



[Environment Horticulture Program Research Summaries](#)

IR-4 Environmental Horticulture Program Liverwort Efficacy Study

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Table of Contents

Table of Contents	2
Table of Tables	3
Table of Figures	5
Abstract	6
Introduction	7
Materials and Methods	8
Results and Summary	10
Post Emergent Efficacy	12
Pre Emergent Efficacy	62
Label Suggestions	88
Appendix 1: Contributing Researchers	89

Table of Tables

Table 1. List of Preemergence and Postemergent Products Tested.....	8
Table 2. Overall Efficacy Summary for post-emergent and pre-emergent herbicide applications on <i>Marchantia sp.</i>	10
Table 3. Control of <i>Marchantia sp.</i> with postemergence applications of oxadiazon and oxyfluorfen. Experiment 1, June 1976, Elmore.....	13
Table 4. Control of <i>Marchantia sp.</i> with postemergence applications of oxadiazon, oxyfluorfen, and oryzalin. Experiment 2. December 1976, Elmore.....	13
Table 5. Phytotoxicity of oxadiazon and oxyfluorfen to container grown ornamentals, Experiment 1 June 1976 (Elmore 1976).	14
Table 6. Phytotoxicity of oxadiazon and oxyfluorfen to container grown <i>Ilex burfordii</i> liners and <i>Camellia japonica</i> 'Colonel fiery', Experiment 2, December 1976, Elmore.	14
Table 7. Phytotoxicity of post emergent herbicides to Pin Oak Liverwort control, Freiberger, 2005.	15
Table 8. Phytotoxicity of post emergent herbicides to container grown Kentucky Coffee Tree and Liverwort control, Freiberger, 2005.....	15
Table 9. Phytotoxicity of post emergent herbicides to container grown Yellowwood and Liverwort control (Frieberger 2005).	15
Table 10. Phytotoxicity of post emergent herbicides to container grown Honey Locust and Liverwort control (Frieberger 2005).	15
Table 11. Injury to Pawpaw (<i>Asimina triloba</i>), Oakleaf hydrangea (<i>Hydrangea quercifolia</i> 'Snowflake'), and Periwinkle (<i>Vinca minor</i>), and percent cover liverwort (<i>Marchantia spp.</i>) at 3 WAT, Czarnota, 2006.	16
Table 12. Injury to Pawpaw (<i>Asimina triloba</i>), Oakleaf hydrangea (<i>Hydrangea quercifolia</i> 'Snowflake'), and Periwinkle (<i>Vinca minor</i>), and % cover liverwort (<i>Marchantia spp.</i>) at 6 WAT, Czarnota 2006.....	16
Table 13. Injury to Pawpaw (<i>Asimina triloba</i>), Oakleaf hydrangea (<i>Hydrangea quercifolia</i> 'Snowflake'), and Periwinkle (<i>Vinca minor</i>), and % cover liverwort (<i>Marchantia spp.</i>) at 12 WAT, Czarnota 2006.....	17
Table 14. Control of liverwort (<i>Marchantia spp.</i>) with Bryophyter, DeFrancesco, 2009.....	17
Table 15. Percent control of liverwort with post emergent applications of Bryophyter and Xeroton, Derr, 2009.	18
Table 16. Crop Safety after over the top post emergent applications of Bryophyter and Xeroton, Derr, 2009.	19
Table 17. Efficacy of Bryophyter on <i>Marchantia sp.</i> Gilliam 2009.....	20
Table 18. Reduction of liverwort (<i>Marchantia spp.</i>) with post-emergent herbicide applications and assessment of new liverwort growth, Gilliam, 2009.	20
Table 19. Efficacy of Bryophyter on Liverwort, Wilen, 2009.....	21
Table 20. Effects of several postemergence herbicide treatments applied on Feb. 19, 2010 on <i>Marchantia sp.</i> Beste/Frank, 2010.....	24
Table 21. Comparison of Bryophyter, Scythe, Xeroton and WeedPharm post-emergent applications applied March 5, 2010 on <i>Marchantia sp.</i> Beste/Frank, 2010.	25
Table 22. Effect of Terracyte Pro liquid post-emergent broadcast applications applied April 1, 2010 on <i>Marchantia sp.</i> Beste/Frank, 2010.....	26

Table 23.	Effect of Terracyte Pro granular broadcast April 1, 2010 on <i>Marchantia sp.</i> Beste/Frank, 2010.	26
Table 24.	Effect of various post-emergent herbicide treatments on <i>Marchantia sp.</i> , Czarnota 2010.	27
Table 25.	Postemergence liverwort control on <i>Marchantia sp.</i> with various herbicides, Derr, 2010.	28
Table 26.	Evaluation of several post-emergent herbicide applications on <i>Marchantia sp.</i> , Freiberger, 2010.	29
Table 27.	Efficacy of post emergent herbicide applications for the control of small Liverwort, Experiment 1, Gilliam, 2010.	30
Table 28.	Efficacy of post emergent herbicide applications for the control of large ^Z Liverwort, Gilliam, 2010.	31
Table 29.	Efficacy of post emergent herbicide applications for the control of small Liverwort, Experiment 2, Gilliam, 2010.	32
Table 30.	Efficacy of post emergent herbicide applications for the control of large ^Z Liverwort, Experiment 2, Gilliam, 2010.	33
Table 31.	Efficacy of pre and post emergent herbicides on liverwort at Spring Meadow Nursery, Lincoln Nursery, and Zelenka Nursery, Mathers, 2010.	35
Table 32.	Phytotoxicity of selected herbicides on rooted cuttings of various ornamental crops, Mathers, 2010.	36
Table 33.	Efficacy of various herbicides applied post-emergent to <i>Marchantia sp.</i> , Peachey, 2010.	37
Table 34.	Efficacy rating for Scythe, Green Match, Racer, and WeedPharm on <i>Marchantia</i> <i>sp.</i> , Reding, 2010.	38
Table 35.	Efficacy of various post-emergent herbicide treatments on <i>Marchantia sp.</i> , Senesac, 2010.	39
Table 36.	Effects of postemergent herbicides on <i>Marchantia sp.</i> and ornamentals – Trial 1, Part A, Mathers, 2011.	45
Table 37.	Effects of postemergent herbicides on <i>Marchantia sp.</i> and ornamentals – Trial 1, Part B, Mathers 2011.	46
Table 38.	Efficacy of post-emergent herbicide treatments on <i>Marchantia sp.</i> – Trial 2, Spring Meadow, Mathers, 2011.	47
Table 39.	Efficacy of post-emergent herbicide treatments on <i>Marchantia sp.</i> – Trial 3, Part A, Northland Farms, Mathers, 2011.	48
Table 40.	Efficacy of post-emergent herbicide treatments on <i>Marchantia sp.</i> – Trial 3, Part B, Northland Farms, Mathers, 2011.	49
Table 41.	Efficacy of various herbicides applied post-emergent to <i>Marchantia sp.</i> Peachey 2011.	50
Table 42.	Efficacy of various herbicides applied post-emergent to <i>Marchantia sp.</i> , Senesac, 2011.	52
Table 43.	Efficacy of various herbicides applied post-emergent to <i>Marchantia sp.</i> , Wilen, 2011.	54
Table 44.	Efficacy of post emergent herbicides for <i>Marchantia sp.</i> , Senesac, 2013.	57
Table 45.	Boxwood injury and liverwort control with post emergence herbicides in newly transplanted liners grown in a greenhouse, Experiment 1, Moretti, 2018.	58

Table 46.	Liverwort control with post emergence herbicides in newly transplanted liners grown in a greenhouse, Experiment 2, Moretti, 2018.....	59
Table 47.	Liverwort control after treatment with postemergence herbicides in newly transplanted roses grown in a greenhouse, Moretti, 2019	59
Table 48.	Liverwort control in pachysandra and rose plots, in response to post-emergent herbicide applications, Moretti 2021	61
Table 49.	Boxwood injury and liverwort control weeks after treatment with preemergence herbicides in newly transplanted liners in a greenhouse experiment, Moretti, 2018.....	62
Table 50.	Liverwort control after treatment with preemergence herbicides in newly transplanted roses grown in a greenhouse, Moretti, 2019	63
Table 51.	Liverwort control in Pachysandra and rose plots, in response to pre-emergent herbicide applications, Moretti, 2021	63
Table 52.	Summary of product efficacy byproduct and crop.	64

Table of Figures

Figure 1.	Bryophyter activity 28 Days after Treatment (Wilén 2009).....	21
Figure 2.	Efficacy of various post-emergent herbicides on <i>Marchantia sp.</i> , Wilén 2010	40
Figure 3.	Efficacy of various post-emergent herbicides on <i>Marchantia sp.</i> , Wilén 2010	41
Figure 4.	Racer over top of hydrangea ‘Forever red’ 2WAT2. Notice abundance of liverwort. 44	
Figure 5.	SureGuard over top of hydrangea ‘Annabelle’9WAR. Injury only occurred to plants that had broken dormancy. At this point, liverwort had started to come back.....	44
Figure 6.	SureGuard over ‘My Monet’ weigela at BFN at 9 WAT.	44
Figure 7.	Terracyte Pro G over hydrangea ‘Forever red’ at 5 WAT. Notice some spotting and leaf necrosis on edges of leaves.	44
Figure 8.	WeedPharm control of liverwort.	51
Figure 9.	Bryophyter control of liverwort	51
Figure 10.	Sureguard control of liverwort.....	51
Figure 11.	Scythe control of liverwort.	51
Figure 12.	Efficacy of various post-emergent herbicides on <i>Marchantia sp.</i> , Wilén 2011	53
Figure 13.	Photo of various post-emergent herbicide applications 4WAT3 on <i>Marchantia sp.</i> , Wilén, 2011.....	55

Abstract

Liverworts (*Marchantia sp.*) are difficult to manage during the production of perennial environmental horticulture crops grown in containers. Liverworts are among the most serious weeds of container grown ornamentals. During the 2004 and 2009 IR-4 Environmental Horticulture Workshops, a project was prioritized to screen for products to manage post-emergent liverwort in container grown ornamentals grown primarily under cover in greenhouses or hoop houses, use sites with very few registered herbicides. Since then, liverwort has been selected as a regional research priority. Between 1976 and 2021, IR-4 sponsored 302 research trials on 37 products or product formulations with 29 actives to manage liverwort. Most research was conducted with post-emergent applications, but active ingredients typically known for pre-emergent activity were included in some post-emergent experiments along with three experiments designed to screen for pre-emergent liverwort management.

The most effective options across these studies include Avenger Ag, baking soda, Byrophyter, Racer, Scythe, SureGuard, Tower (pre-emergent), V-10233, and WeedPharm (Table 2). However, Marengo when applied pre-emergently when no liverworts were initially present did provide excellent prevention. Ronstar, Neudorff's Granular Moss Killer, Terracyte and Xeroton had variable efficacy as post emergent applications, but many of these contact products may need more frequent applications for optimal efficacy. The results from this project have successfully identified several options for pre and postemergent control of liverwort.

Introduction

Liverwort is the common name for a large group of non-vascular plants which emerged about 400,000,000 years ago. These “simplest true plants” thrive in the warm, moist greenhouse and nursery environment which has led them to becoming a significant greenhouse and nursery pest. A national survey of growers by the Society of American Florists ranked liverwort No. 7 on the list of worst nursery weeds. In Oregon, it is now widely regarded as the No. 1 container nursery weed problem. In May 2000, *Marchantia* infestations in container nurseries and greenhouse operations throughout Oregon, Washington and British Columbia reached epidemic proportions and contributed to IR-4 initiating research into herbicides as management options. The cost to remove the liverwort by hand, one pot at a time, can completely consume the profits from each pot. Crops with long growing cycles are more likely to host this pest. In addition to being aesthetically offensive to the customer, liverwort can form mats on the pots surface creating a barrier to irrigation uptake and drainage. They also provide habitat for fungus gnats which damage roots and vector disease.

A common type of liverwort, *Marchantia polymorpha*, has gained much notoriety as a very successful weed. It can propagate asexually, producing clone plants called gemmae that can be dispersed by water splash. Fragments of liverwort can also survive and become established after breaking from the parent plant. Prevention and good cultural practices, including proper irrigation and fertilizer management, can help with liverwort management. The use of mulches can slow down an infestation but are not an effective long-term. Hand removal is labor intensive and can shrink profits rapidly for growers.

Many preemergent herbicides commonly used in nurseries provide significant control of liverwort coverage compared to nontreated controls. Unfortunately, common nursery irrigation and fertilization practices can reduce their effectiveness. Thus, there was a need for post-emergent control of liverwort infestations. In practice, the selection of a post-emergent treatment for liverwort control involves important considerations such as location (greenhouse or field), application type (over the top vs. directed spray), conventional or organic practices, length of control needed, skilled/non-skilled labor, severity of the infestation and crop/variety.

During the 2004 and 2009 IR-4 Environmental Horticulture Workshops, a project was prioritized to screen for efficacious products to manage post-emergent liverwort in container grown ornamentals grown primarily under cover in greenhouses or hoop houses, use sites with very few registered herbicides. Between 2005 and 2011, IR-4 evaluated a diverse group of products for post-emergent control of liverwort, including some herbicides typically utilized for pre-emergent efficacy. Most post-emergent herbicides rely on foliar contact for control while others are more systemic in nature. A few are considered to be natural or organic products.

At the 2017 Workshop, liverwort efficacy became a regional priority project, and IR-4 developed protocols to examine both post-emergent and pre-emergent herbicide applications.

Materials and Methods

A total of thirty-seven (37) herbicides (Table 1) were evaluated, although not all treatments were in all studies. Over the top applications ranging from 40 to 436 gallons per acre (gpa) were made targeting dry foliage when liverwort infestations covered 25-100% of the pot surface for post emergent herbicide experiments, depending on protocol and location. Liverwort stage was noted, as well as, the presence of reproductive structures. After 4 to 8 weeks a second application was made.



Efficacy evaluations were recorded at 1, 2, and 4 weeks after application (WAT) on a scale of 0 to 10 (0= no efficacy; 10 = complete kill). If pots contained a crop in addition to liverwort then phytotoxicity observations were recorded on a scale of 0 to 10 (0= no efficacy; 10 = complete kill). For IR-4 testing, the following protocols were used: 05-009, 09-024, 10-003, 11-003, 18-017, 19-017, and 21-024. Please visit <https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols> to view and download these protocols.

Products were supplied to researchers (See researchers in Appendix 1) by their respective manufacturers.

Table 1. List of Preemergence and Postemergent Products Tested.

Product	Active Ingredient(s)	General Activity	Manufacturer	# of trials
Avenger Ag / GreenMatch	d-limonene	Post	Marrone Bio-Innovations, Cutting Edge Formulations	10
Baking soda	Sodium bicarbonate	Post	--	3
Basagran T&O Herbicide	Benatazon	Post	BASF Professional and Specialty Solutions	4
Broadstar 0.25G ¹	Flumioxazin	Pre	Valent Professional Products	4
Bryophyter	Oregano oil	Post	Moss Buster	23
BW133	Potassium bicarbonate	Post	Bioworks	2
Champ DF	Copper hydroxide	Post	NuFarm	12
FlowerPharm	Cinnamon oil	Post	Pharm Solutions	2
Freehand ¹	Pendimethalin + dimethenamid-p	Pre	BASF Professional and Specialty Solutions	1
Chipco Ronstar 2G ¹	Oxadiazon	Pre	Bayer Environmental Sci.	5
Gentry/Mogetan	Quinoclamine	Pre	Chemtura	7
Goal 2E	Oxyfluorfen	Pre	Corteva	1
Junction	Mancozeb, copper hydroxide	Post	Sepro	4
Marengo 75SC	Indaziflam	Pre	Bayer, Envu	3
Marengo G	Indaziflam	Pre	Bayer, Envu	3
M-Pede	Potassium salts of fatty acids	Post	Gowan	1

Product	Active Ingredient(s)	General Activity	Manufacturer	# of trials
Neudorff's Granular Moss Killer	Pelargonic acid	Post	Neudorff's	3
Oryzalin 75WP ¹	Oryzalin	Pre	UPL NA	1
Oxyfluorfen 2G	Oxyfluorfen	Pre	Dow, Corteva	2
Pendulum 2G	Pendimethalin	Pre	BASF Professional and Specialty Solutions	2
Pendulum 3.3EC	Pendimethalin	Pre	BASF Professional and Specialty Solutions	2
Quicksilver T&O	Carfentrazone		FMC	8
Racer/ Emery Agro 7010	Ammonium nonanoate	Post	Falcon Lab; Emery Oleochemicals LLC	18
Scythe	Pelargonic acid	Post	Gowan	17
Showcase ¹	Ttrifluralin + isoxaben + oxyfluorfen	Pre	Corteva	3
Sporan	Rosemary oil	Post	Biorganic Crop Protection / KeyPlex	1
Sporatec	Rosemary oil + clove oil + thyme oil	Post	Brandt Consolidated	3
SureGuard	Flumioxazin	Pre	Valent Professional Products / Nufarm	19
Terracyte/ Terrcyte PRO	Sodium carbonate peroxyhydrate	Post	BioSafe Systems	22
Tower ¹	Dimethenamid-p	Pre	BASF Professional and Specialty Solutions	20
V-10233 / Piper	Flumioxazin + pyroxasulfone	Pre	Valent Professional Products	5
WeedPharm	Acetic acid	Post	Pharm Solutions	15
Xeroton	Hydrogen Peroxide + Peroxyacetic Acid + Octanoic Acid	Post	Phyton Corp.	2

Results and Summary

Between 1976 and 2021, IR-4 sponsored 302 research trials on 37 products or product formulations with 29 actives to manage liverwort. Most research was conducted with post-emergent applications, but active ingredients typically known for pre-emergent activity were included in some experiments along with three experiments designed to screen for pre-emergent liverwort management.

The most effective options across these studies include Avenger Ag, baking soda, Bryophyter, Racer, Scythe, SureGuard, Tower (pre-emergent), V-10233, and WeedPharm (Table 2). However, Marengo when applied pre-emergently when no liverworts were initially present did provide excellent prevention. Ronstar, Neudorff's Granular Moss Killer, Terracyte and Xeroton had variable efficacy as post emergent applications, but many of these contact products may need more frequent applications for optimal efficacy.

Table 2. Overall Efficacy Summary for post-emergent and pre-emergent herbicide applications on *Marchantia sp.*

Product (Active Ingredients)	MOA	Liverwort (<i>Marchantia sp.</i>)
Avenger Ag (d-limonene)	unknown	4.1 (1 - 5) n9
Baking soda (sodium bicarbonate)	FRAC NC	5.0 (5 - 5) n3
Basagran T&O Herbicide (Bentazon)	WSSA 6	1.3 (1 - 2) n4
BroadStar 0.25G (Flumioxazin)	WSSA 14	2.0 (2 - 2) n3
BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	1.0 (1 - 1) n1
Bryophyter (Oregano oil)	unknown	3.7 (1 - 5) n23
BW133 (BW133)	FRAC NC	1.0 (1 - 1) n2
Champ DF (Copper Hydroxide)	FRAC M1	1.1 (1 - 2) n12
Chipco Ronstar 2G (Oxadiazon)	WSSA 14	2.6 (1 - 5) n5
FlowerPharm (Cinnamon oil + rosemary oil)	unknown	1.0 (1 - 1) n2
Freehand G (Dimethenamid-p + pendimethalin)	WSSA 15 + WSSA 3	1.0 (1 - 1) n1
Gentry (Quinoclamine)	unknown	5.0 (5 - 5) n7
Goal 2E (Oxyfluorfen)	WSSA 14	4.0 (4 - 4) n1
Junction (SePro) (Mancozeb + copper hydroxide)	FRAC M3 + FRAC M1	1.0 (1 - 1) n4
Marengo 74SC (Indaziflam)	WSSA 29	2.7 (1 - 5) n3
Marengo G (Indaziflam 0.0224%)	WSSA 29	1.7 (1 - 3) n3
M-Pede (Horticulture Soap)	FRAC P07	1.0 (1 - 1) n1
Neudorff's Granular Moss Killer (Pelargonic acid)	WSSA 17	2.7 (1 - 4) n3
Oryzalin 75WP (Oryzalin)	WSSA 3	2.0 (2 - 2) n1
Oxyfluorfen 2G (Oxyfluorfen)	WSSA 14	4.0 (3 - 5) n2
Pendulum 2G (Pendimethalin)	WSSA 17	1.0 (1 - 1) n2
Pendulum 3.3 EC (Pendimethalin)	WSSA 3	1.0 (1 - 1) n2
QuickSilver T&O (Carfentrazone-ethyl)	WSSA 14	1.3 (1 - 2) n8
Racer Herbicide (Ammonium nonanoate)	unknown	3.0 (1 - 5) n18
Scythe (Pelargonic acid)	WSSA 17	4.5 (1 - 5) n17
Showcase (Trifluralin + Isoxaben + Oxyfluorfen)	WSSA 3 + WSSA 21 + WSSA 14	1.0 (1 - 1) n3

Product (Active Ingredients)	MOA	Liverwort (<i>Marchantia sp.</i>)
Sporan (Plant Essential Oils)	FRAC NC	1.0 (1 - 1) n1
Sporotec (Clove oil + Rosemary oil + Thyme oil)	FRAC NC	1.0 (1 - 1) n3
SureGuard 51WDG (Flumioxazin)	WSSA 14	4.2 (1 - 5) n19
Terracyte (Sodium carbonate peroxyhydrate)	unknown	1.0 (1 - 1) n1 Labeled
Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)	unknown	2.5 (1 - 5) n22 Labeled
Tower (Dimethenamid-p)	WSSA 15	3.1 (1 - 5) n20
V-10233 76WG (Flumioxazin + pyroxasulfone)	WSSA 14 + WSSA 15	3.6 (1 - 5) n5
Weed Pharm (Acetic acid)	unknown	4.2 (1 - 5) n14 Labeled
Xeroton (Peroxyacetic acid)	unknown	2.5 (1 - 4) n2

Average rating on a scale of 1 – 5 with 1 = 0 to about 70% efficacy and 5 = 100 efficacy or equivalent to non-inoculated control; minimum to maximum rating; number of trials. A rating of 2 or lower is considered unacceptable. A rating of 3 or higher is considered commercially acceptable.

Post Emergent Efficacy

Post emergent herbicides and several pre emergent herbicides were screened for activity after liverwort was growing in containers with coverage of the media surface from about 25% to 100%. Application rates (ai per acre) and volume of final solution per acre varied depending on protocol and refinements to improve efficacy over time.

Several products demonstrated efficacy on emerged liverwort including: Avenger Ag/Greenmatch (d-limonene) at 20% v/v, Bryophyter (oregano oil) at 2% v/v, Racer (ammonium nonanoate) at 5% v/v, Scythe (pelargonic acid) at 5-10% v/v, SureGuard (flumioxazin) at 0.375 lb ai/A, Terracyte Pro (Sodium carbonate peroxyhydrate), V-10233 (flumioxazin + pyroxasulfone) at 10 fl oz/A, and WeedPharm (acetic acid) at 10-20% v/v. SureGuard demonstrated residual control as indicated by a lack of regrowth up to 8 WAT. Contact type treatments such as Bryophyter, Greenmatch, Racer, Scythe and WeedPharm tended to be fast acting showing injury within 1-2DAT and generally required a repeat application to remain effective (>80% control) during the trial period. Improved control with Scythe was observed in experiments where irrigation was not applied immediately after application (Beste 2010) suggesting that contact type products may have better activity if irrigation is delayed. Products applied to younger smaller liverwort tended to be more effective than applications made to more mature liverwort. Although baking soda was not an IR-4 sponsored treatment, research in two trials shows efficacy and merits further investigation. In one experiment where Tower was applied at a post-emergent timing, liverwort growth stalled and further progression across pots was minimal. Although very effective on liverwort, registration for Gentry (quinoclamine) is not being pursued in the United States.

Outcomes for each experiment with herbicides were applied after liverwort was present are below:

Elmore 1976

In 1976 Elmore conducted two experiments testing the effect of single post-emergent applications of oryzalin, oxadiazon (2G and EC), and oxyfluorfen applied over the top of container grown ornamentals for control of *Marchantia sp.* Although results were slow to be observed taking about 4 months to impact liverwort cover, the mid and high rates (4 and 8 lb/A) of oxadiazon and oxyfluorfen gave approximately 70 percent control of established *Marchantia* (Table 3). Regrowth of *Marchantia* occurred in both oxyfluorfen and oxadiazon 2G at the 2 lb/A rate. However, regrowth was not a problem when oxadiazon was applied as the emulsifiable concentrate form in the second experiment (Table 4). Oryzalin at 4 lb/A did not control *Marchantia sp.*

Oxyfluorfen and oxadiazon did not injure environmental horticulture plants in these studies with few exceptions and at excessive rates (Table 5 and Table 6). One exception included *Agapanthus* which was injured significantly with oxyfluorfen at 2, 4, and 8 lb/A because of the granules lodging in the leaf bases. Initially some injury was noted on liners of *I. burfordii* with oxyfluorfen at 8 lb/A and the emulsifiable concentrate form of oxadiazon at 2 lb/A. However, the four month evaluation showed no injury.

Table 3. Control of *Marchantia* sp. with postemergence applications of oxadiazon and oxyfluorfen. Experiment 1, June 1976, Elmore.

Product	Rate (lb ai per acre)	Efficacy ¹			
		19 DAT	33 DAT	120 DAT	4 Months
Oxadiazon 2G	1	3.6	4.1	5.1	4.2
	2	3.8	5.4	7.2	5.7
	4	5.6	6.7	9.0	7.2
	8	6.4	7.8	9.9	9.4
Oxyfluorfen 2G	2	3.8	6.6	5.0	4.8
	4	4.8	6.6	7.0	6.4
	8	5.3	6.4	8.9	9.2
Nontreated	--	2.2	2.2	2.6	3.5

¹Efficacy: 0= no control, 10= complete control

Table 4. Control of *Marchantia* sp. with postemergence applications of oxadiazon, oxyfluorfen, and oryzalin. Experiment 2. December 1976, Elmore.

