CONTROLLING AND MANAGEMENT OF MOSSES AND LIVERWORTS IN NURSERIES

Cheryl A. Wilen, University of California Cooperative Extension and UC Statewide IPM Program. 5555 Overland Ave. Suite 4101, San Diego, CA 92123 cawilen@ucdavis.edu

Liverworts and mosses are primitive plants that lack true roots; water and nutrients are absorbed by the vegetative organs of the plant. They can be propagated and spread vegetatively or sexually by spores. Spores have been found in air and recycled irrigation water and are likely also in potting mix if stored uncovered near a liverwort or moss infestation. It is unlikely that the common disinfecting systems used in recycling nursery irrigation water (chlorination, bromine injection, ozonation) are effective in killing the spores.

Liverwort is a problem in nurseries because they rapidly cover the container surface and compete with the crop for water and nutrients. Additionally, heavy infestations limit the penetration of water and fertilizer into the growing substrate resulting in the failure of irrigation water to reach the plants' roots. This results in water runoff and additional need for irrigation to keep the plants healthy. An indirect effect of a liverwort infestation is that it they create a favorable environment for fungus gnats to breed. Mosses present the similar problems but the competitive effect is not as pronounced.

The nursery is an ideal environment for liverworts and mosses to become established. Because these plants lack roots, they do not have an efficient method of acquiring water and therefore grow best in areas where water is constantly available. Liverworts are nitrophilous (nitrogen loving), growing best when nitrogen is between 75 and 250 ppm. Nitrogen is often a limiting nutrient in nursery production so it is usually applied at high rates. These two conditions are probably the most significant factors in the establishment of liverwort in a nursery. Nitrogen is not as crucial to moss proliferation but water is necessary for spore fertilization. Therefore an integrated program of irrigation and fertility management, supplemented with physical and chemical controls is necessary to reduce and possibly eliminate liverwort and moss.

Cultural control: It is important to prevent the introduction of liverwort into an area. Covering potting mix components will help prevent the infestation of spores during the canning process or in liner production. Sanitize all greenhouse surfaces with a disinfectant registered for greenhouse or nursery use. Containers that have been infested should be thrown away as it is likely that spores are on the plastic. At the very least they should be sterilized with a disinfectant. Media mixes should also be properly stored to prevent contamination.

Once plants are in the production phase, do not overwater the crop. If at all possible, allow the surface of the growing medium to dry between irrigation cycles or use a coarse mulch which will dry quickly. Subbirrigating will allow the plants to take up water but the potting medium surface will be drier.

Continually monitor fertilizer applications and adjust to use only the amount required by the crop. As noted above, excess N is conducive to liverwort growth. Surface applied fertilizers tend to encourage more liverwort growth than if the fertilizer is incorporated. However, surface applications of slow-release iron sulfate or copper sulfate combined with reduced irrigation levels can decrease liverwort infestations.

Chemical control: There few herbicides registered for control of liverwort and fewer specifically for control of mosses. The label must be consulted carefully to determine if the product can be used in greenhouses or nurseries. Many products are contact herbicides and can damage the crop if not washed off the foliage. Heavy irrigation often reduces the effectiveness of herbicides because they are either diluted or washed away. In general preemergent herbicides containing oxadiazon have been shown to be effective in reducing liverwort pressure. Flumioxazin (Broadstar and Sureguard) are registered for controlling liverwort. In trials conducted in Irvine, CA we found that Broadstar was slow to injure liverwort but effective in the long run. It had much faster activity on moss. Terryacyte was also particularly effective in moss control but is not yet

registered in California. Other products which can be effective in some situations include those containing cinnamic aldehyde (Cinnamite). No-Moss is a contact herbicide derived from garlic and clove oil which has shown good control of liverwort of moss. Again, avoid contact the crop foliage to reduce the possibility of phytotoxicity. Hydrogen dioxide (Zero-tol), a disinfectant, can be applied to the potting medium surface twice weekly to control spore germination.

Another product under testing for possible U.S. registration by Crompton-Uniroyal is quinoclamine. In recent studies this material provided excellent liverwort control.

The table below shows the results of a test conducted to examine different cultural and chemical controls for preemergent liverwort management.

Preemergent liverwort control using various cultural and chemical controls 4 and 7 weeks after treatment (WAT).

Treatment	% cover 4 WAT		%cover7 WAT		Rate	
Untreated	10	bc1	28.5	cd		
Broadstar (flumioxazin)	0	a	0	a	2 oz ai/A	
Broadstar	0	a	0	a	1 oz ai/A	
GC Mite (garlic and cinnamon oil)	0.3	a	4	a	6T/gal	
GC Mite	0	a	2.8	a	12 T/gal	
Ironite	2.8	a	6.3	a	50 lb/1000 ft2	
Ironite	10.8	cd	22.5	bc	25 lb/1000 ft2	
Coir mulch_fine	0	a	0	a		
Coir mulch_med	0	a	0	a		
Coir mulch_coarse	1.8	a	3.3	a		
Ronstar 2G (oxadiazon)	3.5	a	2.3	a	100lb/A	(2 lb ai/A)
Ronstar 2G	3.8	a	2.5	a	200lb/A	(4 lb ai/A)

1Means followed by the same letter are not significantly different at the P=0.05 level using SNK means comparison.

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