# Weed Control

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**Section Editor and Moderator**

## Control of Pennsylvania Bittercress and Hairy Crabweed from Repeated Sowings Using Preemergence Herbicides

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**Index words:** *Cardamine*, *Fatoua*, mulberry weed, Biathlon™, BroadStar™, FreeHand™, Rout®, Snapshot®, germination

**Significance to Industry:** Herbicides vary in their efficacy controlling different weeds and in their durations of control. These results demonstrate the relative efficacy of the tested herbicides in controlling Pennsylvania bittercress and hairy crabweed. BroadStar™ was particularly effective in controlling both weeds and FreeHand™ was extremely effective controlling hairy crabweed. Control using Biathlon™ was comparable to that using Rout®, a similar herbicide combination. The apparent reductions in efficacy for some of the herbicides over the 28 day weed seed resowing period underscore the necessity of removing any escaped weeds before they produce seed capable of successfully germinating as the herbicide barriers dissipate.

**Nature of Work:** Bittercress (*Cardamine* spp.) have long been (4) and continue to be some of the most common weeds (1, 2) in nursery production. Hairy crabweed (*Fatoua villosa*) is a more recently introduced but also prolific weed that is found increasingly infesting nurseries and landscapes (3). Despite the existence of preemergence herbicides that reportedly provide significant control of these weeds, they are still listed by growers and landscapers as hard to control. This may be due in part to the fact that the duration of effective control of germinating weed seeds obtainable using preemergence herbicides varies with a number of factors but can be rather short (5). Biathlon™ (OHP, Mainland, PA) is a new combination (oxyfluorfen + prodiamine) herbicide similar to Granular Herbicide 75 (Harrell's, Lakeland, FL), OH2® (Scotts, Marysville, OH) and Rout® (Scotts) [oxyfluorfen + other dinitroaniline herbicides]. There is a need to have comparative efficacy and longevity of control information for preemergence herbicides that can aid in the selection of the products for specific situations.

This experiment was conducted on a full-sun nursery pad irrigated with an overhead sprinkler system at the University of Florida's Mid-Florida Research and Education Center in Apopka, FL. Two hundred eighty-eight 6"-round nursery containers (standard T/W, Dillen, Middlefield, OH) filled with a container mix composed of 60% bark, 24% Canadian *Sphagnum* peat, 8% perlite and 8% vermiculite (by volume) amended with a water-soluble nutrient starter charge, wetting agent and dolomite (#52, Conrad Fafard, Agawam, MA) were placed, 12 per 3' × 3' plot, onto a black polypropylene ground cloth covered pad. The 12 containers/plot were divided into three groups of four containers with two containers in each group to be seeded with one or the other of the two weeds— Pennsylvania bittercress (*Cardamine pensylvanica*) or hairy crabweed/mulberry weed (*Fatoua villosa*)—on three different dates. The first weed seed sowing to one set of containers occurred on 9 February 2009. Twenty seeds of a species were sown per pot. Two and four weeks later from the initial sowing date, the same procedure was used to inoculate the second and third sets of containers in each plot.

Preweighed herbicide treatments were applied on 9 February using hand-held shaker jars, one for each plot, and irrigated with ½" of overhead irrigation water. Treatments included Biathlon™ 2.75G at 2.75 pounds active ingredient per acre (lb a.i./A), BroadStar™ 1453 (flumioxazin) 0.25G (Valent U.S.A., Walnut Creek, CA) at 0.375 lb a.i./A, FreeHand™ (dimethenamid + pendimethalin)1.75G (BASF, Research Triangle, NC) at 2.63 lb a.i./A, Rout® (oxyfluorfen + oryzalin) 3G at 3 lb a.i./A, Snapshot® (trifluralin + isoxaben) 2.5G (Dow AgroSciences, Indianapolis, IN) at 5 lb a.i./A and an untreated control. On 10 February, each container was fertilized with 0.25 oz of Osmocote® Plus 15-9-12, 3–4 month release duration at 70°F. Treatments were replicated four times and the experimental design was a randomized complete block with treatments randomized in each replication using statistical software (PROC PLAN, SAS Institute, Cary, NC).

Emerging weed seedlings were counted approximately two and four weeks after each sowing. The mean of the two containers of each weed per subplot was divided by the number of weed seeds sown (20) and multiplied by 100 to determine the successful germination percentages. Weed control was determined by making visual estimates of weed coverage in each container about every two weeks. The values for the two containers of each weed at each sowing date and treatment were averaged. Weed control (%) was determined by comparing the coverage in the herbicide-treated containers with coverage in the controls. At the end of the experiment (84 DAT), the aboveground weed biomass was harvested from each container and dried for one week at 165°F. Again, the values for the two containers of each weed at each sowing date and treatment were averaged. Data were analyzed by analysis of variance and means separations were by Duncan's new multiple range test at $P \leq 0.05$ (SAS, SAS Institute). Percent values were square root or arcsin square root transformed, as needed, prior to analysis. Control of 80% or higher was considered good, from 60 to <80% fair, and <60% poor.

**Results and Discussion:** Weed seed germination

*From first sowing (same day as herbicide treatments were applied, 0 DAT).* At 28 days after sowing, successful Pennsylvania bittercress seedling growth was reduced by all herbicide treatments [76–99%] (Fig. 1). At this point in time, control of hairy crabweed was good with all treatments except in the FreeHand™ and Snapshot® plots where it was only fair (Fig. 2). *From second sowing (14 DAT).* By 28 days after the second sowing, Pennsylvania bittercress control was poor except for BroadStar™ and Rout®. Good control [94%] of hairy crabweed was only obtained using BroadStar™ and fair control occurred in the FreeHand™ and Rout® plots. *From third sowing (28 DAT).* By 28 days after the third sowing, control of Pennsylvania bittercress was still good using BroadStar™ and fair [61–68%] using Biathlon™ and Rout®. Control of hairy crabweed was good with BroadStar™, fair with FreeHand™ and poor with the other treatments.

Weed control (based on visual estimates)
*From first weed seed sowing (same day as herbicide treatments were applied, 0 DAT).* Control of both weeds was good with all herbicide treatments at 28 DAT (Figs. 3 & 4) and 56 DAT [data not shown (DNS)]. By 84 DAT, control of both weeds was still good with BroadStar™, FreeHand™ and Rout® and fair [77%] with Biathlon™. At that time, control of Pennsylvania bittercress was fair and control of hairy crabweed was poor using Snapshot®. *From second weed seed sowing (14 DAT).* At 28 and 42 (DNS) days after sowing (DAS), control of both weeds was good for all herbicides except for hairy crabweed where control with Snapshot® was fair. At 70 DAS, control of Pennsylvania bittercress was still good with Biathlon™ and BroadStar™ but only fair with FreeHand™ and Rout® (DNS). Also at 70 DAS, control of hairy crabweed was still good with BroadStar™ and FreeHand™ and fair with Rout® (DNS). Snapshot no longer provided significant control of either weed at 70 DAS. *From third weed seed sowing (28 DAT).* Control of Pennsylvania bittercress from this sowing was good to 28 DAS for Biathlon™ and to 56 DAS (DNS) for BroadStar™ and FreeHand™. Rout® and Snapshot® were less effective. Control of hairy crabweed was good for Biathlon™, BroadStar™ and FreeHand™ for 56 DAS (DNS) and fair for Rout®. Again, Snapshot® was less effective. *Changes in efficacy with sowing date*. In general, control of both weeds was similar regardless of weed seed sowing date for Biathlon™, BroadStar™ and FreeHand™. For Rout® and Snapshot® there was a trend for control to decline over the 28 day resowing duration (Figures 3 & 4).