Product	Rate (lb ai per acre)	Efficacy ¹		
		1 Month	4 Months	7 Months
Oxadiazon 2EC	2	7.0	9.2	9.1
Oxadiazon 2G	2	2.0	5.2	3.1
	4	2.0	9.1	6.7
	8	6.0	9.4	10.1
Oxyfluorfen 2G	2	5.0	3.5	4.9
	4	5.0	7.7	5.5
	8	5.0	10.0	10.0
Oryzalin	4	4.0	4.4	5.6
Nontreated	--	3.0	1.2	1.6

¹Efficacy: 0= no control, 10= complete control

Table 5. Phytotoxicity of oxadiazon and oxyfluorfen to container grown ornamentals, Experiment 1 June 1976 (Elmore 1976).

Herbicide	Rate (lb ai per acre)	Phytotoxicity ¹ (4WAT)									
		Agapanthus	Buxus	Ligustrum	Euonymus	Vinca	Euonymus	Juniperus	Raphiolepis	Pinus	Pomegranate
Oxadiazon 2G	1	1	2	2	1	0	0	0	1	0	0
	2	2	2	-	0	-	-	0	0	0	0
	4	2	-	2	0	1	0	0	0	-	0
	8	2	1	-	1	2	0	0	1	-	0
Oxyfluorfen 2G	2	3	3	-	0	1	0	0	2	0	-
	4	4	2	-	1	2	0	0	0	1	-
	8	4	3	2	0	2	0	0	0	0	-
Nontreated	--	1	1	2	0	2	0	0	0	0	0

¹Phytotoxicity: 0= no effect, 4 = unacceptable, 10= dead plants

Table 6. Phytotoxicity of oxadiazon and oxyfluorfen to container grown *Ilex burfordii* liners and *Camellia japonica* ‘Colonel fiery’, Experiment 2, December 1976, Elmore.

Herbicide	Rate (lb ai per acre)	Phytotoxicity ¹					
		<i>Ilex burfordii</i>			<i>Camellia japonica</i> ‘Colonel fiery’		
		1 MAT	4 MAT	7 MAT	1 MAT	4 MAT	7 MAT
Oxadiazon 2EC	2	4.0	0.0	0.0	2.0	1.5	0.0
Oxadiazon 2G	2	0.0	0.0	0.0	0.0	0.6	0.0
	4	3.0	0.0	0.0	0.0	0.7	0.0
	8	2.0	0.0	0.0	1.0	0.8	0.0
Oxyfluorfen 2G	2	2.0	0.0	0.0	0.0	0.7	0.0
	4	0.0	0.0	0.0	0.0	0.7	0.0
	8	4.0	0.0	0.0	2.0	1.1	0.0
Oryzalin 75WP	4	1.0	0.0	0.0	0.0	0.9	0.0
Nontreated	--	0.0	0.0	0.0	0.0	0.8	0.0

¹Phytotoxicity: 0= no effect, 4 = unacceptable, 10= dead plants

Freiberger 2005

Freiberger (NJ) evaluated single applications of Junction, Quicksilver and Gentry on four crops including Pin Oak, Kentucky Coffee Tree, Yellowwood, and Honey Locust (Table 7, Table 8, Table 9, Table 10). None of the treatments resulted in crop injury with the exception of Quicksilver causing minor injury to pin oak which improved over time. Gentry consistently delivered excellent control of *Marchantia sp.* over the thirty day evaluation period. Quicksilver provided poor to moderate control while Junction delivered little to no control of liverwort.

Table 7. Phytotoxicity of post emergent herbicides to Pin Oak Liverwort control, Freiberger, 2005.

Treatment	Liverwort Control			Phytotoxicity		
	Day 9	Day 16	Day 30	Day 9	Day 16	Day 30
Nontreated	0 ²	0	0	0	0	0
Junction 3 lb/A	0.67	0.58	0.67	0	0	0
Quicksilver 6.7 oz/A	2.75	3.25	5.25	0.75	0.42	0.25
Gentry 2 oz/Gal	10.00	9.92	9.92	0	0	0
LSD (P= .05)	0.59	0.79	0.88	0.73	0.41	0.26

Table 8. Phytotoxicity of post emergent herbicides to container grown Kentucky Coffee Tree and Liverwort control, Freiberger, 2005.

Treatment	Liverwort Control			Phytotoxicity		
	Day 9	Day 16	Day 30	Day 9	Day 16	Day 30
Nontreated	0	0	0	0	0	0
Junction 3 lb/A	0.17	0.17	0.50	0	0	0
Quicksilver 6.7 oz/A	1.33	2.33	5.00	0	0	0
Gentry 2 oz/gal	10.00	10.00	10.00	0	0	0
LSD (P= .05)	0.40	0.40	1.31	na	na	na

Table 9. Phytotoxicity of post emergent herbicides to container grown Yellowwood and Liverwort control (Frieberger 2005).

Treatment	Liverwort Control			Phytotoxicity		
	Day 9	Day 16	Day 30	Day 9	Day 16	Day 30
Nontreated	0	0	0	0	0	0
Junction 3 lb/A	0.50	0.33	0.83	0	0	0
Quicksilver 6.7 oz/A	3.50	4.08	5.42	0	0	0
Gentry 2 oz/gal	10.00	9.83	9.67	0	0	0
LSD (P= .05)	0.55	0.60	0.67	na	na	na

Table 10. Phytotoxicity of post emergent herbicides to container grown Honey Locust and Liverwort control (Frieberger 2005).

Treatment	Liverwort Control			Phytotoxicity		
	Day 9	Day 16	Day 30	Day 9	Day 16	Day 28
Nontreated	0	0	0	0	0	0
Junction 3 lb/A	0.83	1.17	1.42	0	0	0
Quicksilver 6.7 oz/A	3.08	4.08	5.75	0	0	0
Gentry 2 oz/gal	10.00	9.83	10.00	0	0	0
LSD (P= .05)	0.51	0.66	0.71	na	na	na

Czarnota 2006

Czarnota (GA) evaluated single applications of four post-emergent herbicide applications for control of liverwort and phytotoxicity to three crops. At 3 WAT, there was no significant difference in percent liverwort cover. At 6 WAT, liverwort percent cover was significantly less with the two Gentry treatments, Broadstar, and Ronstar treatments. At 12 WAT, all treatments were significantly better than the nontreated control and the higher rate of Gentry was providing the significantly best control of liverwort (Table 11).

No treatments caused significant injury to periwinkle, hydrangea, or pawpaw during the course of the experiment (Table 11, Table 12, Table 13). Although not significant, injury to hydrangeas did exceed 20 percent with both Gentry treatments at 3 WAT (Table 11). Results of this study have shown that Gentry and other registered herbicides can provide control of liverwort in containerized ornamentals.

Table 11. Injury to Pawpaw (*Asimina triloba*), Oakleaf hydrangea (*Hydrangea quercifolia* 'Snowflake'), and Periwinkle (*Vinca minor*), and percent cover liverwort (*Marchantia spp.*) at 3 WAT, Czarnota, 2006.

Treatment	Rate	Periwinkle	Hydrangea	Pawpaw *	Liverwort*
		Plant injury 3 WAT			% Cover 3 WAT
Broadstar 0.25G	0.25 lb/A	0 a	14 a	2 a	4 a
Gentry	3.4 lb ai/A	0 a	22 a	0 a	19 a
	6.8 lb ai/A	0 a	23 a	2 a	18 a
Ronstar 2 G	4.0 lb ai/A	0 a	12 a	3 a	8 a
Showcase 2.5G	2.5 lb ai/A	0 a	8 a	0 a	7 a
	Nontreated	0 a	15 a	0 a	8 a
	LSD	0.0	21.4	5.0	24.9

*Means followed by same letter do not significantly differ (P=0.05, LSD)

Table 12. Injury to Pawpaw (*Asimina triloba*), Oakleaf hydrangea (*Hydrangea quercifolia* 'Snowflake'), and Periwinkle (*Vinca minor*), and % cover liverwort (*Marchantia spp.*) at 6 WAT, Czarnota 2006

Treatment	Rate	Periwinkle	Hydrangea	Pawpaw *	Liverwort*
		Plant injury 6 WAT			% Cover 6 WAT
Broadstar 0.25G	0.25 lb/A	0 a	0.0 a	3.3 a	5.8 bc
Gentry	3.4 lb ai/A	0 a	13.3 a	0.0 a	2.5 c
	6.8 lb ai/A	0 a	16.7 a	0.8 a	0.0 c
Ronstar 2 G	4.0 lb ai/A	0 a	13.3 a	0.0 a	7.5 bc
Showcase 2.5G	2.5 lb ai/A	0 a	6.7 a	3.3 a	12.5 ab
	Nontreated	0 a	0.0 a	0.0 a	17.5 a
	LSD	0.0	23.10	4.89	7.95

*Means followed by same letter do not significantly differ (P=0.05, LSD)

Table 13. Injury to Pawpaw (*Asimina triloba*), Oakleaf hydrangea (*Hydrangea quercifolia* 'Snowflake'), and Periwinkle (*Vinca minor*), and % cover liverwort (*Marchantia* spp.) at 12 WAT, Czarnota 2006.

Treatment	Rate	Periwinkle	Hydrangea	Pawpaw *	Liverwort*
		Plant injury 12 WAT			% Cover 12 WAT
Broadstar 0.25G	0.25 lb/A	0 a	0 a	0 a	12 bc
Gentry	3.4 lb ai/A	0 a	2 a	0 a	5 cd
	6.8 lb ai/A	0 a	0 a	0 a	0 d
Ronstar 2 G	4.0 lb ai/A	0 a	0 a	0 a	17 b
Showcase 2.5G	2.5 lb ai/A	0 a	0 a	0 a	15 bc
	Nontreated	0 a	0 a	0 a	33 a
	LSD	0.0	23.8	0.0	11.6

*Means followed by same letter do not significantly differ (P=0.05, LSD)

DeFrancesco 2009

In 2009, DeFrancesco (CA) evaluated three rates of Bryophyter with a second application four weeks after the first. All herbicide treatments controlled liverwort one week after treatment (Table 14). By the second week after treatment, control declined rapidly for the 0.5% and 1% Bryophyter treatments. By the fourth week after treatment control achieved with the 0.5% Bryophyter treatment was not statistically different from the nontreated control. This trend was seen after both the first and second application. Only the 2% Bryophyter treatment achieved adequate control (i.e. a rating of nearly 5.0 or higher) four weeks after treatment, for both the first application and the second application.

Table 14. Control of liverwort (*Marchantia* spp.) with Bryophyter, DeFrancesco, 2009

Treatment	Efficacy ^z						
	1-WAT ^y 8/18/10	2-WAT 8/28/10	4-WAT 9/8/10	Re-treatment	1WAT2 9/15/10	2WAT2 9/22/10	4WAT2 10/6/10
Bryophyter 0.5 % v/v	7.2 b	4.0 b	1.4 a		7.4 bc	1.8 b	1.6 ab
Bryophyter 1% v/v	8.0 b	5.6 c	4.0 b		7.8 b	4.4 c	1.6 ab
Bryophyter 2% v/v	10.0 c	8.8 d	8.6 c		9.8 c	8.0 d	4.8 c
Nontreated	0 a	0 a	0 a		0 a	0 a	0 a

^z Rating: 0 = no effects, 10 = complete death

^y Means within a column followed by the same letter do not differ significantly; Fisher's protected LSD (P ≤ 0.05)

Derr 2009

In 2009, Derr (VA) evaluated one rate of Xeroton and three rates of Bryophyter for control of *Marchantia* sp. and crop injury on Columbine, Shasta Daisy, Hellebores, and Sedum. Two applications were made one day apart since no injury was observed after the first treatment. The 2% v/v solution of Bryophyter (oregano oil) provided good control of liverwort at all rating dates

Table 15). A repeat treatment would be needed for complete control. Bryophyter at 0.5 and 1.0% provided fair liverwort control at 14 DAT2 but control was much less at 42 DAT2. Xeroton did not provide acceptable liverwort control at any rating date.

Columbine was injured approximately 12% 14 DAT2 by the two higher concentrations of Bryophyter but by 42 DAT no injury was seen at any rate (Table 16). The 2% concentration of Bryophyter caused unacceptable injury in Shasta daisy and hellebores, although injury was less at 42 DAT2 compared to earlier ratings. Bryophyter at 0.5% did not injure Shasta daisy, hellebore, or sedum. Bryophyter at 2% caused unacceptable injury in sedum and this plant was unable to outgrow the damage by 42 DAT.

Table 15. Percent control of liverwort with post emergent applications of Bryophyter and Xeroton, Derr, 2009.

Treatment	Rate % v/v	1 DAT1 10/6/09	7 DAT2 10/13/09	14 DAT2 10/20/09	20 DAT 10/26/09	42DAT 11/17/09
Bryophyter	0.5	9	66	65	68	28
Bryophyter	1	11	65	70	63	28
Bryophyter	2	10	86	89	89	81
Xeroton ³	1	9	30	26	24	19
Nontreated		0	0	5	3	3
<i>LSD (P= .05)</i>		3	8	16	10	12

Table 16. Crop Safety after over the top post emergent applications of Bryophyter and Xeroton, Derr, 2009.

Crop	Treatment	Rate % v/v	Percent injury after post emergent over the top application				
			1 DAT1 10/6/09	7 DAT2 10/13/09	14 DAT2 10/20/09	20 DAT 10/26/09	42DAT 11/17/09
Columbine	Bryophyter	0.5	11	9	1	1	1
	Bryophyter	1	5	15	13	11	6
	Bryophyter	2	20	26	11	6	3
	Xeroton	1	13	11	6	6	6
	Nontreated		0	8	3	5	3
	<i>LSD (P= .05)</i>		6	17	9	9	NS
Shasta Daisy	Bryophyter	0.5	1	0	0	0	1
	Bryophyter	1	5	6	8	9	9
	Bryophyter	2	16	25	23	21	11
	Xeroton	1	4	1	0	0	1
	Nontreated		0	1	1	1	4
	<i>LSD (P= .05)</i>		3	4	7	9	10
Hellebore	Bryophyter	0.5	1	1	1	0	0
	Bryophyter	1	1	9	8	6	9
	Bryophyter	2	6	38	33	25	16
	Xeroton	1	0	1	3	1	3
	Nontreated		0	6	2	1	1
	<i>LSD (P= .05)</i>		3	7	8	8	7
Sedum	Bryophyter	0.5	0	3	3	5	3
	Bryophyter	1	0	4	5	8	1
	Bryophyter	2	0	26	29	33	33
	Xeroton	1	0	3	3	5	1
	Nontreated		0	4	0	3	0
	<i>LSD (P= .05)</i>		NS	5	5	6	4

Gilliam 2009

In October 2009 Gilliam (AL) conducted an initial herbicide screen of Bryophyter on *Marchantia sp.* All three rates (0.5, 1%, 2% v/v) had an effect on liverwort control initially but only the high rate was significantly higher at 4WAT (Table 17). A second experiment evaluated the impact of six herbicides on liverwort over a 12 week period (Table 18). Bryophyter at 1% and 2% v/v provided the highest control of any herbicide tested at 1, 2, and 4WAT. Pots treated with the low rate of Bryophyter exhibited approximately 50% coverage in terms of liverwort regrowth 6WAT. Ratings for SureGuard (0.375 and 0.75 lb ai/a) differed significantly from the nontreated by 2WAT (65% and 78% injury) and showed no new regrowth at 6WAT. Tower (1.5 and 3.0 lb ai/A) phytotoxicity ratings ranged from 21-27% 1-2WAT improving to moderate control (47-50%) control at 4WAT. Little to no regrowth was observed with Tower treatments 6WAT. The longest control of liverwort was observed with either rate of SureGuard (100%) and the high rate of Tower (97%) at 12 WAT. Ratings for Broadstar (150 and 300 lb/A), Champ (5.5 and 11 lb/A), and FreeHand (150 and 300 lb/A) were poor to moderate throughout the evaluation period.

Table 17. Efficacy of Bryophyter on *Marchantia sp.* Gilliam 2009

Bryophyter Rates	Liverwort Injury Ratings ^z		
	1 WAT ^x	2 WAT	4 WAT
	10/5/2009	10/12/2009	10/29/2009
0.5% ^x	5.3 b ^y	4.3 b	0.0 b
1.0%	4.8 b	4.5 b	0.0 b
2.0%	8.0 a	8.3 a	5.5 a
Control	0.75 c*	0.0 c	0.0 b

^z Percent Control or efficacy was taken on a scale of 0 to 100, 0 = no control, 100 = complete control.

^x WAT = Weeks after treatment (All pots treated on 11-4-09.)

^y Means separated using Duncan's Multiple Range Test at alpha = 0.05.

Table 18. Reduction of liverwort (*Marchantia spp.*) with post-emergent herbicide applications and assessment of new liverwort growth, Gilliam, 2009.

Herbicide	Rate	Percent Control (Efficacy) ^z			% Coverage New Growth ^y	% Control (Efficacy)
		1 WAT ^x	2 WAT	4 WAT	6 WAT	12 WAT
		11/11/2009	11/18/2009	12/3/2009	12/16/2009	1/29/2010
Bryophyter	1.0% v/v	97.1 a ^w	98.0 a	96.4 a	50.6 d	0.0 c
Bryophyter	2.0% v/v	98.5 a	99.8 a	98.5 a	16.3 e	0.0 c
Champ DF	5.5 lb	2.5 e	3.8 e	8.1 e	86.3 b	0.0 c
Champ DF	11.0 lb	28.8 b	30.0 c	41.3 c	69.4 c	0.0 c
Tower	1.5 lb ai/A	26.3 b	27.5 c	47.5 c	10.6 ef	79.4 b
Tower	3.0 lb ai/A	20.6 bc	21.3 cd	50.0 c	3.1 f	97.0 a
SureGuard	0.375 lb ai/A	13.8 cde	65.0 b	86.3 b	0.0 f	100.0 a
SureGuard	0.75 lb ai/A	10.0 cde	78.8 b	86.3 b	0.0 f	100.0 a
Broadstar	150 lb/A ^t	5.0 ed	0.0 e	0.0 e	100.0 a	0.0 c
Broadstar	300 lb/A	17.5 bcd	12.5 de	18.8 d	90.0 ab	0.0 c
FreeHand	150 lb/A	7.5 ed	0.0 e	0.0 e	100.0 a	0.0 c
FreeHand	300 lb/A	6.3 ed	0.0 e	3.8 e	100.0 a	0.0 c
Control	NA	7.5 ed*	0.0 e	0.0 e	100.0 a	0.0 c

^z Percent Control or efficacy was taken on a scale of 0 to 100, 0 = no control, 100 = complete control.

^y At 6 WAT, data was taken on percent of pot covered with new growth, 0 = no new growth, 100 = pot completely covered with new growth. ^x WAT = Weeks after treatment (All pots treated on 11-4-09.)

^w Means separated using Duncan's Multiple Range Test at alpha = 0.05.

Wilco 2009

In 2009 Wilco (CA) tested three rates of Bryophyter for control of *Marchantia sp.* One application of Bryophyter applied at 1 or 2% provided excellent liverwort control for the duration of this study (28 days). The 0.5% rate provided moderate control but it was not enough to be commercially acceptable (acceptable = 8 or more). Injury to liverwort occurred within hours. Regrowth or recovery was observed in the 0.5% rate by 15DAT. There was slight

recovery at 28DAT at 1% but not sufficient to warrant an additional application. The 2% rate provided slightly better control than the 1% rate but it was not statistically different (Table 19).

Figure 1. Bryophyter activity 28 Days after Treatment (Wilén 2009)

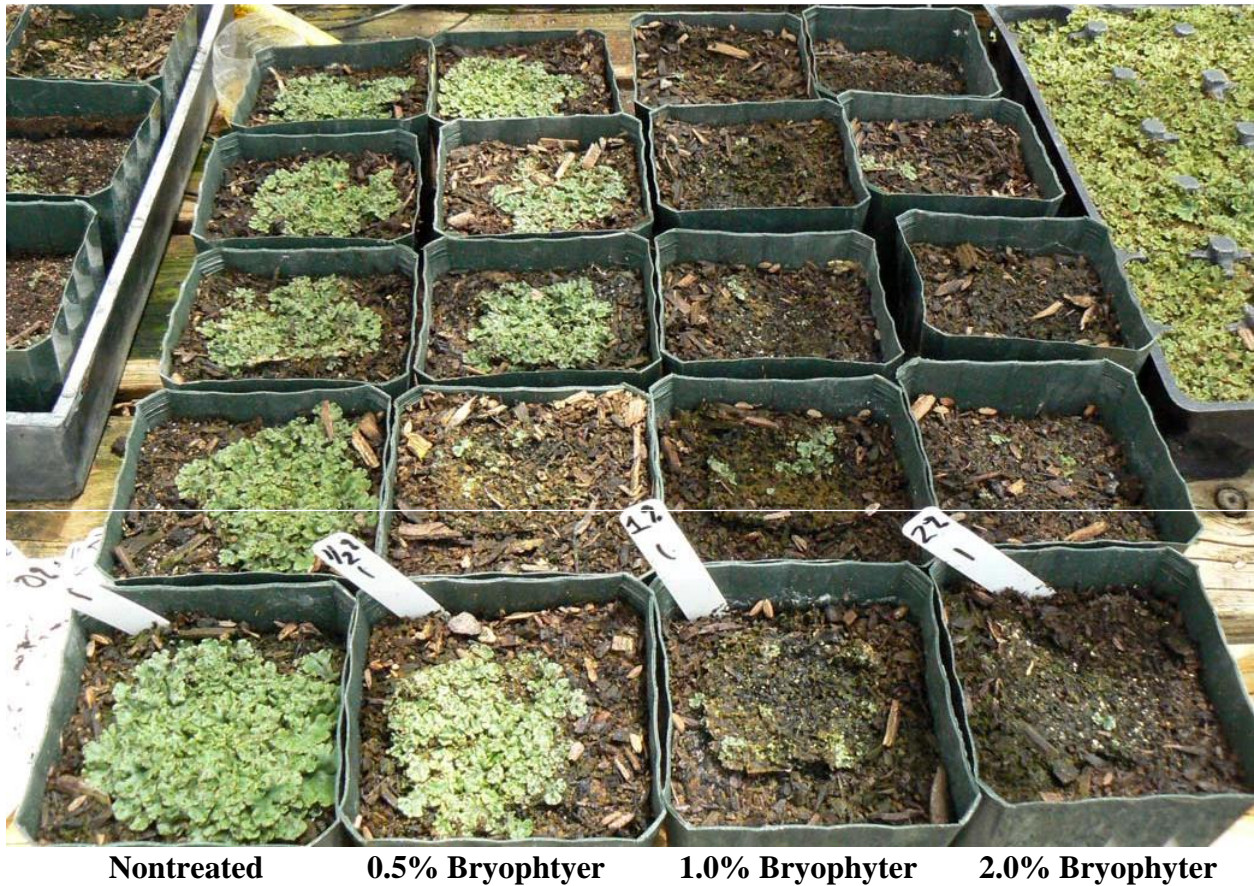


Table 19. Efficacy of Bryophyter on Liverwort, Wilén, 2009.

Treatment	% Damage (0-10)			Growth Reduction as % of Nontreated		
	7DAT	15DAT	28DAT	7DAT	15DAT	28DAT
Bryophyter 0.5%	4.2 b	3.7 b	3 b	38 b	28.4 b	27 b
Bryophyter 2%	9.2 a	9.46 a	8.6 a	95.8 a	93 a	89 a
Bryophyter 2%	9.3 a	9.56 a	9.2 a	95.2 a	95.6 a	94 a
Nontreated	0 c	0 c	0 c	0 c	0 c	0 c
LSD 0.05	1.715	2.516	2.765	23.959	25.817	25.767

Beste/Frank 2010

In 2010 Beste/Frank conducted evaluations of eight post-emergent herbicide treatments for control of liverwort and crop injury on field grown Littleleaf Boxwood. More than one

experiment was conducted for certain products with varying application parameters (Table 20-Table 22); rates and application patterns are included for each product in the following text. Evaluations were reported as percent cover and statistically weighted against the nontreated control data. Irrigation was not applied following the treatment due to grower's irrigation schedule for Scythe, Terracyte, Tower, WeedPharm and Xeroton (see footnotes in tables).

In two separate experiments (Table 20 & Table 21), applications of Bryophyter at 1% w/w undiluted spray at 100 GPA and 200 GPA dramatically reduced liverwort cover in treated pots compared to the nontreated control 1WAT. Liverwort control was very good by 4WAT for the both 100 and 200 gpa spray volumes; therefore, a second application was not applied. Good to excellent control was observed with later evaluations. Overall, Bryophyter as a directed spray was commercially acceptable at 100 and 200 gpa for Liverwort control; however, an additional application of 100 gpa Bryophyter would be required for commercial control extending beyond 60 to 68 days.

Directed spray applications of Scythe were evaluated in two experiments. The first at 10% v/v at 100 gpa was made on Feb 19th, 2010 (Table 20); the second at 5% v/v applied 100 gpa on March 5th, 2010. By 1WAT good to excellent control was achieved with both rates and maintained throughout the evaluation period.

SureGuard 51 WDG was applied as a directed application at 0.383 lb ai/A + 0.25% v/v NIS surfactant on February 19, 2010 (Table 20). By 30DAT SureGuard pot cover was significantly less (47%) compared to the nontreated (72%). At trial's end (10WAT) Liverworts were not present in the treated pots while nontreated control pots had a 62% cover of Liverwort. Two experiments involving Terracyte Pro 85% applied as crystals (Table 20 & Table 23) revealed that broadcasting crystals of sodium carbonate peroxyhydrate is an efficacious treatment for liverwort. Treatments of 278 lb ai/A (327 lb product/A) reduced liverwort pot cover by 97% in the 30 day observation period. Applications of 611 lb per acre had 4% pot cover 7DAT compared to 65% for the nontreated control. This level of control was maintained to 68DAT.

