

# **Weed Control in Residential Landscapes Utilizing Commercially Available Alternative Herbicides**

## **Final Report for Elvenia J. Slosson Endowment Fund 2010**

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### **I. Introduction**

Concerns over the quality of urban streams continues to increase as monitoring consistently reveals the presence of potentially toxic levels of pesticides, most frequently insecticides and herbicides (Sprague and Nowell, 2008; Gilliam et al., 2006; Fuhrer et al., 1999;). Research continues to show that the most widely used herbicide, glyphosate, does not severely impact aquatic environments at the concentrations commonly detected in urban streams (Borggaard and Gimsing, 2008; Kolpin et al., 2006). However, the public's increasing demand for safe "green" products has resulted in many new environmentally-friendly products becoming available for controlling weeds in the garden. Even though information for home gardeners on the efficacy of these new products is limited, their use is still heavily promoted by environmental awareness groups, water quality protection agencies, and municipal stormwater programs in an effort to simply reduce the potential contamination of surface waters.

The majority of these "green" weed control products are botanically-based oils (ex. *d*-Limonene) or acids (ex. pelargonic acid or vinegar) that control weeds by destroying the leaf cuticle or causing cell leakage rapidly leading to death. Unfortunately, long-term control is often

lacking as weeds with extensive root systems or underground storage reserves are able to recover as the materials are not translocated as with some traditional chemical herbicides such as glyphosate or 2,4-D. Yet even with limited control of weeds, these products may provide sufficient weed control in home garden situations, thereby reducing the possible contamination of surface waters with less environmentally-friendly herbicides.

In an effort to provide science-based information to home gardeners and improve the level of information disseminated by well-meaning groups, this project compared traditional weed control methods with alternative less-toxic methods under two residential landscape conditions where weed control is often a challenge; hardscape cracks and crevices as well as in new groundcover plantings.

## **II. Materials and Methods**

### *Weed Control in Hardscape Cracks and Crevices*

The study was established at South Coast Research and Extension Center in Irvine, California in October 2009. The experimental configuration was a randomized complete block design with 4 replications and 7 treatments (Table 1) for a total of 28 plots. Each 2' x 2' plot size consisted of precast concrete paver sections set in sand base with sand also placed in unpaved areas between the plots. The site was overhead irrigated during the dry months to simulate rainfall using Hunter MP Rotator sprinkler heads with precipitation rates of approximately 0.35"/hr. Approximately .35" was applied each week during these dry periods. Seeds of the following weed species were sown randomly throughout the plots to ensure the presence of the most commonly found weeds: groundsel, crabgrass, horseweed. Natural weed populations of spotted or prostrate spurge, sow thistle, pigweed, and purslane also germinated.

A group of the same ten UC Cooperative Extension Master Gardeners and other volunteers evaluated the plots bi-weekly using the following scale: (1) representing 'control weeds' or (0) to 'wait'. After each group evaluation, the results were tabulated and when three of four replicates were rated as "1" by 2/3 of the evaluators, the treatment was applied. Treatments were applied directly to the emerged weeds using ready-to-use (RTU) formulations, if available. Additional data collected included the number of times a treatment was applied, photodocumentation pre-and post-treatment, and the total cost of treatment materials during the study.

Data were analyzed for each evaluation date separately using the GLM procedure for analysis of variance. Mean separation was done using the LSD test at the P=0.05 level.

**Table 1.** Treatments applied to evaluate the level of weed control in patio and walkway cracks

<b>Treatment Number</b>	<b>Treatment Name</b>	<b>Active Ingredient</b>
1	Control	N/A
2	Alternative Treatment #1	Boiling Water
3	Alternative Treatment #2	Acetic Acid (Heinz Vinegar @ 5% A.I.) (Weed Pharm @ 20% A.I.)
4	Alternative Treatment #3	d-limonene (RTU WorryFree @ 17.5% A.I.)
5	Alternative Treatment #4	Eugenol (clove oil) (RTU EcoSmart @ 5% A.I.)
6	Traditional Treatment #1	Glyphosate (RTU Roundup @ 2% A.I.)
7	Traditional Treatment #2	Diquat (Spectracide Pro* @ 2.3% A.I.)

using alternative treatments compared to traditional.

\*Not typically available for non-professionals but is the best comparison to the treatments.

