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P.O. Box 440
Santa Cruz, CA 95061
831-426-6606
www.ofrf.org

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Title: Use of Walnut Hulls for Weed Control

Principle Investigator:
Zachary Heath
Research Assistant
U.C. Cooperative Extension, Glenn County
P.O. Box 697
Orland, CA 95963
530-865-9397

Cooperating Investigator:
Bill Krueger, Farm Advisor, UCCE, Glenn County

Cooperating Growers:
Ronald Heath-Heath Ranch, Orland, CA

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Use of Walnut Hulls for Weed Control

Zachary Heath and Bill Krueger, U.C.C.E. Glenn County

Abstract: Walnut hulls were applied 3 inches deep in the tree row of a mature conventional prune orchard to determine the suitability of walnut hulls as a mulch for weed-control. Evidence of phytotoxicity from the presence of juglone was not seen in the weeds growing through the mulch nor 'on the trees. The hulls were slightly less effective as mulch in comparison to almond shells, which have no known allelopathic properties.

In a similar trial funded by the Organic Farming Research Foundation, walnut hulls were applied to a one-year-old organic citrus orchard. Due to the rough orchard floor, weed control was much less effective at the same rate of application. Phytotoxicity was observed in two species that were not present in the other trial; Buckhorn plantain *(Plantago lanceolata),* Curly dock *(Rumex crispus),* and Cluster dock *(Rumex conglomeratus).*

Problem and Significance: Weed control was cited as one of the primary problems for organic growers, and ranked as the second greatest problem for organic fruit and nut growers, according to the *3rd Biennial National Organic Farmers' Survey.* Weed control options for organic growers are few, and any additional weed control methods would be valuable. Walnut hulls used as mulch around perennial crops may be an effective means of controlling weeds, not only from the weed-smothering effect of the mulch, but also from the allelopathic properties of the hulls. Walnut hulls are known to contain a substance called juglone, which acts as a respiratory inhibitor in many plants *(Purdue pub. #H0-193, Black Walnut Toxicity*). Walnut hulls also contain about 5% protein at harvest, which may contain sufficient amounts of nitrogen that would also cause them to be of value to organic growers as a fertilizer.

Walnut hulls are typically not utilized for any purpose and are often a disposal problem for hullers, and many walnut processors have concerns that the disposal of walnut husks may be regulated in the near future. Often, husks and culls are dumped into piles outside, where they may contribute to nitrate contamination after decomposition.

Objectives: This trial will:

a. study the effectiveness of walnut hulls as a weed control tool;
b. evaluate any phytotoxicity to the trees treated with the walnut hulls;
c. determine if the weed control properties are due to the effects of juglone or from the mulching effect;
d. note any weeds tolerant to juglone at this particular site;
e. evaluate the walnut hulls' potential as a source of plant nutrients;
f. determine the effective life-span of hulls as a weed control agent.

Materials -and Methods: Walnut hulls were applied at two different sites in Glenn County, California; in a one-year-old organic orange orchard and in a 25-year-old conventional prune orchard. In the citrus orchard, hulls were collected and applied on 12/29/99. The hulls were obtained from a local huller and had been allowed to sit in large piles for 1-2 months. Besides walnut hulls, the material also contained twigs, leaves, culled walnuts, and walnut shells, and was moist and partially decomposed. The material was applied around six orange trees (2 Navels on Carizzo citrange and 4 Navels on trifoliate rootstock), in a mulch 3" deep, 10' long, and 34" wide. Almond shells (without hulls) were also applied to six other trees on 1/14/00, in order to determine if the juglone or the mulching effect is responsible for any weed control. Both mulches resulted in the application of 8.3 cubic feet per tree. There was also an untreated check. All treatments were disked the same day, prior to application. The orchard was flood irrigated and planted at a 10'x 18' spacing. Weed control up to this point had been disking only. The orchard had previously been irrigated pasture.

At the prune orchard, the walnut hulls and almond shells were collected and applied 1/14/00. The treatments had been sprayed with Roundup earlier that fall,, and had not been cultivated. No pre-emergents had been applied for at least three years. Besides the hull, shell, and control treatments, a herbicide treatment was added, identical to the grower's herbicide program (Roundup sprayed several times per year). Room for an additional treatment was also set aside but was not used. The mulches at this site were applied in an area 20'long by 5'wide by 3" deep, resulting in 25 cubic feet per tree. The orchard was a French Prune orchard on several different plum rootstocks with solid-set sprinkler irrigation, with a spacing of 20'x 20'.