An initial liquid application of Terracyte Pro 85% at 50 lb per 100 gal with 100 gal per acre on February 19, 2010 (Table 20) failed due to delay in application. The same plants were then retreated at 100 lb per 100 gal per acre resulting in very good liverwort control 1WAT and maintained good control throughout the evaluation period. A second experiment with liquid applications at 79 lb per acre at 100 gpa and 134 lb per acre at 200 gpa resulted in reduced liverwort pot cover ratings of 4% and 0% 1DAT, respectively. There was virtually no regrowth throughout the trial. Terracyte Pro required application immediately after mixing with water to obtain efficacy for liverwort control.

Tower was applied as a single broadcast application at 1.5 lb ai per acre on February 19, 2010 (Table 20). At 4WAT the nontreated control pots had a liverwort cover of 73% while the treated pots had a significantly improved cover (46%). At the end of the trial (10WAT) the Tower treated pots had only 1% liverwort cover compared to the nontreated control (62%). A single spray application of Tower (1.5 lb ai/A) in late winter provided complete liverwort control at 10 weeks after treatment.

A directed spray application of WeedPharm (2.5% v/v acetic acid) at 100 gpa was made on March 5, 2010 at 100 gpa. This lower rate was used to determine to optimum rate for efficacy. By 5DAT the nontreated control containers had 28% pot cover of liverwort and the WeedPharm treated pots had significantly reduced the liverwort (5% pot cover). At trial's end (54DAT) the nontreated control containers had 56% liverwort cover and the Weed Pharm at 2.5% v/v treatment had slight regrowth with 12% liverwort cover. In a separate experiment (Table 20) a directed application of Weed Pharm 20S was applied February 19, 2010 at 5% w/w and 10% w/w. One week after the application, excellent liverwort control was achieved with little to no regrowth over the 68 day trial period. In summary, directed sprays of WeedPharm are effective for control and suppression of Liverwort.

Broadcast spray applications of Xeroton were made on March 5, 2010 at rates of 0.2% v/v at 100 and 200 gpa, and 0.4% v/v at 100 gpa. Pot cover ratings for Xeroton at the 0.2% v/v concentration were only slightly better than the nontreated. The final rating indicated Xeroton efficacy required a 56 day post application period for liverwort death with a 0.4% v/v concentration solution applied at 100gpa spray volume. The lack of efficacy at 0.2% Xeroton indicates a requirement for adequate concentration for toxic effects to kill liverwort. Control of liverwort was not satisfactory with two applications (34 day interval) of Champ DP (copper hydroxide) at 5.5 lb per acre (Table 20).

Overall, commercially acceptable control of liverwort was demonstrated with SureGuard, Scythe, Terracyte Pro, WeedPharm and Xeroton.

Table 20. Effects of several postemergence herbicide treatments applied on Feb. 19, 2010 on *Marchantia sp.* Beste/Frank, 2010.

Treatment	Rate	Volume	Application Type	Percent Liverwort Cover														
				2/19/10		2/26/10		3/3/10		3/10/10		Second app ?	3/17/10		3/31/10		4/28/10	
Bryophyter ^d	1 % w/w	100 gpa	directed	51.5	de ^c	9.0	c	11.5	c	13.0	c		12.5	d	16.5	c	24.0	b
Bryophyter ^d	1 % w/w	200 gpa	directed	65.5	abc	2.0	c	1.5	d	2.0	d		6.0	def	5.0	fg	6.0	d
Champ	5.5 lb/100 gal	100 gpa	broadcast	73.5	ab	84.0	a	75.0	a	75.5	d	Yes	67.0	b	48.0	b	61.0	a
Scythe ^a	10 % v/v	100 gpa	directed	66.5	abc	1.5	c	3.0	d	4.0	d		3.5	ef	7.5	fg	7.0	cd
SureGuard+ X-77	12 fl oz/a	100 gpa	directed	66.5	abc	79.5	a	68.0	a	67.5	b		47.0	c	1.0	g	0.0	d
Terracyte crystals ^a	611 lb/a	shaker	directed	67.7	abc	4.2	c	6.0	cd	6.8	d		6.2	def	9.8	def	5.0	d
Terracyte Pro liquid	50 +100 lb/a	100 gpa	broadcast	76.3	a	84.5	a	75.8	a	77.8	a	Yes	80.3	a	14.8	cde	26.3	b
Tower ^a	32 fl oz/a	100 gpa	broadcast	60.7	cd	66.3	b	60.0	b	63.8	d		49.8	c	15.3	cd	1.0	d
WeedPharm ^a	5 % w/w	100 gpa	directed	70.0	abc	1.5	c	3.0	d	5.0	d		8.0	de	8.5	ef	13.5	c
WeedPharm ^a	10 % w/w	100 gpa	directed	62.0	bcd	1.0	c	1.5	d	1.5	d		4.0	ef	4.5	fg	5.5	d
Nontreated				67.0	abc	64.0	b	70.0	a	69.0	b		72.5	b	78.5	a	62.0	a
LSD (P=.05)				9.95		7.65		7.30		6.14			6.46		6.14		6.63	

^a Irrigation was not applied treatment application as per the protocol because the grower irrigation schedule was followed.

^b A single application of Tower 6E EC (Dimethenamid-p) was applied with a CO₂ powered boom over the foliage of containers on Feb. 19, 2010 at 100 gpa.

^c Means followed by same letter do not significantly differ (P=.05, Duncan's New MRT); Henderson's weighted analysis used. Mean comparisons performed only when AOV Treatment P (F) is significant at mean comparison OSL.

^d 1% w/w undiluted test substance

Table 21. Comparison of Bryophyter, Scythe, Xeroton and WeedPharm post-emergent applications applied March 5, 2010 on *Marchantia* sp. Beste/Frank, 2010.

Treatment	Rate	Volume (gpa)	Application Type	Percent Liverwort Cover									
				3/3/10		3/10/10		3/17/10		3/31/10		4/28/10	
Bryophyter	1% w/w	100	broadcast	39.2	bc	15.3	g	15.3	d	17.5	d	17.2	c
Bryophyter	1% w/w	200	broadcast	37.5	c	7.8	ghi	7.8	fgh	5.2	hi	5.3	d
Scythe ^b	5% w/w	100	directed	39.2	bc	6.8	hi	10.2	cd	13.8	cd	19.8	c
Xeroton ^b	0.2% v/v	100	broadcast	48.3	bc	36.7	c	62.5	b	64.2	b	43.3	b
Xeroton ^b	0.4% v/v	100	broadcast	71.7	a	57.5	b	67.5	ab	79.2	a	9.2	cd
Xeroton ^b	0.2% v/v	200	broadcast	55.8	ab	51.7	b	62.5	b	64.2	b	43.3	b
WeedPharm ^c	2.5% w/w	100	directed	71.7	a	5.0	d	7.5	cd	11.7	c-f	11.7	cd
Nontreated				70.0	a	69.0	a	72.5	a	78.5	a	62.0	a
LSD (P=.05)				15.61		11.10		7.83		8.40		10.57	

^a Means followed by same letter do not significantly differ (P=.05, Duncan's New MRT). Henderson's weighted analysis performed. Mean comparisons performed only when AOV Treatment P (F) is significant at mean comparison OSL.

^b Irrigation was not applied after treatment applications as per the protocol, because the grower irrigation schedule was followed.

^c 2.5% w/w acetic acid

Table 22. Effect of Terracyte Pro liquid post-emergent broadcast applications applied April 1, 2010 on *Marchantia* sp. Beste/Frank, 2010.

Treatment ^{ab}	Rate lb/A	Volume	Percent Liverwort cover				
			4/1/10	4/2/10	4/8/10	4/15/10	4/30/10
Terracyte Pro	79	100	43.1 a	4.4 b	2.5 b	4.0 b	3.0 b
Terracyte Pro	158	200	58.8 a	1.9 b	0.0 b	0.6 b	0.3 b
Nontreated			65.0 a	65.0 a	65.0 a	66.3 a	70.6 a
LSD (P=.05)			17.38	14.47	13.98	15.48	11.60

^a Means followed by same letter do not significantly differ (P=.05, Duncan's New MRT). Henderson's weighted analysis performed. Mean comparisons performed only when AOV Treatment P (F) is significant at mean comparison OSL.

^b Irrigation of 0.5 inch was applied 3 days after treatment application.

Table 23. Effect of Terracyte Pro granular broadcast April 1, 2010 on *Marchantia* sp. Beste/Frank, 2010.

Treatment ^{ab}	Rate	% Liverwort cover				
		4/1/10	4/2/10	4/8/10	4/15/10	4/30/10
Terracyte Pro crystals	327 lb per acre	63.0 a	9.0 b	4.5 b	5.0 b	2.0 b
Nontreated		78.0 a	78.0 a	74.0 a	68.5 a	64.5 a
LSD (P=.05)		19.87	9.96	13.24	11.74	9.05

^a Means followed by same letter do not significantly differ (P=.05, Duncan's New MRT). Henderson's weighted analysis performed. Mean comparisons performed only when AOV Treatment P (F) is significant at mean comparison OSL.

^b Irrigation not applied after TerraCyte Pro application as per the protocol because the grower irrigation schedule was followed. Test plants received water rise of 0.1 inch irrigation before and after TerraCyte PRO application.

Broadcast applications were made over the top of pots containing Littleleaf Boxwood, *Buxus microphylla* Siebold & Zucc. v. 'Winter Gem' at 100 gallons per acre unless otherwise noted.

No significant crop injury and no reduction in growth or marketability was observed for Champ DP (5.5 lb product/a), Terracyte Pro 85% crystals (327 lb per acre), Terracyte Pro 85% liquid (79*, 100, 134* lb product/A), Tower (32 fl oz/A), WeedPharm (directed spray at 2.5, 5, 10% w/w), and Xeroton (0.2% v/v at 100 and 200 gpa and 0.4% v/v at 100 gpa).

Bryophyter broadcast: Littleleaf Boxwood treated with Bryophyter at the 1% w/w rate at 200 gpa had significant 29% phytotoxicity at trial's end, however, Boxwood treated at the 1% w/w at 100 gpa rate were not significantly different from the control. None of the Littleleaf Boxwood plants in this trial were significantly different in size from the control plants. No reduction in marketability would be expected. Bryophyter as a 1% undiluted broadcast spray at 100 or 200 gal per acre caused slight but acceptable injury to Littleleaf Boxwood.

Scythe directed: 2/19/10, crop injury ratings for Boxwood never exceeded 26% during the evaluation 10% v/v Scythe, directed applications. The probable cause of slight phytotoxicity was

foliage contact during application. No significant differences in height x width was observed with the treated plants during the trial. No reduction in crop marketability. On 3/5/10 no significant crop injury or differences in height x width were observed during the trial with 5% v/v Scythe. No reduction in marketability of the Littleleaf Boxwoods was observed.

SureGuard 51 WDG, directed: applied in a single directed application at 0.383 lb ai/A + 0.255% v/v NIS surfactant on February 19, 2010 caused significant Littleleaf Boxwood foliar necrosis at 100 days after treatment which persisted to the trial's end; however, marketability was marginally acceptable and recovery would be expected with new spring growth. Phytotoxicity on the treated Boxwood never exceeded 34%. At trial's end, the Boxwood had 30% phytotoxicity with no differences in height x width. No reduction in crop marketability would be expected. Flumioxazin (SureGuard 51 WDG) 0.3825 lb/A (12 oz product/A) was acceptable as a directed application for Liverwort control in Littleleaf Boxwood. However, additional studies should be conducted at reduced rates.

Czarnota 2010

No treatments completely controlled liverwort through the duration of the study (Table 24). All treatments provided greater than 67% liverwort control at both 4 weeks after first and second treatment. Racer and Scythe were providing $\geq 88\%$ control at both 4 WAT and 4 WAT2. Results of this study have shown that most of these products tested could provide fair control of liverwort ($\geq 71\%$) by 4 WAT or 4 WAT2 if continually applied. Additional study on crop injury and number of applications required to eliminate liverwort with products such as Tower and SureGuard would be valuable.

Table 24. Effect of various post-emergent herbicide treatments on *Marchantia* sp., Czarnota 2010.

Treatment	Rate	Percent Liverwort Control						
		1WAT	2WAT	4WAT	2 nd application	1WAT2	2WAT2	4WAT2
Bryophyter	1% v/v	72 c	82 bc	85 ab	Retreated	92 b	85 cd	81 ab
Champ	5.5 lb/A	35 e	64 d	67 c	Retreated	74 c	73 e	67d
Racer	5% v/v	82 b	86 b	92 a		100 a	93 ab	89 a
Scythe	10% v/v	93 a	97 a	93 a		99 ab	98 a	88 a
SureGuard	12 oz/a	78 bc	87 b	86 ab		93 ab	82 d	71 cd
Terracyte Pro	50 lb/A	74 bc	90 ab	84 ab		98 ab	91 abc	80 abc
Tower	32 oz/A	62 d	77 c	80 b		96 ab	89 bcd	74 bcd
	Nontreated	0 f	0 e	0 d		0 d	0 f	0 e
	LSD (0.05)	8.2	8.3	9.7		8.3	7.7	9.7

Means followed by same letter do not significantly differ (P=.05, LSD)

Derr 2010

In 2010 Derr (VA) conducted a comparison trial of six products for liverwort control involving two applications (Table 25). Observations showed that Bryophyter and Scythe caused significant

and rapid injury (80% or higher) to liverwort within 30 minutes of application. Effects from most of the other treatments were apparent 1 day after treatment (DAT). At 1 DAT, Bryophyter, Scythe, and Weed Pharm acetic acid all provided 75% or greater control of liverwort. By 21 DAT, however, only SureGuard and Tower gave greater than 85% control as regrowth occurred in the other treatments, with Scythe, Weed Pharm, and the higher rate of Bryophyter providing 60% or greater control. A second application of all treatments was made at 3 weeks after the initial treatment. At 15 minutes after the second application, Bryophyter, the higher rate of Racer, Scythe, SureGuard, Tower, and Weed Pharm all gave 75% or greater liverwort control. These treatments all provided 80% or greater control at 8 DAT2. The lower rate of Racer and both Terracyte treatments did not provide acceptable control of liverwort. Thorough coverage of liverwort appears to be critical for all of these treatments since the action seems to be contact for each one.

Crop Injury: SureGuard was the most injurious treatment to Shasta daisy followed by Weed Pharm and Scythe, with the injury being unacceptable for all 3 chemicals. Directed sprays would be needed to improve crop safety. Less injury was seen with the other treatments. More data on crop safety is needed for these treatments.

Table 25. Postemergence liverwort control on *Marchantia sp.* with various herbicides, Derr, 2010.

Treatment	Rate % v/v	1 DAT 5/21/10	12 DAT 6/1/10	21 DAT 6/10/10	2 nd application	15Min 2 6/10/10	8 DAT 2 6/18/10
Bryophyter	1	75	68	14	Retreated	90	95
Bryophyter RTU	2	90	83	60	Retreated	94	95
Racer	2.5	50	40	6	Retreated	20	25
Racer	5	70	60	11	Retreated	90	80
Scythe	5	90	81	54	Retreated	91	89
Scythe	10	85	80	69	Retreated	93	99
SureGuard + X-77	0.38 0.25 % v/v	5	90	93	Retreated	93	93
Tower + X-77	1.5 lb aia 0.25 % v/v	10	75	89	Retreated	90	90
Terracyte	50 lb ai/ 100 gal	23	23	5	Retreated	16	43
Terracyte	7.5 lb/ 1000 ft ²	15	43	9	Retreated	18	55
WeedPharm	10 % v/v	90	93	68	Retreated	79	95
Weed Pharm 20% RTU	20 % v/v	90	89	74	Retreated	84	100
	Nontreated	0	0	0		0	15
	LSD P=0.05	12	11	13		6	13

Freiberger 2010

In 2010 Freiberger evaluated eight active ingredients which were applied twice at four week intervals to nursery containers infested with *Marchantia sp.* SureGuard, V-10233, Bryophyter (1 and 2%) and Scythe demonstrated acceptable control (>7) for the duration of the evaluation period (Table 26). Racer, Champ and Tower provided poor to moderate control of liverwort.

Table 26. Evaluation of several post-emergent herbicide applications on *Marchantia sp.*, Freiberger, 2010

Treatment	Rate	Phytotoxicity						
		1WAT	2WAT	4WAT	2 nd application	1WAT2	2WAT2	4WAT2
Bryophyter	1%	8.8 b	8.7 b	7.9 a	retreated	9.4 a	9.6 a	9.4 a
Bryophyter	2%	10.0 a	10.0 a	8.6 a	retreated	9.9 a	9.9 a	9.9 a
Champ DP	2.75 lb	2.3 f	3.2 e	2.1 d	retreated	1.2 d	1.9 d	2.8 e
Champ DP	5.5 lb	2.6 f	3.4 e	2.6 cd	retreated	1.8 d	2.3 d	2.7 e
Racer	2.5%	2.3 f	2.1 f	0.8 e	retreated	1.3 d	1.4 d	0.8 f
Racer	5%	6.0 de	5.5 d	3.6 bc	retreated	5.4 b	5.8 b	4.0 d
Scythe	5%	8.1 bc	7.8 bc	7.6 a	retreated	9.4 a	9.5 a	9.6 a
Scythe	10%	10.0 a	10.0 a	9.3 a	retreated	10.0 a	10.0 a	10.0 a
SureGuard	12 oz	6.0 de	6 d	9.4 a	retreated	10.0 a	10.0 a	9.9 a
Tower	32 fl oz	0.7	1.3 f	2.5 cd	retreated	3.2 c	4.3 c	5.7 c
V-10233	10 fl oz	5.0 e	5.0 d	10.0 a	retreated	10.0 a	10.0 a	10.0 a
Nontreated		0.0 g	0.0 g	0.0 e		0.0 e	0.0 e	0.0 f

Gilliam 2010

The objective of two experiments was to determine the efficacy of 12 herbicides for managing small and large liverwort in containers in the greenhouse. Experiment 1 was conducted 4/2/10 – 5/26/10. Experiment 2 was conducted 4/30/10 - 6/30/10. Small liverwort is characterized as having *no* reproductive structures with 50% of pot surface covered; large liverwort as *with* reproductive structures and 100% of pot surface covered. All herbicides providing less than 80% control were retreated with the same rates as before and evaluated for an additional 28 days. *Experiment 1, small liverwort* (Table 27): WeedPharm (10 and 20% v/v) provided immediate control of both small liverwort (3DAT) and maintained excellent control through 21DAT. SureGuard reached 90% control of liverwort by 1WAT and maintained acceptable control through the 4WAT evaluation period. Bryophyter (1% v/v), Scythe (10% v/v), Racer and Terracyte provided acceptable control initially (7-14DAT) but impact rapidly declined thereafter. A second application resulted in a similar response for Bryophyter and Racer but Scythe maintained excellent control 28DAT2. V-10233 controlled small liverwort 7DAT – 21DAT. A second application brought Tower from moderate control (52%) 28DAT to good control (76%) 21DAT2. Champ and Quicksilver were not effective treatments for small liverwort. Results from other experiments (Table 28, Table 29 & Table 30) were quite similar. The addition of Greenmatch in experiment 2 resulted in excellent control through 28DAT for small liverwort and 21DAT for large liverwort.

Table 27. Efficacy of post emergent herbicide applications for the control of small Liverwort, Experiment 1, Gilliam, 2010

Herbicide	Rate	% Liverwort Control ^Y Round 1					2 nd application	% Liverwort Control Round 2				
		3 DAT ^X	7 DAT	14 DAT	21 DAT	28 DAT		2 DAT	7 DAT	14 DAT	21 DAT	28 DAT
		4/2/10	4/6/10	4/13/10	4/20/10	4/27/10	retreated	4/30/10	5/5/10	5/12/10	5/19/10	5/26/10
Bryophyter	1%	90.0b	87b	0.0f	0.0f	0.0d	retreated	89.0b	88.0b	72.0b	29.0c	0.0c
Champ DP	5.5 lb/100 gal	0.0f	0.0f	0.0f	0.0f	0.0d	retreated	0.0e	0.0f	0.0d	0.0d	0.0c
Racer 40%	5%	90.0b	87.0b	0.0f	0.0f	0.0d	retreated	87.0b	88.0b	61.0c	0.0d	0.0c
Scythe	10%	99.0a	98.0a	88.0c	35.0d	0.0d	retreated	100.0 a	99.0a	99.0a	100.0 a	100.0 a
SureGuard	12 oz/A	20.0d	90.0b	100.0 a	100.0 a	100.0 a						
Tower	32 fl oz/A	1.0f	5.0e	24.0d	74.0c	52.0c	retreated	79.0c	76.0c	78.0b	78.0b	49.0b
TerraCyte Pro	0.5 lb/gal	60.0c	60.0c	10.0e	9.0e	0.0d	retreated	30.0d	20.0d	2.0d	8.0d	0.0c
Quicksilver T&O	1 oz/A	0.0f	0.0f	2.0f	2.0f	0.0d	retreated	0.0e	10.0e	0.0d	0.0d	0.0c
Quicksilver T&O	2 oz/A	2.0f	1.0d	0.0f	0.0f	0.0d	retreated	0.0e	1.0f	2.0d	2.0d	0.0c
V-10233	10 fl oz/A	10.0e	90.0b	98.0ab	97.0a	0.0d						
WeedPharm 10%	10%	100a	100a	97.0b	87.0b	40.0c						
WeedPharm 20%	20% RTU ^w	100.0 a	100.0 a	100.0 a	82.0b	0.0d						
Control	NA	0.0f	0.0f	0.0f	0.0f	0.0d	retreated	0.0e	0.0f	0.0d	0.0d	0.0c

^Z Small = 50-75% coverage of pot surface, no reproductive structures

^Y Percent control scale 1-100 (0 = no control, 100 = complete control)

^X DAT = days after treatment

^wRTU = Ready to use

Table 28. Efficacy of post emergent herbicide applications for the control of large ^Z Liverwort, Gilliam, 2010.

Herbicide	Rate	Percent Control Round 1 ^Y					2 nd Application	Percent Control Round 2				
		3 DAT ^X	7 DAT	14 DAT	21 DAT	28 DAT		2 DAT	7 DAT	14 DAT	21 DAT	28 DAT
		4/2/10	4/6/10	4/13/10	4/20/10	4/27/10		4/30/10	5/5/10	5/12/10	5/19/10	5/26/10
Bryophyter	1%	81.3b	83.8bc	73.8c	43.8bc	16.3cd	retreated	90.0b	86.3b	83.8b	21.3d	10.0c
Champ DP	5.5 lb/100 gal	5.0ef	13.8ef	18.8f	11.3d	3.8de	retreated	0.0e	10.0e	0.0f	0.0f	0.0d
Quicksilver T&O	1 oz	12.9de	22.9e	17.1f	11.4d	5.7de	retreated	0.0e	1.0e	0.0f	0.0f	0.0d
Quicksilver T&O	2 oz	11.3def	25.0e	20.0f	8.8d	5.0de	retreated	0.0e	0.0f	0.0f	6.3e	0.0d
Racer 40%	5%	82.5b	83.8bc	73.8c	42.5bc	15.0cd	retreated	72.5c	72.5cd	60.0d	0.0f	0.0d
Scythe	10%	88.8b	91.3ab	81.4bc	48.6b	12.9d	retreated	100a	95.7a	92.9a	94.3a	90.0a
SureGuard	12 oz/A	18.8d	78.8cd	91.3ab	88.8a	87.5a	concluded					
Tower	32 fl oz/A	3.8f	18.8ef	38.8e	36.3bc	26.3c	retreated	...	45.0d	66.3c	52.5b	32.5b
TerraCyte Pro	0.5 lb/gal	63.8c	67.5d	53.8d	33.8c	8.8de	retreated	30.0d	40.0d	20.0e	31.3c	0.0d
V-10233	10 fl oz/A	10.0ef	72.5cd	91.3ab	90.0a	85.0a	concluded					
WeedPharm 10%	10%	97.5a	97.5a	93.8ab	88.8a	73.8b	concluded					
WeedPharm 20%	20% RTU	100a	100a	98.6a	97.1a	94.3a	concluded					
Control	NA	7.5ef ^V	5.0g	10.0f	2.5d	0e	retreated	0.0e	1.3f	0.0f	0.0f	0.0d

^Z Large = 100% coverage of pot surface with reproductive structures
^Y Percent control scale 1-100 (0 = no control, 100 = complete control)
^X DAT = days after treatment
^W RTU = Ready to use
^V Slight browning of controls not related to herbicide occurred

Table 29. Efficacy of post emergent herbicide applications for the control of small Liverwort, Experiment 2, Gilliam, 2010.

Herbicide	Rate	Percent Control ^Y					2 nd Application	Percent Control Round 2				
		2 DAT ^X	7 DAT	14 DAT	21 DAT	28 DAT		3 DAT	7 DAT	14 DAT	21 DAT	28 DAT
		4/30/10	5/5/10	5/12/10	5/19/10	5/26/10		6/5/10	6/9/10	6/16/10	6/23/10	6/30/10
Bryophyter	1%	89.0c	90.0c	0.0d	0.0d	0.0d	retreated	90.0b	89.0b	86.0b	79.0b	77.0b
Champ	5.5 lb/100 gal	2.0e	2.0i	0.0d	0.0d	0.0d	retreated	0.0f	7.0d	30.0d	0.0c	10.0d
GreenMatch	20%	100a	100a	100a	100a	93.0a	concluded					
Quicksilver	2 oz/a	10.0 d	20.0 g	0.0 d	2.0 d	2.0 d	retreated	7.0 e	11.0 d	8.0 e	7.0 c	0.0 d
Racer	5%	96.0b	96.0b	90.0b	51.0c	27.0c	retreated	99.0a	100a	100a	100a	100a
Scythe	10%	100a	100a	100a	100a	92.0a	concluded					
SureGuard	12 oz/A	10.0d	70.0f	100a	100a	100a	concluded					
Tower	32 fl oz/A	0.0e	10.0h	80.0c	74.0b	46.0b	retreated	3.0d	60.0c	83.0b	76.0b	71.0a
Terracyte Pro	0.5 lb/gal	90.0c	81.0e	0.0d	0.0d	10.0d	retreated	73.0c	60.0c	53.0c	10.0c	27.0c
WeedPharm	10%	100a	100a	100a	100a	100a	concluded					
WeedPharm RTU	20% RTU ^W	100a	100a	100a	100a	100a	concluded					
V-10233	10 fl oz/A	0.0e	87.0d	100a	99.0a	100a	concluded					
Control	NA	0.0e	0.0i	0.0d	0.0d	0.0d	retreated	0.0f	0.0e	3.0e	0.0c	0.0d

^Z Small = 50-75% coverage of pot surface, no reproductive structures

^Y Percent control scale 1-100 (0 = no control, 100 = complete control)

^X DAT = days after treatment

^W RTU = Ready to use

Table 30. Efficacy of post emergent herbicide applications for the control of large ^z Liverwort, Experiment 2, Gilliam, 2010.

