University of California
Agriculture and Natural Resources
Cooperative Extension
April 2020, Vol. 25.2

THE SCOOP

on fruits and nuts in Stanislaus County

Delayed Irrigation in Walnuts

Kari Arnold, UCCE, Ken Shackel, UCD, Bruce Lampinen, UCD, Allan Fulton, UCCE

Water is flowing into the canals in Stanislaus County and growers are starting to turn on the irrigation, but is this necessary? Recent research by UC Davis and UC Cooperative Extension is showing that walnut trees may not need irrigation as soon as we might think. The use of a pressure chamber is changing the way we think about irrigation.

Moisture is lost from the soil either by direct evaporation from the soil surface (particularly right after irrigation) or by plant transpiration (uptake by roots and evaporation from leaves). Once the canopy shades the ground however, even right after irrigation when the soil surface is wet, the vast majority of water loss is due to transpiration. Additionally, this large amount of water lost during transpiration is when leaves are present. Although trees do transpire during dormancy through lenticels (raised pores in the stem of woody plants that allow gas exchange), the amount is extremely low. Because of this, very little moisture is lost from soil during the dormant months unless a cover crop or weeds are present, but even in that case, the root systems of cover crops and weeds are not as deep as those of walnuts or other trees/vines.

Some believe early irrigation is necessary to fill the soil profile in the spring and push the water down deep. This may be detrimental since trees are not utilizing the soil moisture yet in great capacity. Trees irrigated early in spring tend to show stress symptoms later in July and August. Walnut trees tend to perform better when deep soil moisture is depleted throughout the season. Please see the following photos for over-irrigation in walnuts.

Also in this issue…

Authors

Kari Arnold, PhD, klarnold@ucanr.edu

Roger Duncan, raduncan@ucanr.edu

Jhalendra Rijal, PhD, jrijal@ucanr.edu

The Scoop on Fruits and Nuts in Stanislaus County is now a combined effort of UC Cooperative Extension Farm Advisors Roger Duncan, Kari Arnold, and Jhalendra Rijal and will cover topics on all tree and vine crops and associated pest management.

Due to continued corona virus concerns, our office remains closed to the public and all meetings have been cancelled through at least May 3. We can still be reached at 209-525-6800 or by email.

Recent research looking at delaying irrigation until trees read a certain stem water potential rating suggests a potential for healthier trees, without a detriment to yield. So, what is stem water potential? To answer that question, a discussion of basic plant physiology is required. Water moves from the soil to the atmosphere through plants. Plants, or walnuts, in this case, suck water from the soil, utilize some for photosynthesis (a process by which plant cells convert light energy into chemical energy) as well as nutrient transport and cellular turgidity, but eventually lose the vast majority (over 95%) to the atmosphere when stomates are open. Stomates are like very tiny doors on the underside of most leaves, that open to allow carbon dioxide in (for sugar production, via photosynthesis), and oxygen out (a by-product of photosynthesis). While those stomates are open, water evaporates from the leaf, but this water is not being "wasted." It is the "cost of doing business" for a leaf. The doors to the photosynthetic factory need to remain open for the factory to be productive. In addition, this water must be pulled by the leaf with a certain level of suction (negative pressure). The term stem water potential, or SWP, measures this suction and provides a window into how much water stress the walnut tree is experiencing – more suction means more stress.

SWP is measured during the hottest, driest periods in the day when the tree is under the most stress, typically between the hours of 1:00 pm and 3:00 pm, although in some cases this might be as late as 3:00 pm to 4:00 pm. Leaves are folded inside mylar bags which are

Bruce Lampinen
UCCE Orchard Management Specialist

typically provided with the pressure chamber, and available in multiple sizes, although the smallest bags tend to fit the chamber best. The terminal leaflet of an interior walnut leaf is bagged and allowed to hang enclosed for at least 10 minutes. During this time, the tension of the water in the leaf becomes equal to the tension of the water in the tree. For most trees, the best leaves to measure are on branches closest to the trunk in the lower canopy. The idea here is to reduce the distance from root to shoot so that the value properly represents the tree. The further away from the roots (and the more exposure to the sun), the more variable the value becomes. The stem of the bagged leaf is then inserted into the top piece, tightened down, and the stem is cut flush with the chamber top with a sharp razor blade (be careful!). The top is tightened down by either a clockwise motion for screw-top models, or sturdy push pins provided in box chamber models, and pressure is applied either by pump action or nitrogen gas canisters. Pressure is applied until a small amount of fluid is excreted from the cut stem. Always read all safety precautions and perform safe practices when operating this equipment. The value shown on the dial is recorded and compared TO BASELINE, which is the most important, and often easily misunderstood, part. Baseline is a value that generally represents a fully irrigated tree. This value varies depending on the crop, relative humidity, and temperature. Please see table 1 provided for walnut baseline values and directions on how to use it.