#### *Weed Control in Groundcover Plantings*

In October 2009, a randomized complete block design with 4 replications, 8 weed control treatments (Table 2) and three plant species was established at South Coast Research and Extension Center. Thirty-two 3' x 3' plots with a minimum 1' border were planted with 3 commonly used landscape groundcovers: myoporum, jasmine, and Manzanita. Regular irrigation was applied using overhead sprinklers (Hunter MP Rotators) at a level required to establish and maintain the plants throughout the study period. Seeds of the following weed species were sown randomly throughout the plots to ensure the presence of the most commonly found weeds: groundsel, crabgrass, horseweed. Weed populations of bindweed, fleabane, goosefoot, black nightshade, spotted or prostrate spurge, sow thistle, pigweed, nettle, nutsedge, and purslane germinated without augmentation from outside seed sources.

Pre-emergent treatments were applied once in October 2009 and again in February 2010, except the mulch treatment as the 3" thick layer remained throughout the study. Post-germination treatments, including hand-weeding, were applied directly to the emerged weeds and if available, ready-to-use (RTU) formulations were used. Household vinegar was used as the vinegar treatment until April 16, 2010. After that time WeedPham (20% acetic acid) was used.

A group of the same ten UC Cooperative Extension Master Gardeners or other volunteers evaluated the plots bi-weekly and rated each plot as acceptable (0), tolerable (1), or unacceptable (2). After each group evaluation, the results were summarized and when 2/3 of

the evaluators rated a treatment as “2”, hand-weeding was done to return the plots to a weed-free state, with the exception of the ‘control’ and the two post-emergent treatments (glyphosate and vinegar). The two post emergent treatments, glyphosate and vinegar, were reapplied whenever 2/3 of the evaluators rated at least three of the four replications as unacceptable. Additional data was collected on the number of times a treatment was applied or hand-weeded, groundcover vigor compared to the control on a scale of 1-10 (10 being the most vigorous), and treatment damage compared to the control on a scale of 1-10 (10 being the highest level of injury). The time to hand weed plots and apply any treatments were recorded throughout the study.

Data were analyzed for each evaluation date separately using the GLM procedure for analysis of variance. Mean separation was done using the LSD test at the P=0.05 level.

**Table 2.** Treatments applied to evaluate the level of weed control in groundcover plots using alternative treatments compared to traditional.

Treatment Number	Treatment	Active Ingredient
1	Control	N/A
2	Alternative Treatment #1	Hand-weeding
3	Alternative Treatment #2	3” mulch layer (medium size)
4	Alternative Treatment #3	Corn gluten meal (2 lbs/100 square feet)
5	Alternative Treatment #4	Mustard Seed Meal (2 lbs/100 square feet)
6	Traditional Treatment #1	Glyphosate (RTU Roundup @ 2% A.I.)
7	Traditional Treatment #2	Trifluralin (Preen Weed Preventor @ 1.47% A.I.)
8	Alternative Treatment #5	Acetic Acid (Heinz Vinegar @ 5% A.I.) (Weed Pharm @ 20% A.I.)

### III. Results

#### *Weed Control in Hardscape Cracks and Crevices*

For the paver (weeds in cracks) study, there was considerable variation in weed growth even before treatments were applied (data not shown). Therefore, all plots were hand weeded in February 2010 and allowed to regrow until the plots were statistically similar. Although not indicated by the volunteer evaluations, one diquat treatment was made on 3/23/10. The final evaluation was done on 5/14/10 and no further treatments were applied.

Table 3 shows the results of this study. One application of glyphosate treatment provided adequate weed control for the duration of the study (6 weeks after treatment) although 50% of the evaluators indicated that they would control weeds in those plots by that time. Repeated

treatments of hot water, d-limonene, and eugenol were not effective but this may have been due to the size of the plants. Few weeds were in the seedling stage which is general the best time to treat plants with these materials. This may also be a consequence of the rating system where the evaluators may have felt that a few seedlings did not warrant treatment but by the time they did their next evaluation, the plants had grown considerably. Household vinegar (5% acetic acid) was also not effective but when the treatment was changed to WeedPharm (20% acetic acid), adequate control was achieved for at least 4 weeks.

Table 3. Results of volunteer evaluations of weed pressure in spacing between pavers.

