



Environmental Horticulture Program Research Project Sheet

<https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-extension-resources/>

Project Name: Liverwort Efficacy

New	X	Ongoing		Completed		Duration if ongoing or completed:	N/A
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Project Description:
 Liverworts are among the most serious weeds of container grown environmental horticulture crops, particularly undercover in greenhouses or overwintering covered hoopouses. Classified as bryophytes these simple plants thrive on water and nitrogen for reproduction but can also survive long dry periods. Herbicides effective for other weeds often may not have activity for liverworts, plus most herbicides are not labelled for use within greenhouses or other covered growing structures.

Research Project Abstract (if available):
Abstract from 2015 Liverwort Efficacy Summary
 Data in this report were generated to evaluate several products for post-emergent control of liverworts (*Marchantia sp.*). Liverworts are among the most serious weeds of container grown ornamentals. Classified as bryophytes these simple plants thrive on water and nitrogen for reproduction but can also survive long dry periods. During the 2004 and 2009, IR-4 Ornamental 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. This research was conducted across the United States in 1976, 2005, 2006, and 2009 through 2011 to evaluate several registered products for liverwort control.
 Treatments with proven effectiveness in multiple trials include Bryophyter (oregano oil) at 2% v/v, Greenmatch (d-limonene) at 20% 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) at 10 lb/1000 sq. ft., V-10233 (flumioxazin) at 10 fl oz/A, and WeedPharm (acetic acid) 10- 20% v/v. In limited experiments, Broadstar 0.25G (0.25 lb/A), indaziflam (0.065 lb ai/A), Ronstar 2G (4.0 lb ai/A) and EC (2 lb ai/A) and Showcase 2.5G (2.5 lb ai/A) also demonstrated good control. Contact type treatments such as Scythe and Bryophyter were fast acting but generally required more than one application to remain effective (>80% control) during the trial period. Treatments with unacceptable or inconsistent liverwort control include Champ, FlowerPharm, Freehand, Junction, M-Pedi, Quicksilver, Sporan, Sporatec, and Xeroton. In a single trial the following products were effective in controlling bittercress and crabgrass, as well as, liverwort: Bryophyter, GreenMatch, Scythe, SureGuard, and WeedPharm. Silwett alone also controlled these weeds but was ineffective in controlling liverwort.
 The results from this study successfully identify several options for postemergent control of liverwort. Further research should focus on products that can be safely applied as a conventional application or as a dormant treatment to container grown ornamentals which provide residual control of liverwort, as well as, other weeds.

Target Species (Phytotoxicity, or common and Latin name of arthropod, pathogen, weed):
Marchantia sp

Target Crops (list tested crops if ongoing or completed project)
 n/a

Target Product(s)(list tested products or numbered compounds if ongoing or completed project)	
Avenger Ag (d-limonene)	Freehand G (Dimethenamid-p + pendimethalin)
Basagran T&O Herbicide (Bentazon)	Gentry (Quinoclamine)
BroadStar 0.25G (Flumioxazin)	Junction (SePro) (Mancozeb + copper hydroxide)
BroadStar 0.25G VC1604 (Flumioxazin)	Marengo 74SC (Indaziflam)
Bryophyter (Oregano oil)	Marengo G (Indaziflam 0.0224%)
Champ DF (Copper Hydroxide)	Neudorff's Granular Moss Killer (Pelargonic acid)Quicksilver
Chipco Ronstar 2G (Oxadiazon)	T&O (Carfentrazone-ethyl)
FlowerPharm (Cinnamon oil + rosemary oil)	Racer Herbicide (Ammonium nonanoate)



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Terracyte Pro (GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate) Tower (Dimethenamid-p) V-10233 76WG (Flumioxazin + pyroxasulfone) Weed Pharm (Acetic acid) Xeroton (Peroxyacetic acid)	Terracyte Pro (GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate) Tower (Dimethenamid-p) V-10233 76WG (Flumioxazin + pyroxasulfone) Weed Pharm (Acetic acid) Xeroton (Peroxyacetic acid)
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Product Registration and Research Status			
	Fully Screened (also includes standards)	Partially Screened through IR-4 ¹	Need Data Across Species?
Labeled Generally & Commercialized			
Labeled Generally But NOT Commercialized			
Labeled Specifically & Commercialized			
Labeled Specifically but NOT Commercialized			
Not yet registered or Labeled			
No longer available for development			
* IR-4 Data contributed to registration decision – either adding pest to label or not pursuing further research			
1 At least one species screened fully			