Trials are ongoing in both Stanislaus and Tehama counties. In Tehama, four treatments are being compared. Initially, the control, or the grower standard, was to keep trees irrigated according to evapotranspiration recommendations. The other treatments are delay treatments, with varying levels of stress being the trigger point to start irrigation, defined by stem water potential readings: one, two or three bars below baseline on a given day, consistently measured for a few days. Only the four bars below baseline treatment shows a significant drop in yield meaning one, two and three bar stress levels are equally comparable to the grower standards. After the first year's observations, the grower decided to cut back the irrigation on the control treatment because trees appeared healthier in other treatments (delay treatments). In Stanislaus, two treatments are being compared. The grower standard irrigation time is triggered by the recommended number given by a soil moisture meter at an 18-inch depth. The second treatment is delaying irrigation until the trees read two to three bars below baseline. Additionally, trees which were declining in the orchard in Stanislaus County are now recovering in the delay treatment.

When should we begin irrigating? If you have a pressure chamber, use it. Read the trees and only irrigate once the trees have reached at least one to two bars below baseline. You know your field better than anyone else, if you have an area that tends to behave differently from another, you should check both areas in terms of SWP. Yet you do not need to read every tree, just a few per block depending on the variability in your field. Feel free to contact your local UCCE farm advisor for information. For a how-to video on using a pressure chamber, check out this video from Dr. H2O himself, Ken Shackel: https://www.youtube.com/watch?v=M6ZkmB1ld60

Some of this information is also available in a separate article, "Declining walnuts, what's the deal?" which is posted on this website and available in the September 2018 issue of West Coast Nut.

Read a few trees in the block and take the average of those trees for comparison to baseline. Avoid reading edge trees due to edge effects.

UCCE University of California

Table 1. Values of midday stem water potential (SWP in Bars tension) to expect for fully irrigated walnut trees under different conditions of air temperature and relative humidity.

(Table courtesy of Ken Shackel, Department of Pomology, University of California Davis)

