.

"There's a window where we want the nitrogen to be—a sweet spot where it's not too hungry but not going overboard either," she said. "If it predicts that in mid-July, you'll be at 2.6% N, then stay the course with your usual plan. If it tells you that you're at 2.1% N and it looks like the trees are hungry and will be throughout the growing season, then you're off track and need to apply a little more N this year. If it comes back that in mid-July, you'll be at 3% N, then lay back on the nitrogen. You have more than enough already stored in the trees to help hit the crop goal and you can reduce what you're going to feed."

Pulling leaf samples in May shouldn't necessarily preclude you from pulling another set of samples in July, Jarvis-Shean said. Calling the mid-summer sampling a "report card," she said, "I think July sampling is still a great way to go, especially in mature walnut orchards that have a fair amount of nitrogen storage in their perennial tissue.

"You can watch those nitrogen levels year to year using those July samples. I'd be surprised if anyone had a lot of big surprises using that approach. But certainly, as we tighten our nitrogen belt in this regulatory environment, some people are a lot more comfortable with more information rather than less information."

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A STREAMLINED NEPA PROCESS

Californians may be one step closer to critical infrastructure improvements and a more reliable water supply.

By **MIKE WADE** | *California Farm Water Coalition*

In July, the White House Council on Environmental Quality (CEQ) announced long-needed modernizations to the National Environmental Policy Act (NEPA). On September 14, those changes will go into effect, making critical infrastructure projects one step closer to reality.

NEPA, signed into law in 1970, requires Federal agencies to consider environmental impacts before issuing permits for Federal projects. Farmers, whose livelihoods disappear if we fail to protect the environment, deeply understand the importance of this process.

However, the NEPA rules governing that process have not been updated since 1978, which was around the time the first personal computer was invented. You would get nothing done trying to use a 40-year-old computer, and that has also been the case with the outdated NEPA process. Projects would stall for years, mired in literally thousands of pages of regulations.

According to the Department of the Interior (DOI), it now takes the federal government an average of 4.5 years to complete an environmental impact statement (EIS), but it can also take much longer. And through those long years of review, the pages of rules that must be followed grow exponentially.

One example of the extreme burdens imposed by the current system comes from Denver, Colo. An effort to widen Interstate 70 took 15 years to get through the process and begin construction, and it came with more than 15,000 pages of rules. That's the equivalent of roughly 50 novels, that not only need to be read, but adhered to throughout the process.

Process Improvements

Since Fall 2017, the Bureau of Reclamation has been operating under more stringent DOI NEPA requirements than the ones recently published by the CEQ. A recent Reclamation project, the Friant-Kern Canal Middle Reach Capacity Correction Project, initiated a joint EIS/EIR in Dec. 2019, and Reclamation expects to sign the Record of Decision in Oct. 2020 for the project. The NEPA process will be completed in less than one year for a very complicated and environmentally sensitive project meeting the DOI requirements.

Water projects are almost always top-of-mind for farmers, but streamlining the NEPA rules will have a profound impact on all kinds of critical infrastructure projects benefitting all Californians - roads, bridges, mass transit, airways, waterways, affordable housing, expanding broad band to rural and poor communities, and renewable energy projects to help the environment.

We're constantly reminded by scientists that the time to prepare for climate uncertainties is now. And much of what we must do to protect ourselves from climate change impacts involves building and repairing infrastructure – water projects to help us capture water in wet years for use in dry ones, flood control projects to counter heavy rains, mass transit to cut emissions, housing projects closer to where people work, and more.

And at a time of massive unemployment, moving these projects forward can create much-needed jobs. The U.S. Chamber of Commerce estimates that for every $1 billion spent on infrastructure, 22,000 jobs are created.

The streamlined process means reviews will take no longer than 2 years and will limit the number of pages of rules that come with approval.

And streamlining the NEPA review process still maintains the integrity of critical environmental review. All of the underlying laws such as the Clean Water Act and the Clean Air Act remain unchanged, and the review must still allow for critical public input – projects just won't drag on unnecessarily.

This is great news for all Californians. Speeding up critical infrastructure projects benefits farmers, cities, rural areas, minority communities, the economy and the environment.

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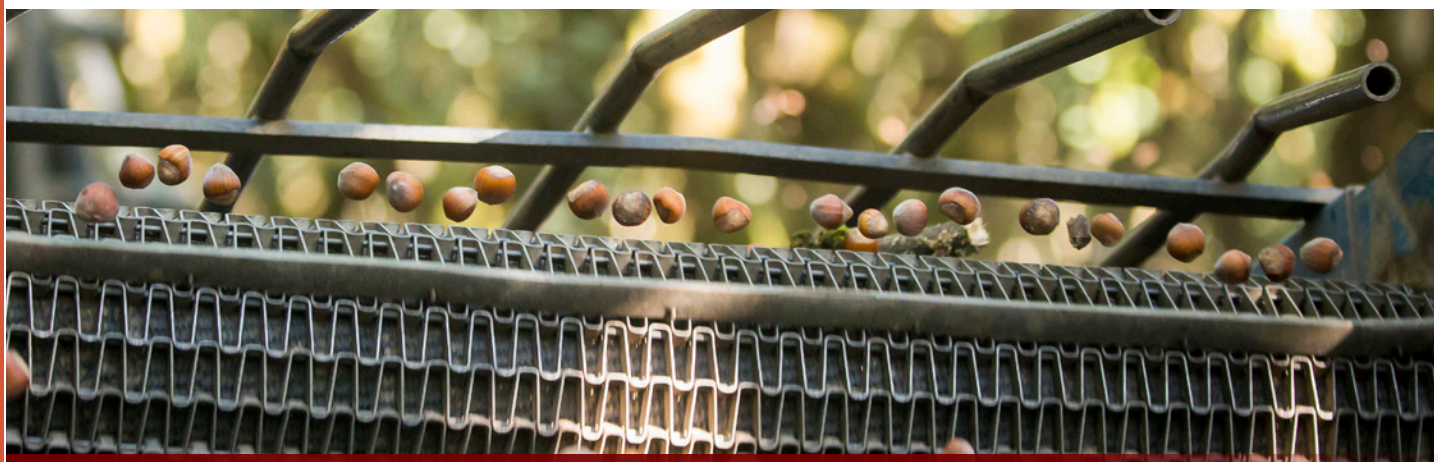

Planning, Preparation and Maintenance Can Help Harvest Run Smoothly

By **HAZELNUT MARKETING BOARD** | *Contributing Writer*

With a bumper harvest, hazelnut growers should pay extra attention to maintenance and service of harvesting equipment (photo courtesy Hazelnut Marketing Board.)

HAZELNUT HARVEST IS HERE. THIS month, hundreds of farmers throughout the Willamette Valley will take to the orchard to harvest millions of pounds of Oregon's state nuts. This year could mark a new yield standard for the U.S. hazelnut industry, but to achieve this herculean task, proper harvest preparation and maintenance must come first.

These nine steps will help keep harvest going smoothly; some of them may sound basic but are still often neglected and can lead to downtime in the field or a trip to the shop.

Dirt is the Enemy

Dirt, in all its forms, is the nemesis of a successful harvest and operational harvest equipment. In dry conditions, dirt can be easily blown around and get caught up in the blower fan during harvest. In wet conditions, mud sticking to the nuts will build up in the machinery. A final, thorough pass of the flail and scraper will go a long way toward a smoother harvest.

If adverse conditions arise, it will

pay dividends in the long run to take frequent breaks to clear out any type of dirt build up.

Begin with Bearings

Bearings are the lifeline for any piece of farm equipment. They will give insights into the health of the machine. It is nearly impossible to over lubricate bearings, so begin harvest with freshly serviced bearings and gear boxes.

In addition, checking bearing temperature with a probe will also prevent issues in the long run; high temperatures in a bearing indicate failure is imminent. These bearings should be replaced before harvest begins.

Take Everything for a Test Drive

Just like getting behind the wheel of a new car before purchasing, every piece of harvesting equipment should be given a test drive before heading out into the field. No matter how old an implement is, this should be repeated before every harvest. First, pull each item onto a safe surface outside of the orchard and simply fire up the engines; let it run for a while and listen and observe the machinery. An extended dry run will help identify potential problem areas and better allow for preventive maintenance, rather than lose time in the field during a breakdown.

Pay special attentions to leaks and any potentially loose belts. There is no such thing as too much time doing a dry run, greasing key points and tightening every part of any implement.

Small Rodents, Big Problems

Equipment that is left largely unused, if not untouched, for 10 months out of the year can become a haven for rodents. There are plenty of places to hide, and equipment that has spent many hours in a hazelnut orchard is a lush food source. Even the smallest residual shells, leaves or kernels can entice rodents into the shed.

Additionally, these animals can gnaw through nearly any non-metallic surface on a sweeper or harvester. Thus, a thorough inspection of all hoses and wiring is crucial. Not only can damage inhibit equipment performance, but rodent nests and damage can also be a fire hazard.

Sweeper Check

Sweepers should be the first piece of equipment thoroughly inspected; a delayed sweeper means a delayed harvest all around. In addition to the aforementioned bearing checks and thorough tightening, focus on basic cleaning. Extra scrutiny needs to be given to the brushes/bristles and tine bars to ensure these are in full working order. If wear is evident, replace before going into the fields.

Lastly, double-check the mounting hardware for proper tightness and review the hydraulic system. A good rule of thumb is for 500 hours for hydraulic oil in a sweeper. Once beyond that threshold, service the hydraulic system.

Harvester/Picker Maintenance

The implement most likely to give a grower headaches during harvest time is the harvester. With so many intricate

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Hazelnut harvest is a team effort, so it is important to properly prepare the workforce ahead of harvest (photo courtesy Hazelnut Marketing Board.)

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pieces that need to work in unison, even the slightest equipment failure could severely delay harvest. U-joints are a frequent problem area, yet issues are easily avoidable if properly inspected before harvest. The paddle wheels can wear very quickly and should be changed if damage is visible. A similar situation can arise with suction fan blades and should be identified during the test run.

The conveyor belt on the harvester produces its own set of unique challenges. A malfunctioning conveyor chain is near the top of the list of worst breakdowns. During the test run, give the chain plenty of time to run and build up temperature. Keep an eye on the hydraulic system and drive sprockets, as these two must be in working order before harvest.

Lastly, calibrate the height of the harvester. It may sound elementary, but a harvester set too high versus one set too low could mean the difference between picking up mounds of dirt with the hazelnuts and missing nuts altogether. It is possible to get a good feeling for the proper height by doing the test run on a smooth, flat surface and observing how close to the ground the paddles are. One of the more ingenious ways to improve harvester height is by simply inflating or deflating the tires to the desired level.

Blower Maintenance

Blowers can also prove to be particularly problematic if not exquisitely maintained. Fan blades take a lot of damage throughout years and years of harvest and should be replaced regularly. Another easy yet oft overlooked area is the air intake system and air filter; thoroughly clean the air intake and replace the air filter before each harvest.

Don't Out-Sweep the Harvester

It may sound simple, but it's imperative to strike a balance between the rate of the sweeper windrowing the nuts and the harvester collecting. While spread out on the orchard floor, hazelnuts can last a long time before deteriorating. However, once they are compiled into tight windrows, the airflow is diminished, and the kernel quality can begin to diminish. If a heavy storm comes, those residual nuts can turn into a near total loss.

Prepare Your People

Hazelnut harvest is a team effort, and the importance of properly preparing the workforce for harvest can't be overstated. This includes lining up paperwork, insurance and licenses as well as providing safety education. Lastly, don't forget to line up details with the receiving stations and handlers! This includes ordering tote boxes and transportation logistics.

Harvest is the most pivotal time of the year. There is no such thing as being too thorough. As the old adage goes, "prior proper preparation prevents poor performance."

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Postharvest Nutrition

What to Do as Nutrition Budgets Tighten

By **RICH KREPS** | *CCA, SSp*

WE "WEST COAST NUT" GROWERS (see what I did there?) invest, work, pray, work, hope and work some more for three to seven years before we even get our first crops to harvest. And now it's upon us, the "fruit" of our labor. Especially in California, where the ground shakes almost as much as our orchard harvesting equipment, we rattle our babies until they let loose of our most prized farming possessions—our nuts. As much as that's a necessity to make farming profitable, harvesting takes its toll on our trees. This year seems to be playing out a little differently than most and we need to keep the changes in mind.

Your trees have worked hard to produce. We fed them early and often as they put out their solar panels and raced through pollination. Early nutrition came from root storage and sequestered nutrition trapped in the spurs. As transpiration increased, we hit the roots hard and added foliar nutrition to orchard health prevention and suppression sprays. Managing nitrogen with balanced P, K, Ca, Mg, S and minors, we worked hard to balance our trees' food to optimize nut fill and yield. We battled through heat stress, managed water and timing to keep our orchards as healthy as possible. Now we need to realize that we were only the coaches. Our trees did the real work. And here we are….harvest.

Focus on Foliars

The world has been tipped on its head. Atlas is straining, hard. The almond world is seeing its biggest crop ever as the entire world is trying to figure out how it is going to be able to acquire that crop. The uncertainty of delivery and volume of nuts we will need to store has made future prices fall this year. In many cases, that has led to a tightening of the nutrition budget. Here comes the perfect storm. The biggest crop ever, potentially for pistachios and walnuts as well, and no price. When this happens and nutrition gets the axe, we greatly inhibit next year's crop potential. All those babies were produced, and no food for next year's buds. Combine that with a further budget reduction in post-harvest nutrition and we run the risk of a catastrophe next year: no crop and lower prices.

"Okay coach, what now?" Focus. Pay very close attention to those July and August tissue numbers.

Make sure your trees are hydrated soon after and/or during harvest depending on your crop. Trees don't assimilate nutrition well if they are dehydrated, especially foliarly. Get them recovered with water and then feed them.

Micronutrients can be addressed well with foliar sprays, but make sure your tank water has been dropped to acidic levels. Foliar nutrition with micronutrients applied properly can go many times farther than the same soil-applied nutrients.

Plant-Ready Ca and P

In the second irrigation after harvest, capture that big root flush. Add soluble and plant-ready calcium for cell division. With all the potassium

added during heat stress and nut fill, we are probably calcium deficient in our younger tissues. With much of that calcium going to root production, more will be needed for new foliage and buds. However, it has to be plant ready. Insoluble calcium salts will not feed a plant or even displace sodium. It has to split into its ionic form to be assimilated and stick to binding sites.

In my humble opinion, I'd address plant-ready phosphorus next. Those trees just ran a marathon; they are going to need help producing energy, and adequate P is required to make that happen. However, here are three things to think about: 1) make sure it's orthophosphate so it's plant ready; 2) don't overdo it with too much P (what can't be assimilated will tie up calcium); and 3) add a good chelator like humic acid to keep combinable nutrients separate and provide a good carbon source. The extra carbon will feed the soil biology, keep the soil wetter longer and grab other nutrients that may become etched off the soil colloid. Feeding the soil biology will also exacerbate nutrient transformation as they eat and respire.

