Liverwort Control in Propagation Systems: What We've Learned©

David Joeright
Spring Meadow Nursery, Inc., 12601 120th Ave., Grand Haven, Michigan 49417, USA
Email: dave@springmeadownursery.com

BACKGROUND

Liverwort has become a problem for many propagation nurseries, and controlling it can be very difficult. The biggest problem with liverwort in the United States is that there are no products labeled for post-emergent control over the top of plants that are actually effective. A lot of academic research and a lot of anecdotal information can be found on the prevention and control of liverwort. Based on some of this information a group of growers at Spring Meadow Nursery have been trialing various products on test plots to try to gain an understanding of the type of chemistries that might best work to kill liverwort while not killing the affected crops. Here I'll briefly discuss several of the more interesting products we've tried over the course of many years, however this is not an endorsement of any product as some of these are not labeled for use on crops and therefore might not be legal to use in your situation.

Prevention is always the best place to start in any liverwort management program. Severe liverwort infestations are often coupled with over-watering of a crop. If crops are being grown in an enclosed greenhouse, improving water-management and avoiding over-watering can go a long way in reducing your incidence of liverwort infestation. Sanitation is also very important in prevention especially when there are established liverwort populations nearby. Using disinfectant and herbicide sprays over growing areas after they are emptied of crops can significantly reduce the amount of viable spores lingering in an area. Maintaining clean stock plants is also extremely helpful. Cuttings taken form stock plants infested with liverwort will most certainly carry the liverwort spores over to the propagation media resulting in liverwort infesting newly propagated crops. It has been noted that liverwort spores "hitch a ride" on some plants more easily than others. *Buxus* is one example. There are pre-emergent herbicides available that do work well to prevent germination and growth of liverwort however none are labeled for use in enclosed structures and do not have any effect on established liverwort. Freehand® from BASF is a granular pre-emergent herbicide that we've found works very well as a preventative (Fig. 1). Trials with weekly applications of ZeroTol®, Kleen-Grow™, and Physan 20™ were also conducted to evaluate their effectiveness in preventing liverwort growth (Fig. 2). ZeroTol® was applied at 0.25 oz./gal, Kleen-Grow™ at 0.4 oz./gal, and Physan 20™ at 0.33 oz./gal. Weekly applications were made for 11 weeks. ZeroTol® was not effective in preventing liverwort growth, Kleen-Grow™ was moderately effective, and Physan 20™ was effective at preventing liverwort growth. However both Kleen-Grow™ and Physan 20™ did result in some phytotoxicity (Fig. 3).

We have trialed many products and chemicals for post-emergent control including baking soda, potassium bicarbonate, GreenClean® PRO, OxiClean®, cinnameldahyde, benzalkonium chloride, and vinegar.

Fig. 1. Freehand® at 200 lbs/acre works well as a pre-emergent treatment.