Herbicide	Rate	Percent Control ^Y					2 nd Application	Percent Control Round 2				
		2 DAT ^X	7 DAT	14 DAT	21 DAT	28 DAT		3 DAT	7 DAT	14 DAT	21 DAT	28 DAT
		4/30/10	5/5/10	5/12/10	5/19/10	5/26/10		6/5/10	6/9/10	6/16/10	6/23/10	6/30/10
Bryophyter	1%	80.0b	80.0d	80.0d	18.8e	15.0cd	retreated	77.5b	81.3b	75.0b	63.8b	16.3b
Champ	5.5 lb/100 gal	15.0c	6.3h	0.0h	0.0g	0.0e	retreated	0.0e	2.5f	30.0d	0.0d	10.0b
GreenMatch	20%	100a	98.8a	92.5abc	90.0b	47.5b	concluded					
Quicksilver	2 oz/A	10.0 d	20.0 g	10.0 g	10.0 f	20.0 c	retreated	10.0 d	10.0 e	10.0 e	0.0 d	0.0 b
Racer	5%	8.3b	85.0c	80.0d	30.0d	10.0d	retreated	91.3a	88.8a	88.8a	75.0ab	68.8a
Scythe	10%	100a	98.8a	96.3ab	97.5a	91.3a	concluded					
SureGuard	12 oz/A	0.0e	37.5f	90.0bc	90.0b	90.0a	concluded					
Tower	32 fl oz/A	0.0e	0.0i	40.0f	60.0c	42.5b	retreated	40.0c	40.0d	78.8b	77.5a	62.5a
Terracyte Pro	0.5 lb/gal	80.0b	80.0d	58.8e	30.0d	22.5c	retreated	72.5b	66.3c	58.8c	15.0c	15.0b
WeedPharm	10%	97.5a	91.3b	88.8c	90.0b	91.3a	concluded					
WeedPharm RTU ^w	20%	98.8a	98.8a	98.8a	100a	96.3a	concluded					
V-10233	10 fl oz/A	0.0e	60.0e	90.0bc	90.0b	90.0a	concluded					
Control	NA	0.0e	0.0i	0.0h	0.0g	0.0e	retreated	0.0e	0.0f	0.0f	0.0d	0.0b

^Z Large = 100% coverage of pot surface with reproductive structures

^Y Percent control scale 1-100 (0 = no control, 100 = complete control)

^X DAT = days after treatment

^w RTU = Ready to use

Mathers 2010

Mathers conducted efficacy evaluations at three locations including phytotoxicity assessments on ten field grown ornamental crops. Two broadcast applications of each product were made four weeks apart. Each spray application involved two passes at 45 gpa to deliver a total of 90 gpa. SureGuard was highly effective on liverwort (Table 31) provided 100% control of liverwort at Lincoln and Spring Meadow and almost 100% control at Zelenka. Scythe exhibited fast acting contact type symptoms with excellent control initially. It did not provide residual control and required two applications for eight weeks of liverwort control. Tower provided some control of liverwort but not as well as SureGuard or Scythe. Commercial control was achieved after the second application. Terracyte treatments were inconsistent and reached acceptable levels of control only at Spring Meadow at 4 WA2T. Injury ratings for WeedPharm were significantly different from the nontreated but generally did not reach acceptable levels. Bryophyter, Champ and Racer treatments did not yield commercial control of liverwort during the evaluation period. SureGuard and Scythe were the only treatments providing consistent control of liverwort but they also had the highest levels of phytotoxicity.

Crop Safety (Table 32): Scythe was phytotoxic to all other species tested including *Berberis thunbergii* 'Crimson Pygmy', *Buxus microphylla* 'Green velvet', *Hydrangea* 'Invincibelle amorences', and *Syringae meyeri* 'Paliban'. SureGuard caused unacceptable injury on these same crops, as well as, *Chaenomeles* 'Double Take Pink Storm' and *Euonymus* 'White Album'. SureGuard treatments did not negatively impact *Viburnum dentatum* 'Double pink' and *Juniperus horizontalis* 'Hughes Gold'. Bryophyter injury ratings on *Syringa sp.* remained high throughout the evaluation period. However, injury ratings for Bryophyter on *Buxus sp.* and *Ilex sp.* began as unacceptable and decreased with time to slight injury. *Berberis*, *Hydrangea*, *Euonymus*, *Viburnum*, *Juniperus*, and *Chaenomeles* demonstrated little to no injury from Bryophyter. Tower significantly impacted *Berberis* and *Buxus* compared to the control. *Berberis* and *Ilex* treated with Terracyte Pro were not marketable by the end of the evaluation period. Initially, Champ injury ratings were significantly higher from the nontreated on *Buxus* and *Ilex* but were marketable by the end of the trial. Champ, Racer and WeedPharm crop injury was slight or transient for all crops except *Syringae*. Crop injury on *Syringae* was difficult to assess due to symptoms unrelated to the treatments.

Table 31. Efficacy of pre and post emergent herbicides on liverwort at Spring Meadow Nursery, Lincoln Nursery, and Zelenka Nursery, Mathers, 2010.

Treatment	Rate	Percent Control Liverwort (0= none, 10 = death)											
		1WAT ^z		2 WAT		4 WAT		1 WAT2		2 WAT2		4 WAT2	
Spring Meadow Nursery													
Bryophyter	1% v/v	2.3	e ^y	1.5	e	1.3	f	2.6	d	2.3	c	1.7	c
Champ	5.5 lb/100 gal	3.9	d	2.7	d	0.8	fg	5.2	c	3.1	c	2.8	c
Racer	0.2% v/v	0.6	f	0.4	f	0.5	fg	2.0	d	2.3	c	2.3	c
Scythe	10 % v/v	9.6	a	8.5	a	7.2	b	9.8	a	9.9	a	7.0	b
SureGuard	12 oz/ac	4.9	c	6.3	b	10.0	a	10.0	a	9.9	a	10.0	a
Tower	32 oz/ac	3.6	d	3.4	d	6.1	c	7.5	b	6.6	b	9.9	a
Terracyte	0.5 lb/gal	4.8	c	3.0	d	2.5	e	5.4	c	6.1	b	9.2	a
WeedPharm	10% v/v	6.6	b	4.4	c	3.9	d	5.7	c	3.1	c	6.1	b
Nontreated		0.0	f	0.0	f	0.0	g	2.0	d	0.8	d	2.3	c
Lincoln Nursery													
Bryophyter	1% v/v	1.2	c	4.2	cd	1.6	c	2.4	cd	4.0	cde	5.0	b
Champ	5.5 lb/100 gal	2.3	bc	2.8	d	2.6	c	3.5	cd	5.0	cd	4.1	b
Racer	0.2% v/v	2.1	c	3.8	d	1.7	c	2.0	de	3.1	e	4.1	b
Scythe	10 % v/v	9.7	a	10.0	a	8.9	a	10.0	a	10.0	a	10.0	a
SureGuard	12 oz/ac	1.2	c	7.3	b	9.8	a	9.9	a	10.0	a	10.0	a
Tower	32 oz/ac	1.9	c	5.2	b	6.4	b	6.7	b	7.9	b	8.8	a
Terracyte	0.5 lb/gal	3.1	b	2.7	d	1.3	cd	3.6	c	3.5	de	3.8	b
WeedPharm	10% v/v	3.7	b	5.1	c	1.4	cd	5.6	b	5.7	c	4.1	b
Nontreated		0.1	d	5.4	b	0.0	d	0.7	e	1.3	f	1.8	c
Zelenka Nursery													
SureGuard	12 oz/A	0.9		4.1	a	6.3	a	9.1	a	8.4	a	9.3	a
Bryophyter	1% v/v	0.5		0.0	b	3.8	b	3.1	b	1.9	b	1.3	b
Nontreated		0.0		1.9	b	0.0	c	1.4	c	1.2	b	0.3	c

z = WAT: weeks after first treatment; WAT2: weeks after second treatment

y = Visual ratings in the same column followed by the same letter are not significantly different based on LS means ($\alpha = 0.05$)

Table 32. Phytotoxicity of selected herbicides on rooted cuttings of various ornamental crops, Mathers, 2010.

Crop	Slight or none	Moderate or Transient Injury	Unacceptable
<i>Berberis thunbergii</i> ‘Crimson Pygmy’	Bryophyter Racer WeedPharm	Champ	Scythe SureGuard Tower Terracyte Pro
<i>Buxus microphylla</i> ‘Green Velvet’	Terracyte WeedPharm	Champ Bryophyter Racer	Scythe SureGuard Tower
<i>Chaenomeles</i> ‘Double Take Pink Storm’	Bryophyter		SureGuard
<i>Euonymus</i> ‘White Album’	Bryophyter		SureGuard
<i>Hydrangea</i> ‘Invincibelle amorences’	Bryophyter Champ Racer Tower Terracyte WeedPharm		Scythe SureGuard
<i>Ilex merservea</i>	Racer WeedPharm	Champ Bryophyter Tower	Scythe SureGuard Terracyte Pro
<i>Juniperus horizontalis</i> ‘Hughes Gold’	Bryophyter SureGuard		Scythe
<i>Syringae meyeri</i> ‘Paliban’ ^a			Bryophyter Scythe
<i>Viburnum dentatum</i> ‘Double Pink’	Bryophyter SureGuard		Scythe

^a Crop Injury was difficult to assess for *Syringae* sp. due to symptoms unrelated to treatments.

Peachey 2010

In 2010 Peachey (OR) evaluated thirteen herbicides applied post-emergently to *Marchantia* sp. Green Match, Scythe, and WeedPharm appeared to control liverwort best at 2 WAT (Table 33). Maximum control was achieved at 2 WAT. However, control dissipated rapidly for all treatments, and at 4 WAT, Scythe (10%) and undiluted WeedPharm were the only herbicides that were rated greater than 5 for control of liverwort. WeedPharm was given a rating of 2 nearly 6 WAT. Most treatments were reapplied on June 17 because of poor efficacy but these treatments did not improve the final outcome. The evaluation on July 17 indicated that none of the products adequately controlled liverwort. Green Match, Scythe, and WeedPharm are nonselective herbicides and will have limited use unless controlling liverwort under benches or in other areas where crops are not present.

Table 33. Efficacy of various herbicides applied post-emergent to *Marchantia sp.*, Peachey, 2010.

Treatment Rate	Efficacy Rating (0 = no impact; 10 = death)				
	15 DAT1	25DAT1	2 nd application	20DAT2	37DAT2
Bryophyter 1 % v/v	0.6	0.8		0.0	0.0
Bryophyter 2% v/v	0.3	0.1	retreated	0.0	0.0
SureGuard 12 oz/A + 0.25% NIS	1.6	4.9		0.0	2.6
SureGuard 12 oz/A, no NIS	1.8	2.0		0.0	0.0
Champ DP 2.75 lb/100 gal	0.2	0.4	retreated	0.0	0.0
Greenmatch 14% v/v	1.5	1.2	retreated	0.8	0.0
Greenmatch 20% v/v	5.6	2.4		0.1	0.0
Quicksilver 1 oz prod/A	0.7	0.0	retreated	0.0	0.0
Quicksilver 2 oz prod/A	0.6	0.2	retreated	0.0	0.0
Racer 2.5% v/v	0.7	0.0	retreated	0.0	0.0
Racer 5% v/v	1.8	0.6	retreated	0.0	0.0
Scythe 5% v/v	7.8	3.3	retreated	8.8	0.7
Scythe 10% v/v	9.4	5.7		0.0	0.0
Tower 32 fl oz/A	1.4	0.9		0.0	0.0
Terracyte Pro 0.5 lb/gal initially 0.25 lb/gal retreat	0.5	0.2	retreated	0.0	0.0
Terracyte Pro 7.5 lb/1000 ft ² 2.5 lb/1000 ft ² retreat	1.3	0.3	retreated	0.0	0.0
WeedPharm 5% v/v	1.9	0.9	retreated	1.4	0.0
WeedPharm 10% v/v	4.7	5.1		0.0	0.0
WeedPharm 20% RTU	9.2	8.9		2.0	0.6
V10233 10 fl oz/A	0.8	1.1	retreated	0.0	0.0
Sporan 1.5 oz/gal (1.7%)	0.7	0.0		0.0	0.0
Nontreated	0.5	0.2		0.0	0.0
FPLSD (0.05)	1.3	1.6		1.1	1.0

Reding 2010

In 2010, Reding (OH) compared the effects of six herbicides applied twice on *Marchantia sp.* grown in nursery containers. Scythe, GreenMatch, Racer and WeedPharm were efficacious against liverwort (Table 34). Results from the first application showed a difference in treatments although some pots showed re-growth of liverwort starting 14 days after treatment. The second application required new liverwort plants in order to have equal plant coverage before treatment. A second application was made for all treatments except for Terracyte and Champ which showed no efficacy. Re-growth data was recorded as a percent of pot area covered with liverwort on pots previously showing complete die back from herbicide applications. Pots treated with Scythe had a significant amount of regrowth.

Table 34. Efficacy rating for Scythe, Green Match, Racer, and WeedPharm on *Marchantia sp.*, Reding, 2010.

Treatment	Efficacy Rating (0 to 10) ¹						% Pot Coverage ²			
	1DAT	7DAT	14DAT		1DAT2	10DAT2				
Scythe 10% v/v	9.9 a ³	10.0 a	10.0 a	retreated	9.8a	9.9 a	39.0 a	12.4 a	30.5 a	58.8 a
GreenMatch 20% v/v	9.8 a	9.9 a	10.0 a	retreated	9.9a	10.0 a	28.5 ab	6.0 b	15.5 b	32.0 b
Racer 5 % v/v	8.7 b	9.6 a	10.0 a	retreated	9.2b	9.9 a	16.0 b	2.4 b	9.5 b	23.5 b
WeedPharm 10%	7.3 c	10.0 a	10.0 a	retreated	9.2b	9.9 a	15.5 b	1.7 b	4.5 b	17.6 b
Terracyte 7.5 lb/100 sq. ft.	0.0 d	1.3 b	0.5 bc							
Champ 5.5 lb/100gal	0.0 d	0.2 c	0.7 b							
Control	0.0 d	0.0 c	0.0 c		0.0c	0.0 b				

¹ Efficacy was rated 0 for no effect to 10 for complete kill.

² Re-growth data was recorded as a percent of pot area covered with liverwort on pots previously showing complete die back from herbicide applications.

³ Means within columns followed by the same letter are not significantly different ANOVA (P=0.05), means separated by LSD (a=0.05)

Senesac 2010

Senesac (NY) evaluated eleven products for control of *Marchantia sp.* Pots containing soilless media were treated with a slurry of liverwort gemmae to insure uniform inoculation. A single herbicide application was applied on July 21, 2010. Very good to excellent control was achieved by 4WAT with treatments of Bryophyter (1 and 2% v/v), Greenmatch (14 and 20% v/v), Racer (2.5 and 5% v/v), Scythe (5 and 10% v/v), Tower (32 fl oz/A) and WeedPharm (5-20% v/v). Champ, Quicksilver and Terracyte Pro, and V-10233 did not provide acceptable control of liverwort (Table 35).

Table 35. Efficacy of various post-emergent herbicide treatments on *Marchantia sp.*, Senesac, 2010.

Treatment/Rate	Percent Control Liverwort		
	1WAT	2WAT	4WAT
Bryophyter 1% v/v	75	94	98
Bryophyter 2% v/v	89	100	99
Champ DP 2.75 lb prod/100 gal	47	16	16
Champ DP 5.5 lb prod/100 gal	28	3	1
GreenMatch 14%	84	100	98
GreenMatch 20%	73	100	97
QuickSilver 1 fl oz prod/A	5	0	0
QuickSilver 2 fl oz prod/A	1	0	0
QuickSilver 6 fl oz prod/A	1	1	0
Racer 2.5% v/v	81	100	74
Racer 5% v/v	59	100	88
Scythe 5% v/v	68	100	94
Scythe 10% v/v	73	100	100
SureGuard 12 oz/A + 0.25% NIS	33	67	18
Tower 32 fl oz/A	60	9	91
Terracyte Pro 0.5 lb/gal	33	29	16
Terracyte Pro 7.5 lb/1000 ft ²	39	48	48
V-10233 10 oz/A	41	66	24
WeedPharm 5% v/v	86	100	100
WeedPharm 10% v/v	70	100	100
Weed Pharm 20% v/v	81	100	100
Nontreated	0	0	0
Fisher's LSD@ 0.05	13	6	9

2010 Wilen

Wilen (CA) evaluated eight herbicides for post-emergent control of *Marchantia sp.* After 4 weeks, Bryophyter, Champ, Racer, Terracyte and Tower treated pots had less than 80% control and were retreated. Figure 2 shows that all treatments except for Tower and SureGuard lost activity over time. Champ and Terracyte did not provide adequate control (>8 efficacy rating) within the first 4 weeks of application or within 4 weeks of the second application. While Tower

activity increased over time, it never reached an acceptable level even with a second application. SureGuard took one week to see good control but the control was maintained for the 8-week span of the study and a second application was not warranted. A second application of Bryophyter 1% and 2% and Racer increased efficacy to acceptable levels during the second 4 weeks. Scythe at 5 and 10% and WeedPharm at 10 and 20% had sufficient efficacy at 4 weeks to not warrant a second application. However, WeedPharm activity at both rates decreased to below an 8 rating by the end of the study. Scythe activity was similar but slightly better than WeedPharm.

In summary, SureGuard was the most effective material for long-term liverwort control in this test. Champ was not effective at all. Tower and Terracyte provided moderate control but not enough at any evaluation date to be acceptable. All other treatments lost activity over time but a second application resulted in improved control. A 4-week interval may be too long to maintain control for Scythe, Race, WeedPharm, and Bryophyter as new plants began to emerge within that interval even though the initial plug appeared to be well controlled.

Figure 2. Efficacy of various post-emergent herbicides on *Marchantia sp.*, Wilen 2010

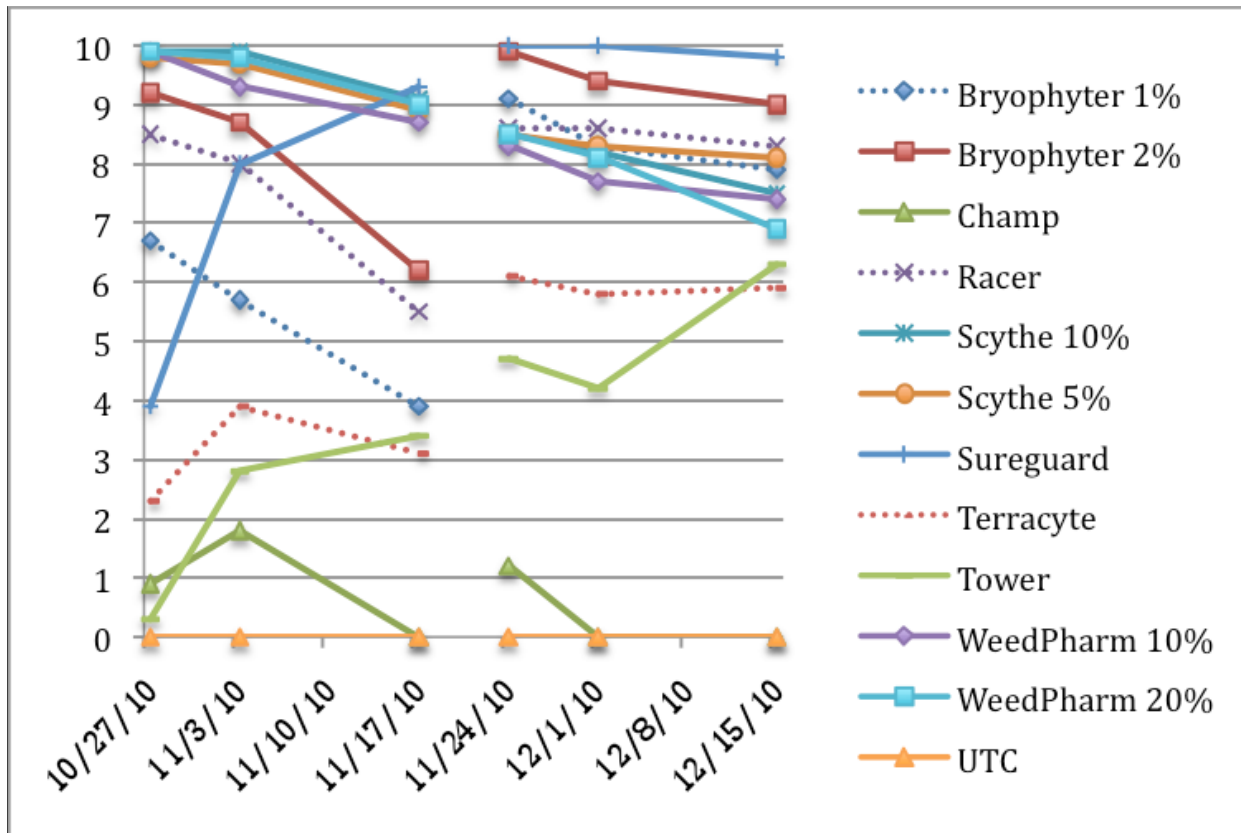
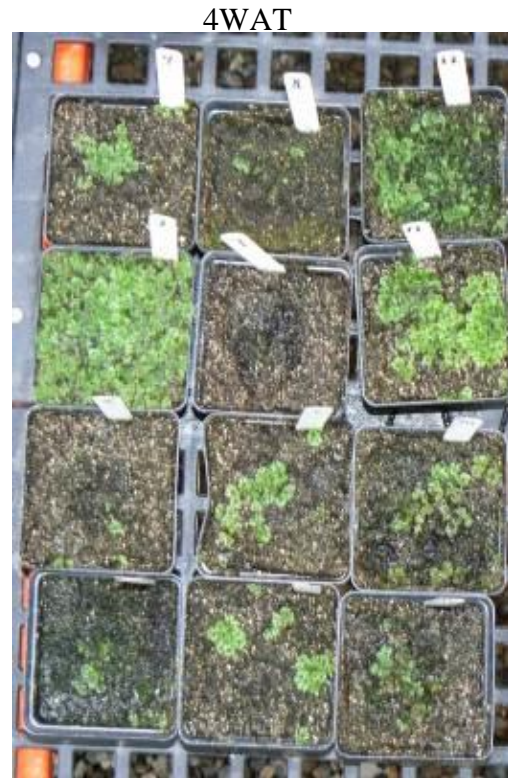


Figure 3. Efficacy of various post-emergent herbicides on *Marchantia sp.*, Wilen 2010



4 Racer	8 Terracyte	12 UTC
3 Champ	7 SureGuard	11 WeedPh. 20%
2 Bryo. 2%	6 Scythe 5%	10 WeedPh. 10%
1 Bryo. 1%	5 Scythe 10%	9 Tower

2011 Mathers

Mathers conducted three trials at nurseries near Grand Haven, MI in heated greenhouses or hoopouses. In addition to efficacy evaluations, several ornamental species were rated for crop safety.

Efficacy: All treatments provided some level of control of liverwort in comparison to the nontreated pots at each location. However, some differences among treatments existed between locations (Table 36, Table 38, Table 39). In Trial 2, excellent control was generally obtained with all treatments throughout the experiment. This location had a heavy liverwort infestation. The nontreated control received a moderate visual rating (4.2) which was likely due to competition with the crop for water and nutrients (Table 38).

The differences between products can be characterized as quickness of control and the length of control. GreenMatch, Racer, Bryophyter, baking soda and WeedPharm were very fast acting similar to contact type herbicides and produced very good results within 1 WAT. Terracyte was slightly slower in demonstrating efficacy followed by SureGuard and Tower, respectively. The quickness of the herbicide is somewhat inversely related to the amount of residual the product provides. Tower appeared to be the slowest acting herbicide. Control increased gradually until the final evaluation but it did not provide acceptable control with two applications in Trial 1 (BFN) or Trial 3 (Northland Farms). SureGuard was applied only once and provided commercially acceptable ratings by 4 WAT at each location. Commercial levels of control were maintained throughout the experiment.

Bryophyter and Racer performance was comparable. Racer was reapplied at 4 WAT while Bryophyter was reapplied at 6 WAT. Liverwort appeared to regrow very quickly where Racer was applied and possibly more abundantly than what was originally in the pot before the initial application (Figure 4). Reasons for this are not known but it could possibly be due to an increase in nitrogen from the ammonium in the Racer. GreenMatch was never reapplied; however, visual ratings in Trial 1 suggest reapplication is necessary after 3 WAT. WeedPharm demonstrated the longest residual of the “contact” herbicides in Trial 1 and reapplication was not needed until 6 WAT.

Baking soda gave excellent control of liverwort (Table 38). This treatment was not part of the IR-4 protocol but rather was suggested by Michigan growers. Treatment rate was unknown which is why there are different rates at each location. Only a “dusting” is needed for control with this rate providing at least 4 weeks of control.

