Evaluation of Quinoclamine and Diuron for Postemergence Control of Liverwort©

Adam F. Newby[1], Charles H. Gilliam, and Glenn R. Wehtje
Auburn University, Department of Horticulture, Auburn, Alabama 36849

James E. Altland
Oregon State University, North Willamette Research & Extension Center, Aurora, Oregon 97002

INTRODUCTION

Marchantia polymorpha, also known as liverwort, has established itself as a primary weed in nursery production within the Southern United States. It is well adapted to nursery environments and especially propagation environments. Liverwort thrive in low UV light, high fertility, high moisture, and high humidity environments (Svenson, 2002). Therefore liverwort is especially problematic in shaded areas with frequent irrigation.

Liverwort is a physiologically primitive plant with no vascular system. Instead of leaves, it has leaf-like structures known as thalli that grow in prostrate form along the medium surface. Liverwort propagates both sexually and asexually. During the sporophytic life cycle, it propagates sexually when archegonia fertilize antheridia to form a sporophyte. The archegonia and antheridia are each borne on stalks that rise above the thalli. Microscopic spores are released and give rise to the gametophytic life cycle in which the plant propagates asexually by way of gemmae. Gemmae are basically small clones of the parent plant produced in gemma cups on the thalli. They are dispersed to the immediate area when splashed by water. Liverwort can also propagate asexually by fragmentation.

While liverwort was initially located in the Northwest and Northeast, it has spread to nursery production areas throughout the U.S.A. Some preemergence herbicides have been proven effective (Svenson, 1998; Fausey, 2003), however these cannot be used in closed structures thus creating a need for postemergence herbicides. Potential postemergence controls include quinoclamine and diuron. Quinoclamine is a chemical originally used in Japan as an algaecide in rice production. It has proven to provide effective postemergence liverwort control, and a broad range of nursery crops have proven tolerant (Altland et al., 2003; Newby et al., 2004). It is produced as a 25% wettable powder. It is currently used in Europe for liverwort control. The proposed recommendation by its company is based on amount of product per gallon applied at a specified spray volume. The current recommendation is 2 oz of product per gallon applied at 2 qt per 100 ft^2 (219 gal per A). This recommendation is equivalent to 6.8 lbs ai/a. In a previous study, a quinoclamine rate of 1 oz per gallon applied at 1 quart per 100 ft^2 (109 gal/A) provided similar postemergence control compared to the recommended rate (Newby et al., 2004).

Diuron is a substituted urea herbicide registered for use in cotton. It was first registered in the 1950s. Diuron inhibits photosynthetic electron transport within the chloroplast membrane. It is used for postemergence liverwort control in Germany (Dr. Heinrich Loesing, pers. commun.).

[1]Graduate Student Research Paper Winner; 1st Place.

The objective of this research was to evaluate the use of lower quinoclamine rates and spray volumes than currently recommended and to evaluate diuron for postemergence liverwort control.

MATERIALS AND METHODS

Two experiments were conducted at Auburn University. Sprayable herbicides were applied with a CO_2 backpack sprayer fitted with an 8004 flat-fan nozzle at a pressure of 30 psi and calibrated to deliver the specified spray volume.

Experiment 1. Full gallon containers were filled with a 6 pine bark : 1 sand (v/v) mix amended with 14 lb (8.3 kg) of Polyon 18-6-12 (Pursell Technologies), 5 lb (3.0 kg) of dolomitic lime, and 1.5 lb (0.9 kg) of Micromax (The Scotts Company) per cubic yard (cubic meter). Containers were inoculated with *M. polymorpha* and grown under mist irrigation until it covered at least 60% of the container surface. Herbicide treatments were applied on 4 Nov. 2004. Twelve quinoclamine treatments were applied in a factorial arrangement consisting of four rates and three spray volumes. Rates of 0.25, 0.5, 1.0, and 2.0 oz product/gal (0.0625, 0.125, 0.25, and 0.5 oz ai/gal) were each applied at 27, 54, or 109 gal/A (0.25, 0.5, or 1.0 qt/100 ft^2). Diuron was applied at 0.5 lb ai/A and 1.0 lb ai/A. Linuron, another substituted urea herbicide with similar chemistry to diuron, was also applied as at 0.5 lb ai/A and 1.0 ai/A. Both diuron and linuron were applied at 40 gal/A. Treatments were arranged with a nontreated control group in a completely randomized design with 6 single pot replications. Data included percent postemergence control at 3, 7, 14, and 28 days after treatment (DAT) on a 0 to 100 percent scale where 0 equals no control and 100 equals death of entire liverwort within the container. As a comparison of liverwort re-growth, percent liverwort coverage of the container surface was recorded 35 and 70 DAT. Treatments were also applied to 6 single-pot replications of *Humata tyermannii* (rabbit foot fern) and *Euphobia pulcherrima* (poinsettia) and compared to a nontreated control group in order to evaluate plant tolerance. The study was conducted in a temperature-controlled greenhouse that remained at or above 65 ^{o}F. Total irrigation applied was 0.25 inches daily split into two cycles.

