

Major Weed Control Issues in Ohio Nurseries

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Project summary. Over 273 herbicide trials were set up in fields or containers at six nurseries and Christmas tree plantations: Studebaker Nurseries, New Carlisle, OH; Willoway Nurseries, Inc., Avon, OH and Willoway Nurseries, Inc., Huron, OH; North Branch Nursery, Pemberville, OH; Timbuk Farms, Granville, OH; and Decker's Nursery, Groveport, OH. 229 of these trials dealt with objectives 1 and 2 of the proposal and the remaining 44 with objective 3. Nursery visits and pre-trial surveys were conducted between December, 2012 to January, 2013 to determine current weed problems and crops, herbicide management practices and problems. These meetings determined which herbicides and crops would be evaluated in the 2013 container and field trials. The five container weeds are listed in Table 1. The current field weeds are listed in Table 2. Products were chosen to address their current issues and concerns. The total financial impact of these 273 trials is estimated at \$8 Mn due to savings in four key areas, reduction in crop losses, proper herbicide use, marketing the crop sooner and reduction in cultivation, weeding and postemergence herbicide use (Table 3). Two new herbicides Marengo G and Biathlon were found safe on a variety of crops and one new spray combination, Gallery + Barricade was found safe on seven container crops, four field crops and safer than Gallery +Surflan (Table 18).

Table 1. Five common Ohio container weeds at six container nurseries surveyed in fall 2012.

Common name	Scientific name	Life cycle
Pennsylvania bittercress	<i>Cardamine pennsylvanica</i>	Winter annual
Prostrate spurge	<i>Chamaesyce maculata</i> or <i>Euphorbia maculata</i>	Summer annual
Groundsel	<i>Senecio vulgaris</i>	Winter and summer annual
Pearlwort	<i>Sagina procumbens</i>	Perennial
Liverwort	<i>Marchantia polymorpha</i>	Perennial

Table 2. Common weeds in Christmas tree plantations and nursery fields listed by family and life cycle at four nurseries or plantations surveyed in fall 2012.

Common name	Scientific name	Division or family	Life cycle
1. Poison ivy	<i>Rhus radicans</i>	Anacardiaceae	Perennial
2. Horseweed or marestail	<i>Conyza canadensis</i>	Asteraceae	Summer or winter annual
3. Prickly lettuce	<i>Lactuca serriola</i>	Asteraceae	Winter or summer or biennial
4. Annual sowthistle	<i>Sonchus oleraceus</i>	Asteraceae	Summer annual
5. Common groundsel	<i>Senecio vulgaris</i>	Asteraceae	Winter annual
6. Musk thistle	<i>Carduus nutans</i>	Asteraceae	Biennial
7. Cressleaf groundsel	<i>Senecio glabellus</i>	Asteraceae	Winter annual
8. Canada thistle	<i>Cirsium arvense</i>	Asteraceae	Perennial
9. Dandelion	<i>Taraxacum officinale</i>	Asteraceae	Simple perennial
10. Hairy galinsoga	<i>Galinsoga cilata</i>	Asteraceae	Summer annual

11. Hairy bittercress	<i>Cardamine hirsuta</i>	Brassicaceae	Winter annual
12. Pennsylvania bittercress	<i>Cardamine pennsylvanica</i>	Brassicaceae	Winter annual
13. Wild mustard	<i>Brassica kaber</i> var. <i>pinnatifida</i>	Brassicaceae	Biennial
14. Amur honeysuckle	<i>Lonicera maackii</i>	Caprifoliaceae	Creeping perennial
15. Birdseye pearlwort	<i>Sagina procumbens</i>	Caryophyllaceae	Perennial
16. Common chickweed	<i>Stellaria media</i>	Caryophyllaceae	Winter annual
17. Mouse-eared chickweed	<i>Ceraastium vulgatum</i>	<i>Ceraastium vulgatum</i>	Perennial
18. Russian thistle	<i>Salsola iberica</i>	Chenopodiaceae	Annual
19. Yellow nutsedge	<i>Cyperus esculentus</i>	Cyperaceae	Perennial
20. Horsetail	<i>Equisetum arvense</i>	Equisetaceae	Creeping perennial
21. Prostrate spurge	<i>Chamaesyce maculata</i> or <i>Eurphobia maculata</i>	Eurphorbiaceae	Summer annual
22. White clover	<i>Trifolium repens</i>	Leguminosae	Perennial
23. Red Clover	<i>Trifolium pretense</i>	Leguminosae	Perennial
24. Purple deadnettle	<i>Lamium purpurea</i>	Labiatae	Winter annual
25. Henbit	<i>Lamium amplexicaule</i>	<i>Lamium amplexicaule</i>	Winter annual
26. Wild garlic	<i>Allium vineale</i>	Liliaceae	Perennial
27. Northern willowherb	<i>Epilobium ciliatum</i>	Onagraceae	Summer annual
28. Creeping red woodsorrel	<i>Oxalis corniculata</i>	Oxalidaceae	Creeping perennial
29. Annual bluegrass	<i>Poa annua</i>	Poaceae	Winter annual
30. Shatter cane	<i>Sorghum bicolor</i>	Poaceae	Summer annual
31. Large crabgrass	<i>Digitaria sanguinalis</i>	Poaceae	Summer annual
32. Fall panicum	<i>Panicum dichotomiflorum</i>	Poaceae	Summer annual
33. Yellow foxtail	<i>Setaria lutescens</i>	Poaceae	Summer annual
34. Barnyard grass	<i>Echinochloa crusgalli</i>	Poaceae	Summer annual
35. Quackgrass	<i>Elytrigia repens</i>	Poaceae	Creeping perennial
36. Curly dock	<i>Rumex crispus</i>	Polygonaceae	Perennial
37. Purslane	<i>Portulaca oleracea</i>	Portulacaceae	Summer annual
38. Wild carrot	<i>Daucus carota</i>	Umbelliferae	Winter

In the winter 2012 to Jan., 2013 surveys, liverwort was found to be one of the fastest disseminating weeds in Ohio nurseries. Even though liverwort trials were not required in the original proposal, we determined the lack of known controls for this weed warranted addition to the AGR-SCG-12-03 project. We added these liverwort trials under objective 3, regarding difficult weeds.

Table 3. Summary of the Specialty Crop Block Grant (SCBG) financial impact of X herbicide trials at seven nurseries in 2012-13.

Type of savings	Amount	No. of sites	Total
Reduction of crop losses	1.5 Mn	2	3.0 Mn
Proper herbicide selection	0.5 Mn	5	2.0 Mn
Market crop sooner	2 Mn	2	2.0 Mn
Reduction in cultivation, weeding and postemergence herbicides	0.25 Mn	2	1.0 Mn
Grand Total			8 Mn

Project approach

Container studies. Phytotoxicity and weed control studies were carried out at four locations in Ohio including Studebaker Nurseries, North Branch Nursery, Willoway Nurseries, Inc., Avon, OH, and Willoway Nurseries, Inc., Huron, OH.

Studebaker Nurseries. Three species of containerized ornamentals including viburnum (*Viburnum* x'Juddi'), daylily (*Hemerocallis* 'Stella d'Oro'), and hydrangea (*Hydrangea paniculata* 'Little lamb') were treated on 6 May 2013. Treatments included Marengo G at 100 lb/ac, 150 lb/ac, 200 lb/ac, and 400 lb/ac; Gallery + Barricade at 1.3 lb/ac + 21 oz/ac, respectively; Biathlon at 100 lb/ac, 200 lb/ac, and 400 lb/ac; and BroadStar at 150 lb/ac. Reapplications were made approximately 6 weeks later on June 17, 2013. Hydrangea and viburnum were in #3 (3 gallon) trade size pots and daylily was in #1 (1 gallon) trade size pot at time of application.

North Branch Nursery. Three species of containerized ornamentals including boxwood (*Buxus sempervirens* 'Vardar Valley'), rose (*Rosa* 'Knockout') and yew (*Taxus xmedia* 'Runyon') were treated on April 23, 2013. Treatments included Marengo G at 100 lb/ac and 150 lb/ac; Gallery + Surflan (oryzalin, Dow AgroSciences) at 1.3 lb/ac + 2 qt/ac, respectively; Gallery + Surflan at 1.3 lb/ac + 1 qt/ac, respectively; Tower + Pendulum at 21 oz/ac + 2 qt/ac; Tower + Pendulum at 1 qt/ac + 1 qt/ac, respectively; Biathlon at 100 lb/ac; and F6875 (sulfentrazone + prodiamine, FMC Corp.) at 0.375 lb ai/ac, 0.75 lb ai/ac, and 1.5 lb ai/ac. Reapplications were approximately 6 weeks later on June 4, 2013. All species were in #3 trade size containers at time of application and just breaking dormancy.

Willoway Nurseries, Huron. Six species of containerized ornamentals including rhododendron (*Rhododendron* 'Nova Zembla'), Pieris (*Pieris* 'Red Mill'), azalea (*Azalea* x'Karen'), holly (*Ilex Xmeserveae* 'Blue Maid'), hydrangea (*Hydrangea paniculata* 'Limelight') and viburnum (*Viburnum* x'Juddi') were treated on May 1, 2013. Treatments included Marengo G at 100 lb/ac, 150 lb/ac, 200 lb/ac and 400 lb/ac; Gallery + Barricade at 1.3 lb/ac + 21 oz/ac, respectively; Gallery + Surflan at 1.3 lb/ac + 1 qt/ac, respectively; Tower + Pendulum at 21 oz/ac + 2 qt/ac, respectively; Tower + Pendulum at 1 qt/ac + 1 qt/ac, respectively; Biathlon at 100 lb/ac, 200 lb/ac, and 400 lb/ac; BroadStar at 150 lb/ac; and Gallery + Ronstar (oxadiazon, Bayer Corp.) at 1 lb/ac + 2 lb/ac, respectively. Reapplications were made approximately 8 weeks later on June 26, 2013. Rhododendron and Pieris were in #1 size pots, azalea and holly were in #2 size pots, and viburnum and hydrangea were in #3 size pots at time of application. All species had broken dormancy by time of first application. Due to a nutrient problem, the trials at Willoway Nurseries were terminated. Data taken at 1 WA2T, was corrupted due to the nutrient issues at the site, and is not presented.

