Liverwort Control in Nursery Production©

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INTRODUCTION

Marchantia polymorpha, commonly known as liverwort, is an emerging weed problem in propagation systems throughout the southeast U.S.A. While it has historically been reported as a problem in cooler regions of the Northeast and Pacific Northwest U.S.A., reports from Florida and Alabama indicate it is well adapted to the propagation environment in warmer climates.

Liverwort is a primitive plant that lacks stems, leaves, and a vascular system. It is identified by leaf-like structures known as thalli that grow in prostrate form along the surface. It has two alternate life cycles: a gametophytic and a sporophytic life cycle. In the sporophytic stage, a sporophyte is formed when archegonia fertilize antheridia (each borne on stalks). As many as 7 million spores per plant are developed and released. Spores give rise to the gametophytic life cycle in which the plant propagates asexually by producing gemma cups. Each gemma cup gives rise to numerous gemmae that are released to the immediate area when splashed by water. Liverwort may also propagate asexually by fragmentation.

Liverwort thrives in low UV light, high humidity, and substrates high in moisture (Svenson, 2002). Liverwort growth is especially optimized in high frequency irrigation (Svenson, 1998). *Marchantia polymorpha* has been a weed problem in container production for years in other areas of the U.S.A.; however, it has recently become a weed problem within the Southeast. The prostrate growth creates a mat over the media surface of containers and impedes the movement of water and fertilization into the root zone. Within the Southeast, it is especially a problem in propagation. Preemergence herbicides have been shown to have some preemergence control (Svenson, 1997), however preemergence herbicides are not available for use in closed structures. Furthermore, postemergence herbicides such as Roundup, Diquat, and Scythe cannot be applied over container-grown nursery crops. A safe postemergence herbicide application would be ideal for control of liverwort.

Preliminary studies in Oregon have shown quinoclamine and TerraCyte to have potential to provide postemergence liverwort control and to be safe on a wide variety of nursery crops (Altland, 2003). Quinoclamine is an algaecide that has been used in Japanese rice production for decades. Crompton Uniroyal Company is currently seeking a label for its use within closed structure in the U.S.A. Ongoing research in Oregon has documented broad-spectrum tolerance of woody and herbaceous crops to over-the-top applications of quinoclamine. Over 30 taxa have been evaluated with no signs of visual injury or growth reduction (pers. commun. with James Altland, Oregon State University). TerraCyte is manufactured by BioSafe Systems, Inc. It is a granular form of sodium carbonate peroxyhydrate. Upon contact with water, it breaks down into hydrogen peroxide. Hydrogen peroxide oxidizes the cell membranes, and the liverwort dies. Preliminary trials have shown that BroadStar (flumioxazin) may provide postemergence liverwort control in addition to preemergence control (Altland, 2003).

The objective of our research was to evaluate selected chemicals for postemergence control of *M. polymorpha.*

MATERIALS AND METHODS

Experiment 1. Full gallon containers were filled with a 6 pine bark : 1 sand mix (v/v) amended with 8.3 kg (14 lb) of Polyon 18-6-12 (Pursell Technologies), 3.0 kg (5 lb) of dolomitic lime, and 0.9 kg (1.5 lb) of Micromax (Scotts Company) per cubic meter (cubic yard). On 26 Feb. 2004, containers were inoculated with *M. polymorpha.* Inoculation consisted of blending liverwort thalli with buttermilk and water to produce a slurry that was applied to the medium surface. Containers were placed under mist irrigation, and the liverwort becomes established over the container surface within about 6 to 8 weeks. Postemergence treatments were applied to the established liverwort on 16 April 2004. Quinoclamine was applied at 1 oz/gal (0.25 oz ai/gal) and 2 oz/gal (0.5 oz ai/gal) with and without surfactant (Silwet L-77 organosilicone surfactant) at 1 qt/100 ft^2 (109 gal/A) and 2 qt/100 ft^2 (218 gal/A). Treatments were applied with a CO_2 backpack sprayer with an 8005 flat fan nozzle at 30 PSI. TerraCyte (34% ai) was applied at 435 lb/A (148 lb ai/A) and 653 lb/A (222 lb ai/A). In addition an experimental TerraCyte formulation (ETC) with twice the amount of active ingredient was also applied at 292 lb/A (192 lb ai/A) and 435 lb/A (296 lb ai/A). BroadStar 0.25G was applied at the labeled rate of 150 lb/A (0.375 lb ai/A). TerraCyte, ETC, and BroadStar treatments were applied with a handheld shaker. A nontreated control group was maintained. Treatments were arranged in a completely randomized design with six single-pot replications. The study was conducted in a greenhouse under mist irrigation ($6 \text{ sec} \cdot 4 \text{ min}^{-1}$). Percent control was recorded at 1, 3, 7, 14, and 21 DAT on a 0% to 100% scale where 0% equals no control and 100% equals dead liverwort. As a measure of liverwort re-growth and long-term control, percent of the substrate surface covered with living liverwort was recorded at 56 DAT. Means were separated with Duncan's Multiple Range Test (α=0.05).

