Weed Control

Joseph C. Neal
Section Editor and Moderator

Fertilizer Placement and Herbicide Rate Affect Weed Growth in Containers

James E. Altland and Glenn B. Fain
North Willamette Research and Extension Center
Oregon State University, Aurora, OR 97002

Index words: dibble, topdress, incorporate

Nature of Work: Successful weed management is necessary to produce saleable container crops. Weed control in container production is achieved primarily through use of preemergence herbicides in conjunction with some hand-weeding. Preemergence herbicides are expensive and not 100% effective. Cultural practices and environmental factors influence weed and crop growth. Placement of controlled release fertilizers (CRFs) will affect the spatial availability of nutrients in containers, and thus could affect weed growth. In container production, CRFs are commonly applied by one of three placement methods: topdressing (applied on the substrate surface after potting), incorporating (mixing CRFs into the substrate prior to potting), or dibbling (placing CRFs just below the liner rootball while potting). Fertilizer placement affects container crop growth. Meadows and Fuller (4) reported dibble placement of Osmocote 18N-2.6P-10.0K (18-6-12) and 17N-3.0P-10.1K (17-7-12) to be more efficient than incorporation, resulting in faster plant "green-up" and superior plant quality. Fertilizer placement also affects seedling establishment. Seeds require available nutrients for establishment. Physiological tradeoffs prevent most plants from adapting to environments of high and low nutrient availability, and agricultural weeds are at one end of this adaptive continuum, in that they generally outcompete other corps in high nutrient environments but compete poorly in low nutrient environments (3). Bark is the primary component used in outside container nursery crop production. Bark substrates are inherently low in available nutrients (2). Thus without a fertilizer source, weed germination and growth would be limited. When CRFs are used as the sole source of nitrogen (N), phosphorus (P), and potassium (K) in containers, placement (topdressed, incorporated, or dibbled) should affect the level of available nutrients on the container surface, thus affecting weed seedling establishment and subsequent growth.

Little research has addressed the effects of cultural practices on weed growth and herbicide effectiveness in container production. The objectives of this research were to determine the effect of fertilizer placement on weed seedling establishment, container crop growth, and potential interactions with preemergence herbicide efficacy.

Experiment 1. The first experiment was conducted at the North Willamette Research and Extension Center (NWREC) in Aurora, Ore. 'Stewartsonia' azalea (Rhododendron 'Stewartsonia') were potted April 30, 2002, in #1 (3-L) containers with a 100% Douglas fir bark amended with 1.5 lbs/yd^3 Micromax micronutrients. Treatment design was a 3×4 factorial, with 3 fertilizer placement methods and 4 herbicide rates. Osmocote 18N-2.6P-10.0K (18-6-12; Scotts Co.) was applied at potting at 0.4 oz per container either topdressed, incorporated, or dibbled.

Topdressed fertilizers were placed on the container surface, incorporated fertilizers were premixed into the bark just prior to potting, and dibbled fertilizers were placed immediately beneath the root ball of azalea liners, 8 cm below the container surface. Azaleas were selected for uniformity from a larger group and were approximately 7.5 inches tall and 7 inches wide at potting. On May 7, 2002, Ornamental Herbicide 2 (OH2, 2% oxyfluorfen + 1% pendimethalin) was applied at 0, 25, 50, or 100 lbs/acre with a handheld shaker. Applications were immediately followed by 0.5 inch of irrigation, and containers were overhead irrigated with 0.5 inch/day thereafter. Approximately 60 seeds of common groundsel (*Senecio vulgaris*) were applied to the surface of each container May 8, 2002. Data collected included weed control ratings on a scale from 0 to 100 (where 0 = no control and 100 = complete control) 5 and 8 WAT, azalea quality rating on a scale from 1 to 10 (where 1 = poor quality and 10 = excellent quality) 8 WAT, and azalea growth index [(height + width + width)÷3] 8 WAT. Data were subjected to analysis of variance, regression analysis, and means were separated with Duncan's multiple range test ($\alpha = 0.05$). Weed counts were square root transformed prior to analysis to improve homogeneity of variance; however, actual values are reported in tables and text. The experiment was arranged in a completely randomized design with 8 replications per treatment combination.

