ELDERBERRY FIELD ASSESSMENT

Sacramento Valley

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

Sustainable Agriculture Research and Education Program

Elderberry field assessment

Sacramento Valley

By Katie Fyhrie, The Cloverleaf Farm
Sonja Brodt and Laura Crothers,
University of California Sustainable Agriculture Research and Education Program

Summary

We planted and observed blue[1] and American[2] elderberry on three Yolo/Solano county farms for two growing seasons in 2018 and 2019. Under the typical hedgerow establishment conditions, blue elderberry seedlings grew and yielded more by their second growing season than American elderberry cultivars. Management strategies, including land preparation, weed management, and irrigation frequency, appear to have profound effects on growth and yield in the first two seasons.
We harvested ripe fruit from nine mature blue elderberry shrubs of known ages in similar growing conditions in 2018 and 2019. Our results show that established plants can be very productive, but yield per plant varies. Observations suggest that age, spacing, and access to supplemental water may affect mature yield.
We used yield data to assess berry yield timing. Mature blue elderberry and second-season blue elderberry seedlings showed a long potential harvest window of mid-June through mi- September. American elderberry cultivars had a shorter one month harvest window in August only.

Blue elderberry berries

source: Wikipedia - Dcrjsr / CC BY (https://creativecommons.org/licenses/by/3.0)

Elderberry Growth and Yield after Two Growing Seasons

Highlights:

- ◊ Blue elderberry yielded more than American elderberry in their second growing season under the same management conditions
- ◊ Average yield per tree varied by farm, presumably due to management differences
- ◊ Higher yielding farms had higher growth rates in general
- ◊ The most drastic growth rate difference between farms appears in the number of basal shoots, not growth in height or diameter

[1]Blue elderberry, *Sambucus nigra* ssp. *cerulea*
[2]American elderberry, *Sambucus nigra* ssp. *canadensis*

Description of Field Sites and Data Collection

Data Collection

Yield: Blue and American elderberry plants began to yield in their second growing season (2019) on all three farms. We harvested all ripe berries weekly for the calculation of average per-tree yield. Yields of individual second-season plants were not tracked; berries were all aggregated. The berries were weighed after being destemmed. Plants were not pruned.

Growth rate: We measured height (from soil level to tallest point), number of basal shoots (suckers from root crown or from soil), and the diameter of the largest basal shoot monthly during summer 2018 and 2019. We also counted whole cymes of buds, flowers, and unripe, and ripe berries at each data collection.

Field sites

In late April 2018, we planted blue elderberry seedlings and bare-root rooted cuttings of American elderberry cultivars (Johns and Adams) on three farms then tracked growth and yield for two growing seasons (2018, 2019). All three farms are certified organic and located within 25 miles of each other in Yolo and Solano counties on prime agricultural soils. Through this document, these farms are referred to as Farms A, B, and C. Each farm established and managed their elderberries uniquely (see Table 1: Field Site Preparation and Management).

PLANTING DESIGN			
	Farm A	**Farm B**	**Farm C**
spacing	10 feet	6 feet	12 feet
mulch	cardboard and 6" aged asparagus fern over entire hedgerow area	woven black plastic landscape fabric over entire hedgerow area	cardboard and 6" aged asparagus fern in circles around each plant
tree protection tubes	12" plastic with bamboo stake		
irrigation system	poly tube with emitters installed next to plants		
TILLAGE			
	Farm A	**Farm B**	**Farm C**
shallow	rototilled 3x	disced, rototilled 1x, hilled a raised bed	none, mowed weeds and dug planting holes
deep	3' deep rip	none	none
MAINTENANCE			
	Farm A	**Farm B**	**Farm C**
irrigation (2018)	weekly May-Sep (216 gal/plant total)	every other week May-Aug (155 gal/plant total)	every other week May-Oct (450 gal/plant total)
irrigation (2019)	weekly Jun-Aug (83.5 gal/plant total)	monthly May-Aug (24 gal/plant total)	monthly Jul-Sep (100 gal/plant total)
tree protection tube removal	July 2018	not removed	October 2018

Growth and Yield Results

The discussion below focuses on blue elderberry, because American elderberry did poorly in the growing conditions of this trial. Results comparing blue to American elderberry, and their relative performance on demonstration farms A, B, and C are summarized in the Table 2: Growth and Yield Results.