Experiment 2. Liverwort was grown in gallon containers as described in Experiment 1. Treatments were applied on 14 March 2005 when liverwort covered at least 60% of the container surface. Nine quinoclamine treatments were applied in a factorial arrangement consisting of three rates and three spray volumes. Rates of 0.5, 1.0, and 2.0 oz product/gal (0.0625, 0.125, 0.25, and 0.5 oz ai/gal) were each applied at 27, 54, or 109 gal/A (0.25, 0.5, or 1.0 qt/100 ft^2). Diuron 4L was applied at 0.5 lb ai/A and 1.0 lb ai/A at 40 gal/A. A non-treated control group was maintained. Treatments consisted of 6 single pot replications arranged in a completely randomized design. The study was conducted under a shade house with 47% shade. Cyclic overhead irrigation was applied daily at 0.5 inches per day split into two cycles. Percent liverwort control was recorded 7, 14, and 21 DAT. Percent liverwort coverage within the container was recorded 35 and 63 DAT.

RESULTS

Experiment 1. Among quinoclamine treatments, rate and surfactant affected postemergence liverwort control 7 DAT and 14 DAT. In general, control increased as rate increased and as spray volume increased. At 3 DAT, rates of 0.5, 1.0, and 2.0

Table 1. Experiment 1: Liverwort control with quinoclamine, diuron, and linuron (Nov. 2004).

Herbicide	Rate (oz product/gal)	Volume (gal/A)	% Control 7 DAT[Z]		% Control 14 DAT		% Coverage 70 DAT	
Quinoclamine								
	0.25	27	33	ef[Y]	28	fg	97	a
		54	46	ed	36	ef	97	a
		109	61	cd	53	de	87	a
	0.5	27	58	cd	61	cd	89	a
		54	71	bc	66	cd	73	ab
		109	88	ab	87	abc	79	ab
	1	27	34	ef	28	fg	88	a
		54	93	ab	94	ab	59	bc
		109	97	a	83	abc	54	bc
	2	27	82	abc	78	abcd	73	ab
		54	81	abc	97	a	40	cde
		109	99	a	98	a	22	de
	Main effects[X]	rate	***		***		***	
		spray volume	***		***		***	
		rate*volume	NS		NS		*	
	lb ai/A							
Diuron	0.5	40	35	e	70	bcd	44	cd
	1	40	33	ef	86	abc	16	e
Linuron	0.5	40	25	efg	17	fgh	94	a
	1	40	10	fg	4	gf	100	a
Control			2	g	1	h	100	a

[Z] Days after treatment.
[Y] Means within a column with the same letter are similar according to Duncan's multiple range test ($\alpha = 0.05$).
[X] Main effects of rate, spray volume, and interaction thereof among quinoclamine treatments.
NS, *, **, *** represent nonsignificant or significant at the 0.05, 0.01, 0.001 level, respectively.

Table 2. Experiment 2. Liverwort control with quinoclamine and diuron (March 2005).

		Volume	% Control		% Coverage
Herbicide	Rate	gal/A	7 DAT[Z]	14 DAT	63 DAT
Quinoclamine	oz product/gal				
	0.5	27	13 ef[Y]	6 d	93 ab
		54	14 ef	12 d	95 ab
		109	29 cd	20 cd	93 ab
	1	27	18 de	8 d	96 ab
		54	40 c	18 cd	92 ab
		109	68 b	63 b	83 b
	2	27	35 c	19 cd	98 a
		54	83 a	82 a	66 c
		109	89 a	83 a	67 c
	Main effects[X]	rate	***	***	***
		spray volume	***	***	***
		rate*volume	***	***	**
	lb ai/A				
Diuron	0.5	40	3 f	35 c	23 d
	1	40	5 f	60 b	1 e
Control			6 ef	2 e	100 a

[Z] Days after treatment.
[Y] Means within a column with the same letter are similar according to Duncan's multiple range test (α =0.05).
[X] Main effects of rate, spray volume, and interaction thereof among quinoclamine treatments.
NS, *, **, *** represent nonsignificant or significant at the 0.05, 0.01, 0.001 level, respectively.

oz/gal applied at 109 gal/A provided 88%, 97%, and 99% postemergence control, respectively (Table 1). Similarly, rates of 1.0 and 2.0 oz/gal applied at just 54 gal/A provided 93% and 81% postemergence control, respectively. By 14 DAT, rates of 0.5, 1.0, and 2.0 oz/gal applied at 109 gal/A provided 83% to 98% postemergence control. Again, rates of 1.0 and 2.0 oz/gal applied at just 54 gal/A provided similarly effective postemergence control. Percent liverwort coverage 70 DAT was lowest in containers treated with 2.0 oz/gal applied at 54 and 109 gal/A.