Experiment 2. Expt. 2 was conducted similarly to Expt. 1 with the following exceptions. The experiment was conducted at the Truck Crops Branch Experiment Station in Crystal Springs, Miss. 'Compacta' holly (*Ilex crenata*) were potted May 18, 2002 in 8:1 (v:v) pinebark:sand medium amended with 5 lb/yd^3 of dolomitic limestone and 1.5 lb/yd^3 of Micromax micronutrients. Rout (oxyfluorfen + oryzalin; Scotts Co.) was applied May 19, 2002, using the same herbicide rates applied in Expt. 1 with the addition of a hand-weeded check. Osmocote 17-7-12 was applied at 0.6 oz per container; and was placed 3 inches below the container surface for the dibbled treatments. Containers were overseeded with 20 prostrate spurge (*Chamaesyce prostrata*) seeds per container. Data collected included prostrate spurge counts 4 and 8 WAT, weed control ratings 8 WAT, weed shoot dry weight 12 WAT, and holly growth index 12 WAT.

Results and Discussion: _Experiment 1._ CRF placement and herbicide rate interacted to affect weed control ratings. By 8 WAT, weed control in topdressed and incorporated containers increased linearly and quadratically, respectively, with increasing herbicide rate (Table 1). In topdressed and incorporated containers, the recommended herbicide rate (100 lb/acre) provided 86 and 92% control, respectively. Lower rates, while less than the recommended rate, provided poor control. Dibbled containers did not respond to herbicide rate, and averaged 91.5% control across rates. Even when no herbicides were used in dibbled containers, weed control was acceptable.

Incorporating CRFs reduced azalea growth index by 9% compared to dibbling and 11% compared to topdressing (Table 2). Azalea growth index increased linearly with increasing herbicide rate. Differences were small, not obvious by casual observation, and only revealed after statistical analysis. Across fertilizer placement methods, weed control and azalea growth index increased with increasing herbicide rate, suggesting competition from common groundsel. Berchielli-Robertson et al. (1) also reported competition from container weeds to reduce crop growth. Dibbling and topdressing CRFs resulted in higher quality ratings than incorporating. This concurs with Meadows and Fuller (4) who reported higher quality ratings of three azalea cultivars from dibbling compared to incorporating.

Experiment 2. By 8 WAT, weed control in containers where fertilizers were dibbled was > 90%, while control in topdressed and incorporated treatments were 85% and 88%, respectively. The Rout label recommends reapplication intervals not be less than 12 weeks (3 months), however, when CRFs were topdressed or incorporated, control was at best marginal by only 8 WAT. In Expts. 1 and 2, incorporation generally resulted in numerically greater, though statistically similar, weed control compared to topdressing (summarizing across all measured weed parameters). Previous research supports these observations. In two separate experiments evaluating Rout (among other products) for prostrate spurge control, Rueter and Glaze (5) reported 86 and 96% control of prostrate spurge (*Euphorbia humistrata*) 8 and 12 WAT, respectively, after incorporating CRFs; while Whitwell and Kalmowitz (6) reported 52 and 59% control of prostrate spurge (also *Euphorbia humistrata*) 8 and 12 WAT after topdressing CRFs. Fertilizer placement may explain some of the discrepancy between results in these two studies.

Weed shoot dry weight was 56 and 61% less in containers where CRFs were dibbled compared to topdressed and incorporated, respectively. Weed shoot dry weight decreased quadratically with increasing herbicide rate.

Holly growth index was greater in dibbled containers than topdressed or incorporated, though differences were not commercially important. Growth index increased linearly with increasing herbicide rate. Similar to Expt. 1, increased growth index was likely a result of reduce weed pressure in containers with higher herbicide rates.

Significance to Industry: In conclusion, data herein suggest that topdressing CRFs results in poorer weed control when compared to dibble-applied CRFs even when recommended herbicide rates are used. Furthermore, reduced herbicide rates may be possible when combined with dibble-applied fertilizers. Results were generally similar across two geographical regions, using different herbicides and weed species. Dibbling CRFs reduced weed shoot dry weights compared to topdressing and incorporating, and resulted in acceptable weed control even when no herbicides were used. Dibbling fertilizers is a cultural practice that can be incorporated into most nursery production systems to reduce weed pressure and improve effectiveness of preemergence herbicide programs without adversely affecting crop growth.