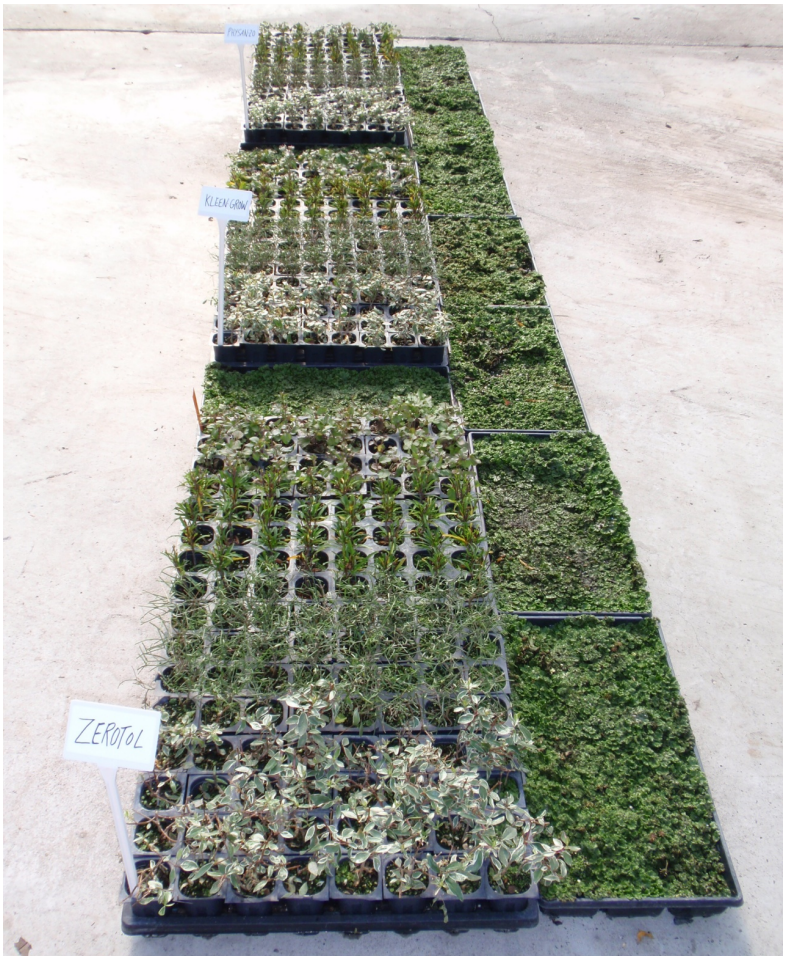

Fig. 2. Experiment set-up.

Fig. 3. *Rhamnus* after 11 weeks of weekly applications.

PRODUCTS TESTED

Baking Soda

While there is no evidence that baking soda kills liverwort spores, it does work very well to rapidly kill actively growing liverwort. It can be hand-broadcast, spread, or blown with a blower designed for granular dispersal. It can be safely applied to many species when they are dormant. It can also be safely applied to many species while actively growing provided the leaves of the plant are dry. Baking soda will stick to wet leaves and cause phytotoxicity. In general, some species are less tolerant to baking soda regardless of the conditions during application therefore phytotoxicity tests should always be conducted first. Baking soda should not be watered-in after application. In general a light dusting is sufficient (Fig. 4). In a warm and sunny environment, complete kill will be evident within a day or two (Fig. 5). In cooler, low light environments it can take up to 1 week or more to see results. It is difficult to make exact recommendations on application rates because the amount needed to be effective may be different depending on weather conditions, degree of infestation, and grade of baking soda used. There are different grades of baking soda, primarily the powdered form that can be found in the grocery store (powder grade #1) and a more salt-like granular form (granular grade #5) that can be purchased from chemical supply companies. We have found that the granular grade #5 works best, is less dusty, and has less of a tendency to stick to the leaves resulting in a reduced incidence of phytotoxicity. It is important to remember baking soda is sodium bicarbonate and applying it to plants can result in increased sodium levels in the plant tissue, and over-

application can result in sodium toxicity as well as an increase in soil pH. It is important to remember that different species of plants have different levels of tolerance to sodium.