ANR University of California

Air	Air Relative Humidity															
Temp (F)	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
60	-3.8	-3.7	-3.7	-3.6	-3.6	-3.5	-3.5	-3.4	-3.3	-3.3	-3.2	-3.2	-3.1	-3.1	-3.0	-2.9
62	-3.9	-3.8	-3.8	-3.7	-3.6	-3.6	-3.5	-3.4	-3.4	-3.3	-3.3	-3.2	-3.1	-3.1	-3.0	-3.0
64	-4.0	-3.9	-3.8	-3.8	-3.7	-3.6	-3.6	-3.5	-3.4	-3.4	-3.3	-3.2	-3.2	-3.1	-3.0	-3.0
66	-4.0	-4.0	-3.9	-3.8	-3.8	-3.7	-3.6	-3.5	-3.5	-3.4	-3.3	-3.3	-3.2	-3.1	-3.1	-3.0
68	-4.1	-4.1	-4.0	-3.9	-3.8	-3.8	-3.7	-3.6	-3.5	-3.5	-3.4	-3.3	-3.2	-3.2	-3.1	-3.0
70	-4.2	-4.1	-4.1	-4.0	-3.9	-3.8	-3.7	-3.7	-3.6	-3.5	-3.4	-3.3	-3.3	-3.2	-3.1	-3.0
72	-4.3	-4.2	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.6	-3.5	-3.4	-3.3	-3.2	-3.1	-3.0
74	-4.4	-4.3	-4.2	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.5	-3.4	-3.3	-3.2	-3.1	-3.1
76	-4.5	-4.4	-4.3	-4.3	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.5	-3.4	-3.3	-3.2	-3.1
78	-4.7	-4.6	-4.5	-4.4	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.5	-3.4	-3.3	-3.2	-3.1
80	-4.8	-4.7	-4.6	-4.5	-4.3	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.5	-3.3	-3.2	-3.1
82	-4.9	-4.8	-4.7	-4.6	-4.5	-4.3	-4.2	-4.1	-4.0	-3.9	-3.7	-3.6	-3.5	-3.4	-3.3	-3.1
84	-5.1	-4.9	-4.8	-4.7	-4.6	-4.4	-4.3	-4.2	-4.1	-3.9	-3.8	-3.7	-3.5	-3.4	-3.3	-3.2
86	-5.2	-5.1	-5.0	-4.8	-4.7	-4.5	-4.4	-4.3	-4.1	-4.0	-3.9	-3.7	-3.6	-3.5	-3.3	-3.2
88	-5.4	-5.2	-5.1	-4.9	-4.8	-4.7	-4.5	-4.4	-4.2	-4.1	-3.9	-3.8	-3.6	-3.5	-3.4	-3.2
90	-5.6	-5.4	-5.2	-5.1	-4.9	-4.8	-4.6	-4.5	-4.3	-4.2	-4.0	-3.9	-3.7	-3.6	-3.4	-3.2
92	-5.7	-5.6	-5.4	-5.2	-5.1	-4.9	-4.7	-4.6	-4.4	-4.3	-4.1	-3.9	-3.8	-3.6	-3.4	-3.3
94	-5.9	-5.7	-5.6	-5.4	-5.2	-5.0	-4.9	-4.7	-4.5	-4.4	-4.2	-4.0	-3.8	-3.7	-3.5	-3.3
96	-6.1	-5.9	-5.7	-5.6	-5.4	-5.2	-5.0	-4.8	-4.6	-4.4	-4.3	-4.1	-3.9	-3.7	-3.5	-3.3
98	-6.3	-6.1	-5.9	-5.7	-5.5	-5.3	-5.1	-4.9	-4.8	-4.6	-4.4	-4.2	-4.0	-3.8	-3.6	-3.4
100	-6.5	-6.3	-6.1	-5.9	-5.7	-5.5	-5.3	-5.1	-4.9	-4.7	-4.5	-4.2	-4.0	-3.8	-3.6	-3.4
102	-6.8	-6.6	-6.3	-6.1	-5.9	-5.7	-5.4	-5.2	-5.0	-4.8	-4.6	-4.3	-4.1	-3.9	-3.7	-3.4
104	-7.0	-6.8	-6.6	-6.3	-6.1	-5.8	-5.6	-5.4	-5.1	-4.9	-4.7	-4.4	-4.2	-4.0	-3.7	-3.5
106	-7.3	-7.0	-6.8	-6.5	-6.3	-6.0	-5.8	-5.5	-5.3	-5.0	-4.8	-4.5	-4.3	-4.0	-3.8	-3.5
108	-7.6	-7.3	-7.0	-6.8	-6.5	-6.2	-6.0	-5.7	-5.4	-5.2	-4.9	-4.6	-4.4	-4.1	-3.8	-3.6
110	-7.8	-7.6	-7.3	-7.0	-6.7	-6.4	-6.2	-5.9	-5.6	-5.3	-5.0	-4.7	-4.5	-4.2	-3.9	-3.6
112	-8.1	-7.8	-7.5	-7.2	-7.0	-6.7	-6.4	-6.1	-5.8	-5.5	-5.2	-4.9	-4.6	-4.3	-4.0	-3.7
114	-8.5	-8.1	-7.8	-7.5	-7.2	-6.9	-6.6	-6.3	-5.9	-5.6	-5.3	-5.0	-4.7	-4.4	-4.0	-3.7
116	-8.8	-8.5	-8.1	-7.8	-7.5	-7.1	-6.8	-6.5	-6.1	-5.8	-5.5	-5.1	-4.8	-4.4	-4.1	-3.8
118	-9.1	-8.8	-8.4	-8.1	-7.7	-7.4	-7.0	-6.7	-6.3	-6.0	-5.6	-5.3	-4.9	-4.5	-4.2	-3.8
120	-9.5	-9.1	-8.8	-8.4	-8.0	-7.6	-7.3	-6.9	-6.5	-6.1	-5.8	-5.4	-5.0	-4.6	-4.3	-3.9

Common ranges of SWP under cool weather conditions (blue)

Common ranges of SWP under normal weather conditions (green)

Common ranges of SWP under hot weather conditions (red)

Table 1. Baseline values for walnuts. To use, access the temperature (in °Fahrenheit or °F) and relative humidity (percent or % RH) for your location at the time of the reading (1:00 pm to 3:00 pm). Find the temperature on the left side of the table, then follow that line over to the corresponding relative humidity. The value inside the box is the baseline for walnuts at that given temperature and relative humidity. Keep in mind the baseline value is negative, and the pressure chamber value is negative; therefore, two bars below baseline will be two numbers more negative than baseline. For example, follow 64°F on the table over to 30% RH, baseline -3.7, therefore one to two bars below baseline would be -4.7 or -5.7, respectively, which would be a good time to irrigate. If the trees read -1.7, this would mean that these trees were above baseline, no need for irrigation.