Literature Cited:

1. Berchielle-Roberstion, D.L., C.H. Gilliam, and D.C. Fare. 1990. Competitive effects of weeds on the growth of container-grown plants. HortScience 25: 77-79.

2. Landis, T.D., R.W. Tinus, S.E. McDonald, and J.P. Barnett. 1990. Containers and Growing Media, Vol. Two, The Container Tree Nursery Manual. Agric. Handbk. 674. Department of Agriculture, Forest Service, Washington, DC.
3. Liebman, M., C.L. Mohler, and C.P. Staver. 2001. Ecological Management of Agricultural Weeds. Cambridge University Press, NY.
4. Meadows, W.A. and D.L. Fuller. 1983. Relative effectiveness of dibble applied vs. incorporated Osmocote for container grown woody ornamentals. Proc. Southern Nursery Res. Conf. 28:63-66.
5. Ruter, J.M. and N.C. Glaze. 1992. Herbicide combinations for control of prostrate spurge in container-grown landscape plants. J. Environ. Hort. 10:19-22.
6. Whitwell, T. and K. Kalmowitz. 1989. Control of prostrate spurge (*Euphorbia humistrata*) and large crabgrass (*Digitaria sanquinalis*) in container grown *Ilex crenata* 'Compacta' with herbicide combinations. J. Environ. Hort. 7:35-37.

Table 1. Effect of fertilizer placement and herbicide rate on weed control in containers 8 WAT (Expt. 1).

	OH2[y] (lb/acre)				
Fertilizer placement	0	25	50	100	
Topdressed	19 c	65 b	75 b	86 a	Q***
Incorporated	55 b	79 ab	71 b	92 a	L***
Dibbled	85 a	89 a	95 a	97 a	NS

[z]Weeks after herbicide treatment.

[y]Ornamental Herbicide 2 (Scotts Co., Marysville, Ohio).

[x]Means with different letters are significantly different, separated by Duncan's Multiple Range test (a = 0.05).

L, Q, and NS represent linear, quadratic, and nonsignificant rate response, respectively.

*, **, and *** represent significance where P ≤ 0.05, 0.01, and 0.001.

Table 2. Effect of fertilizer placement and herbicide rate on azalea growth index (Expt. 1).

Fertilizer placement	Growth index (cm)[z]	Quality rating[y]
Topdressed	33.0 a[x]	6.7 a
Incorporated	29.3 b	5.5 b
Dibbled	32.0 a	7.0 a
Ornamental Herbicide 2 (lb/acre)		
0	29.8	6.1
25	31.9	6.5
50	31.7	6.0
100	32.2	7.0
	L*	Q*

[z]Growth index = (height + width + width)/3.

[y]Quality rating on a scale from 1 to 10 where 1 = poor quality and 10 = high quality.

[x]Means with different letters are significantly different, separated by Duncan's Multiple Range test (a = 0.05).

L and Q represent linear and quadratic rate response.

*, **, and *** represent significance where P ≤ 0.05, 0.01, and 0.001.

Table 3. Effect of fertilizer placement and herbicide rate on weed numbers in containers (Expt. 2).

		Control (%)	Weed SDW[y]	
Fertilizer placement		8 WAT	12 WAT	Holly growth index (cm)
Topdressed		85 b	6.4 a	8.9 b
Incorporated		88 ab	7.2 a	8.5 b
Dibbled		93 a	2.8 b	9.7 a
Handweed		100	0.0	9.4
OH2	0	69	11.4	8.7
	25	94	4.9	9.1
	50	94	4.5	8.7
	100	99	1.1	9.3
		L***Q***	L***Q**	L*

[z]Weed numbers were square root transformed prior to analysis, actual values are presented.

[y]Shoot dry weight (g).

[x]Growth index = (height + width + width)/3.

[w]Weeks after herbicide treatment.