Ripe American elderberry cymes harvested during this study, like the one shown here, were sparse. Each empty stem represents a flower where fruit set failed to occur.

Elderberry plants on Farm A, shown here, were the highest yielding in this study. Elderberries are planted in a single line (middle right) between two rows of other native shrubs and forbs (left) and a row of poplars planted for additional wind-break (far right). This photo was taken in the first growing season, during late summer 2018.

Management differences on the three farms likely explain yield and growth differences between farms. The lower yield of second-year American elderberries is likely attributable to smaller plant sizes as well the fact that ripe berry cymes on the American cultivars were nearly all incomplete, meaning that not all flowers successfully set fruit, resulting in sparse fruit on each individual cyme.

TABLE 2. Results summary			
		Blue	**American**
Average yield per plant in second growing season (lbs. destemmed berries)	Farm A	11.21	1.19
	Farm B	2.21	0.04
	Farm C	0.34	0.2
Average height (ft) in Oct 2019 (percent increase since planting date)	Farm A	8.9 (1580%)	6 (368%)
	Farm B	7.3 (1829%)	3.6 (193%)
	Farm C	6 (1168%)	4.8 (285%)
	overall final average (feet)	**6.8**	**4.6**
Average diameter (in) of largest shoot in Oct 2019 (percent increase since planting date)	Farm A	1.8 (1050%)	0.9 (92%)
	Farm B	1.5 (850%)	0.6 (9%)
	Farm C	1.3 (682%)	0.7 (30%)
	overall final average (inches)	1.5	0.7
Average number of basal shoots in Oct 2019 (percent increase since planting date)	Farm A	18.3 (1730%)	10.3 (930%)
	Farm B	4.4 (340%)	5.2 (420%)
	Farm C	4.8 (380%)	3.7 (270%)
	overall final average (# basal shoots)	**9.2**	**6.4**

Blue elderberry plants on Farm C, shown here, fill gaps in a pre-existing habitat strip along the property border. These seedlings grew less and yielded much less than other farms on average during the first two growing seasons. This photo was taken at planting time in late April 2018.

The blue elderberry plants on Farm B, shown here, are planted in a single, closely-spaced line adjacent to a pre-existing narrow habitat strip. These seedlings grew consistently and vigorously, but yielded approximately 1/5 as much as those on Farm A in their second growing season. This photo was taken in their first growing season during late summer 2018.

How management decisions may affect growth and berry yield in young plants

Management strategies that encourage vigorous, widely branching growth may improve yields

Blue elderberry, similar to most American elderberry cultivars, will bloom and produce fruit at the tips of branches that grew the previous summer in addition to the tips of fresh branches that grow during the current season.
Therefore, the number of basal shoots that grow may be more important for early per plant yield than height or diameter. The blue elderberry yield difference between Farms A and B was large, but differences in height and diameter increase were not drastic. Farm A's rate of basal sprouting was markedly higher, however. We also observed that basal sprouts also grew more side branches on Farm A.

Leaving tree tubes in place over the summer may kill basal shoots

On Farm A, plastic tree tubes were removed by July of the first growing season after plants had begun to grow vigorously and leaves began pressing against the walls of the tube. On Farm B, tubes were left in place for the duration of the project. Young basal shoots on Farm B were frequently found brown, stunted, or dead,
presumably due to extreme heat inside the tree tube. Black plastic mulch on Farm B may also have contributed to heat accumulation.

Tillage may increase growth rates for spring-planted elderberry (but fall is the best time to plant)

Fall is the best time to plant perennials in California regardless of land preparation strategy, when the entire soil profile is softened by winter rains making it easier for young roots to explore.
But our on-farm trials planted elderberry in late April. Of the three farms we studied, only Farm C chose to plant without tillage for late April plantings, simply mowing weeds and digging planting holes as land preparation. Lack of tillage may have negatively impacted the young roots' ability to penetrate the soil, contributing to Farm C's lower growth rates and yields.

Irrigating frequently may result in higher growth rates and yields.

