

From Liverwort to Spurge – an Update on Weed Management[©]

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INTRODUCTION

Weed management continues to be an important production concern for growers. The diversity in production practices, including propagation in enclosed structures as well as outdoor production in containers or in field soil, as well as the diversity in plants being produced, makes weed control a particular challenge. Two important weed species in the nursery industry are liverwort and spotted spurge.

LIVERWORT

Liverwort is a primitive moss-like plant that forms leaf-like mats on the soil surface. Liverwort grows best in cool, moist conditions. In areas of frequent irrigation, such as in propagation or in the production of perennials, liverwort can develop into a major weed problem.

There are two types of liverworts (Hepaticophyta), leafy and thallose; the major species that infests nursery stock is *Jungermannia polymorpha* (syn. *Marchantia polymorpha*), which is a thallose type, one of the most primitive plants alive today. The thallus, a leaf-like structure, does not form stems, leaves, or roots. There is little or nothing in the way of conducting tissue, which may be a factor that limits the effectiveness of herbicides. There are pores on the upper surface but they do not function like stomata. There are unicellular root-like rhizoids which help to hold the plant down. The plant absorbs water over its entire surface and it lacks a cuticle so it is susceptible to desiccation.

Liverwort can reproduce both sexually and asexually. Asexual reproduction can occur from newer branches that develop into separate plants when older parts of the plant die. Liverwort also spreads asexually by producing gemmae, balls of cells that develop in cup-like structures on the thallus. When rain droplets hits the gemmae cups, the gemmae are thrown out and can then develop into separate plants.

Liverwort also spreads through sexual reproduction. The plants (gametophytes) produce umbrella-like reproductive structures known as gametophores. The gametophores of female plants consist of a stalk with star-like rays at the top. Male gametophores are topped by a flattened disc containing the antheridia which produce sperm. Sexual reproduction involves sperm from the male plant fertilizing ova from the female plants. A fertilized ovum develops into a small sporophyte plant which remains attached to the larger gametophyte plant. The compact sporophyte consists of a terminal round spore case called a capsule, a stalk called the seta and a basal mass of cells called a foot which is embedded in and, therefore, obscured by the tissues of the gametophyte. The sporophyte produces male and female spores, which can develop into free-living gametophyte plants.

Previous Research on Liverwort Management

Allowing the soil surface to dry out between irrigations will aid in the management of this weed. Mulches have been tried for control, since a layer of coarser material will hold less water than a peat-based potting mix. Individuals have tried a number of chemical control options with varying success, including use of acetic acid (vinegar), hydrogen peroxide, and sodium carbonate peroxyhydrate (Terracyte), which breaks down into hydrogen peroxide. There is a need for selective postemergence herbicides for control of liverwort. A promising chemical a few years ago was quinclamine (Mogeton, Gentry). This chemical has been used in Europe for liverwort control but the EPA has not approved its use in the US due to toxicology issues, and it does not appear likely that it will ever be labeled in the US. A useful report on this weed species is located at this website:

http://ir4.rutgers.edu/ir4_pdf/default.aspx?pdf=http://ir4.rutgers.edu/Ornamental/Summar

Preemergence Liverwort Control Study

I have been evaluating preemergence herbicides for liverwort control. In my preemergence trial, the most effective chemical was FreeHand[®] (dimethenamid + pendimethalin), followed by BroadStar[™] (flumioxazin), Rout[®] (oxyfluorfen + oryzalin), and Ronstar[®] 2G (oxadiazon). BroadStar and Rout are used predominantly on woody nursery crops since they can cause unacceptable injury in herbaceous species. Ronstar also has greater utility in woody ornamentals so FreeHand would be the one most useful in perennial production conducted outdoors. One of the ingredients in FreeHand, dimethenamid, is sold by itself under the trade name Tower. Tower also is an effective treatment for liverwort. No preemergence herbicides are registered, however, for use in pots in enclosed structures, such as greenhouses or overwintering houses. So we do have selective options for preventing liverwort infestations in containers maintained outdoors, but do not have approved options in greenhouse production.