Weed control (based on weed top dry weights)
*Pennsylvania bittercress*. When the weed seeds were sown the day the herbicides were applied, all herbicides provided significant control (Figure 5). When weed seeds were sown 14 or 28 days after treatment (DAT), all herbicides except Snapshot® still provided significant control. *Hairy crabweed*. All herbicide treatments reduced dry weed top weights compared to the untreated control regardless of sowing time; however, Snapshot® was less effective than the other herbicides. It is interesting to note that control of hairy crabweed in the FreeHand™ plots gradually increased over time and by the end of the experiment (84 DAT) was nearly 100% from all three sowings.

**Acknowledgements:** We thank BASF, Dow AgroSciences, OHP, Scotts, Valent and the Florida Agricultural Experiment Station for supporting this research. Donations of growing medium by Conrad Fafard and fertilizer by Scotts are greatly appreciated.

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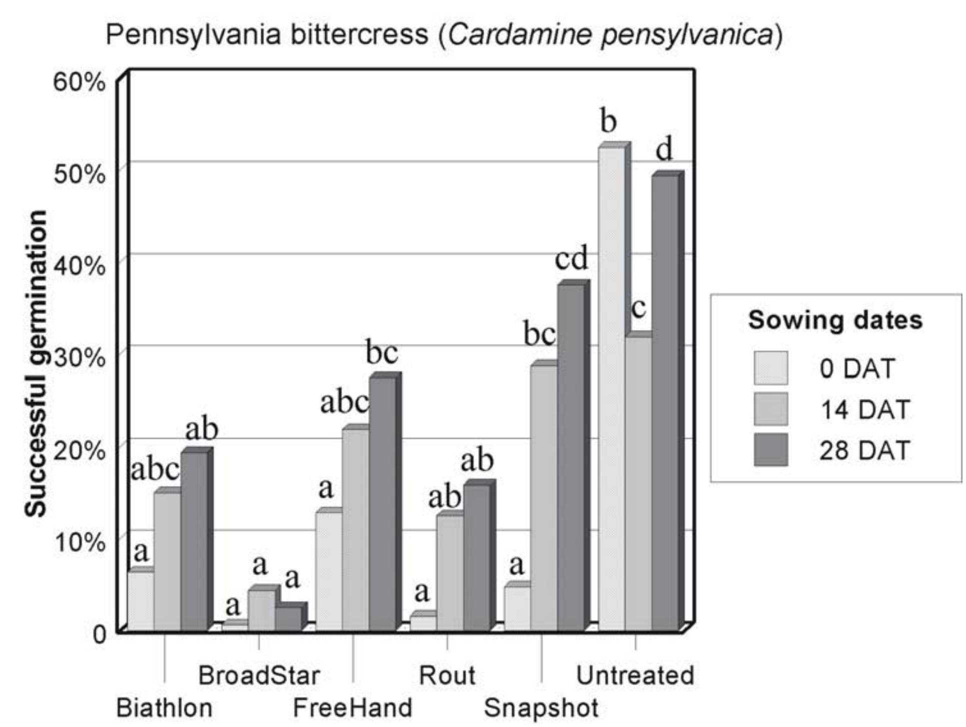


**Figure 1.** Pennsylvania bittercress germination percentages at 28 days after each of the three sowings — 28, 42 and 56 days after herbicide treatments were applied (DAT). Percentage germination tended to increase for some herbicides as the time after the herbicides were applied increased. Means separations, by seed sowing dates, using Duncan's new multiple range test at $P \leq 0.05$.

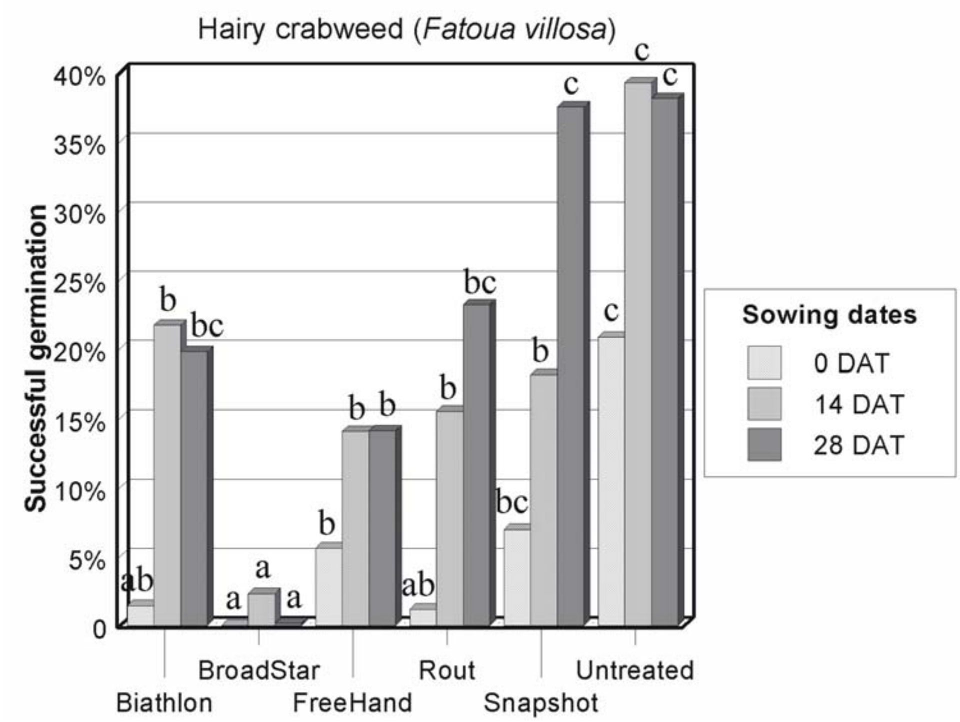


**Figure 2.** Hairy crabweed germination percentages at 28 days after each of the three sowings — 28, 42 and 56 days after herbicide treatments were applied (DAT). Percentage germination tended to increase for some herbicides as the time after the herbicides were applied increased. Means separations, by seed sowing dates, using Duncan's new multiple range test at $P \leq 0.05$.