Phytotoxicity: All treatments were phytotoxic to at least one of the species tested (Table 36, Table 38, Table 39). Although SureGuard is slow to act on liverwort but caused contact type injury on susceptible plants with visual symptoms showing up within a day or two. Normal use rates for container ornamentals are 8-12 oz/A. Half this rate (4 oz/A) was used in these trials to reduce phytotoxicity to the crop. Nevertheless, this lower rate of 4 oz/A of SureGuard injured most species that had broken dormancy. For ‘Annabelle’ hydrangea in Trial 1 some buds had broken when the SureGuard was applied. Those that had broken dormancy were severely injured or died while those that had not broken dormancy were not injured at all (Figure 5). Previous study has shown SureGuard to be injurious to actively growing weigela. However, the weigela ‘My Monet’ in Trial 1 treated at dormancy did not demonstrate significant injury symptoms

(Error! Reference source not found.) at any time except for the initial rating. A similar case is found with hosta and barberry in Trial 3. Note: no phytotoxicity ratings were taken in Trial 3 until 8 WAT when all plants finally broke dormancy. Here ostrich fern visual ratings indicate that there was some injury from a dormant application of SureGuard. For this species one replication was injured and two replications were not injured (data not shown).

Tower injured all ten species that were tested. Bryophyter, GreenMatch, Racer, and WeedPharm all caused burning to leaf tissue after application. This burning was minor to severe depending on the species, size, and maturity of the crop. If the crop was not killed after application, injury from these four products was temporary decreasing over time for many of the treatments. Terracyte injury was variable. Some replications exhibited injury while some did not. Visual ratings indicate that Terracyte was injurious to four of the six species tested. Terracyte was applied as a granule and variability may be due to the granule not getting washed from the leaves in a timely fashion. A similar observation was made by Wilen in 2011. Baking soda at 25-50 ml/ft² caused death of five of the six species tested. When applied as a “dusting” (actual rate not known) much less injury occurred. Ostrich fern was the only species to exhibit significant injury (Table 3).

Overall, all treatments provided control of liverwort. The contact type herbicides (Bryophyter, Racer, WeedPharm and GreenMatch) were safe as dormant applications. Results show reapplication is needed for effective liverwort control with these products but this may cause injury once the crop is actively growing. WeedPharm has the best residual of the contact type herbicides. WeedPharm also provided the least injury of the contact type herbicides to Dappled willow, ‘Blacklace’ elderberry, ‘Annabelle’ hydrangea, ‘My Monet’ weigela, and ‘Forever pink’ hydrangea (Table 1). Good coverage is essential for the “contact” herbicides. Where there was a crop canopy limiting application coverage liverwort control generally decreased. Thoroughly rinsing granular products from crop foliage may reduce crop injury.

SureGuard provided residual commercial level control of liverwort with one application at a low rate of 4 oz/A. Species that had broken dormancy frequently demonstrated crop injury. More research is warranted to fine tune the rate and timing of dormant applications for various ornamental species. This product offers the additional advantage of preemergent weed control. More research is warranted for baking soda to establish the rate of application, as well as, crop safety.

Figure 4. Racer over top of hydrangea 'Forever red' 2WAT2. Notice abundance of liverwort.



Figure 6. SureGuard over 'My Monet' weigela at BFN at 9 WAT.



Figure 5. SureGuard over top of hydrangea 'Annabelle' 9WAR. Injury only occurred to plants that had broken dormancy. At this point, liverwort had started to come back.



Figure 7. Terracyte Pro G over hydrangea 'Forever red' at 5 WAT. Notice some spotting and leaf necrosis on edges of leaves.



Table 36. Effects of postemergent herbicides on *Marchantia sp.* and ornamentals – Trial 1, Part A, Mathers, 2011.

Product	Rate	Efficacy (0= no control, 10 = complete control)							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
GreenMatch	20% v/v	--	--	--	8.8b	8.2bc	5.8d	6.3e	5.2e
Racer	10% v/v	7.9b	7.0b	4.8e	7.0d	5.8d	1.9f	3.5g	2.9b
Sureguard	4 oz/A	4.4c	6.5b	8.7b	8.9b	8.6b	6.6c	8.4d	7.8bc
Tower	32 oz/A	1.9d	4.4c	5.3e	3.2e	4.4e	3.0e	5.6f	6.6d
Terracyte	10 lb/1000	--	--	6.9d	7.8c	7.7c	9.2ab	9.4ab	9.3a
Bryophyter	2% v/v	9.6a	9.8a	7.6c	6.7d	6.3d	8.7b	8.6cd	7.6c
WeedPhar	10% v/v	9.9a	9.9a	8.8b	8.3b	7.9bc	9.3ab	9.2bc	8.4b
Baking	50 ml/ft ²	10.0a	10.0a	10.0a	10.0a	10.0a	9.9a	10.0a	10.0a
Nontreated	--	2.1d	0.9d	1.0f	1.4f	2.2f	0.6g	2.3h	1.9g
Product	Rate	Dappled willow (<i>Salix integra</i> 'Hakuro Nishiki') Crop Injury							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
GreenMatch	20% v/v	--	--	--	6.7**	7.2	6.9**	5.2**	3.2
Racer	10% v/v	6.6**	4.8**	4.1	7.3**	6.0	7.5**	5.0**	5.0**
Sureguard	4 oz/A	9.1**	9.2**	8.7	8.6**	9.2**	9.2**	8.2**	7.7**
Tower	32 oz/A	1.4**	0.8	0.8	0.5**	5.8	7.2**	4.6	4.1*
Terracyte	10 lb/1000 ft	--	--	0.4	0.0**	5.4	4.3	0.0**	
Bryophyter	2% v/v	8.0**	5.9**	4.8	4.7	5.6	8.6**	7.2**	7.1**
Weed	10% v/v	5.4**	4.1**	4.8	4.1	5.9	7.8**	5.3**	4.6**
Baking	50 ml/ft ²	8.9**	10.0**	10.0	10.0**	10.0**	10.0**	10.0**	10.0**
Nontreated	--	0.0	0.0	0.0	4.4	5.3	4.7	2.9	1.5
Product	Rate	Black lace elderberry (<i>Sambucus nigra</i>) Crop Injury							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
GreenMatch	20% v/v	--	--	--	9.0**	9.0**	9.0**	7.3**	7.3**
Racer	10% v/v	9.3**	7.0**	6.7**	9.8**	9.3**	9.5**	8.8**	9.0**
Sureguard	4 oz/A	6.2**	6.3**	7.3**	6.6**	5.3	5.6**	5.5	5.3
Tower	32 oz/A	4.0**	4.1	3.7	3.7	□3.6	3.9	4.5	4.2
Terracyte	10 lb/1000	--	--	4.1	4.5	4.5	4.7**	5.3	4.9
Bryophyter	2% v/v	7.6	6.4**	6.5**	6.0*	5.4	9.3**	9.1**	8.7**
WeedPhar	10% v/v	3.3**	3.7	2.9	3.1	2.2	6.0**	3.8	4.0
Baking	50 ml/ft ²	6.9**	7.3**	8.8**	8.9**	9.3**	9.6**	9.3**	9.5**
Nontreated	--	0.0**	2.4	2.7	2.8	2.9	1.3	2.8	2.7

Table 37. Effects of postemergent herbicides on *Marchantia sp.* and ornamentals – Trial 1, Part B, Mathers 2011.

Product	Rate	Annabelle hydrangea (<i>Hydrangea arborescens</i> ‘Annabelle’)							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
GreenMatch	20% v/v	--	--	--	10.0**	10.0	10.0**	9.9**	9.9
Racer	10% v/v	7.4	8.3**	8.9**	9.9**	9.8	9.9**	9.7**	9.8
Sureguard	4 oz/A	8.3	7.5**	7.2*	6.6	6.0	5.9**	6.0	5.9
Tower	32 oz/A	4.5	2.7	2.8	3.0	2.3	7.3**	6.4*	6.6*
Terracyte	10 lb/1000	--	--	7.1*	7.3**	7.3	7.8**	7.4**	7.3**
Bryophyter	2% v/v	8.8	8.3**	8.5**	8.4**	8.4	9.7**	9.5**	9.3**
Weed	10% v/v	4.4	3.3	3.8	3.3	2.7	6.3**	4.7	4.5
Baking	50 ml/ft ²	8.8	9.8**	10.0**	10.0**	10.0	10.0**	10.0**	10.0**
Nontreated	--	6.7	3.5	3.7	3.7	3.5	2.5	3.3	3.3
Product	Rate	Monet weigela (<i>Weigela florida</i> ‘My Monet’)							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
GreenMatch	20% v/v	--	--	--	8.5**	8.8**	9.2**	8.1**	8.2**
Racer	10% v/v	6.6**	4.3	3.8	7.7**	6.5**	8.4**	6.0**	5.3
Sureguard	4 oz/A	4.7**	1.7	1.5	1.0	1.0	1.3	1.0	0.9
Tower	32 oz/A	7.2**	7.3**	6.7*	6.3*	6.2*	7.8**	7.3	7.2**
Terracyte	10 lb/1000	--	--	0.9	0.6	1.1	2.2*	3.8	4.2
Bryophyter	2% v/v	6.8**	5.4*	5.3	4.6	4.4	8.8**	7.7**	7.3**
Weed	10% v/v	3.0**	1.7	1.5	1.3	1.6	6.4	5.5	5.1
Baking	50 ml/ft ²	9.0**	9.6**	9.9**	9.8**	9.9**	10.0**	10.0**	10.0**
Nontreated	--	0.0	2.1	3.4	3.1	3.0	4.7	2.9	2.8
Product	Rate	Forever Pink hydrangea (<i>Hydrangea macrophylla</i>) Crop Safety							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
GreenMatch	20% v/v	--	--	--	6.5**	7.5**	9.2	7.8	7.3
Racer	10% v/v	5.4**	4.7**	2.3	8.8**	7.9**	8.6	5.5	4.0
Sureguard	4 oz/A	9.8**	9.9**	9.9**	9.9**	9.9**	9.9	9.8	9.8
Tower	32 oz/A	0.5	3.1**	2.8	1.2	0.8	8.5	7.0	8.1
Terracyte	10 lb/1000 ft	--	--	5.6**	4.1	4.2	7.1	4.8	4.4
Bryophyter	2% v/v	5.8**	7.2**	6.6**	6.3**	5.8**	9.0	8.8	8.2
Weed	10% v/v	4.7**	4.1**	5.1**	3.3	2.4	6.6	4.2	3.4
Baking	50 ml/ft ²	9.8**	10.0**	10.0**	10.0**	10.0**	10.0	10.0	10.0
Nontreated	--	0.8	1.3	1.5	2.8	2.9	2.6	3.0	3.0

Table 38. Efficacy of post-emergent herbicide treatments on *Marchantia* sp. – Trial 2, Spring Meadow, Mathers, 2011.

Product	Rate	Efficacy (0= no control, 10 = complete control)							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
Baking Soda	50 ml/ft ²	9.6ab	9.9a	9.9a	10.0a	10.0a	9.3a	10.0a	9.5a
Racer	10% v/v	7.2d	7.3c	7.2c	7.9c	9.6a	8.8ab	7.8b	7.3b
Sureguard	4 oz/ac +	6.8d	7.4c	10.0a	10.0a	10.0a	7.6b	10.0a	10.0a
Tower	32 oz/ac	0.1e	2.0d	3.1e	2.6f	7.5 ^y b	5.6c	9.6a	9.2a
Terracyte	10	--	--	5.3d	6.6d	□8.0b	8.9ab	9.8a	8.8a
Bryophyter	2% v/v	8.3c	8.2b	9.1b	9.0b	9.5a	8.4ab	8.7a	8.8a
WeedPharm	10% v/v	10.0a	9.8a	10.0a	10.0a	10.0a	9.2ab	9.9a	9.8a
GreenMatch	20% v/v	--	--	--	5.1e	7.1b	5.3c	7.4b	8.3a
Baking Soda	25 ml/ft ²	9.0b	10.0a	10.0a	10.0a	10.0a	9.0ab	9.3a	8.8a
Nontreated		0.0e	0.0e	0.0f	0.1f	3.0c	1.9d	2.6c	4.2a
Product	Rate	Ghost weigela (<i>Weigela florida</i> 'Ghost') Crop Injury							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
Baking Soda	50 ml/ft ²	0.5	0.4	0.6	1.0	0.4	1.0	0.2	0.5
Racer	10% v/v	2.7**	3.1**	1.1	1.9	1.7	4.3**	0.7	0.8
Sureguard	4 oz/ac +	7.9**	7.1**	5.7**	5.6**	2.5*	4.7**	2.8**	2.5**
Tower	32 oz/ac	0.0	0.5	0.9	1.3	□2.3	5.5**	3.4**	5.2**
Terracyte	10	--	--	0.5	2.1**	□1.3	5.1**	2.7**	2.8**
Bryophyter	2% v/v	3.3**	4.5**	2.2**	2.2**	0.4	2.0	0.5	0.8
WeedPharm	10% v/v	1.2	2.1**	1.3	2.3**	1.8	4.5**	0.2	0.8
Green	20% v/v	--	--	--	5.5**	4.9**	6.7**	3.3**	2.1
Baking Soda	25 ml/ft ²	0.9	1.3	1.7*	1.5	1.9	4.7**	1.2	0.8
Nontreated		0.6	0.6	0.4	0.6	0.9	1.0	0.6	0.7

z = visual ratings based on a 0-10 scale with 0 being no control, 10 perfect control and ≥ 7 commercially acceptable.

Ratings followed by the same letter in the same evaluation date are not significantly different based on lsmeans ($\alpha = 0.05$)

y = ✓ indicates that treatment was reapplied on specified date

x = phytotoxicity ratings based on a 0-10 scale with 0 being no phytotoxicity, 10 death and ≤ 3 commercially acceptable.

Ratings followed by * and ** are significantly different from the nontreated control based on Dunnett's t-test ($\alpha = 0.10$ and 0.05, respectively).

Table 39. Efficacy of post-emergent herbicide treatments on *Marchantia* sp. – Trial 3, Part A, Northland Farms, Mathers, 2011.

Product	Rate	Efficacy (0= no control, 10 = complete control)							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
Racer	10% v/v	6.0c	4.0b	5.0 ^y c	7.4bc	7.4b	5.7b	5.9b	5.3c
Sureguard	4 oz/ac +	4.5c	5.7b	8.0b	8.4ab	9.4a	7.9a	9.3a	9.1a
Tower	32 oz/ac	1.9d	2.9	3.9c	2.0d	4.9c	4.5b	6.2b	6.4bc
Bryophyter	2% v/v	8.0b	8.3a	7.7b	6.8c	5.5c	8.3a	8.7a	7.7b
Baking		9.7a	10.0a	9.9a	✓9.2a	--	9.5a	10.0a	10.a0
Nontreated		0.0e	4.8b	3.8c	3.4d	5.1c	4.1b	3.3c	7.0bc
Product	Rate	Big Daddy hosta (<i>Hosta</i> ‘Big Daddy’) Crop Injury							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
Racer	10% v/v	--	--	--	--	--	--	1.3	1.0
SureGuard	4 oz/ac +	--	--	--	--	--	--	0.0	0.0
Tower	32 oz/ac	--	--	--	--	--	--	3.7**	2.7**
Bryophyter	2% v/v	--	--	--	--	--	--	0.0	0.0
Baking		--	--	--	--	--	--	1.3	0.7
Nontreated		--	--	--	--	--	--	0.0	0.0
Product	Rate	Sagae hosta (<i>Hosta</i> ‘Sagae’) Crop Injury							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
Racer	10% v/v	--	--	--	--	--	--	0.0	0.7
SureGuard	4 oz/ac +	--	--	--	--	--	--	0.0	0.0
Tower	32 oz/ac	--	--	--	--	--	--	3.7**	2.3**
Bryophyter	2% v/v	--	--	--	--	--	--	0.0	0.0
Baking		--	--	--	--	--	--	0.0	0.1
Nontreated		--	--	--	--	--	--	0.0	0.0

z = visual ratings based on a 0-10 scale with 0 being no control, 10 perfect control and ≥ 7 commercially acceptable.

Ratings followed by the same letter in the same evaluation date are not significantly different based on lsmeans ($\alpha = 0.05$)

y = ✓ indicates that treatment was reapplied on specified date

x = phytotoxicity ratings based on a 0-10 scale with 0 being no phytotoxicity, 10 death and ≤ 3 commercially acceptable.

Ratings followed by * and ** are significantly different from the nontreated control based on Dunnett’s t-test ($\alpha = 0.10$ and 0.05 , respectively).

Table 40. Efficacy of post-emergent herbicide treatments on *Marchantia* sp. – Trial 3, Part B, Northland Farms, Mathers, 2011.

Product	Rate	Ostrich fern (<i>Matteuccia struthiopteris</i>) Crop Safety							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
Racer	10% v/v	--	--	--	--	--	--	1.0	0.7
SureGuard	4 oz/ac +	--	--	--	--	--	--	5.3**	3.3
Tower	32 oz/ac	--	--	--	--	--	--	5.7**	3.0
Bryophyter	2% v/v	--	--	--	--	--	--	2.7	1.0
Baking		--	--	--	--	--	--	6.0**	4.3**
Nontreated		--	--	--	--	--	--	0.0	0.0
Product	Rate	Crimson pygmy barberry (<i>Berberis thunbergii</i>) Crop Safety							
		1WAT	2WAT	4WAT	5WAT	6WAT	7WAT	8WAT	9WAT
Racer	10% v/v	--	--	--	--	--	--	1.2	1.0
SureGuard	4 oz/ac +	--	--	--	--	--	--	1.8	1.7
Tower	32 oz/ac	--	--	--	--	--	--	4.9	5.8*
Bryophyter	2% v/v	--	--	--	--	--	--	4.9	4.3
Baking		--	--	--	--	--	--	5.3	5.2
Nontreated		--	--	--	--	--	--	2.5	2.5

z = visual ratings based on a 0-10 scale with 0 being no control, 10 perfect control and ≥ 7 commercially acceptable.
Ratings followed by the same letter in the same evaluation date are not significantly different based on lsmeans ($\alpha = 0.05$)
y = ✓ indicates that treatment was reapplied on specified date
x = phytotoxicity ratings based on a 0-10 scale with 0 being no phytotoxicity, 10 death and ≤ 3 commercially acceptable.
Ratings followed by * and ** are significantly different from the nontreated control based on Dunnett's t-test ($\alpha = 0.10$ and 0.05 , respectively).

2011 Peachey

Peachey evaluated thirteen herbicides for efficacy in controlling liverwort in one gallon container plantings. Pots were grown without a crop. Treatments 12-14 had half the reps compared to treatments 1-10 and initial coverage was more variable.

Immediate control (\geq a rating of 8.0 within one week) was observed in pots treated with TerraCytePro G, Racer, GreenMatch, Scythe, WeedPharm, and Bryophyter. These six products retained efficacy over the course of the experiment. In general, control increased over time for all treatments. Re-growth at 4 and 12 WAT was observed in nontreated pots, as well as, in those treated with Tower EC, FlowerPharm, Sporotec, M-Pede, and Supreme oil.

The apparent increase in control by 12WAT with Tower EC, Indaziflam, and SureGuard may be due to seasonal dieback unrelated to treatment or slow to activity from the treatment. A better indication of effectiveness may be the regrowth data at 4 and 12 WAT. Tower, Indaziflam and SureGuard did not demonstrate long-term control in these evaluations. Due to the climate of the Pacific Northwest, retreatment and re-evaluation is planned for in the spring of 2013 on any pots with a control rating ≤ 8 at that time.

Table 41. Efficacy of various herbicides applied post-emergent to *Marchantia sp.* Peachey 2011.

Treatment	Rate	Initial % cover	Percent Control (0= none, 10 = complete control)				
			1WAT	2WA T	4WA T	6WA T	12WA T
Indaziflam ¹	0.065 lbs ai/A	40	1.4 d	1.8 d	5.4 b	6.9 b	8.5 b
GreenMatch	20% v/v	45	9.8 a	9.9 a	10 a	9.9 a	9.6 ab
Scythe	3% v/v	52	9.5 a	10 a	9.6 a	9.5 a	9.4 ab
SureGuard	12 oz/A	45	1.2 d	1.7 d	5.4 b	7.2 b	9.6 ab
Tower 63.9%EC	1.50 lbs ai/A	43	1.4 d	2.3 cd	3.5 c	4.7 c	6.8 c
TerraCyte Pro G)	1lb/10 ft ²	48	10 a	10 a	10 a	10 a	10 a
Bryophyter	2% v/v	41	8.3 b	9.4 a	9.9 a	9.8 a	9.4 ab
FlowerPharm	10%	43	2.3 c	3 cd	3.2 c	3.1 d	5.1 d
Sporotec	1.20%	48	1.8 d	3.1 cd	2.8 c	2 d	4.3 d
WeedPharm	10%	45	9.1 ab	9.7 a	9.9 a	9.9 a	9.8 ab
Racer	10%	37	10 a	10 a	9.6 a	9.6 a	9.2 ab
M-Pede	4%	13	3.2 c	5.4 b	5.4 b	4.6 c	5.4 cd
Supreme Oil	1%	14	1.6 d	3.4 c	2.6 c	5.4 c	5.6 cd
Nontreated	-----	45	0.1 e	0.1 e	0.7 d	0.1 e	0.8 e

¹ Applied 16 April 2011

² Values within a column followed by the same letter do not differ (FPLSD, $\alpha=0.05$).

2011 Senesac

Senesac tested ten products for liverwort control in the greenhouse under hourly mist irrigation. Several treatments provided excellent control for twelve weeks with one application. FlowerPharm, Racer, Sporotec and Terracyte required a retreatment at 6WAT. WeedPharm, Bryophyter, and Scythe provided equivalent control compared to SureGuard. Tower worked well in suspending growth and the spread of liverwort but required a long period for conventional control symptoms. Liverwort treated with Tower appeared to have stalled growth rather than typical injury symptoms.

In addition to controlling liverwort, the following products were effective in controlling bittercress and crabgrass: Bryophyter, GreenMatch, Scythe, SureGuard, and WeedPharm. Silwett alone also controlled these weeds but ineffective in controlling livewort.

Figure 8. WeedPharm control of liverwort.

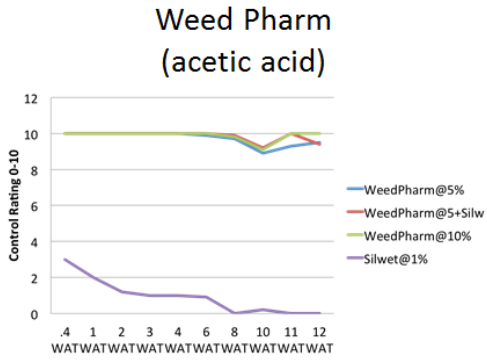


Figure 10. Sureguard control of liverwort.

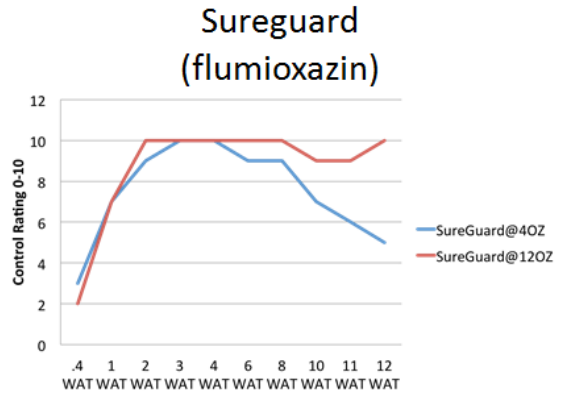


Figure 9. Bryophyter control of liverwort

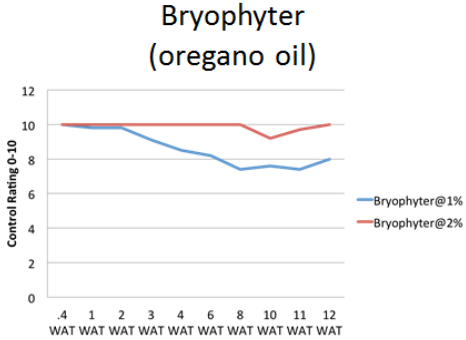


Figure 11. Scythe control of liverwort.

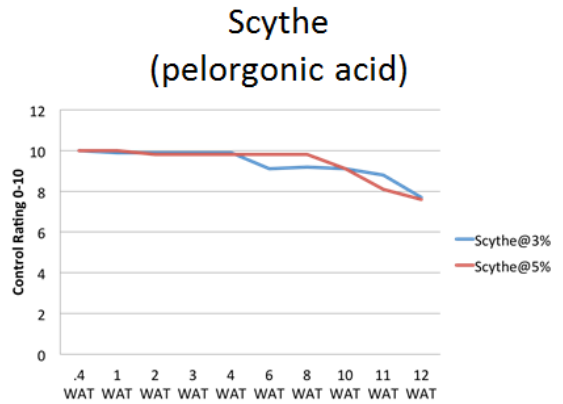


Table 42. Efficacy of various herbicides applied post-emergent to *Marchantia sp.*, Senesac, 2011.