If you were deficient in magnesium at all, it can be applied both through the irrigation or in a spray. Magnesium is critical right now for carbohydrate production to create adequate chlorophyll levels. If we can store more carbohydrates in the fall, we give our trees a better chance to produce big yields again next year.

Doing More with Less

Don't forget to drop the pH. A little acidity will go a long way. Keep the irrigation water as close to 6.0 pH as possible. This will solubilize as much nutrition as possible and mine what's still in the soil and tied up. Try to use more acidic nutrients: elemental sulfur, boric acid, magnesium acid, sulfuric acid, acidifiers, ammonium sulfate, citric, lactic, etc. There are even stories of industry legends adding vinegar to their spray rigs to drop pH. Do whatever it takes to hedge your bet. Remember, it's not what you put on your trees, it's what you get into your trees that matters.

Logistically, it can be very difficult to get more nutrition into your trees with less. But a careful eye on irrigation rates when fertigating will help. Shorter irrigation sets when fertigating will keep nutrition in the flushing feeder roots. Adjusting pH when spraying is critical. Check your water. A couple sprays addressing different nutrients in each will help as well.

If it gets difficult to get across a lot of acres post-harvest, many nutrients can be applied with only 10 gallons of water by air. Hire it out. It'll save critical time and labor for about the same cost. Adding a little nutrition to each irrigation after that first one all the way through dormancy can greatly enhance tree health. Specifically addressing complimentary nutrients in adequate, soluble and non-excessive rates should go a long way. Not over-doing it will keep that nutrition from tying up. Our trees just ran their marathon. Be a good coach and help them recover. Don't put them to bed hungry and you'll both be rewarded with a good crop again at next year's finish line.

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Soilborne Pests in Tree Nut Crops

MyAgLife Webinar Offers Strategies for Preventing and Managing Common Soilborne Issues in Almond and Walnut

By **CECILIA PARSONS** | *Associate Editor*

Pocket formation with debris, leaf, and rain collected at the crotch area of an almond tree can create phytophthora problems (photo courtesy Brent Holtz, UCCE.)

PRESERVING TREE HEALTH IN THE FACE OF SOILBORNE DISEASes and pests requires both careful management and choosing appropriate rootstock genetics for a given orchard site.

In a West Coast Nut MyAgLife webinar on soilborne pests and diseases in nut crops, several experts in soilborne diseases and rootstock development shared their knowledge and experience on a number of common soilborne pathogens in walnuts and almonds, as well as breeding efforts to find solutions through resistant rootstock.

Diseases in Almonds

Mohammad Yaghmour, UCCE orchard systems advisor in Kern County, said there has been a resurgence in recent years in Phytophthora, one of the most aggressive soilborne pathogens, in Kern County.

"It is the most important soilborne disease we face every year," Yaghmour said.

There are several species of this pathogen which cause root, crown, trunk and scaffold cankers. Infected trees lose vigor and eventually collapse. Sources of the infection can include infected plant material and surface irrigation water. The disease is best managed through prevention, by avoiding over-irrigation and standing water in low spots in the orchard and by planting on elevated berms.

In almond orchard sites, where Phytophthora has been found, Yaghmour said, using resistant rootstocks is advised. Preventative foliar sprays are another control option. Applying a fall or spring spray of phosphonate has shown to have a significant effect, suppressing development of cankers for up to five months after the treatment. The sprays will not eradicate the pathogens from the tree, Yaghmour emphasized.

It is important to meet nutrition needs of trees and to avoid stress, Yaghmour said, as stress and poor nutrition predispose trees to diseases.

Other soilborne diseases that can affect almonds include verticillium and armillaria root rot. Verticillium, also known as blackheart, is a vascular disease that mainly affects young trees. Infections can be obvious after a heat event in late spring or early summer. There will be flagging on one side of the tree and the shoot tips will resemble a shepherd's hook. A cross section will show discoloration that extends to the origin of the infection in the root.

Knowing the site history is important as the pathogen may be in the soil. A preplant fumigation or solarization can reduce the level of inoculum in the soil, but it will not eliminate all of the sclerotia. Verticillium has many hosts, with cotton and tomatoes being highly susceptible hosts. These should be avoided as intercrops.

A less common but still devastating disease is Armillaria root rot. Almond orchards adjacent to riparian areas or oak trees are more likely to be affected. This disease is spread from tree to tree through root grafts, and introduced at a site via infested soil or plant material. Affected trees have

thin canopies and pale foliage. They lack new growth, and the trees may wilt and die during hot weather. Inspection of the roots shows the presence of mycelial mats between the bark and wood tissue. Exclusion of infested soils on equipment and removing old roots from the orchard before replanting are the best strategies for control of this disease.

Yaghmour emphasized the importance of confirmation of a disease with laboratory tests as symptoms are not diagnostic and may be confused with other maladies.

Soilborne Issues in Walnuts

The second portion of the webinar focuses on soilborne diseases of walnut. UC nemotology specialist Andreas Westphal summarized the effort of a research consortium including plant scientists, geneticists, engineers and economists. Supported by federal, state and California Walnut Board funding, this group set out to improve walnut rootstocks with improved capacities to resist soilborne diseases. Selections for elevated resistance to Phytophthora rots, crown gall, root lesion and root knot nematodes are underway.

USDA-ARS plant pathologist Greg Browne explained that Phytophthora is an oomycete that differs from true fungi. Water status is central to its biology and pathology. Soil water saturation favors zoospore production, dispersal and attraction to plant roots. Due to these characteristics, Phytophthora infections in an orchard can explode, Browne said.

Regionally, surface sources of irrigation water, including rivers and canals, can spread Phytophthora species. Ponds and reservoirs can support the pathogen. Browne emphasized that growers should be aware of the potential of infection from these water sources and manage accordingly.

In California, Phytophthora *cinnamomi* is the most aggressive species in walnuts. In an aerial photo, Browne noted the devastation in a walnut orchard due to Phytophthora at a site that was fumigated with methyl bromide prior to planting. Susceptible rootstock and soil characteristics contributed to the severity of the infection.

When this species infects trees in an orchard, Browne said it invades the roots first, then the crown and trunk. A bleeding trunk is not diagnostic for a Phytophthora infection because other diseases or disorders can cause similar symptoms.

The other major species is Phytophthora *citricola*. It is also an aggressive pathogen, but it is more of a "crown rotter."

It is important to confirm suspicions of the disease based on symptoms by laboratory procedures. Browne noted that ELISA test results can be misleading and a laboratory test either using morphological or molecular procedures should be done. Paradox canker, for example, looks similar to Phytophthora, but is of unknown etiology.

Genetic resistance in rootstocks is an important factor for Phytophthora suppression. Browne noted the currently available walnut rootstocks and their resistance levels. The clonal walnut rootstock RX1, even in field trials, is showing high resistance to P. *cinnamomi* and moderate to high resistance to P. *citricola*. English seedling or clonal and northern black seedling both have very low resistance. Paradox seedling has variable resistance from low to moderate in both species. Vlach clonal has low resistance to both, and VX211 has low resistance to *cinnamomi* and moderate resistance to *citricola*.

Crown Gall

Next-generation rootstocks and crown gall resistance was addressed by USDA–ARS researcher Dan Kluepfel. The objectives of this project are to generate a genetically diverse Juglans germplasm collection, identify hybrid Juglans germplasm resistant to crown gall (Agrobacterium *tumefaciens*), and then generate and clonally propagate hybrid disease-resistant genotypes for validation in field trials with a goal of delivering disease resistant rootstocks to growers.

This pathogen, Kluepfel explained as

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he showed how crown gall resistance is determined, requires a wound to enter a tree. Wound sites inoculated with Agrobacterium *tumefaciens*, the causative agent of crown gall, are rated for the appearance of galls after 2 to 4 months or, in some cases, after a dormancy period. A No. 1 rating means no symptoms (i.e. resistant), No. 2 is gall symptoms with stem girdling less than 25%, No. 3 is gall symptoms and stem girdling between 25 to 50% and No. 4 is gall symptoms with stem girdling more than 50%. In this way, the novel walnut genotypes are categorized based on their response to the crown gall pathogen. Selections with a rating of 1 or 2 are re-propagated and re-examined under both greenhouse and field conditions to confirm resistance.

Currently, there are five large-scale field trials evaluating "elite" putative resistant rootstock germplasm. The trials are in Glenn, Sutter, Lake, Solano and Tulare counties. At the Solano trial, the trees are being inoculated with the pathogens for crown gall and Phytophthora. At the other sites, the trees are planted in naturally infested soils.

Kluepfel said that 25 other putative disease-resistant hybrids have been clonally propagated and will be ready for field testing in 2020-2021.

Root Lesion Nematode

Later in the webinar, Westphal covered tolerance and resistance determination for nematodes. There are other nematode species that can harm walnut tree roots, but root lesion nematodes are the most damaging. Westphal explained that the definition of resistance to this nematode depends on its ability to reproduce on the roots. If it cannot, the rootstock is resistant. Tolerance is different in that it is the plant's response to the presence of the nematode. Plants can be tolerant to this nematode, but they can also be susceptible.

Screening rootstocks for nematode resistance and tolerance involves planting clonal hybrids and inoculating the plants, monitoring growth and sampling the roots for damage. Westphal said huge differences in plant responses have been seen in just the first year. But in his work, he confirmed that a second year of field cultivation is necessary to find meaningful numbers of root infections. After one year of growth, it can happen that 50-60% of the test plants have low nematode numbers in the roots – misleading to rate them "resistant". But in the second year, only 2-3% of these same genotypes may only have low nematode numbers in the root nullifying the erroneous assumptions of the first year. Thus, Westphal's testing always takes at least two years.

Work by this group of plant pathologists and researchers continues to provide California walnut growers with the genetics proven to ensure good walnut production.

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Effectively Managing Your Grower and Farm Labor Contractor Relationship

COVID-19 Adds Extra Complexity When it Comes to Liability for Workers

By **AMY WOLFE** | *MPPA, CFRE, President and CEO Emerita, AgSafe*

State regulation holds the grower equitably responsible with the FLC for ensuring workers are protected from possible injury and illness (photo courtesy AgSafe.)

AS HARVEST GETS UNDERWAY FOR some and is in full swing for others, the issue around having sufficient labor persists. The challenge drives many growers to use a farm labor contractor (FLC) as a means for ensuring there are enough people to get the job done.

Often times, though, growers use FLCs believing that in doing so, there is a firewall of protection between them and the liability of having workers. Nothing could be further from the truth in California. The current COVID-19 pandemic adds layers of complexity to their already complicated relationship, as growers and FLCs alike work diligently to mitigate the disease's risks. It is critical that growers not only understand the challenges inherent in working with an FLC but also how to vet a contractor to ensure the best possible working relationship.

Understanding Your Joint Employer Risk

Nearly five years ago, California changed the state Labor Code, Section 2810.3 to more fully define joint employment liability as it pertains to worker safety and compensation issues. The modification impacted all employers, not just those in agriculture, and applies when the contracting company (for example, the grower) uses six or more employees from the contractor. If fewer than 20 employees are working between both businesses, there is an exemption from these provisions. However, during harvest when the need for bodies exists, this allowance is rarely any help.

The regulation holds the grower equitably responsible with the FLC for ensuring workers are protected from possible injury and illness, and that all the conditions of employment compensation are met. The latter includes but is not limited to stipulated wages, a workplace free from harassment and discrimination, and paid sick leave and health insurance. As such, the grower must take steps to ensure that the FLC they work with complies with all these applicable employment laws and that they demonstrate a good faith effort to stay informed of the FLCs' business practices in these areas.

There is also a federal law, updated in March 2020, that speaks to joint employer liability. Under the Fair Labor Standards Act (FLSA), when an employee performs work for the employer that simultaneously benefits another person, that person will be considered a joint employer when that person is acting directly or indirectly in the interest of the

employer in relation to the employee.

Part of the update included the creation of a four-part test to simplify for an employer their understanding of whether the liability exists. Joint employment will exist if the grower does the following for the FLC employees:

- Hires or fires the employees
- Supervises and controls the employees' work schedule or conditions of employment to a substantial degree
- Determines the employees' rate and method of payment
- Maintains the employees' employment records

The FLSA does not stipulate that all these factors must be in place, nor does it note that the presence of only one of these elements will constitute liability. Rather, the regulation states that all circumstances will be considered, including factors such as the length of the relationship between the grower and FLC, pervasiveness of the actions by the grower, and the overall workplace culture that exists. The U.S. Department of Labor, Wage and Hour Division enforces the FLSA and, along with the California Department of Industrial Relations, Division of Labor Standards Enforcement, will hold a grower liable for the failings of his or her farm labor contractor.

As a result, a grower's risk has grown because both the U.S. Department of Labor and the California Division of Labor Standards Enforcement can cite the business for the same violation by the farm labor contractor. This is an instance of two-for-the-price-of-one, and not in the good way.

Vetting Your Farm Labor Contractor

With so much at stake, it is critical that growers take the time to vet their FLC annually as well as request evidence of compliance throughout the course of the season.

Prior to when a grower needs the services of an FLC, it is important to request evidence of compliance with the many employment laws impacting the contractor, as well as those that fall under the auspices of joint employment liability. If the contractor is not able to provide written evidence of compliance, that is a sign that the grower may need to consider finding a new farm labor contractor.

At minimum, the FLC should provide the following documentation:

- Copy of current State of California FLC License
- Copy of the Federal FLC Certificate of Registration
  - If providing worker transportation, Transportation Authorization should be noted
  - If providing worker housing, Housing Authorization should be noted
- Proof of workers' compensation insurance
- Proof of general liability insurance
- Copy of the Injury and Illness Prevention Program (IIPP)
- Copy of the COVID-19 IIPP Supplement
- Copy of the Heat Illness Prevention Program
- Copy of the Employee Handbook, including an Anti-Harassment and Discrimination Policy

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- Evidence of the following annual training for supervisors and workers:
  - Sexual Harassment Prevention (2 hours for supervisors, 1 hour for workers)
  - General Workplace Safety
  - Heat Illness Prevention
  - Worker Protection Standard
  - COVID-19 Risk Protection
  - First Aid/CPR (1 trained individual for every 20 workers)
- Evidence of worker wage and other compensation terms and conditions provided to the crew that will be contracted
- Copy of a paystub, with confidential information removed

Check in on Compliance

If, after review of these elements and determining compliance, moving forward working with the contractor makes sense, it is also important to check in on the FLC and their crews periodically throughout the season.

