A Test of the Herbicide Weed Slayer for the Control of Invasive Plants

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ABSTRACT

Glyphosate is the most widely used herbicide for the control of non-native invasive plants in North America because of the broad spectrum of plants that it controls, its systemic action and its high relative cost effectiveness. Recently, many practitioners have been seeking alternatives because of a number of problems with glyphosate use. These include the growing number of weeds that have developed genetic resistance; the determination by the International Agency on Research on Cancer that glyphosate is a probable carcinogen; and regulatory constraints on its use, such as in red-legged frog habitat. Other synthetic herbicides can be used as substitutes, but these also have some limitations, such as concerns about human health risks, especially in public areas. Therefore, there is growing interest in the use of natural products that are perceived to be much safer and less toxic. However, most of these are "burn-down" agents that kill the foliage but do not translocate to the roots and kill the entire plant. A new formulation of the natural essential oil eugenol combined with proprietary additives, Weed Slayer, is purported to have systemic activity lacking in other natural herbicides. This study involves a test of Weed Slayer on a number of invasive plants, including fennel, jubatagrass, yellow starthistle and dittrichia, applied at the maximum label rate. Preliminary results indicate that it may have good efficacy in controlling them, possibly comparable to that of glyphosate when applied as a foliar spray. Application of Weed Slayer as a cut-stump treatment is also being tested.

INTRODUCTION

In the integrated pest management approach to invasive plant management, herbicides remain one of the most useful tools for controlling invasive plants. Of the available herbicides, glyphosate is the most widely used in North America because of the broad spectrum of plants that it controls, its systemic action and its high relative cost effectiveness.

However, recently many practitioners have been seeking alternatives because of a number of problems with glyphosate use. One of these is that a growing number of weeds that have developed genetic resistance to glyphosate as a result of over-use. Currently at least 50 weeds have developed resistance, including Italian ryegrass in California. Additionally, it has been determined by the International Agency on Research on Cancer that glyphosate is a probable carcinogen. Because of this, glyphosate has been added to the California Proposition 65 list of carcinogens, resulting in many agencies restricting or suspending its use. Also, glyphosate is the list of 66 pesticides covered by the stipulated injunction on red-legged frogs, restricting its use in red-legged frog habitat.

Other synthetic herbicides can be used as substitutes, but these also have some limitations. For example, some are also on the red-legged frog injunction list. Others have problems of long soil residual activity, leaching into groundwater or human toxicity. Also, many people find the use of all synthetic herbicides objectionable, especially in public areas.

Therefore, there is growing interest in the use of natural products that are perceived to be much safer and less toxic. Most of these, such natural oils (e.g., clove oil, eugenol, and d-limonene), soaps (e.g., pelargonic acid), or acetic acid, are "burn-down" agents that kill the foliage but do not translocate to the roots and kill the entire plant. A new formulation of eugenol with proprietary additives, Weed Slayer, is purported to have systemic activity lacking in other natural herbicides.

This study involves a test of Weed Slayer on a number of invasive plants. Though preliminary result show some efficacy during the first season of use, additional time may be required to evaluate the full effectiveness of Weed Slayer and its suitability as an alternative for glyphosate.

Figure 1. The effect of Weed Slayer applied as a foliar spray, on the left, compared to an untreated control, on the right, for yellow starthistle at the 4% rate (top row), for stinkwort at the 4% rate (second row), for tall fescue at the 2% rate (third row) and for jubatagrass at the 4% rate (bottom row).

METHODS

Weed Slayer is prepared by mixing two components, Part A and Part B, in water adjusted to about pH 4. Part A contains eugenol mixed with molasses. Part B contains a proprietary mixture of micro-organisms. The pH adjustment was made by adding enough citric acid to register approximately 4 on a pH meter, as recommended by the manufacturer (http://www.andaman-ag.com/products/weed-slayer-organic-herbicide/).

Spray treatments. In most cases Weed Slayer was applied as a foliar spray at the highest label rate of 4% (5 fl. oz./gal.). However, in a few cases, it was applied at a lower or higher concentrations to assess the efficacy of these rates. The methylated seed oil Can-Hance was used as an adjuvant for spray applications. Foliar treatment was made with a hand spray bottle or backpack sprayer.

Cut-stump treatments. Cut-stump treatments were made at one of three different rates of application: 4% (5 fl. oz./gal.), 8% (10 fl. oz./gal) or 16% (20 fl. oz./gal.). The surfactant Pentrabark was added to Weed Slayer to enhance penetration into the stem tissue. For some treatments, all three rates were applied to a plant species to test for efficacy, while for other plant species, only one or two different rates of application were tested. For cut stump applications, stems were cut with a hand saw or loppers and Weed Slayer was applied immediately after the cut was made either with a paint brush or with a hand spray bottle.

