

## Control of Liverwort in Herbaceous Perennials

**Principle Investigators: Luke Case and Hannah Mathers**

**Significance to the Industry:** Liverwort is a common problem in many nursery crops, and it is often a problem during overwintering of herbaceous material in Ohio. It would be advantageous to a herbaceous perennial grower for additional postemergence control options for Liverwort.

**Materials and Methods:** It has been shown that flumioxazin and diuron can control Liverwort preemergence (Newby et al., 2005); however, it is not known whether or not these products can control them postemergence. Flumioxazin and diuron are often phytotoxic to herbaceous perennials during active growth; however, it is not known what effect they have to dormant material. The objective of this study was to determine if Liverwort could be controlled postemergence from four sprayable herbicides during overwintering of herbaceous perennials. Phytotoxicity and efficacy trials were conducted at The Ohio State University, Columbus, Ohio, starting on March 1, 2006. Ten herbaceous perennials were selected for phytotoxicity; Coral Bells (*Heuchera* 'Palace Purple'), Yarrow (*Achillea* 'Anthea'), Spiderwort (*Tradescantia* 'Mrs. Loewer'), Sedge (*Carex* 'Silver Scepter'), Beard-Tongue (*Penstemon* 'Husker Red'), Shasta Daisy (*Leucanthemum* 'Alaska'), Purple Coneflower (*Echinacea* 'Bravado'), Jacob's Ladder (*Polemonium caeruleum*), Dwarf Columbine (*Aquilegia* 'Cameo Pink & White'), and Siberian Iris (*Iris* 'Butter and Sugar'). All species were vegetatively propagated in August of 2005 and put into #1 containers with a media consisting of 60% pine bark, 20% Rice hulls, 10% sand 5% technigrow (composted sewage sludge, Kurtz Brothers, Inc., Groveport, OH), and 5% stone aggregate. All species except Shasta Daisy had started to grow, much to the dismay of the investigators. Treatments consisted of Zeritol (hydrogen peroxide plus additives) at 1.25 oz/gal solution, SureGuard (flumioxazin) at 0.25 lb ai/ac, Mogeton (quinoclamine) at 2 oz/gal solution, Diuron (diuron) at 1 lb ai/ac, and untreated control. Carrier volume was 25 gal/ac of water for all treatments using a CO<sub>2</sub> backpack sprayer equipped with Teejet™ 8002 evs nozzles spaced 19 in apart. Spray pressure was approximately 44 psi. Treatments were reapplied 4 weeks later on March 29, 2006. The label for Mogeton suggests using 100 gal/ac as a carrier volume, so this was used for the second application of Mogeton using Teejet™ VS 7.5 nozzles with 19 in spacing and a spray pressure of 47 psi. Phytotoxicity was evaluated by taking visual ratings based on a 1-10 scale (1 representing no phytotoxicity, ≤3 commercially acceptable, and 10 death) at 1 and 2 weeks after each treatment. Plant heights and widths were taken at 1 DAT (day after treatment) and 8 WAT (weeks after treatment) for all species except the Spiderwort and Iris, only heights were taken for these two species because of their growth habit. For the efficacy trial, the same treatments described above were applied at the same time as the phytotoxicity trial to established liverwort in XL™ 250 containers with a Scott's 360 media. Efficacy was evaluated by taking visual ratings at 1 and 2 weeks after each treatment. Both trials were set up in a randomized complete block design with 4 single pot replications per treatment. Repeated measures analysis of variance (i.e. analysis of covariance) using Dunnett's t-test was conducted for phytotoxicity data to compare treatments to the control using Proc Mixed in SAS.

Repeated measures analysis of variance was also used for efficacy data in Proc Mixed; however, treatments were compared using least squares means to find the best treatments.

### **Results and Discussion:**

*Phytotoxicity.* Jacob's Ladder, Shasta Daisy, Beard-Tongue, Sedge, Yarrow, Purple Coneflower, and Spiderwort all showed phytotoxicity from the SureGuard treatment, with all those species except the Sedge (with a phytotoxicity of only 2.38), being severely injured beyond commercially acceptable levels (Table 1) Sedge and Purple Coneflower did not show injury until after the second application. Jacob's Ladder, Shasta Daisy, Yarrow, and Purple Coneflower showed phytotoxicity from the Diuron after the second application; the Coneflower and Yarrow were the only species severely injured from the Diuron. None of the species were injured beyond commercially acceptable by the Zeritol or Mogeton. Columbine, in general, across all treatments did not grow well, which explains the high phytotoxicity levels. The untreated Coral Bells had a high level of phytotoxicity because some of them either did not grow or died shortly after emergence. There were just enough Coral Bells at the start of the experiment; some of them were not growing well, and these were chosen for the untreated specimens.