Onsite, you should be looking for the following, which demonstrates actionable compliance related to the paperwork initially reviewed:

- First aid kits with each crew
- Enough water and shade for the number of workers present, including ensuring that workers can maintain appropriate social distancing protocol
- Clean, usable portable toilets with ample hand washing supplies, enough to encourage best practices in accordance with CDC COVID-19 recommendations
- Appropriate personal protective equipment (PPE), including face coverings and hand sanitizer for use when not immediately next to hand washing stations
- An emergency action plan, including a map of how to safely evacuate the property, easily accessible for workers
- Required postings, including Pesticide Safety Information Sheet A-8 and A-9

Should something appear amiss during a field visit, it is critical to communicate what was deficient with the farm labor contractor and determine the immediate corrective action plan. It is also important that follow-up occur to ensure changes are made and documented. Failing to do so more simply codifies the definitive liability, as defined under California regulations, for the grower based on the lack of compliance by the FLC.

Keep in mind that both the list of items to review prior to engaging a contractor and the list of elements to evaluate in the field are not exhaustive. For a complete, robust list, contact AgSafe at safeinfo@agsafe.org or 209-526-4400. That being said, these provide an excellent place for growers to start the critical and important task of further protecting their business by more thoughtfully considering who to engage when trying to tackle the ever-present labor challenges.

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Overview of Biostimulants in Permanent Crops

By **JOY HOLLINGSWORTH** | *UCCE Nutrient Management and Soil Quality Farm Advisor*

UC CE | University of California Agriculture and Natural Resources | Cooperative Extension

ONE OF THE FEW THINGS PEOple can agree on about biostimulants is that they are difficult to define. The Biological Products Industry Alliance (BPIA) suggests:

"Plant biostimulants contain substance(s) and/or micro-organisms whose function when applied to plants or the rhizosphere is to stimulate natural processes to enhance/benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress and crop quality."

What is a Biostimulant?

Biostimulants are hard to define as there are many different substances and microorganismal inoculants used in their production. It is also difficult to quantify the mechanisms for how biostimulants work and ultimately provide benefits to crop health and quality.

Commercial products may have several different ingredients such as amino acids, micronutrients and beneficial microbes. Biostimulant research has focused on many different products, tested on different crop species, in different environments. Some studies have shown evidence for biostimulants reducing the impact of stressors on plants, but this has not been universal.

A review paper by Povero et al. shows examples of reported biostimulant effects including enhanced fruit set, size, quality, root development, plant growth, water and nutrient uptake, stress mitigation and soil improvements. Another review discussed 26 different biostimulant studies conducted on fruit trees (Tanou et al. 2017). The categories of products (used individually or sometimes in combination) included protein hydrolysates, seaweed extracts, humic substances, leaf/pollen/yeast extracts, amino acid chelate and Leonardite extract. This broad range of products and effects can make it difficult to decide whether any one biostimulant will be helpful for a particular situation.

Biostimulants are not currently regulated in the United States as they are classified differently from fertilizers and pesticides. However, it is possible that they will be regulated in the future. In spring 2019, the EPA released for public comment a "Draft Guidance for Plant Regulators, Including Plant Biostimulants". There has not been a new update since then, but it is possible that some biostimulants, which have the properties of plant growth regulators, will become subject to the Federal Insecticide, Fungicide and Rodenticide Act, which will require registration and labeling. If this happens, it may change what products will be available, but will also provide some oversight to the industry.

How Biostimulants Function

Biostimulants have a different function than fertilizers. Fertilizers are used to add macro- and

Biostimulants can be applied through irrigation systems to aid in specific functions such as stress tolerance or fruit quality (photo by Marni Katz.)

Vaguely defined, biostimulants can enhance/benefit nutrient uptake or nutrient efficiency, or increase tolerance to abiotic stress and crop quality (photo courtesy USDA NRCS.)

Enhanced fruit set is among the benefits found in some studies (photo courtesy USDA NRCS.)

micro-nutrients to the crop, which improves crop growth. Like fertilizers, biostimulants can be applied either foliarly or through the irrigation system and may contain some low levels of nutrients. However, the addition of nutrients is not their main purpose. They are more likely to be used to add biological products such as microbials, acids and hormones to the plant and soil to aid in specific functions such as stress tolerance or fruit quality.

To date, most of the studies that have been done on biostimulants have been on vegetable crops, possibly because they can be completed more quickly than permanent crops. Also, permanent crops contain reserves of nutrients in their woody structures, which could become a confounding factor in their evaluation (Soppelsa et al. 2018). Even when all applied substances have been controlled, permanent plant tissue can release nutrients to assist in plant growth in ways that are difficult to account for. This makes it more challenging to determine if an observed effect is due to the applied biostimulant or not.

Trial Results

As mentioned earlier, many biostimulant products contain multiple components, which can make identifying the causal agent difficult. For example, in a potted almond trial, Saa et al. applied two different products to two-year-old trees. One product was from seaweed extracts, and one was from the microbial fermentation of a proprietary mix of organic cereal grains. The seaweed extract product also contained amino acids, glycosides, betaines and vitamins. This study was especially interested in potassium, and it compared both biostimulant treatments to a foliar potassium treatment and a control. All four treatments were applied to trees that had been fertilized with either adequate or low levels of potassium, with all other nutrients controlled for. The results showed that both biostimulant treatments increased the shoot length and biomass when potassium levels were adequate, but only the seaweed-based treatment was also effective in the low potassium treatment. That would seem to indicate that potassium was a limiting factor and that the seaweed-based product was able to resolve that, but the microbial fermentation product contained even higher levels of potassium, so the actual mechanism is still unclear (Saa et al. 2015).

Another biostimulant trial done on young almond trees in Spain compared the combined application of two biostimulants to a control treatment in three almond cultivars with two irrigation treatments (Gordillo et al. 2019). Each of the biostimulants had multiple components. One had a combination of aerobic and anaerobic bacteria. The other was extracted from shrimp meal through a microbial fermentation process and contained amino acids, nitrogen and trace levels of other nutrients. Each of the three cultivars had a slightly different response to the treatments. In biostimulant-treated 'Guara' trees, there

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was a higher leaf water potential (less stress) than in the control under both irrigation regimes. The treated trees also had higher yields in both irrigation regimes. Biostimulant-treated 'Lauranne' and 'Marta' trees had higher stomatal conductance than control during vegetative stages, and 'Lauranne' trees' stomatal conductance was also higher during kernel fill. This study shows that even within a particular species, biostimulants may have different effects. However, this study only had one season of data collection, so it is unclear whether the results can be replicated.

Seaweeds are one category of biostimulants that have shown a lot of promise. In a review article on seaweed biostimulants, Battacharyya et al. referenced over 50 seaweed studies that have been conducted on vegetable and fruit crops as well as ornamental crops and turf grasses. The reported effects included increased germination, increased yield and increased uptake of various nutrients. In a different study of brown seaweed, *Ascophyllum nodosum,* researchers found that skin total anthocyanins at harvest were significantly higher in wine grapes treated with the biostimulant than in the untreated control (Frioni et al. 2018). The first year of the study was conducted in Italy with two different concentrations of the seaweed extract on Sangiovese grapes. The second year of the study was conducted in Michigan with one concentration of the biostimulant applied to two grape cultivars: Pinot Noir and Cabernet Franc. The goal was to test out the seaweed extract in different climates and in different cultivars. The anthocyanin level was the one factor that increased in all seaweed biostimulant treatments in all cultivars in both locations, indicating some consistency.

Although there is anecdotal support for the use of some biostimulants, more replicated research trials are needed to demonstrate which products are effective for which crops in which situations. If the mechanism for how the products work can be defined, it will make it easier to decide when and how they should be used. There are many different products on the market, and if growers are interested in trying them out, they should contact their local farm advisors, PCAs or CCAs to help them set up a demonstration trial. Products should be chosen based on the needs of the crop, and compared to an untreated control. For best results, conduct trials over multiple seasons.

Resources

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Popular **Progressive Crop Consultant** Conference Goes Virtual

Progressive Crop Consultant Magazine's popular two-day Crop Consultant Conference this year will be a live virtual event, featuring more than six hours of DPR and CCA continuing education credits, a virtual trade show, live presentations and interactive educational seminars. The Virtual Crop Consultant Conference will be held over two afternoons on Sept. 17 and 18.

The Crop Consultant Conference has become a premier event held in the San Joaquin Valley each September for Pest Control Advisors and Certified Crop Advisors. This year, JCS Marketing, the publisher of PCC Magazine is working with co-host Western Region Certified Crop Adviser and its sponsors to continue the traditional event while acknowledging restrictions on large public gatherings.

"I think the whole industry is learning to be nimble given changes to how we do business during this Coronavirus era and Progressive Crop Consultant is no different," said JCS Marketing Publisher and CEO Jason Scott.

"Obviously agriculture is a relationship-driven business and there is no substitute for live events," Scott continued. "But given our current circumstances, our team is working with our co-host, Western Region Certified Crop Adviser, to make this a dynamic, interactive experience where PCAs and crop consultants can hear the latest about products, strategies and technologies, earn CEUs, and connect with experts, suppliers and each other."

Topics for the interactive seminars include: Managing pests in grapes, citrus and tree nut crops; a special seminar on hemp production; new tools and technology for applying pesticides; application safety; and fumigation options. In addition, hard to get CCA hours will be hosted by Western Region CCA on topics related to reading and understanding nutrient analysis lab reports; biologicals and biostimulants; and features and benefits of potassium sources.

In addition, Western CCA will present the CCA of the Year Award and announce its scholarship winners.

Registration fees for the two-day event have been reduced to $65 and include a T-shirt mailed to the participant's address along with other prizes and surprises. Pre-registration is required and can be done at progressivecrop.com/conference.

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Research Examines Biochar Potential

Soil Amendment Could Provide Outlet for Almond Waste Byproducts

By **CECILIA PARSONS** | *Associate Editor*

A UC Davis field crew applies biochar to the soil through subsurface banding. Biochar is placed in concentrated trenches above the drip tape, which are then closed to prevent the biochar from becoming airborne (photo courtesy D. Gelardi, UCCE.)

GOOGLE THE WORD BIOCHAR AND THE FIRST WORDS you see are "environmental solution" and "benefits are amazing."

There is no shortage of hype surrounding biochar as a soil amendment, but most articles about this pyrolysis product still use the word 'potential' in the description. Given the numerous variables in both biochar production and agronomic systems, research continues to determine the value of this product to field and orchard fertility and to the environment.

Gabriele Ludwig, Almond Board of California's director for sustainability and environmental affairs, said the almond board has funded biochar research to learn its potential as an outlet for almond shells and wood waste.

Biochar is known to improve soil by providing space for microorganisms in the soil, improving aggregation, Ludwig said. The caveat in biochar use, she noted, is the need to look at the feedstock used to produce it as well as the temperature and humidity in production as different chemical and physical properties can result.

Biochar has become a general term for charcoal produced for use in soils. Biochar is the result of burning plant matter in an oxygen-limited oven. The process, called pyrolysis results in a product that is high in carbon and is resistant to decomposition. Biochar use in agriculture has been proposed as an effective way to increase carbon stocks and improve soil health. Researchers who are studying biochar as a soil amendment report that differences in the feedstock used to produce biochar, production methods, soil properties, climate and cropping systems have yielded inconsistent reports on the impacts of biochar on soil.

Feedstocks for biochar can include soft woods from commercial almond production pruning and tree removal, almond and walnut shells, along with manure, turkey litter and other wood waste.

Interest in biochar as a soil amendment piqued in 2006 when soil scientists investigating Brazilian rainforest soils noted the health and growth of trees growing in 'black earth'.

Sanjai Parikh, soil chemistry professor at UC Davis, has been focusing on understanding biochars, includ-

'RESULTS FROM STUDIES VARY ON ABILITY OF BIOCHAR TO INCREASE CROP YIELDS WHILE ADDRESSING ISSUES SUCH AS NITRATE LEACHING, NUTRIENT USE EFFICIENCY AND SOIL ORGANIC MATTER LEVELS.'

UC Davis researcher Dani Gelardi poses at the UC Kearney Agricultural Research and Extension Center where her tomatoes are grown in soil amended with seven different biochars at two different rates, combined with two different nitrogen fertilizer rates (photo courtesy Sanjai Parikh, UC Davis.)

ing the impact of feedstock and conditions of production on the utilities of different biochars. The research indicates some biochars, when added to the soil, provide better habitats, thus encouraging more microbial activity in the soils that leads to improved soil aggregation. He has also found tremendous variability in the characteristics of biochars, and has been heading up or participating in efforts to set up standards for criteria so growers can more easily assess which biochar will be useful for a particular purpose.

Air quality concerns over the production process with biochar remain. This complexity along with expected costs to growers has slowed adoption of biochar as a soil amendment.

California Department of Food and Agriculture Science Advisor Amrith Gunasekara said, in general, there is a lot of scientific literature on biochar as a promising soil amendment that sequesters carbon long term. Legislation was passed to standardize biochar and require at least 60% carbon as part of the statutes related to CDFA's Fertilizer Materials and Inspection Program that regulates claims. If there are gaps in the data, Fertilizer Research and Education Program (FREP) tries to gather some of the data through funded research.

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Gunasekara said that there are scientific data gaps that exist to add biochar as a practice in the Healthy Soils Program. One of the missing parameters, he said, is the lack of application rates for biochar for California's different crops. Another is understanding if there are agronomic or environmental impacts from biochar in different crops.

Results from studies vary on ability of biochar to increase crop yields while addressing issues such as nitrate leaching, nutrient use efficiency and soil organic matter levels.

Two current studies funded by FREP are examining biochar's impact in California agronomic systems. According to the project leaders, there is a need for reliable and localized research data to inform growers, stakeholders and policy makers of the benefits and trade-offs of biochar use on agricultural lands. UC Davis researcher Danielle Gelardi said the work is focused on providing long-term research data about the potential for biochar to boost crop yields and improve nutrient use efficiency as well as minimize nitrogen losses due to leaching. The researchers tested basic physical and chemical properties of seven types of biochar produced from different feedstocks and temperatures.

Research is focused on potential benefits to yield and nutrient use efficiency with biochar (photo courtesy D. Gelardi.)

One project, led by Dr. Suduan Gao of USDA-ARS, has been focused on biochar characterization and the impact that biochar can potentially have on greenhouse gas emissions, nitrogen leaching, water availability and nitrogen availability. Gao's team is also looking at interactions between biochar and compost when incorporated into the field together. The trials are using both laboratory and field studies. Gao conducted field trials in onion and tomatoes, and all of her trials were located in the south of Fresno. In this trial, biochar was broadcast and then incorporated into the soil. Field trials are complete and laboratory analysis is ongoing. The project is expected to be completed by the end of 2020

Another project took a more applied approach and focused on biochar interactions in the field and different ways to optimize the use of biochar amendments while monitoring potential impacts on the crop. Gelardi said the trials, in Davis and at the UC Kearney Research Center in Parlier, in production tomato fields have used biochar from almond shells pyrolyzed at 500 degrees C, at 800 degrees C and raw. They are also testing softwood biochar.

In the trial, the different biochar products were applied to the soil in a trench just above the drip line and then covered to place it as close to the plant roots as possible. In most other studies, Gelardi noted, the biochar is broadcast in the field. The project is also looking at differences in impacts of biochar on crops in different soil types. During the first two years of this three-year study, Gelardi said there were no significant differences in yields in tomatoes.

