CWSS Research Update and News

Information on Weeds and Weed Control from the California Weed Science Society

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In This Issue

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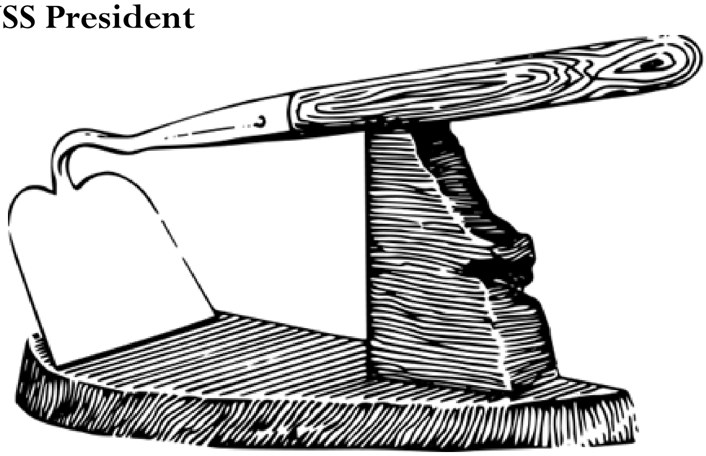
Message from CWSS President

CWSS Members,

As the year comes to a close, now is a great time to catch up on the fantastic work being done by our colleagues in weed science. Thank you Clebson for putting together another excellent Research Update! Now is also a great time to make sure you are registered for our Annual Conference which will be held January 28-30, 2026 at the Hilton Santa Barbara Beach Front Resort.

We look forward to seeing you all there!

Joy Hollingsworth
CWSS President



Morphology and Control of White Water Fire in California

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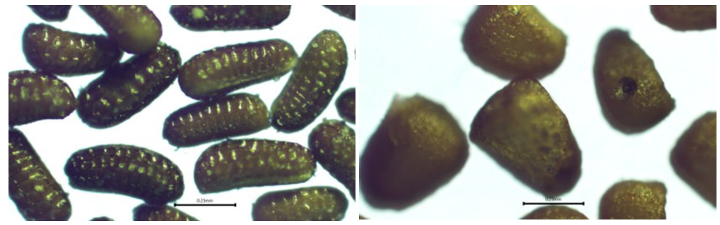
White Water Fire (*Bergia capensis* L.) is an annual broadleaf weed native to southern China, tropical Asia, and Africa, which was recently reported in a California rice field by the Butte County Agricultural Commissioner's office in September 2023. This is the first confirmed report in California and, most likely, in the United States. This immediately raises concerns about its potential economic and environmental impacts; however, due to incomplete and inadequate information, White Water Fire could not be rated appropriately.

White Water Fire plants.

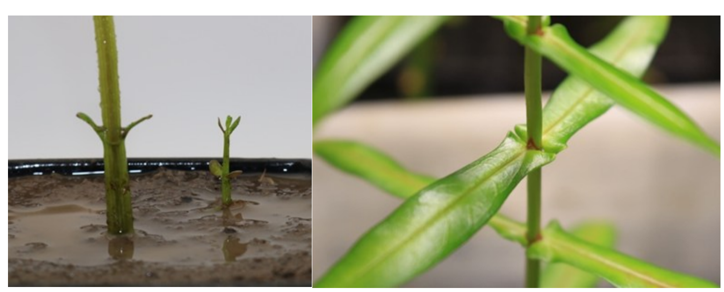
White Water Fire is often mistaken for the more common broadleaf weed Redstems (*Ammannia* spp.), leading to potential misidentification in the field. However, some of the key distinguishing features include that White Water Fire has broader, thicker, ovate leaves with some examples having minor serration. They also produce white flowers, which all surround a round stem characterized internally by an extremely small central pith surrounded by large air spaces known as lacunae, arranged in a highly organized radial pattern like spokes on a wheel.



Seeds of White Water Fire (left) and Redstems (right).

Leaf of White Water Fire (left) and Redstems (right).

Redstems, on the other hand, have narrower, thinner, linear leaves with a very distinct shape characterized by the base of the leaf wrapping around the stem, with the shape known as auriculate, and the overall shape of the leaf being lanceolate. These all surround the stem, which distinctly varies from red to green with a clear square/rectangular shape. The internal portion of the stem differs significantly from that of White Water Fire, featuring a distinct, large pith. This pith is surrounded by a more sponge-like aerenchyma/cortex with air spaces that are less organized than those of White Water Fire. Another key feature is the flowers, which typically range from purple to pink.