*Efficacy.* The efficacy experiment showed some interesting results. Mogeton severely burns Liverwort, and thus, efficacy was quite high for the duration of the experiment (Table 2). SureGuard and Diuron have the same mode of action, but the Liverwort behaved differently from the two treatments. SureGuard, at first, caused the Liverwort to produce many more gamma cups than the other treatments, which gave rise to gametes. The Liverwort in the Diuron treatment did not produce any more gamma cups than the control. By the second application, both SureGuard and Diuron were causing the Liverwort to turn brown. By the end of the experiment, all the liverworts were dead from the Diuron and almost dead with the SureGuard. It is the opinion of the author that the second application was probably not needed for the SureGuard and Diuron to control the Liverwort. Mogeton, on the other hand, has little, if any residual, and the second application was needed to control the liverwort for the duration of the experiment. Zeritol had little effect on the Liverwort; some browning, which did not cause death, was all that was noticed.

### **Future studies:**

There are future studies that will be conducted at The Ohio State University with Liverwort. The study(s) will involve some more postemergence trials, and some preemergence trials that will look at application at earlier times in the year, when the crops will be dormant. It should also be noted, that even though the trial was ended at 4 weeks after the second application, control of liverwort was achieved for approximately 6 months with the SureGuard and Diuron. Looking at reduced rates of these chemicals is warranted in herbaceous material, which often show phytotoxicity to these chemicals at the recommended rates. SureGuard and Diuron were applied as sprayables; granular forms exist which could alleviate some of the phytotoxicity, so they also should be studied.

### **Literature Cited:**

Newby, A., J. Altland, C. Gilliam, D. Fare, and G. Wehtje. 2005. Preemergence control of *Marchantia polymorpha*. Proc. S. Nurseryman's Res. Conf. 50:444-445.

**Table 1. Phytotoxicity of Selected Herbaceous Perennials to Zerotol, SureGuard, Mogeton, and Diuron During Overwintering**

| Principle Investigators: Hannah Mathers and Luke Case |                     |        |        |        |                             |        |        |        |        |
|---|---------------------|--------|--------|--------|-----------------------------|--------|--------|--------|--------|
| Yarrow 'Anthea'                                       |                     |        |        |        | Spiderwort 'Mrs. Loewer'    |        |        |        |        |
| Treatment   | 1 WA1T <sup>z</sup> | 2 WA1T | 1 WA2T | 2 WA2T | Treatment                   | 1 WA1T | 2 WA1T | 1 WA2T | 2 WA2T |
| Zerotol   | 1.00                | 1.00   | 1.00   | 2.25   | Zerotol                     | 1.00   | 1.00   | 1.67   | 1.25   |
| SureGuard   | 3.00 <sup>y</sup>   | 3.25 * | 7.00 * | 7.25 * | SureGuard                   | 4.00 * | 5.50 * | 7.00 * | 3.50 * |
| Mogeton   | 1.00                | 1.00   | 1.00   | 1.25   | Mogeton                     | 1.00   | 1.00   | 2.00   | 1.50   |
| Diuron  | 1.25                | 1.75   | 5.25 * | 4.25 * | Diuron                      | 1.00   | 1.00   | 2.75   | 1.75   |
| Control   | 1.00                | 1.00   | 1.50   | 1.00   | Control                     | 1.00   | 1.00   | 1.25   | 1.25   |
| Sedge 'Silver Scepter'                                |                     |        |        |        | Beard-Tongue 'Husker Red'   |        |        |        |        |
| Treatment   | 1 WA1T              | 2 WA1T | 1 WA2T | 2 WA2T | Treatment                   | 1 WA1T | 2 WA1T | 1 WA2T | 2 WA2T |
| Zerotol   | 1.00                | 1.00   | 1.00   | 1.00   | Zerotol                     | 1.00   | 1.25   | 1.00   | 1.25   |
| SureGuard   | 1.00                | 1.75   | 3.75 * | 3.00 * | SureGuard                   | 3.25 * | 4.00 * | 6.75 * | 5.00 * |
| Mogeton   | 1.00                | 1.00   | 1.25   | 1.00   | Mogeton                     | 1.00   | 1.00   | 1.00   | 1.00   |
| Diuron  | 1.00                | 1.75   | 2.25   | 1.50   | Diuron                      | 1.25   | 1.00   | 1.75   | 1.75   |
| Control   | 1.00                | 1.00   | 1.00   | 1.00   | Control                     | 1.00   | 1.25   | 1.00   | 1.00   |
| Shasta Daisy 'Alaska'                                 |                     |        |        |        | Purple Coneflower 'Bravado' |        |        |        |        |
| Treatment   | 1 WA1T              | 2 WA1T | 1 WA2T | 2 WA2T | Treatment                   | 1 WA1T | 2 WA1T | 1 WA2T | 2 WA2T |
| Zerotol   | 1.00                | 1.25   | 1.00   | 1.00   | Zerotol                     | 1.00   | 1.00   | 3.50   | 4.00   |
| SureGuard   | 2.50                | 4.25 * | 8.00 * | 5.25 * | SureGuard                   | 1.00   | 3.75   | 9.00 * | 8.00   |
| Mogeton   | 2.25                | 1.50   | 1.50   | 1.00   | Mogeton                     | 5.50   | 1.00   | 2.33   | 7.75   |
| Diuron  | 2.50                | 1.00   | 3.50 * | 2.75 * | Diuron                      | 3.25   | 4.00   | 8.50 * | 9.75   |
| Control   | 1.00                | 1.00   | 1.00   | 1.00   | Control                     | 3.25   | 1.00   | 1.67   | 6.00   |