Treatment	Rate	3 DAT	1 WAT	2 WAT	3 WAT	4 WAT	6 WAT	8 WAT	10 WAT	11 WAT	12 WAT
GreenMatch	14%	10	10	10	10	9	7	10	10	10	10
GreenMatch	20%	10	10	10	10	9	9	7	8	7	7
Racer 40%	5%	9	9	9	8	6	4✓	9	9	8	8
Racer 40%	10%	10	10	10	10	9	8	10	10	10	9
Scythe	3%	10	10	10	10	10	9	9	9	9	8
Scythe	5%	10	10	10	10	10	10	10	9	8	8
SureGuard 51WDG	4 oz/A + 0.25% v/v NIS	3	7	9	10	10	9	9	7	6	5
SureGuard 51WDG	12 oz/A + 0.25% v/v NIS	2	7	10	10	10	10	10	9	9	10
TerraCyte Pro G	10 lb/1000 sq. ft	7	7	7	7	6	6✓	10	10	10	10
Bryophyter	1%	10	10	10	9	9	8	7	8	7	8
Bryophyter	2%	10	10	10	10	10	10	10	9	10	10
Sporotec	1.5 fl oz/gal	4	4	3	2	2	2✓	1	2	2	0
FlowerPharm	5% v/v	2	2	1	1	1	1✓	0	1	0	0
FlowerPharm	10% v/v	5	5	4	2	2	2✓	3	2	2	1
WeedPharm	5%	10	10	10	10	10	10	10	9	9	10
WeedPharm	5% + Silwet 1% v/v	10	10	10	10	10	10	10	9	10	9
WeedPharm	10%	10	10	10	10	10	10	10	9	10	10
Silwet	1% v/v	3	2	1	1	1	1	0	0	0	0
Green Guardian	Ratio 1:3	8	8	9	8	8	7	6	6	6	4
Nontreated	Nontreated	0	0	0	0	0	0	0	0	0	0
<i>Fisher's LSD @ 0.50</i>		<i>0.3</i>	<i>0.4</i>	<i>0.3</i>	<i>0.3</i>	<i>0.3</i>	<i>0.7</i>	<i>0.5</i>	<i>0.5</i>	<i>0.5</i>	<i>0.5</i>

Wilén 2011

Wilén evaluated seven postemergence herbicide treatments for control of liverwort grown in 4” pots in the greenhouse. All treatments were applied three times during the trial.

GreenMatch provided very good initial control which decreased within 2 to 3 weeks, thus, requiring repeat applications. Terracyte had moderate but unacceptable control throughout the trial with a maximum rating of 7.5. Activity with this granular product was high in some pots and low in others. Application of the granular formulation may have been uneven and caused variable results. SureGuard provided moderate but unacceptable control with the first application. Subsequent applications were ineffective. Racer, Scythe, Sporotec, and Tower appeared to have little to no control.

Figure 12. Efficacy of various post-emergent herbicides on *Marchantia sp.*, Wilén 2011

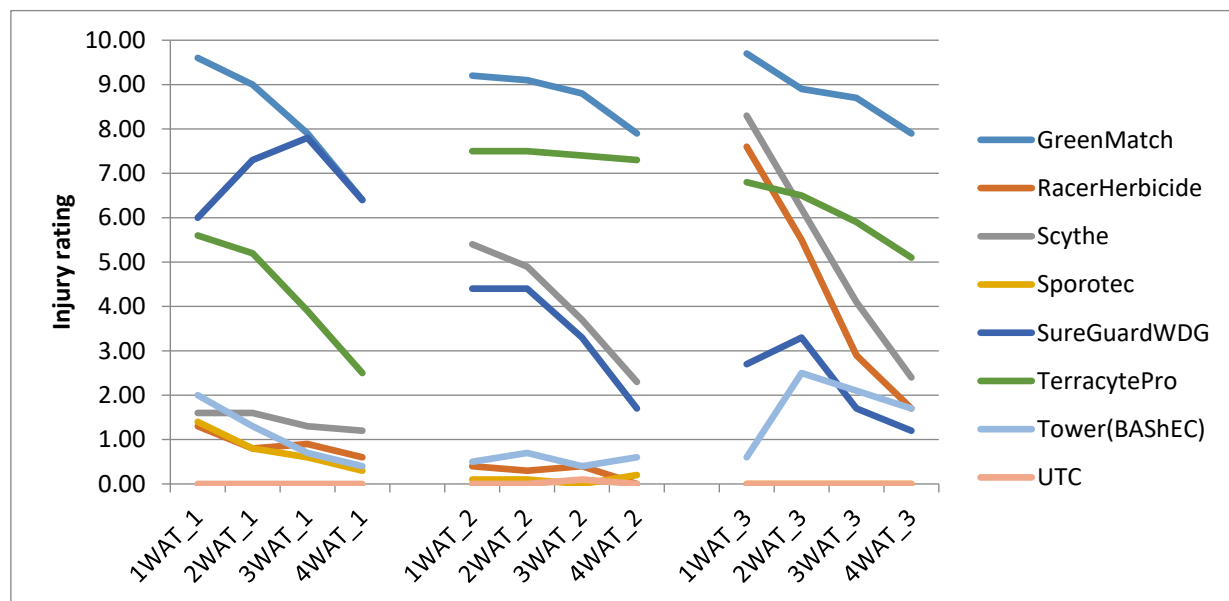


Table 43. Efficacy of various herbicides applied post-emergent to *Marchantia* sp., Wilen, 2011.

Product	Rate	Efficacy (0 = no control, 10 = complete control)											
		1 WAT	2 WAT	3 WAT	4 WAT	1 WAT2	2 WAT2	3 WAT2	4 WAT2	1 WAT3	2 WAT3	3 WAT3	4 WAT3
GreenMatch	20% v/v	9.60a ¹	9.00a	7.90a	6.40a	9.20a	9.10a	8.80a	7.90a	9.70a	8.90a	8.70a	7.90a
Racer	10% v/v	1.30c	0.80d	0.90c	0.60bc	0.40c	0.30c	0.40c	0.00c	7.60bc	5.50b	2.90cd	1.70c
Scythe	5% v/v	1.60c	1.60d	1.30c	1.20bc	5.40b	4.90b	3.70b	2.30b	8.30b	6.20b	4.10c	2.40c
Sporotec	1.5 fl oz/1000 ft ²	1.40c	0.80d	0.60c	0.30bc	0.10c	0.10c	0.00c	0.20c	0.00e	0.00d	0.00e	0.00c
SureGuard 51WDG	12 oz /A + 0.25% NIS ²	6.00b	7.30b	7.80a	6.40a	4.40b	4.40b	3.30b	1.70bc	2.70d	3.30c	1.70de	1.20c
Terracyte Pro	10 lb/1000 sq ft	5.60b	5.20c	3.90b	2.50b	7.50a	7.50a	7.40a	7.30a	6.80c	6.50b	5.90b	5.10b
Tower EC	32 fl oz /A	2.00c	1.30d	0.70c	0.40bc	0.50c	0.70c	0.40c	0.60c	0.60e	2.50c	2.10cde	1.70c
UTC		0.00c	0.00d	0.00c	0.00c	0.00c	0.00c	0.10c	0.00c	0.00e	0.00d	0.00e	0.00c
	<i>LSD (P=.05)</i>	1.66	1.52	1.40	1.69	1.91	1.74	1.56	1.39	1.21	1.65	1.74	1.82

¹Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls).

²NIS = nonionic surfactant, Activator 90

Figure 13. Photo of various post-emergent herbicide applications 4WAT3 on *Marchantia sp.*, Wilen, 2011.



1	2	3	4	5	6	7	8
GreenMatch	Racer	Scythe	Sporotec	SureGuardWDG	TerracytePro	Tower EC	UTC

Senesac 2013

Senesac screened organic and bioherbicides for post-emergent activity for liverwort management. The first applications were made on March 1 when liverwort covered approximately 75% of the pots and then on April 26 when liverwort covered approximately 100% of the nontreated pots. To determine whether post treatment irrigation to reduce herbaceous perennial crop injury with over the top applications impacted liverwort efficacy, half of the pots also received irrigation 15 minutes after herbicide applications.

Avenger Ag (d-limonene) provided effective management of liverwort at 28% v:v and a second application tended to improve efficacy long term. The lower rate (14% v:v) also effectively reduced liverwort. Overhead irrigation slightly reduced efficacy.

The high rate of Bryophyter (oregano oil extract) reduced liverwort with a second application providing improved efficacy. The lower rate was ineffective. Overhead irrigation did not affect activity.

Racer (ammounoim nonanoate) at 3% and 6% v:v did not provide effective management of liverwort in this experiment.

Table 44. Efficacy of post emergent herbicides for *Marchantia sp.*, Senesac, 2013.

Treatment	Rate % V/V	Post-trt Irrigation	Application Timing	Percent Liverwort Control						
				1WAT	2WAT	4WAT	8WAT	1WAT 2	2WAT 2	4WAT 2
Nontreated	~	with	Winter Only	0	0	0	0	0	0	0
Nontreated	~	without	Winter Only	0	0	0	0	0	0	0
d-limonene 55%	14	with	Winter Only	70	83	77	73	80	70	70
d-limonene 55%	14	without	Winter Only	83	90	90	90	80	80	80
d-limonene 55%	28	with	Winter Only	73	90	90	100	100	90	90
d-limonene 55%	28	without	Winter Only	80	90	90	100	93	90	90
oregano oil extract 1%	50	with	Winter Only	18	20	20	23	70	50	50
oregano oil extract 1%	50	without	Winter Only	28	30	30	30	70	50	50
oregano oil extract 1%	100	with	Winter Only	37	80	80	80	87	67	60
oregano oil extract 1%	100	without	Winter Only	37	73	80	87	77	60	60
ammonium nonanoate 40%	3	with	Winter Only	13	13	20	23	37	30	0
ammonium nonanoate 40%	3	without	Winter Only	20	37	27	27	50	33	17
ammonium nonanoate 40%	6	with	Winter Only	25	37	33	30	57	30	10
ammonium nonanoate 40%	6	without	Winter Only	28	50	43	37	57	33	23
Untreated	~	with	Winter&Act.-Grow.					0	0	0
Untreated	~	without	Winter&Act.-Grow.					0	0	0
d-limonene 55%	14	with	Winter&Act.-Grow.					77	70	60
d-limonene 55%	14	without	Winter&Act.-Grow.					97	90	87
d-limonene 55%	28	with	Winter&Act.-Grow.					100	90	87
d-limonene 55%	28	without	Winter&Act.-Grow.					100	100	97
oregano oil extract 1%	50	with	Winter&Act.-Grow.					93	50	50
oregano oil extract 1%	50	without	Winter&Act.-Grow.					97	70	67
oregano oil extract 1%	100	with	Winter&Act.-Grow.					100	90	83
oregano oil extract 1%	100	without	Winter&Act.-Grow.					100	93	87
ammonium nonanoate 40%	3	with	Winter&Act.-Grow.					37	33	0
ammonium nonanoate 40%	3	without	Winter&Act.-Grow.					57	33	23
ammonium nonanoate 40%	6	with	Winter&Act.-Grow.					70	33	27
ammonium nonanoate 40%	6	without	Winter&Act.-Grow.					77	43	37
			<i>Fisher's LSD @ 0.05</i>	6	10	9	9	12	11	13

Moretti 2018

Moretti conducted two experiments with post emergent herbicides to manage liverwort (*Marchantia* sp) in boxwoods grown in greenhouses. No liverwort control was observed in the first experiment after the first two applications so volume per acre was increased along with the amount of ai per acre for Terracyte PRO and Neudorff's MossKiller, plus irrigation after treatments was increased from 4 to 24 hours after application (Table 45). Terracyte Pro at 93 lb ai/A provided 67% control of liverwort 4 WAT 3 (12 WAT1), but this was not commercially viable. and control reduced to 39% by the end of the trial (table 1). No impact to boxwood was observed.

In the second experiment, Neudorff's Moss Killer, Terracyte Pro as a granular application and Terracyte Pro as as a liquid application were evaluated. All three Terracyte Pro treatments provided excellent control through 4 WAT; the lower rate applied as a liquid was less effective starting at 8 WAT (Table 46). The high rate of Neudorff's Moss Killer provided good efficacy through 12 WAT, but the two lower rates were ineffective. No crop injury was observed with any of the treatments.

Table 45. Boxwood injury and liverwort control with post emergence herbicides in newly transplanted liners grown in a greenhouse, Experiment 1, Moretti, 2018

Treatment	Rate	1 DAT	1 WAT	2 WAT	4 WAT	8 WAT	12 WAT	14 WAT	20 WAT
<i>Liverwort Percent Control</i>									
Nontreated		0a	0a	0a	0a	0b	0b	0b	0c
Basagran	32 fl oz	0a	0a	0a	0a	1b	3b	0.5b	0c
Terracyte PRO	0.05 lb/gal	0a	0a	0a	0a	1.5b	4b	7.8b	1.6b
Terracyte PRO	0.5 lb/gal	0a	0a	0a	0a	5.5ab	67a	48a	39a
Neudorff's MossKiller	10 oz/gal	0a	0a	0a	0a	9a	10b	9b	3b
<i>Boxwood injury</i>									
Nontreated		0a	0a	0a	0a	0a	0a	0a	0a
Basagran	32 fl oz	0a	0a	0a	0a	0a	0a	0a	0a
Terracyte PRO	0.05 lb/gal	0a	0a	0a	0a	0a	0a	0a	0a
Terracyte PRO	0.5 lb/gal	0a	0a	0a	0a	0a	0a	0a	0a
Neudorff's MossKiller	10 oz/gal	0a	0a	0a	0a	0a	0a	0a	0a

Table 46. Liverwort control with post emergence herbicides in newly transplanted liners grown in a greenhouse, Experiment 2, Moretti, 2018

Name	Rate	1 WAT	2 WAT	4 WAT	8 WAT	12 WAT
Nontreated		0c	0d	0d	0e	0d
Neudorff's MossKiller	14.7 lb ai/A granular	5.6c	14.4c	8.1cd	11.9de	32.5cd
Neudorff's MossKiller	16.3 lb ai/A granular	20.6c	21.3c	16.3c	35 cd	55bc
Neudorff's MossKiller	47 lb ai/A granular	32.5ab	84.4b	73.1b	77.5ab	80ab
Terracyte PRO 218 GPA	520 lb ai/A granular	36.3ab	99.4a	97.8a	96.3a	100a
Terracyte PRO – 436 GPA	93 lb ai/A spray	35ab	99.4a	97.1a	68.8c	65abc
Terracyte PRO – 436 GPA	183 lb ai/A spray	52.6a	99.7a	99.6a	88.1a	92.5ab

Moretti 2019

Moretti continued studying post emergent herbicide applications to manage liverwort in 2019. Rose 'BAlload' in greenhouses was evaluated with Basagran (bentazon) 24 fl oz/A, Terracyte (sodium carbonate peroxyhydrate) 0.5 gal/L 5 gal/1000 sq ft, and Scythe (pelargonic acid) 10% v/v in 75 GPA. In this experiment, neither Basagran or Scythe provided effective management of liverwort, while Scythe provided acceptable management within 1 and 2 weeks after each application. Further refinements for reapplication timings and rate are warranted.

No injury was observed with Basagran, but Scythe caused significant injury and Terracyte exhibited moderate injury. Unlike Basagran and Scythe, plants applied with Terracyte Pro were not irrigated after application to remove herbicide residues on foliage; thus, it is thought that with irrigation injury might not have been observed.

Table 47. Liverwort control after treatment with postemergence herbicides in newly transplanted roses grown in a greenhouse, Moretti, 2019

Treatment - Rate	1 WAT	2 WAT	4 WAT	8 WAT	12 WAT	20 WAT
Nontreated	0 c	0 c	0 c	0 b	0 b	0 c
Basagran - 24 fl oz	42 b	29 b	18 b	7 b	18 b	28 b
Terracyte - 0.5 lb/gal	46 b	37 b	30 b	12 b	22 b	50 b
Scythe - 10 % v/v	91 a	68 a	88 a	42 a	81 a	95 a

Moretti 2021

During 2021, Moretti examined Basagran (0.75 lb ai/acre), Milstop/BW133 (4.25 and 8.5 lb ai/acre), Neudorff's Moss Killer (1425 lb ai/acre), and TerraCyte PRO (65.3 lb ai/acre) for post-emergent liverwort efficacy and crop safety in container grown Japanese pachysandra and hybrid rose. Liverwort was transplanted and established in the tested containers prior to the start of the experiment. Neudorff's Moss Killer provided good to excellent liverwort management throughout the experiment with the exception of 60DAT (Table 48). No other treatment provided consistent efficacy.

Injury was observed at 28 DAT in roses after Basagran and TerraCyte applications. Basagran induced widespread chlorosis on leaf margins and TerraCyte caused necrotic spots on leaves and necrosis of growing tips and leaf margins (data not shown).

Table 48. Liverwort control in pachysandra and rose plots, in response to post-emergent herbicide applications, Moretti 2021

Treatment		Percent Liverwort Efficacy						
		7DAT	14DAT	21DAT	30DAT	60DAT	90DAT	120DAT
Nontreated		4.6 d	13.8 c	0.0 c	2.5 c	0.0 c	0.0 b	0.0 c
Basagran	0.75 lb ai/acre	32.1 b	38.3 b	30.0 b	50.6 b	38.8 ab	75.0 a	41.3 b
BW133(Milstop)	4.25 lb ai/acre	9.2 d	13.8 c	0.0 c	2.5 c	10.0 bc	5.0 b	0.0 c
	8.5 lb ai/acre	15.6 cd	20.8 bc	5.0 c	3.8 c	0 c	8.8 b	1.3 c
Neudorff's Moss Killer	1425 lb ai/acre	85.0 a	81.9 a	97.5 a	97.5 a	55.6 a	83.7 a	71.9 a
TerraCyte PRO	65.3 lb ai/acre	25.0 bc	35.0 bc	48.1 b	53.1 b	32.5 abc	66.3a	45.0 ab

Pre Emergent Efficacy

Starting in 2018, in addition to examining post-emergent herbicide applications, IR-4 began sponsoring research into pre-emergent applications of herbicides to expand current labels. Marengo G, Marengo SC, Pendulum G, Pendulum EC, Ronstar G, and Tower were studied for their ability to prevent liverwort establishment. In two experiments relying on infestation from nearby containers, Marengo G, Marengo SC, Ronstar and Tower provided excellent efficacy. However, in a third experiment where liverwort plugs were placed into the test containers, only Tower provided excellent control.

Outcomes for each experiment with herbicides applied prior to liverwort infestation are below.

Moretti 2018

During 2018, Moretti investigated liverwort (*Marchantia* sp) management in boxwood “Wintergreen” (*Buxus microphylla* var japonica) with preemergent herbicides applied after transplanting. Over the top treatments were applied 24 hours after transplanting and again 8 weeks after treatment (WAT), consistent with grower practices. No crop injury was observed. Excellent liverwort control (>95%) was provided by all treatments through 4 WAT. While Marengo G, Marengo SC, and Tower provided excellent efficacy through 20 WAT, Ronstar G declined by 8 WAT and reapplication at that time was not as effective.

Table 49. Boxwood injury and liverwort control weeks after treatment with preemergence herbicides in newly transplanted liners in a greenhouse experiment, Moretti, 2018

Treatment	Rate	Weeks after treatment						
		1	2	4	8	12	14	20
<i>Liverwort Percent Control</i>								
Nontreated		0b	0b	0b	0b	0c	0b	0b
Marengo G (indaziflam)	200 lb/a	100a	99a	98a	99a	98ab	98a	98a
Marengo SC (indaziflam)	9 fl oz/a	100a	99a	99a	99a	100a	99a	99a
Ronstar G (oxadiazon)	200 lb/a	100a	97a	97a	83a	56b	66b	66b
Tower (dimethenamid)	32 fl oz/a	100a	98a	98a	98a	91ab	99a	99a
<i>Boxwood injury</i>								
Nontreated		0a	0a	0a	0a	0a	0a	0a
Marengo G (indaziflam)	200 lb/a	0a	0a	0a	0a	0a	0a	0a
Marengo SC (indaziflam)	9 fl oz/a	0a	0a	0a	0a	0a	0a	0a
Ronstar G (oxadiazon)	200 lb/a	0a	0a	0a	0a	0a	0a	0a
Tower (dimethenamid)	32 fl oz/a	0a	0a	0a	0a	0a	0a	0a

Moretti 2019

During 2019, Moretti continued examining preemergent herbicide applications for liverwort management. Rose ‘Elegance Yellow Brick Road’ was transplanted into pots which were placed in a greenhouse interspersed with pots containing liverwort as a ‘seed’ bank. Marengo SC at 4.5 fl oz/A, Marengo G at 65, 125, and 200 lb/A, and Tower at 32 fl oz/A were applied 24 hours

after transplanting roses and reapplied eight weeks later. All treatments provided good to excellent control of liverwort (80 to 98%) during the 20 weeks of evaluation. No crop injury was observed with any of the herbicides tested (data not shown).

Table 50. Liverwort control after treatment with preemergence herbicides in newly transplanted roses grown in a greenhouse, Moretti, 2019

Treatment - Rate	1 WAT	2 WAT	4 WAT	8 WAT	12 WAT	20 WAT
Nontreated	0 b	0 b	0 c	0 c	0 b	0 b
Marengo G - 65 lb	100 a	100 a	77 b	71 b	90 a	84 a
Marengo G - 125 lb	100 a	100 a	86 ab	85 ab	88 a	82 a
Marengo G - 200 lb	100 a	100 a	85 ab	81 ab	92 a	86 a
Marengo SC - 4.5 fl oz	100 a	100 a	98 a	90 ab	99 a	98 a
Tower - 32 fl oz	100 a	100 a	99 a	100 a	100 a	90 a

Moretti 2021

During 2021, Moretti evaluated Pendulum 2G, Pendulum 3.3 EC, Marengo G, Marengo SC, and Tower for pre-emergent efficacy and safety in potted rose and Japanese pachysandra. Although after transplanting containers with sporulating liverwort were present, very little liverwort established in the nontreated controls, so plugs of liverwort were inoculated into containers. Through 140 DAT Tower provided the best efficacy in both pachysandra and rose, but none of the other treatments provided commercially acceptable prevention of liverwort establishment (Table 51). Phytochemical damage from Marengo Flo and Tower applications on pachysandra was exhibited first at 84 days after treatment (data not shown).

Table 51. Liverwort control in Pachysandra and rose plots, in response to pre-emergent herbicide applications, Moretti, 2021

Treatment		Liverwort control at 140 DAT			
		Pachysandra		Rosa	
Nontreated					
Pendulum 2G	2.00%	8	a	30	a
Pendulum 3.3 EC	3.3 lb ai/gal	10	a	50	a
Marengo G	0.02%	0	a	13	a
Marengo SC	0.622 lb ai/gal	3	a	60	a
Tower	6 lb ai/gal	88	b	100	b