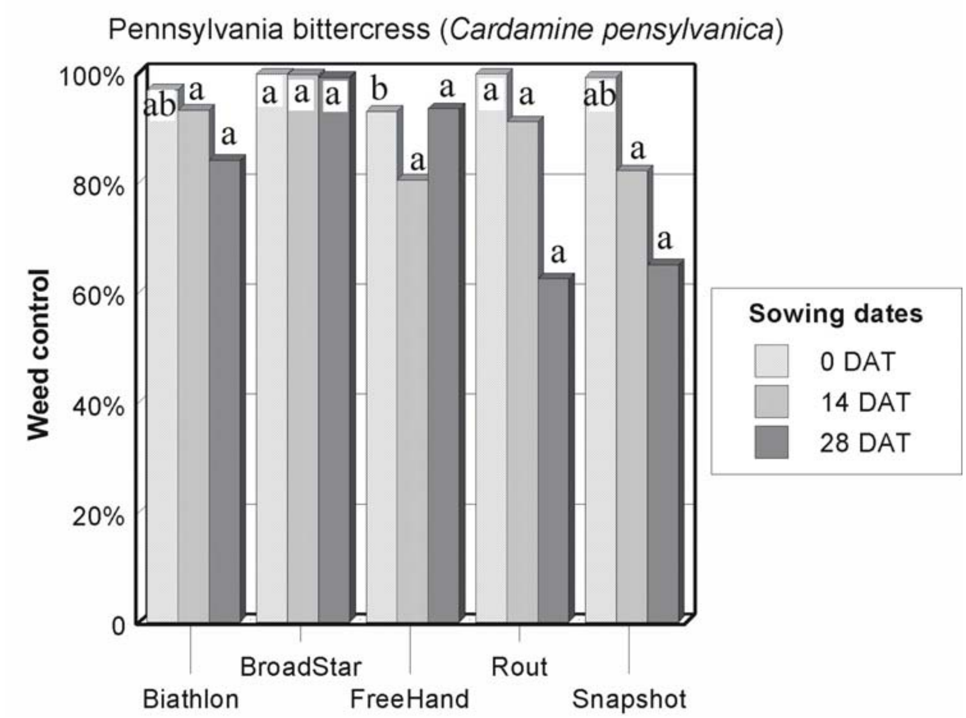


**Figure 3.** Pennsylvania bittercress control, compared to untreated plots, at 28 days after each of the three sowings — 28, 42 and 56 days after herbicide treatments were applied (DAT). Percentage control tended to decrease for some herbicides as the time after the herbicides were applied increased. Means separations, by seed sowing dates, using Duncan's new multiple range test at $P \leq 0.05$.

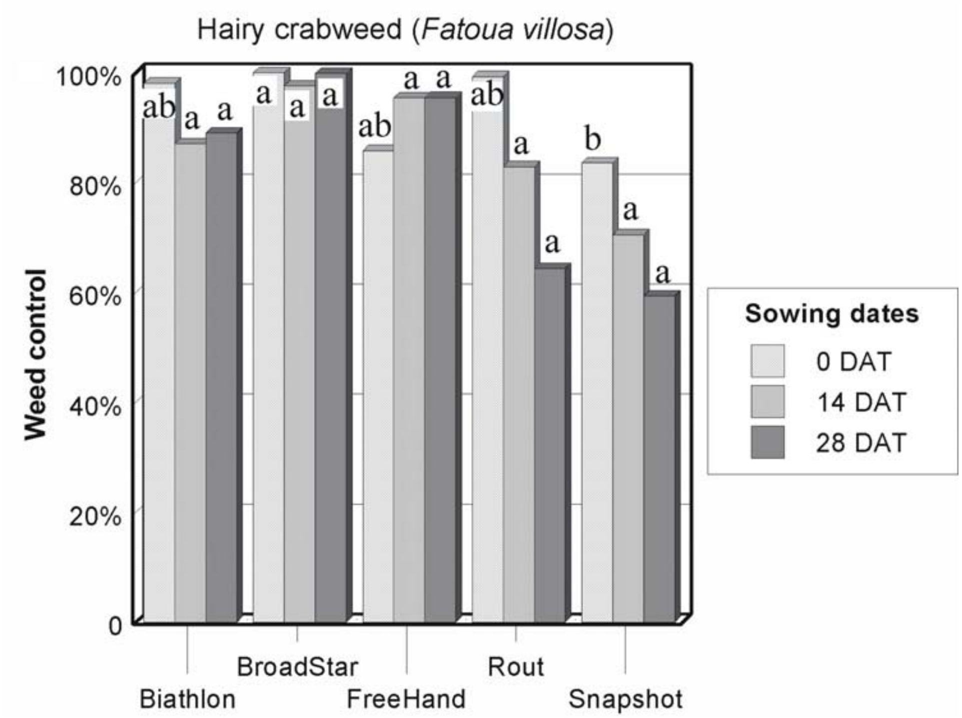


**Figure 4.** Hairy crabweed control, compared to untreated plots, at 28 days after each of the three sowings — 28, 42 and 56 days after herbicide treatments were applied (DAT). Percentage control tended to decrease for some herbicides as the time after the herbicides were applied increased. Means separations, by seed sowing dates, using Duncan's new multiple range test at $P \leq 0.05$.

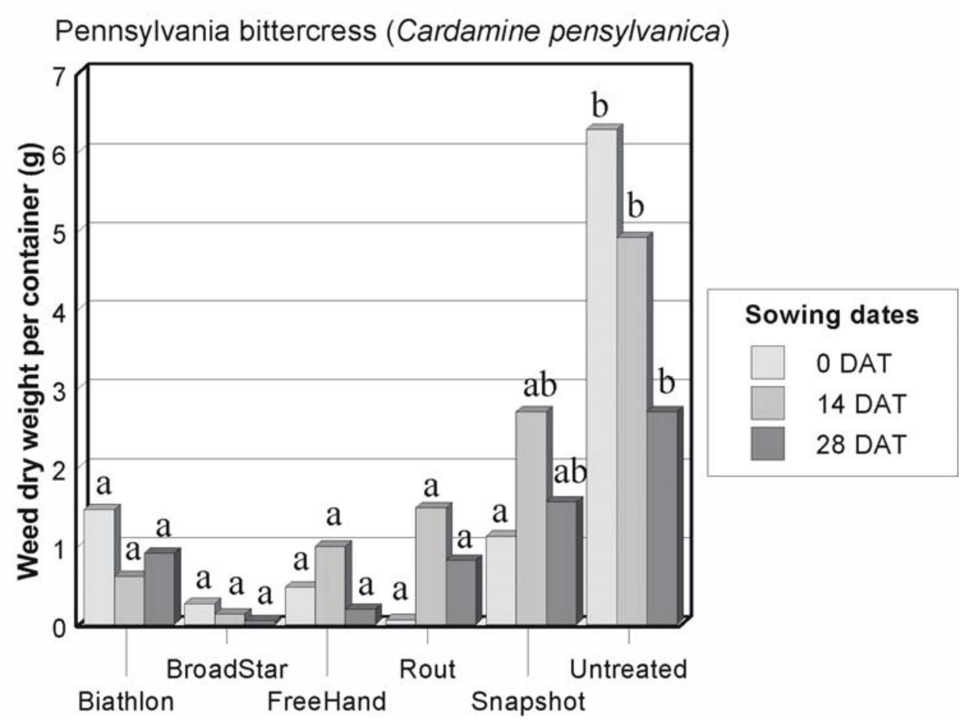


**Figure 5.** Pennsylvania bittercress dry weed weights at 84 days after herbicide treatments were applied (DAT); therefore, 84, 70 and 56 days after weed seeds were sown. Means separations, by seed sowing dates, using Duncan's new multiple range test at $P \leq 0.05$.