Compost May Not Improve Orchard Performance

Roger Duncan, UC Cooperative Extension, Stanislaus County

Many studies have shown that soil applications of composted green waste or manure can increase the diversity and activity of soil microorganisms, soil water holding capacity, nutrients such as potassium and nitrogen, humic acid, organic matter and carbon sequestration. Although most compost studies focus on improvements in "soil health", few if any trials have tested if compost actually enhances orchard performance or increases profits.

Current costs for purchase, delivery and application of composted green waste in the Modesto area is approximately \$27 - \$30 per ton. Common application rates range between five & ten tons of compost per acre, representing a significant investment to the grower. It is important to determine if almond growers can improve tree performance enough to recover such a substantial input cost.

Field Trials with Compost. In a Stanislaus County trial, we worked with a local nursery to determine if applying composted green waste prior to planting is beneficial when establishing an almond orchard, and if so, which rate might be best. The field was a sandy loam soil where a vineyard had been removed the previous year and the soil was fumigated. Prior to planting, composted green waste was applied at 0, 5, 10, 20, or 30 tons to the acre in a concentrated, 4-foot wide band down the future tree rows (Fig. 1). The compost was then incorporated into the soil and potted trees were planted in May 2017. The orchard was fertilized and irrigated according to the grower's normal farming practices. The trees were monitored for two years, recording tree growth, leaf nutrients and stem water potential (using a pressure bomb to monitor water stress).

At no time during the two years of the trial did we see or measure any differences in tree performance. Even 30 tons of composted green waste, at a cost of about \$800 per acre, had no effect on tree establishment, growth, leaf nutrient content or tree water status. If the rows weren't labeled, you would never know which rows had compost and which did not.

Fig. 1: 30 tons of compost per acre applied before planting.

So, one application of compost at planting did not affect orchard establishment or longer-term tree performance. What about a compost program where compost is incorporated at planting time AND applied to the soil surface every year for several years? To test this, two replicated field trials were established in 2015 to document the effects of compost and examined the differences between using composted green waste and composted cow manure. One orchard is in Riverbank on a Hanford sandy loam soil that has not been previously farmed. The test variety is Nonpareil on Nemaguard rootstock and is irrigated with full coverage sprinklers. The second orchard is in North Modesto on very sandy soil in a fumigated replant site following an almond orchard removed the previous fall. This orchard is irrigated with microsprinklers. The variety is Independence on Nemaguard rootstock.

Fig. 2: 10 tons of composted green waste applied annually

In both locations, 5.2 tons of compost per acre were applied in a concentrated band about 4 feet wide and then incorporated into the soil during planting of the bareroot trees. An additional 0.5 tons / acre was applied to the base of the new trees after one month of growth. Each subsequent spring (2016 – 2019), approximately 10 tons of composted green waste or manure has been applied to the soil surface in a concentrated band approximately eight feet wide (Fig. 2). Trees are periodically monitored for stem water potential (water stress), and annually for leaf nutrients, nematodes, growth and yield.

Results and Conclusions: Composted green waste and manure both slightly increased July leaf levels of chloride and nitrogen. Leaf calcium was significantly lower in the compost treatments. Potassium was increased in the composted manure treatment but not the green waste treatment. No other significant changes in leaf nutrients occurred. After five years of study, the application of composted green waste or manure has not increased growth or yield of almond trees whether grown in excellent, first generation orchard soil or very sandy, second generation orchard soil. Stem water potential measurements with a pressure bomb have shown that trees in compost areas have not had less water stress than without compost. Compost treatments have not reduced pathogenic nematode numbers.

Costs for purchase, delivery and application of composts at 10 tons / acre were approximately \$265 annually, or \$1,325 per acre over the five-year period. Many growers only apply five tons so their costs would be lower.

Why have we not seen improvements in tree performance? Maybe for several reasons. Although 5-10 tons of compost per acre sounds like a lot, when you consider that an acre of soil weighs well over 5000 tons, it is easy to understand how these rates of compost would not likely substantially influence soil physical properties, especially considering 35-50% of compost is water. Part of the lack of response may be that just placing compost on the soil surface may not significantly change soil physical or chemical properties below the top few inches in a no till orchard system. Preliminary soil samples of a local orchard indicated no difference in soil organic matter, cation exchange capacity or saturation percentage below four inches, even though compost had been applied annually for seven years. Perhaps with today's high input farming practices (more precise irrigation, liberal use of commercial fertilizers through fertigation, etc.), any benefits of compost would go unnoticed. Composts may be more beneficial in orchards deprived of commercial fertilizers although at a substantially higher cost. Based on leaf analyses from these field trials, manure compost may replace the need for potash (potassium). Even though 10 tons of composted green waste may contain 250 – 300 lb of nitrogen, most of it is in an organic form and only a small percentage is available to the trees during the first year. In these trials, leaf analyses indicated at most an increase of 0.2% nitrogen in July sampled leaves (2.7% N in compost-treated trees, 2.5% without compost), even after several years of application. In some years, there was no difference. It is possible that benefits to orchard systems may be very long term and not observable in just five years. There may also be special cases, like organic orchards or soils with surface water penetration issues where compost may have benefits.