Several invasive plant species were selected for treatment with Weed Slayer. These included annual herbaceous species, perennial herbaceous species and woody species. For tests of Weed Slayer as a foliar application, the following species were used: *Centaurea solstitialis* (yellow starthistle), *Cortaderia jubata* (jubatagrass), *Dittrichia graveolens* (stinkwort), *Festuca arundinacea* (tall fescue), *Foeniculum vulgare* (fennel) and *Genista monspessulana* (French broom). For tests of Weed Slayer as a cut-stump application, the following species were used: *Acacia melanoxylon* (Blackwood acacia), *Cortaderia jubata*, *Cytisus scoparius* (Scotch broom), *Eucalyptus globulus* (blue gum eucalyptus), *Foeniculum vulgare, Genista monspessulana* and *Spartium junceum* (Spanish broom).

All tests were performed in the Peninsula Watershed of the San Francisco Public Utilities Commission.

Application Date	Observation Date	Plant Tested On	Rate of Application of Weed Slayer (v/v)	Effect of Weed Slayer Treatment	Comments
3/30/2020	9/9/2020	Jubatagrass (Cortaderia jubata)	4%	Foliage of treated plants is brown and dead. Some re-sprouting occurred along outer margin of dead patch.	Plants treated with Weed Slayer show symptoms of phytotoxicity comparable nearby plants treated with a combination of glufosinate and imazimox at the same time
4/10/2020	10/12/2020	Fennel (Foeniculum vulgare)	4%	Foliage was killed and there was no re-growth	Untreated plants nearby exhibited vigorous re-growth.
6/8/2020	9/23/2020	Stinkwort (Dittrichia graveolens)	4%	Brown dead foliage, indicating high efficacy	Untreated control plants nearby remained green and healthy.
6/8/2020	10/12/2020	Jubatagrass (Cortaderia jubata)	4%	Foliage of treated plants is mostly brown and dead.	Jubatagrass plants in this serpentine seep habitat showed delayed response to Weed Slayer. Phytotoxicity only apparent months after treatment.
6/12/2020	7/17/2020	Yellow starthistle (Centaurea solstitialis)	4%	Treated plants were killed and failed to flower.	Untreated control plants nearby flowered and set seeds.
6/15/2020	7/27/2020	Stinkwort (Dittrichia graveolens)	4%	Most treated plants appeared to be killed but some plants in treated area appear to have escaped treatment.	Assessment of treatment was complicated by subsequent road mowing of treatment area.
7/17/2020	10/12/2020	Tall fescue (Festuca arundinacea)	4%	Foliage of treated plants was brown and dead, indicating some degree of efficacy.	Nearby untreated plants remained green
7/27/2020	9/14/2020	Stinkwort (Dittrichia graveolens)	4%	Treated plants appeared dead, with brown foliage.	Follow-up treatment of plants that had escaped previous treatment.
7/31/2020	8/31/2020	Tall fescue (Festuca arundinacea)	2%	Foliage of treated plants was brown and dead, indicating some degree of efficacy.	Lower application rate of Weed Slayer appeared to be as effective as higher rate.
7/31/2020	10/12/2020	Jubatagrass (Cortaderia jubata)	2%	Foliage of treated plants is mostly brown and dead.	Lower application rate of Weed Slayer appeared to be as effective as higher rate.
8/3/2020	9/18/2020	French broom (Genista monspessulana)	2%	Foiliage of treated plants was brown and dead.	Though foliage was killed, stem tissue appears to be alive, and plants may re-sprout in the following growing season.
8/24/2020	10/12/2020	Jubatagrass (Cortaderia jubata)	4%	Foliage of treated plants was brown and dead, indicating some degree of efficacy.	Plants treated with Weed Slayer show symptoms of phytotoxicity comparable to nearby plants treated with glyphosate at the same time.
8/28/2020	10/9/2020	French broom (Genista monspessulana)	4%	Foliage killed by spray but stems appeared to remain alive.	Though foliage was killed, plants may re-sprout in following growing season.
8/31/2020	10/12/2020	Tall fescue (Festuca arundinacea)	4%	Foliage of treated plants was brown and dead, indicating some degree of efficacy.	Though foliage was killed, plants should be monitored for re-growth in following growing season.

Table 1. Summary of the effect of Weed Slayer applied as a foliar spray to invasive plants.

RESULTS AND DISCUSSION

In the initial efficacy trials, Weed Slayer appeared to be effective against herbaceous annual plants when applied as a foliar spray at the maximum label rate of 4%. This is apparent in Figure 1 which shows the effect on yellow starthistle and stinkwort compared to an untreated control. This is not unexpected because this result would also be the likely effect for other natural herbicides, including other formulations of eugenol.