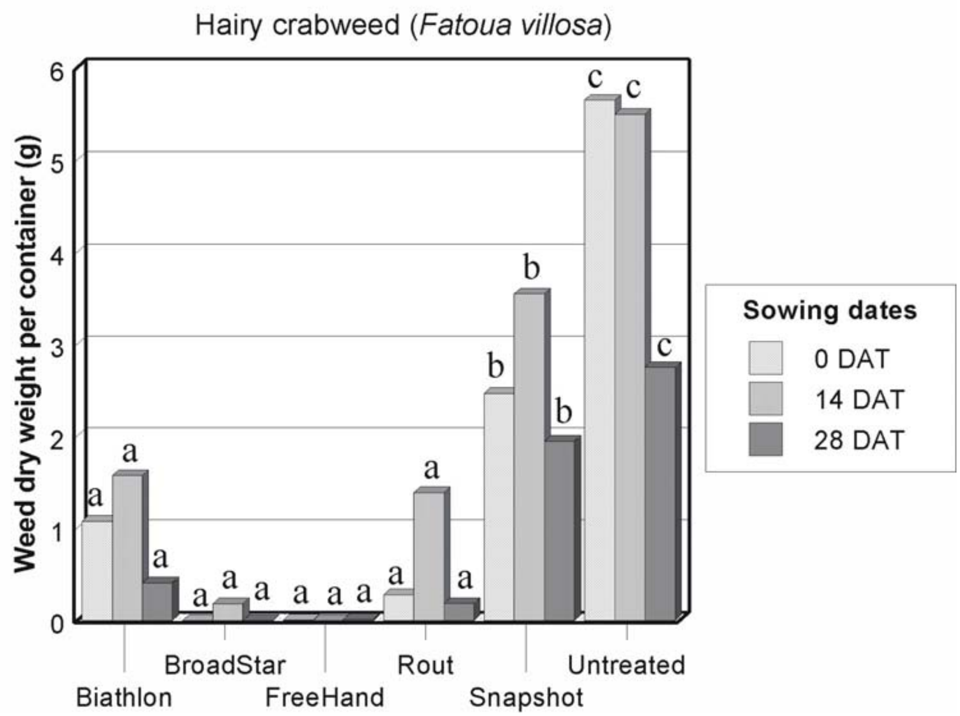


**Figure 6.** Hairy crabweed dry weed weights at 84 days after herbicide treatments were applied (DAT); therefore, 84, 70 and 56 days after weed seeds were sown. Means separations, by seed sowing dates, using Duncan's new multiple range test at $P \leq 0.05$.

## Screening to assess woody and perennial ornamental plant safety to select postemergent herbicide applications

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**Index Words:** bentazon, dimentenamid, pendimethalin, photo bleaching, phytotoxicity, topramezone

**Significance to Industry:** Selecting herbicidal inhibitors of either long-chain fatty acid, mitosis, and photosystem II (PSII) pathways in plants have potential to offer new management tools for both preemergence (PRE) and postemergence (POST) control of many weeds that challenge field and container ornamental plant producers. Work in progress indicated that topramezone (4-hydroxyphenylpyruvate dioxygenase (= HPPD) inhibitor), bentazon (PSII inhibitor), and dimethenamid + pendimethalin (inhibitors of long chain fatty acids and mitosis, respectively), provide effective control of several key weeds and may be safe for use as POST control herbicides over many ornamental plant species. Foliar injury to ‘Purple Prince’ butterfly bush and ‘Scarlet Curls’ willow indicates the need for more extensive screening on additional ornamental species.

**Nature of Work:** In 2009 in eastern Tennessee, replicated shadehouse studies were undertaken to determine the safety and weed control efficacy of dimethenamid, topramezone, pendimethalin, and bentazon herbicides when applied directly to selected ornamental plants. Treatments were made between 9:30 and 11 AM on 11 August using either a handheld shaker with granules or a $CO_2$ backpack sprayer (40 psi) with handheld 4-nozzle wand calibrated to deliver 0.8 liters of formulated herbicide during a 3 mph ambulatory transit. Container-grown plants in shadehouse studies included 1 gal. mugo pine (*Pinus mugo*), flowering dogwood (*Cornus florida*) and sourwood (*Oxydendrum arboreum*), and 3 gal. Kentucky yellowwood (*Cladrastis kentukea*), ‘Aphrodite’ rose-of-Sharon (*Hibiscus syriacus*), ‘Eleanor Tabor’ Indian hawthorn (*Rhaphiolepsis indica*), ‘Texas Scarlet’ flowering quince (*Chaenomeles speciosa*), osmanthus (*Osmanthus x fortunei)*, and star magnolia (*Magnolia stellata*) that were treated with a PRE application of a pre-mix product containing dimethenamid + pendimethalin (Freehand™, BASF) at 2940, 5880, and 8820 g ai/ha. ‘Lynwood Gold’ forsythia (*Forsythia* x *intermedia*), ‘Scarlet Curls’ willow (*Salix matsudana*), ‘Purple Prince’ butterfly bush (*Buddleia davidii*), ‘Patriot’ hosta (*Hosta*), ‘Green Sheen’ pachysandra (*Pachysandra terminalis*), autumn fern (*Dryopteris erythrosora*), ‘May Night’ salvia (*Salvia* x *sylvestris*), kousa dogwood (*Cornus kousa),* ‘Little Princess’ Japanese spiraea (*Spiraea japonica*), ‘Green Giant’ giant arborvitae (*Thuja plicata*), and

'Rosea' weigela (*Weigela florida*) were treated with PRE applications of dimethenamid alone at 1100, 1680, and 3352 g ai/ha, the PRE-mix of dimethenamid + pendimethalin at 1960, 2940, 3920 and 5880 g ai/ha, and POST applications of topramezone at 25 and 97 g ai/ha, bentazon at 493 g ai/ha, and combinations of topramezone plus bentazon at 25 + 493 g ai/ha and 97 + 493 g ai/ha. After drying, plants were arranged in a randomized complete block design. Visual ratings of weed control in hand sewn pots were collected 14, 28, 42, 56 DAT, plant phytotoxity at 59 DAT and weed growth data on 64 DAT. Data were analyzed using Agricultural Resource Management (ARM) software (Vers. 8, Gylling Data Management Inc., Brookings, SD) and means were separated using Fisher's protected LSD.

**Results and Discussion:** Prior research has provided evidence that select HPPD and PS-II inhibiting herbicides can be used for PRE and some POST control of select weedy plants while being safe for use in over-the-top spray applications (1, 2). In field studies (3), dimethenamid has controlled large crabgrass (*Digitaria sanguinalis*) (90 to 98%), giant foxtail (*Setaria faberi*) (90 to 91%), smooth pigweed (*Amaranthus hybridus*) (80 to 95%), prickly sida (*Sida spinosa*) (84 to 93%), and eclipta (*Eclipta prostrata*) (88 to 100%). Addition of pendimethalin to dimethenamid (Freehand™) improved both yellow woodsorrel (*Oxalis stricta*) (99%) and ivyleaf morningglory (*Ipomoea hederacea*) (89 to 99%) control, over dimethenamid alone (33 to 51% and 49 to 67%, respectively). Saflufenacil alone and in combinations with dimethenamid and pendimethalin, controlled common ragweed (*Ambrosia artemisiifolia)* (96 to 99%), yellow woodsorrel (80 to 95%), and ivyleaf morningglory (85 to 99%). Saflufenacil needed to be applied in combinations with dimethenamid or pendimethalin to adequately control dandelion (*Taraxacum officinale*) and annual grasses. Anecdotal observations suggested saflufenacil may not be safe for use over red maple (*Acer rubrum*) (99% control of *Acer* seedling volunteers within plots). In field studies, topramazone controlled common ragweed (88%) and yellow woodsorrel (90%).