Postemergence Liverwort Control Study

In my 2010 postemergence trial, Bryophyter[™] (oregano oil) and Scythe[®] (pelargonic acid) caused significant and rapid injury (80% or higher) to liverwort within 30 min of application. Effects from most of the other treatments were apparent 1 day after treatment (DAT). At 1 DAT, Bryophyter, Scythe, and WeedPharm (acetic acid) all provided 75% or greater control of liverwort. By 21 DAT, however, only SureGuard[®] (flumioxazin) and Tower[®] (dimethenamid) gave greater than 85% control as regrowth occurred in the other treatments, with Scythe, WeedPharm, and the higher rate of Bryophyter providing 60% or greater control. A second application of all treatments was made at 3 weeks after the initial treatment. At 15 minutes after the second application, Bryophyter, the higher rate of Racer (ammonium nonanoate), Scythe, SureGuard, Tower, and WeedPharm all gave 75% or greater liverwort control. These treatments all provided 80% or greater control at 8 days after the second application. The lower rate of Racer and both Terracyte treatments did not provide acceptable control of liverwort. Thorough coverage of liverwort appears to be critical for all of these treatments since the action seems to be contact for each one.

SureGuard was the most injurious treatment to Shasta daisy, followed by WeedPharm and Scythe, with the injury being unacceptable for all 3 chemicals. SureGuard, Racer (high rate), and Scythe (high rate) caused 40% or greater injury to caladium at 21 DAT. Directed sprays would be needed to improve crop safety. Less injury was seen with the other treatments. More data on crop safety is needed for these treatments.

SureGuard can really only be used in conifers, as most broadleaf nursery crops will not tolerate overtop applications. So although SureGuard provides effective preemergence and postemergence control of liverwort, its use in liverwort control programs is very limited. Scythe and WeedPharm acetic acid are essentially contact nonselective herbicides. Although these two chemicals provide rapid control of liverwort, their use would be limited by the amount of damage I have seen in herbaceous nursery crops. Of the treatments I have evaluated, Bryophyter, Racer, and Tower appear to have the best combination of liverwort control and crop safety. A granular application of Terracyte outperformed the sprayed application I made, so perhaps the granular treatment needs to be explored in greater detail. Others have reported good control of emerged liverwort with Terracyte.

To expand on this trial, I did a study in 2011 comparing two rates of Tower (dimethenamid), two rates of FreeHand (dimethenamid + pendimethalin), and iron HEDTA. Tower at 32 fluid ounces per acre gave better liverwort control than at 21 fluid ounces. At 20 days after treatment, the higher rate of Tower gave 95% liverwort control while the higher rate of iron HEDTA gave 66% control. At 53 days after treatment, Tower at the higher rate gave 75% control with iron HEDTA providing 60% control. I did, however, see unacceptable injury in two sedum cultivars with iron HEPTA while Tower caused no injury. FreeHand caused some suppression of liverwort but did not

provide acceptable control, probably because this is a granular formulation. Tower is a sprayable formulation and thus would provide greater surface area coverage than that seen with a granular treatment.

Since Tower contains an oil solvent, I wanted to determine if it was the oil solvent or if it was the herbicide itself that was providing the liverwort control. I was able to obtain a sample of the organic solvent used in the formulation and compared it to Tower. I did not see significant control with the organic solvent while Tower provided good control. So the liverwort control was due either to the herbicide itself or a synergistic action of the herbicide with the solvent, although the oil solvent itself does injure liverwort. In that study, I included Scythe for comparison. At 20 days after treatment, Scythe provided slightly higher control than the higher rate of Tower, but at 48 days after treatment Tower gave greater control than Scythe.

I continued my liverwort experiments in 2012, evaluating the impact of irrigation immediately after treatment on crop tolerance and liverwort control. Irrigating immediately after application reduced iceplant injury, as no treatment resulted in greater than 15% crop damage at 5 days after treatment (DAT), but generally at the cost of reduced liverwort control. At 5 days after the first application, unacceptable injury (20% or greater) injury was only seen with the following treatments that were not irrigated immediately after treatment: Avenger (d-limonene) high rate, Bryophyter high rate, Racer (ammonium nonoate) high rate, and Scythe low and high rate. Iceplant quickly outgrew the injury, though, with all damage ratings less than 20% at 25 DAT and no injury seen at later rating dates. Acceptable liverwort control (80% or greater) at 25 DAT was seen with Avenger low rate no immediate irrigation, Avenger high rate with or without irrigation, Bryophyter high rate no irrigation, Scythe low and high rate no irrigation, WeedPharm low rate no irrigation, and WeedPharm high rate with or without irrigation.