White Water Fire (left) and Redstems (right).

Some other distinct features include the seeds of both plants being very different, with White Water Fire having small, ellipsoidal or oblong seeds with regularly aligned rows of pits that create a ribbed appearance. On the other hand, Redstems seeds are more like a hemisphere with an overall more ovate shape and less consistency. With how small the seeds are, there is no benefit for field identification, as they look close enough to each other that they would be challenging to identify in the field. However, one key thing could assist in the field identification would be that Redstems have a more yellow seed in color and a rounder shape while White Water Fire is darker in color being a dark brown to black and much longer and oval in shape.

White Water Fire (left) and Redstems (right).

White Water Fire and Redstems were treated with six herbicides commonly used in rice production: Loyant CA, Grandstand CA, Regiment CA, Cliffhanger SC, RebelEX CA, and SuperWham! CA. Loyant CA was the most effective herbicide with over 95% control of White Water Fire at 28 days after treatment (DAT), followed by Grandstand CA with 80% control (Table 1). Preliminary results also confirmed that copper sulfate applications inhibit seed germination and control White Water Fire, which might be promising for reducing overall costs for rice growers.

Table 1. White water fire herbicide treatments.

No	Herbicide	Active ingredient	Group	Rate	Unit	Timing	Control (%)
1	Loyant CA	florpyrauxifen-benzyl	4	40	g ai ha^{-1}	10–15 cm tall	95
2	Grandstand CA	triclopyr	4	420	g ae ha^{-1}	10–15 cm tall	80
3	Regiment CA EZ	bispyribac-sodium	2	45	g ai ha^{-1}	10–15 cm tall	0
4	Cliffhanger SC	benzobicyclon	27	302	g ai ha^{-1}	10–15 cm tall	15
5	RebelEX CA	penoxsulam + cyhalofop-butyl	1&2	44 + 312	g ai ha^{-1}	10–15 cm tall	5
6	SuperWham! CA	propanil	5	6,725	g ai ha^{-1}	10–15 cm tall	50
7	Nontreated control	—	—	—	—	—	—

Replications: 4, Design: RCBD, Treatment units: Treated Pot, Experimental unit size: 9 cm × 9 cm plant pot.

White Water Fire plants at 28 DAT. Upper left, nontreated; upper right, Loyant CA; bottom left, SuperWham! CA; and bottom right, Grandstand CA.

Evaluating Novel Stale and False Seedbed Methods for Weed Control in Organic Snap Bean Production

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Summary: The processed vegetable industry is interested in expanding organic production and needs new tools for organic weed management. Stale and false seedbed methods are an important tool used in organic production to reduce weed populations during the crop's growing season. Electric weed control (EWC) is a novel tool with potential for use in organic annual production systems. EWC, flaming, and tillage were evaluated in false stale seedbed and stale seedbed methods on snap beans. EWC performed best on larger weeds and in a stale seedbed than a false stale seedbed. Flaming performs best on small weed seedlings and tillage can work in either scenario. Stale seedbeds are a better option to avoid potential crop injury. Treatment differences across weed control were observed. EWC improved control of pigweeds, nightshades, purslane, and wild radish compared to tillage. Further research is needed to confirm results and improve the use of EWC as a new tool for organic vegetable production.

Keywords: *Electric weed control, flaming, tillage, processed vegetables*

Introduction:

Organic vegetable production is an increasing market for processed vegetable producers; however, weed management is often the main challenge in transitioning fields to organic. Few effective tools are available for organic weed control.

Stale and false seedbed methods are useful tools to reduce weed populations in a field in both conventional and organic fields (Boyd et al. 2006). The stale seedbed method is when fields are prepared and irrigated to let weeds emerge and then controlled by herbicides, flaming, or tillage. The false seedbed method is when the field is prepared and the crop is planted, then herbicide, flaming or shallow tillage kills emerging weeds on the soil surface before the crop emerges over the soil.

Electric weed control (EWC) is an emerging tool that may have a fit for organic vegetable production; however, minimal research is available in annual cropping systems. In a stale and false seedbed, it could provide an additional tool with minimal soil disturbances and may control missed weeds from the other available tools.

