Identifying and managing liverwort in Michigan nurseries and greenhouses

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Liverwort is one of the major weeds in Michigan's production nurseries and greenhouses. Historically, liverwort has been reported as a weed problem in cooler regions of the the United States, including the Northeast and Pacific Northwest. It is primarily a problem in herbaceous perennials, woody ornamentals or crops that have a long production cycle with a dormant or vernalization period where they remain damp for long periods of time. There are 6,000 to 9,000 species of liverwort with *Marchantia polymorpha* being the most common prevailing in greenhouses and container nurseries (Marble et al., 2017).

Liverwort is a primitive plant that can be easily confused with mosses. This fact sheet will help growers identify liverwort, understand its biology and learn strategies to control it in their operations.

Liverwort Identification and Reproduction

HABITAT

Liverwort naturally grows in damp habitats such as the banks of rivers, bogs, fens and other riparian environments. Liverwort can be found growing on the top of the container substrate of ornamental plants (Fig. 1)—especially those that are overhead irrigated—in greenhouses, propagation and nursery ground cloth areas and any poorly drained or moist areas.

Liverworts including *Marchantia polymorpha* prefer cool temperatures, low ultraviolet (UV) light radiation, high fertility and moist or damp substrate.

Figure 1. Liverwort growing profusely in the container along with ornamental plants inside a greenhouse. Photo by Debalina Saha, MSU Horticulture.

It reproduces rapidly where overhead irrigation is present or in any poorly drained or moist areas. The optimum temperature for vegetative growth is 64 to 72 degrees Fahrenheit. These environmental conditions are common inside greenhouses and nurseries and the organism thrives and spreads rapidly once established in containers.

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Figure 2. Dichotomously branched vegetative thallus structure of liverwort (*Marchantia polymorpha*). Photo by Debalina Saha, MSU Horticulture.

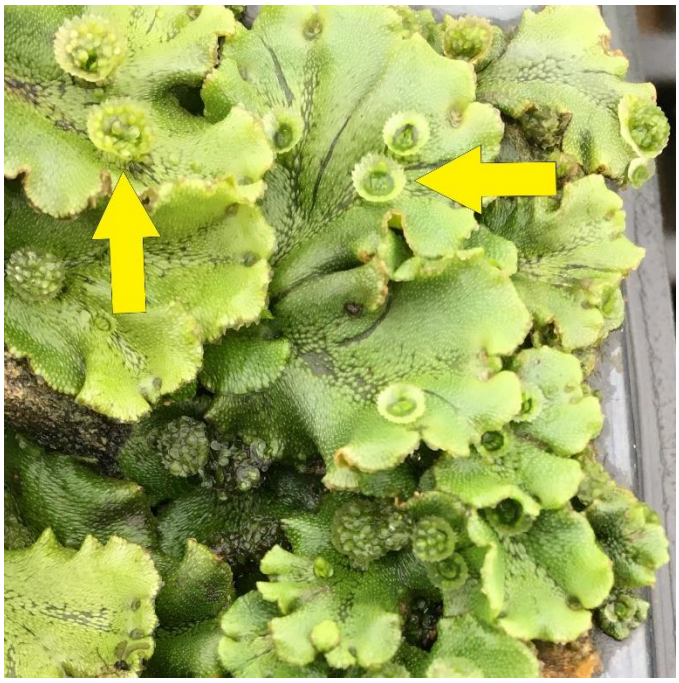

Figure 3. The arrows show asexual reproductive structures called gemma cups containing numerous gemmae. The gemmae spread with irrigation water splashing and germinate in suitable conditions to produce an entire new liverwort plant. Photo by Debalina Saha, MSU Horticulture.

GROWTH HABIT

Liverwort has a thallus structure without any differentiated true stems, leaves and root system. Liverworts form dense, prostrate mats covering the soil or container media surface. In container production, liverwort becomes highly competitive with the ornamental crop for water, nutrients and space. The liverwort mat can prevent irrigation water and fertiligation from reaching the root zone of the ornamental crop and can repel water when dry (Neal and Derr, 2005). As a result, overall quality and market value decreases.

THE VEGETATIVE STRUCTURE (THALLUS)

Marchantia polymorpha is a non-vascular plant that consists of dichotomously branched thallus (undifferentiated plant body) 2-8 centimeters long, 1-8 centimeters wide and up to 1.5 milimeters thick (Fig. 2). It is prostrate on the soil or substrate. Individual lobes of the thallus are 8-15 milimeters wide. Adjacent lobes can merge at their bases. The thallus becomes thinner towards the margins. The tips of the lobes are notched. The margins are smooth, toothless and undulate.