For iceplant, the overall best combination of liverwort control and limited crop injury was seen with Bryophyter high rate no immediate irrigation, Tower high rate no immediate irrigation, and WeedPharm acetic acid low rate no immediate irrigation. Iceplant outgrew the effects from all treatments, though, so no long term injury was seen from any treatment.

This year I have been evaluating a formulation of monarda oil. It has provided equivalent control to oregano oil, causing a relatively rapid contact action. As with the other contact products, thorough coverage is essential for control, and follow-up treatments are needed for any regrowth. I also evaluated baking soda (sodium bicarbonate). It also caused significant injury to liverwort.

We have identified treatments that provide acceptable liverwort control, although repeat applications are generally needed for longer term control. We need additional data on the tolerance of nursery species to overtop applications of the most promising candidates, including oregano oil, monarda oil, Avenger, Racer, and Tower. Additional research on baking soda is warranted.

SPOTTED SPURGE

Spotted spurge [*Euphorbia maculate* (syn. *Chamaesyce maculata*)] is a troublesome weed in outdoor container and field production and also is a greenhouse weed problem. I learned this plant as prostrate spurge (*Euphorbia supina*), but changes have occurred in the taxonomic handling of this species. It is a prostrate-growing summer annual with opposite leaves, often a red mark on each leaf, and pink stems with a milky sap. It grows best during the summer months. Freshly-produced seed lack dormancy – if a plant is allowed to produce seed during the growing season, many seedlings will develop inside that pot. There are other weed species in the Euphorbiaceae that have a white sap, including garden spurge and nodding spurge. Most of my work has been done on spotted spurge.

Preemergence Control of Spotted Spurge

I evaluated two strategies for spotted spurge control, along with general herbicide evaluation. In the first set of trials, I evaluated granular products, either alone or in combination, and I made multiple applications. One objective to this trial was to determine how to improve spurge control with Rout (oxyfluorfen + oryzalin), either through application of other herbicides or through rotation to another product. In a trial I conducted at Saunders Brothers Nursery, Snapshot (isoxaben + trifluralin), FreeHand, Rout plus RegalKade[®] (prodiamine), and Rout plus Pendulum 2G (pendulum) provided the numerically highest control of spotted spurge, with lower control seen with Rout applied alone. BroadStar and Rout followed by BroadStar were intermediate in regards to spurge control. In a trial I conducted at Bennett's Creek Nursery, similar results were seen. The numerically highest spurge control was seen with FreeHand, followed by Snapshot and Rout plus RegalKade.

Adding the other herbicides to Rout improved spotted spurge control. One needs to compare the extra herbicide costs to the hand labor savings to determine if these are viable options to Rout applied alone.

Our second strategy was to include a sprayable herbicide to improve spurge control over Rout applied alone. At Saunders Brothers Nursery and at Bennett's Creek Nursery, adding Barricade (prodiamine), Pendulum AquaCap, Surflan (oryzalin), or Tower to a base application of Rout resulted in greater spurge control compared to any of these herbicides applied alone. As with the granular trials, one has to weigh the cost of the sprayable herbicide used in conjunction with a granular product versus the savings in hand weeding.

To summarize my other trials on spotted spurge, Tower and FreeHand have been very effective on this weed when applied preemergence. Members of the dinitroaniline herbicide class (the yellowish-orange group that includes pendimethalin, prodiamine, oryzalin, and trifluralin) generally are also effective preemergence control options. Some of the herbicides we consider to be more effective on broadleaf weeds, such as oxyfluorfen, isoxaben, and oxadiazon, are less effective on spotted spurge.

Postemergence Control of Spotted Spurge

I have controlled spotted spurge postemergence with SureGuard, but that product essentially only fits conifer production. If one can catch spotted spurge in the cotyledon to one leaf stage, control has been seen with Pendulum EC (pendimethalin), FreeHand, and Tower. At the two to four leaf stage, the 4.0 lb/acre rate of Pendulum has provided control of spotted spurge, with suppression seen with Tower. Pendulum EC can be more injurious to nursery crops compared to granular or microencapsulated formulations of pendimethalin. For herbaceous nursery crops and woody species other than conifers, we do not have acceptable control options for spotted spurge that is beyond the two leaf stage.