Willoway Nurseries, Avon. Four species of containerized ornamentals including two cultivars of hydrangea (*Hydrangea macrophylla* 'Endless summer' and *Hydrangea arborescens* 'Invincible spirit') rose (*Rosa* 'Knockout'), and Itea (*Itea* 'Little Henry') were treated on April 19, 2013 with the exception of the 'Endless summer' hydrangea, which was treated on 1 May 2013. Treatments included Marengo G at 100 lb/ac; Gallery + Surflan at 1 lb/ac + 1 qt/ac, respectively; Tower + Pendulum at 21 oz/ac + 2 qt/ac, respectively; Tower + Pendulum at 1 qt/ac + 1 qt/ac, respectively; Biathlon at 100

lb/ac; FreeHand at 150 lb/ac; Regal O-O at 100 lb/ac; and Jewel at 100 lb/ac. Reapplications were made on June 26, 2013. All species were in #3 containers at time of application and had broken dormancy. Due to a nutrient problem, the trials at Willoway Nurseries were terminated. Data taken at 1 WA2T, was corrupted due to the nutrient issues, and is not presented.

At all locations, liquid applications were applied via CO₂ backpack sprayer delivering 25 gal/ac and granular formulations were applied via handheld shaker jars. Phytotoxicity visual ratings were based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable. Treatments at Studebaker Nurseries and Willoway Nurseries were evaluated at 1 WAT, 2 WAT, 4 WAT, and 1 WA2T; evaluations at North Branch were done 1 WAT, 2 WAT, 4 WAT, 1 WA2T, 2 WA2T, and 4 WA2T. For phytotoxicity, treatment means were compared to a control using Dunnett's t-test with $\alpha = 0.10$ and 0.05 using Proc Mixed in SAS® software.

Field studies. Several trials were conducted to determine weed control and phytotoxicity from several herbicides and herbicide combinations at three locations in Ohio, which included Studebaker Nurseries, Inc., New Carlisle, OH; North Branch Nursery, Inc., Pemberville, OH, and Timbuk Farms, Granville, OH. Species at Studebaker Nurseries included boxwood (*Buxus* 'Green velvet') and yew (*Taxus densiformis*). Species at North Branch Nursery included eastern white pine (*Pinus strobus*) and white spruce (*Picea glauca*), and at Timbuk Farms, Canaan fir (*Abies balsamea* var *phanerolepis*). Liquid applications were applied via CO₂ backpack sprayer delivering 25 gal/ac and granular formulations were applied via handheld shaker jars. At each location, the rows were hoed just prior to first treatment application.

Studebaker Nurseries. Treatments were applied at Studebaker Nurseries on May 6, 2013 and included V-10366 (flumioxazin + pyroxasulfone, Valent U.S.A.) at 7.5, 15, and 30 oz/ac, Tower + Pendulum Aquacap (dimethenamid-p + pendulum, both from BASF Corp.) at 32 oz/ac + 2 qt/ac, respectively, and SureGuard (flumioxazin, Valent U.S.A.) at 6 oz and 12 oz/ac. Treatments were reapplied on June 17, 2013. Liquid applications were applied as directed sprays. For both boxwood and yew, there were four replications/treatment and three subsamples/replication arranged in a completely randomized design in the liner field for each species. Treatments were evaluated at 1 WAT (weeks after treatment) 2 WAT, 4 WAT and 1 WA2T (weeks after second treatment).

North Branch Nursery. Treatments were applied at North Branch on April 23, 2013 and included Gallery (isoxaben, Dow AgroSciences) + Barricade (Syngenta Crop Protection, Inc.) at 1.3 lb/ac + 21 oz/ac, respectively; Tower + Pendulum at 21 oz/ac + 2 qt/ac, respectively; Tower + Pendulum at 1 qt/ac + 1 qt/ac, respectively; Biathlon (oxyfluorfen + prodiamine, OHP, Inc.) at 100 lb/ac; Marengo G (indaziflam, OHP, Inc.) at 150 lb/ac; V-10366 at 15 oz/ac; and SureGuard at 6 oz/ac. Treatments were reapplied on June 4, 2013. Liquid applications were applied as directed sprays. For each species, there were four replications with three subsamples/replication for each treatment in a completely randomized design within each species. Treatments were evaluated at 1 WAT, 2 WAT, 4 WAT, 1 WA2T, 2 WA2T, and 4 WA2T.

Timbuk Farms. Treatments were applied at Timbuk Farms on July 9, 2013 and included the same treatments describe above for North Branch Nursery, and the treatments were reapplied on September 3, 2013. At Timbuk, one species, Canaan Fir, *Abies balsamea* var *phanerolepis* also known as West Virginia fir was used. However, there were two growth stages evaluated, which were newly planted and trees in the ground for three years. Studies were also conducted in the fall of 2012 with three growth stages, newly planted, 3 years old and trees in the ground 5 years. The results of the fall 2012 study were presented with the SCBG 11-08 project. Treatments were applied over-the-top of the newly planted trees and as directed applications for the older trees. For each growth stage, there were three subsamples/replication with four replications/treatment randomized in a completely randomized design. Treatments were evaluated at 1 WAT, 2 WAT, 3 WAT, 4 WAT, 1 WA2T, and 2 WA2T.

At all locations, phytotoxicity visual ratings were based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable. Efficacy visual ratings were based on a 0-10 scale with 0 being no control and 10 perfect control with ≥ 7 commercially acceptable. For phytotoxicity, treatment means were compared to a control using Dunnett's t-test with $\alpha = 0.10$ and 0.05 using Proc Mixed in SAS® software. For efficacy, treatment means were compared using lsmeans in Proc Mixed with $\alpha = 0.05$.

Liverwort trials. Trials were initiated at Decker's Nursery, Inc., Groveport, OH on February 28, 2013 in a covered hoop house that had minimum heat to protect plants from frost. Liquid applications of SureGuard (flumioxazin, Valent U.S.A) at 3 oz and 4 oz/ac; WeedPharm (20% acetic acid, Pharm Solutions, Inc.) at 10% v/v; and Marengo SC (indaziflam, Bayer Corp.) at 9 oz/ac were applied with a CO₂ backpack sprayer delivering 50 gal/ac. A 100 gal/ac rate was desired, so two passes were made at each application. Treatments of baking soda and reagent grade potassium bicarbonate (Sigma-Aldrich Corp.) were also each applied at approximately 2.24 g/ft² with a Dustin-Mizer or handheld shaker jar. A second application was made on April 26, 2013. For phytotoxicity, ornamental species included barberry (*Berberis* 'Orange Rocket'), boxwood (*Buxus microphylla* 'Winter gem'), hydrangea (*Hydrangea arborescens* 'Incrediball'), and Physocarpus (*Physocarpus* 'Summer wine'). Evaluations of efficacy and phytotoxicity were conducted at 1 WAT (weeks after treatment), 2 WAT, 4 WAT, 8 WAT, 1 WA2T (weeks after second treatment), 2 WA2T, and 4 WA2T. Phytotoxicity visual ratings were based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable. Efficacy visual ratings were based on a 0-10 scale with 0 being no control and 10 perfect control with ≥ 7 commercially acceptable. The trial was set up as a completely randomized design for each species with three replications/treatment and three subsamples/replication. For phytotoxicity, treatment means were compared to a control using Dunnett's t-test with $\alpha = 0.10$ and 0.05 using Proc Mixed in SAS® software. For efficacy, treatment means were compared using lsmeans in Proc Mixed with $\alpha = 0.05$.

Difficult weeds. Rorippa trials. Addressing objective 3, in pre- project start surveys we found that liner bed growers were using the following herbicides, Rout, Barricade, Snapshot, SureGuard, Pendulum, Round up, Goal, Tower, Lontrel and 2, 4-D. On average, they were spending \$2300.00/ ac to hand weed problem areas with difficult weeds such as *Rorippa*. We had targeted to reduce

their weed program cost by 30%. We accomplished this goal. The acceptable use of Lontrel in this study provided 35% control, thus reducing hand weeding costs by 35%. We recommend more work with Lontrel on more species and with lower rates to reduce phytotoxicity.

Two trials were conducted in fields, one as a preemergence study, and the other a postemergence study. Evaluations for the pre- and post- emergence trials consisted of visual ratings of weed control and phytotoxicity to crop species. Visual ratings of weed control were based on a 0-10 scale with 0 being no control and 10 perfect control with ≥ 7 commercially acceptable. Visual ratings of phytotoxicity were based on a scale of 0-10 with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable. Data was analyzed using SAS® GLM. Phytotoxicity effects of treatments were compared to the controls using Dunnett's t-test ($\alpha = 0.10$ and 0.05). Efficacy treatments were compared to each other using least significance difference (ls means).

The preemergence trial was started on April 4, 2013 in a liner bed of Common purple lilacs (*Syringa vulgaris*) that had not yet broken dormancy and were approximately 6" (15 cm) tall. Weather at time of application was sunny, approximately 40 °F with no dew present. Six herbicides and one herbicide + mulch were compared to an untreated control. Herbicides included Corsair (chlorsulfuron, Nufarm Americas, Inc.) at 5.3 oz/ac, Certainty (sulfosulfuron, Monsanto Corp.) at 1 oz/ac, SedgeHammer (halosulfuron, Gowan Co.) at 2 oz/ac, Lontrel (clopyralid, Dow Agro Sciences) at 1 pt/ac, V-10336 (no trade name yet, flumioxazin + pyroxasulfone, Valent U.S.A.) at 15 oz/ac, and Diuron 80 (diuron, Drexel, Inc.) at 3 lb./ac. For the herbicide + mulch treatment, Casoron CS (dichlobenil, Chemtura Corp.) at 3 gal/ac was applied just prior to application of 2 inches of pine nugget mulch. The herbicides were applied with a CO₂ backpack sprayer delivering 25 gal/ac. The creeping yellow cress was just beginning to green below the soil surface. Plots were approximately 3' x 3' with approximately 1-2' between plots.

The postemergence trial treatments were also conducted on Common purple lilacs (*Syringa vulgaris*); however, unlike the preemergence trial, the lilacs had broken dormancy at the time of application and were approximately 7" (17.5 cm) tall. Applications were made on May 16, 2013. Weather was approximately 65 °F, 5 mph wind, sunny. Herbicides included: Corsair (chlorsulfuron, Nufarm Americas, Inc.) at 5.3 oz/ac, Certainty (sulfosulfuron, Monsanto Corp.) at 1 oz/ac, SedgeHammer (halosulfuron, Gowan Co.) at 2 oz/ac, Lontrel (clopyralid, Dow Agro Sciences) at 1 pt/ac, V-10336 (no trade name yet, flumioxazin + pyroxasulfone, Valent U.S.A.) at 15 oz/ac, Diuron 80 (diuron, Drexel, Inc.) at 3 lb/ac, Classic (chlorimuron, Dupont Crop Protection) at 2/3 oz/ac, and Marengo SC at 9 oz/ac. All treatments included the addition of nonionic surfactant at 0.25% v/v. Herbicides were applied with a CO₂ backpack sprayer delivering 25 gal/ac.