The treatments at both sites were placed in a single tree randomized complete block design and replicated six times (in the oranges) or five times (in the prunes). Weeds growing under these trees were identified and visually rated for percent ground cover once a month. At the prune orchard, soil temperatures were taken at 4" depths monthly. Pressure bomb measurements were taken periodically to observe any interference with water uptake.

The orange site was abandoned after 5/12/00 due to very poor weed control in the walnut husk plots.

Samples taken from the walnut hulls on 1/14/00 were sent to the U.C. Davis D.A.N.R. Analytical Laboratory and analyzed for nitrogen, phosphorus, potassium, copper, and zinc content, and for pH.

Figure 1. Pecent Weed Cover - Orange Orchard

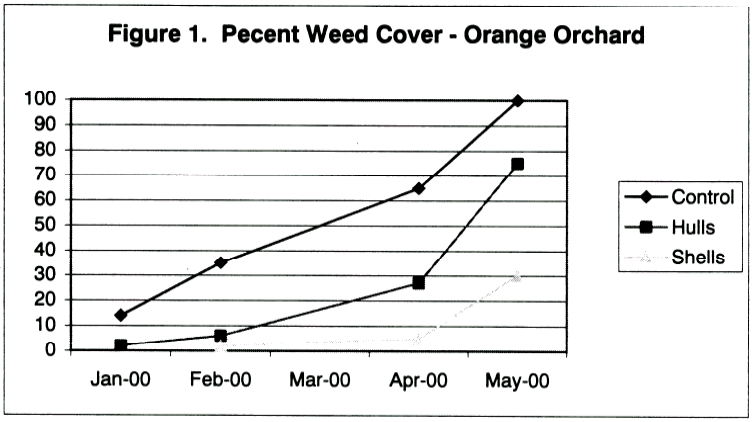
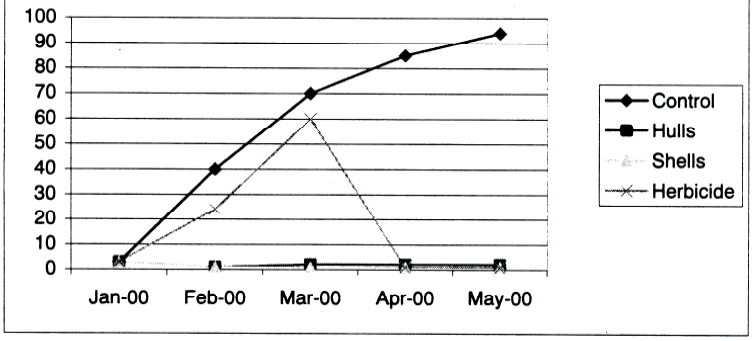


Figure 2. Percent Weed Cover - Prune Orchard



Preliminary results: See Figures 1 and 2 for the percent ground cover by weeds. Weed species present at the two sites are listed in Appendix 2.

At the orange orchard, weeds were able to grow through the mulches easily due to the rough surface caused by disking, which caused shallow spots in the mulches. Also, many of the weeds were not killed by the disking and reemerged through the mulch. Curly dock, Cluster dock, and Buckhorn plantain showed symptoms of phytotoxicity with blackened leaf margins the first month after application. These symptoms disappeared by the second month. Other weeds unaffected by the mulch were rough buttercup, Persian Speedwell, chickweed, and annual bluegrass, but were established prior to application and did not seem to germinate in the mulch. At the prune orchard, the main weeds in the mulches were chickweed, annual bluegrass, cheeseweed, filaree, and rough buttercup.

Visual inspections found no signs of phytotoxicity to the trees in the experiment. Pressure bomb readings also showed no differences in the water potential between mulched and non-mulched trees. Soil temperatures at 4" deep showed that the soil was consistently cooler under the mulches by one or two degrees (see Figure 3).