Yield of Almond Trees With and Without Annual Compost Applications				
	Yield (kernel pounds per acre)			
	3rd Leaf	4th Leaf	5th Leaf	Cumulative Yield
	Orchard A. Nonpareil on Nemaguard; 1rst generation orchard, Hanford sandy loam soil			
Untreated	568 a	2148 a	3154 a	5870 a
Green Waste Compost	559 a	1992 a	2898 a	5449 a
Manure Compost	602 a	1977 a	2909 a	5488 a
	Orchard B. Independence on Nemaguard; replant site with sandy soil			
Untreated	-	1987 a	1779 a	3766 a
Green Waste Compost	-	2256 a	1788 a	4044 a
Manure Compost	-	1990 a	1859 a	3849 a

*Data followed by the same letter indicates they are not significantly different ($P<0.05$)

ID, Monitoring, and Management of Plant Bug and Stink Bugs in Almond Orchards

Jhalendra Rijal, UC Cooperative Extension IPM Advisor, Merced, Stanislaus, and San Joaquin Counties

April is the time that we need to pay close attention to "true bugs" infestation in almonds. In entomological terms, true bugs or simply 'bugs' are the insects within a group (technically, sub-order) called 'Heteroptera.' All true bugs have a slender beak-shaped or "straw" like mouthparts (in technical terms – piercing and sucking type of mouthparts, see Fig. 1) to poke through the seeds or fruits and uptake the sap or juice. Although several small and large bugs may be present in almond orchards, in this article, we discuss economically significant large bugs – leaffooted bug, a few native stink bugs, and a new invasive stink bug.

Leaf-footed bug (LFB) adults are relatively large insects, brown, and about 1-inch long, with a narrow white zig-zag band across the back and have a leaf-like structure on the hind legs (Fig. 3G). LFB may not be a big issue in every almond orchard every year, but they can cause a severe economic loss when they occur. LFB adults overwinter outside but migrate to the orchard in the spring (April-May) as the temperature warms up. LFB feeding on young almonds causes nut abortion, and ultimately nut drop. Late season feeding (i.e., mid-May and after) causes feeding injury manifested by a clear gummings on the hull, and minimal nut drop. The

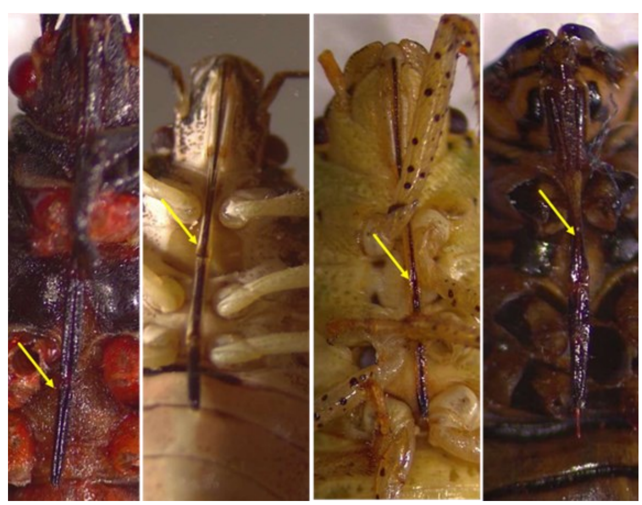

Fig. 1. Piercing and sucking type of mouthpart of large and small true bugs

Fig. 2. Leaffooted bug damaged almond kernels

majority of these nuts have kernel damage (gummy, dark spots; Fig 2) at harvest. Unfortunately, no specific trap/ lure is available LFB monitoring. The best option is to conduct regular scouting in the orchard to look for egg masses, live bugs, and damaged or dropped nuts. Visually scanning of the nuts, especially on the sunny side of the trees on edges, helps to detect live adults. Almond varieties with softer shells such as Fritz, Sonora, Aldrich, Livingston, Monterey, and Peerless are more susceptible than Nonpareil. Although LFB has two generations per year in San Joaquin Valley, the overwintering adults moving into the orchard in the spring are the ones causing the most economic damage.