Container results.

Studebaker Nurseries. Marengo G was phytotoxic to all three species; however, daylily injury was at commercially acceptable levels (Fig. 1A) for all dates and rates and decreased after the second application (Table 4). Marengo G injury to *Hydrangea paniculata*, however, was not commercially acceptable and continued after the second application (Table 4) (Fig. 2 C). We speculate that the 200 lb. rate of Marengo was never applied. Marengo injury to *Viburnum X 'Juddi'* was the least of the three species evaluated and was commercially acceptable at all rates after the first application. The

second application, however, significantly increased injury at all rates after the second application and was not commercially acceptable at 400 lb./ac 1WA2T (Table 4).



Fig. 1. A, B and C. (A) (left) Marengo G at 400 lb/ac 2 WAT (2.4 rating) at Studebaker Nurseries, Inc., New Carlisle, OH on *Hemerocallis* 'Stella d'Oro' although the injury from Marengo is significant it is far less severe than the injury caused by Biathlon 400 lb/ac 2WAT (rating 5.4) (B) (below) or Broadstar (150 lb/ac) (C) (below). (pictures taken by H. Mathers).



Gallery + Barricade showed some passing phytotoxicity to *Hydrangea paniculata* (Fig. 2 A) and inconsistent injury on *Viburnum* X 'Juddi' compared to the control (Fig. 2 B). Gallery + Barricade did not injure *Hemerocallis* 'Stella d'Oro' (Table 4). Biathlon did cause significant injury on *Hemerocallis* 'Stella d'Oro' at 200 and 400 lb rates (Fig. 1B); although, by the end of the trial only the 400 lb rate showed not commercially acceptable injury (Table 4). With *Viburnum* X 'Juddi', Biathlon at 100 lb /ac showed significant injury but only at 4 WAT and 1 WA2T. *Hydrangea paniculata* had significant injury caused by the 200 and 400 lb rates of Biathlon; however, this injury decreased over time (Table 4).

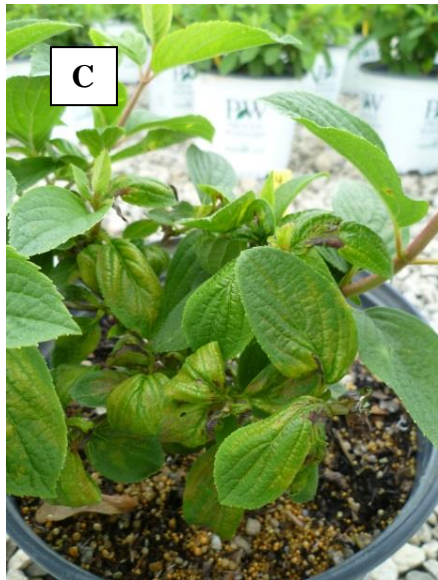


Fig. 2 A, B and C. (A). (Above) Gallery + Surflan, 2 WAT on *Hydrangea paniculata* 'Little Lamb' at Stuebaker Nurseries, Inc., New Carlisle, OH (rating 3.7). (B) (above) Control at 2 WAT showing no damage on *Hydrangea paniculata* 'Little Lamb' and (C) (left) Marengo at 400 lb/ac (rating 5.3) 2 WAT, severe leaf distortion, puckering, burn and chlorosis. (Pictures taken by H. Mathers)

BroadStar caused significant injury that was not commercially acceptable on *Hemerocallis* 'Stella d'Oro' (Fig. 1 C) and *Hydrangea paniculata*. With *Viburnum* X 'Juddi' the BroadStar caused injury that was commercially unacceptable after second application (Table 4) (Fig.3).



Fig. 3. (Center of picture) BroadStar 150 lb/ac applied on *Viburnum* X 'Juddi' 4 WAT (rating 3) showing severe stunting compared to surrounding treated pots and general chlorosis at Stuebaker Nurseries, Inc., New Carlisle, OH. (Picture taken by H. Mathers).

Table 4. Phytotoxicity of several herbicides on selected containerized ornamentals at Studebaker Nurseries, New Carlisle, OH. Trial initiated May 6, 2013.

Hemerocallis 'Stella d'Oro'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT	1 WA2T
Marengo G	100 lb	2.6	2.7 **	2.8 **	1.5 *
Marengo G	150 lb	1.4	2.7 **	2.6 **	0.8
Marengo G	200 lb	1.9	1.1	1.8	1.0
Marengo G	400 lb	0.5	2.4 **	2.5 **	1.2
Gallery + Barricade	1.3 lb + 21 oz	1.5	0.8	0.5	0.8
Biathlon	100 lb	1.8	0.9	0.6	0.8
Biathlon	200 lb	1.5	2.9 **	2.2	1.3
Biathlon	400 lb	3.1 **	5.4 **	5.8 **	3.7 **
BroadStar	150 lb	4.0 **	5.1 **	4.8 **	2.3 **
Untreated	--	1.1	0.8	0.5	0.1

Hydrangea paniculata 'Little Lamb'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT	1 WA2T
Marengo G	100 lb	3.3 **	3.3 **	2.3 **	2.8 **
Marengo G	150 lb	4.2 **	4.6 **	2.9 **	3.5 **
Marengo G	200 lb	0.9	0.7	0.0	0.8
Marengo G	400 lb	4.8 **	5.3 **	4.3 **	4.7 **
Gallery + Barricade	1.3 lb + 21 oz	0.5	3.7 **	1.3	1.8
Biathlon	100 lb	0.3	0.6	0.4	0.3
Biathlon	200 lb	2.7 **	1.8 **	0.8	1.6
Biathlon	400 lb	3.4 **	2.3 **	0.2	1.8
BroadStar	150 lb	4.8 **	4.7 **	3.0 **	3.9 **
Untreated	--	0.0	0.1	0.0	0.8

Viburnum x'Juddi'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT	1 WA2T
Marengo G	100 lb	0.7	0.2	0.3	1.3
Marengo G	150 lb	1.6	1.3 *	1.7	2.9 **
Marengo G	200 lb	0.6	0.2	2.1 *	2.7 *
Marengo G	400 lb	1.9	1.7 **	2.3 **	3.1 **
Gallery + Barricade	1.3 lb + 21 oz	1.8	2.1 **	1.9	2.8
Biathlon	100 lb	1.1	1.2	3.1 **	3.3 **
Biathlon	200 lb	2.0 *	0.6	2.0 *	2.3
Biathlon	400 lb	1.0	0.6	1.4	2.3
BroadStar	150 lb	1.7	1.5 **	2.5 **	3.0 **
Untreated	--	0.9	0.2	0.2	1.0

z = weeks after treatment

y = visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable
x = visual ratings followed by *, ** are significantly different from the control based on Dunnett's t-test ($\alpha = 0.10$ and 0.05 , respectively)

North Branch Nursery. Marengo G was safe at 150 and 200 lb/ac with all three species evaluated (Table 5). Gallery + Surflan was safe at 1.3 lb + 2 qt and 1.3 lb + 1 qt with *Buxus sempervirens* 'Vardar Valley' and *Taxus xmedia* 'Runyon'; however, Rosa 'Knock out' was severely injured by both rates (Table 5), concurring with our results from the 2011-08 SCBG. Although the rose grew out of the severe stunting caused by the first application (Fig. 4 A) and was not increased after the second application (Table 5). Random mottling typical of Gallery injury persisted 2 weeks (Fig. 4B) and 4 weeks following the second application (Table 5).



Fig. 4 A and B. (A) (above - left) Gallery + Surflan at 1.3 lb + 2 qt 2 WAT at North Branch Nursery, Pemberville, OH on Rosa 'Knock out' (rating 5.3) and (B) (above-right) 1.3 lb + 1 qt. 2 WAT2T (rating 1.6).

Tower + Pendulum (1qt + 1qt) provided some injury on after the first application (Table 5) and no injury to *Taxus xmedia* 'Runyon' at any date. The Tower + Pendulum (21 oz + 2 qt) rate, with 11 less ounces of dimethamid- p but 32 ounces more of pendimethalin did not cause commercial injury to *Buxus sempervirens* 'Vardar Valley' (Fig. 5 B) or *Taxus xmedia* 'Runyon' (Table 5). The Tower + Pendulum (1qt + 1qt) injury on Buxus caused an injury rating of 2.3, 2 WAT (Fig. 5 B); however, the injury decreased over time and was not different from the control by 1WA2T (Table 5). Tower + Pendulum at both rates severely injured rose; however, the (1qt + 1 qt) (3.3, 2 WAT) (Fig. 5 A – far right) was slightly worse than the (21 oz + 2 qt) (3.9 2 WAT) injury (Fig. 5 A – center). The Tower + Pendulum injury was most severe after the first application (Fig. 5A) but was still noticeable by the end of the trial (Table 5) with the oldest leaves still appearing mottled. The extra Tower with both these species caused slightly more injury than extra pendulum being added to the combination.



Fig. 5 A and B. A. (above - left) *Rosa* 'Knock out' treated from left to right (Marengo, Tower + Pendulum (21 oz + 2 qt) and Tower + Pendulum (1qt + 1qt) 2 WAT at North Branch Nursery, Pemberville, OH. Note the lack of growth caused by both rates of Tower + Pendulum compared to the Marengo treated rose. (B) (above – right) *Buxus sempervirens* 'Vardar Valley' treated from left to right (Control, Tower + Pendulum (21 oz + 2 qt) and Tower + Pendulum (1qt + 1qt) 2 WAT at North Branch Nursery, Pemberville, OH. Note the injury from the Tower + Pendulum (1qt + 1qt) is greater than from the (21 oz + 2 qt). (Pictures by H. Mathers).

F6875 was not injurious to *Taxus xmedia* 'Runyon' at any rate tested (Table 5). *Rosa* 'Knock out' or *Buxus sempervirens* 'Vardar Valley' were not injured by F6875 at the lowest rate of application (Table 5). However, F6875 did cause injury to *Buxus sempervirens* 'Vardar Valley' and *Rosa* 'Knock out' at the 2X and 4X rates (Table 5). This injury was worst after the first application and on rose (Fig. 6 A and B). The second application did not increase the injury; however, some injury persisted from the first application at the highest rate on rose by 2WA2T (Table 5).