[v]Means with different letters are significantly different, separated by Duncan's Multiple Range test (a = 0.05).

L and NS represent linear and nonsignificant rate response, respectively.

*, **, and *** represent significance where P ≤ 0.05, 0.01, and 0.001.

Fertilizer Placement Affects Weed Growth in Container Production

Glenn B. Fain and Patricia R. Knight
Mississippi State University
Truck Crops Branch Experiment Station
Crystal Springs, MS 39059

Charles H. Gilliam and John W. Olive
Department of Horticulture, Auburn University, AL 36849

Index words: dibble, top-dress, controlled release fertilizer, spurge, chamaecyce

Nature of Work: Weed control in container production is achieved primarily through use of preemergence herbicides, along with some hand-weeding. Since most herbicide programs are not 100% effective, growers are continually evaluating new strategies to improve weed control in their nurseries. Fertilizer placement has been shown to affect weed growth in several agronomic cropping systems. Banding of fertilizers below the soil surface in wheat (*Triticum aestivum)* (1) and peanut (*Arachis hypogaea*) (2) reduced weed growth compared to broadcast surface applications. However, the potential impact of fertilizer placement on weeds in container crops has not been investigated. Dibble fertilization is when fertilizer is placed directly beneath the liner being transplanted.

Pinebark is the primary component of soilless plant growth substrates used in Southerastern U.S. nursery crop container production. Pinebark substrates are inherently low in cation exchange capacity and available nutrients (3). Thus, without a fertilizer source, weed seedling establishment and growth may be limited in pinebark substrates. Fertilizer placement (topdressed or dibbled) should affect the level of available nutrients on the container surface, thus affecting weed germination and subsequent growth. Therefore the objective of this research was to determine the effect of fertilizer placement on prostrate spurge germination and growth in container crops. Experiments were conducted at Truck Crops Branch Experiment Station in Crystal Springs, MS, and the Auburn University Ornamental Horticulture Research Center, Mobile, AL.

<u>*Experiment 1:*</u> At the Truck Crops Branch Experiment Station in Crystal Springs, MS, uniform one gallon wax leaf ligustrum were potted on May 24, 2002, in 7 gallon containers using an 8:1 (v:v) pinebark:sand medium amended per m^3 (yd^3) with 2.97 kg (5 lb) of dolomitic limestone and 0.9 kg (1.5 lb) of Micromax (The Scotts Co.) micronutrients. Polyon (Purcell Technologies Inc.) 17-5-11 was applied at 180 g (5.9 oz) per container either topdressed or dibbled. Plants were placed in full sun under overhead irrigation. Thirty DAP one half of the containers were seeded with 20 prostrate spurge seed. Experimental design was a randomized complete block with eight single plant replicates. Data collected were initial plant growth indices [(height + width + width) ÷3], percent weed coverage (PWC) and weed count (number of weeds per pot) at 60, 90, and 120 days after potting (DAP). Weed shoot dry weight (SDW) and ligustrum growth indices were measured at 120 DAP.

*Experiment 2: Experiment t*wo was conducted at the Auburn University Ornamental Horticulture Research Center, Mobile, AL. Methods were the same except the potting substrate was 3:1 (v:v) pinebark:peat amended per m^3 (yd^3) with 3.56 kg (6 lb) dolomitic limestone, 1.19 kg (2 lb) gypsum and 0.9 kg (1.5 lb) Micromax micronutrients.

Results and Discussion: *Experiment 1.* There were no interactions between fertilizer placement and prostrate spurge seeding. By 90 DAP there were no differences in prostrate spurge count or PWC, whether over-seeded or not (Table 1). This was most likely due to the high weed pressure in and around the study site. At 120 DAP ligustrum in seeded containers were statistically larger than those in non-seeded containers; however, this difference was not noticeable and would not be considered a marketable difference. By 90 DAP prostrate spurge count and PWC were 230 to 423% greater, respectively, for topdressed containers, compared to dibbled containers. At 120 DAP SFW was 313% greater for topdressed containers, compared to dibbled containers. There was no difference in final plant growth index between fertilizer placement methods.