Objective:

Evaluate weed control and crop injury from EWC, flaming, and tillage alone and in combination in false stale seedbed and stale seedbed methods on snap bean production.

Methods:

Two studies were conducted at the Oregon State University Vegetable Research Farm in Corvallis, OR in June and August 2025.

Trial 1 evaluated EWC and flaming alone applied is a false stale seedbed method. The field was prepared by discing and a single pass with a power harrow, then, snap bean variety 'OSU 5630' was planted on two 30-inch rows at 10 seeds per foot.

Treatments were then applied once weed seedlings were observed in the plots. EWC was applied with a tractor driven electricity generator and an offset 4 ft wide applicator (EH30 Thor, Zasso, Brazil) (*Figure 1*).

Figure 1. *Trial 1, EWC application in a false seedbed method at 3 mph. In his field, snap beans emerged quicker and outgrew the weeds leading to greater bean injury at the time of application.*

The electricity is generated from the PTO. The application speed was about 3 mph. The flame treatments were applied with a custom-made tractor driven two-row flamer that only applies flame over the crop row as described in Peachey (2019) (*Figure 2*). The flame is created with propane at 10 gal/A and an electric switch that ignites the flame. The application speed was 3 mph. Weed control and crop emergence and injury were collected at 1 and 2 weeks after treatment (WAT).

Figure 2. *Two-row flamer used in the study to apply over the crop rows in trial 1. The snap beans emerged to early and were larger than the weeds at time of application leading to significant injury on the beans.*

Trial 2 evaluated EWC and tillage alone in stale seedbed method and a combination with flaming in a stale plus false seedbed method. A different field from the previous study was chosen which had greater weed population pressure. The field was prepared with the power harrow and irrigated twice. Weeds were allowed to get larger in this field before treatments. EWC was applied with similar equipment as mentioned above but at 0.5 mph. The tillage treatment was applied with a tractor PTO-driven rototiller with two passes on the plots at about 2 mph. After the treatments snap beans were planted on two 30-inch rows at 4 seeds per foot. Weed counts and crop stand count were collected at 1 and 3 WAT within the crop row only on a 24 in by 5 in quadrat that went over the crop row. Weed biomass was collected at 2 WAT with the same quadrat.

All data was run by ANOVA and mean separation with Tukey's HSD (α=0.05) where appropriate.

Results and Discussion:

Trial 1. The field site did not have high enough weed populations and therefore, snap beans emerged quickly and established faster than weeds. In this scenario, the false stale seedbed did not work and many of the beans were killed by the electric and flame.

Despite the emerging beans, EWC was still applied; however, it was applied at a faster speed to see if we would avoid injury to some of the emerged beans (Figure 1). EWC needs good contact with the plants to cause injury and kill. Many of the beans with the first true leaves developed were killed, while the small weed seedlings were left untouched or only slightly damaged (*Figure 3*). Additionally, at the 3mph the equipment was not a smooth ride and may be too fast for this equipment to operate on in this field site.

Figure 3. *Snap beans injury from EWC minutes after application in trial 1. The emerged snap beans already had their first true leaves developed, which led to greater contact with the applicator unlike the small weeds that were missed.*

Flame injury on the emerged beans was also observed (*Figure 4*). Snap beans are moderately tolerant to flame when only the hypocotyls have emerged over the soil or still protected under the soil as it begins cracking after emergence (Figure 2; Peachey 2019).

Figure 4. *Flame injury to emerged snap beans. Snap beans are moderately tolerant to flame if less than 12% of seedlings and 8% of hypocotyls have emerged from the soil.*

On average, EWC resulted in nearly complete snap bean stand loss while with flaming some beans remained for about 50% stand compared to the nontreated (*data not shown*). No weed control treatment difference was observed after killing the beans in this study (*data not shown*).

Trial 2. Trial 2 was conducted in late August and in a different field with greater weed populations. At time of application, weed dry biomass averaged 161 g/10ft^2 made up of pigweeds, common lambsquarters, hairy nightshade, purslane, crabgrass, witchgrass, and wild radish (*Figure 5*). The EWC treatment left weed residue on the plots and snap beans were planted right after and no soil disturbance occurred (Figure 6).