## Pavers

	3/5/10	3/23/10	4/2/10		4/16/10		4/30/10		5/14/10
Untreated	13.64	50.00	65.91	b	78.13	b	95.45	d	100.00
Hot water	9.09	59.09	77.27	b	78.13	b	72.73	bcd	70.45
Vinegar	11.36	50.00	70.45	b	78.13 <sup>#</sup>	b	47.73	ab	65.91
D-Limonene	4.55	47.73	72.73	b	81.25	b	86.36	cd	75.00
Eugenol (clove oil)	11.36	54.55	70.45	b	75.00	b	68.18	bc	59.09
Glyphosate	9.09	56.82	72.73	b	18.75	a	25.00	a	50.00
Diquat	4.55	61.36	9.09	a	28.13	a	52.27	b	79.55
			***		***		***		

<sup>#</sup>20% vinegar applied

Warranted treatment

### *Weed Control in Groundcover Plantings*

There were significant differences among treatments by 2 weeks after initiation (WAI) but the evaluators did not trigger an action (hand weed or postemergence treatment) until 4 WAI (Table 4). At that time, the rating for the preemergent treatment of corn gluten meal (CGM) was found to be equivalent to that of the untreated control. Other treatments that warranted application or weed removal at that time were handweeding and glyphosate and vinegar (household). The other preemergence treatments (Preen and mustard seed meal (MSM)) as well as the mulch treatments provided good control up to 4 WAI. The handweeded and CGM plots were handweeded 7 WAT. Weed control by MSM lasted about 6 WAI (Figure 1 left photo) and Preen was adequate until 17 WAI (Figure 1 right photo). Household vinegar was not effective, only causing minor damage to leaf margins. The mulch treatment provided excellent weed control for entire 29 weeks of the study. Plants appeared to be more robust in the mulch treatment as well (Figure 2).

Table 4. Results of evaluations of weed pressure in groundcovers by volunteers. Treatments 2, 6, and 8 were triggered when at least 66% of the evaluators indicated that weed pressure was unacceptable.

	Treatment	10/9/09	10/23/09		11/6/09		11/20/09		12/4/09		12/18/09	
1	Control	0.0	56.8	c	77.8	b	90.9	d	100.0	c	97.7	c
2	Hand Weed	0.0	56.8	c	88.9	b	2.3†	ab	0.0	a	0.0	a
3	Mulch	0.0	2.3	a	0.0	a	0.0	a	0.0	a	0.0	a
4	Corn Gluten Meal	0.0	72.7	c	80.6	b	2.3†	ab	0.0	a	0.0	a
5	Mustard Seed Meal	0.0	9.1	ab	22.2	a	63.6	c	90.6	c	0.0‡	a
6	Glyphosate	0.0	59.1	c	77.8	b	81.8	cd	12.5	ab	6.8	a
7	Trifluralin	0.0	6.8	ab	8.3	a	22.7	b	28.1	b	45.5	b
8	Acetic Acid	0.0	50.0	bc	72.2	b	79.6	cd	78.1	c	86.4	c
			*		***		***		***		***	

	Treatment	1/8/10		2/5/10		2/19/10	3/5/10	3/23/10		4/2/10		4/16/10	4/30/10	
1	Control	93.8	c	97.5	d	0.0^	0.0	2.3	a	9.1	a	21.9	47.7	bc
2	Hand Weed	2.1	a	0.0	a	0.0^	0.0	2.3	a	4.6	a	12.5	18.2	ab
3	Mulch	4.2	a	0.0	a	0.0^	0.0	0.0	a	0.0	a	9.4	4.6	a
4	Corn Gluten Meal	10.4	a	30.0	b	0.0^	0.0	22.7	b	22.7	b	25.0	68.2	c
5	Mustard Seed Meal	2.1	a	0.0	a	0.0^	0.0	0.0	a	0.0	a	3.1	2.3	a
6	Glyphosate	6.3	a	2.5	a	0.0^	0.0	0.0	a	0.0	a	3.1	25.0	ab
7	Trifluralin	60.4	b	72.5	c	0.0^	0.0	0.0	a	0.0	a	3.1	15.9	ab
8	Acetic Acid	81.3	c	72.5	c	0.0^	0.0	0.0	a	2.3	a	28.1	31.8	ab
		***		***				***		**		n.s.	**	

† Plots hand weeded on 11/13/09, ‡ Plots hand weeded on 12/10/09, ^Plots hand weeded on 2/9/10

☐ Treatment    ☐ No Treatment – Herbicide slow but effective

Data was also collected to compare total time to handweed each treatment. Table 5 shows that mulching was considerably less labor intensive for that activity, although not significantly different from MSM or glyphosate.