The UC Davis Biochar database shows growing interest in biochar use. Field and laboratory studies have included production analysis, soil properties, soil nutrients, plant response, soil biology and nutrient loss.

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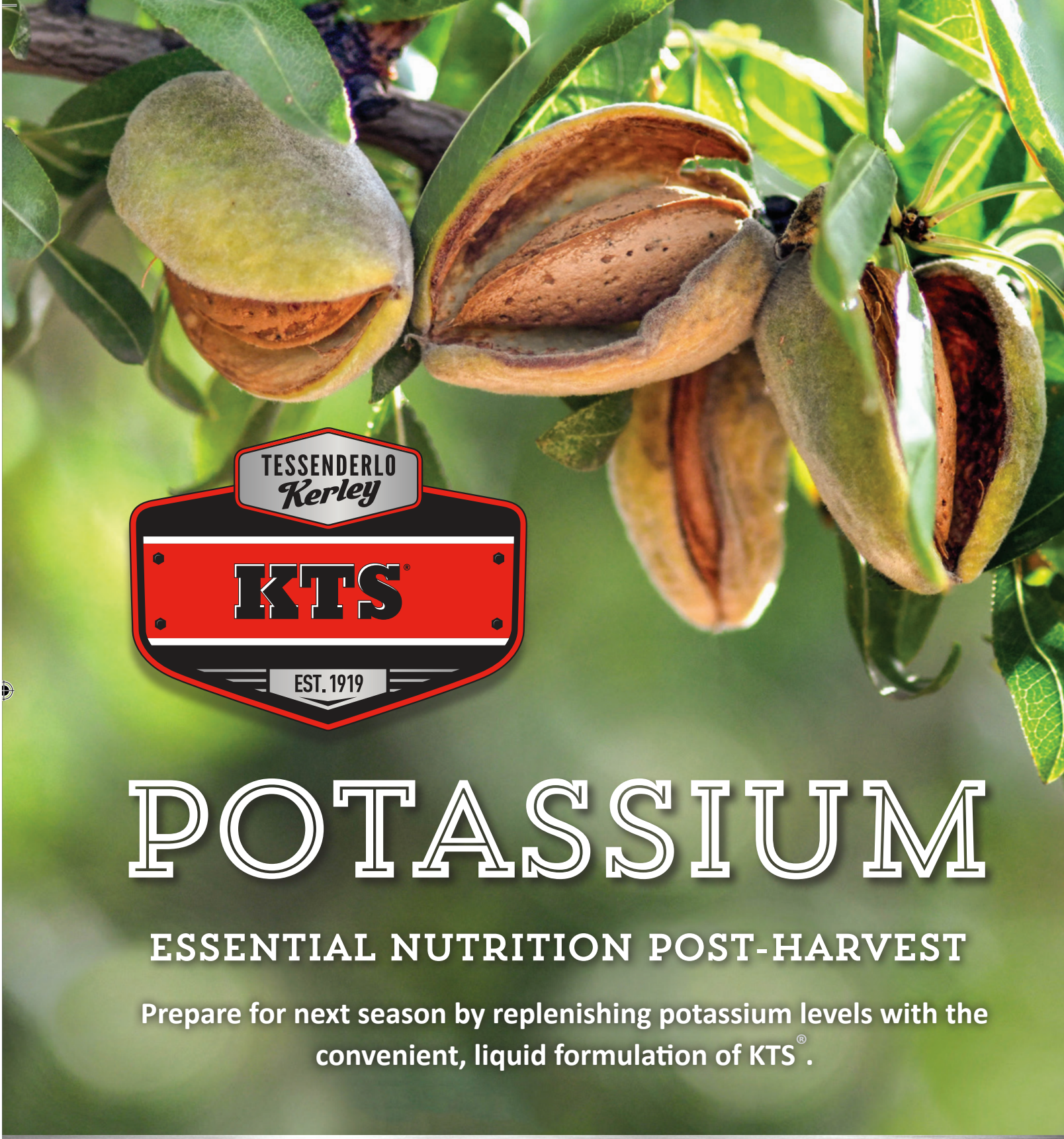

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Bt and viruses must be ingested by the target insects to be effective while other products work on contact. It is important to understand pest biology and mode of action when using biopesticides (photo courtesy UC IPM.)

BIOLOGICAL PESTICIDES IN NUT CROPS

A LOOK AT USE STRATEGIES AND THE RISK OF RESISTANCE DEVELOPMENT

By **SURENDRA K. DARA** | *UCCE Entomology and Biologicals Advisor, San Luis Obispo and Santa Barbara Counties*

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SOME OF THE BIOLOGICAL PRODUCTS USED IN CONVENTIONALLY or organically produced nut crops include those based on bacteria (abamectin, *Bacillus amyloliquefaciens*, *Bacillus mycoides*, *Bacillus thuringiensis* (*Bt*), *Burkholderia rinojensis*, *Chromobacterium subtsugae* and spinosad), fungi (*Isaria fumosorosea*, *Paecilomyces lilacinus*), virus (Cydia pomonella granulovirus) and botanicals (azadirachtin, neem oil, pyrethrins, and some essential oils.) Except for *B. amyloliquefaciens* and *B. mycoides* for disease control and *P. lilacinus* for nematode control, the rest of the products are used for controlling insect and mite pests. While bacteria and the virus are primarily used against lepidopterous pests, others are used for insect and/or mite pests. Research shows that entomopathogenic nematodes such as *Steinernema carpocapsae* and *Steinernema felitiae* can also be effectively used against the navel orangeworm (*Amyelois transitella*). There are other biological products that can be used against one or more pests of nut crops depending on the cost of the treatment.

Modes of Action

When using biological pesticides, understanding their mode of action or infection is very important. For example, *Bt* needs to be ingested by the target insect and hence is ideal for lepidopteran larvae which has chewing mouthparts. Viruses also need to be ingested by the insect and are generally specific to a particular species of insect or a closely related species. Both bacteria and viruses act in the intestines of the target insects.

Entomopathogenic fungi such as *Isaria fumosorosea* cause infection through contact and can be used against a wide variety of pests. Infective juveniles of entomopathogenic nematodes seek out their hosts, enter the host body through natural orifices, and the symbiotic bacteria in the nematodes kill the host insect. Depending on the active ingredient, botanical pesticides have different modes of action. Azadirachtin, for example, is an insect repellent, antifeedant, growth regulator and insecticide. While pyrethrins are nerve poisons, oil-based pesticides and their toxic compounds can suffocate, repel or kill target arthropods through one or more modes.

Abamectin, spinosad and products containing the metabolites of *B. rinojensis* and *C. subtsugae* derive their activity from their toxic molecules. Both abamectin and spinosad are nerve poisons, but the other two bacterial metabolites have complex modes of action resulting in arthropod mortality or repellence. It is important to understand the biology of the target pest, its vulnerable stages, the suitability of various biopesticides to the target life stages of the pest, and then using them according to the label guidelines will ensure the success of biopesticides. Some of the biopesticides contain live organisms, so proper storage, transportation and mixing with compatible materials during application are critical for their efficacy.

Whether it is a synthetic or biological pesticide, there are certain basic principles for their effective use. Applying according to the label guidelines, avoiding excessive and repetitive use of any particular pesticide or those with the same mode of action, and alternating or rotating pesticides among multiple modes of action are essential for maintaining pest control effica-

cy and reducing the risk of resistance development. IPM principles are to be followed in both conventional and organic production systems where pesticides are encouraged to be used only as needed after exploring all non-pesticidal options.

Botanical Pesticides and Resistance

Repeated use of any pesticide can create selection pressure on arthropod populations, and those with beneficial mutations will resist both synthetic and biological pesticides. Arthropods develop resistance to pesticides through genetic, metabolic, or behavioral changes resulting in reduced penetration of toxin, increased sequestration or excretion, reduced binding to the target site, altered target site that prevents binding of the toxin, or reduced exposure to the toxin through modified behavior. Depending on the mode of action, both synthetic and biological pesticides can lead to resistance problems from excessive use.

Botanical insecticide pyrethrum, extracted from the flowers of *Chrysanthemum cinerariaefolium* and *C. cineum*, contains insecticidal esters known as the pyrethrins. Pyrethrins are nerve poisons disrupting the sodium channels in neurotransmission and are commonly used for controlling pests in agricultural, structural, and public and animal health sectors. Arthropod resistance to pyrethrins and their synthetic analogs, pyrethroids, is very common and has been reported for several decades. Insect mutations that reduce the penetration of the toxin through the cuticle, reduce its binding to the target site, or alter the properties of the sodium channels, and other mechanisms impart pyrethrin resistance. The navel orangeworm is one of the examples that developed pyrethrin resistance.

Another botanical insecticidal compound, azadirachtin, is a tetranortriterpenoid limonoid from neem (*Azadirachta indica*) seeds, which acts as an insecticide, antifeedant, repellent and insect growth regulator. While neem oil, which has a lower concentration of azadirachtin, has been used in the US as a fungicide, acaricide and insecticide for a long time, several azadirachtin formulations in powder and liquid forms have become popular in recent years.

Although there was a report of artificially induced resistance to azadirachtin in the green peach aphid, several studies demonstrated the efficacy of azadirachtin against various pests and recommended it as an option in IPM and for managing resistance to other pesticides. Azadirachtin is also thought to reduce the production of detoxification enzymes and known to improve the efficacy of other biopesticides. While arthropod resistance to botanical pesticides other than pyrethrins is not commonly reported, it is known that plant allelochemicals (e.g. alkaloids, phenolics, terpenoids, etc.) can contribute to cross-resistance to certain chemical pesticides. It is important to monitor the potential risk of resistance development and cross-resistance when botanical pesticides are used.

Bacterial Biopesticides and Resistance

Abamectin is derived from the bacterium *Streptomyces avermitilis* and contains insecticidal and nematocidal avermectins (avermectin B1a and B1b) which

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are nerve poisons. Abamectin interferes with neuromuscular transmission and paralyzes the target pest. Resistant mite and insect populations have higher levels of detoxifying enzymes that sequester abamectin. Abamectin-resistant arthropods can develop cross-resistance to emamectin benzoate, spinosad and fipronil. The twospotted spider mite, diamondback moth, Colorado potato beetle and vegetable leafminer are some examples of resistant arthropods to abamectin.

Bt, which contains crystalline toxic protein that is activated upon ingestion by an insect host, is a gram-positive soil bacterium that binds to the receptor sites in the midgut, and eventually causes insect death. *Bt* pesticides are used against a variety of lepidopteran (*Bt* subsp. *aizawai* and *Bt* subsp. *kurstaki*), dipteran (*Bt* subsp. *israelensis* and *Bt* subsp. *sphaericus*) and coleopteran (*Bt* subsp. *tenebrionis*) pests. Since the mode of action involves toxins rather than the bacterial infection itself, resistance to *Bt* pesticides or transgenic crops that contain *Bt* toxins is also very common. Some examples of resistant insects to *Bt* include the beet armyworm, cabbage looper, corn earworm, Colorado potato beetle and diamondback moth. Mutations in insects that regulate the immune system or interfere with the activation of *Bt* toxins and their binding to the target site led to insect resistance.

Spinosad is a mixture of macrocyclic lactones, spinosyns A and spinosyns D, derived from *Saccharopolyspora spinosa*, an actinomycete gram-positive bacterium, and is used against dipteran, hymenopteran, lepidopteran, thysanopteran and other pests. Although naturally derived, some spinosad products are not registered as biopesticides.

Insect resistance to spinosad later led to the development of spinetoram, which is a mixture of chemically modified spinosyns J and L. Both spinosad and spinetoram are contact and stomach poisons and act on insect nervous system by continuous activation of nicotinic acetylcholine receptors. The American serpentine leafminer, beet armyworm, diamondback moth, tomato borer, onion thrips and western flower thrips are some insects with spinosad resistance. Production of detoxifying enzymes (metabolic resistance) and changes in the target site are the most common mechanisms of spinosad resistance in insects. Cross-resistance between spinosad and some chemical insecticides has also occurred in some insects.

Viral Biopesticides and Resistance

Baculovirus infections in Lepidoptera have been known for centuries, especially in silkworms. Currently, there are several commercial formulations of nucleopolyhedroviruses (NPV) and granuloviruses (GV). When virus particles are ingested by the insect host, usually a lepidopteran insect, they invade the nuclei of midgut, fatbody, or other tissue cells and kill the host. Baculoviruses are generally very specific to their host insect species and can be very effective in bringing down the pest populations. However, variations in the susceptibility of certain insect populations and development of resistance to viruses has occurred in several host species. Mutations in one or more genes with complex mechanisms are involved in insect resistance to viruses.

Fungal Biopesticides and Resistance

There are several fungi that infect insects and mites. The fungal infection starts when fungal spores come in contact with an arthropod host. First, they germinate and gain entry into the body by breaching through the cuticle. Fungus later multiplies, invades the host tissues, kills the host and emerges from the cadaver to produce more spores.

Entomophthoralean fungi such as *Entomophthora* spp., *Pandora* spp. and *Neozygites* spp. can be very effective in pest management through natural epizootics, but cannot be cultured in vitro for commercial-scale production. Hypocrealean fungi such as *Beauveria bassiana*, *Isarea fumosorosea*, *Metarhizium brunneum* and *Verticillium lecanii*, on the other hand, can be mass-produced in vitro and are commercially available. These fungi are comparable to broad-spectrum insecticides and are pathogenic to a variety of soil, foliar and fruit pests of several major orders. Since botanical, bacterial and viral biopesticides have insecticidal metabolites, proteins, or viral particles that have specific target sites and modes of action, insects have a higher chance of developing resistance through one or more mechanisms.

Although fungi also have insecticidal proteins such as beauvericin in *B. bassiana* and *I. fumosorosea* and dextruxin in *M. anisopliae* and *M. brunneum*, their mode of action is more through fungal infection and multiplication, and arthropods are less prone to developing resistance to entomopathogenic fungi. However, insects can develop resistance to entomopathogenic fungi through increased melanism, phenoloxidase activity, protease inhibitor production, and antimicrobial and antifungal peptide production. It also appears that the production of detoxification enzymes in insects against fungal infections can also impart resistance to chemical pesticides.

Good agricultural practices based on IPM principles help maintain pest control efficacy and reduce the risk of resistance development. Biopesticides are a critical part of IPM and are especially important in organic farming. A good understanding of biopesticides can help with their long-term use by avoiding resistance issues.

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Organic Pistachio Production at Nichols Farms

Site Selection Helps Overcome Pest and Nutrition Challenges

By **CECILIA PARSONS** | *Associate Editor*

Trap crops growing in Nichols organic pistachio block. These are meant to lure insect pests away from vulnerable pistachio nuts (all photos courtesy Caleb Adams, Nichols Farms.)