The highest yielding Farm A irrigated weekly throughout the first and second growing season, whereas farms B and C irrigated approximately half that frequency or less (see Table 1: Field Site Preparation and Management). Farms A and B applied approximately similar amounts of water in the first summer, and Farm A applied more total water in the second summer. Farm C applied substantially higher total quantities of water in both years, but with much lower frequency and the lowest yields, altogether suggesting that higher frequency may be at least as important as or more important than amount in determining early yields. (However, see below for other factors that likely impacted yield on Farm C.)

Mulching to inhibit winter weeds may improve yields

Winter weed competition may have stunted blue elderberry on Farm C prior to their second growing season. Weeds grew thickly between the circles of mulch that had been placed around each individual elderberry plant, and were not mowed in time to prevent them from overtaking young plants. Many resilient seedlings survived and may recover fully, but their spring growth was stunted. On farms A and B, continuous mulch over the entire hedgerow area reduced the number of winter weeds and the amount of labor needed for control.

Other factors can also contribute

In addition to the major management differences discussed above, many other subtler factors may be at play as well. Farm B planted their blue elderberry seedlings at only six feet apart, while Farm A planted at 10 feet apart. Could spacing have played a role? How about mulch material? These and many other outstanding questions remain to be addressed in future research.

Yields of Mature Blue Elderberry Shrubs

Highlights:

- ◊ Mature blue elderberry shrubs (4-11 years old) in un-irrigated hedgerows can be highly productive in the Sacramento Valley
- ◊ Yield is variable. Many factors interact to create this variability.
- ◊ Older plants yielded more on average, but spacing and potential for water scavenging may significantly affect relative yield once plants are mature.

Data collection

We harvested ripe berries from nine mature blue elderberry shrubs growing in three un-irrigated Sacramento valley hedgerows of known ages (with planting dates of 2008, 2012, and 2014) for two seasons (2018 and 2019). We chose three healthy individuals at each hedgerow site to harvest. These hedgerows (planted in 2008, 2012, and 2014) are located on three certified organic farms in Solano and Yolo counties within a 25-mile radius on prime agricultural soils.
These unpruned shrubs had reached heights of 15-30 ft, so only the fruit safely reachable by hand from an 8-foot orchard ladder was harvested in order to simulate realistic harvest conditions. No mechanical harvesters exist. Whole cymes of ripe fruit were harvested by hand weekly with no specialized tools.

Hedgerow planted in 2008

Blue elderberries grow in a wide, multi-species hedgerow which runs through the center of a mature drip-irrigated organic walnut orchard. An unlined irrigation ditch runs just adjacent to the hedgerow, which fills periodically during the summer, carrying water to nearby fields. There are access roads on either side of the hedgerow.

Hedgerow planted in 2012

This hedgerow is located on Farm C. Two of the mature blue elderberry shrubs we harvested are growing on the downslope of a county-maintained canal road, with an access road on the other side separating them from fallow fields. The third elderberry is on flatter ground, adjacent to an irrigated field. All three are part of narrow multi-species hedgerows.

How management decisions may affect yield in mature elderberries

Hedgerow planted in 2014

Located on Farm A, this multi-species native hedgerow is planted with wide dirt roads on either side. Irrigated crops are grown across from the roads, at least 30 feet away from the hedgerow.

Closely spaced plants may produce smaller yields

The lowest yielding blue elderberry planted in 2008 (only 58 lbs in 2019) was spaced approximately 12–15 feet from another elderberry. Where the two had grown into one another, fewer live shoots, leaves, and berries were present, and the shrubs themselves were relatively small. The higher yielding shrubs planted in 2008 (126 and 171 lbs in 2019) had no other large shrubs or trees growing within 20–30 feet, were somewhat larger, and bore fruit around their entire circumference.

Additional water may increase yield

Although all three mature hedgerows were un-irrigated, blue elderberries are able to scavenge far and deep for water. In addition to winter rains stored in the soil and sub-soil, other nearby water sources such as irrigated fields may also be scavenged. The highest yielding hedgerow (planted in 2008) has the most obvious, regular sources of additional water. It runs through an irrigated walnut orchard and is adjacent to an irrigation ditch which fills periodically during the growing season when bringing water to nearby fields.