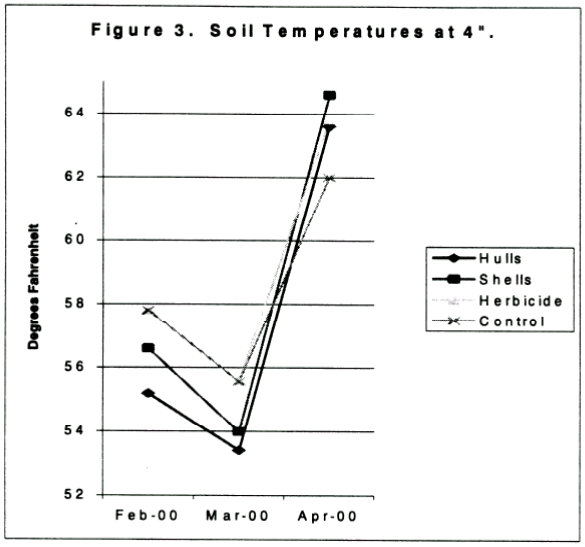


Table 1 shows the nutrient content of the walnut hulls used in this experiment. Since the hulls had been allowed to decompose for a month or two, these values will probably be different from those of fresh hulls.

Table 1. Nutrient analysis of walnut hulls collected 1/14/00.

N-Total %	P-Total %	K-Total %	Zn ppm	Cu ppm	pH
1.806	0.15	4.36	26	50.7	9

One cubic foot of wet hulls weighs about 28 lbs., and has a wet to dry ratio of 3.45:1 (determined by samples taken at application). This equals 200 lbs. of dry matter per tree was applied in the prunes and 65 dry lbs. per tree was applied in the oranges. This should supply 1.3 lbs. N, 0.1 lbs. P, and 3 lbs. K per tree at the rate applied to the orange trees and 3.7 lbs. N, 0.3 lbs. P, and 9 lbs. K per tree at the rate used in the prunes. It is likely that a portion of the nitrogen will never be available due to volatilization and

leaching. The nitrogen and the other nutrients may not be available immediately and could take over one year to completely decompose and release the nutrients.

Analyses of Eastern black walnuts *(J. nigra)* published by the South-West School of Botanical Medicine, showed similar nutrient percentages as in J. regia. Their analyses also showed the hulls and fruit to contain about 0.3% calcium and 450 ppm iron and magnesium, as well as trace amounts of boron, manganese, molybdenum, chlorine, and nickel.

Discussion: No phytotoxicity to any of the trees in the experiment was seen, and only noticed for a short time on the two dock species and Buckhorn plantain.

As the hulls provided less weed control and only controlled weeds that were also controlled by the shell mulch, there probably was little or no weed control resulting from the juglone. This may be due to the fact that the hulls were collected after harvest and had been allowed to decompose for at least a month. Also, the hulls were wetter than the shells, causing some dry-down, and the hulls probably decomposed quicker and released more plant nutrients than the shells, resulting in more weed growth in the walnut hulls. Perennial plants and well-established annuals at time of mulch application were able to grow through both mulches, with the exception of *Malva neglecta*, which did not reemerge through either mulch.

It is questionable that any juglone was even present in the walnut hull mulch. Besides breakdown of juglone by microorganisms or temperature, it is possible that the juglone was in an inactive form during the span of the trial. Although reports contradict each other as to the conditions in which juglone is active, low pH and anaerobic conditions seem to increase the amount of active juglone in the environment (Schlien, 1990). Although the mulch was wet for most of the experiment, it had a high pH which may have destroyed the juglone if it was not already destroyed by decomposition.
Since the hulls did not appear to cause any phytotoxicity to the trees, walnut hulls may be safe to apply in orchards. The nutrient content of the hulls is similar to manure or compost, and could supply a very significant amount of plant nutrients even if applied at lower rates than used in this trial. The hulls also provided weed control comparable to a herbicide spray when applied under the right conditions. The mulch did lower the temperature by about 1-2 degrees Fahrenheit, which could have implications in young orchards where maximum root growth is important.

Outreach: My findings have been presented at a C.S.U. Chico research symposium, and one trial was shown at a Water Stewardship Tour of Glenn County. We plan on giving a U.C. Cooperative Extension field meeting at the prune site (which was selected due to its suitability to such a meeting) once more data has been collected. U.C. field meetings are advertised in the local newspaper and are free. I will attempt to advertise this field meeting directly to local organic growers and through organic certification organizations.

References:

Dana, Michael and B. Lerner (1994). Black Walnut Toxicity, Purdue Pub. H0-193 Schlien, Laura (1990). Juglone. Unpublished Thesis, U.C. Davis.