PEST CONTROL AND NUTRITION ARE TWO OF THE biggest challenges to organic pistachio production, but the Nichols family of Hanford, Calif., has found a way to thrive in the organic market. By selecting a location where their organically farmed pistachio trees would have minimal disease pressure and an optimal environment for production, Nichols Farms aimed to put themselves in a position to produce quality pistachios in an organic system.

The Nichols family began planting tree nuts in the 1980s, transitioning from row crops. Their orchards are in Tulare, Kings and Fresno counties. James Nichols, the third generation of the family to farm tree nuts, said the decision to diversify their tree nut production and branch into organic production was a way to further diversify their crop production. A side benefit has been to develop another line of retail pistachio from their processing and marketing operation. The nut processing facility was built on-farm in 1991 and includes a 6-acre solar farm that generates 50% of the power needed to operate the facility.

The Nichols Farms branded almond and pistachio products processed there are sold in major retail outlets nationwide. Nichols Farms packaging emphasizes the family's sustainable farming practices including drip irrigation, solar power to run the processing facility, recycling crop by-products and use of compost. The conventionally and organically grown pistachios are sold shelled and inshell. Marketing director Caleb Adams said Nichols Farms will soon be direct marketing almond and pistachio products online.

To produce a quality product and meet market demand for organically grown pistachios, Nichols pays close attention to farming practices in the organic blocks. Choosing a site on the arid west side of the San Joaquin Valley was the first step. Nichols said the organically grown blocks of pistachio trees are adjacent to other organically produced crops

including asparagus, sweet peas, and carrots and grains. Having organic producers as neighbors increases beneficial insect populations, and reduces the likelihood of drift from conventionally produced crops.

Nichols said the first block of pistachio trees were planted in that location and farmed conventionally until their 7th year when they began the transition to organic in 2009. A second block was transitioned in 2013. All the trees are Kerman variety on PG I rootstock.

When transitioning the trees, Nichols said their fertilizer program underwent the most change. In order to provide adequate nutrition for the trees to maintain health and achieve good yields, Nichols said they worked with a local farmer, providing land for compost production and supplying all by-products from their processing plant plus orchard litter to make compost. Poultry and dairy manures are added to the compost mix. The compost applications in the orchards have worked well for the trees for the past 11 years, Nichols said. They have to get that part right, he added, because nutrition is a key factor in having a high split percentage.

The organic certifier, California Certified Organic Farmers, requires a leaf and soil analysis annually to justify fertilizer applications. Nichols said the trees do have a much lower nitrogen percentage in the leaves compared to the conventionally grown trees, but levels are sufficient for crop yield.

Irrigation in the orchards is also managed differently, as they made a decision to move the single line drip hose from the tree rows to the middles. This move accomplishes several objectives: It

Continued on Page 54

James and Mary Alice Nichols of Hanford are the third generation farming Nichols Farms and began transitioning some acreage to organic pistachios in 2009.

Nichols Farms' winter sanitation program is the cornerstone of their insect pest control program in a block of organic pistachios growing on the West Side of the San Joaquin Valley.

Continued from Page 53

irrigates a trap crop of vegetation; moves nutrients from compost applications to the tree roots; and the dry tree rows have less weed pressure.

Root systems of the mature trees have spread to the middles, Nichols said. He uses sensors and pressure bombs to measure water stress on the trees with the new system and found he was using the same amount of water to irrigate in the middles without stressing the trees.

The trap crops are part of a research project initiated by UC Riverside research entomologist Houston Wilson. Trap crops work by drawing pests away from the target crop. The theory is that by providing an attractive habitat, the insect pests would

cause less damage in the tree crops. In 2019, the first year of the project, Wilson determined that beneficial and predatory insects were found in greater numbers in the trap crop and parasitoid populations increased in the tree canopies where trap crops were planted.

Nichols said they have tried different mixes of plants for their trap crops, including alfalfa and radish, clovers, sunflowers, wheat and oats. The trap crops are mowed just prior to harvest, so insect pests won't move into the trees when they lose the habitat. Nichols said they planned to continue with the trap crops to lessen crop damage from small and large bug feeding.

Insect pest management has been a challenge, but Nichols noted the terrible production year 2015 may be one reason the NOW has not re-gained a foothold in the area, as numbers did not rebuild after that year. Nichols Farms has a rigorous orchard sanitation program which is the foundation of its NOW control. Nichols said mummies are shaken after harvest and the floors of the orchards are cleaned. He added that the heavier soils in the orchard retain much more water, which helps by breaking down any remaining food sources on the orchard floor for overwintering NOW.

Stink bugs and leaffooted bugs are their main insect pests. Stink bugs feeding on the developing nuts can impact split percentages, cause shell staining, and defects which lowers value.

They do have extra labor costs for controlling vertebrate pests that girdle tree roots and weaken trees. Trapping gophers and squirrels is done year round to keep populations under control.

Early harvests are normally recommended to prevent insect damage to the crop, but Nichols said they tend to harvest their organic blocks a little later than their conventional blocks. Their first shake in the organic orchards is usually the third week in September to first of October. By that time, he said, their conventional production takes a break and they have a spot open in the processing facility for the organic product.

They have to follow CCOF requirements in the processing and hauling, sanitizing with approved products and documenting the process. At the processor, the organically grown pistachios have an extra step. After hulling and drying, the nuts are held in cold storage.

Product quality is an important part of their organic production, Nichols said. While their yields may be lower, they aim for a high quality product. The payable yields have been lower for organic pistachios, Nichols said, but the dry weight yields are roughly the same as conventionally produced pistachios. This is the reason for the focus on stink-bug control, fertilization and irrigation management. With those three dialed in, the payable yields will be higher with a higher return per pound produced organically, he added.

Presently, organic pistachio production is a very small part of the pistachio industry. Higher production costs, with nutrients being a significantly higher input, means growers must emphasize quality, Adams said. There is consumer demand for an organic option in pistachios, and along with the health benefits promoted by American Pistachio Growers, he expects the market will grow.

"We are focused on producing a consistent, quality product and we want to be 100% comfortable with the products we are selling," Adams said.

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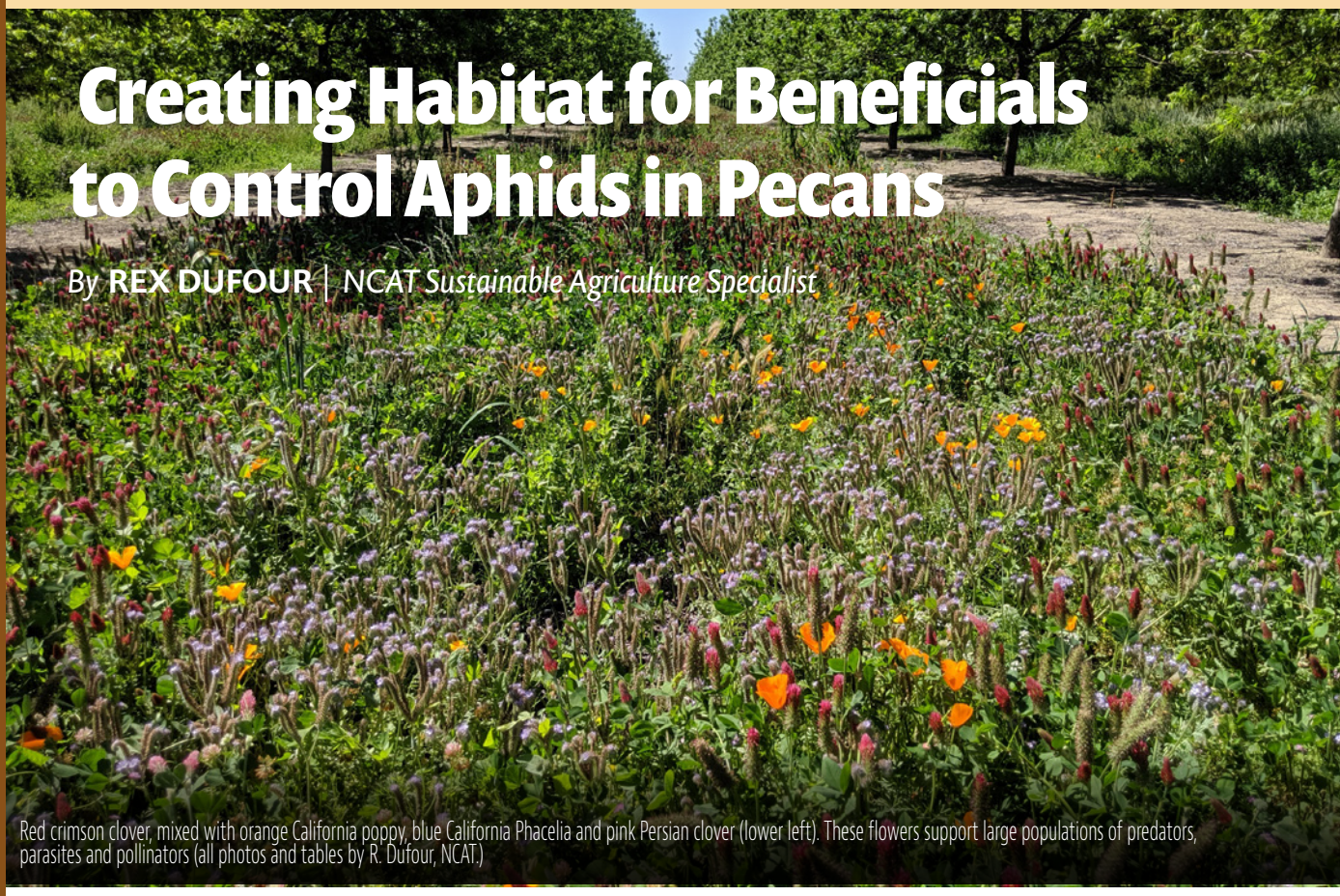
Creating Habitat for Beneficials to Control Aphids in Pecans

By **REX DUFOUR** | *NCAT Sustainable Agriculture Specialist*



Red crimson clover, mixed with orange California poppy, blue California Phacelia and pink Persian clover (lower left). These flowers support large populations of predators, parasites and pollinators (all photos and tables by R. Dufour, NCAT.)

THIS ARTICLE DISCUSSES PLANT-ing and managing a cover crop mix in pecan orchards to attract beneficials, which provide some control of two species of pecan aphids. Controlling aphids in pecans with chemicals generally requires two to three spray applications over the season. To date, the grower has saved 1-2 sprays, and learned that alternate row mowing of the cover crop can extend the flowering and, therefore, the availability of nectar and pollen for supporting a wide variety of beneficial insects which suppress aphid populations.

California Wildlife Conservation Board has funded a collaboration between the Environmental Defense Fund (EDF) and the National Center for Appropriate Technology (NCAT) to work with two pecan orchards: one at PacGold in Colusa, Calif., owned by Ben King, and one at Bypass Farms, managed by Ammy Reyes, on the north side of the Sacramento River, just east of I-5. The goal of this work is to develop habitat in or adjacent to the orchard that can support beneficial insects, including monarch populations.

Natural Aphid Predators

Major pecan pests in California orchards include a couple different species of aphids: the yellow pecan aphid and the black margined pecan aphid. The yellow pecan aphid is the more benign pest of the two aphid species and generally appears first in the late spring and early summer. Unless honeydew generated by the aphids becomes a problem, the economic threshold for the yellow pecan aphid is an average of 20 aphids per compound leaf during this time of year.

Treatment guidelines:

Before June 1: Apply an insecticide if honeydew is accumulating.

June 1 to August 15: Apply an insecticide if the total number of aphids exceeds an average of 20 per compound leaf.

August 15 to leaf fall: Apply an insecticide if the total number of aphids exceeds an average of 10 per compound leaf.

To date, the cover crops have saved the grower at least one spray, perhaps two (**See Table 1 on page 58** for cover crop species mix and comments.) The hope is to go the whole season without spraying. However, the NCAT team does weekly monitoring of aphids in the pecan canopy. This information provides the grower with some good information for making spray/no-spray decisions.

Sampling for Aphid and Beneficials

We select 3 compound leaf samples from each of the 20 trees located around the 200-acre orchard, and count the aphids, as well as green lacewing eggs and other predators such as all life stages of lady bird beetle, assassin bugs, syrphid flies and spiders. The aphid counts are listed in **Figure 1 (see page 57)** by date, and have not yet come close to approaching the economic threshold of 20/compound leaf. But

Cover crops in pecan orchards attract a number of beneficial aphid predators including (from left) lady bird beetles, flower fly, Assassin bug nymphs (and adults,) and dozens of species of small, parasitic wasps (photos by R. Dufour, NCAT.)

conditions can change quickly in hot weather, so it's important that the grower have weekly updates of aphid counts. The aphid populations are being managed by the changing array of predators, including very tiny spiders. These tiny spiders feed on the first and second instars of the aphids, just as the just-hatched lady bird beetle larvae do. Small predators, small prey. Having a diverse array of predators and parasites, with different prey and host preferences, provides dynamic and flexible aphid suppression.

We also have done sweep sampling of the cover crop every two weeks at 10 different locations in the orchard, mostly looking for predators and parasites—adults and larvae of green lacewings, syrphid flies, lady bird beetles, tiny parasitic wasps, six-spotted thrips and other various predators.

We've hung sticky traps in 10 trees around the orchard, and collected them and counted beneficials on them every two weeks to better understand what critters are migrating from the cover crop into the pecan canopy. We've found many green and brown lacewing adults, other predators and many species of small, parasitic wasps.

Beneficial Habitat

Alleys in orchards are underutilized as habitat for beneficial insects. What we found was not surprising. Planting cover crops in the alleys can provide nectar and pollen resources for a wide range of beneficials, some of which migrate into the pecan canopy in search of prey. It's good to remember that cover crops, which require management inputs, are an *investment* in the biological system of checks and balances which supports populations of parasites and predators of aphids and other insects. Investments such as seed costs, planting costs and other management considerations like mowing costs can have significant returns.

There is, however, a learning curve related to how best to manage the cover crop. Knowledge about when to plant the cover, what species to include and when to mow will be informed by experience. If you're interested in planting cover crops, there are many resources available to farmers about planting cover crops, including NRCS, RCDs, NCAT, other non-profits and seed suppliers. For example, we found mowing alternate rows is less disruptive to beneficial insects. Cover crops are also an investment in the soil, supporting a healthier soil, which will store and cycle nutrients more

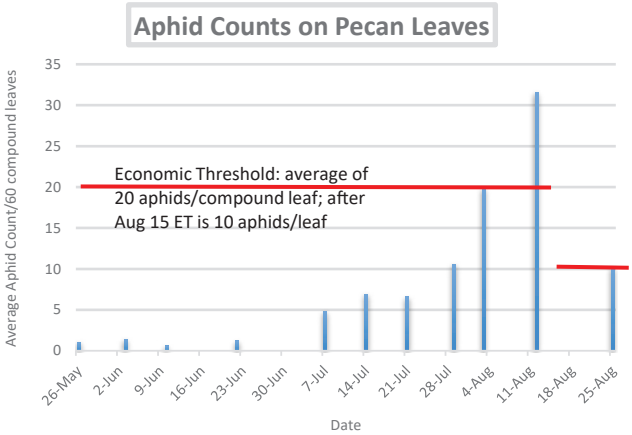


Figure 1. Average aphid counts at various sampling dates.

efficiently, and absorb and store more water.