Fig. 6 A and B. (A) *Buxus sempervirens* 'Vardar Valley', from left to right control 1X, 2X and 4X of F6875 at North Branch Nursery, Pemberville, OH. Note the injury from the 4X rate is the worst. (B) *Rosa* 'Knock out', from left to right 1X, 2X (rating 2.3) and 4X (rating 2.3) of F6875. Note the injury on rose is equal whether the rate is 2X or 4X.

Table 5. Phytotoxicity of several herbicides on selected containerized ornamentals at North Branch Nursery, Pemberville, OH. Trial initiated April 23, 2013.

<i>Buxus sempervirens</i> 'Vardar Valley'							
Treatment	Rate/ac	1 WAT	2 WAT	4 WAT	1 WA2T	2 WA2T	4 WA2T
Marengo G	150 lb	0.3	0.0	0.0	0.3	0.0	0.0
Marengo G	200 lb	0.3	0.1	0.4	0.6	0.4	0.0
Gallery + Surflan	1.3 lb + 2 qt	0.3	0.1	0.2	0.5	0.4	0.0
Gallery + Surflan	1.3 lb + 1 qt	0.3	0.0	0.2	0.8	0.7	0.2
Tower + Pendulum	21 oz + 2 qt	0.4	0.1	0.8	0.9	0.8	0.4
Tower + Pendulum	1 qt + 1 qt	1.6 **	2.3 **	1.7 **	0.6	0.3	0.3
Biathlon	100 lb	0.4	0.5	0.3	0.3	0.1	0.1
F6875	0.375 lb ai	0.1	0.1	0.2	0.5	0.3	0.1
F6875	0.75 lb ai	0.7	0.9 **	1.4 **	1.0	0.5	0.8
F6875	1.5 lb ai	1.3 **	2.0 **	2.8 **	2.7 **	2.3 **	2.2 **
Untreated	--	0.1	0.0	0.0	0.5	0.3	0.0
<i>Taxus xmedia</i> 'Runyon'							
Treatment	Rate/ac	1 WAT	2 WAT	4 WAT	1 WA2T	2 WA2T	4 WA2T
Marengo G	150 lb	0.0	0.1	0.0	0.0	0.1	0.1
Marengo G	200 lb	0.3	0.1	0.0	0.1	0.1	0.0
Gallery + Surflan	1.3 lb + 2 qt	0.4	0.2	0.0	0.1	0.3	0.4
Gallery + Surflan	1.3 lb + 1 qt	0.3	0.1	0.0	0.4	0.3	0.0
Tower + Pendulum	21 oz + 2 qt	0.2	0.3	0.0	0.3	0.4	0.8
Tower + Pendulum	1 qt + 1 qt	0.5	0.5	0.0	0.0	0.3	0.1
Biathlon	100 lb	0.4	0.5	0.0	0.2	0.1	0.0
F6875	0.375 lb ai	0.4	0.1	0.0	0.1	0.2	0.0
F6875	0.75 lb ai	0.3	0.2	0.0	0.1	0.0	0.1
F6875	1.5 lb ai	0.8	0.3	0.0	0.3	0.4	0.3
Untreated	--	0.2	0.1	0.0	0.1	0.1	0.0
<i>Rosa</i> 'Knockout'							
Treatment	Rate/ac	1 WAT	2 WAT	4 WAT	1 WA2T	2 WA2T	4 WA2T
Marengo G	150 lb	0.0	0.0	0.0	0.1	0.2	0.4
Marengo G	200 lb	0.3	0.0	0.0	0.3	0.4	0.8
Gallery + Surflan	1.3 lb + 2 qt	3.1 **	5.3 **	2.9 **	2.8 **	1.9 **	0.8
Gallery + Surflan	1.3 lb + 1 qt	3.4 **	5.3 **	2.1 **	2.7 **	1.6 **	0.9
Tower + Pendulum	21 oz + 2 qt	3.2 **	3.3 **	0.3	2.8 **	1.4 **	1.2 *
Tower + Pendulum	1 qt + 1 qt	3.7 **	3.9 **	1.4 **	2.4 **	1.2 **	0.8
Biathlon	100 lb	2.7 **	0.8	0.5	0.5	0.3	0.2
F6875	0.375 lb ai	0.8	0.0	0.1	2.0 **	0.8	0.5
F6875	0.75 lb ai	3.8 **	2.3 **	0.7	2.9 **	1.8 **	0.4
F6875	1.5 lb ai	3.3 **	2.3 **	1.2 **	3.5 **	1.7 **	0.8

Untreated	--	0.6	0.2	0.0	0.0	0.1	0.3
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z = weeks after treatment

y = visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤3 commercially acceptable

x = visual ratings followed by *, ** are significantly different from the control based on Dunnett's t-test (α = 0.10 and 0.05, respectively).

Willoway Huron. Marengo G caused no injury to *Rhododendron* ‘Nova Zembla’, *Pieris* ‘Red Mill’, *Azalea* x‘Karen’ or *Hydrangea paniculata* ‘Limelight’. Marengo did cause some slight, transient injury on *Ilex Xmeserveae* 'Blue Maid' at the 200 lb/ ac rate and some injury on *Viburnum* x‘Juddi’ that was never significantly greater than the control at 150 and 200lb/ac. This concurs with last year’s results where Marengo was safe on a wide variety of materials but could only be safely used on *Viburnum* at a 1X rate.

Gallery + Barricade (1.3 lb + 21 oz) was not injurious to any to the species and Gallery + Surflan (1.3 lb + 1 qt) was also not injurious to any non-commercially acceptable level with the exception of *Hydrangea paniculata* ‘Limelight’ (Table 6). *Hydrangea paniculata* ‘Limelight’ injury was most severe at 1 WAT (rating 2.6).

Tower + pendulum at the 21 oz/ac + 2 qt/ac rate provided no injury to *Rhododendron* ‘Nova Zembla’ and *Ilex Xmeserveae* 'Blue Maid'; however, injury was noticeable on *Azalea* x‘Karen’ (Fig. 7 C), *Hydrangea paniculata* ‘Limelight’ (Fig. 7 A) and *Viburnum* x‘Juddi’ (Table 6). Tower + Pendulum at the 1 qt/ac + 1qt/ac rate was also injurious to *Azalea*, *Viburnum* and *Hydrangea* (Fig. 7 B) as it was with 21 oz + 2 qt rate; however, the addition of 11 more ounces of Tower also picked up injury *Pieris* (Table 6). *Azalea* x‘Karen’ and *Hydrangea paniculata* 'Limelight' were the two species with the most injury from tower + pendulum and in the *Azalea* the injury from the 21 oz/ac + 2 qt/ac rate caused more injury (Fig. 7C) (Table 6). This was different than at North Branch Nursery where the 1qt/ac + 1 qt/ac rate caused more injury on rose and boxwood. Neither rate of Tower +pendulum should be used on *Hydrangea* or *Azalea*.



Fig. 7 A, B and C. (A) (above-left) Tower + Pendulum on *Hydrangea paniculata* 'Limelight' at 21 oz + 2 qt/ ac rate 2 WAT at Willoway Nursery, Huron, OH and (B) (above-right) Tower + Pendulum on *Hydrangea paniculata* 'Limelight' at 1 qt/ac + 1qt/ac rate 2 WAT. Note the injury is very comparable at both rates. (C) (Left) *Azalea* x'Karen' 6 WAT showing control (left in picture) and Tower + Pendulum at 21 oz + 2 qt/ ac at Willoway, Huron, OH.



Biathlon at (100, 200 or 400 lb/ac) and BroadStar at 150 lb/ ac did not injure any of the six species evaluated (Table 6). This was similar to last year where we only found injury from Biathlon on Daylily. The Gallery + Ronstar also caused no injury (Table 6).

Table 6. Phytotoxicity on selected ornamentals from several herbicides at Willoway Nurseries, Huron, OH the trial was initiated on May 1, 2013.

Rhododendron 'Nova Zembla'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT
Marengo G	100 lb	0.0 ^{yx}	0.3	0.8
Marengo G	150 lb	0.0	0.3	0.6
Marengo G	200 lb	0.0	0.0	0.8
Marengo G	400 lb	0.0	0.0	0.3
Gallery + Barricade	1.3 lb + 21 oz	0.0	1.0	1.3
Gallery + Surflan	1.3 lb + 1 qt	1.7 **	1.5 **	0.8
Tower + Pendulum	21 oz + 2 qt	0.0	0.0	1.2
Tower + Pendulum	1 qt + 1 qt	0.0	0.0	0.6
Biathlon	100 lb	0.0	0.0	0.3
Biathlon	200 lb	0.0	0.3	0.5
Biathlon	400 lb	0.0	0.2	0.0
BroadStar	150 lb	0.0	0.0	0.0
Gallery + Ronstar WSP	1 lb + 2 lb	0.0	0.3	0.3
Untreated	--	0.0	0.1	0.6

Azalea 'Karen'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT
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Marengo G	100 lb	1.1		1.4	1.3
Marengo G	150 lb	0.0	**	0.0	0.3
Marengo G	200 lb	0.5		0.8	1.1
Marengo G	400 lb	1.0		1.0	0.9
Gallery + Barricade	1.3 lb + 21 oz	0.4		1.3	0.6
Gallery + Surflan	1.3 lb + 1 qt	0.4		2.0	1.6
Tower + Pendulum	21 oz + 2 qt	2.2	*	3.6	5.1
Tower + Pendulum	1 qt + 1 qt	1.2		4.2	4.2
Biathlon	100 lb	1.0		1.3	0.3
Biathlon	200 lb	0.3		0.4	0.3
Biathlon	400 lb	0.3		0.5	0.8
BroadStar	150 lb	0.3		0.2	0.3
Gallery + Ronstar WSP	1 lb + 2 lb	0.0	**	0.5	0.3
Untreated	--	1.2		0.6	0.4

Pieris 'Red Mill'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT
Marengo G	100 lb	0.0	0.0	0.0
Marengo G	150 lb	0.0	0.0	0.0
Marengo G	200 lb	0.0	0.0	0.0
Marengo G	400 lb	0.0	0.0	0.3
Gallery + Barricade	1.3 lb + 21 oz	0.0	0.0	0.3
Gallery + Surflan	1.3 lb + 1 qt	0.0	0.0	0.5
Tower + Pendulum	21 oz + 2 qt	0.0	1.7	1.3
Tower + Pendulum	1 qt + 1 qt	0.0	2.9	2.7
Biathlon	100 lb	0.0	0.0	0.0
Biathlon	200 lb	0.0	0.0	0.0
Biathlon	400 lb	0.0	0.3	0.1
BroadStar	150 lb	0.0	0.0	0.0
Gallery + Ronstar WSP	1 lb + 2 lb	0.0	0.0	0.1
Untreated	--	0.0	0.0	0.0