Mature unirrigated blue elderberry yield results

		2018		2019	
Year planted	**tree**	**lbs. destemmed berries**	**average**	**lbs. destemmed berries**	**average**
2008	1	135	108	126	118
	2	61		58	
	3	128		171	
2012	1	40	77	116	105
	2	172		156	
	3	20		42	
2014	1	35	36	43	63
	2	43		78	
	3	30		68	

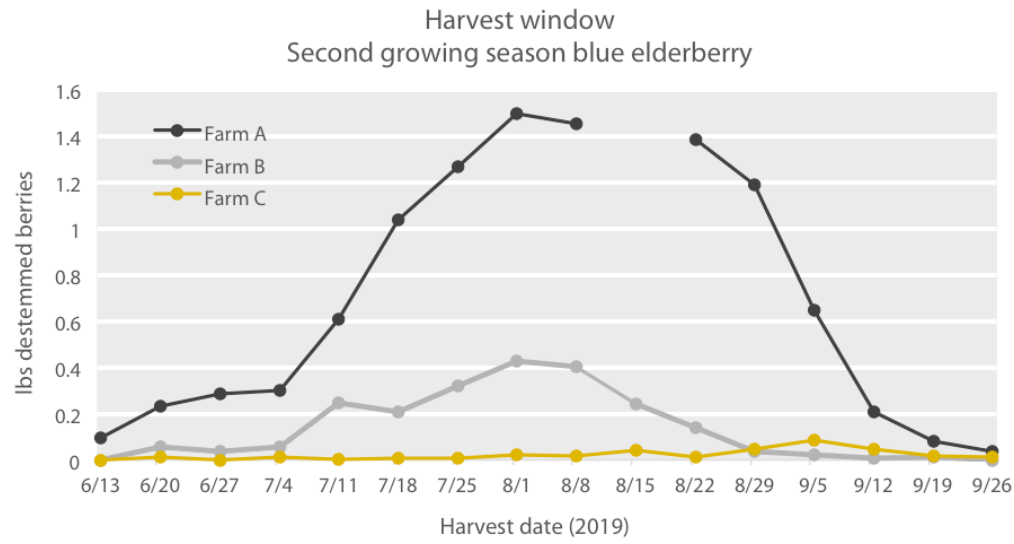
Total yield per mature blue elderberry (lbs, destemmed), actual measurements of individuals and averages according to the year they were planted. All ripe berries within safe reach of an 8-foot orchard ladder were harvested weekly.

Yield pattern and timing

Highlights:

- 2-year old blue elderberry seedlings had a long harvest window (mid-June through mid-September), with a peak in August.
- Mature, un-irrigated blue elderberry had a long harvest window (mid-June through mid-September). Yield patterns differed between different hedgerows.
- American elderberry cultivars had a one month harvest window in August, with a peak on the first week.

FIGURE 1: Early Harvest Window. This graph shows the average weekly yield per plant of blue elderberry seedlings in their second growing season on demonstration farms A, B, and C. Yield is measured as pounds of destemmed ripe berries. The gap in Farm A's curve between Aug 8 and Aug 22 represents missing data from Aug 15 harvest. Berries harvested from Farm A could not be measured due to issues with cold storage.



Yield patterns may differ between genetically distinct individuals

Figure 2: Percent yielding over time illustrates that not all of the second-season plants ripened at the same time. As each seedling is a genetic individual, there may be inherent differences in yield timing, pattern, and amount.