Black Walnut Analysis taken from the website: http:chili.rt66.com/hrbmoore/Constituents/Juglans_nigra. Posted by the South-West School of Botanical Medicine in Bisbee, AZ.

Appendix l - Plot Maps

Orange Orchard

X	check	shells	row 5 trees on carrizo rootstock
4			
X	hulls	check	row 6 trees on carizzo rootstock
X	shells	hulls	row 7 trees on carizzo rootstock
X	check	shells	row 8 trees on trifoliate rootstock
X	shells	check	row 9 trees on trifoliate rootstock
X	hulls	hulls	row 10 trees on trifoliate rootstock
X	hulls	check	row 11 trees on trifoliate rootstock
X	shells	shells	row 12 trees on trifoliate rootstock
X	check	hulls	row 13 trees on trifoliate rootstock
X	x	x	row 14 trees on trifoliate rootstock
X	x	x	row 1 5 trees on trifoliate rootstoc

Prune Orchard

row 2	row 3		Rep# row
x	x		x
x	x		x
x	x		x
x	x	I	x
x	check	I	x
x	hulls	I	x
x	herbicide	I	x
x	shells	I	x
x	hulls	II	x
x	check	II	x
x	shells	II	x
x	x	II	x
x	herbicide	II	x
x	x	III	x
x	shells	III	x
x	herbicide	III	x
x	check	III	x
x	hulls	III	x
x	hulls	IV	x
x	x	IV	x
x	shells	IV	x
x	herbicide	IV	x
x	x		x
x	trees left out due to replant		
x	x		x
x	check	IV	x
x	check	V	x
x	hulls	V	x
x	shells	V	x
x	x	V	x
X	herbicide	V	x

Appendix 2 -Weeds present

			Orange orchard			Prune orchard			
			control	hulls	shells	control	hulls	shells	herbicide
Annual bluegrass	*Poa annua*	annual	x	x	x	x	x		
Annual ryegrass	*Lolium multiflorum*	annual	x	x					
Annual sowthistle	*Sonchus oleraceus*	annual	x			x			
Bermudagrass	*Cunodon dactylon*	perennial	x	x					
Black medic	*Medicago lupulina*	annual	x						
Buckhorn plantain	*Plantago lanceolata*	biennial	x	x					
Burclover	*Medicago polymorpha*	annual				x	x	x	
Cheeseweed	*Malva neglecta*	biennial				x	x		x
Chicory	*Cichorum intybus*	perennial	x	x	x				
Chickweed	*Stellaria media*	annual	x	x		x	x	x	x
Cluster dock	*Rumex conglomeratus*	perennial	x	x	x				
Common groundsel	*Senecio vulgaris*	annual				x			
Common purslane	*Portulaca oleracea*	annual							x
Creeping woodsorrel	*Oxalis corniculata*	perennial	x						
Curly dock	*Rumex crispus*	perennial	x	x	x				
Dallisgrass	*Paspalum dilitatum*	perennial			x				
Dandelion	*Taraxacum officinale*	perennial				x			
Field bindweed	*Convolvulus arvensis*	perennial			x				
Filaree sp.	*Erodium sp.*	annual				x	x	x	x
Henbit	*Lamium amplexicaule*	annual				x			
Marestail	*Conyza canadensis*	annual	x			x			
Panicle willowweed	*Epilobium paniculatum*	annual	x			x			
Persian speedwell	*Veronica persica*	annual	x	x	x	x			
Prickly lettuce	*Lactuca serriola*	annual				x			
Prostrate knotweed	*Polygonium aviculare*	annual	x		x				
Prostrate spurge	*Euphoria supina*	annual				x			x
Rabbitfootgrass	*Polypogon monspeliensis*	annual				x			
Rescuegrass	*Bromus wildenowii*	annual				x			
Rough buttercup	*Ranunculus muricatus*	annual	x	x	x	x	x	x	
Scarlet pimpernel	*Anagallis arvensis*	annual	x						
Scotch thistle	*Onopordum acanthium*	biennial	x		x				
Shepardspurse	*Capsella bursa-pastoris*	annual				x			
Smooth cat's ear	*Hyperchoeris glabra*	annual				x			
White clover	*Trifolium sp.*	perennial	x	x		x			
Wild barley	*Hordeum leporinum*	annual				x	x		x
Yellow nutsedge	*Cyperus escuelentus*	perennial		x	x			x	x