Ilex Xmeserveae 'Blue Maid'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT
Marengo G	100 lb	0.0	0.0	0.0
Marengo G	150 lb	0.0	0.0	0.3
Marengo G	200 lb	1.3	0.6	0.3
Marengo G	400 lb	0.0	0.0	0.0
Gallery + Barricade	1.3 lb + 21 oz	0.0	0.0	0.0
Gallery + Surflan	1.3 lb + 1 qt	1.3	0.0	0.0
Tower + Pendulum	21 oz + 2 qt	0.0	0.0	0.2
Tower + Pendulum	1 qt + 1 qt	0.0	0.0	0.3
Biathlon	100 lb	0.0	0.0	0.0
Biathlon	200 lb	0.0	0.0	0.0
Biathlon	400 lb	0.0	0.0	0.0
BroadStar	150 lb	0.0	0.0	0.0
Gallery + Ronstar WSP	1 lb + 2 lb	0.0	0.0	0.0
Untreated	--	0.0	0.0	0.0

Viburnum x 'Juddi'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT
Marengo G	100 lb	1.6	0.6	1.0
Marengo G	150 lb	1.5	2.1	2.2
Marengo G	200 lb	1.8	1.8	2.9
Marengo G	400 lb	1.1	0.9	1.4
Gallery + Barricade	1.3 lb + 21 oz	1.1	0.2	0.3
Gallery + Surflan	1.3 lb + 1 qt	0.7	0.8	1.4

Tower + Pendulum	21 oz + 2 qt	1.7	2.3	3.4 **
Tower + Pendulum	1 qt + 1 qt	0.8	1.8	2.6
Biathlon	100 lb	1.4	0.8	2.4
Biathlon	200 lb	0.8	0.8	1.3
Biathlon	400 lb	1.3	0.3	0.0
BroadStar	150 lb	0.8	0.9	0.7
Gallery + Ronstar WSP	1 lb + 2 lb	0.6	1.1	2.1
Untreated	--	1.2	1.2	1.2

<i>Hydrangea paniculata</i> 'Limelight'				
Treatment	Rate/ac	1 WAT	2 WAT	4 WAT
Marengo G	100 lb	0.3	0.0	0.0
Marengo G	150 lb	0.1	0.5	0.5
Marengo G	200 lb	0.5	0.3	0.2
Marengo G	400 lb	0.2	0.0	0.0
Gallery + Barricade	1.3 lb + 21 oz	0.6	0.2	0.0
Gallery + Surflan	1.3 lb + 1 qt	2.6 **	0.9 **	0.0
Tower + Pendulum	21 oz + 2 qt	4.2 **	4.1 **	2.7 **
Tower + Pendulum	1 qt + 1 qt	3.7 **	3.7 **	0.8 **
Biathlon	100 lb	0.2	0.0	0.0
Biathlon	200 lb	0.6	0.0	0.0
Biathlon	400 lb	1.1 **	0.0	0.0
BroadStar	150 lb	0.8	0.6	0.0
Gallery + Ronstar WSP	1 lb + 2 lb	1.7 **	0.3	0.0
Untreated	--	0.0	0.0	0.0

z = weeks after treatment

y = visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable

x = visual ratings followed by *, ** are significantly different from the control based on Dunnett's t-test

($\alpha = 0.10$ and 0.05 , respectively).

Willoway Avon. Marengo G at 100 lb/ac did not injure the four species evaluated, *Hydrangea macrophylla* 'Endless summer', *Hydrangea arborescens* 'Invincible spirit', rose (*Rosa* 'Knockout'), and *Itea* (*Itea* 'Little Henry') (Table 7). The Gallery + Surflan (1 lb + 1 qt) did cause significant injury to *Hydrangea macrophylla* (rating 3.8 and 4.8, at 2 (Fig. 8) and 4 WAT, respectively) (Table 7); however, there was no injure to *Rosa* 'Knockout'. This was a different result from other years and compared to North Branch nursery, where the Gallery + Surflan has been quite phytotoxic to Rose (Table 7). From early on in the trial, random chlorosis across all treatments in the rose was occurring (Fig. 9). We later found out from the nursery manager that the cause of the problem was nutritional. This nutritional issue did eventually spread to all the species evaluated at both Willoway sites and resulted in our not conducting evaluation past 4 WAT.



Fig. 8. (Left) From left to right *Hydrangea macrophylla* 'Endless summer' control, Tower + Pendulum (21 oz + 2 qt/ ac) 2 WAT and Gallery + Surflan (1 lb + 1 qt) (rating 3.8).



Fig. 9. (Left) *Rosa* 'Knockout' 2 WAT showing random leaf chlorosis across all species that was not related to any herbicide at Willoway Nursery, Avon, OH.

Tower + Pendulum at (21 oz + 2 qt/ ac) and (1 qt/ac + 1qt/ac) caused significant injury to *Hydrangea macrophylla* 'Endless summer', *Hydrangea arborescens* 'Invincible spirit' and rose (*Rosa* 'Knockout'). The Itea (*Itea* 'Little Henry') was the only species not injured by the Tower + Pendulum. Injury to rose was not as severe as with the two *Hydrangea* species and was considered commercially acceptable throughout the trial period.



Fig. 10 A, B and C. **A.** (above – left) *Hydrangea macrophylla* 'Endless summer' Tower + Pendulum (21 oz + 2 qt/ ac) 2 WAT and **B.** (above - right) Tower + Pendulum (1 qt + 1 qt/ac). **C** (left) *Hydrangea arborescens* 'Invincible spirit' Tower + Pendulum (21 oz + 2 qt/ ac) 2 WAT at Willoway Nursery, Avon, OH.

Biathlon at 100 lb/ac and FreeHand at 150 lb/ac were increasingly injurious only to the *Hydrangea arborescens* reaching commercially unacceptable by 4 WAT (Table 7). Regal O-O at 100 lb/ac severely injured the *Hydrangea arborescens* on all dates. None of the species were affected by the Jewel.



Fig. 11 (A and B). (Above) A. Regal O-O at 100 lb/ac causing severe injury (rating 5.9) 2 WAT on *Hydrangea arborescens* 'Invincible spirit'. B. From left to right control and FreeHand at 150 lb/ac 2 WAT (rating 2.3) at Willoway Nursery, Avon, Ohio.

Table 7. Phytotoxicity on selected ornamentals from several herbicides at Willoway Nurseries, Avon, OH trial was initiated on April 19, 2013 with the exception of the *Hydrangea macrophylla* 'Endless summer' which needed to be retreated on May 1, 2013 due to a severe frost event that occurred after the April 19 applications.

Hydrangea arborescens 'Invincible spirit'

Treatment	Rate/ac	1 WAT ^z	2 WAT	4 WAT
Marengo G	100 lb	0.0 ^{yx}	1.5	1.7
Gallery + Surflan	1 lb + 1 qt	0.8	2.1	2.1
Tower + Pendulum	21 oz + 2 qt	1.8 **	3.9 **	4.4 **
Tower + Pendulum	1 qt + 1 qt	2.3 **	3.6 *	4.8 **
Biathlon	100 lb	0.6	2.5	3.4 *
FreeHand	150 lb	0.7	2.3	3.1
Regal O-O	100 lb	4.0 **	5.9 **	5.0 **
Jewel	100 lb	0.5	0.0	0.7
Untreated	--	0.0	1.1	0.9

Rosa 'Knockout'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT
Marengo G	100 lb	0.0	0.0	1.1
Gallery + Surflan	1 lb + 1 qt	0.8 *	1.6 **	0.8
Tower + Pendulum	21 oz + 2 qt	1.7	1.7 **	2.6 **
Tower + Pendulum	1 qt + 1 qt	0.9	1.6 **	2.4 **
Biathlon	100 lb	0.0	0.0	0.3
FreeHand	150 lb	0.0	0.0	0.4
Regal O-O	100 lb	0.5	0.0	1.2
Jewel	100 lb	0.0	0.0	0.7
Untreated	--	0.0	0.0	1.0

Hydrangea macrophylla 'Endless Summer'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT
Marengo G	100 lb	0.6	0.0	0.1
Gallery + Surflan	1 lb + 1 qt	1.8 **	3.8 **	4.8 **
Tower + Pendulum	21 oz + 2 qt	1.8 **	4.2 **	5.3 **
Tower + Pendulum	1 qt + 1 qt	1.1	2.7 **	4.0 **
Biathlon	100 lb	0.9	0.2	0.3
FreeHand	150 lb	0.3	0.8	1.2
Regal O-O	100 lb	1.0	0.3	0.0
Jewel	100 lb	1.0	1.1	0.5
Untreated	--	0.6	0.3	0.8

Itea virginica 'Little Henry'

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT
Marengo G	100 lb	0.0	0.7	0.3
Gallery + Surflan	1 lb + 1 qt	0.0	0.0	0.0
Tower + Pendulum	21 oz + 2 qt	0.0	1.0	0.0
Tower + Pendulum	1 qt + 1 qt	0.0	0.0	0.0
Biathlon	100 lb	0.0	0.0	0.2
FreeHand	150 lb	0.0	2.2 **	0.6 **
Regal O-O	100 lb	0.0	0.2	0.1
Jewel	100 lb	0.0	0.0	0.0
Untreated	--	0.0	0.2	0.0

z = weeks after treatment

y = visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable

x = visual ratings followed by *, ** are significantly different from the control based on Dunnett's t-test

($\alpha = 0.10$ and 0.05 , respectively).

Field studies.

Studebaker Nurseries. None of the treatments were phytotoxic to either *Buxus* 'Green velvet' or *Taxus densiformis* at any evaluation date (Table 8). All treatments provided commercially acceptable weed control (≥ 7) at Studebaker Nurseries through 4 WAT. Only the V-10366 at 30 oz/ac was commercially acceptable 1 WA2T (Table 9) (Fig. 12). By the second application, there was severe weed pressure at Studebaker Nurseries including Canada thistle, field bindweed and many of the weeds listed in Table 2, including musk thistle which favor abandoned sites and is indicative of the severe weed pressure at Studebaker Nurseries (Fig. 13).



Fig. 12. *Buxus* 'Green velvet' providing commercially acceptable weed control (≥ 7) at Studebaker Nurseries, New Carlisle, OH at 1 WA2T with V-10366 at 30 oz/ac.

Fig. 13. (Left) *Buxus* 'Green velvet' field at Studebaker Nurseries, New Carlisle, OH at 1 WA2T showing severe weed pressure including many of the weeds in Table 2 including musk thistle (below) which favors abandoned sites.