Also in initial trials on perennial herbaceous plants, Weed Slayer appeared to be relatively effective. Figure 1 shows the effect of Weed Slayer applied as a foliar spray to tall fescue and jubatagrass. The foliage was killed and there was no apparent regrowth for at least 3 months after application. It also killed the foliage of fennel when applied as a foliar spray, and there was no regrowth after 3 months. Weed Slayer applied as a foliar spray to a woody perennial plant, French broom, also killed the foliage but apparently not the stem tissue.

The claim for Weed Slayer that it has systemic action suggested that Weed Slayer might also be effective as a cut-stump application. Therefore cut-stump applications of Weed Slayer were also tested. So far, the results are inconsistent and inconclusive. While most of the plants treated with cut-stump applications have not yet re-sprouted, some re-sprouting has been observed for fennel, coyote brush and eucalyptus.

This inconsistent response is difficult to explain. One possibility is incorrect pH adjustment in the later cut-stump applications. Large batches of pH 4 water were prepared with citric acid and stored for later use. It was discovered that, while in storage over a period of months, micro-organisms were metabolizing the citric acid and changing the pH of the solution, probably diminishing the activity of Weed Slayer. Therefore, a fresh batch of pH 4 water needs to be prepared with citric for each application. Alternatively, an acidifying agent not subject to breakdown might be used instead of citric acid. Trials have begun using ammonium sulfate instead of citric acid as an acidifying agent. The commercial product Tri-Fol should also be compared with citric acid in future efficacy trials.

In the search for a natural alternative to synthetic herbicides in general and for glyphosate in particular, to what extent can Weed Slayer be considered as a substitute? The efficacy of of eugenol as a non-selective post-emergent herbicide has been demonstrated in numerous studies (Tworkoski 2002, Bainard et al. 2006, Vaid et al. 2010 and Ahuja et al. 2015). In addition, the Weed Slayer formulation of eugenol was found to be as effective against weeds as glyphosate in a study in Jamaica, and it was concluded that it had a systemic effect (Brown 2020). Locally, field trials by Conforti at the Presidio in San Francisco (https://www.youtube.com/watch?v=P_QEvlZ8kxc) and by Deac Jones in vineyards in the Santa Cruz Mountains (https://www.youtube.com/watch?v=PiGLc4iySqE&t=10s) seem to substantiate this claim.

Based on the present study, it can be concluded that Weed Slayer may be an effective replacement for glyphosate for use on annual herbaceous plants. It also appears to be phytotoxic to herbaceous perennial plants, such as fennel, tall fescue and jubatagrass. However, based on this study, it is still too early to evaluate its full effects on perennial plants because the effects have only been observed during the current growing season.
For woody plants, it cannot yet be determined whether cut-stump treatment has been effective over the long term. For Scotch broom, French broom and Blackwood acacia there was no observed re-sprouting of cut stumps treated with Weed Slayer. However there was also none for untreated control plants. So it may require an extended period of time to evaluate these plants for the full effectiveness of the treatment. Some re-sprouting was observed for fennel, coyote brush and eucalyptus treated with Weed Slayer. However, this lack of efficacy may have been affected by the degradation of the citric acid acidifying agent.

Similarly, for herbaceous perennials, like fennel and tall fescue, in spite of the initial phytotoxicity, a systemic effect of Weed Slayer may only be apparent after monitoring for regrowth through an additional growing season. It is possible that Weed Slayer inhibits but does not completely prevent re-sprouting. For example, for the jubatagrass apparently killed by a foliar treatment of Weed Slayer, shown in Figure 1, recently there has been some re-sprouting on the outer margin of the dead patch of foliage. This indicates that some retreatment may be necessary. However, a similar result is often found for jubatagrass treated with glyphosate, where control is often less than 100 per cent effective through a single application (DiTomaso, Drewitz and Kyser 2008). One promising result for jubatagrass was the finding that a cut-stem treatment with 16% Weed Slayer suppressed regrowth, compared to a control treatment, for several months after treatment (Figure 2), indicating a systemic effect.

A more thorough assessment of the effect of Weed Slayer on invasive plants requires a more comprehensive test with a greater number of randomized replicated treatments and a longer evaluation period. One limitation for the use of Weed Slayer on invasive plants is its greater cost. A preliminary test of foliar spray with a lower rate of application, 2%, applied to jubatagrass and to tall fescue (Figure 1) indicates that this may be as effective as the 4% rate.

Figure 2. Comparison of a cut-stem treatment of 16% Weed Slayer to jubatagrass, on the left, to a cut-stem control treatment, on the right.

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