After the treatments at 2 WAT, no difference across weed dry biomass within the crop row was observed. Weed dry biomass was 4 to 6 g/quadrat in the crop row (data not shown). While weed biomass was no different, weed counts did differ across species (Table 1). Most notably, EWC reduced pigweeds, nightshades, purslane, and radish compared to tillage (*Table 1*). The grass control appeared to be less by EWC; however, the grass weeds were not dominant in the field and patches were common in the field.

Figure 6. *Left, a 4-ft wide application with EWC on emerging weeds before planting snap beans. The seed bed was not tilled again before planting, and the snap beans were planted in that 4-ft wide area shortly after. Right, tillage for controlling emerged weeds and preparing the seedbed before planting snap bean.*

Table 1. *Snap bean and weed count within the crop row of the plot at 3 WAT for trial 2 on stale seedbed and false stale seedbed methods in Corvallis, OR*[1]

Treatments	Snap bean	Pigweed	Lambsquarters	Nightshade	Purslane[2]	Wild radish[2]	Grasses[2,3]
	Number per quadrat in crop row[4]						
Tillage	3 ab	13 a	11 b	7 ab	6 a	2 a	0 b
Tillage, fb flaming after planting	2 b	15 a	25 a	8 a	2 b	1 ab	0 b
EWC	3 a	6 ab	11 b	4 bc	1 bc	0 b	1 a
EWC, fb flaming after planting	2 b	3 b	10 b	1 c	0 c	0 b	1 a

[1]Means with the same letter within a column do not differ by Tukey's HSD α=0.05.
[2]Data was log-transformed and back transformed for presentation.
[3]Grasses were grouped together but most species observed was witch grass and crabgrass.
[4]Quadrat was 24 in by 5 in

The additional flaming treatments did not necessarily improve weed control in this study. In this field, the flaming was more appropriately applied with less than 15% beans emerging over the soil and some weed seedlings present on the soil surface (*Figure 7*). However, this research demonstrates some difficulties in flaming after planting which can injure crops and not provide additional weed control. The flaming may have performed better if performed before planting snap beans, but that would delay planting. Flaming in an EWC treated area is not recommended. A lot of weed residue remained and was prone to catch fire after passing the flamer (*Figure 7*). Mowing before planting may be useful to reduce the residue; however, that may compact the soil even more and could affect crop response negatively. Future research aims to explore methods for EWC to be used in no-till systems effectively and efficiently.

EWC followed by flaming in crop row

EWC followed by flaming

Tillage followed by flaming in crop row

Tillage followed by flaming

Figure 7. *Treated plots 2 weeks after treatment and snap bean planting in trial 2.*

Conclusions:

This research demonstrates potential for EWC in organic vegetable production systems as a stale seed bed method as compared with tillage and flaming. EWC performs best when weeds are larger, and good contact with the electrodes occurs unlike flaming which performs best when broadleaf weeds are small seedlings and tillage can work in either scenario. False stale seedbed methods can work on snap beans if you understand field history and know the weed population beforehand and the correct equipment is utilized. However, stale seedbeds may be a better option to avoid potential crop injury. Weed control across different species by the treatments was observed. EWC could provide value in control of weeds other methods don't control or could be integrated with other methods for improved control. Future research will continue to explore the EWC in stale seedbed methods for organic vegetable crops.

Acknowledgements:

Funding was provided by the Oregon Processed Vegetable Commission and Oregon State University Agricultural Research Foundation.

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Response of Walnut Leaf Mulch for Weed Suppression in Organic and Conventional Orchard Systems

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Introduction:

Typically, weed management practices in walnut orchards include preventative, chemical, physical/mechanical, and cultural controls. In organic farming systems, mechanical mowing is still the primary weed management tactic in the middle and tree rows. On the other hand, for conventional farming systems, herbicide use is the primary management practice, and it provides practical and economical weed control. However, overreliance on herbicide use has exacerbated herbicide resistance problems in weeds, and poor weed control has often been observed in conventional orchard systems. Typical examples observed of weeds suspected of being resistant to herbicides, or that herbicide programs have failed to control in walnut orchards, included Italian ryegrass (*Lolium multiflorum*), horseweed (*Conyza canadensis*), and hairy fleabane (*Conyza bonariensis*).