Experiment 2: There were no interactions between fertilizer placement and prostrate spurge seeding. By 90 DAP there was no difference in PWC regardless of whether containers were over-seeded or not (Table 2). At 120 DAP weed count and SFW were 121 and 269% greater in topdressed containers, compared to dibbled containers. At 120 DAP seeded containers had a SDW 269% greater than non-seeded containers. By 90 DAP PWC was 111% greater among containers which were topdressed compared to dibbled containers. Analysis of the data indicated ligustrum in topdressed containers were larger than those in dibbled containers; however, these differences were not considered economically important.

Dibbling fertilizer minimizes the amount of nitrogen, phosphorus and potassium available at or near the container surface where weeds germinate. Small seeded weeds like prostrate spurge with limited nutrient reserves would have difficulty obtaining needed nutrients in dibbled containers. It is likely that nutrient deficiencies of spurge seedlings resulted in the differences in prostrate spurge weight in the containers where dibbled fertilizer was used.

In conclusion, data herein suggest that dibbling fertilizer results in reduced prostrate spurge growth when compared to top-dressed fertilizer applications. Results were similar in tests conducted at two locations. Dibbling fertilizers is a cultural practice that can be incorporated into most nursery production systems to reduce weed pressure resulting in less hand-weeding, less competition to the nursery crop and possibly fewer herbicide applications.

Significance to the Nursery Industry: Container growers rely heavily on preemergence herbicides and hand labor for weed control. Even with a good preemergence herbicide weed control program, less than 100% control is obtained. Some growers of large container plants rely only on hand-weeding. Data herein indicate fertilizer placement influences weed control. Dibbling fertilizers (placement of the fertilizer below the liner roots immediately prior to potting) reduced prostrate spurge seedling establishment and reduced subsequent spurge growth, compared to topdressing fertilizers. Dibbling fertilizer reduced weed growth, compared to topdressing fertilizer, and resulted in similar crop shoot growth. Understanding how cultural practices, like fertilizer placement affect weed control will help growers better manage their crops and weed control program. These data provide growers another non-chemical option when developing weed control strategies for container-grown nursery crops.

Literature Cited:

1. Chochran, B.L., L.A. Morrow, and R.D. Schirman. 1990. The effect of N placement on grass weeds and winter wheat responses in three tillage systems. Soil Tillage Res. 18:347-355.
2. Everaarts., A.P. 1992. Response of weeds to the method of fertilizer application on low-fertility acid soils in Suriname. Weed Res. 32:391-397.
3. Landis, T.D., R.W. Tinus, S.E. McDonald, and J.P. Barnett. 1990. Containers and Growing Media, Vol. Two, The Container Tree Nursery Manual. Agric. Handbk. 674. Department of Agriculture, Forest Service, Washington, DC.

Table 1. Effect of fertilizer placement and over-seeding on spurge control in 7 gallon containers (Experiment 1).

	Ligustrum	Prostrate Spurge							Ligustrum
	GI[y]	Count	% Coverage	Count	% Coverage	Count	% Coverage	Weight[z]	GI
Fertilizer Placement	0 DAP[x]	60 DAP	60 DAP	90 DAP	90 DAP	120 DAP	120 DAP	120 DAP	120 DAP
Topdressed	60.1 a[w]	0.9 a	2.8 a	6.8 a	28.1 a	17.1 a	58.1 a	18.6 a	111.3 a
Dibbled	61.9 a	0.4 a	1.9 a	1.3 b	8.5 b	0.6 b	8.6 b	4.5 b	110.8 a
Seed Source									
Seeded	60.9 a	0.9 a	3.4 a	4.1 a	21.4 a	9.6 a	35.9 a	11.9 a	115.1 a
Non-Seeded	61.0 a	0.4 a	1.3 b	3.9 a	15.3 a	8.2 a	30.8 a	11.2 a	107.1 b

[z]Spurge dry weight in grams.

[y]Ligustrum growth index (cm) = (height + width + width)/3.

[x]Days after potting.

[w]Means(within a column and for each factor) with different letters are significantly different, according to Duncan's Multiple Range Test (a = 0.05).

Table 2. Effect of fertilizer placement and over-seeding on spurge control in 7 gallon containers (Experiment 2).