In shadehouse trials presented by this study, topramezone controlled eclipta (87 to 94%), and prickly sida (93 to 95%) (Figure 1). Rates of Freehand™ (dimethenamid + pendimethalin) controlled prickly sida, eclipta, spurge, and smooth pigweed in shadehouse trials (93 to 100%) (Figure 2). Bentazon alone also controlled prickly sida (91 to 95%), eclipta (85 to 98%), and smooth pigweed (85 to 86%) in shadehouse trials (*pigweed and spurge data not shown*). All rates of dimethenamid, pendimethalin, and dimethenamid + pendimethalin provided no significant negative effects in either appearance or growth of any ornamentals at tested rates and seasonal timings. Topramezone and bentazon alone and in combinations also resulted in no phytotoxic or growth effects when applied to forsythia, hosta, pachysandra, autumn fern, flowering dogwood, Green Giant arborvitae, weigela, and Japanese spiraea in containers, but did cause aesthetic injury, as leaf burn, contortion, and necrosis, to butterfly bush and willow (Figure 3).

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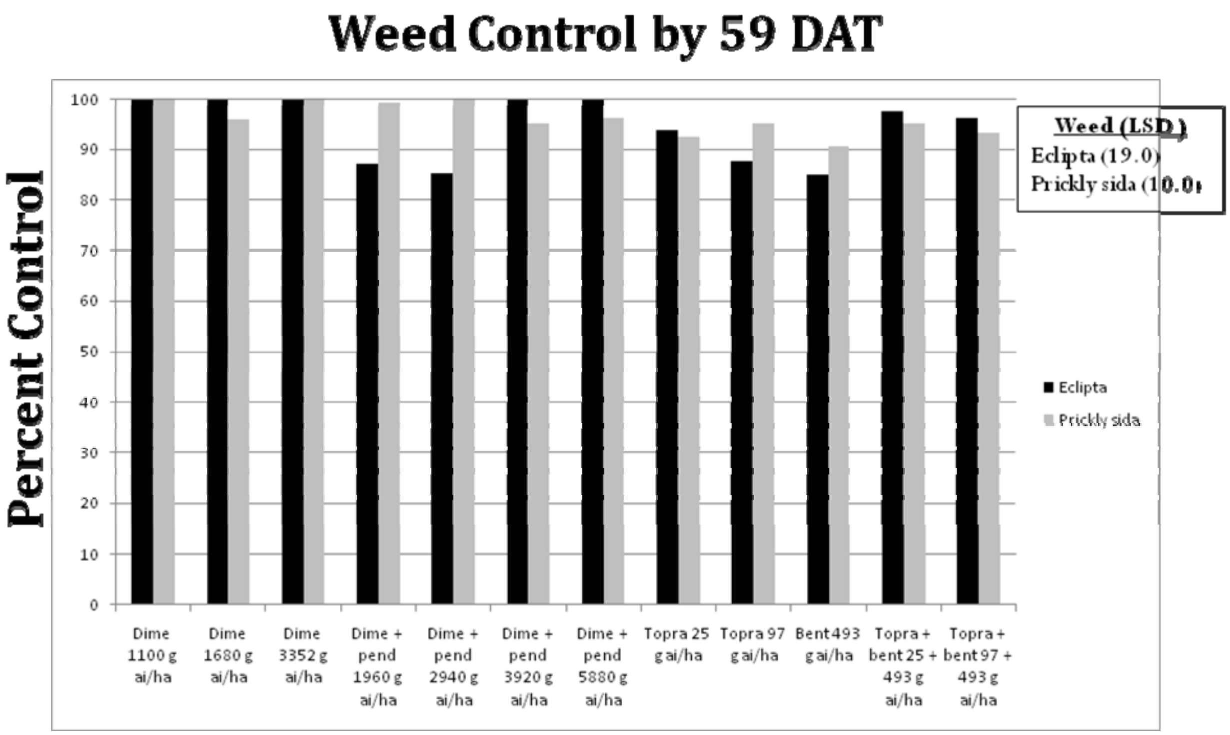


Figure 1. Control of eclipta and prickly sida on 59 DAT following PRE and POST herbicide applications to container grown ornamental plants.

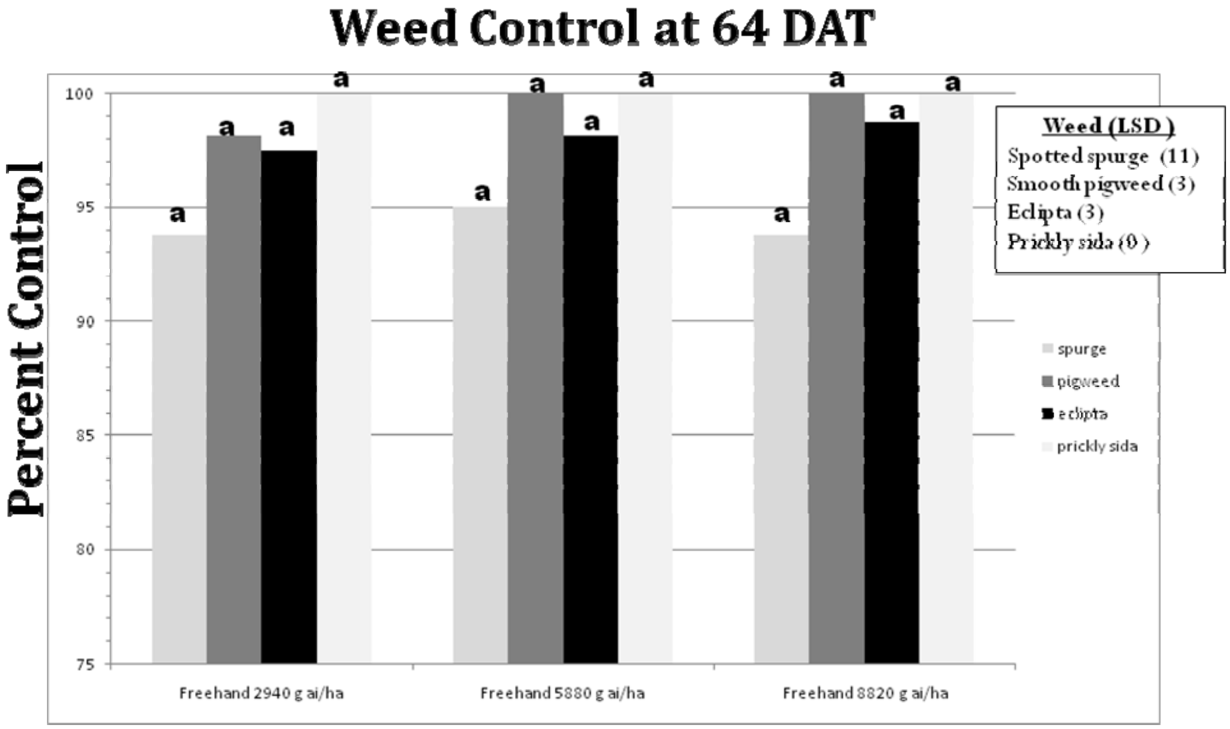


Figure 2. Control of spurge, pigweed, eclipta and prickly sida on 64 DAT following PRE herbicide applications of three rates of dimethenamid + pendimethalin (Freehand™). Mean control within weed species followed by the same letter did not differ in comparison to weeds in untreated control pots by Fisher's protected LSD ($P > 0.05$).