The upper surface of the thallus is bright green. However, it may turn purplish along the margins with aging. There are gemma cups along the middle of each lobe on the upper surface of the thallus. These gemma cups have circular membranous rims that are crenate along their upper margins.

ASEXUAL REPRODUCTIVE STRUCTURE (GAMETOPHYTIC LIFE CYCLE)

In gametophytic life cycle, the liverwort plant propagates asexually by producing gemmae within the gemma cups (Fig. 3). Each gemma cup can produce numerous gemmae (asexual plant buds). Each gemma is shaped like a shallow circular pan and are about 1 millimeter across, oval shaped and green. Gemmae are released to the immediate

area when splashed by water from rain or irrigation. After leaving the mother plant, each gemma can form one to two clonal plants after contact with moist soil or substrate. Liverwort may also propagate asexually by fragmentation.

SEXUAL REPRODUCTIVE STRUCTURES (SPOROPHYTIC LIFE CYCLE)

When liverworts are exposed to temperatures between 50 and 59 F, they develop sexual structures or fruiting bodies. Stalked, umbrella-like male and female reproductive structures are borne on separate thalli. The antheridia (male reproductive organs) produce the sperm and are located on the upper surface of a flattened disc atop a narrow stalk called antheridiophore (Fig. 4).

Archegoniophores (female reproductive structures) are also stalked, but the upper portion has narrow lobes bending downward along its margins. The archegonia, which produce the eggs, are located on the underside of those lobes. Sperm cells produced by antheridia travel via water (rainwater or irrigation splashing on the upper surface of the antheridiophore) to fertilize the eggs on the undersides of the archegoniophore.

After fertilization, spore development takes place. Once they mature, they get dispersed by wind or water and germinate on moist substrate under suitable growing conditions.

Liverwort Management

PHYSICAL AND CULTURAL CONTROL

As liverwort thrives in damp conditions, improve drainage in containers and greenhouse or nursery facilities such as walkways and floors. Avoid over-irrigating containers. Research has shown that drip or microirrigation can reduce the spread of liverwort when compared with overhead irrigation systems.

When possible, avoid introducing infested stock to the crop area. Sanitation is very important in controlling liverwort in production nurseries and greenhouses. Sanitize greenhouse surfaces, pots and tools with labeled disinfectants, such as quaternary ammonium or peroxides.

Figure 4. The arrow shows the male reproductive structure called antheridia, which produces the sperm for sexual reproduction in liverwort. The antheridia are located on the upper surface of a flattened disc atop a narrow stalk called antheridiophore. Photo by Debalina Saha, MSU Horticulture.

Mulching with organic mulch such as pine bark or hazelnut shells can also decrease liverwort cover (Svenson, 1998). Commercial growers of plugs and liners commonly topdress with parboiled rice hulls, however more research is needed to determine the best mulch type, depth and particle size for liverwort control in nursery and greenhouse conditions. Avoid topdressing containers with fertilizer, as incorporating or subdressing fertilizer in containers reduces liverwort growth. Do not over-fertilize because liverwort reproduces rapidly when exposed to elevated levels of nitrogen and phosphorus.

CHEMICAL CONTROL

Preemergence Herbicides

Preemergence herbicides that have shown some degree of liverwort control in ornamental production in nurseries and greenhouses are listed in Table 1. However, applying preemergence herbicides alone cannot kill liverwort. Integrating cultural and chemical

methods is required to effectively control liverwort.

Flumioxazin (SureGuard and Broadstar) is labeled for liverwort control. SureGuard is a water dispersible granule formulation that can be applied as directed application to the container substrate surface, avoiding ornamental crop foliage. It is most helpful on nursery floors and in dormant, large, container-grown, leafless deciduous trees. Broadstar is a granular formulation and can be applied over the top of many woody nursery crops. However, neither formulation of flumioxazin can be applied to plants inside a greenhouse according to the product label. Sureguard can be applied if no plants are present in the greenhouse and growers must then wait at least 24 hours before bringing plants inside the treated greenhouse (Marble et al., 2017).

The Group 14 herbicides, known as protox inhibitors, may show some degree of liverwort suppression. Herbicides containing oxyfluorfen (OH2, Regal O-O, Rout) or oxadiazon (Ronstar) may reduce liverwort prevalence on container media when applied preemergence (Newby, 2006). More research is required to test the efficacy of preemergence herbicides.