Due to their long growing season and late harvest, pecans are ideal locations to plant cover crops. They're generally harvested in October, and if the trees are irrigated with microsprinklers, cover crops can be grown in the alley for several months to attract and maintain populations of beneficials. Alternate mowing of alleys, spaced about every two weeks, can allow cover crops to go to seed, and at the same time help to extend the time flowers can provide nectar and pollen resources for the beneficials.

Continued on Page 58

NAME	COMMENTS
Persian Clover	Seed mix drilled @ 15lbs/acre on 197 acres. Persian clover (an annual) dominated late spring, and came on after crimson clover.
Crimson Clover	Seed mix drilled @ 15lbs/acre on 197 acres. Crimson clover (an annual) dominated early spring, and went to seed earlier that Persian clover.
Red Clover	Seed mix drilled @ 15lbs/acre on 197 acres. Red clover (a perennial clover) flowered after first mowing in early/mid-June.
Cayuse Oats	Seed mix drilled @ 15lbs/acre on 197 acres. Oats only appeared occasionally.
Narrow leaf milkweed	Seed mix broadcast @ 12lbs/acre on 119 acres. Neither milkweed species were observed at PacGold, but did grow at Bypass farms.
Showy milkweed	Seed mix broadcast @ 12lbs/acre on 119 acres. Some did grow at Bypass farms.
Common yarrow	Seed mix broadcast @ 12lbs/acre on 119 acres. Yarrow was rarely observed.
Lacy phacelia	Seed mix broadcast @ 12lbs/acre on 119 acres
California phacelia	Seed mix broadcast @ 12lbs/acre on 119 acres. California phacelia bloomed early spring in some patches, but was not widespread.
California poppy	Seed mix broadcast @ 12lbs/acre on 119 acres. California poppy was seen at the edges of dense legume cover crop, and in some of the sparser cover crop mid-spring.
Creeping Wild Rye	Seed mix broadcast @ 12lbs/acre on 119 acres. Did not observe this growing at PacGold.
Sweet alyssum	Seed mix broadcast @ 12lbs/acre on 119 acres. Sweet alyssum was able to grow at the border of the alley and tree row, where herbicides controlled weeds.

Table 1: NCAT and EDF sat down with the grower and developed a cover crop mix of 7 species. We experimented with both drilling the larger seeds and broadcasting the smaller seeds to see the results, and understand that growers would normally do one or the other, not both.

Continued from Page 57

Resources:

Overview of Cover Crops and Green Manures
https://attra.ncat.org/product/overview-of-cover-crops-and-green-manures/

Cover Crop 340 for Organic Systems.
https://attra.ncat.org/product/cover-crop-340-in-organic-systems/

Cover Crop Options for Hot and Humid Areas
https://attra.ncat.org/product/cover-crop-options-for-hot-and-humid-areas/

For more information about this project, contact Rex Dufour, rexd@ncat.org, or 530-792-7338. For information about a wide range of sustainable and organic practices, visit NCAT's ATTRA website at www.attra.ncat.org.

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FARM ADVISOR PROFILE

ELIZABETH FICHTNER

UCCE FARM ADVISOR, TULARE COUNTY

By **CRYSTAL NAY** | *Contributing Writer*

Fichtner takes tree height data in a pistachio pruning trial in Kings Co., Calif. (photo by Bruce Lampinen.)

AN AVID MEMBER OF 4H CLUB WHEN she was a kid, UCCE farm advisor Elizabeth Fichtner was exposed early to the elements of agriculture and extension. She also had the unique experience of observing how urbanization can affect agricultural lands. Originally from Long Island, N.Y., Fichtner watched an area that was rural in her father's generation— and still relatively rural early in her own— transform into the densely populated area that it is today.

Seeing that transition sparked an interest that led her to Cornell University, where she earned her undergraduate degree in horticulture. After working summers at University of Wisconsin, Madison, Fichtner developed an interest in soilborne plant pathogens and decided to continue her education at NCSU, Raleigh. She completed her M.S. and Ph.D. at NCSU with dual majors in plant pathology and soil science.

Research and Career Opportunities

While in North Carolina, Fichtner had the opportunity to conduct interdisciplinary research that focused on investigating soil properties that are suppressive to plant disease. At the time, North Carolina was dedicated to finding alternate crops to replace tobacco acreage, while grappling with the waste from hog farming. Fichtner's research, in part, focused on manipulating swine waste to suppress soilborne pathogens.

After completing her Ph.D., Fichtner made the cross-country move to California as a post-doctoral researcher in forest pathology at UC Davis. It was there that her experience working with phytophthora, a common pathogen of tobacco, was easily applied to researching sudden oak death, a disease that had emerged in both California and Europe within the last 20 years.

During her post-doctoral work, Fichtner collaborated with several farm advisors within UC ANR and developed an interest in an extension career. When a farm advisor position opened up in Tulare County, she was eager to apply.

"It was just really intriguing to me, because I had been working in forestry, and [the new position] was in trees," said Fichtner of how she ultimately landed in California's vast growing region. "It just kind of felt like a natural fit."

It's been 11 years since that decision shaped Fichtner's career as a farm advisor. While there have been some big changes during the nearly two decades in total that she's been with UCCE, Fichtner notes one in particular.

"Because I worked in tree nuts, I've seen tremendous growth," said Fichtner. "Absolutely tremendous growth."

The nut crop acreage in Tulare County is almost three times higher than it was in 2009, with increases in pistachio and almond acreage accounting for the most dramatic increase in the county's nut crops.

In addition to tree nuts, Fichtner also works with olives. When she first began with extension, her workload consisted of more olives than pistachios. These days, there is a huge decline in table olives, with a vast majority of that acreage going into citrus and pistachios. Crop value and rising labor costs for hand-harvesting of olives are the most likely reasons for the decline of olive acreage, she said.

Fichtner's work in tree nuts and other crops have opened up access to a lot of different grower communities, boards, grant opportunities, grower incentives and more, but she also sees how streamlining and a movement toward more collaboration among the organizations could help to further support growers.

"So many growers are growing multiple kinds of nuts," said Fichtner. "So more cooperation at the administrative level among major nut crops, government and the research community would allow [cooperative extension] to serve the clientele more efficiently."

Fortunately, this is starting to happen. Part of being able to serve the agriculture community herself is through

Fichtner's own research. Even with the extensive knowledge available through UCCE, ongoing research continues to reveal surprising remedies to some of today's agricultural dilemmas.

Recently, Fichtner collaborated with Bruce Lampinen, UCCE almond specialist at UC Davis, and Mae Culumber, UCCE Farm Advisor in Fresno County, on studies assessing the value of minimal pruning techniques on pistachio and walnut. The ultimate goal of these projects is to improve both an orchard's early maturity and overall productivity while reducing management costs.

"It's interesting to evaluate the growth characteristics and dynamics of each crop," said Fichtner, who enjoys considering projects at both physiological and horticultural levels. "It was eye opening to consider how much of a potential crop is pruned off trees during the dormant season, only to be regrown the following year."

Advice to Growers

Because research is ongoing and best practices are always changing, Fichtner encourages growers to establish an orchard plan prior to planting, and to focus on data-driven material. Preplant planning, she said, can make huge differences later when it comes time for growers to manage the crop, such as with soil quality, environment, potential issues with soil pathogens like nematodes, and tree training and pruning.

"Gather information from multiple sources and take advantage of third-party, unbiased resources whenever available," said Fichtner.

The resources are plenty, including educational events like Statewide Pistachio Day and Tri-County Walnut Day, hosted by UC ANR, and trade magazines that include articles written by UCCE farm advisors, who provide neutral, unbiased data.

Over the past few years, Fichtner and a network of UCCE farm advisors have developed a series of multi-day short courses held each November. These courses provide attendees with detailed production practices for each nut crop and highlight scientific advances contributing to production. In addition to the information presented being incredibly valuable to growers, the short course also helps foster interaction between UC researchers and growers, thus developing a synergy of new ideas with the potential to catapult the industry forward.

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A Look at Newer Hazelnut Varieties

Some Considerations When Deciding Between Jefferson, Yamhill and PollyO

By **DANITA CAHILL** | *Contributing Writer*

One of Ryan Glaser's Jefferson orchard blocks in Tangent, Ore. (photo by Danita Cahill.)

Yamhill is one of several EFB resistant varieties to come out of the OSU breeding program in recent years (photo courtesy Rebecca McCluskey, OSU.)

THERE'S A LOT TO CONSIDER BEFORE CHOOSING THE HAZELNUT variety, or varieties, to plant in a new orchard. Besides yield expectations, there's also kernel versus inshell, harvest times, tree growth habits and a variety's susceptibility to disease—especially to eastern filbert blight (EFB).

EFB was first discovered in the 1970s in western Washington. It moved into the Willamette Valley in the 1980s and has proven to be one of the most devastating diseases to hazelnuts. Since then, Oregon State University (OSU) has worked diligently to breed resistant hazelnuts in cooperation with Rutgers University in New Jersey, the University of Nebraska at Lincoln and the National Arbor Day Foundation.

OSU's hazelnut breeding program formed in the late 1960s. Researchers and plant breeders there have collected hazelnut germplasm from around the world to develop new hazelnuts for the Pacific Northwest. So far, OSU plant breeder Shawn Mehlenbacher, along with Senior Research Assistants Rebecca McCluskey and David Smith, has come up with several EFB resistant varieties, including Jefferson, Yamhill and the very recent PollyO. All three varieties have the Gasaway gene, which imparts the blight resistance. The Gasaway variety is an obsolete pollinizer, but still extremely useful in the hazelnut breeding world.

Jefferson

Jefferson was released in 2009. It's a good producer and a tidy, upright grower. A later variety than most, Jefferson leafs out in April instead of the more typical March. Once established, Jefferson takes less pruning to maintain its shape than most other varieties.

Jeff Newton, a hazelnut grower in the McMinnville, Ore. area and farm manager for Crimson West/Christensen Farms, grows a lot of Jefferson trees.

"It grows more up than out," Newton said of Jefferson. "It's precocious; it produces early."

Jefferson trees are 30 to 40% smaller than Barcelona. They don't have a tendency to lean.

Newton's 11-year-old Jefferson trees are yielding well, although he has had some problems with mold at the processor.

Tangent, Ore. hazelnut grower Ryan Glaser likes the way Jefferson grows. He also likes the idea of a nut that is small enough to be sold inshell, yet large enough that it could also be marketed for kernel sales.

"In theory, Jefferson is a duel direction. The only inshell hazelnut OSU has come out with. It could go in two directions—inshell or kernel," Glaser said. "Duel market hasn't 100% worked out at the moment," he admits, "but I think it will be better in the future. It did a little better last year."

Glaser fertilizes his Jefferson trees just after leaves fall in late November and into December.

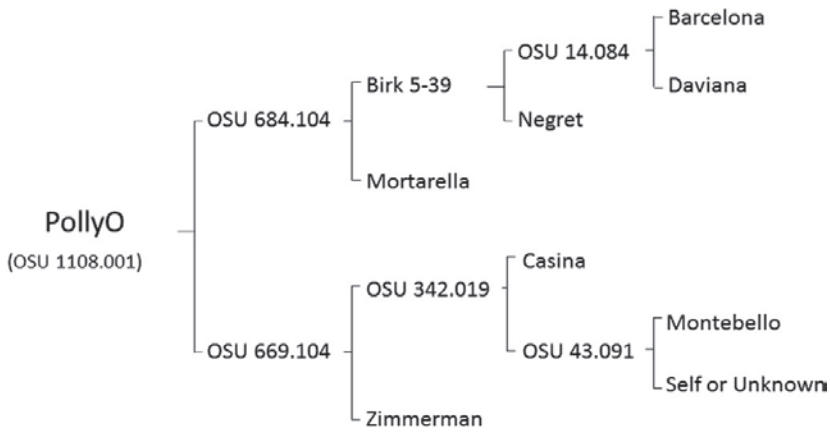
"The tree sucks nutrients out of the leaves, back into the wood, so we don't waste any nutrients," Glaser said about his fertilizer timing.

With the nutrient package that Glaser uses, it puts him at 43- to 44-percent crack-out weight. "That puts you in the mid-range kernel variety," he said.

Some nuts tend to hang longer in Jefferson trees. Harvest, Glaser said, is three to seven days later than Barcelonas. "I don't see that it's an issue," he said of the later drop.

When Jefferson nuts are mature, green husks are still persistent, according to research by Orchard Specialist Nik Wiman and others at OSU. Some of the nuts tend to hold on

Professor Shawn Mehlenbacher, with the Oregon State hazelnut breeding and genetics program, stands next to a 7th-leaf PollyO tree (photo courtesy Rebecca McCluskey, OSU.).



to the tree. Expect 95% of nut drop by Oct. 14 in the Pacific Northwest.

As far as mold, Glaser said that hasn't been an issue for him. "We pick often and early," he noted.

Mold issues could crop up with Jefferson if growers pick late, or if it's a rainy harvest and the nuts sit in mud before being swept up.

Glaser learned the hard way about EFB on resistant varieties. He got a bad batch of Jefferson trees with EFB on the trunk. "Jefferson are resistant, but they're still susceptible when they're young," Glaser said. Now he makes sure that his young trees have been treated with an EFB spray at the nursery.

Yamhill

Oregon State University released Yamhill in 2008. It's sometimes called the upside-down tree because of its short and wide growth pattern. Yamhill is a less vigorous growing tree with flatter branch angles than Barcelona. Even though it's a smaller tree than Barcelona, nut yield is greater.

Yamhill nuts are small and thin shelled with a fairly long period of nut drop. Nuts fall free of husks. Around the last 10% are stubborn, clingy nuts, according to Wiman. Expect 95% nut drop by September 26. Yamhill has a high tolerance to big bud mite infestation. Among the recommended pollinizers are York, Dorris, Wepster and Jefferson.

Some years Yamhill sets a very heavy nut crop. Unfortunately, nuts in those years can be so poorly filled that the kernels are not suitable for market.

PollyO

PollyO was released in 2018, creating much excitement among hazelnut growers. PollyO is an alternative to Yamhill. It complements McDonald and Wepster, which were also bred at OSU.

"It's a good producer, a kernel variety," Newton said.

PollyO is a vigorous, globe-shaped tree with high nut yield. Nuts are small to medium in size, but larger than Yamhill and drop a few days earlier. Nuts are round with thin shells and are a blanching variety, meaning the brown skin, or pellicle, must be removed with heat. They mature early and have high kernel percentages.