Table 8. Phytotoxicity on selected ornamentals from several herbicides at Studebaker Nurseries, New Carlisle, OH trial was initiated on May 6, 2013.

Buxus 'Green velvet'

Treatment	Rate/ac	1 WAT ^z	2 WAT	4 WAT	1 WA2T
V-10336	7.5 oz	0.8 ^{yx}	0.5	0.3	0.6
V-10336	15 oz	0.7	0.3	1.3	1.7
V-10336	30 oz	0.6	0.3	0.7	0.8
Tower + Pendulum	32 oz + 2 qt	0.0	0.0	0.0	0.0
SureGuard	12 oz	0.0	0.0	0.8	0.8
SureGuard	6 oz	0.8	0.7	1.8	1.9
Untreated	--	0.4	0.3	0.3	0.6

Taxus densiformis

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT	1 WA2T
V-10336	7.5 oz	0.0	0.0	0.8	1.0
V-10336	15 oz	0.8 **	0.1	0.0 **	0.0 **
V-10336	30 oz	0.0	0.2	1.1	1.4
Tower + Pendulum	32 oz + 2 qt	0.0	0.0	0.2 *	0.3 *
SureGuard	12 oz	0.0	0.2	0.4 *	0.5 **
SureGuard	6 oz	0.0	0.0	0.5	1.0
Untreated	--	0.0	0.1	1.5	2.1

z = weeks after treatment

y = Phytotoxicity visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable

x = Treatment means followed by *,** are significantly different from the untreated control for that date ($\alpha = 0.10$ and 0.05 , respectively).

Table 9. Efficacy with several herbicides at Studebaker Nurseries, New Carlisle, OH trial was initiated on May 6, 2013.

Weed control

Treatment	Rate/ac	1 WAT	2 WAT	4 WAT	1 WA2T
V-10336	7.5 oz	10.0 ^{wv} a	9.6 ab	8.8 bc	5.4 b
V-10336	15 oz	10.0 a	9.8 ab	9.5 ab	6.4 ab
V-10336	30 oz	10.0 a	9.9 a	10.0 a	7.5 a
Tower + Pendulum	32 oz + 2 qt	9.5 b	7.7 c	8.4 cd	5.9 b
SureGuard	12 oz	10.0 a	9.7 ab	9.5 ab	6.0 b
SureGuard	6 oz	9.9 a	9.1 b	9.3 abc	4.2 c
Untreated	--	9.2 c	7.8 c	7.7 d	1.4 d

w = Weed control ratings based on a 0-10 scale with 0 being no weed control and 10 perfect weed control with ≥ 7 commercially acceptable

v = Treatment means followed by the same letter in the same column are not significantly different based on lsmeans ($\alpha = 0.05$)

North Branch Nursery. All treatments were safe on the *Pinus strobus* and *Picea glauca*. Canada thistle, spiny sowthistle, yellow nutsedge, and prickly lettuce were the main weeds. The *Pinus strobus* was hoed prior to the second application, while *Picea glauca* was not. Therefore, only in the *Pinus strobus* were there two treatments that provided commercially acceptable weed control over all dates (Table 10). Biathlon was the best treatment for weed control in each species averaged across dates with a 7.8 rating in *Pinus strobus* and 5.0 rating in the *Picea glauca* (Fig. 14) (Table 10). Marengo also provided commercially acceptable weed control across all dates in the *Pinus strobus* (rating 7.3) (Table 10). V-10366 at 15 oz/ac provided comparable control to the non-treated (control plots) across all dates (Fig. 15) in pine (Table 10). Biathlon, however, was more capable of suppressing Canada thistle, which is why it had the highest ratings in both species (Table 10).

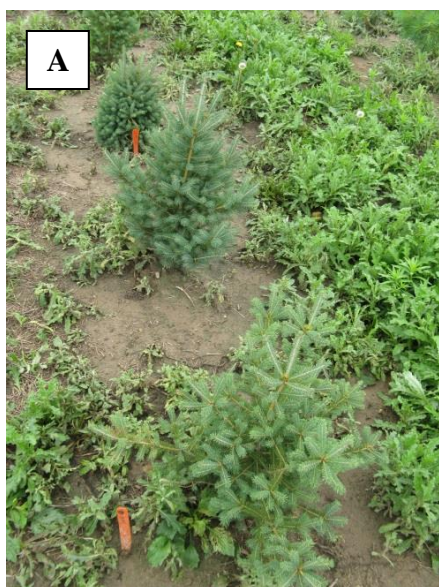


Fig. 14. A and B. A. (left) Note the region behind the first *Picea glauca* in the foreground where Biathlon was applied at North Branch Nursery, 4WAT compared to B. (below) Control plot in *Picea glauca*. Note the severe Canada thistle infestation on the control.



Fig. 15. A and B. A. (above) Note the region behind the first *Pinus strobus* in the foreground where V-10366 at 15 oz/ ac was applied at North Branch Nursery, 4WAT compared to B. Control plot in

Pinus strobus. Note the control with V-10336 at 15 oz/ ac was comparable to the un-treated plots over all dates.

Table 10. Phytotoxicity and efficacy (weed control) on selected ornamentals with several herbicides at North Branch Nursery, Pemberville, OH the trial was initiated on April 23, 2013 averaged across 6 dates of evaluation with reapplication at 6 WAT and evaluations being conducted to 4 WA2T.

Treatment	Rate/ac	<i>Pinus strobus</i>		<i>Picea glauca</i>	
		Phytotoxicity ^z	Weed control	Phytotoxicity	Weed control
Gallery + Barricade	1.3 lb + 21 oz	0.0 ^y no diff	2.0 ^{xw} cd	1.3 no diff	1.8 b
Tower + Pendulum	21 oz + 2 qt	1.3 no diff	6.3 ab	0.1 no diff	2.5 ab
Tower + Pendulum	1 qt + 1 qt	0.5 no diff	4.0 bc	1.2 no diff	2.3 ab
Biathlon	100 lbs	0.1 no diff	7.8 a	0.3 no diff	5.0 a
Marengo G	150 lbs	0.6 no diff	7.3 ab	0.3 no diff	3.5 ab
V-10336	15 oz	0.5 no diff	2.5 cd	0.4 no diff	3.5 ab
SureGuard	6 oz	0.6 no diff	1.5 d	0.0 no diff	2.0 b
Untreated	--	0.8 no diff	2.3 cd	0.0 no diff	2.0 b

z = Phytotoxicity and weed control ratings are averaged over all evaluation dates

y = Phytotoxicity visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable

x = Weed control ratings based on a 0-10 scale with 0 being no weed control and 10 perfect weed control with ≥ 7 commercially acceptable

w = Treatment ratings followed by the same letter in the same column are not significantly different based on lsmeans ($\alpha = 0.05$)

Timbuk Farms. With the newly planted Canaan Fir, *Abies balsamea* var *phanerolepis* also known as West Virginia Fir trees, Tower + Pendulum at 21 oz + 2 qt (Fig. 16 A), V-10366 at 15 oz/ac (Fig. 16 B) and SureGuard at 6 oz/ac (Fig. 16 C) caused significant, non- commercially acceptable injury (Table 11). The most phytotoxic treatment was the V-10366 on the newly planted trees (Table 11). The Tower + Pendulum at 21 oz + 2 qt and SureGuard injury, on the newly planted trees, were after the second application (Table 11). The V-10366 injury was after the first and second application (Table 11).

On the three year old trees the V-10366 at 15 oz/ac again caused the most injury; however, the injury occurred after the second application (Table 11). The Tower + Pendulum at 21 oz + 2 qt also became injurious at non-commercially acceptable levels after the second application to the three year old trees (Table 11). The addition of 1 qt of pendulum caused increased injury with both stages of Canaan fir. This was opposite to the container trial at North Branch where the increase in Tower caused more injury but a similar result to Willoway, Huron, OH where the higher rate of pendulum increased injury on *Azalea* and *Hydrangea*.



Fig. 16 A, B and C. **A.** (left) Newly planted *Abies balsamea* var *phanerolepis*, Canaan fir applied with Tower + Pendulum at 21 oz + 2 qt with significant, non- commercially acceptable injury 1WA2T at Timbuk Farms, Granville, OH; **B.** (below-left) applied with SureGuard 6 oz/ac. and **C.** (below – right) applied with V-10366 15 oz/ac.



Commercially acceptable (≥ 7) weed control occurred with all treatments until 1 WA2T averaged across dates (Table 12). At 1 WA2T Tower + Pendulum (21 oz + 2 qt) (Fig. 16 A) (1 qt + 1 qt); V-10366 at 15 oz/ac (Fig. 16 C); and SureGuard at 6 oz/ac (Fig. 16 B) were still providing commercially acceptable efficacy across dates (Table 12). Weed pressure was quite severe in the untreated plots by 1 WA2T (Fig. 17). By 2 WA2T, only Tower + Pendulum (21 oz + 2 qt), V-10366 and SureGuard were commercially acceptable across dates (Table 12). V-10366 at 15 oz/ac was the best treatment overall and Gallery + Barricade was the worst treatment for weed control (Table 12).



Fig. 17. Newly planted *Abies balsamea* var *phanerolepis*, Canaan fir showing untreated plot with severe weed pressure 1 WA2T at Timbuk Farms, Granville, OH.

Table 11. Phytotoxicity on two different sizes of field grown Canaan fir Christmas trees from several herbicides at Timbuk Farms, Granville, OH trial was initiated on July 9, '13.