Postemergence Herbicides

Postemergence herbicides that have shown some efficacy in liverwort control in ornamental production in nurseries and greenhouses are listed in Table 2. Flumioxazin (SureGuard, Broadstar) provides some postemergence control of liverwort. SureGuard provides more effective and faster control of liverworts than Broadstar (Marble et al., 2017). Glyphosate, rarely used in greenhouse production due to its risk to volitailize and cause crop damage, offers little to no control of liverwort. A limited number of studies have shown that acetic acid products can control liverwort. However, be careful to choose products containing acetic acid and that are labeled for use as pesticides in nurseries.

Other pesticides that have postemergence activity on liverwort include: ammonium nonanoate (Axxe), diquat (Reward), sodium carbonate peroxyhydrate (TerraCyte) and pelargonic acid (Scythe). However, these herbicides have been shown to cause significant damage to the ornamental plants. Dimethenamid-P is a potential herbicide that can suppress liverwort growth, but it works very slowly and the results may vary (Marble et al., 2017).

Table 1. Preemergence herbicides[1] labeled for use in ornamental plant production (adapted from Marble et al., 2017).

Common name	Trade name and formulation	Container production	Field production	Greenhouse
flumioxazin[2]	Broadstar™ 0.25G	Yes	Yes	No
	SureGuard®51WDG	Yes[3]	Yes[3]	Yes[4]
oxadiazon	Ronstar®2G	Yes	Yes	No
oxyfluorfen	Goal®2XL(EC)	Yes	Yes	No
oxyfluorfen + oryzalin	Rout®3G	Yes	Yes	No
oxadiazon + prodiamine	RegalStar®II	Yes	Yes	No
oxyfluorfen + pendimethalin	OH2®3G	Yes	Yes	No

Table 1. Preemergence herbicides[1] labeled for use in ornamental plant production (adapted from Marble et al., 2017).

Common name	Trade name and formulation	Container production	Field production	Greenhouse
oxyfluorfen + prodiamine	Biathlon®2.75G	Yes	Yes	No
oxyfluorfen + oxadiazon	Regal OO, Double O™ 3G	Yes	Yes	No

[1]Herbicides have shown some efficacy in previous preemergence liverwort research trials. Not all herbicides or combinations have been tested, and results may vary based on individual nursery conditions. Along with the herbicide, proper cultural and sanitation practices are required for effective liverwort control.

[2]Flumioxazin is the only herbicide that lists liverwort on the label as a controlled species.

[3]Can only be used in selected conifer and deciduous tree species. Check manufacturer's label for complete list of species and recommended application methods.

[4]Cannot be used while an ornamental crop is inside the greenhouse. Check label for further details and precautions.

Table 2. Herbicides labeled for use in ornamental plant production that have postemergence liverwort activity[1] (adapted from Marble et al., 2017).

Active ingredient	Trade name	Container production	Field production	Greenhouses	Notes
Organic products					
acetic acid (vinegar)	Many products available	Yes	Yes	Yes	See individual product label for use sites. Must be labeled and manufactured for use as a pesticide.
ammonium nonanoate	Axxe	Yes	Yes	Yes	Repeated applications may be needed.
d-limonene	AvengerAg	Yes	Yes	Yes	Repeated applications may be needed.
pelargonic acid	Scythe	Yes	Yes	Yes	Repeated applications may be needed.
Synthetic products					
diquat	Reward	Yes	Yes	No	Use with a surfactant; repeated applications may be needed.
flumioxazin	Broadstar	Yes	Yes	No	Greater control achieved with SureGuard.
	SureGuard	Yes	Yes	No	

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Active ingredient	Trade name	Container production	Field production	Greenhouses	Notes
oxadiazon	Ronstar 2G	Yes	Yes	No	Sprayable formulations (FLO) only labeled for over the top use on selected species. Check label for details. Granular formulation is slower and less effective to provide control.
oxyfluorfen	GoalTender	Yes	Yes	No	Applicable only in selected conifers and trees. See label for more information.
sodium carbonate peroxyhydrate	TerraCyte	Yes	No	Yes	Injury may occur if granules become trapped in/on ornamental plant foliage.

[1]Complete liverwort control with postemergence herbicide alone may not be achieved. Integrating proper cultural and sanitation practices is required for a long-term success. These herbicides have shown postemergence activity on liverwort in nursery conditions in research trials. Depending upon liverwort growth stage and environmental factors, results may vary. Except for Tower, Broadstar and Ronstar 2G, all other products need to be applied as a directed application, avoiding ornamental crop foliage.

References

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