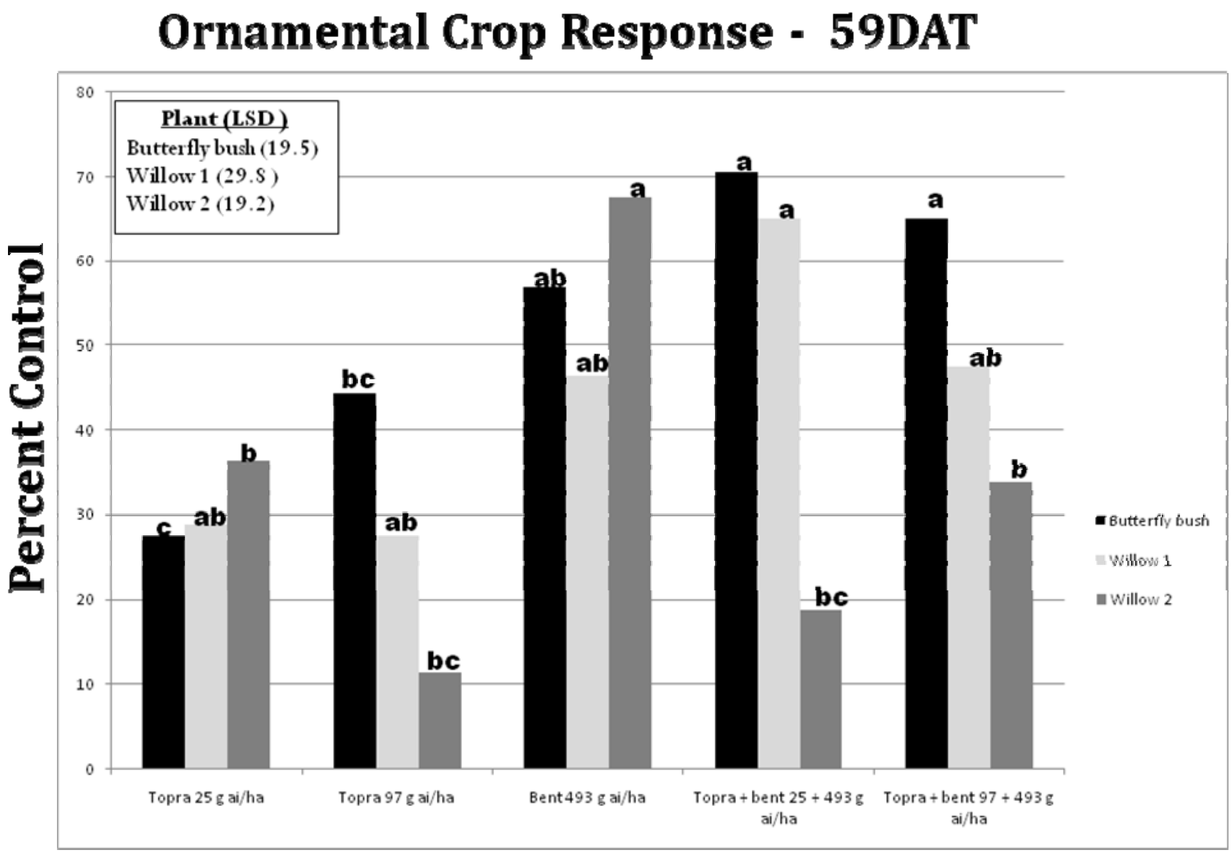


Figure 3. Butterfly bush and willow phytotoxicity evident 59 DAT following either PRE or POST herbicide applications of rates of either topramezone or bentazon alone and in combination. Means of responses within species followed by the same letter did not differ by Fisher's protected LSD (*P* > 0.05).

## Evaluation of Tower (Dimethenamid-P) for Potential Greenhouse Use

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**Index Words**: Tower™, dimethenamid, greenhouse, weed control

**Significance to the Industry**: This preliminary research indicates that Tower (dimethenamid) has potential for greenhouse use on floors under benches with three days of venting prior to enclosing greenhouses.

**Nature of Work:** There are no currently registered preemergence herbicides for use in greenhouses due to liability concerns from herbicide manufacturers(1). Tower has shown excellent crop safety (2) and controls a wide range of weeds (3), including those problematic in greenhouses. Tower has low volatility and has potential for greenhouse use.

Plants with known and unknown tolerances and sensitivities to Tower herbicide were selected for evaluation. Tolerant species included petunia, dusty miller, and marigold. Aquilegia was selected as a sensitive species. Sensitivity of begonia was not known when it was selected for the test. Plants were treated within one to three weeks of transplanting to represent typical greenhouse production. Plug trays (288-count) of *Begonia x semperflorens-cultorum* 'Prelude Rose', yellow dwarf French Marigold *Tagetes patula* 'Little Hero,' and *Centaurea cineraria* 'Silver Dust' dusty miller were potted into 3.5-inch pots on May 6, 2009. *Aquilegia caerulea* 'McKana Giants' (72-cell pack) were potted on May 17. *Petunia intregifolia* 'Celebrity Blue' (144-cell pack) were potted on May 27. All plants were potted in a pinebark:sand substrate (6:1; v:v) amended with 14 lbs of Polyon 17-5-11, 5 lbs of dolomitic limestone, and 1.5 lbs of Micromax micronutrient per $yd^3$. Black polyethylene trays measuring 10.5 inches x 20.5 inches with solid sides and open-meshed bottoms were used to hold the pots. Fifteen ground beds 9.5 feet square by 14 inches deep with metal support walls and a gravel floor were used in the study. A mini-greenhouse, measuring 8 ft. by 8 ft. by 46 in. tall with a frame of ½ in. PVC pipe and covered with Klerk's K-1 white 70% co-poly, was constructed for each ground bed.

The design of the experiment allowed 3 or 7 days of open air, or venting, in the treated beds before covering with mini-greenhouses for 3 days to determine if there was any volatility from the Tower application. Some treatments were placed on the gravel immediately after treatment, before covering, to look for volatility effects from treated gravel in open air. Treatments labeled "PV" had plants set on treated gravel immediately after treatment, while "NP" involved setting plants on treated gravel after venting for 3 or 7 days, just before the mini-greenhouses were installed. Three non-treated controls labeled “C” were maintained: plants placed on non-treated gravel and vented for 3 days (3C) or 7 days (7C) and plants placed outside the ground beds on adjacent gravel that was non-treated with no cover (OC). Four treatments were applied at 64 oz/acre: 3-day venting before plants were placed on treated gravel (3NP); 3-day venting with plants on treated gravel (3PV); 7-day venting before plants were placed on treated gravel (7NP); and 7-day venting with plants on treated gravel (7PV). A separate treatment was applied at 32 oz over the top (32 OTT) of plants on gravel outside the ground beds. All treatments were immediately shaded with 55% black shade cloth. Each in-ground bed was watered with a 2.5 GPM popup sprinkler and received 0.4 inches of water daily. The Tower application was watered in with the first irrigation. Treatments outside the beds received overhead irrigation at 0.5 inches/day.

Tower herbicide treatments were applied on May 29, 2009. Plants were placed in 3PV and 7PV immediately after the spray application and in 3C, 7C, and OC. On June 1, plants were placed in 3NP. 3C, 3PV, and 3NP treatments were then covered with mini-greenhouses. Temperatures in the houses reached 99 and 100° F on June 1, 100-104° on June 2, and 95-98° on June 3. On the morning of June 4 all covers were removed.