First year Canaan fir

Treatment	Rate/ac	1 WAT ^z	2 WAT	3 WAT	4 WAT	1 WA2T	2 WA2T
Gallery + Barricade	1.3 lb + 21 oz	0.6 ^y ^x	0.0	0.8	0.6	2.9	2.8
Tower + Pendulum	21 oz + 2 qt	0.5	0.9	1.4	0.9	3.3 *	3.3 **
Tower + Pendulum	1 qt + 1 qt	1.2	0.2	1.0	0.0	2.3	2.5
Biathlon	100 lbs	0.8	0.6	0.5	0.0	0.9	0.9
Marengo G	150 lbs	0.8	0.6	0.5	0.0	1.4	1.1
V-10366	15 oz	3.4 **	3.0 **	2.6	2.5 *	5.8 **	6.5 **
SureGuard	6 oz	1.3	1.1	1.3	0.1	2.8	3.0
Untreated	--	1.4	0.5	1.3	0.3	0.3	0.4

3 year Canaan fir

Treatment	Rate/ac	1 WAT	2 WAT	3 WAT	4 WAT	1 WA2T	2 WA2T
Gallery + Barricade	1.3 lb + 21 oz	0.0	0.0	0.4	0.1	1.6	2.1
Tower + Pendulum	21 oz + 2 qt	0.0	0.0	0.0	1.5	3.9	3.1
Tower + Pendulum	1 qt + 1 qt	0.7	0.5	0.0	0.0	1.5	1.5
Biathlon	100 lbs	0.0	0.0	0.0	-0.1	0.1	0.3
Marengo G	150 lbs	4.1 **	0.0	0.0	0.4	0.5	0.6
V-10366	15 oz	0.0	0.4	1.8 **	2.5 **	4.5 **	4.4
SureGuard	6 oz	0.0	0.0	0.0	0.0	1.5	1.4
Untreated	--	0.0	0.3	0.4	0.0	1.3	1.5

z = weeks after treatment

y = phytotoxicity visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable

x = treatment means followed by *, ** are not significantly different from the untreated control at that evaluation date based on Dunnett's t-test ($\alpha = 0.10$ and 0.05 , respectively)

Table 12. Efficacy across two ages of field grown Canaan fir Christmas trees from several herbicides at Timbuk Farms, Granville, OH trial was initiated on July 9, 2013.

Treatment	Rate/ac	1 WAT ^z	2 WAT	3 WAT	4 WAT	1 WA2T ^y	2 WA2T
Gallery + Barricade	1.3 lb + 21 oz	9.3 ^{xw} ab	8.4 b	9.3 abc	7.8 c	6.3 c	5.6 d
Tower + Pendulum	21 oz + 2 qt	9.1 b	8.9 ab	9.4 abc	8.8 abc	7.3 abc	7.2 ab
Tower + Pendulum	1 qt + 1 qt	9.4 ab	8.9 ab	9.1 bc	8.2 bc	7.0 abc	6.7 bc
Biathlon	100 lbs	9.5 ab	8.8 ab	9.2 abc	9.3 a	6.7 bc	6.1 cd
Marengo G	150 lbs	9.7 a	8.8 ab	9.3 abc	9.1 ab	6.8 bc	6.1 cd
V-10366	15 oz	9.6 a	9.7 a	9.8 ab	9.3 a	8.2 a	8.1 a
SureGuard	6 oz	9.7 a	9.5 a	9.9 a	9.7 a	7.6 ab	7.5 ab
Untreated	--	9.4 ab	9.0 ab	9.0 c	8.2 bc	3.8 d	3.8 e

z = weeks after treatment

y = weeks after second treatment

x = weed control ratings based on a 0-10 scale with 0 being no weed control and 10 perfect weed control with ≥ 7 commercially acceptable

w = treatment means followed by the same letter in the same column are not significantly different based on lsmeans ($\alpha = 0.05$)

Liverwort Results.

WeedPharm was phytotoxic to boxwood, *Buxus microphylla* 'Winter gem' after the first application (Fig. 18) (Table 13). WeedPharm became phytotoxic to barberry, *Berberis* 'Orange Rocket' (Fig. 19); hydrangea, *Hydrangea arborescens* 'Incrediball'; and, Physocarpus 'Summer wine' after the second application (Fig. 22) (Table 13). SureGuard did not cause commercially unacceptable injury (≤ 3) to any of the species until after the second application. The 4 oz/ac rate was

consistently more phytotoxic than the 3 oz/ac (Table 13) with *Hydrangea arborescens* 'Incrediball' being almost completely killed with the 4 oz/ac rate (Table 13) (Fig. 20). Marengo was phytotoxic only to *Berberis* 'Orange Rocket' after the first application (Table 13). Marengo, like SureGuard, had increased phytotoxicity after the second application on all species, severely so on *Hydrangea arborescens* 'Incrediball' (Fig. 21) and *Physocarpus* 'Summer wine' (Fig. 22) (Table 13). The potassium bicarbonate (2.24 g/ft³) had the least amount of phytotoxicity in this study and never reached commercially acceptable injury even after the second application (Table 13). The only exception was *Hydrangea arborescens* 'Incrediball' at 12 WAT (rating 6.7). The untreated control also developed a high visual rating (5.0) at 12 WAT. It is probable the injury attributed to the potassium bicarbonate on hydrangea at 12 WAT was not a treatment effect. The baking soda (2.24 g/ft³) had low phytotoxicity on all species until 12 WAT on *Physocarpus* 'Summer wine' (Table 13). The baking soda (2.24 g/ft³) also became very phytotoxic with the *Hydrangea arborescens* 'Incrediball' at 12 WAT (rating 7.3) (Table 13). As with the potassium bicarbonate on hydrangea at 12 WAT, the high visual rating (5.0) at 12 WAT in the untreated control leads us to believe the injury was not a treatment effect. All treatments controlled liverwort very well; however, liverwort pressure was generally low (data not shown). SureGuard and Marengo provided excellent efficacy and low phytotoxicity as dormant applications; however, most species are sensitive to these products during bud break and after active growth is occurring. Baking soda, however, can be used during both dormant and active growth. The best combination for residual liverwort control would be to use SureGuard 3 oz/ac dormant or Marengo 9 oz/ac. followed by baking soda or K-bicarbonate applications in the active growth, as required. We recommend more work on these combinations to determine optimum rates and timings.



Fig. 18. (Left) *Buxus microphylla* 'Winter gem' from left to right control versus WeedPharm 10% v/v at 2 WAT at Decker's Nursery, Groveport, OH.



Fig. 19. (Left) *Berberis* 'Orange Rocket' from left to right WeedPharm 10% v/v versus control at 9 WAT or 1 WA2T at Decker's Nursery, Groveport, OH.



Fig. 20. (Left) *Hydrangea arborescens* 'Incrediball' 9 WAT with SureGuard 4 oz/ac at Decker's Nursery, Groveport, OH.



Fig. 21. (Left) *Hydrangea arborescens* 'Incrediball' 9 WAT with Marengo 9 oz/ac at Decker's Nursery, Groveport, OH.



Fig. 22. (Left) *Physocarpus* 'Summer wine' 9 WAT from left to right WeedPharm 10% v/v, Marengo 9 oz/ac and control at Decker's Nursery, Groveport, OH.

Table 13. Liverwort control trials were initiated at Decker's Nursery, Inc., Groveport, OH on February 28, 2013 in a covered hoop house that had minimum heat. Several herbicides were evaluated for their phytotoxicity on four crops with particular susceptibility to liverwort infestation. Reapplications were made on April 26, 2013 or 6 WAT.

<i>Berberis</i> 'Orange Rocket'								
Treatment	Rate	1 WAT ^z	2 WAT	4 WAT	8 WAT	9 WAT	10 WAT	12 WAT
SureGuard	3 oz/ac	0.0 ^x	0.0	1.4 **	0.0	1.7 **	2.0 **	3.0 **
SureGuard	4 oz/ac	0.0	0.0	1.9 **	0.0	2.6 **	2.7 **	4.0 **
Baking soda	2.24 g/ft ²	0.0	0.0	0.0	1.0 **	0.2	0.1	0.1
K-bicarbonate	2.24 g/ft ³	0.0	0.0	2.9 **	0.0	0.0	0.0	0.0
WeedPharm	10% v/v	0.0	0.0	2.0 **	0.0	8.7 **	7.7 **	2.8 **
Marengo SC	9 oz/ac	0.0	0.0	3.3 **	0.2	5.0 **	5.1 **	5.3 **
Untreated	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Buxus macrophylla</i>								
Treatment	Rate	1 WAT	2 WAT	4 WAT	8 WAT	9 WAT	10 WAT	12 WAT
SureGuard	3 oz/ac	0.8	0.4	1.2	0.0	1.4 **	2.6 **	3.0 **
SureGuard	4 oz/ac	0.7	0.6	0.7	0.2	0.9	3.1 **	3.0 **
Baking soda	2.24 g/ft ²	0.4	0.0	1.4	0.0	1.1 *	2.0 **	2.0 **
K-bicarbonate	2.24 g/ft ³	1.3	1.1	1.3	0.2	0.3	1.4 **	1.0 **
WeedPharm	10% v/v	2.9 **	6.0 **	5.2 **	5.3 **	5.7 **	6.4 **	5.8 **
Marengo SC	9 oz/ac	0.7	0.7	1.3	0.0	1.0	3.1 **	3.0 **
Untreated	--	0.6	0.6	0.7	0.0	0.0	0.0	0.0
<i>Hydrangea arborescens</i>								
Treatment	Rate	1 WAT	2 WAT	4 WAT	8 WAT	9 WAT	10 WAT	12 WAT
SureGuard	3 oz/ac	0.0	0.0	0.0	2.1	8.0 **	8.0 **	4.9
SureGuard	4 oz/ac	0.0	0.0	0.0	2.0	9.8 **	9.3 **	9.9 **
Baking soda	2.24 g/ft ²	0.0	0.0	0.0	0.1	1.7 **	2.9 **	7.3 **
K-bicarbonate	2.24 g/ft ³	0.0	0.0	0.0	0.3	0.0	1.0	6.7 **
WeedPharm	10% v/v	0.0	0.0	0.0	2.0	7.2 **	8.1 **	4.9
Marengo SC	9 oz/ac	0.0	0.0	0.0	5.6 **	6.9 **	8.7 **	9.6 **
Untreated	--	0.0	0.0	0.0	0.0	0.0	0.0	5.0
<i>Physocarpus</i> 'Summer wine'								
Treatment	Rate	1 WAT	2 WAT	4 WAT	8 WAT	9 WAT	10 WAT	12 WAT
SureGuard	3 oz/ac	0.0	0.0	0.0	0.0	2.0 **	1.0 **	3.0 **

SureGuard	4 oz/ac	0.0	0.0	0.0	0.0	1.7 **	0.0	2.8 **
Baking soda	2.24 g/ft ²	0.0	0.0	0.0	0.0	1.0 **	1.0 **	3.6 **
K-bicarbonate	2.24 g/ft ³	0.0	0.0	0.0	0.0	0.0	0.1	1.0 **
WeedPharm	10% v/v	0.0	0.0	0.0	0.0	7.8 **	8.3 **	4.4 **
Marengo SC	9 oz/ac	0.0	0.0	0.0	0.0	4.6 **	7.9 **	5.8 **
Untreated	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0

z = weeks after treatment

y = visual ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤3 commercially acceptable

x = visual ratings followed by *, ** are significantly different from the control based on Dunnett's t-test ($\alpha = 0.10$ and 0.05, respectively)

Difficult weeds. Rorippa trial.