Native stink bugs (Green, Uhler, Red-shouldered, and consperse) have a shield-shaped body (Fig 3 A-B, D-E). Green and Uhler stink bugs both are green, are about the same size (¾-inch). The main distinction is that Uhler stink bugs are more rounded and have yellow spots on the back and head (Fig. 3B), compared to the green stink bug, which is solid green with yellow lining with dark spots on the entire body margin (Fig. 3A). Red-shouldered and consperse stink bugs are relatively smaller in size (1/2-inch). The red-shouldered has either red/pink band across the shoulder and has the 'red feet' (Fig 3D), while consperse stink bugs lack the shoulder band, and have yellowish legs with scattered dark spots on the leg (Fig 3E). Native stink bugs often overwinter as adults outside potentially in weeds and

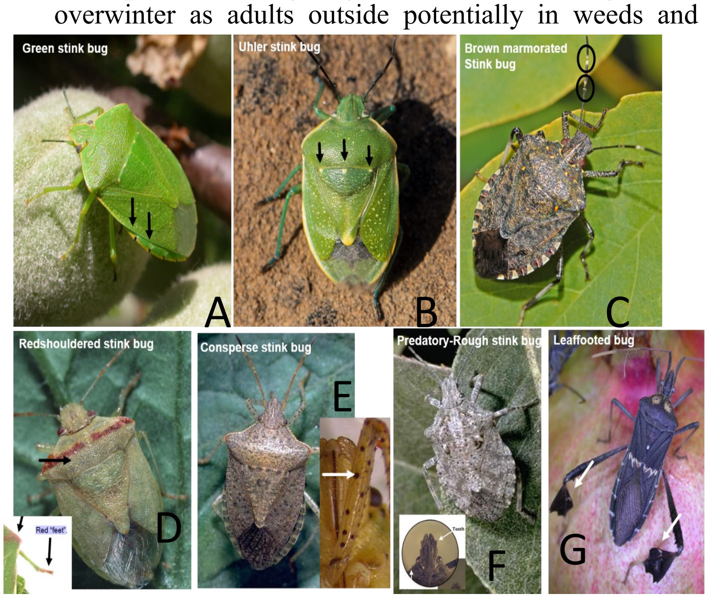

Fig. 3. Large plant bug and stink bugs in almond orchards

move into the almond orchard in summer (June-July). Some species (e.g., green stink bug) may overwinter within the orchard. Don't confuse these pest stink bugs with the predatory one - rough stink bug (Fig. 3F), which can be found commonly in tree fruit and nut orchards in California. The rough stink bug is a faded gray or "dull" color compared to pests (consperse or BMSB) and has a toothlike projection on the lateral side of the head (Fig. 3F).

Native stink bug feeding can produce clear gumming on the hull (Fig 4), with potentially some kernel damage, but minimal nut drop. Also, this late-season feeding may cause external gumming to the hull, but most of that infestation can end up not impacting the kernel. Similar to LFB, visual monitoring of gummy fruits (Fig. 4A), barrel-shaped egg masses (Fig 4B), and live bugs are the methods to monitor stink bug activity in the orchard. Stink bugs are sporadic pests, and the damage level is not justifiable to spray insecticide.

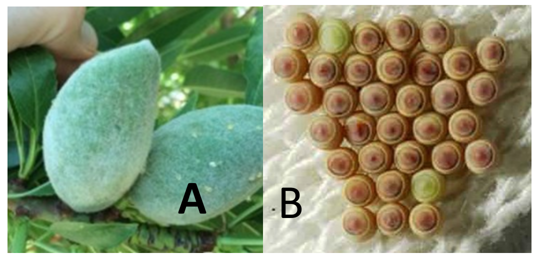

Fig. 4.A) Clear but minimal gumming in almond due to native stink bug feeding in almonds (Source: The Almond Doctor) B) stink bug egg mass with barrel -shaped eggs

Brown marmorated stink bug (BMSB) is a new invasive stink bug species and has established more than 40 states since its first detection in Pennsylvania in the early 2000s. BMSB is a fairly big (size ~ ¾ inch) and marble brown stink bug species. The most important characteristic to identify BMSB is having two white bands on its antennae and legs (Fig 2C). BMSB has over 170 host plants. In Central Valley, this stink bug was first established in the Sacramento area in 2013 but now found pretty much all counties from Glenn to Fresno, mostly residential areas. To date, damage in commercial orchards is limited to Stanislaus and Merced counties. BMSB feeding may begin as early as mid-March when overwintering adults migrate into the orchard and can feed on almonds throughout the season. They overwinter near farmland in homes, shops, woodpiles, etc. Early-season feeding (from the fruit set and before shell hardening) tends to be very serious as adult feeding at this time can cause substantial nut abortion and drop.