Diuron and linuron treatment means were compared to quinoclamine treatments and the nontreated control group using Duncan's multiple range test ($\alpha = 0.05$). At 7 DAT, diuron provided minimal postemergence control. Linuron treatments had no postemergence effect as compared to the control group. However, diuron applied 0.5 and 1.0 lb ai/A provided effective postemergence control 14 DAT. Diuron applied at 1.0 lb ai/A provided similar control to the most effective quinoclamine treatments. Percent coverage 70 DAT in containers treated with 1.0 lb ai/A diuron was numerically lowest at only 16%.

Humata tyermannii and *E. pulcherrima* displayed no injury throughout the course of the study.

Experiment 2. As in Experiment 1, quinoclamine rate, spray volume, and the interaction thereof affected postemergence liverwort control. The rate of 2 oz/gal applied at 54 and 109 gal/A provided superior control at 83% and 89% postemergence control 7 DAT (Table 2). Rates of 0.5 and 1.0 oz/gal did not provide adequate postemergence control regardless of spray volume. Results were similar 14 DAT. Liverwort covered 66% and 67% of the surface 63 DAT in containers treated with 2 oz/gal applied at 54 and 109 gal/A, respectively.

Diuron treatments did not provide significant postemergence control 7 DAT. By 14 DAT, diuron at 1.0 lb ai/A provided 60% postemergence control, while diuron at 0.5 lb ai/A provided 35% postemergence control. By 63 DAT, percent liverwort coverage in containers treated with diuron at 0.5 lb ai/A and 1.0 lb ai/A were significantly lower than containers treated with the highest rate and spray volume of quinoclamine. Percent coverage in containers treated with diuron at 1.0 lb ai/A was only 1%, while percent coverage in containers treated with diuron at 0.5 lb ai/A was 23%.

DISCUSSION

Quinoclamine rate and spray volume influence postemergence liverwort control. These data show that lower than recommended spray volumes and rates can provide effective postemergence control. Heavy liverwort infestations may require a higher rate/spray volume, while lighter liverwort infestations may be controlled by a lower rate/spray volume.

Percent postemergence control attained by quinoclamine treatments was higher in Experiment 1 when compared to similar treatments in Experiment 2. Experiment 1 was conducted in a temperature-controlled greenhouse. Experiment 2 was conducted outdoors, and treatments were applied in March. Quinoclamine activity is fast on liverwort. Temperatures directly after application in March dropped to 43 °F and remained below 65 °F for the following 7 days. The lower amount of postemergence control in Experiment 2 could be accounted for by the cooler outdoor temperatures. Physiological activity of the liverwort would have been lower in cooler temperatures.

Diuron provides excellent postemergence liverwort control when applied at 1.0 lb ai/A. This product is not registered for use in nursery crops, however it caused no injury to crops treated in this study. Diuron has potential as a postemergence herbicide for use in container crops.

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Pinebark Mini-Nuggets Provide Effective Weed Control in Nursery Crops Grown in Large Containers©

Ben M. Richardson[1], Charles H. Gilliam, and Glenn R. Wehtje
Auburn University, Department of Horticulture, Auburn, Alabama 36849

Glenn B. Fain
USDA-ARS, Southern Horticultural Laboratory, Poplarville, Mississippi 39470

While the market for large plants increases steadily, weed control in large containers presents new production problems for growers. Preemergence herbicides are inefficient in large containers due to nontarget loss, and hand weeding is expensive. Mulches can provide an alternative. Experiments were conducted to evaluate fresh pine bark nuggets for weed control in 7-gal containers. *Gardenia* were seeded with oxalis and crapemyrtle with bittercress. Treatments consisted of mulch applied at 0, 3.8, and 7.7 cm (0, 1.5, and 3.0 inches) and seeding was done before or after mulch. A separate group of treatments were included similar to the above except that a granular preemergence herbicide was applied after mulch application. Growth of gardenia and crapemyrtle were similar regardless of mulch depth. Season long weed control was obtained in all treatments when mulch was applied at 7.6 cm (3 inch) depth.

INTRODUCTION

Container nursery crops are increasingly valuable compared to agronomic crops in the southeast. However, weeds growing in containers can reduce the value of the crop by reducing growth through competitive effects (Berchielli-Robertson et al., 1990) and reducing salability due to customer demand for weed-free crops. Most growers use preemergence herbicides along with supplemental hand weeding to control weeds, thus maximizing crop value.

[1]Graduate Student Research Paper Winner; 2nd Place.