z= WA1T: weeks after first treatment, WA2T: weeks after second treatment

y= Treatments denoted with \* are significantly different from control at that evaluation date, based on Dunnett's t-test ( $\alpha = 0.05$ )

**Table 1 cont. Phytotoxicity of Selected Herbaceous Perennials to Zerotol, SureGuard, Mogeton, and Diuron During Overwintering**

| Principle Investigators: Hannah Mathers and Luke Case |                     |        |        |        |                                      |        |        |        |        |
|---|---------------------|--------|--------|--------|--------------------------------------|--------|--------|--------|--------|
| Jacob's Ladder  |                     |        |        |        | Dwarf Columbine 'Cameo Pink & White' |        |        |        |        |
| Treatment   | 1 WA1T <sup>z</sup> | 2 WA1T | 1 WA2T | 2 WA2T | Treatment                            | 1 WA1T | 2 WA1T | 1 WA2T | 2 WA2T |
| Zerotol   | 1.00                | 1.25   | 2.00   | 1.00   | Zerotol                              | 1.50   | 3.50   | 3.75   | 8.00   |
| SureGuard   | 6.00 <sup>y</sup>   | 6.75 * | 7.25 * | 5.75 * | SureGuard                            | 2.75   | 3.50   | 6.75   | 6.25   |
| Mogeton   | 1.75                | 1.00   | 2.75   | 1.50   | Mogeton                              | 1.75   | 1.50   | 2.00   | 4.50   |
| Diuron  | 1.25                | 2.25   | 3.75 * | 2.75   | Diuron                               | 1.75   | 2.25   | 5.50   | 6.75   |
| Control   | 1.25                | 1.50   | 1.00   | 1.50   | Control                              | 1.50   | 1.50   | 4.00   | 7.75   |
| Siberian Iris 'Butter and Sugar'                      |                     |        |        |        | Coral Bells 'Palace Purple'          |        |        |        |        |
| Treatment   | 1 WA1T              | 2 WA1T | 1 WA2T | 2 WA2T | Treatment                            | 1 WA1T | 2 WA1T | 1 WA2T | 2 WA2T |
| Zerotol   | 1.00                | 1.00   | 1.00   | 1.25   | Zerotol                              | 1.00   | 1.00   | 1.25   | 1.50   |
| SureGuard   | 1.00                | 1.00   | 3.00   | 4.25   | SureGuard                            | 1.00   | 1.00   | 3.50   | 4.50   |
| Mogeton   | 1.00                | 1.00   | 1.50   | 3.50   | Mogeton                              | 1.00   | 1.00   | 1.00   | 1.50   |
| Diuron  | 1.00                | 1.00   | 1.75   | 2.00   | Diuron                               | 1.00   | 1.00   | 2.50   | 2.50   |
| Control   | 1.00                | 1.00   | 1.00   | 6.25   | Control                              | 2.50   | 3.33   | 3.67   | 5.50   |

z= WA1T: weeks after first treatment, WA2T: weeks after second treatment

y= Treatments denoted with \* are significantly different from control at that evaluation date, based on Dunnett's t-test ( $\alpha = 0.05$ )

**Table 2. Postemergence Control of Liverwort with Zerotol, SureGuard, Mogeton, and Diuron**

| Treatment | 1 WA1T <sup>z</sup> | 2 WA1T | 1 WA2T | 2 WA2T  |
|-----------|---------------------|--------|--------|---------|
| Zerotol   | 0.50 c              | 0.00 c | 0.00 d | 1.75 c  |
| SureGuard | 4.00 b              | 3.00 b | 6.25 c | 9.25 ab |
| Mogeton   | 5.75 a              | 5.00 a | 9.00 a | 8.25 b  |
| Diuron    | 0.50 c              | 0.00 c | 7.50 b | 10.00 a |
| Control   | 0.00 c              | 0.00 c | 0.00 d | 0.00 d  |

z= WA1T: weeks after first treatment, WA2T: weeks after second treatment

y= Treatments with similar letters in the same column are not significantly different, based on LSmeans ( $\alpha = 0.05$ )