Prior to covering the 7C, 7PV and 7NP treatments, 2.0 inches of rain occurred on June 2 and 2.09 inches on June 4. On June 5, plants were placed in 7 NP and 7C, 7PV, and 7NP were covered for 3 days. Temperatures reached 82-84° F on June 5, 89-91° on June 6, and 96-98° on June 7. Covers were removed on June 8. 55% shade was maintained for two additional days and then removed. At 14 DAT, Aquilegia and marigolds were moved to the shade house due to high temperatures and sun exposure. Begonias were moved to shade at 19 DAT.

Spray treatments were applied at 20 GPA with a $CO_2$-powered backpack sprayer (80-04 flat fan nozzle) at 25 psi. Data collected included injury ratings at 13, 24, and 42 DAT rated on a 1-10 scale (1 = no injury and 10 = dead plant). Fresh weights (FW) were taken at 45 DAT. Plants were evenly separated into three sets of trays, 5-8 per tray depending on the number of individual plants per species. Each tray was treated as an experimental unit with three replications. Individual plants in the trays were rated separately. Data were analyzed using Duncan’s Multiple Range Test and the SAS program. Ambient and closed mini-greenhouse temperatures and rainfall after spray application but before placement of mini-greenhouses were recorded.

**Results and Discussion:** Marigold, petunia, and dusty miller (Table 1) showed no foliar injury throughout the test. Marigold FW for 3C was the highest and 32 OTT the lowest. The remaining treatments were similar. Petunia FW for 3C, 7C, 3PV, 7NP, 7PV, and 32 OTT were similar. OC and 3NP were different from 3C and 7PV but similar to all other treatments. It should be noted that a trend existed with petunia. Plants placed on gravel immediately after Tower application tended to be larger than those placed on gravel 3 and 7 days after treatment. This may have been due to the cooler temperatures in the ground beds. Dusty miller FW for 3C, OC, 3PV, 7NP, 7PV, and 32 OTT were similar. OC, 3PV, 7NP, 7PV and 32 OTT were similar with the highest FW. 3NP had the lowest FW. There was no consistent trend in these slight differences in FW among marigold, petunia, and dusty miller. No injury symptoms appeared at any time on these plants.

Aquilegia initially showed necrotic spots immediately after the 32 OTT application. Subsequent growth was similar to all other treatments until end of the study, when pale color was noted on 32 OTT foliage, which had the lowest FW (Table 2).

Begonia injury (Table 3) was observed at 13 DAT with slightly darker foliage and in some cases slight russeting occurring with all Tower treatments. At 19 DAT all begonia were moved under shade due to excessive heat. At 24 DAT 3C, 7C, OC, 3PV, 7NP, and 7PV had similar injury ratings with slight russeting and stunting. 3NP, 7NP, and 7PV were similar for injury. Injury ratings for 32 OTT, which increased throughout the study and suffered significant mortality, were highest. 3C and OC FW were similar to 7C, which was similar to all other treatments except 32 OTT, which was much lower than the other treatments. (The level of tolerance of begonia spp. to Tower was not fully known at the beginning of the trial. Subsequent landscape investigations have shown this plant to be sensitive to direct Tower applications.)

Our experiments were conducted in mini-greenhouses under a worst-case scenario where air temperatures rose to 100-104° with no ventilation for 3 days following 3 or 7 days of venting.

Our study determined that under these extreme conditions some volatility of Tower likely occurred after 3 days of venting prior to placement of the mini-greenhouse covers causing slight injury to begonia. Most of the crops tested exhibited no injury from Tower in this study, including Aquilegia, a crop with previously demonstrated sensitivity to Tower.

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Table 1. Effects of Tower at 64 oz/acre in selected greenhouse situations on fresh weights of three annuals

| Treatment | | Marigold FW^Z | Petunia | Dusty Miller |
|---|---|---|---|---|
| Non-treated 3-day vent | 3C | 37.9a^X | 11.7a | 18.7abc |
| Non-treated 7-day vent | 7C | 31.4bc | 8.4ab | 17.2bc |
| Non-treated outside | 0C | 27.7bc | 7.4b | 20.7a |
| 3-day vent, no plants | 3NP | 28.9bc | 7.2b | 16.6c |
| 3-day vent, plants | 3PV | 32.5b | 10.9ab | 20.4a |
| 7-day vent, no plants | 7NP | 27.1bc | 9.6ab | 19.9ab |
| 7-day vent, plants | 7PV | 29.3bc | 12.0a | 19.1abc |
| 32oz OTT^Y outside | 32 OTT | 26.7c | 9.2ab | 20.9a |

^Z Fresh weights = grams fresh weight
^Y OTT = over the top
^X Duncan's Multiple Range test α = 0.05

Table 2. Effects of Tower at 64 oz/acre in selected greenhouse situations on injury ratings and fresh weights of Aquilegia

| Treatment | | 13 DAT^Z | 24 DAT | 45 DAT | FW^Y |
|---|---|---|---|---|---|
| Non-treated 3-day vent | 3C | 1.0a^XW | 1.0a | 1.0a | 11.2bc |
| Non-treated 7-day vent | 7C | 1.0a | 1.0a | 1.0a | 11.3bc |
| Non-treated outside | 0C | 1.0a | 1.0a | 1.0a | 11.8b |
| 3-day vent, no plants | 3NP | 1.0a | 1.0a | 1.0a | 10.6bc |
| 3-day vent, plants | 3PV | 1.0a | 1.0a | 1.0a | 12.6b |
| 7-day vent, no plants | 7NP | 1.0a | 1.0a | 1.0a | 15a |
| 7-day vent, plants | 7PV | 1.0a | 1.0a | 1.0a | 12.1b |
| 32oz OTT^V outside | 32 OTT | 3.0b | 1.0a | 3.7b | 9.4c |

^Z DAT = days after treatment
^Y FW = grams fresh weight
^X Injury ratings 1 = no injury, 10 = dead plant
^W Duncan's Multiple Range test α = 0.05
^V OTT = over the top

Table 3. Effects of Tower at 64 oz/acre in selected greenhouse situations on injury ratings and fresh weights for begonia

| Treatment | 13 DAT[Z] | 24 DAT | 45 DAT | FW[Y] |
|---|---|---|---|---|
| Non-treated 3-day vent 3C | 1.2c[XW] | 2.3c | 1.0d | 93.8a |
| Non-treated 7-day vent 7C | 1.3c | 2.7c | 1.8cd | 52.6bc |
| Non-treated outside 0C | 1.0c | 2.1c | 1.1d | 97.1a |
| 3-day vent, no plants 3NP | 2.1ab | 4.9b | 4.0b | 35.7c |
| 3-day vent, plants 3PV | 2.0b | 3.0c | 1.6d | 55bc |
| 7-day vent, no plants 7NP | 2.1ab | 3.5bc | 3.6bc | 51.7bc |
| 7-day vent, plants 7PV | 2.2ab | 3.5bc | 2.8bcd | 60.1b |
| 32oz OTT[V] outside 32 OTT | 2.4a | 6.7a | 7.0a | 12.2d |

[Z] DAT = days after treatment

[Y] FW = grams fresh weight

[X] Injury ratings 1 = no injury, 10 = dead plant

[W] Duncan's Multiple Range test $\alpha = 0.05$

[V] OTT = over the top

# Early Post-emergent Control of *Phyllanthus tenellus* (Longstalked Phyllanthus)

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**Index Words:** Lontrel®, SureGuard®, SedgeHammer®, Roundup®, phyllanthus.