BMSB feeding signs in almonds include gummy nuts in a cluster with multiple feeding spots within the fruit (Fig 5). See various signs of BMB feeding in Fig. 5. Some of the signs of BMSB feeding resemble the LFB and other stink bugs, but the severity and timing of damage are different (see Table). BMSB damage occurs as early as mid-March and seems to continue for a few weeks to months. In the northern San Joaquin Valley, we observed BMSB infestation in multiple almond orchards in the past three years, with a substantial nut drop in April and sometimes until mid-May. The feeding signs found on the hull after the shell hardening (mid-May to August) is identical with

Table. Summary of various characteristics of the large bugs feeding in almonds

Description	Native Stink Bugs	Leaf-footed Bug (LFB)	Brown Marmorated Stink Bug (BMSB)
Adult ID	Shield-shaped. Various colors	Narrow brown body	Shield-shaped with white bands on antennae
Damage occurrence timing	June-July	March-April	March-July
Generation(s) causing damage	Overwintering adults	Overwintering adults	Overwintering adults and seasonal adults/ nymphs
Population building over the season	Low	Low-Moderate	Moderate-High
Feeding damage symptoms			
Gummosis (Clear gumming)	Multiple – thread-like	Single to few – thread-like	Multiple – 'glob- like'
Nut drop	Not common	Common (April-May)	Common (March-early May)
Mid-to-late season feeding occurrence	Yes (June-July)	Not significant	Yes (May-July) Capable to penetrate to the kernel
Kernel damage	Wrinkled or dark spots. Late-season feeding may not damage kernel	Aborted or gummy or sunken dark spots	Aborted or gummy or sunken dark spots

the LFB bug and native stink bug damage; however, the degree of kernel damage by the late-season BMSB feeding (Fig. 6) tends to be higher than other bugs. Also, once established, BMSB abundance in the area tends to be steady, and that poses a higher risk. In our experience, Fritz, Monterey, Aldrich, and Butte are more susceptible than Nonpareil. Also, damage incidence is much higher in the border rows (Fig 7), mostly in a side of the orchard next to the open field or alternate hosts such as Tree of heaven, *Ailanthus altissima.* These trees are abundant in many residential areas, near to the highways, and in orchards that are closer to residential areas.

For monitoring, commercial traps and lures that attract both nymphs and adults of BMSB are commercially available to use. We recommend to use sticky panel traps (9 x12-inch double-sided sticky) that can be affixed to the top of a 5-ft long wooden stake, 1-ft of which is pounded into the ground. The lures can be suspended on top near to the sticky panel (see Fig 8). BMSB lures and sticky traps can be purchased from Trece Pheromone company. These traps should be placed in the border-tree row facing the open field and other potential overwintering sites. We recommend a minimum of three sticky panel traps in an orchard. Besides, it is vital to do a visual sampling of the orchard for stink bug life stages (Fig. 9) and damaged nuts. The visual observation and beat-tray sampling should also be focused on trees on the edges of the orchard.

Managing LFB and stink bugs in the orchard. It is crucial to conduct visual and trap-based monitoring (if traps are available) to detect bug activity in the orchard. There are several predators and parasites (e.g., birds assassin bugs, spiders, and parasitic wasps) out there to keep the bug population below a certain level. A known egg parasite, *Gryon* spp., can keep the leaffooted bug population under control in later part of the season. However, as egg parasites, they cannot control the adult leaffooted bugs in the spring. Seeing a few native stink bugs in the orchard in June may not need any kind of

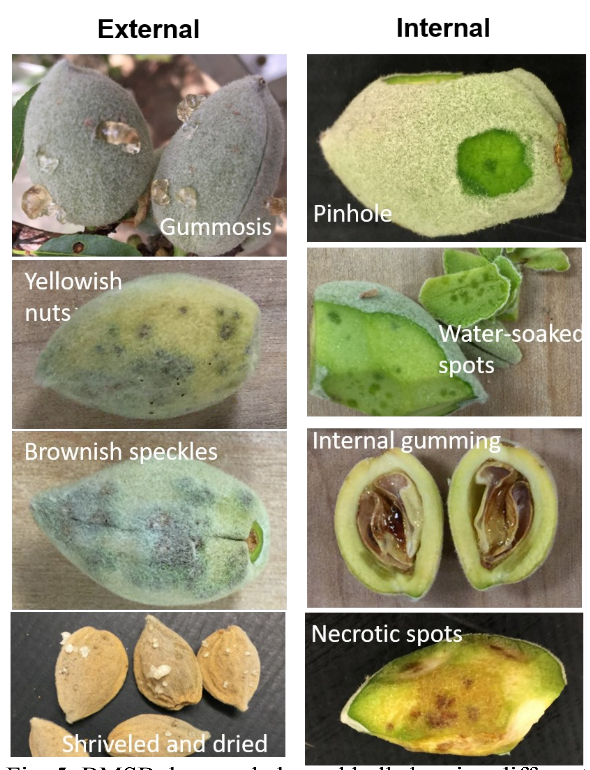

Fig. 5. BMSB damaged almond hull showing different feeding signs. Notice clear gumming (multiple) with big sized 'blobs' on the fruit externally