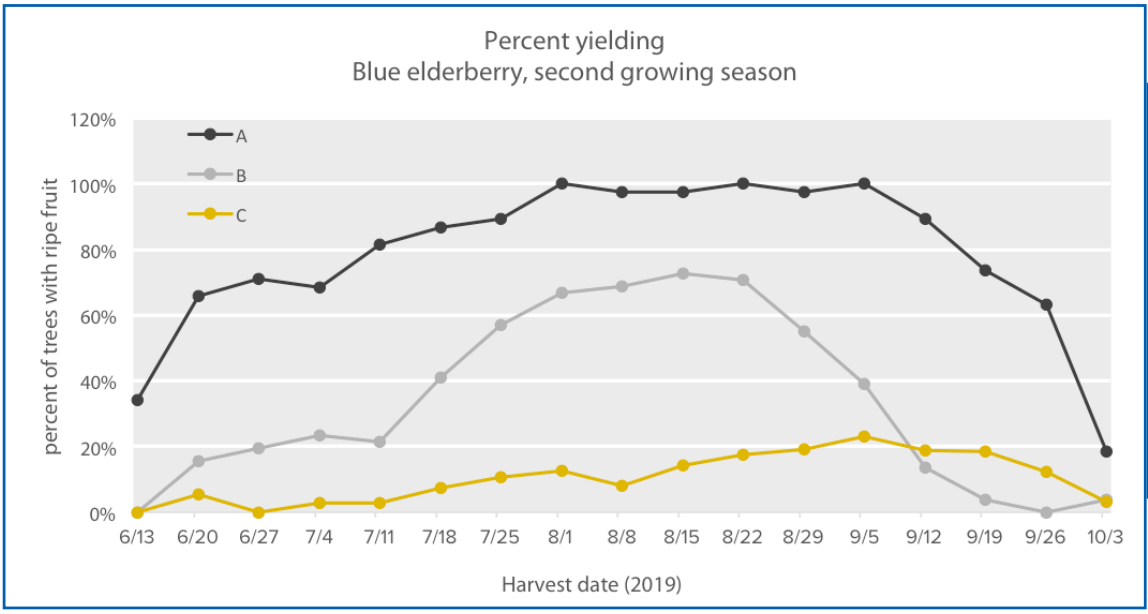


FIGURE 2: Percent Yielding Over Time - This graph shows the percentage of second-season blue elderberry seedlings on each demonstration farm A, B, and C that had ripe fruit present on each harvest week in 2019.