Preemergence trial. Trials to control *Rorippa sylvestris* (creeping yellow cress) preemergence in *Syringa vulgaris* liner fields resulted in Corsair, Certainty, and SedgeHammer providing perfect efficacy through 8 WAT (Table 15). Corsair provided the highest efficacy at 11 WAT and was the only treatment that was significantly better than the untreated controls (Table 15). Lontrel provided little to no preemergence efficacy for creeping yellow cress. This is not surprising, as Lontrel is not labeled as a preemergence herbicide. V-10336 provided excellent control through 5 WAT; however, by 6 WAT, efficacy decreased to a rating of 5.5, only slightly better than untreated (Table 15).

Phytotoxicity varied among the treatments (Table 14). Corsair, although extremely efficacious, was also extremely phytotoxic. BY 11 WAT, all the lilacs were dead in the Corsair plots (Table 14). V-10336 at 15 oz/ac was also very phytotoxic to lilac by 11 WAT (Table 14). V-10336 became more phytotoxic as the trial progressed (Table 14), even though it was applied during dormancy. Casoron also became increasingly phytotoxic over time and significantly so by 11 WAT (Table 14). We recommend Certainty and SedgeHammer be used in further studies for preemergence control of *Rorippa* in lilacs and other species as both showed promise in efficacy and reduced phytotoxicity.

Table 14. Phytotoxicity to *Syringa vulgaris* from selected preemergence applications applied April 4, 2013.

Phytotoxicity

Treatment	Rate/ac	4 WAT ^z	5 WAT	6 WAT	8 WAT	11 WAT
Corsair	5.3 oz	7.5 ^y _x	8.3 **	9.0 **	9.3 **	10.0 **
Certainty	1 oz	4.5	4.5	5.5	6.5	5.0
SedgeHammer	2 oz	5.3	5.3	6.3 *	6.0	4.8
Lontrel	1 pt	3.3	3.5	4.8	4.5	4.3
V-10336	15 oz	3.8	4.3	5.0	7.3	7.0 **
Diuron	3 lb	2.0	3.0	4.5	5.8	5.8
Casoron + PN	3 gal	3.5	4.8	5.3	6.3	8.0 **
Untreated	--	2.3	1.5	2.5	3.5	2.5

Table 15. Efficacy in *Syringa vulgaris* fields for *Rorippa sylvestris* (creeping yellow cress) from selected preemergence applications applied April 4, 2013.

Creeping yellow field cress control

Treatment	Rate/ac	4 WAT		5 WAT		6 WAT		8 WAT		11 WAT	
Corsair	5.3 oz	9.0 ^{wv}	a	9.3	a	10.0	a	10.0	a	9.8	a
Certainty	1 oz	10.0	a	9.5	a	10.0	a	10.0	a	8.8	ab
SedgeHammer	2 oz	10.0	a	9.8	a	10.0	a	9.8	a	8.5	abc
Lontrel	1 pt	2.8	c	3.3	d	6.8	bcd	7.0	bc	6.8	bc
V-10336	15 oz	9.5	a	7.5	ab	5.5	cd	2.5	d	5.8	c
Diuron	3 lb	4.3	bc	6.3	bc	7.5	bc	7.8	ab	8.3	abc
Casoron + PN	3 gal	6.3	b	8.0	a	7.8	ab	7.0	bc	9.0	ab
Untreated	--	3.5	c	4.0	cd	5.0	d	4.8	cd	6.0	bc

Note. For Table 14 and 15.

z = weeks after treatment

y = Phytotoxicity ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤ 3 commercially acceptable

x = Treatment ratings followed by *,** are significantly different from the control, based on Dunnett's t-test ($\alpha = 0.10$ and 0.05 , respectively)

w = Control ratings are based on a 0-10 scale with 0 being no control and 10 perfect control with ≥ 7 commercially acceptable

v = Treatment ratings followed by the same letter in the same column are not significantly different based on lsmeans ($\alpha = 0.05$)

Postemergence trial. All of the treatments caused greater phytotoxicity than the control (Table 16). Lontrel, however, was the only treatment where the injury was near commercially acceptable (Table 16). More work and trials need to be conducted to determine the best option for control of creeping yellow field cress in field situations.

Excellent efficacy was achieved with six of the eight treatments; Marengo SC and Lontrel were the only two treatments not providing acceptable control at 5 WAT (Table 17). Marengo was significantly better than the control at 2 WAT, but not 5 WAT (Table 17). Lontrel, although not commercially acceptable, provided better control than Marengo and the untreated plots and was similar to Diuron at 5 WAT (Table 17) Corsair, just like in the preemergence trial, provided the best control of *Rorippa*.

We recommend Lontrel be further studied for control of *Rorippa* as it was the only product to provide near acceptable phytotoxicity and some level of weed control. Although Lontrel's efficacy was not as high as some of the other products, it seems to be the only one with promise.

Table 16. Phytotoxicity to *Syringa vulgaris* from selected postemergence herbicide applications applied May 16, 2013.

Phytotoxicity

Treatment	Rate/ac	2 WAT ^z		5 WAT	
Corsair	5.3 oz	6.0 ^{yx}	**	9.8	**
Certainty	1 oz	4.8	**	6.3	**

SedgeHammer	2 oz	6.0	**	7.3	**
Classic	2/3 oz	6.5	**	8.8	**
Lontrel	1 pt	3.8	**	3.3	**
V-10336	15 oz	9.0	**	7.8	**
Diuron	3 lb	7.5	**	7.5	**
Marengo SC	9 oz	4.3	**	6.0	**
Untreated	--	1.0		0.8	

Table 17. Efficacy in *Syringa vulgaris* fields for *Rorippa sylvestris* (creeping yellow cress) from selected postemergence applications May 16, 2013.

Creeping yellow field cress control

Treatment	Rate/ac	2 WAT		5 WAT	
Corsair	5.3 oz	9.0 ^{wv}	a	9.8	a
Certainty	1 oz	9.0	a	9.5	a
SedgeHammer	2 oz	8.8	ab	9.0	a
Classic	2/3 oz	9.0	a	9.5	a
Lontrel	1 pt	6.0	c	6.5	b
V-10336	15 oz	9.0	a	9.0	a
Diuron	3 lb	6.5	bc	7.8	ab
Marengo SC	9 oz	6.8	abc	5.5	bc
Untreated	--	3.0	d	2.3	c

Note: For table 16 and 17:

z = weeks after treatment

y = Phytotoxicity ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤3 commercially acceptable

x = Treatment ratings followed by *, ** are significantly different from the control, based on Dunnett's t-test ($\alpha = 0.10$ and 0.05 , respectively)

w = Control ratings are based on a 0-10 scale with 0 being no control and 10 perfect control with ≥7 commercially acceptable

v = Treatment ratings followed by the same letter in the same column are not significantly different based on lsmeans ($\alpha = 0.05$)

From our pre- project start surveys we found that liner bed growers were using the following herbicides, Rout, Barricade, Snapshot, SureGuard, Pendulum, Round up, Goal, Tower, Lontrel and 2, 4-D. On average, they were spending \$250.00/ac to hand weed problem areas with difficult weeds such as *Rorippa*. We had targeted to reduce their weed program cost by 30%. We accomplished this goal. The acceptable use of Lontrel in this study provided 35% control, thus reducing hand weeding costs by 35%.

Table 18. Summary of some herbicides and crops that experienced **no phytotoxicity** at the seven sites in 2013.

Herbicide	No phytotoxicity	Comments
Marengo G (100, 150, 200, 400 lb/ac)	<i>Azalea</i> 'Karen'	
	<i>Pieris</i> 'Red Mill'	
	<i>Ilex x meserveae</i> 'Blue Maid'	
	<i>Hemerocallis</i> 'Stella d oro'	

	<i>Hydrangea paniculata</i> 'Limelight'	
	<i>Hydrangea paniculata</i> 'Little Lamb'	
	<i>Rhododendron</i> 'Nova Zembla'	
Marengo (100 lb/ac)	<i>Hydrangea arborescens</i> 'Invincibelle spirit'	
	<i>Hydrangea macrophylla</i> 'Endless Summer'	
	<i>Itea virginica</i> 'Little Henry'	
Marengo G (100,200 lb/ac)	<i>Viburnum</i> X 'Juddi'	
	<i>Buxus sempervirens</i> 'Vardar Valley'	
	<i>Taxus</i> X media 'Runyon'	
	<i>Rosa</i> 'Knockout'	
Biathlon (100, 200, 400 lb/ac)	<i>Azalea</i> 'Karen'	
	<i>Pieris</i> 'Red Mill'	
	<i>Ilex</i> x <i>meserveae</i> 'Blue Maid'	
	<i>Rhododendron</i> 'Nova Zembla'	
	<i>Hydrangea paniculata</i> 'Little Lamb'	
	<i>Viburnum</i> 'Juddi'	
Biathlon (100 lb/ac)	<i>Hydrangea macrophylla</i> 'Endless Summer'	
	<i>Itea virginica</i> 'Little Henry'	
	<i>Rosa</i> 'Knockout'	
	<i>Pinus strobus</i>	Field
	<i>Picea glauca</i>	Field
	Canaan fir (newly planted)	Field
	Canaan fir (3 yr. old)	Field
Gallery + Surflan (1.3 lb + 1 qt/ac)	<i>Azalea</i> 'Karen'	
	<i>Pieris</i> 'Red Mill'	
	<i>Ilex</i> x <i>meserveae</i> 'Blue Maid'	
	<i>Hemerocallis</i> 'Stella d oro'	
	<i>Viburnum</i> 'Juddi'	
	<i>Hydrangea paniculata</i> 'Little Lamb'	
	<i>Rhododendron</i> 'Nova Zembla'	
	<i>Ilex</i> x <i>meserveae</i> 'Blue Maid'	
Gallery + Surflan (1.3 lb +	<i>Buxus sempervirens</i>	

1 qt/ac) and (1.3 lb + 2qt)	'Vardar Valley'	
	<i>Taxus X media</i> 'Runyon'	
Gallery + Barricade (1.3 lb + 21 oz)	<i>Azalea</i> 'Karen'	
	<i>Pieris</i> 'Red Mill'	
	<i>Ilex x meserveae</i> 'Blue Maid'	
	<i>Viburnum X</i> 'Juddi'	
	<i>Hydrangea paniculata</i> 'Limelight'	
	<i>Hydrangea paniculata</i> 'Little Lamb'	
	<i>Rhododendron</i> 'Nova Zembla'	
	<i>Pinus strobus</i>	Field
	<i>Picea glauca</i>	Field
	<i>Canaan fir</i> (newly planted)	Field
	<i>Canaan fir</i> (3 yr. old)	Field