treatment as not all levels of pest pressure warrants treatment. There are currently no treatment thresholds for leaffooted and stink bugs in almonds. Spring infestations, either by the leaffooted bug or by BMSB, are more critical as the nuts are much vulnerable to abortion and drop. For all true bugs, pyrethroids (bifenthrin, lambda-cyhalothrin, esfenvalerate), and neonicotinoids (clothianidin) are considered effective. Keep in mind, though, that the use of these broad -spectrum insecticides in the early part of the season likely impacts the natural enemies of mites and other pests. Please follow the UCIPM Pest Management Guidelines for the [stink bug] and [leaffooted bug] for specific insecticide, rates, and potential effectiveness and impact on the natural enemies. Typically, the one-time spray should be enough for the leaffooted bug control in the spring, if scouting warrants a treatment. For BMSB, due to the overlapping generations and extended period of the adult presence in the orchard from spring through summer, multiple applications may be required. In that case, it is essential to rotate among the active ingredients. Our lab-based bioassays showed that bifenthrin, lambda-cyhalothrin, lambda-cyhalothrin+chlortraniliprole based insecticides are effective against BMSB in almonds. For organic productions, based on the trials conducted in other states in various crops, here are some insecticide products to use against BMSB: Azera (Azadirachtin + pyrethrin), Azera + M-Pede (Potassium salts of fatty acid), Aza-Direct (Azadirachtin), Entrust (Spinosad), Pyganic (Pyrethrin), Encap (Pyrethrum), Pyganic + Surround (Kaolin). Please follow label instructions before using any pesticides.

Fig. 6. Almond kernel at harvest damaged by BMSB feeding at different times of the year

Fig. 7. Substantial nut drops due to BMSB feeding in almond orchard in Turlock. Note that border row (1st row) has visibly higher level of damage compared to the 3rd and 5th row of the orchard.

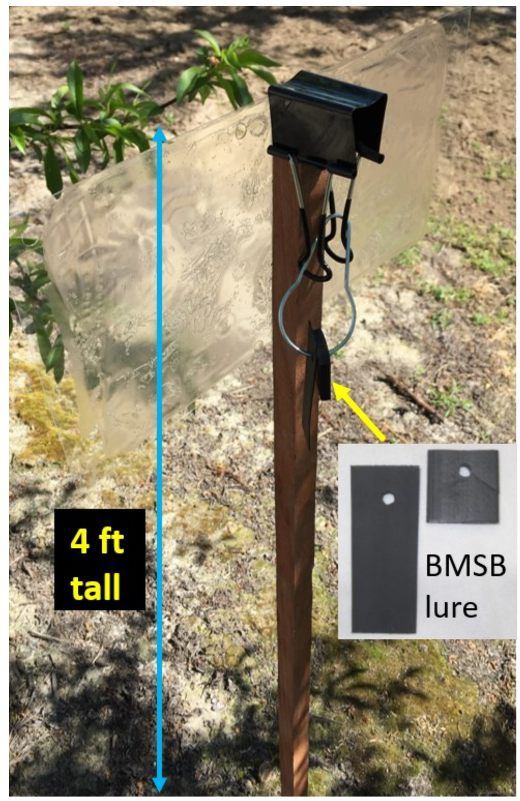

Fig. 8. Sticky panel trap with BMSB lures for BMSB monitoring

Fig. 9. Different life stages of BMSB (from left to right: 1st instar nymphs coming out from the eggs, 2nd, 3rd, 4th, 5th instars, adult male, adult female; Photo: W. Hershberger, stopbmsb.org)

University of California
Agriculture and Natural Resources

Cooperative Extension

April 2020, Vol. 25.2

In This Issue:

- Delayed irrigation in walnuts
- Compost may not improve orchard performance
- Managing true bugs in almonds

UNIVERSITY OF CALIFORNIA
COOPERATIVE EXTENSION
3800 Cornucopia Way, Suite A
Modesto, CA 95358

NONPROFIT ORG.
US POSTAGE PAID
MODESTO, CA
PERMIT NO. 400

CURRENT RESIDENT OR