Experminet 2. Experiment 2 was similar to Experiment 1 with the following exceptions. Treatments were applied on 3 June 2004. The study was conducted outdoors under 50% shade with a mist interval of $5 \text{ sec} \cdot 5 \text{ min}^{-1}$.

RESULTS

Experiment 1. Among quinoclamine treatments, rate, surfactant, and spray volume did not affect liverwort control at 3 DAT and 14 DAT. Quinoclamine treatments were pooled and compared to the remaining treatments using Duncan's Multiple Range Test (Table 1). Quinoclamine provided almost 100% postemergence control by 3 DAT. ETC at the 2× rate provided similar control to quinoclamine. BroadStar control was similar to the nontreated control. At 14 DAT quinoclamine and ETC provided similar control while both TerraCyte rates provided less control than quinoclamine. BroadStar provided poor postemergence control at both 3 DAT and 14 DAT.

Orthogonal contrast analysis revealed that quinoclamine rate affected liverwort control 56 DAT despite similar grouping from Duncan's multiple range test (Table 2). Quinoclamine treatments were grouped by rate and compared to other treat-

Table 1. Percent postemergence liverwort control in containers.

		Experiment 1		Experiment 2	
Herbicide	Rate	3 DAT[z]	14 DAT	3 DAT	14 DAT
Quinoclamine	all treatments	99.5 a[y]	97.7 a	100 a	100 a
TerraCyte	148 lb aia	75.8 c	74.0 c	91.7 a	93.7 a
TerraCyte	222 lb aia	88.2 b	76.7 bc	93.8 a	95.2 a
Exp. TerraCyte (ETC)	192 lb aia	88.0 b	86.7 ab	93.2 a	89.8 a
Exp. TerraCyte (ETC)	296 lb aia	94.8 ab	87.0 ab	97.2 a	95.8 a
BroadStar .25G	0.375 lb aia	4.5 d	20.8 d	18.3 b	57.5 b
Control		0 d	8.3 e	5.3 c	16.7 c

[z] Days after treatment.

[y] Means separated within column using Duncan's Multiple Range Test ($\alpha = 0.05$).

Table 2. The affect of herbicide on percent surface covered by liverwort at 56 DAT.

		Experiment 1	Experiment 2
Herbicide	Rate	56 DAT[z]	56 DAT
quinoclamine	0.25 oz ai/gal	14.8 de[y]	0.5 c
	0.5 oz ai/gal	1.6 e	0.3 c
TerraCyte	148 lb aia	47.5 bc	9.0 bc
TerraCyte	222 lb aia	32.5 cd	5.2 bc
Exp. TerraCyte (ETC)	192 lb aia	34.2 cd	19.2 b
Exp. TerraCyte (ETC)	296 lb aia	26.7 cd	10.2 bc
BroadStar .25G	0.375 lb aia	67.5 ab	16.0 bc
Control		75.3 a	75.8 a

[z] Days after treatment.

[y] Means separted within column using Duncan's Multiple Range Test ($\alpha = 0.05$).

ments. Quinoclamine at 0.5 oz ai/gal resulted in 1.6% of the container surface covered with liverwort, while liverwort coverage was 14.8% in containers treated with 0.25 oz ai/gal. Containers treated with TerraCyte and ETC ranged from 26.7% to 47.5% coverage, similar to the low rate of quinoclamine but greater coverage (poorer control) than the high rate of quinoclamine. There was a similar amount of liverwort in containers treated with BroadStar as compared to the nontreated control group.

Experiment 2. Quinoclamine treatments provided 100% control by 3 DAT and 14 DAT. TerraCyte and ETC provided similar control compared to quinoclamine. BroadStar provided poor postemergence control by 14 DAT with only 57.5%.

Among quinoclamine treatments, rate, surfactant, or spray volume had no effect on liverwort growth by 56 DAT (Table 2). There was almost no liverwort by 56 DAT in containers treated with quinoclamine. Although statistically similar, there was numerical trend for more liverwort (greater surface coverage) in containers treated with both rates of TerraCyte, ETC at 296 lb aia, and BroadStar.

Across all treatments, there was greater control in Experiment 2 than Experiment 1 (α=0.05). Greater control in Experiment 2 was likely due to reduced liverwort vigor from higher summer temperatures.

DISCUSSION

Quinoclamine provided consistently excellent postemergence liverwort control. TerraCyte provided less control than quinoclamine in Experiment 1, but similar control in Experiment 2. This was most likely due to hot and humid conditions during the study. Quinoclamine provided superior long-term control. It is still undetermined if quinoclamine provides preemergence control. Lack of liverwort re-growth within quinoclamine treatments may be due to the absence of living liverwort within the container after treatment, or there may be residual activity of quinoclamine. Further research will determine if there is residual activity from quinoclamine. BroadStar provided poor postemergence control in both studies. Current studies are evaluating preemergence liverwort control with available preemergence herbicides.

A product that could be applied in propagation settings to control liverwort without danger of crop injury would be of tremendous value to the nursery industry in the Southeast. Quinoclamine and, in some situations, Terracyte will be powerful tools for controlling liverwort early in the crop production cycle.

LITERATURE CITED

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