	Ligustrum	Prostrate Spurge					Ligustrum
	GI[y]	Count	Count	% Coverage	Count	Weight[z]	GI
Fertilizer Placement	0 DAP[x]	60 DAP	90 DAP	90 DAP	120 DAP	120 DAP	120 DAP
Topdressed	56.0 a[w]	2.9 a	3.6 a	42.3 a	7.1 a	21.9 a	95.6 a
Dibbled	54.9 a	2.1 a	3.7 a	20.0 b	5.4 b	9.9 b	90.1 b
Seed Source							
Seeded	55.6 a	4.0 a	5.1 a	37.2 a	7.6 a	25.1 a	93.7 a
Non-Seeded	55.3 a	0.9 b	2.3 b	25.1 a	4.9 a	6.8 b	92.1 a

[z]Spurge dry weight in grams.

[y]Ligustrum growth index (cm) = (height + width + width)/3.

[x]Days after potting.

[w]Means(within a column and for each factor) with different letters are significantly different, according to Duncan's Multiple Range Test (a = 0.05).

Comparison of Oxyfluorfen and Flumioxazin for Weed Control in Field Nurseries

Marzena Mackiewicz and James Altland
Oregon State University, North Willamette Research and Extension Center, Aurora, Oregon 97002

Index Words: Preemergence, Postemergence, SureGuard 51WDG, Goal 2XL, Christmas trees, Ornamental conifers

Nature of work: Weed control is an important component of Christmas tree and ornamental conifer production. Goal 2 XL (2 lb ai/gal liquid formulation of oxyfluorfen) is the most widely used herbicide for weed control in conifers. It is an effective herbicide with unique characteristics including: excellent preemergence control of broadleaf weeds (4), postemergence control of seedling broadleaf weeds (less than 4 inches tall), and demonstrated tolerance over a broad spectrum of conifers (2). While weed management programs vary from grower to grower, a common approach in Oregon has been to use the maximum labeled yearly rates of Goal, split into two applications. One application is made in spring prior to bud break, and another application in the fall after plant foliage has hardened off. Some growers complain that yearly Goal rates are insufficient for year-round weed control. To alleviate reliance on Goal and to improve year-round weed control strategies, alternatives should be explored. Sureguard (51% WDG formulation of flumioxazin) possess similar properties to Goal. Although from different chemical classes, SureGuard and Goal have the same mode of action (protoporphyrinogen oxidase inhibition) and a similar weed control spectrum.. Sprayable formulations of flumioxazin might be useful as an alternative or rotational herbicide to reduce reliance on Goal. Therefore, the objectives of this study were to compare the efficacy of SureGuard, and Goal 2XL for preemergence weed control, and to establish the size of weeds susceptible to postemergence applications.

Three experiments were conducted at the Oregon State University North Willamette Research and Extension Center (OSU NWREC); two to compare preemergence efficacy of Goal 2XL and Sureguard 51WDG on spring-germinating and fall-germinating weeds, and a third to compare postemergence efficacy on seedling broadleaf weeds. Each was conducted on a Willamette silt loam soil.

Preemergence experiments

Goal 2XL at 1.0 and 2.0 lb ai/acre, SureGuard 51WDG at 0.25 and 0.5 lb ai/acre were applied on May 20, 2002, to weed-free soil and compared to a non-treated control. Plots 3 feet wide and 10 feet long were delineated. There were six replications per treatment, arranged in a randomized complete block design (RCBD). Plots were over-seeded with ¼ tsp. each of the following weed species: black nightshade (*Solanum nigrum*), wild mustard (*Brassica kaber*), pale smartweed (*Polygonum lapathifolium*), field bindweed (*Convolvulus arvensis*), annual bluegrass (*Poa annua*), wild carrot (*Daucus carrota*), redroot pigweed

(*Amaranthus retroflexus*), and common groundsel (*Senecio vulgaris*). Overhead irrigation was provided as needed. Data collected included weed control ratings (where 0 = no control and 100 = complete control) at 30, 60, and 90 days after treatment (DAT). Shortly after the 90 DAT rating, an irrigation malfunction destroyed the plot and did not allow for further data collection.