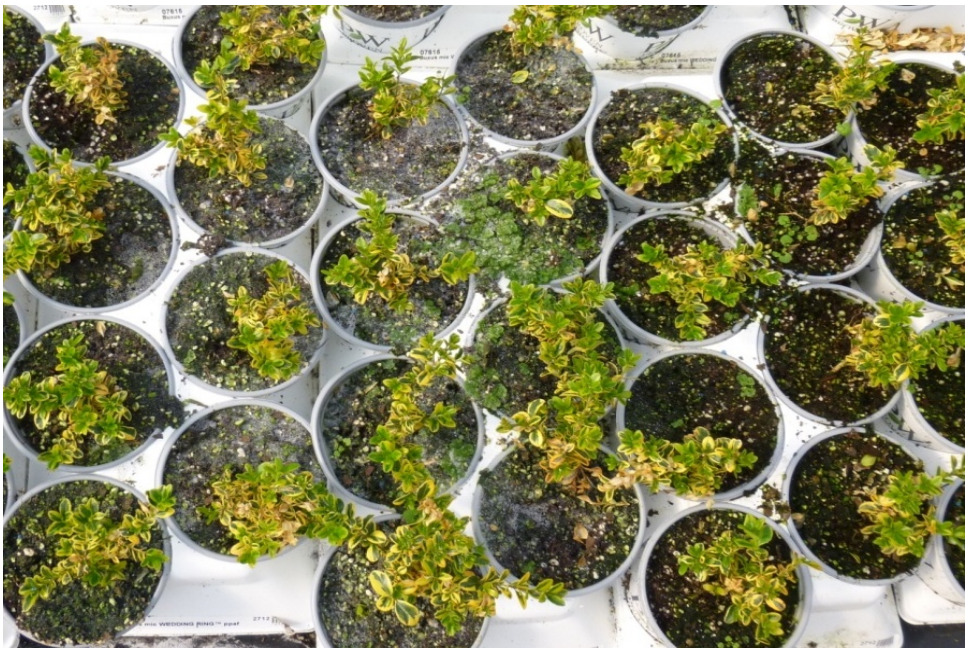

Fig. 4. A light dusting of baking soda is sufficient.

Fig. 5. Effect of baking soda on liverwort.

Potassium Bicarbonate

Often used as a tool for raising the pH of growing media, potassium bicarbonate is also effective at killing liverwort when broadcast or spread as a granular. Being that it is potassium instead of sodium, it would not lead to elevated sodium levels in plant tissue. It will however raise media pH and can cause phytotoxicity if it remains in contact with the leaves of a plant. It can be used and applied the same way as baking soda. We did find

that depending on the source it can be a fine-powder form, a granular-powder, or even a crystalline-like granular. The crystalline granular was not very effective at killing liverwort, but the more powder-like form was very effective. MilStop® is a product produced by BioWorks® as a fungicide whose active ingredient is potassium bicarbonate. This product is also very effective on liverwort when applied as a granular, however it is not labeled for this type of application.

GreenClean® PRO/TerraCyte® PRO

BioSafe Systems produces two products, GreenClean® PRO and TerraCyte® PRO, which contain 85% sodium carbonate peroxyhydrate. They are very effective when applied as a granular, and appear to be safe on a wide range of plants (Fig. 6). It did work better when applied under warm and sunny conditions, it was safer when plant leaves were dry, and it did need to be watered-in slightly in order to activate the product and be effective (Fig. 7). At the time of these trials, TerraCyte® PRO was labeled for use on plants when dissolved and sprayed as a liquid, but not for a granular application. Since then, TerraCyte® PRO has been relabeled for use as a granular application on crops, and so it is a better choice than GreenClean® PRO and it is more effective. GreenClean® PRO is not labeled for use on plants in any way. When applied as a spray solution, we did not find GreenClean® PRO or TerraCyte® PRO to be very effective at killing liverwort and they caused phytotoxicity on the crops we tested.

Fig. 6. GreenClean® PRO applied as a granular on liverwort.

Fig. 7. One day after applying GreenClean® PRO as a granular.

OxiClean®

The household laundry detergent OxiClean® contains the active ingredient sodium percarbonate which is synonymous with sodium carbonate peroxyhydrate, the active ingredient in TerraCyte® PRO and GreenClean® PRO. OxiClean® works very well to control liverwort however we did see more plant phytotoxicity (Fig. 8). This could be because of OxiClean®'s more powdered form and its tendency to clump, or due to additional unknown ingredients. OxiClean® was also less effective when applied as a spray and resulted in greater phytotoxicity. It is also more effective under sunny and warm conditions.

Cinnameldehyde

Cinnamite was an insecticide that used to be available, which was also labeled for liverwort control, and it was effective at killing liverwort. Unfortunately this product is no longer on the market. The active ingredient in Cinnamite was 30% cinnameldehyde, which is an organic compound used to flavor foods and gum. It is available at chemical supply companies as a concentrated liquid. When diluted with water down to 30%, it was effective at killing liverwort (Fig. 9). We did experience some phytotoxicity on the plants we tested, but when experimenting with the actual Cinnamite product many years ago we saw that it caused little or no phytotoxicity. Because it is only slightly soluble in water, its effectiveness and safety might possibly be improved with the addition of an adjuvant to the solution, like a surfactant and/or spreader-sticker.