**Significance to Industry:** This study shows that SureGuard® (flumioxazin) is a valuable herbicide in post-emergence control of longstalked phyllanthus. SureGuard® provided excellent post-emergence control of phyllanthus at the ½x rate. Post-emergence control was similar to Roundup® applied at 1 lb aia but phyllanthus sustained rapid burn down within 1-3 days of treatment. Lontrel® and SedgeHammer® had little post-emergence activity on phyllanthus.

**Nature of Work:** Weed management is an essential part of any nursery or landscape's operation. In 2004, a study estimated that weed management (hand-weeding and herbicide programs) cost $967-$2,228 per acre (1). These costs rose from an earlier report in 1990 that estimated costs of hand weeding in conjunction with an herbicide program to be $812-$1,133 per acre (3). In today's struggling economy, post-emergence weed control is becoming increasingly important. (2). Longstalked phyllanthus is not well controlled by pre-emergence herbicides labeled for nursery/landscape use; therefore, it is especially pertinent to find a suitable post-emergence herbicide for control (4).

Longstalked phyllanthus is a summer annual with an erect stem that can reach 2 to 3 feet in height (4). Seed were overseeded in 3.5-inch pots on August 18, 2009. The substrate used was a 6:1 pinebark:sand mix amended with 14 lbs/yd$^3$ Harrells 17-6-12, 5 lbs/yd$^3$ lime and 1.5 lbs/yd$^3$ Micromax. Pots were then placed in a greenhouse and overhead irrigated until the phyllanthus reached 5-6 inches (approximately 2½ weeks). On September 4, 2009, phyllanthus were sprayed with the following treatments: Lontrel® (clopyralid) at 4, 8 (label rate) and 16 oz/A rates; SureGuard® (flumioxazin) at 0.19, 0.38 (label rate) and 0.76 lbs aia; SedgeHammer® (halosulfuron-methyl) at 0.03, 0.062 (label rate) and 0.126 lb aia; Roundup® (glyphosate) at 1 lb aia and the non-treated control. This gave a total of 11 treatments with 7 replicates each. All treatments were applied at 20 gallons per acre with a $CO_2$ backpack sprayer (80-04 nozzle) at 25 psi. After spraying, the foliage was allowed to air-dry and then the pots were returned to the greenhouse, arranged in a complete randomized design and placed under overhead irrigation. Plants were rated on a scale of 1 to 10 (1 = no injury, 10 = dead) on days 3, 7, 14 and 21 days after treatment (DAT). Fresh weights were also taken on all pots 21 DAT and the pots were left under irrigation to check for regrowth. Regrowth data were taken on November 9, 2009, 66 DAT. Data was analyzed using Duncan's Multiple Range test at $P$ = 0.05 for means separation.

**Results and Discussion:** At 3 DAT all SureGuard® treatments caused major injury to phyllanthus (8.0-8.6) (Table 1). Phyllanthus treated with Roundup® had a relatively low rating of 4.3 followed by the two higher-rate Lontrel® treatments (3.7 and 3.1). The control and the 4 oz/A Lontrel® treatment had little-to-no injury (2.0). SedgeHammer® treatments were somewhat puzzling due to their injury ratings: for the 0.03 lbs aia, the rating averaged 6.0; at 0.062 lbs aia, the injury decreased to 3.4 followed by another decrease for the 0.126 lbs aia (1.6). With the exception of the Roundup® treatment, the trends continued to be similar to 3 DAT throughout the study: SureGuard® had the highest injury ratings and its activity continued to increase, Lontrel® caused minimal injury and response to SedgeHammer® did not change. However, the Roundup® 4 treatment's activity and injury ratings continued to increase, slowly burning the phyllanthus. At 21 DAT, phyllanthus treated with Roundup® were similar to those treated with SureGuard®. Fresh weight results were similar in that SureGuard® and Roundup® treatments had average weights of 0.4-0.5 g and 0.7 g, respectively. Injury ratings and fresh weight indicate that SureGuard® and Roundup® were effective at post-emergence control of longstalked phyllanthus. Regrowth data shows that SureGuard® had a complete kill with a regrowth weight of 0.00 as did Roundup® (Table 1). The effectiveness of SureGuard® at relatively low rates of application and its speed of success should be noted. Use of SureGuard® and Roundup® for the control of existing longstalked phyllanthus has the potential of reducing labor costs over time from hand weeding. Both herbicides should be used as a directed application either in large containers or landscape situations. SureGuard® at the ½x rate (0.19 lb aia) provides excellent post-emergence control of plyllanthus. Future research will evaluate lower rates of SureGuard® for post-emergence control of phyllanthus.

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Table 1. Effects of selected herbicides on post-emergence control of longstalked phyllanthus (*Phyllanthus tenellus*).

| Treatment | Rate | 3 DAT[X] | Injury Ratings[Z] 7 DAT | 14 DAT | 21 DAT | Fresh Weights[Y] Initial[W] | Regrowth[V] |
|---|---|---|---|---|---|---|---|
| Lontrel® | 4.0 oz/A[U] | 2.0 de[T] | 2.3 cd | 2.4 de | 2.0 cd | 17.3 ab | 0.9 a |
| Lontrel® | 8.0 oz/A | 3.7 c | 2.7 cd | 3.7 d | 2.9 cd | 14.3 abc | 0.4 ab |
| Lontrel® | 16.0 oz/A | 3.1 cd | 2.3 cd | 2.9 de | 2.7 cd | 16.4 ab | 0.4 ab |
| SureGuard® | 0.19 lbs aia[S] | 8.6 a | 8.9 a | 9.0 a | 9.1 a | 0.5 e | 0.0 b |
| SureGuard® | 0.38 lbs aia | 8.6 a | 9.1 a | 9.1 a | 9.3 a | 0.4 e | 0.0 b |
| SureGuard® | 0.76 lbs aia | 8.0 a | 9.0 a | 9.1 a | 9.1 a | 0.5 e | 0.0 b |
| SedgeHammer® | 0.03 lbs aia | 6.0 b | 5.9 b | 5.9 c | 6.0 b | 6.8 d | 0.1 b |
| SedgeHammer® | 0.062 lbs aia | 3.4 c | 3.1 c | 3.6 d | 3.3 c | 11.3 c | 0.3 b |
| SedgeHammer® | 0.126 lbs aia | 1.6 e | 1.6 d | 1.7 e | 2.0 cd | 17.9 a | 0.1 b |
| Roundup® 4 | 1.0 lbs aia | 4.3 c | 6.7 b | 7.7 b | 8.4 a | 0.7 e | 0.0 b |
| Control | non-treated | 2.0 de | 1.9 d | 1.9 e | 1.7 d | 13.0 bc | 0.2 b |

[Z]Ratings on a scale of 1 to 10 (1 = no injury, 10 = dead plant).

[Y]Fresh weights measured in grams and taken at 21 and 66 DAT (regrowth).

[X]DAT = days after treatment.

[W]Initital fresh weights were taken at 21 DAT. Plants were cut back to ¼-inch above substrate.

[V]Regrowth fresh weights were taken at 66 DAT. New growth was cut off the existing old growth.

[U]Ounces per acre.

[T]Means within column followed by the same letter are not significantly different (Duncan K-ratio t test p≤0.05).

[S]aia = active ingredient per acre.