Table 52. Summary of product efficacy byproduct and crop.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
30991	Avenger Ag (d-limonene)		Bigleaf Hydrangea (Hydrangea macrophylla) H. 'Forever Pink'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Significant injury with one application at 20% v/v.
30989	Avenger Ag (d-limonene)		Hydrangea (Hydrangea sp.) H. arborescens 'Annabelle'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Mortality with one application at 20% v/v.
29656	Avenger Ag (d-limonene)		None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 2 (only): Excellent control of large liverwort through 28 DAT at 20%.
29656	Avenger Ag (d-limonene)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Very good control through 6WAT1 with 20% v/v decreasing with time.
29656	Avenger Ag (d-limonene)		None (None)	Greenhouse	Peachey	OR	2010	Over the top	Fair control (56%) 2 WAT decreasing with time with one application of 20% d-limonene. No control with the 14% rate.
29656	Avenger Ag (d-limonene)		None (None)	Greenhouse	Peachey	CA	2011	Over the top	Excellent control through 12WAT with one application at 20% v/v.
29656	Avenger Ag (d-limonene)		None (None)	Greenhouse	Reding	OH	2010	Over the top	Excellent control with 20% with slight to fair regrowth.
29656	Avenger Ag (d-limonene)		None (None)	Greenhouse	Senesac	NY	2010	Over the top	Excellent control with peak at 2 WAT using 14 and 20%.
29656	Avenger Ag (d-limonene)		None (None)	Greenhouse	Senesac	NY	2011	Over the top	Excellent control through 12WAT with two applications at 14% v/v. Excellent control decreasing to good control with one application at 20% v/v.
29656	Avenger Ag (d-limonene)		None (None) M. polymorpha	Greenhouse	Senesac	NY	2013	Over the top	Good to excellent efficacy at 14 and 28% with and without irrigation.
29656	Avenger Ag (d-limonene)		None (None)	Greenhouse	Wilen	CA	2011	Over the top	Very good efficacy initially but decreased after each application at 20% v/v.
30987	Avenger Ag (d-limonene)		Willow (Salix sp.) S. integra 'Hakuro Nishiki'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery) One application at 20% v/v caused unacceptable damage (67%) decreasing with time (32%).
30988	Avenger Ag (d-limonene)		Elderberry (Sambucus sp.) S. nigra 'Blacklace'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Severe injury with one application at 20% v/v.
30990	Avenger Ag (d-limonene)		Weigela (Weigela sp.) W. florida 'Ghost'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 3 (Spring Meadow): Significant crop injury (67%) at 7WAT2 decreasing to nonsignificant (21%) at 9WAT1 at 20% v/v.
30990	Avenger Ag (d-limonene)		Weigela (Weigela sp.) W. florida 'My Monet'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Significant crop injury with one application at 20% v/v.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
31046	Baking soda (sodium bicarbonate)	FRAC NC	Japanese Barberry (<i>Berberis thunbergii</i>)	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 2 (Northland Farm): Minor to moderate injury but not significantly different from untreated. (Rate unknown).
31044	Baking soda (sodium bicarbonate)	FRAC NC	Plantain Lily (<i>Hosta</i> sp.) H. 'Sagae'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 2 (Northland Farms): No crop injury to new growth following dormant application. (rate unknown.)
31042	Baking soda (sodium bicarbonate)	FRAC NC	Bigleaf Hydrangea (<i>Hydrangea macrophylla</i>) H. 'Forever Pink'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Mortality with one application at 50 ml/sq. ft.
31041	Baking soda (sodium bicarbonate)	FRAC NC	Hydrangea (<i>Hydrangea</i> sp.) H. <i>arborescens</i> 'Annabelle'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery):Mortality with one application at 50 ml/ sq. ft.
31045	Baking soda (sodium bicarbonate)	FRAC NC	Fern, Ostrich (<i>Matteuccia struthiopteris</i>)	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 2 (Northland Farms): Significant injury (rate unknown).
31047	Baking soda (sodium bicarbonate)	FRAC NC	None (None)	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Complete control throughout the evaluation period with 50 ml/sq. ft.
31047	Baking soda (sodium bicarbonate)	FRAC NC	None (None)	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 2 (Northland Farms): Complete control throughout the evaluation period. (rate unknown)
31047	Baking soda (sodium bicarbonate)	FRAC NC	None (None)	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 3 (Spring Meadow): Complete control throughout the evaluation period with 25 and 50 ml/sq. ft.
31039	Baking soda (sodium bicarbonate)	FRAC NC	Willow (<i>Salix</i> sp.) <i>S. integra</i> 'Hakuro Nishiki'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Mortality by 2WAT1 with 50 ml/sq. ft.
31040	Baking soda (sodium bicarbonate)	FRAC NC	Elderberry (<i>Sambucus</i> sp.) <i>S. nigra</i> 'Blacklace'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Severe injury with one application at 50 ml/sq. ft.
31043	Baking soda (sodium bicarbonate)	FRAC NC	Weigela, Oldfasioned (<i>Weigela florida</i>) W. 'Ghost'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	rial 3 (Spring Meadow): Little to no crop injury with 50 ml/sq. ft.
31043	Baking soda (sodium bicarbonate)	FRAC NC	Weigela, Oldfasioned (<i>Weigela florida</i>) W. 'Ghost'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 3 (Spring Meadow): Little to no crop injury with 25 ml/sq. ft.
31043	Baking soda (sodium bicarbonate)	FRAC NC	Weigela, Oldfasioned (<i>Weigela florida</i>) W. 'My Monet'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Mortality with one application at 50 ml/ sq. ft.
33619	Basagran T&O Herbicide (Bentazon)	WSSA 6	Boxwood (<i>Buxus</i> sp.) <i>B. macrophylla</i> 'Wintergreen'	Field Container	Moretti	OR	2018	Over the top	Poor liverwort control with 32 fl oz per acre applied as post treatment; no crop injury.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
35094	Basagran T&O Herbicide (Bentazon)	WSSA 6	Japanese Pachysandra (Pachysandra terminalis) 'Green Sheen'	Field Container	Moretti	OR	2021	Directed	Very little impact with 24 fl oz per acre. No impact on canopy volume.
33825	Basagran T&O Herbicide (Bentazon)	WSSA 6	Rose (Rosa sp.) 'Yellow Brick Road'	Field Container	Moretti	OR	2019	Over the top	Poor control with 24 fl oz per acre applied twice. No injury.
33825	Basagran T&O Herbicide (Bentazon)	WSSA 6	Rose (Rosa sp.) 'Grace n grit'	Field Container	Moretti	OH	2021	Directed	60% reduction with 24 fl oz per acre. Severe injury on foliage.
26603	BroadStar 0.25G (Flumioxazin)	WSSA 14	Pawpaw (Asimina triloba)	Field Container	Czarnota	GA	2006	Over the top	No significant injury at 0.25 lb ai per acre; good liverwort control (64%).
26601	BroadStar 0.25G (Flumioxazin)	WSSA 14	Hydrangea, Oakleaf (Hydrangea quercifolia) 'Snowflake'	Field Container	Czarnota	GA	2006	Over the top	No significant injury at 0.25 lb ai per acre; good liverwort control (64%).
26597	BroadStar 0.25G (Flumioxazin)	WSSA 14	Periwinkle (Vinca sp.) V. minor	Field Container	Czarnota	GA	2006	Over the top	No injury at 0.25 lb ai per acre; good liverwort control (64%).
30156	BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Poor efficacy throughout experiment with 150 and 300 lb product per acre as post emergent applications (19% control) and little impact on new growth.
31031	Bryophyter (Oregano oil)		Japanese Barberry (Berberis thunbergii)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farm): Minor to moderate injury with 2% v/v but not different from untreated.
29640	Bryophyter (Oregano oil)		Boxwood, Littleleaf (Buxus microphylla) 'Winter Gem'	Greenhouse	Beste/Frank (ARS)	MD	2010	Directed	Trial 1: Good to excellent efficacy (82-97%) increasing with volume per acre (1% solution at 100 or 200 gal per acre); no crop injury (directed spray)
29640	Bryophyter (Oregano oil)		Boxwood, Littleleaf (Buxus microphylla) 'Winter Gem'	Greenhouse	Beste/Frank (ARS)	MD	2010	Over the top	Trial 2: Good to great efficacy (63-86%) increasing with volume per acre (1% solution at 100 or 200 gpa); slight to moderate but commercially acceptable injury increasing with volume over the top application.
31028	Bryophyter (Oregano oil)		Plantain Lily (Hosta sp.) H. 'Sagae'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farms): No crop injury with 2% v/v.
31027	Bryophyter (Oregano oil)		Bigleaf Hydrangea (Hydrangea macrophylla) H. 'Forever Pink'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Moderate to severe with two applications at 2% v/v.
31026	Bryophyter (Oregano oil)		Hydrangea (Hydrangea sp.) H. arborescens 'Annabelle'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Severe injury with two applications at 2% v/v.
31030	Bryophyter (Oregano oil)		Fern, Ostrich (Matteuccia struthiopteris)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farms): Minor injury with 2% v/v.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Czarnota	GA	2010	Over the top	Good to very good control of liverwort with two applications of 1% RTU 4 weeks apart at 100 gpa.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	DeFrancesco	OR	2009	Over the top	Excellent efficacy 1 WAT with 2% v:v, but little impact with 0.5% and 1%. Regrowth occurred by 4 weeks after second application
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Derr	VA	2009	Foliar	Fair control of liverwort at 0.5 and 1, good at 2 % solution. (89% control)
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Derr	VA	2010	Over the top	95 and 98% control at 8 DAT2 with 1 and 2 % v/v conc.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Freiberger	NJ	2010	Over the top	Very good to excellent control with one and two applications of 1% and 2% v/v.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Gilliam	AL	2009	Foliar	Excellent control at 1 and 2% with post emergent applications (99% control), but little residual control was observed.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 1: Great control of small and large liverwort up to 14 DAT at 1% v:v; a second application was needed. (90% efficacy 7DAT)
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 2: Great control of small liverwort up to 14 DAT at 1 % and slightly lesser control of large liverwort; a second application was needed.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Experiment 1: Virtually no impact on liverwort
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Experiment 2: Approximately 50% efficacy 4 weeks after second application.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Experiment 3: Little (38% 4 WAT) to no effect throughout the evaluation period with 1% v/v.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Good to excellent control with two applications at 2% v/v.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farms): Very good control with two applications at 2% v/v.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 3 (Spring Meadow): Very good control with two applications at 2% v/v.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Peachey	OR	2010	Over the top	Little to no control with 1 application at 1% or two applications at 2% at any time during this experiment.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Peachey	OR	2011	Over the top	Excellent control through 12WAT with one application at 2% v/v.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Senesac	NY	2010	Over the top	Excellent efficacy at 1 and 2 %.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Senesac	NY	2011	Over the top	Very good to excellent control through 12WAT with one application 1 and 2% v/v.
29458	Bryophyter (Oregano oil)		None (None) M. polymorpha	Greenhouse	Senesac	NY	2013	Over the top	Poor to good efficacy at 1 % and 2 % concentrations with and without irrigation.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Wilén	CA	2009	Foliar	Excellent control of liverwort at 1 and 2 % solution, poor at 0.5 %.
29458	Bryophyter (Oregano oil)		None (None)	Greenhouse	Wilén	CA	2010	Foliar	2% rate gave very good control with one to two applications decreasing with time. 1% rate control was unacceptable.
31024	Bryophyter (Oregano oil)		Willow (Salix sp.) S. integra 'Hakuro Nishiki'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Significant injury throughout evaluation with two applications of 2% v/v.
31025	Bryophyter (Oregano oil)		Elderberry (Sambucus sp.) S. nigra 'Blacklace'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Severe injury with two applications at 2% v/v.
31029	Bryophyter (Oregano oil)		Weigela, Oldfashioned (Weigela florida) W. 'Ghost'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Tria 3 (Spring Meadow): Significant injury (45%) at 2WAT1 decreasing to minor (8%) by 9WAT1 with 2% v/v.
31029	Bryophyter (Oregano oil)		Weigela, Oldfashioned (Weigela florida) W. 'My Monet'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Significant injury with two applications at 2% v/v.
35095	BW133 (BW133)	FRAC NC	Japanese Pachysandra (Pachysandra terminalis) 'Green Sheen'	Field Container	Moretti	OR	2021	Directed	No impact with 5 or 10 lb per acre. No impact on canopy volume.
35096	BW133 (BW133)	FRAC NC	Rose (Rosa sp.) 'Grace n grit'	Field Container	Moretti	OH	2021	Directed	No impact with 5 or 10 lb per acre. No impact on canopy volume.
29641	Champ DF (Copper Hydroxide)	FRAC M1	Boxwood, Littleleaf (Buxus microphylla) 'Winter Gem'	Greenhouse	Beste/Frank (ARS)	MD	2010	Over the top	No consistent reduction in liverwort cover at 0.88 oz per gal with 100 gal per acre; no injury.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Czarnota	GA	2010	Over the top	Moderate to good control of liverwort with two applications 4 weeks apart at 5.5 lb per acre.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Freiberger	NJ	2010	Over the top	Poor control with one and two applications of 2.75 and 5.5. lbs/100 gallons.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Poor efficacy through 4 WAT (5.5 and 11.0 lb product per acre) with post emergent applications (41% control), and little residual efficacy.

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29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 1: Essentially no control of small and large liverwort at 5.5 lb per 100 gal.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 2: Essentially no control of small and large liverwort at 5.5 lb per 100 gal.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 1: Poor efficacy with the greatest rating (52%) at 1 WAT2 with 5.5 lb/ 100 gal.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 2: Poor to mediocre efficacy with the greatest rating (50%) at 2 WAT2 with 5.5 lb/ 100 gal.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Peachey	OR	2010	Over the top	Little to no control with 2.75 lbs (repeat application) at any time during this experiment.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Reding	OH	2010		Little to no control with 5.5 lb/100 gal.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Senesac	NY	2010	Over the top	Minimal impact at 2.75 and 5.0 lb product per 100 gal.
29518	Champ DF (Copper Hydroxide)	FRAC M1	None (None)	Greenhouse	Wilen	CA	2010	Foliar	No efficacy with 5.5. lb product/100 gal.
26605	Chipco Ronstar 2G (Oxadiazon)	WSSA 14	Pawpaw (Asimina triloba)	Field Container	Czarnota	GA	2006	Over the top	No significant injury at 4 lb ai per acre; fair liverwort control (48%).
26599	Chipco Ronstar 2G (Oxadiazon)	WSSA 14	Hydrangea, Oakleaf (Hydrangea quercifolia) 'Snowflake'	Field Container	Czarnota	GA	2006	Over the top	No significant injury at 4 lb ai per acre; fair liverwort control (48%).
35552	Chipco Ronstar 2G (Oxadiazon)	WSSA 14	None (None)	Field Container	Elmore	CA	1976	Broadcast	Exp 1. Poor to excellent efficacy increasing with rate (1, 2, 4, 8 lb ai per acre); multiple crops utilized and crop safety outcomes reported by crop.
35552	Chipco Ronstar 2G (Oxadiazon)	WSSA 14	None (None)	Field Container	Elmore	CA	1976	Broadcast	Exp 2. Poor to excellent efficacy after post emergent applications increasing with rate (2, 4, 8 lb ai per acre); multiple crops utilized and crop safety outcomes reported by crop.
26595	Chipco Ronstar 2G (Oxadiazon)	WSSA 14	Periwinkle (Vinca sp.) V. minor	Field Container	Czarnota	GA	2006	Over the top	No injury at 4 lb ai per acre; fair liverwort control (48%).

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30401	FlowerPharm (Cinnamon oil + rosemary oil)		None (None)	Greenhouse	Peachey	OR	2011	Over the top	Poor control throughout the evaluation period with 10% v/v.
30401	FlowerPharm (Cinnamon oil + rosemary oil)		None (None)	Greenhouse	Senesac	NY	2011	Over the top	Poor control with one application at 5 and 10% v/v.
30157	Freehand G (Dimethenamid-p + pendimethalin)	WSSA 15 + WSSA 3	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Virtually no efficacy with 150 and 300 lb product per acre as post emergent applications and little inhibition of new growth.
26602	Gentry (Quinoclamine)		Pawpaw (<i>Asimina triloba</i>)	Field Container	Czarnota	GA	2006	Over the top	No significant injury at 3.4 and 6.8 lb ai per acre; good to excellent liverwort control (85-100%).
25268	Gentry (Quinoclamine)		Yellowwood (<i>Cladrastis</i> sp.)	Field Container	Freiberger	NJ	2005	Directed	No injury at the tested rate (2 oz per gallon). with post emergent applications. Excellent control of liverwort.
25269	Gentry (Quinoclamine)		Locust (<i>Gleditsia</i> sp.)	Field Container	Freiberger	NJ	2005	Directed	No injury at tested rate (2 oz per gallon) with post emergent applications. Excellent management of liverwort
25267	Gentry (Quinoclamine)		Kentucky Coffee Tree (<i>Gymnocladus dioicus</i>)	Field Container	Freiberger	NJ	2005	Directed	No injury at tested rate (2 oz per gallon) with post emergent applications. Excellent management of liverwort
26598	Gentry (Quinoclamine)		Hydrangea, Oakleaf (<i>Hydrangea quercifolia</i>) 'Snowflake'	Field Container	Czarnota	GA	2006	Over the top	No significant injury at 3.4 and 6.8 lb ai per acre; good to excellent liverwort control (85-100%).
25266	Gentry (Quinoclamine)		Oak, Pin (<i>Quercus palustris</i>)	Field Container	Freiberger	NJ	2005	Directed	No injury at tested rate (2 oz per gallon) with post emergent applications. Excellent management of liverwort
26594	Gentry (Quinoclamine)		Periwinkle (<i>Vinca</i> sp.) V. minor	Field Container	Czarnota	GA	2006	Over the top	No significant injury at 3.4 and 6.8 lb ai per acre; good to excellent liverwort control (85-100%).
35555	Goal 2E (Oxyfluorfen)	WSSA 14	None (None)	Field Container	Elmore	CA	1976	Over the top	Exp 2. Great efficacy after post emergent application of 2 lb ai per acre; multiple crops utilized and crop safety outcomes reported by crop.
25272	Junction (SePro) (Mancozeb + copper hydroxide)	FRAC M3 + FRAC M1	Yellowwood (<i>Cladrastis</i> sp.)	Field Container	Freiberger	NJ	2005	Directed	No crop injury with 3 lb per 100 gal per acre with post emergent applications. Little to no efficacy on liverwort.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
25273	Junction (SePro) (Mancozeb + copper hydroxide)	FRAC M3 + FRAC M1	Locust (Gleditsia sp.)	Field Container	Freiberger	NJ	2005	Directed	No crop injury with 3 lb per 100 gal per acre with post emergent applications. Little to no efficacy on liverwort.
25271	Junction (SePro) (Mancozeb + copper hydroxide)	FRAC M3 + FRAC M1	Kentucky Coffee Tree (Gymnocladus dioicus)	Field Container	Freiberger	NJ	2005	Directed	No crop injury with 3 lb per 100 gal per acre with post emergent applications. Little to no efficacy on liverwort.
25270	Junction (SePro) (Mancozeb + copper hydroxide)	FRAC M3 + FRAC M1	Oak, Pin (Quercus palustris)	Field Container	Freiberger	NJ	2005	Directed	No crop injury with 3 lb per 100 gal per acre with post emergent applications. Little to no efficacy on liverwort.
33624	Marengo 74SC (Indaziflam)	WSSA 29	Boxwood (Buxus sp.) B. macrophylla 'Wintergreen'	Field Container	Moretti	OR	2018	Over the top	Excellent liverwort control with 9 fl oz per acre applied twice as pre treatment; no crop injury.
35090	Marengo 74SC (Indaziflam)	WSSA 29	Japanese Pachysandra (Pachysandra terminalis) 'Green Sheen'	Field Container	Moretti	OR	2021	Directed	Virtually no efficacy with 12 fl oz per acre. No impact on canopy volume.
30155	Marengo 74SC (Indaziflam)	WSSA 29	Rose (Rosa sp.) 'Yellow Brick Road'	Field Container	Moretti	OR	2019	Over the top	Preemergent Application. Excellent control with 4.5 fl oz per acre applied twice. No injury.
30155	Marengo 74SC (Indaziflam)	WSSA 29	Rose (Rosa sp.) 'Grace n grit'	Field Container	Moretti	OH	2021	Directed	60% reduction of liverwort with 12 fl oz per acre. No impact on canopy volume.
33623	Marengo G (Indaziflam 0.0224%)	WSSA 29	Boxwood (Buxus sp.) B. macrophylla 'Wintergreen'	Field Container	Moretti	OR	2018	Over the top	Excellent liverwort control with 200 lb per acre applied twice as pre treatment; no crop injury.
35091	Marengo G (Indaziflam 0.0224%)	WSSA 29	Japanese Pachysandra (Pachysandra terminalis) 'Green Sheen'	Field Container	Moretti	OR	2021	Directed	No efficacy with 200 lb per acre. No impact on canopy volume.
30661	Marengo G (Indaziflam 0.0224%)	WSSA 29	Rose (Rosa sp.)	Field Container	Moretti	OR	2019	Over the top	Preemergent Application. Good control with 65, 125 and 200 lb per acre applied twice. No injury.
30661	Marengo G (Indaziflam 0.0224%)	WSSA 29	Rose (Rosa sp.) 'Grace n grit'	Field Container	Moretti	OH	2021	Directed	Very little impact with 200 lb per acre. No impact on canopy volume.
33620	Neudorff's Granular Moss Killer (Pelargonic acid)	WSSA 17	Boxwood (Buxus sp.) B. macrophylla 'Wintergreen'	Field Container	Moretti	OR	2018	Over the top	Good liverwort control with 47 lb ai per acre, poor with 14.7 and 16.3 lb, granular over the top applied as post treatment; no crop injury.

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35155	Neudorff's Granular Moss Killer (Pelargonic acid)	WSSA 17	Japanese Pachysandra (Pachysandra terminalis) 'Green Sheen'	Field Container	Moretti	OR	2021	Over the top	Good to excellent reduction in liverwort but slight injury with 6.5 oz per gal.
33827	Neudorff's Granular Moss Killer (Pelargonic acid)	WSSA 17	Rose (Rosa sp.) 'Grace n grit'	Field Container	Moretti	OR	2021	Over the top	Good efficacy with 6.5 oz per gal.
35553	Oryzalin 75WP (Oryzalin)	WSSA 3	None (None)	Field Container	Elmore	CA	1976	Over the top	Exp 2. Some reduction of liverwort after post emergent application of 4 lb ai per acre but not commercially viable; multiple crops utilized and crop safety outcomes reported by crop.
35554	Oxyfluorfen 2G (Oxyfluorfen)	WSSA 14	None (None)	Field Container	Elmore	CA	1976	Broadcast	Exp 2. Poor to excellent efficacy after post emergent applications increasing with rate (2, 4, 8 lb ai per acre); multiple crops utilized and crop safety outcomes reported by crop.
35554	Oxyfluorfen 2G (Oxyfluorfen)	WSSA 14	None (None)	Field Container	Elmore	CA	1976	Over the top	Exp 1. Poor to good efficacy increasing with rate (1, 2, 4, 8 lb ai per acre); multiple crops utilized and crop safety outcomes reported by crop.
35092	Pendulum 2G (Pendimethalin)	WSSA 17	Japanese Pachysandra (Pachysandra terminalis) 'Green Sheen'	Field Container	Moretti	OR	2021	Over the top	Very little impact with 200 lb per acre. No impact on canopy volume.
35097	Pendulum 2G (Pendimethalin)	WSSA 17	Rose (Rosa sp.) 'Grace n grit'	Field Container	Moretti	OH	2021	Over the top	Poor efficacy with 200 lb per acre. No impact on canopy volume.
35093	Pendulum 3.3 EC (Pendimethalin)	WSSA 3	Japanese Pachysandra (Pachysandra terminalis) 'Green Sheen'	Field Container	Moretti	OR	2021	Over the top	Very little impact with 7.2 pints per acre. No impact on canopy volume.
35098	Pendulum 3.3 EC (Pendimethalin)	WSSA 3	Rose (Rosa sp.) 'Grace n grit'	Field Container	Moretti	OH	2021	Over the top	About 50% reduction of liverwort with 7.2 pints per acre. No impact on canopy volume.
25264	QuickSilver T&O (Carfentrazone-ethyl)	WSSA 14	Yellowwood (Cladrastis sp.)	Field Container	Freiberger	NJ	2005	Directed	No crop injury with 6.7 fl oz ai/A in 100 gal with post emergent applications. Poor to fair liverwort control.
25265	QuickSilver T&O (Carfentrazone-ethyl)	WSSA 14	Locust (Gleditsia sp.)	Field Container	Freiberger	NJ	2005	Directed	No crop injury with 6.7 fl oz ai/A in 100 gal with post emergent applications. Poor to fair liverwort control.
25263	QuickSilver T&O (Carfentrazone-ethyl)	WSSA 14	Kentucky Coffee Tree (Gymnocladus dioicus)	Field Container	Freiberger	NJ	2005	Directed	No crop injury with 6.7 fl oz ai/A in 100 gal with post emergent applications. Poor liverwort control.

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29967	QuickSilver T&O (Carfentrazone-ethyl)	WSSA 14	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 1: Little impact on small or large liverwort at 1 and 2 oz per acre even with second application 4 WAT.
29967	QuickSilver T&O (Carfentrazone-ethyl)	WSSA 14	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 2: Little impact on small or large liverwort at 2 oz per acre even with second application 4 WAT.
29967	QuickSilver T&O (Carfentrazone-ethyl)	WSSA 14	None (None)	Greenhouse	Peachey	OR	2010	Over the top	No control with one or two applications at 1 or 2 oz product per acre at any time during this experiment.
29967	QuickSilver T&O (Carfentrazone-ethyl)	WSSA 14	None (None)	Greenhouse	Senesac	NY	2010	Over the top	No efficacy with 1 or 2 fl oz per acre.
25262	QuickSilver T&O (Carfentrazone-ethyl)	WSSA 14	Oak, Pin (<i>Quercus palustris</i>)	Field Container	Freiberger	NJ	2005	Directed	No crop injury with 6.7 fl oz ai/A in 100 gal with post emergent applications. Poor liverwort control.
30999	Racer Herbicide (Ammonium nonanoate)		Japanese Barberry (<i>Berberis thunbergii</i>)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farm): Minor injury with 10% v/v.
30997	Racer Herbicide (Ammonium nonanoate)		Plantain Lily (<i>Hosta</i> sp.) H. 'Big Daddy'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farm): No different from untreated with 10% v/v.
30997	Racer Herbicide (Ammonium nonanoate)		Plantain Lily (<i>Hosta</i> sp.) H. 'Sage'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farm): No different from untreated with 10% v/v.
30995	Racer Herbicide (Ammonium nonanoate)		Bigleaf Hydrangea (<i>Hydrangea macrophylla</i>) H. 'Forever Pink'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Acceptable injury at 4WAT1 becoming significant with second application at 10% v/v.
30994	Racer Herbicide (Ammonium nonanoate)		Hydrangea (<i>Hydrangea</i> sp.) H. <i>arborescens</i> 'Annabelle'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Severe injury with two applications at 10% v/v.
30998	Racer Herbicide (Ammonium nonanoate)		Fern, Ostrich (<i>Matteuccia struthiopteris</i>)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farms): Minor injury to new growth after dormant application with 10% v/v.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Czarnota	GA	2010	Over the top	Very good to excellent control with one application at 5% v/v.o
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Derr	VA	2010	Over the top	25 and 80% control at 8 DAT2 with 2.5 and 5 % v/v conc.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Freiberger	NJ	2010	Over the top	Poor to moderate control with one and two applications at 2.5% and 5% v/v.

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29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 1: Good to great control of small and large liverwort up to 14 DAT at 5% v/v; a second application was needed.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 2: Great to excellent efficacy for small and large liverwort up to 14 DAT 5%; a second application was needed to achieve continued good to excellent efficacy. (80 to 100%)
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 1: Poor control with 0.2% v/v throughout the evaluation period.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 2: Poor to mediocre efficacy with the greatest rating (41%) at 4 WAT2 with 0.2% v/v.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Mediocre efficacy with two applications at 10% v/v decreasing with time.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farms): Good control at 3WAT2 decreasing to mediocre efficacy.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 3 (Spring Meadow): Good control to excellent control with two applications at 10% v/v.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Peachey	OR	2010	Over the top	Little to no control with 2.5 or 5 gallons (2.5 and 5%) including the retreat application at any time during this experiment.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Peachey	CA	2011	Over the top	Excellent control through 12WAT with one application at 10% v/v.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Reding	OH	2010		Very good to excellent control with 5% v/v and slight regrowth.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Senesac	NY	2010	Over the top	Great control with peak at 2 WAT using 2.5 and 5%.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Senesac	NY	2011	Over the top	Very good to excellent control through 12WAT with two applications at 5 and 10% v/v.
29519	Racer Herbicide (Ammonium nonanoate)		None (None) M. polymorpha	Greenhouse	Senesac	NY	2013	Over the top	Poor efficacy at 3 and 6% with and without irrigation.