Area	Characteristic	Pro	Con
Availability & effectiveness of alternative management tools			
Damage potential of target			
Performance and crop safety of proposed products (from other systems)			
Compatibility with IPM, resistance management programs			
Economics			
Geographic distribution			
Manufacturer interest in labeling products			
Other			
Comments:			

IR-4 Efficacy Trials to Date
Average rating on a scale of 1 – 5 with 1 = 0 to about 50% efficacy (not effective) and 5 = 95 to 100 efficacy (very effective); minimum to maximum rating; number of trials (See table on next page). For product/insect combinations that are blank, IR-4 has not screened this combination.
‘Labeled’ indicates that this insect species or genera is listed on the label. A rating of 2 or lower is considered unacceptable efficacy (<i>red text</i>). A rating of 3 or higher is considered commercially acceptable (black text). Non-labeled, completed product/insect combinations (3 or more trials) with an average rating of 3 or higher are highlighted with green text . For insect/product combinations that are blank, IR-4 has not screened this combination.

MOA	Products (Active Ingredients)	Liverwort (<i>Marchantia sp</i>)
WSSA 3 + WSSA 21 +WSSA 14	Showcase (Trifluralin + Isoxaben + Oxyfluorfen)	1.0 (1 - 1) n3
WSSA 6	Basagran T&O Herbicide (Bentazon)	1.0 (1 - 1) n2
WSSA 14	BroadStar 0.25G (Flumioxazin)	2.0 (2 - 2) n3
	BroadStar 0.25G VC1604 (Flumioxazin)	1.0 (1 - 1) n1
	Chipco Ronstar 2G (Oxadiazon)	1.0 (1 - 1) n3
	QuickSilver T&O (Carfentrazone-ethyl)	1.3 (1 - 2) n8
	SureGuard 51WDG (Flumioxazin)	4.2 (1 - 5) n16
WSSA 14 + WSSA 15	V-10233 76WG (Flumioxazin + pyroxasulfone)	3.6 (1 - 5) n5
WSSA 15	Tower (Dimethenamid-p)	3.1 (1 - 5) n15
WSSA 15 + WSSA 3	Freehand G (Dimethenamid-p + pendimethalin)	1.0 (1 - 1) n1
WSSA 17	Neudorff's Granular Moss Killer (Pelargonic acid)	1.0 (1 - 1) n1
	Scythe (Pelargonic acid)	4.5 (1 - 5) n17
WSSA 29	Marengo 74SC (Indaziflam)	5.0 (5 - 5) n1
WSSA 29	Marengo G (Indaziflam 0.0224%)	3.0 (3 - 3) n1
FRAC M1	Champ DF (Copper Hydroxide)	1.1 (1 - 2) n12
FRAC M3 + FRAC M1	Junction (SePro) (Mancozeb + copper hydroxide)	1.0 (1 - 1) n4
FRAC NC	Sporan (Plant Essential Oils)	1.0 (1 - 1) n1
	Sporotec (Clove oil + Rosemary oil + Thyme oil)	1.0 (1 - 1) n3
unknown	Avenger Ag (d-limonene)	4.1 (1 - 5) n9
unknown	Bryophyter (Oregano oil)	3.7 (1 - 5) n20
unknown	FlowerPharm (Cinnamon oil + rosemary oil)	1.0 (1 - 1) n2
unknown	Gentry (Quinoclamine)	5.0 (5 - 5) n7
unknown	Racer Herbicide (Ammonium nonanoate)	3.1 (1 - 5) n15
unknown	Terracyte (Sodium carbonate peroxyhydrate)	1.0 (1 - 1) n1 Labeled
unknown	Terracyte Pro (GC Pro, GreenClean Max) (Sodium carbonate peroxyhydrate)	2.3 (1 - 5) n20 Labeled
unknown	Weed Pharm (Acetic acid)	4.2 (1 - 5) n12 Labeled
unknown	Xeroton (Peroxyacetic acid)	2.5 (1 - 4) n2