Fig. 8. Dead liverwort 1 day after an application of OxiClean® powder.

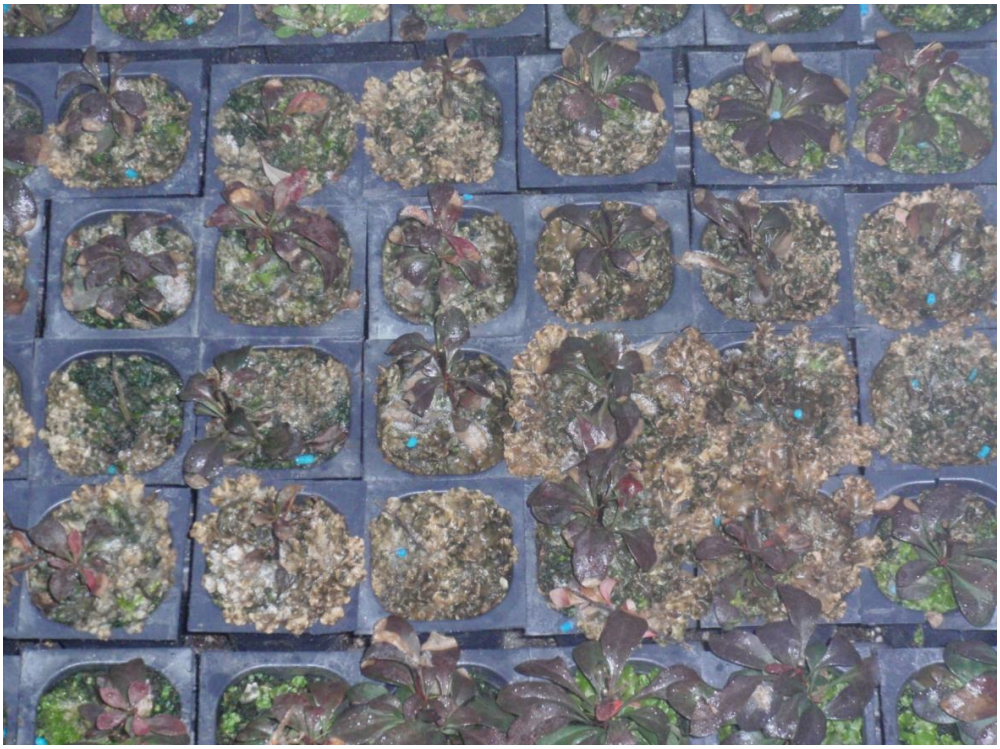

Fig. 9. Liverwort killed by 30% cinnameldehyde after 2 weeks.

Benzylkonium-Chloride
This compound falls into the quaternary ammonium group, similar to Kleen-Grow™, Physan 20™, and Green-Shield®. Available in its pure concentrated form from chemical supply companies, benzylkonium-chloride can be found as the active ingredient in institutional disinfectants, antiseptics, hand-sanitizers, and some algaecides. Our trial was on dormant plants as a 5000 parts per million spray. While it did effectively kill liverwort, it turned out to be cost prohibitive and it is too hazardous to handle in its concentrated form.

Vinegar (Acetic Acid)
There are effective herbicides on the market that contain 20% acetic acid as their active ingredient. Large drums of 56% industrial grade acetic acid can be purchased from chemical supply companies. We found that making solutions of as low as 8% acetic acid can be effective at killing liverwort, but can still be phytotoxic to most crops.

While it is certainly much easier to prevent liverwort infestations than it is to eradicate them, there are ways to kill liverwort without necessarily killing your plants. Unfortunately some of these methods and products are not labeled for use on ornamental greenhouse and nursery crops, and no single method is safe on every plant species. Many of these methods have the potential to cause crop phytotoxocity when applied to actively growing plants, and while they may be relatively safe to apply over dormant plants during winter, liverwort itself has a dormant period during which it is much more difficult to kill. There are certainly more chemicals, products, and methods which are effective and yet haven't been mentioned or tested here. Sometimes the only way to learn how to control a problem that has few or no solutions is to learn from the successes and failures of others and to just start experimenting.