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29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Wilén	CA	2010	Foliar	Good control with 5% v/v decreasing over time.
29519	Racer Herbicide (Ammonium nonanoate)		None (None)	Greenhouse	Wilén	CA	2011	Over the top	Poor control with first two applications at 10% v/v. Third application achieved good control initially but decreased with time.
30992	Racer Herbicide (Ammonium nonanoate)		Willow (<i>Salix</i> sp.) <i>S. integra</i> 'Hakuro Nishiki'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Unacceptable injury with two applications at 10% v/v.
30993	Racer Herbicide (Ammonium nonanoate)		Elderberry (<i>Sambucus</i> sp.) <i>S. nigra</i> 'Blacklace'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Severe injury throughout evaluation with two applications at 10% v/v.
30996	Racer Herbicide (Ammonium nonanoate)		Weigela (<i>Weigela</i> sp.) <i>W. florida</i> 'Ghost'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 3 (Spring Meadow): Moderate injury with one application at 10% v/v decreasing to acceptable with time.
30996	Racer Herbicide (Ammonium nonanoate)		Weigela (<i>Weigela</i> sp.) <i>W. florida</i> 'My Monet'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Marginally unacceptable at 4WAT1 (38%) and 5WAT2 (53%) at 20% v/v.
33625	Ronstar G (Oxadiazon)	WSSA 14	Boxwood (<i>Buxus</i> sp.) <i>B. macrophylla</i> 'Wintergreen'	Field Container	Moretti	OR	2018	Over the top	Excellent liverwort control with 200 lb per acre applied twice as pre treatment; no crop injury.
29643	Scythe (Pelargonic acid)	WSSA 17	Boxwood, Littleleaf (<i>Buxus microphylla</i>) 'Winter Gem'	Greenhouse	Beste/Frank (ARS)	MD	2010	Directed	Excellent efficacy at 10% v:v with some minor regrowth by 6 WAT; slight injury, but not of commercial significance. (96% control)
29643	Scythe (Pelargonic acid)	WSSA 17	Boxwood, Littleleaf (<i>Buxus microphylla</i>) 'Winter Gem'	Greenhouse	Beste/Frank (ARS)	MD	2010	Directed	Good to great efficacy at 5% v:v with some regrowth by 8 WAT; no injury. (83% control)
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Czarnota	GA	2010	Over the top	Excellent control with one application at 10% v/v.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Derr	VA	2010	Over the top	89 and 99% control at 8 DAT2 with 5 and 10 % v/v conc.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Freiberger	NJ	2010	Over the top	Good to excellent control with one and two applications of 5% and 10% v/v.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 1. Excellent control of small liverwort up to 28 DAT at 10 % and good control of large liverwort; but second applications were needed particularly with large liverwort to achieve continued excellent efficacy. (99%, 83% respectively for small an

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 2. Excellent control of small and large liverwort up to 28 DAT at 10 %; no second application was needed.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 1: Good to excellent control with first and second application of 10% v/v.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 2: Excellent control with first and second application of 10% v/v.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Peachey	OR	2010	Over the top	Good initial control (78-94%) with 5 and 10 gallons (5 and 10%) 2 WAT. A second application of the 5% rate delivered very good control 20DAT2 but no control at 30DAT2.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Peachey	CA	2011	Over the top	Excellent control through 12WAT with one application at 3% v/v.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Reding	OH	2010		Excellent control with 10% v/v and moderate regrowth.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Senesac	NY	2010	Over the top	Excellent efficacy using 5 and 10% through 4 WAT.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Senesac	NY	2011	Over the top	Excellent control throughout the 12 wk. evaluation period with one application at 3 and 5% v/v.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Wilen	CA	2010	Foliar	Good to very good control with 5% and 10% v/v decreasing over time.
29459	Scythe (Pelargonic acid)	WSSA 17	None (None)	Greenhouse	Wilen	CA	2011	Over the top	Poor control with first application at 5% v/v. Moderate to good with 2nd and 3rd application decreasing with time.
34162	Scythe (Pelargonic acid)	WSSA 17	Rose (Rosa sp.) 'Yellow Brick Road'	Field Container	Moretti	OR	2019	Over the top	Great control with 0.5 lb per acre applied twice. Severe injury.
26604	Showcase (Trifluralin + Isoxaben + Oxyfluorfen)	WSSA 3 + WSSA 21 +WSSA 14	Pawpaw (Asimina triloba)	Field Container	Czarnota	GA	2006	Over the top	No injury at 100 lb per acre (55% liverwort control).
26600	Showcase (Trifluralin + Isoxaben + Oxyfluorfen)	WSSA 3 + WSSA 21 +WSSA 14	Hydrangea, Oakleaf (Hydrangea quercifolia) 'Snowflake'	Field Container	Czarnota	GA	2006	Over the top	No significant injury at 2.5 lb ai per acre; fair liverwort control (55%).

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
26596	Showcase (Trifluralin + Isoxaben + Oxyfluorfen)	WSSA 3 + WSSA 21 + WSSA 14	Periwinkle (Vinca sp.) V. minor	Field Container	Czarnota	GA	2006	Over the top	No significant injury at 2.5 lb ai per acre; fair liverwort control (55%).
30077	Sporan (Plant Essential Oils)	FRAC NC	None (None)	Field Container	Peachey	OR	2010	Over the top	Little to no control with one or two applications of 1.5 fl oz/gal.
30400	Sporotec (Clove oil + Rosemary oil + Thyme oil)	FRAC NC	None (None)	Field Container	Peachey	OR	2011	Over the top	Poor control throughout the evaluation period with 1.2% v/v.
30400	Sporotec (Clove oil + Rosemary oil + Thyme oil)	FRAC NC	None (None)	Field Container	Senesac	NY	2011	Over the top	Poor control with one application at 1.5 fl oz/gal.
30462	Sporotec (Clove oil + Rosemary oil + Thyme oil)	FRAC NC	None (None)	Greenhouse	Wilen	CA	2011	Over the top	No control with 1.5 fl oz per 1000 sq ft applied 3 times.
31007	SureGuard 51WDG (Flumioxazin)	WSSA 14	Japanese Barberry (Berberis thunbergii)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farm): Minor crop injury with 4 oz/A.
29644	SureGuard 51WDG (Flumioxazin)	WSSA 14	Boxwood, Littleleaf (Buxus microphylla) 'Winter Gem'	Greenhouse	Beste/Frank (ARS)	MD	2010	Directed	Very slow efficacy, but excellent control at 6 WAT with 12 fl oz/A; slight to moderate foliar necrosis. (100% control)
31005	SureGuard 51WDG (Flumioxazin)	WSSA 14	Plantain Lily (Hosta sp.) H. 'Sagae'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farms): New growth not injured after dormant application with 4 oz/A plus surfactant.
31003	SureGuard 51WDG (Flumioxazin)	WSSA 14	Bigleaf Hydrangea (Hydrangea macrophylla) H. 'Forever Pink'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Significant injury with 4 oz/A.
31002	SureGuard 51WDG (Flumioxazin)	WSSA 14	Hydrangea (Hydrangea sp.) H. arborescens 'Annabelle'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Severe injury decreasing with time with one application at 4 oz/A.
31006	SureGuard 51WDG (Flumioxazin)	WSSA 14	Fern, Ostrich (Matteuccia struthiopteris)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farms): Moderate injury with 4oz/A plus surfactant decreasing with time to no difference from untreated.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Czarnota	GA	2010	Over the top	Good to very good control with one application at 12 oz/A.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Derr	VA	2010	Over the top	Excellent efficacy (93% control) at 8 DAT2 with 0.38 lb ai per acre + X-77.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Freiberger	NJ	2010	Over the top	Good control with one application at 12 oz/A + NIS 0.25% v/v and excellent with a second application at the same rate.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Slow but great efficacy at 4 WAT (0.375, 0.75 lb ai per acre) as a post emergent application (86% control) and excellent prevention of new growth.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 1: Excellent efficacy of small and large liverwort at 12 oz per acre starting at 14 DAT.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 2: Excellent efficacy of small and large liverwort at 12 oz per acre starting at 14 DAT.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 1: Excellent residual control throughout the experiment with 10 oz /A + 0.25% NIS.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 2: Excellent, but slow to develop, control throughout the experiment with 10 oz per acre + 0.25% NIS.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 3: Moderate (63% 4WAT) to excellent control increasing over time (93% 4WAT2) with 12 oz/A + 0.2% NIS.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Great control with one application at 4 oz/A plus surfactant.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farms): Very good to excellent control with one application at 4 oz/A plus surfactant.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 3 (Spring Meadow): Excellent control with one application at 4 oz/A plus surfactant.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Peachey	OR	2010	Over the top	Poor to fair control with one application at 12 oz/ac +NIS 0.25%.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Peachey	CA	2011	Over the top	Slow to start but ratings reached good to excellent by 6 and 12WAT respectively with one application at 0.38 lb ai per acre.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Senesac	NY	2010	Over the top	Some impact at 2 WAT with 2.5 oz per acre, but tapered off by 4WAT.

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29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Senesac	NY	2011	Over the top	Excellent control 2-10WAT with one application at 4 and 12 oz/A + 0.25% v/v NIS.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Wilén	CA	2010	Over the top	12 oz/a provided 90-100% control by 4WAT1 and again at 4WAT2.
29521	SureGuard 51WDG (Flumioxazin)	WSSA 14	None (None)	Greenhouse	Wilén	CA	2011	Over the top	Initial application of 12 oz/A + 0.255 Activator 90 gave good control decreasing with time. Second and third application showed little to no effect.
31000	SureGuard 51WDG (Flumioxazin)	WSSA 14	Willow (Salix sp.) S. integra 'Hakuro Nishiki'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Severe injury with one application at 4 oz/A.
31001	SureGuard 51WDG (Flumioxazin)	WSSA 14	Elderberry (Sambucus sp.) S. nigra 'Blacklace'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Moderate to significant injury (73%) decreasing over time (53%) with one application at 4 oz/A.
31004	SureGuard 51WDG (Flumioxazin)	WSSA 14	Weigela (Weigela sp.) W. florida 'Ghost'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 3 (Spring Meadow): Significant injury (79%) decreasing to acceptable (25%) with time.
31004	SureGuard 51WDG (Flumioxazin)	WSSA 14	Weigela (Weigela sp.) W. florida 'My Monet'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Minor injury with one application at 4 oz/A.
31019	Terracyte (Sodium carbonate peroxyhydrate)		Bigleaf Hydrangea (Hydrangea macrophylla) H. 'Forever Pink'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Significant injury (71%) at 7WAT1 decreasing to nonsignificant by 9WAT1.
31018	Terracyte (Sodium carbonate peroxyhydrate)		Hydrangea (Hydrangea sp.) H. arborescens 'Annabelle'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Significant injury with one application at 10 lb/1000 sq. ft.
33826	Terracyte (Sodium carbonate peroxyhydrate)		Rose (Rosa sp.) 'Yellow Brick Road'	Field Container	Moretti	OR	2019	Over the top	Postemergent Application. Poor control with 0.5 lb per acre applied twice. Moderate injury.
31016	Terracyte (Sodium carbonate peroxyhydrate)		Willow (Salix sp.) S. integra 'Hakuro Nishiki'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Moderate injury with one application decreasing to none by 8WAT.
31017	Terracyte (Sodium carbonate peroxyhydrate)		Elderberry (Sambucus sp.) S. nigra 'Blacklace'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Moderate injury with one application at 10 lbs/1000 sq. ft.
31020	Terracyte (Sodium carbonate peroxyhydrate)		Weigela (Weigela sp.) W. florida 'Ghost'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 3 (Spring Meadow): Significantly different with two applications compared to untreated.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
31020	Terracyte (Sodium carbonate peroxyhydrate)		Weigela (Weigela sp.) W. florida 'My Monet'	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Not different with one application at 10 lb/1000 sq. ft compared to the untreated.
33621	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		Boxwood (Buxus sp.) B. macrophylla 'Wintergreen'	Field Container	Moretti	OR	2018	Over the top	Excellent liverwort control with higher rates - 93 and 183 lb ai per acre spray and 520 lb ai per acre granular over the top applied as post treatment; no crop injury.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Czarnota	GA	2010	Over the top	Very good control with one application at 50 lb per acre.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Derr	VA	2010	Broadcast	Some impact (55% control) at 8 DA2T with 7.5 lb product per 1000 sq ft.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Derr	VA	2010	Over the top	Some impact (43% control) at 8 DAT2 with 50 lb ai per 100 gal.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Freiberger	NJ	2010	Over the top	Terracyte Pro (granular) applied initially at 7.5 lbs/1000 sq. ft. then three additional applications at 2.5 lbs/1000 sq ft delivered moderate to marginally acceptable control.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Freiberger	NJ	2010	Over the top	Terracyte Pro (liquid) applied initially at 0.5 lb/gal then three additional applications at 0.25 lbs/gal plus a granular application by mistake at 2.5 lb/1000sq. Ft. delivered marginally acceptable to moderate control.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 1: Poor to fair control of small and large liverwort only up to 7 DAT at 0.5 lb per gal; second application did not enhance activity. (63% control)

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 2: Great initial control of small and large liverwort at 0.5 lb per gal, but it quickly tapered off; second application did provide good control but once again it tapered off quickly.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 1: Poor to fair control except at 4WAT2 (92%) with 0.5 lb per gal.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 2: Poor control with 0.5 lb/gal.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 1 (BFN Nursery): Good to excellent control through 9WAT with two applications at 10 lb/1000 sq. ft.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Broadcast	Trial 2 (Spring Meadow): Very good control through 9WAT with two applications at 10 lb/1000 sq. ft.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Peachey	OR	2010	Broadcast	Little to no control with either rate at any time during this experiment. Rates included 7.5 lb/1000 sq ft retreated with 2.5 lb/1000 sq ft.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Peachey	OR	2010	Over the top	Little to no control with either rate at any time during this experiment. Rates included 0.5 lb/gal initially, retreated at 0.25 lbs/gal.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Peachey	CA	2011	Over the top	Excellent control through 12WAT with one application at 1 lb/10 sq. ft..

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29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Reding	OH	2010	Broadcast	Poor control with 7.5 lbs/100 sq. ft.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Reding	OH	2010	Foliar	0.5 lbs ai/gal was not efficacious therefore no second application was made.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Senesac	NY	2010	Broadcast	Some impact throughout experiment using 7.5 lb per 1000 sq ft but not commercially acceptable.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Senesac	NY	2010	Over the top	Minimal impact on liverwort using 5 lb product per 100 gal.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Senesac	NY	2011	Broadcast	Good to excellent control through 12 WAT with two applications at 10 lb/1000 sq. ft.
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Wilen	CA	2010	Over the top	0.5 lb/gal provided unacceptable control (
29460	Terracyte Pro (PerCarb, GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)		None (None)	Greenhouse	Wilen	CA	2011	Over the top	First application of 10 lb /100 sq. ft. gave poor control, second application good and third mediocre. Inconsistent from pot to pot. Higher rate recommended.
31015	Tower (Dimethenamid-p)	WSSA 15	Japanese Barberry (Berberis thunbergii)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farm): Moderate injury with 32 oz/A.
29645	Tower (Dimethenamid-p)	WSSA 15	Boxwood, Littleleaf (Buxus microphylla) 'Winter Gem'	Greenhouse	Beste/Frank (ARS)	MD	2010	Over the top	Excellent efficacy by 10 WAT with 1.5 lb ai per acre, but it was slow to present; no injury. (98% control)

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33626	Tower (Dimethenamid-p)	WSSA 15	Boxwood (Buxus sp.) B. macrophylla 'Wintergreen'	Field Container	Moretti	OR	2018	Over the top	Excellent liverwort control with 32 fl oz per acre applied twice as pre treatment; no crop injury.
31013	Tower (Dimethenamid-p)	WSSA 15	Plantain Lily (Hosta sp.) H. 'Sageai'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (BFN Nursery): Marginally unacceptable (23-37%) injury with 32 oz/A.
31011	Tower (Dimethenamid-p)	WSSA 15	Bigleaf Hydrangea (Hydrangea macrophylla) H. 'Forever Pink'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Acceptable injury (12%) at 5WAT1 increasing to significant by 4WAT2 (81%).
31010	Tower (Dimethenamid-p)	WSSA 15	Hydrangea (Hydrangea sp.) H. arborescens 'Annabelle'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Acceptable injury at 4WAT1; moderate injury at 9WAT2.
31014	Tower (Dimethenamid-p)	WSSA 15	Fern, Ostrich (Matteuccia struthiopteris)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 2 (Northland Farms): Moderate injury with 32 oz/a decreasing to no different from untreated.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Czarnota	GA	2010	Over the top	Good to very good with one application at 32 oz/A.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Derr	VA	2010	Over the top	Great efficacy (90% control) at 8 DAT2 with 1.5 lb ai per acre + X-77.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Freiberger	NJ	2010	Over the top	Poor control with 32 fl oz per acre applied one and two times.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Good efficacy at 4 WAT (1.5, 3.0 lb ai per acre) as post emergent applications (86% control), and good to excellent inhibition of new growth.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Trial 1: Poor control of small and fair, delayed control of large liverwort from 2 to 28 DAT at 32 fl oz per acre; second application at 4WAT provided good control of small liverwort but not of large liverwort.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Trial 2: Poor control of small and fair, delayed control of large liverwort from 2 to 28 DAT at 32 fl oz per acre; a second application at 4WAT provided good delayed control.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 1: Slow to start but very good residual control after the second application at 32 oz per acre. (99% control)
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Trial 2: Slow to start but very good residual control after the second application at 32 oz per acre. (88% control)

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Mathers (OSU)	CA	2011	Over the top	Trial 1 (BFN Nursery): Moderate control with two applications at 32 oz/A.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Mathers (OSU)	CA	2011	Over the top	Trial 2 (Northland Farms): Moderate control with two applications at 32 oz/A.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Mathers (OSU)	CA	2011	Over the top	Trial 3 (Spring Meadow): Slow to start but reaching excellent control with two applications at 32 oz/A.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Peachey	OR	2010	Over the top	Little to no control with one application at 32 fl oz per acre at any time during this experiment.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Peachey	CA	2011	Over the top	Poor results with 1.5 lb ai per acre through 6WAT. Higher rating at 12WAT (68%) may be due to seasonal dieback.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Senesac	NY	2010	Over the top	Great, slightly delayed efficacy with 32 fl oz per acre.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Senesac	NY	2011	Over the top	Moderate control at best with one application 0.75, 1.5, and 3 lb aia but effective in suspending the growth.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Wilens	CA	2010	Foliar	Unacceptable control with 32 oz/A.
29520	Tower (Dimethenamid-p)	WSSA 15	None (None)	Greenhouse	Wilens	CA	2011	Over the top	Little to no effect with three applications at 32 fl oz/A.
35132	Tower (Dimethenamid-p)	WSSA 15	Japanese Pachysandra (Pachysandra terminalis) 'Green Sheen'	Field Container	Moretti	OR	2021	Over the top	Good efficacy with 21 fl oz per acre. No impact on plant growth.
33824	Tower (Dimethenamid-p)	WSSA 15	Rose (Rosa sp.) 'Yellow Brick Road'	Field Container	Moretti	OR	2019	Over the top	Preemergent Application. Excellent control with 32 fl oz per acre applied twice. No injury.
33824	Tower (Dimethenamid-p)	WSSA 15	Rose (Rosa sp.) 'Grace n grit'	Field Container	Moretti	OR	2021	Over the top	Excellent efficacy with 21 fl oz per acre. No impact on plant growth.
31008	Tower (Dimethenamid-p)	WSSA 15	Willow (Salix sp.) S. integra 'Hakuro Nishiki'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Acceptable injury with initial application at 32 oz/A but unacceptable after second application decreasing with time.
31009	Tower (Dimethenamid-p)	WSSA 15	Elderberry (Sambucus sp.) S. nigra 'Blacklace'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Moderate injury (37-45%) with two applications at 32 oz/A.
31012	Tower (Dimethenamid-p)	WSSA 15	Weigela (Weigela sp.) W. florida 'Ghost'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 3 (Spring Meadow): Minor injury with one application at 32 oz/A increasing to significant injury with two applications.
31012	Tower (Dimethenamid-p)	WSSA 15	Weigela (Weigela sp.) W. florida 'My Monet'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Significant injury with two applications at 32 oz/A.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
29968	V-10233 76WG (Flumioxazin + pyroxasulfone)	WSSA 14 + WSSA 15	None (None)	Greenhouse	Freiberger	NJ	2010	Over the top	10 fl oz/A applied once gave moderate control increasing to excellent with a second application.
29968	V-10233 76WG (Flumioxazin + pyroxasulfone)	WSSA 14 + WSSA 15	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 1: Excellent control of small and excellent control of large liverwort at 10 fl oz per acre starting at 14 DAT.
29968	V-10233 76WG (Flumioxazin + pyroxasulfone)	WSSA 14 + WSSA 15	None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 2: Excellent control of small and excellent control of large liverwort at 10 fl oz per acre starting at 14 DAT.
29968	V-10233 76WG (Flumioxazin + pyroxasulfone)	WSSA 14 + WSSA 15	None (None)	Greenhouse	Peachey	OR	2010	Over the top	Little to no control with one or two applications of 10 fl oz per acre.
29968	V-10233 76WG (Flumioxazin + pyroxasulfone)	WSSA 14 + WSSA 15	None (None)	Greenhouse	Senesac	NY	2010	Over the top	Some impact with 10 fl oz per acre.
29647	Weed Pharm (Acetic acid)		Boxwood, Littleleaf (Buxus microphylla) 'Japanese #1'	Greenhouse	Beste/Frank (ARS)	MD	2010	Directed	Great efficacy at 2.5% v:v with 100 gal per acre by 1 WAT with slight regrowth by 7 WAT; no injury. (86% control)
29647	Weed Pharm (Acetic acid)		Boxwood, Littleleaf (Buxus microphylla) 'Winter Gem'	Greenhouse	Beste/Frank (ARS)	MD	2010	Directed	Excellent efficacy at 5% and 10% v:v with 100 gal per acre by 1 WAT with very slight regrowth by 10 WAT.
31035	Weed Pharm (Acetic acid)		Bigleaf Hydrangea (Hydrangea macrophylla) H. 'Forever Pink'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Not significantly different from untreated at 5WAT1 or 3WAT2.
31034	Weed Pharm (Acetic acid)		Hydrangea (Hydrangea sp.) H. arborescens 'Annabelle'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Not different from untreated at 6WAT1 (27%) and 3WAT2 (45%) with 10% v/v.
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Derr	VA	2010	Over the top	95 and 100% control at 8 DAT2 with 10 and 20 % v/v conc.
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Gilliam	AL	2010	Over the top	Experiment 1: Good to excellent control of small and large liverwort up to 28 DAT at 10 and 20 % conc. (100% control)
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Experiment 1: Some impact (66%) with 10% v:v.
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Mathers (OSU)	MI	2010	Over the top	Experiment 2: Some impact (59%) with 10% v:v.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Very good control with two applications at 10% v/v.
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 3 (Spring Meadow): Excellent control with two applications at 10% v/v.
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Peachey	OR	2010	Over the top	Excellent control (92 and 89%) at 2 and 4WAT with 20% RTU but little to no control by 8WAT. Fair control with 10% (1 part water and 1 part 20%) at 2-4WAT with no control at later evaluations. Little to no control with 5% (3 part water ,1 part RTU) at any
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Peachey	OR	2011	Over the top	Excellent control through 12WAT with one application at 10% v/v.
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Reding	OH	2010	Over the top	Excellent control with 10% v/v.
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Senesac	NY	2010	Over the top	Excellent, slightly delayed efficacy with 5, 10, and 20%.
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Senesac	NY	2011	Over the top	Excellent control through 12 WAT with one application at 5% v/v WeedPharm with and without Silwett 1% v/v, and 10% WeedPharm v/v alone. Silwet appeared to increase efficacy.
29457	Weed Pharm (Acetic acid)		None (None)	Greenhouse	Wilen	CA	2010	Foliar	Good to very good control with 10 and 20% v/v decreasing with time.
31032	Weed Pharm (Acetic acid)		Willow (Salix sp.) S. integra 'Hakuro Nishiki'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Significant injury throughout the evaluation with two applications at 10% v/v.
31033	Weed Pharm (Acetic acid)		Elderberry (Sambucus sp.) S. nigra 'Blacklace'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Moderate but acceptable injury at 4WAT1 with 10% v/v, significant with second application decreasing with time.
31036	Weed Pharm (Acetic acid)		Weigela (Weigela sp.) W. florida 'Ghost'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 3 (Spring Meadow): Moderate injury (45%) at 7WAT1 with 2% v/v decreasing to minor by 9WAT1 (8%).
31036	Weed Pharm (Acetic acid)		Weigela (Weigela sp.) W. florida 'My Monet'	Greenhouse	Mathers (OSU)	MI	2011	Over the top	Trial 1 (BFN Nursery): Minor crop injury with one application at 10% v/v increasing to moderate injury with second application but not significantly different than untreated.

PR #	Product (Active Ingredients)	MOA Class	Crop	Production Site	Researcher	Trial State	Trial Year	Application Type	Results
29756	Xeroton (Peroxyacetic acid)		Boxwood (Buxus sp.) 'Japanese #1'	Field Container	Beste/Frank (ARS)	MD	2010	Over the top	Minimal efficacy with 0.2% v:v at 100 or 200 gal per acre and good efficacy with 0.4% v:v at 100 gal per acre at 7 WAT; no injury. (89% efficacy at last reading date with 0.4%)
30097	Xeroton (Peroxyacetic acid)		None (None)	Greenhouse	Derr	VA	2009	Over the top	Little impact with 1% v:v. (30% control)

Label Suggestions

The following label suggestions are for postemergence greenhouse or hoop house use for container grown ornamentals for control of liverwort (*Marchantia sp.*) assuming an acceptable level of crop safety exists and adequate worker safety conditions are met.

Avenger Ag/Greenmatch (d-limonene) – at 15-20% v/v as a directed spray

Bryophyter (oregano oil) – 1-2% v/v at 200 gallons per acre as a directed spray

Racer¹ (ammonium nonanoate) – at 5% v/v as a directed spray

Scythe (pelargonic acid) – 5-10 % v/v as a directed spray

SureGuard² (flumioxazin) – 12 oz /A to greenhouse or hoop house floors; do not contact desirable crops.

¹Already registered for liverwort in greenhouse

² Current label lists preemergence field applications for control of liverwort in container grown conifers, deciduous trees.

Appendix 1: Contributing Researchers

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