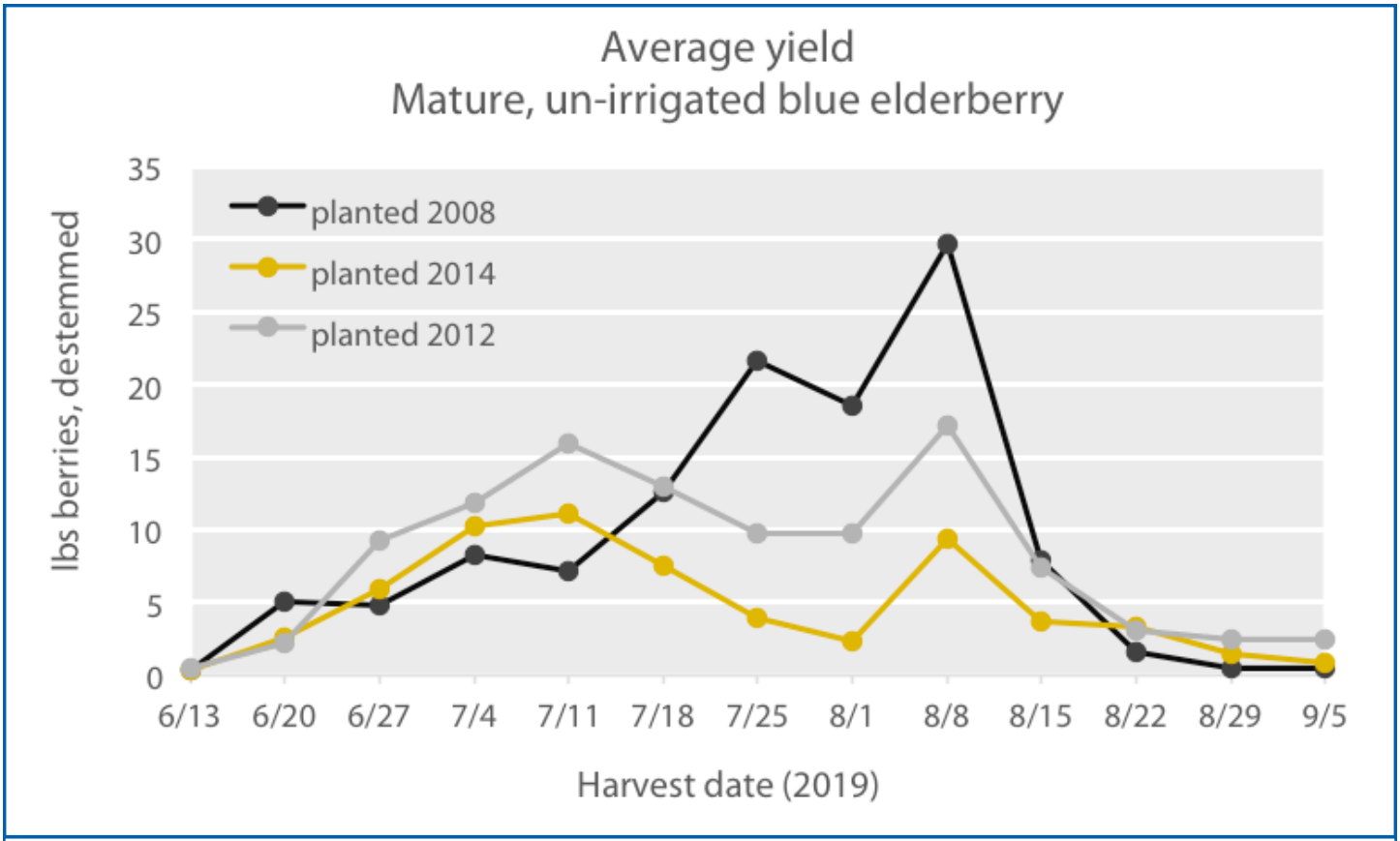


Figure 3: Mature Harvest Window. This graph shows the average weekly yield of unirrigated mature blue elderberry shrubs according to planting date (2019 harvest season). All ripe berries within approximately 10-12 ft of ground level were hand picked weekly using an 8 foot orchard ladder. Yield is measured as pounds of destemmed ripe berries.

Water access may affect the yield pattern of mature, un-irrigated blue elderberry

Figure 3: Mature harvest window shows that the mature shrubs planted in 2012 and 2014 had similar yielding patterns, with two shallow peaks in yield. Those planted in 2008 show a yield pattern similar to second-year seedlings, with a single peak later in the season. This pattern may be related to differences in the three hedgerows' regularity of access to supplemental water.

Blue elderberry may be suitable for weekly or monthly harvest, while American elderberry may require multiple harvests per week

We found that blue elderberries held well on young and mature trees. With weekly harvest, none of the yield was lost by berries over-ripening or drying between harvest days. Observation of nearby mature trees which were not harvested suggests that ripe berries can hold on mature, un-irrigated trees for weeks, possibly even months. During our harvest of second-year American elderberry, berries regularly progressed from unripe or unevenly ripe to fully dried raisins within the span of one week.

Blue elderberry may bloom earlier and for a longer time than American elderberry

Blue elderberry seedlings began blooming in mid-April of their second growing season. The number of flowers declined steeply in July, although scattered flowers were present through September. American elderberry cultivars had not yet set flower buds in mid-April, but flowers were observed in mid-June. Similar to blue elderberry, American elderberry bloom declined in July.

Conclusion

This study was designed as an opportunity for observation, not as a controlled experiment. Because of this, our results are far from conclusive, but are suggestive of key considerations for prospective elderberry growers in California and other western states where blue elderberry is native. Long-term effects are unknown, as this establishment trial covered only the first two growing seasons; slower-growing and lower-yielding trees may "catch up" over time. This study also explored a limited scope as far as geography, management practices, and cultivars; growers may see different results.

However, within the scope of this study, wild-type seedlings of California's native blue elderberry have shown great potential as a high-yielding, resilient crop appropriate for low-intensity management in un-irrigated hedgerows.

Topics for Further Research

- How much variability exists between individual blue elderberry seedlings? (yield, growth habit, breaking dormancy, berry size and quality, flower aroma, etc)
- Can blue elderberry cultivars be developed to balance the need to minimize introduction of non-local genetics with the need for more predictability in key desirable characteristics?
- How many years does it take for blue elderberry to reach their mature yield? How are final yield and years to maturity affected by spacing, water availability, individual genetics, and other factors?
- How does pruning affect yield and other factors? What are the best pruning practices for Central Valley growers that follow regulations for Valley Elderberry Longhorn Beetle conservation?

For more information on blue elderberry management, compositional analysis, marketing and other aspects of producing blue elderberries in hedgerows, please see https://elderberry.ucdavis.edu

Published online June 2020

contact:
Sonja Brodt, UC Sustainable Agriculture Research and Education Program (UC SAREP)
sbbrodt@ucanr.edu

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources
Sustainable Agriculture Research and Education Program