Walnut leaf mulch over the tree row for integrated weed management is not a new concept. Annual weeds established from seed can be suppressed by practices that cover the soil surface and discourage germination, which block sunlight and physically cover the soil and alter the soil environment. The use of walnut leaf biomass as a natural mulch and an eco-friendly practice can help prevent weed seed germination by excluding light and/or acting as a physical barrier that prevents weed emergence. Beyond that, several studies have shown potential allelopathic effects of juglone and leaf extracts of walnut on seed germination and seedling root and shoot growth (*Kocacë and Terzi, 2001; Zhang et al., 2008; Chauhan et al., 2022; Đorđević et al., 2022*).

Despite the multiple benefits of walnut leaf mulch for weed control, this strategy has been minimally adopted by growers or recommended by managers and Pest Control Advisors (PCAs) in California. Walnut leaf mulch is particularly challenging because of the lack of field research available in the literature regarding weed control effectiveness, the impact of this strategy on soil organic matter accumulation, soil moisture, soil temperature, root diseases, vertebrate and invertebrate pest populations, and the concern that the presence of the mulch would interfere with winter sanitation.

Objective:

Given the importance of finding an integrated and low-input strategy for weed management, field research trials were conducted in the 2024/2025 growing season in one organic and one conventional walnut orchard with an existing stand of mixed grass and broadleaf weeds to assess the walnut leaf biomass mulch thickness required for adequate weed suppression (***Figure 1***).

Figure 1. *Walnut leaf mulch small plots trial as a low-input strategy for weed management.*

Procedures:

One of the benefits of using walnut leaf as mulch is that growers will not have additional costs associated with the transportation or purchase of other mulch sources. An established walnut orchard may produce enough biomass to cover the tree rows. The only requirement and added cost to this management strategy is to sweep the leaves into the tree rows after harvest in late fall or early winter (***Figure 2***).

Figure 2. *Walnut leaves being swept into the tree rows.*

Results:

Our results have demonstrated that walnut leaf mulch effectively suppresses the weed community in the tree rows (***Figure 3***). Both four and eight-inch-thick mulch were enough for effective control of annual winter and summer weeds throughout the growing season. The results showed that even in the late summer, control was still greater than 60% even with four-inch-thick mulch (***Figure 3***).

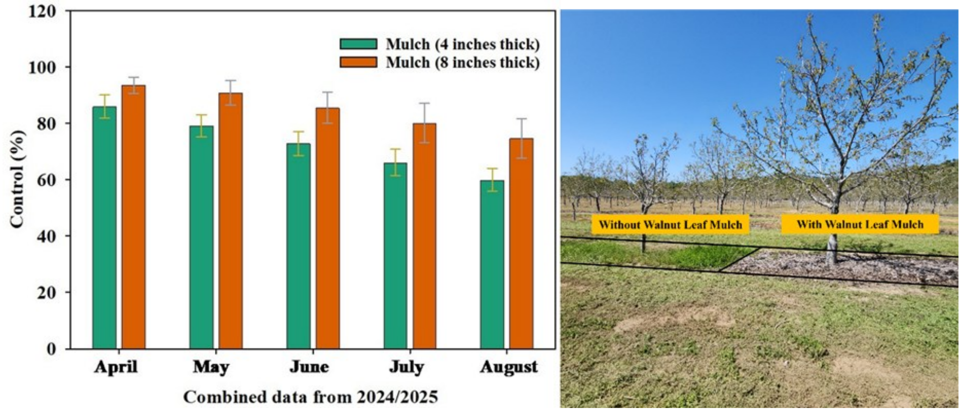

Figure 3. *Weed control (%) throughout the growing season with walnut leaf mulch (4 and 8 inches thick).*

Perennial weeds such as field bindweed (*Convolvulus arvensis*) and blackberry (*Rubus* spp.) proved more challenging to control (***Figure 4***), and over time, emerged through the four-inch-thick mulch more frequently compared to the eight-inch-thick mulch.

Figure 4. *(A) field bindweed (Convolvulus arvensis) and (B) blackberry (Rubus spp.) emerging through the walnut leaf mulch.*

In addition, we also observe a reduction in soil temperature in the plots using the walnut leaf mulch of greater than 5 °F. The reduction in temperature may contribute to holding the soil moisture for an extended period of time in the tree rows by preventing evaporation from occurring at the soil surface when compared to bare soil control plots (*data not collected*).

It is expected that walnut leaf mulch will degrade relatively quickly, avoiding biomass accumulation on the soil surface by the harvest time. However, growers should be aware that too thick mulch may lead to a high accumulation of biomass in the tree row. Mulch that is greater than 10 inches in thickness can make mowing difficult in the tree rows before harvest and may affect the harvesting process by affecting the sweep of the nuts.