Table 5. Total time required to hand-weed groundcover treatments.

Treatment	Time (min.)	
Untreated	23.5	b
Hand weed	22.25	b
Mulch	2.25	a
Corn Gluten Meal	23.25	b
Mustard Seed Meal	12	ab
Glyphosate	1.75	a
Preen	16.75	b
Vinegar	16.75	b
	**	

#### IV. Summary

##### *Weed Control in Hardscape Cracks and Crevices*

Weeds in cracks were successfully controlled only with glyphosate and diquat, both “traditional” treatments. Of the alternative treatments, hot water, household vinegar, or the d-

limonene based herbicide did not result in any change even after 3 biweekly applications. There was a slight reduction in weed pressure when eugenol was repeatedly applied. While household vinegar was ineffective, when we replaced that treatment with a product containing 4X the acetic acid concentration, we were able to achieve moderate weed control for at least 2 weeks. Figure 3 (right photo) is an example of the weed pressure seen in the pavers prior to treatment.

### *Weed Control in Groundcover Plantings*

Where feasible, mulching is clearly the best approach for sustainable, long term weed control in groundcovers, and presumably shrub and similar perennial landscape bed plantings. While there is some upfront labor involved in placing the mulch and generally additional mulch needed to maintain an adequate depth, the payback in reduced labor and superior weed control outweighs the initial outlay and maintenance. A major product of this study was the development of both an English and Spanish quick-tip card covering the advantages and methods of mulch for weed control in the landscape (Figure 4).

Of the alternative pre-emergent treatments of mustard seed and corn gluten meal, only mustard seed meal provided good weed control as indicted by the evaluators. Corn gluten meal was ineffective. We cannot recommend that gardeners use this product and expect good weed control. Mustard seed meal is not currently available as a weed control product for home gardeners but the activity in this study warrants more investigation.

Figure 3 (left photo) is an example of the weed pressure present prior to spray treatments, such as vinegar and glyphosate. The alternative post-emergent treatment of household vinegar was also not effective, although this may have been due to the advanced stage of plant growth at treatment.

*Evaluators:* Use of Master Gardeners and other trained volunteers as evaluators was a successful process. They were asked to rate the plots on their own threshold, i.e. level of tolerance, as if in their own home. This allowed us to make a more realistic determination of control triggers that would be used by home gardeners (Figure 5).

At the end of the study, the Master Gardeners that participated in this work were invited to a meeting where the investigators presented the results of the trials. The volunteers strongly indicated that they were interested in the results and felt that they contributed to the success of the project. Many expressed that they appreciated being involved in a research project and especially that they were informed of the final results.

Figure 1. Weed pressure in Mustard Seed Meal 6 WAI (left) and Preen 17 WAI (right), prior to any treatments.



Photographs by Tammy Majcherek

Figure 2. Mulched plot 29 WAI.



Photograph by Tammy Majcherek

Figure 3. Weed pressure in groundcover study (left) and paver study (right), prior to treatments.



Photographs taken by Tammy Majcherek.



Figure 4. English and Spanish Quick-tip Cards

## Mulch

**Mulching is one of the simplest and most beneficial practices you can use in the garden.** Mulch is a protective layer of a material that is spread on top of the soil. Mulches can be organic such as grass clippings, bark chips, leaves, compost, etc. They can also be inorganic such as stones, brick chips and plastic. Both can be beneficial when used properly.

**Mulch**

- Protects the soil from erosion.
- Reduces compaction of soil.
- Conserves moisture reducing irrigation frequency.
- Maintains a more even soil temperature.
- Prevents weed growth.
- Provides a "finished" look to the garden.

Organic mulches improve the condition of the soil. They slowly decompose and provide organic matter which helps keep the soil loose. This improves root growth, increases the filtration of water and also improves the water-holding capacity of the soil. Organic matter is a source of plant nutrients and provides a good environment for earthworms and other beneficial soil organisms.

While inorganic mulches will reduce weed growth, soil erosion, and provide aesthetic qualities, they lack the soil improving properties of organic mulches. Unlike organic materials, they can be difficult to remove, because of their permanence, if you change your landscape design.

## Mantillo

**El uso de mantillo (mulch) es una de las practicas mas simples y beneficiales que se pueden utilizar en el jardin.** Mantillo es una capa protectora de un material que se esparce en la superficie de la tierra. Mantillos pueden ser organicos, tales como cortes de pasto, corteza de árbol, hojas, abono vegetal (compost), etc. Mantillos también pueden ser inorganicos, tales como piedras, pedazos de ladrillo y plásticos. Ambos pueden ser beneficiales.