PollyO's lineage comes from trees originating in Spain, Italy and England. It was named in honor of Polly Owen, who served as director of the hazelnut industry office from 1995-2018. During her years of service to the industry,

Continued on Page 64

Jefferson nuts and kernels. (photo by Rebecca McCluskey, OSU)

Yamhill nuts and kernels (photo by Rebecca McCluskey, OSU)

PollyO nuts and kernels compared with Wepster and McDonald (photo by Rebecca McCluskey, OSU.)

Continued from Page 63

Owen worked with university researchers, government officials, four industry organizations and hundreds of growers. Newton started some PollyO trees for Owen and gifted them to her so she could grow some of her namesake hazelnuts. Nurseries can obtain licensing agreements for PollyO from OSU, but sales are strictly limited to only the United States for the first four years after release.

According to OSU, PollyO nuts are in the range of 11 to 13 mm, which is the size preferred by major chocolate makers. Also noted by OSU is the early-season nut maturity—growers may cash in on the premium price offered by some hazelnut handlers for early nut delivery with PollyO. Early harvest before fall rains also equates to lower drying costs and higher nut yield.

In OSU trials from 2013-17, nuts of PollyO showed high percentages of good nuts, and low percentages of blanks, twins, poorly filled nuts, brown stain and kernels with black tips. Mold issues are similar in percentage to Jefferson. Kernel percent (kernel weight to nut weight) averaged 47% in trials.

It takes 18 years of testing before OSU releases a new variety. Most don't make it. The university makes around 20,000 crosses a year, according to Newton. *Maybe* one of those makes it into the mainstream. OSU tests numbered varieties in Newton's orchards. In 2019, he had approximately 50 trees being tested, with 15 different numbers. All of them, except the four which received the name PollyO, were removed at the end of that season.

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CAN TRUNK PAINT MITIGATE HERBICIDE DAMAGE IN YOUNG ALMOND TREES?

By **DREW WOLTER** | UCCE Junior Specialist, UC Davis,
and **DANI LIGHTLE** | UCCE Orchards Advisor(Former), Glenn, Butte & Tehama Counties

Second-leaf almond trees showed the most symptoms of herbicide damage with old paint applications (photo courtesy D. Wolter.)

IN ORDER TO PREVENT HERBICIDE DAMAGE IN YOUNG TREES, especially from postemergence herbicide, standard pomological practice has been to apply white latex paint to the bottom 2 to 3 feet of trunk of newly planted trees, before applying herbicides[1-5]. While this may provide some level of protection[4-8], research to support this practice is lacking. In order to assess the efficacy of white latex paint in mitigating herbicide damage, a field experiment was conducted in Arbuckle, Calif., to evaluate the impacts of latex paint on herbicide injury in young almond trees.

Methods

To conduct this experiment, second-leaf almond trees were grouped into three categories: old paint (9-week old), new paint (2-day old), no paint (hardened-off for 9 weeks), and cartons. In June 2019, treatment combinations of different rates of glyphosate (Roundup PowerMAX), glufosinate (Rely 280), or a tank mix of both were applied. Each treatment combination had 4 replicates.

Herbicide applications were made using a CO_2 backpack sprayer at 35 psi, and a spray volume of 20 gallons per acre. A

Continued on Page 68

Figure 1. The images above illustrate different levels of trunk gummosis observed in the field when comparing old paint (left) vs. no paint (right) (photos courtesy D. Wolter.)

Figure 2. These three images demonstrate the level of defoliation observed 5 weeks after the high rate tank-mix applications were made. Arranged in order of stress response severity from left to right: New paint exhibiting the highest level of defoliation, old paint, and no paint (photos courtesy D. Wolter.)

Continued from Page 66

single nozzle was held 18 inches from the trunk, moving vertically (from top to bottom) for one second on both the eastern and western sides of the trees.

In 2017, the block used to conduct this experiment was planted with greenhouse-grown trees. Each tree came with preinstalled cartons. Nine weeks before the herbicide applications for this experiment took place, the cartons for the "no paint" and "old paint" treatments were removed for the first time, exposing green bark. Valspar interior latex paint diluted 50:50 with water was then applied using a painter's mitt to the group of trees in the old paint treatment. This also allowed for the no paint treatment to harden off for nine weeks prior to the herbicide application. Two days prior to the herbicide application, the cartons for the new paint treatments were removed for the first time (again, exposing green bark) and painted. The carton treatments in this experiment never had their cartons removed.

Evaluations

Evaluations across three categories of tree stress were taken on a weekly basis, starting three weeks after treatment (WAT) to allow symptoms to develop.

Trunk damage: Assessments made

from 3WAT-5WAT quantified the number of individual gumming sites on each trunk (**Figure 1, see page 68.**) No further trunk gummosis was observed starting five weeks after the herbicide applications.

Canopy stress: Evaluations were taken from 5-8 WAT assessing the degree of interveinal chlorosis, mottled chlorosis, spotting, stacked internodes, necrosis and stem dieback (**see figure page 71**.)

Defoliation: Ratings were taken from 5-8 WAT assessing the degree of defoliation for each tree (**Figure 2, see page 68**.)

Results

Results from this study indicate that paint as a trunk protection method may not provide significant protection from glyphosate or glufosinate. Tree stress caused by trunk-applied herbicides was lowest in most treatments with no paint at all, which suggest that hardening of the bark is key to mitigating herbicide damage in young trees.

Trunk Damage: Five weeks after herbicide treatments, data from the top-of-label-rate tank-mix application showed a 22% increase in trunk damage in trees with old paint, and a 4% increase in damage in trees with new paint, when compared to trees with no paint.

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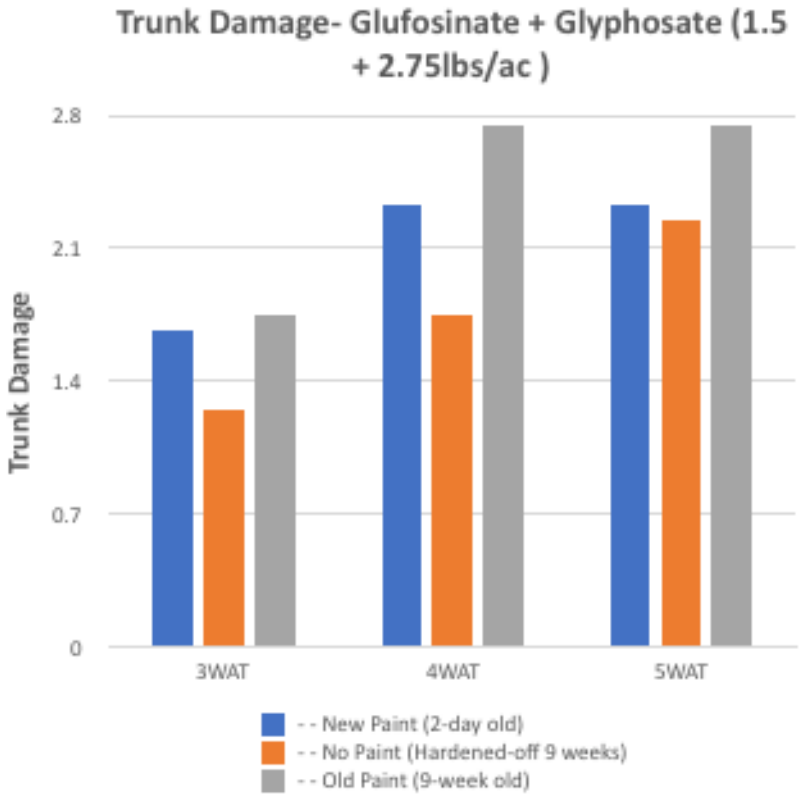
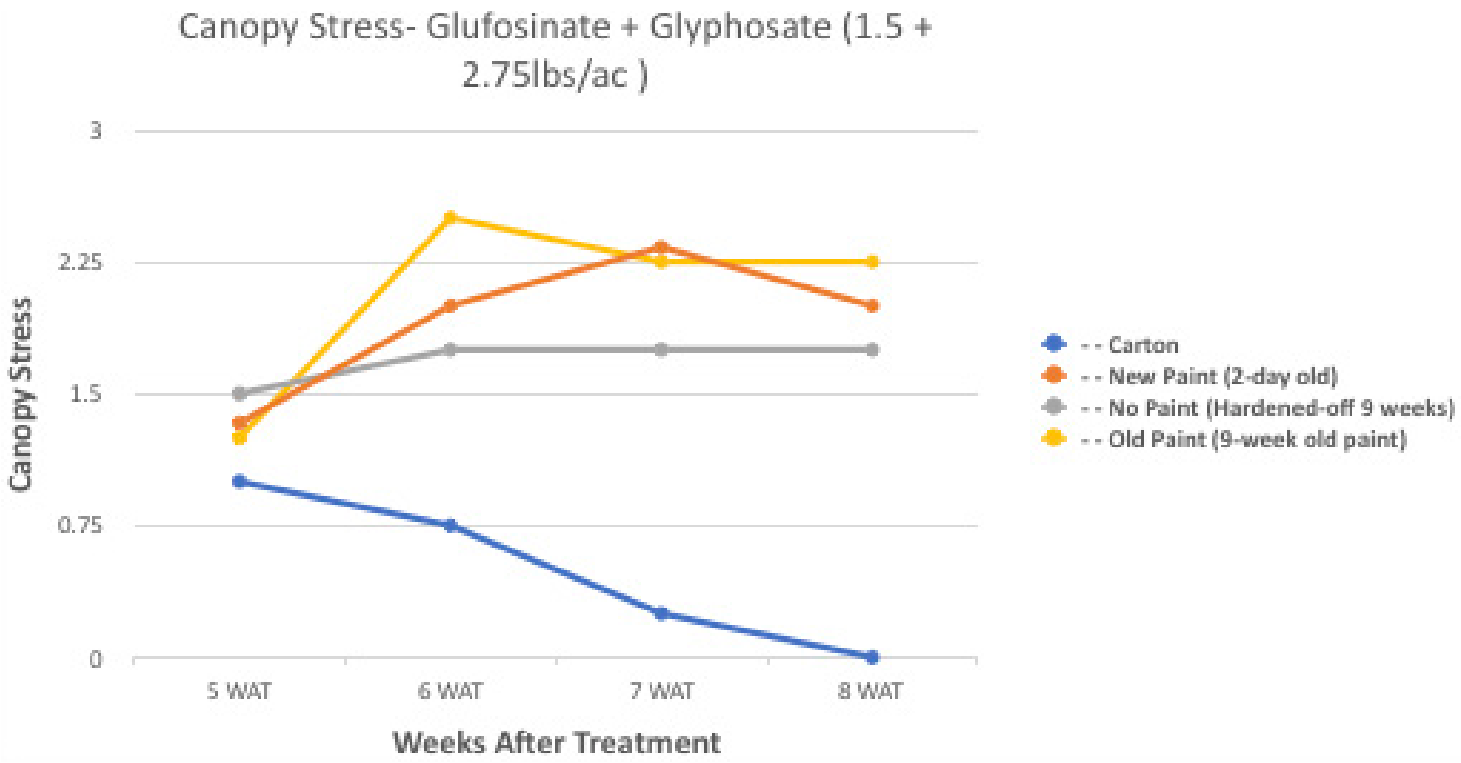


A trunk with carton freshly removed. While cartons provide good protection against herbicide injury, when cartons are eventually removed, green bark may be present and susceptible to herbicide injury (photo courtesy D. Wolter.)



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Canopy Stress:

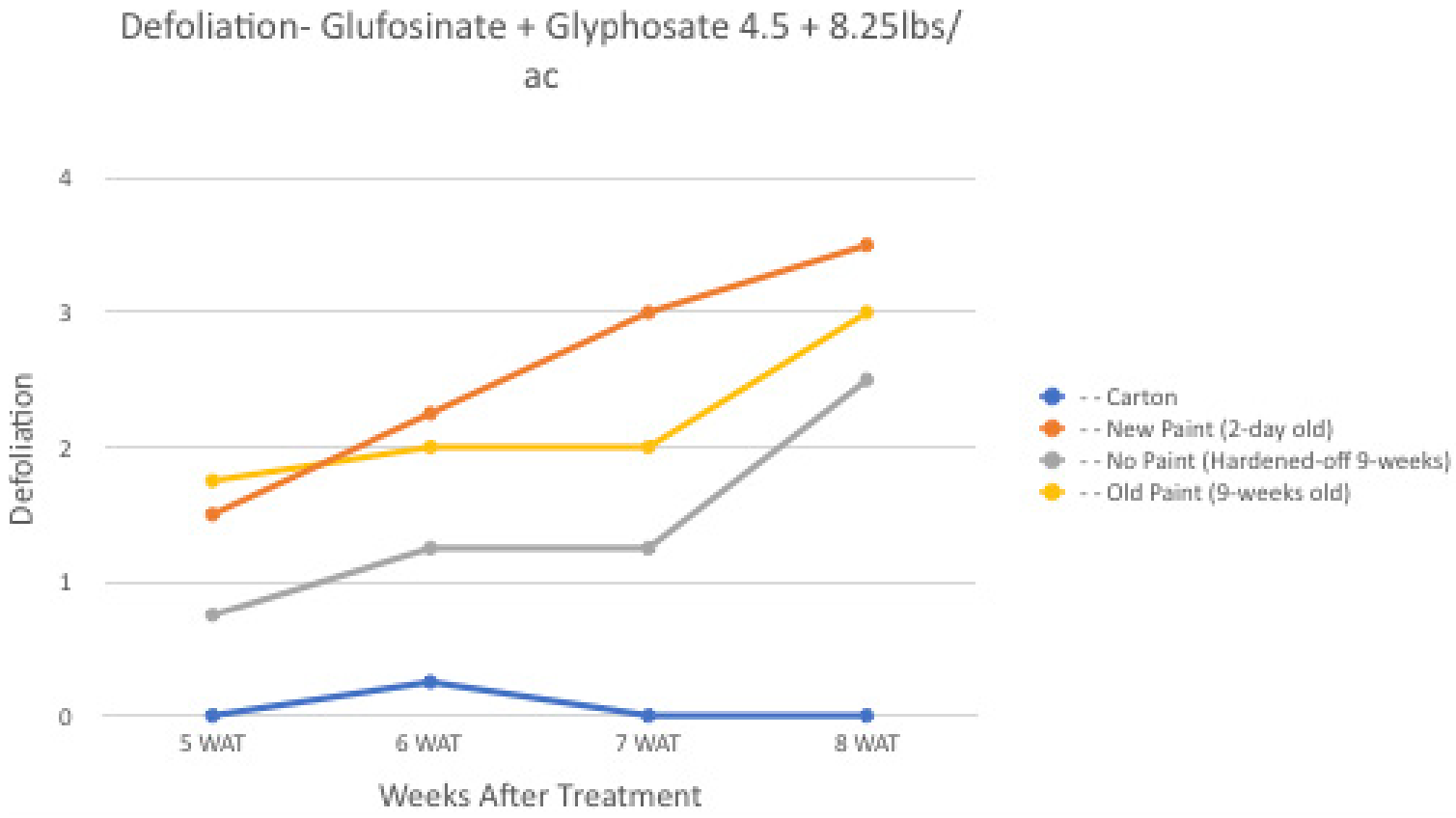
Eight weeks after treatment, the label rate tank-mix applications showed a 29% increase in canopy stress in trees with old paint, and a 14% increase in damage was observed in trees with new paint, when compared to trees with no paint.