Soil disturbance by wild pigs was observed in both orchard sites where the leaf mulch weed management strategy was implemented. The accumulation of biomass in the tree rows associated with soil humidity and temperature may attract wild pigs to dig the tree rows' soil profile, looking for earthworms or other food sources (***Figure 5***). This may be a drawback associated with this type of weed management strategy in sites with wild pig infestations.

Figure 5. *Soil disturbance by wild pigs in a walnut orchard site where walnut leaf mulch was implemented for weed management.*

Organic and Conventional walnut growers in Lake County, CA, have implemented walnut leaf mulch for weed management successfully, as shown in the following examples. In organic farming systems, growers have reported a reduction in the number of mowings in the tree rows. Growers have also reported the benefits of this integrated weed management practice in conventional farming systems. As a result, conventional growers were able to reduce the volume of herbicide applications by adopting spot applications (***Figure 6A***) or by projecting the herbicide spray line outside the mulch line/tree rows (***Figure 6B***). In particular, the strategy of projecting the herbicide spray line away from the tree rows may bring several benefits, such as reducing the number of mowings in the middle, mitigating the risks of herbicide uptake by the trees, and reducing the potential risks of tree trunk damage due to overreliance on a number of herbicide sprays over time.

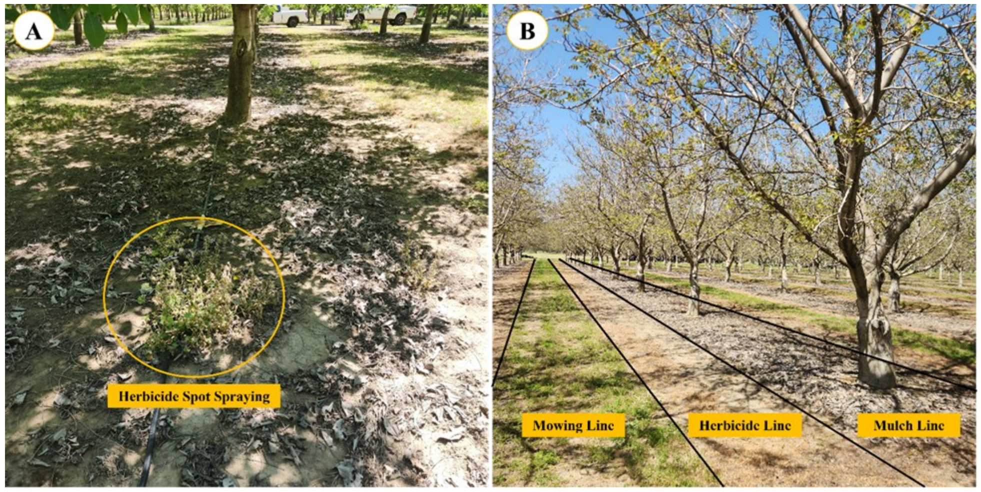

Figure 6. *Adoption of herbicide spot application (A) and herbicide spray line outside the mulch line/tree rows (B) in a conventional walnut orchard site where walnut leaf mulch was implemented for weed management.*

As a low-input strategy, the results of those studies suggest that walnut leaf mulch may be implemented as a sound integrated weed management practice. This research establishes successful documented cases of using walnut leaf biomass mulch to provide integrated weed management in organic and conventional walnut farming systems. Several benefits can be expected when adopting this management strategy, including improved economic profitability, environmental sustainability, and resilience of walnut orchards.

However, there are still several knowledge gaps that require further study, including the impact of this strategy on soil organic matter, soil quality, tie-up of soil nitrogen, soil moisture, diseases (root or crown rot or canker disease caused by soil moisture), vertebrate and invertebrate pest populations, and the selection of new weed community species more adapted to this type of weed management (perennial weeds establishing and spreading from rhizomes or stolons). For all these reasons, it is difficult to determine when and how walnut leaf mulch should be used. This lack of information warrants additional research regarding the effectiveness of walnut leaf mulch practices in short and long-term perspectives.

Acknowledgment:

We thank the grower cooperators for allowing these trials to be conducted at the Walnut Orchards. We thank the UCCE Lake and Mendocino counties agricultural technicians (Wilfredo Bello and Taylor Delbar) for field support.

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