**Mantillo**

- Protege la tierra contra erosión.
- Reduce la compactación de la tierra.
- Conserva humedad reduciendo la frecuencia de riego.
- Mantiene una temperatura mas uniforme de la tierra.
- Previene el crecimiento de malezas.
- Provee un terminado mejor del jardin.

Los mantillos organicos mejoran la condicion de la tierra. Se descompone lentamente y provee material organico el cual ayuda a mantener la tierra porosa. Esto mejora el crecimiento de la raiz, el agua se va filtrando mas rapido y mejora la capacidad de la tierra de retencion de agua. El material organico es una buena fuente de nutrientes para las plantas y provee un buen medio ambiente para las lombrices de la tierra y para otros organismos beneficos.

Mientras que los mantillos inorganicos pueden ser utiles en ciertos jardines, no tienen las propiedades de los mantillos organicos para mejorar la tierra. También si en el futuro se cambian las plantas, estos pueden ser dificiles de remover.

**Guidelines**


- Do not apply mulch too closely around the plant stem or trunk. Leave a space of 1-2" around the base of plant stems. For mature trees, a 6" space from the base of the trunk is adequate while a younger tree will require a 12" spacing from the trunk base.
- Apply a 1-3" layer of mulch if using fine organic materials (sawdust, grass clippings). Coarser materials (bark, straw or shredded plant material) should be layered 3-6" deep.
- Remove weeds before spreading mulch.
- Check the soil moisture under the mulch periodically to be sure that irrigation water is properly reaching the soil and root zone of desired plants.


**Sources of Mulch**

Check under mulches or garden centers or nurseries in the Yellow Pages. Your community may also have wood chips from the removal of street trees that are available free to residents.

**-PROTECT YOUR WATER-**  
To eliminate runoff to storm drains and protect our creeks, rivers and the ocean, minimize the use of pesticides and follow proper use and disposal practices. Whenever possible, use non-chemical alternatives or less toxic pesticide products.

For more information, contact the University of California Cooperative Extension Master Gardeners of Orange County Hotline: (714) 708-1646 or [ucmstergardeners@yahoo.com](mailto:ucmstergardeners@yahoo.com) or visit [www.uccemp.org](http://www.uccemp.org) and [www.ipm.ucdavis.edu](http://www.ipm.ucdavis.edu).





**What you use in your garden affects our creeks, lakes, and rivers!**

**Guia**

- Se recomienda no poner mantillo muy cerca de los troncos y tallos. Para prevenir enfermedades es mejor dejar un espacio libre de 1-2 pulgadas alrededor de troncos y tallos. Para arboles maduros, 6 pulgadas desde la base del tronco es adecuado. Los arboles jovenes necesitan 12 pulgadas.
- Aplicar la capa de 1-3 pulgadas de material organico fino como (aserrin, pasto cortado). Material mas grueso como corteza, paja, plantas picadas debe aplicarse a 3-6 pulgadas de profundidad.
- Remueva las malezas antes de esparcir el mantillo.
- Revise la humedad de la tierra debajo del mantillo periódicamente para asegurarse que el agua llega a la tierra y raices.
- Deje algunas areas del jardin sin mantillo para atraer abejas nativas que hacen sus nidos en la tierra.


**Fuentes De Mantillo**

Averigue por mantillo en centros de jardineria. Su comunidad puede tener mantillo gratis de los arboles que renuevan.

Reduzca al minimo el uso de pesticidas que contaminan nuestros canales. Utilice alternativas sin quimicas o productos pesticidas menos toxicos siempre que sea posible. Lea las etiquetas de los productos cuidadosamente y siga las instrucciones sobre el uso, almacenaje y desecho correcto.

Para más información, contacte la University of California Cooperative Extension Master Gardeners of Orange County Hotline: (714) 708-1646 o [hotline@uccemp.com](mailto:uccemp.com) o busque en el internet [www.uccemp.com](http://www.uccemp.com) y [www.ipm.ucdavis.edu](http://www.ipm.ucdavis.edu).





**¡lo que usted utiliza en su jardin puede afectar nuestros arroyos, rios y el océano!**

Text developed through a grant from Ebernia J. Slosson Endowment Fund

Figure 5. Volunteers evaluating study plots.



Photographs by Tammy Majcherek.