Defoliation:

Eight weeks after treatment, the high rate (3x) tank-mix applications showed a 40% increase in defoliation in trees with new paint, and a 20% increase in defoliation was observed in trees with old paint, when compared to trees without paint that were allowed to harden-off for 9 weeks.

Conclusion

Results from this study indicate that in most treatment combinations, old and new paint as trunk protection methods did not reduce tree stress caused by trunk-applied herbicides. Allowing the bark of young almond trees to harden off for at least nine



weeks reduced herbicide damage. The most efficacious trunk protection option for young almond trees is to install a carton, though remember when cartons are eventually removed green bark may be present and susceptible to herbicide injury. Therefore, as the trees mature and cartons are removed, allow the bark on trunks of trees to harden off to minimize herbicide damage.

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(photo courtesy Almond Board)

COLLABORATIVE BEE+ SCHOLARSHIP SUPPORTS GROWERS WHO PLANT POLLINATOR COVER CROPS

By **ALMOND BOARD OF CALIFORNIA** | *Contributing Writer*

THIS PAST JUNE, THE ALMOND BOARD of California (ABC) launched its Bee+ Scholarship for almond growers. This scholarship supports growers seeking to plant cover crops in and/or around their orchards, an effort that is not only shown to promote pollinator health but which also provides multiple in-orchard benefits, as well.

Support for Growers

There are two key elements of the scholarship. The first is that ABC will cover the cost for growers to register for Pollinator Partnership's Bee Friendly Farming (BFF)[1] program, which was recently aligned with ABC's California Almond Sustainability Program (CASP).[2] The CASP and BFF program alignment promote the importance of providing pollinators with nutritional forage, expanding on a commitment made in ABC's Pollinator Protection Plan last January that encourages pol-

linator health and biodiversity among almond growers.

"Responsible farming is at the heart of what the California almond community does. ABC's Bee+ Scholarship and the alignment between CASP and BFF allow us to increase our support to growers as they remain committed to growing almonds in better, safer and healthier ways, adding biodiversity to their farms, and improving outcomes for pollinators," said Josette Lewis, ABC's chief scientific officer.

The second element of the Bee+ Scholarship involves ABC providing free cover crop seed to 100 almond growers through Project *Apis* m.'s Seeds for Bees program.[3] This program encourages the use of cover crops to increase the density, diversity, and duration of bee forage in California agriculture, while also improving soil health. Seeds for Bees' seed mixes are designed to bloom at critical times of the year when natural forage is scarce but managed and native bees are active.

Funding provided by ABC's Bee+ Scholarship will allow growers to plant an estimated 3,500 acres of quality pollinator forage statewide – that's in addition to the cover crop seed Project *Apis* m. typically distributes directly to almond growers through their Seeds for Bees program each year.[4] Currently, over half of almond growers participating in ABC's California Almond Sustainability Program report allowing native cover crops to grow in their orchards.[5] This scholarship will help to convert more of those native cover crops to quality pollinator forage.

"Protecting and improving honey bee health, not only during the short time that bees are in our orchards but year round, is critical to the success of every almond grower. By working with national organizations such as Pollinator Partnership and Project *Apis* m., we are expanding our focus to all pollinators, viewing working lands as part of biodiverse ecosystems," Lewis said.

Research on Cover Crop Benefits

Beyond cover crops' benefit to pollinators – native and honey bees – research funded by ABC continues to show that planting winter cover

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Research shows planting pollinator cover crops in and around orchard middles has benefits for bees and orchards as well (photo courtesy Almond Board.)

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crops between orchard rows is good for the soil and water infiltration.

At The Almond Conference 2019 last December, UC Davis Dept. of Plant Science faculty member Amélie Gaudin, Ph.D., spoke to the benefits of cover crops examined by her team. Gaudin has spent the past three years leading an ABC-funded research project studying whether cover crops make sense for the almond industry. At orchard testing sites in Tehama, Merced and Kern counties, Gaudin and collaborators have carefully tracked what happens when growers either let native vegetation grow or plant cover crops, rely on winter rains for water supply, then allow the crops to grow and bloom, and finally remove them in the spring.

The team studied two seed mixes at these sites, one directed primarily at improving soil conditions, and the other weighted toward helping honey bees. The "soil mix" is composed of 10% Bracco white mustard, 10% Daikon radish, 30% Merced ryegrain, 20% Berseem clover and 30% common vetch. The "pollinator mix"

is composed of 15% Bracco white mustard, 20% Daikon radish, 15% Nemfix yellow mustard, 15% common yellow mustard and 35% canola. Both, however, achieve multiple purposes.

Research shows that a mixture higher in legumes (such as clover and vetch) can boost nitrogen levels in the soil; conversely, grasses can help reduce nitrogen losses, decreasing compaction and improving infiltration.

Beyond contributions to soil and pollinator health, the team found that cover crops, depending on the mix, are also capable of:

Effectively improving water infiltration and addressing aggregation and compaction issues, which plagued some of the trial locations,

Relying on winter rains and therefore not increasing overall irrigation water demand,

Significantly decreasing winter weed pressure and diversity, and

Increasing microbial biomass and shifting biological properties in the soil, which includes increasing populations of beneficial bacterial-feeding nematodes.

Gaudin said the key for effective cover cropping is for growers to first assess what goal/s they want to achieve by employing a cover crop. She suggested a grower will likely need to try different mixes when looking to reach their goal, depending upon the outcome they want to achieve in their orchard and what works well on a specific piece of land.

In addition, UCCE orchard advisor Katherine Jarvis-Shean created a useful guide that details what growers should consider when preparing to plant cover crops and what mixes are more likely to achieve certain goals. The guide is titled "Cover Crop Seed Selection" and may be accessed at the Sacramento Valley Orchard Source website.

Growers who are interested in learning more about ABC's Bee+ Scholarship are encouraged to visit Almonds.com/Pollination. Because early-to-mid October is the optimal time to plant cover crops, growers are strongly encouraged to reach out to Billy Synk, director of Pollination Programs at Project Apis m., soon to learn more about the program and how they may receive free cover crop seed through ABC's Bee+ Scholarship.

References

[1] For more on the BFF program, visit www.pollinator.org/bff.

[2] For more on CASP, visit www.sustainablealmondgrowing.org.

[3] For more on the Seeds for Bees program, visit www.projectapism.org/seeds-for-bees.html.

[4] Billy Synk. Director of Pollination Services. Project Apis m. Nov. 2019. Represents total plantings from 2013-June 2020.

[5] California Almond Sustainability

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Program Updates: Adapting to the Times and Preparing for the Future

By **AMERICAN PECAN COUNCIL** | *Contributing Writer*

The American Pecan Council in 2019 implemented its first course of action based on findings in its Strategic Plan. The result: We were able to repurpose upwards of $2 million into other marketing initiatives that have doubled our reach. That is double the number of consumers that have seen the American Pecan story year over year.

Last fall, APC took a multi-dimensional approach to its marketing efforts collaborating with several agencies and partners to expand our overall target audience engagement and exposure. Due to the increase of marketing activities, we eclipsed the total amount of eyes on our ads last year, within the first seven months of this year alone! On top of that, pecan's top of mind awareness is at a record high for the season ranking in the No. 2 spot among tree nuts.

Prior to COVID-19, the industry kicked off the Superpowers of Pecans campaign. This campaign was geared towards our target audience of young moms and messaging hit on the super nutrition pecans are packed with. We saw much success from this campaign alone. Social media continues to be a powerful marketing tool to reach young moms. Pulling from data and analytics and conversation listening, we've seen

an uptick in plant-based meals as well as baking with the stay at home orders in place. We were able to quickly accommodate messaging around these insights.

In our recently wrapped "Pecans at Home" influencer campaign utilizing the Aspire IQ platform, we worked with 7 nano lifestyle creators and reached over 49,000 people to show how pecans can easily be added to a daily diet for added nutritional benefits. We asked influencers to align their messaging with how consumers might be feeling right now being quarantined at home, with a goal of driving purchase consideration for pecans by showcasing how this pantry staple incorporates into family recipes and snacks. While marketing efforts are such a big push in our Federal Marketing Order, there are many other project and activities underway.

Quality Assurance Program

The industry is currently in development of the Quality Assurance Program. This program is the next step in preparation for the future. The goal of the Quality Assurance Program is to create a quality management program that harmonizes American pecan grower, sheller, and accumulator practices to the evaluated U.S. pecan industry "standard" to ultimately make a claim at the consumer level through an APC-branded logo, thus driving demand for U.S grown pecans. The American Pecan Council Quality Assurance Program assures consumers that the pecans they purchase are grown under circumstances that address food safety risks, financial factors, environmental concerns, and treatment of employees. The voluntary Program acknowledges and enhances current industry practices and initiatives, adding value to participating growers, shellers, and accumulator.

A new Quality Assurance Program is in development that will harmonize American pecan grower, sheller, and accumulator practices create a pecan industry "standard" for U.S grown pecans (photos courtesy American Pecan Council.)

We are currently in Phase 2 of the project which involves the development of the program standard and governance structures. The initial standard has been drafted. We have a QAP working group of industry members who are currently revising and editing the standard to ensure it is tailored to our industry. Please keep an eye out for the upcoming article where we will do a deeper dive in the program.

Transparency Through Industry Reports

APC has published data beginning in the 2016 crop year. These reports represent the first time the U.S. pecan industry has had access to their own personal mandatory data from handlers. You might have noticed some additions to the May 2020 pecan industry report. The year over year comparison as well as the month to prior year month comparison is now included in the reports. This gives you an idea of the percent of change. The data is also taken a step further and broken down to the net open position which represents the total pecans in inventory that is available for the marketplace (deducting the net commitments). We will continue to fine tune the report to make sure the display is user friendly and useful for industry members.

Keeping industry informed on the current and upcoming projects is of utmost importance to the APC. We like to say this is YOUR Federal Marketing Order, so we want to ensure you're up-to-date on how valuable industry dollars are working hard to benefit every member of the American Pecan Industry. If you have any questions or comments, don't hesitate to drop us a line at industry@americanpecan.com, or reach out to your local Council Representative.

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New Incentives Help Tree Nut Industry Comply With Truck Air Quality Rules

This article is sponsored by

By **ROGER A. ISOM** | *President and CEO, Western Agricultural Processors Association*
and **CHRISTOPHER MCGLOTHLIN** | *Director of Technical Services*
Western Agricultural Processors Association

THE TRIALS AND TRIBULATIONS OF DOING BUSINESS IN California. Just about the time you think you've seen every possible regulation there could ever be, the State of California raises the bar one notch higher. Recently, California Air Resources Board (CARB) approved the next generation "Truck Rule" when they adopted the Advanced Clean Truck (ACT) Regulation. This is a far-reaching, first-of-its-kind regulation for new trucks anywhere in the country. It would require truck manufacturers to sell an increasing amount of zero-emission trucks (electric) from 2024 to 2035. By 2035, zero-emission truck/chassis sales would need to be 55% of Class 2b – 3 truck sales, 75% of Class 4-8 truck sales and 40% of truck tractor sales. This is different than CARB's current truck rule, which requires the mandatory replacement of all existing trucks operating in California with trucks that contain 2010 or newer engines by 2023. This has been a costly endeavor for business in California, especially agriculture with little to no incentives available to help fund the replacement of those trucks. And while we haven't even finished complying with the existing truck rule, we now have to look forward to yet another regulation?

The Western Agricultural Processors Association (WAPA) was part of a coalition that opposed this new regulation, but many groups did not actively fight it. Why? Some weren't aware of the proposed regulation, while others have simply given up believing this is how life in California is going to be. It's hard to argue that mindset given the makeup of the voters and the current legislature, but giving up just doesn't seem right. Layered on top of this was the stepped enforcement of CARB's Periodic Smoke Inspection Program (PSIP). The PSIP Program helps CARB achieve two main goals through the required routine smoke inspections. One being that diesel equipment's visible emissions are checked based on the approved opacity of emissions for that equipment's model year, and the second objective is that the yearly mileage is noted on each PSIP certification. The second objective is very critical, specifically for compliance within CARB's Truck and Bus Regulation. If a businesses' fleet is not in compliance with the Truck and Bus Regulation, the first thing that CARB staff will ask for is the equipment's PSIP certificate for the reporting year. PSIPs are considered a verifiable document through a third-party inspector, and the mileages included in a vehicle's PSIP is creditable amongst the compliance staff at CARB.

With all of this in play, the industry was left with a decision to make. Do we fold and go home, or do we find another way to survive? A new thought was born: use the same approach that has been working for tractors and harvesters and get ahead of the curve. That is to find incentive monies and replace trucks with the latest technology where and when it will work.

Partnering with the San Joaquin Valley Air Pollution Control District (SJVAPCD), Federal EPA, CARB and Orange EV, WAPA was able to deliver 17 electric yard trucks to replace old diesel trucks using both Federal and State air pollution incentive funds. This "first-of-its-kind program" was the brainchild of the San Joaquin Valley APCD and WAPA to "stack" two air pollution incentive funding programs to create enough incentive to get tree nut hullers or processors to destroy the old diesel yard trucks with brand new fully electric yard trucks. 45% of the cost came from Federal EPA from the Diesel Emission Reduction Act (DERA) funds that Air Districts throughout the country compete for. On our first application, SJVAPCD was approved and received enough funding for 17 trucks. The only caveat was we had to destroy the old diesel trucks. This was then coupled with California's Clean Off-Road Equipment (CORE) Program which provided up to an additional $150,000 towards the purchase of the new electric truck. That means paying a few thousand dollars for a truck that costs more than $280,000. It took almost two years to complete this process, but the first 14 trucks have been delivered to tree nut hullers and processors throughout the valley and the remaining three are on their way. We look forward to working to repeat this successful effort in the coming year.

WAPA wishes to thank partners at EPA, CARB, SJVAPCD and Orange EV for their efforts in making this happen.

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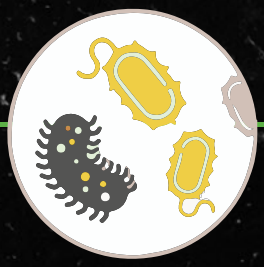

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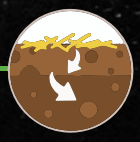

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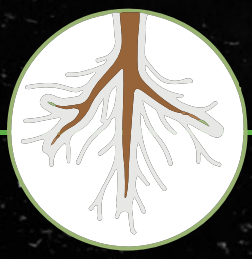

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