In a separate study SureGuard and Goal efficacy on fall germinating weeds was compared. On September 2, 2002, a field adjacent was plowed and disked. Seeds of annual bluegrass, common groundsel, and wild mustard were sown (1/4 tsp.) on September 9. On September 18, Goal was applied at the same rates used in the spring preemergence experiment, while flumioxazin rates were lowered to 0.125 and 0.25 lb ai/acre. A non-treated control was also included. Herbicides were applied to weed-free soil. Data collected included weed control ratings monthly and weed shoot dry weight (SDW) 180 DAT. SDW data were analyzed with nonparametric methods due to non-homogeneity of variance.

Postemergence control of seedling broadleaf weeds.

The treatment design for this experiment was a 4x2 factorial, with the same four herbicide treatments used in the spring preemergence experiment, applied with and without 0.25% (by volume) X-77 nonionic surfactant. Herbicides were applied June 17, 2002. The following weeds were present at the time of application with average weed size in parentheses: pale smartweed (4 inches tall), common lambsquarter (*Chenopodium album*, 5 inches tall), common groundsel (1.5 inches tall and flowering), redroot pigweed (4 inches tall), prostrate knotweed (*Polygonum aviculare*, 2 to 8 inches wide), mayweed chamomile (*Anthemis cotula*, 3 inches tall), and wild mustard (5 inches tall and flowering). Data collected included postemergence weed control 4, 7, and 14 DAT, and subsequent preemergence weed control 60 DAT. The same irrigation malfunction that occurred in the preemergence experiment also destroyed the integrity of this experiment 60 days after initiation.

Result and Discussion:

Preemergence experiments

Spring study. One week after treatment (WAT), wild mustard, redroot pigweed, and smartweed germinated in control plots. Broadleaf weeds were observed germinating in treated plots (both herbicides), however, cotyledons in these plots appeared chlorotic and lacked turgor. By 30 DAT, germinated seedlings in treated plots failed to develop, and thus both herbicides provided excellent preemergence broadleaf weed control (Table 1). In control plots, the following weed species were present: smartweed, common lambsquarter, common groundsel, redroot pigweed, prostrate knotweed, mayweed chamomile, and wild mustard. By 70 DAT, all herbicide treatments provided excellent broadleaf weed control. At 70 and 90 DAT, the high SureGuard rate provided better broadleaf weed control than the high Goal rate, although differences were of little practical importance. Grass control was difficult to evaluate due to inadequate pressure.

Fall study. Through 180 DAT, all herbicides provided 100% broadleaf weed control (data not presented). Weeds in control plots and areas immediately surrounding treated plots (thus from native seed sources) included: wild mustard, dandelion (*Taraxacum officinale*), mayweed chamomile, annual sowthistle (*Sonchus oleraceus*), shepherd's purse (*Capsella bursa-pastoris*), mouseear chickweed (*Cerastium vulgatum*), common groundsel, common chickweed (*Stellaria media*), spring whitlowgrass (*Draba verna*), ivy leaf speedwell (*Veronica hederaefolia*), annual bluegrass, broadleaf dock (*Rumex obtusifolius*), henbit (*Lamium amplexicaule*), and red dead nettle (*Lamium purpureum*). Both herbicides provide excellent preemergence control of these species. None of the herbicides provided complete control of annual bluegrass. Annual bluegrass SDW in plots treated with Goal were lower than in those treated with SureGuard and the non-treated control (Table 3). Reports of grass control with Goal are conflicting. Kuhns et al. (2) reported complete control of yellow foxtail (*Setaria lutescens*) with Goal at 1.0 lb ai/acre; in contrast, it did not control barnyardgrass (*Echinochloa crus-galli*). Similarly, Setyowati et al. (3) reported excellent annual grass control with Goal at 2 lb ai/acre, while Coffman et al. (1) reported no control with 4 lb ai/acre. Many growers tank mix additional herbicides with Goal to improve grass control. Therefore, pre- or postemergence grass control will not likely be a factor in comparing these products.

Postemergence control of seedling broadleaf weeds

Heavy rain occurred immediately after herbicide application (within ½ hour). Nonetheless, by 4 DAT weeds showed signs of severe injury ranging from 86% to 94% control (Table 2). By 7 DAT, all herbicide treatments provided excellent postemergence broadleaf weed control. By 60 DAT, preemergence weed control ratings were slightly higher with Goal compared to SureGuard. Weed species in control plots and surrounding areas were similar to those in spring preemergence study. Diminished weed control in SureGuard treated plots was attributed to regeneration of prostrate knotweed from plant crowns and not from newly germinated seeds. While it appeared that these weeds were controlled completely soon after application, plants were able to regenerate. Only a few weeds per plot survived (2 to 5), however, without competition from other weeds or crop, a single prostrate knotweed can cover a large area (approximately 5 ft^2 in our plot). Therefore, even in plots with lower weed control ratings, only a few weeds (less than 6) survived. Herbicides without surfactants were as effective as those containing surfactants. Spring weather in the Pacific Northwest can be characterized as cloudy and wet, conditions that might lead to less cuticle development in some plants. This may be the cause for excellent postemergence control without surfactants. Under different conditions, surfactants might be necessary for adequate control.

Significance to Industry: Safe and effective herbicides are needed in Christmas tree and ornamental conifer production for accelerated growth and marketability. Data presented herein demonstrates that SureGuard provides excellent preemergence and postemergence broadleaf weed control, similar to that of Goal. Pre- and postemergence annual bluegrass control was less effective with Sureguard than with Goal.

Literature Cited:

1. Coffman, C.B., J.R. Frank, and W.A. Gentner. 1984. Sethoxydim (Poast) and Oxyfluorfen (Goal) efficacy and tolerance by landscape plants. J. Environ. Hort. 2:120-122.
2. Kuhns, L.J., G. Twerdok, and C. Haramaki. 1983. The effects of time of herbicides application on conifer seedbeds. Proc. Northeastern Weed Sci. Soc. 37:113-117.
3. Setyowati, N., L.A. Weston, and R. E. Mc Niel. 1995. Evaluation of selected preemergence herbicides in field-grown landscape crops in Kentucky. J. Environ. Hort. 13:196-202.
4. Sharman, K.V. 1993. Herbicides for container-grown rain forest species. HortScience 28:303-305.

Table 1. Broadleaf weed control[z] following herbicide application to weed-free soil.

Herbicide	Rate (lb ai/acre)	Broadleaf weed control (%) 30DAT[y]	70 DAT	90 DAT
Goal	1.00	99 a[x]	98 ab	98 ab
	2.00	100 a	97 b	95 b
SureGuard	0.25	98 a	98 ab	97 ab
	0.50	99 a	100 a	100 a
Control	0.00	40 b	0 c	0 c

[z]Weed control rated from 0 to 100 where 0 = no control and 100 = complete control. Weeds present in control plots when rated includes smartweed (*Polygonum lapathifolium*), common lambsquarter (*Chenopodium album*), common groundsel (*Senecio vulgaris*), redroot pigweed (*Amaranthus retroflexus*), prostrate knotweed (*Polygonum aviculare*), mayweed chamomile (*Anthemis cotula*), and wild mustard (*Brassica kaber*).

[y]Days after treatment.

[x]Means separated with a column. Means with the same letters are similar according to Duncan's multiple rage test (alpha = 0.05).

Table 2. Early-postemergence broadleaf weed control[z] following herbicide applications to May.

			Broadleaf weed control (%)			
Herbicide	Rate (lb ai/acre)	Surfactant	4 DAT[y]	7 DAT	14 DAT	60 DAT
Goal	1.00	No	86 a[x]	97 a	100 a	88 ab
		Yes	95 a	99 a	100 a	98 a
	2.00	No	90 a	99 a	100 a	97 a
		Yes	89 a	97 a	100 a	98 a
SureGuard	0.25	No	91 a	99 a	98 a	74 b
		Yes	94 a	100 a	98 a	78 ab
	0.50	No	90 a	99 a	99 a	85 ab
		Yes	93 a	99 a	100 a	98 a
Control	-	-	43 b	23 b	7 b	0 c

[z]Weed control rated from 0 to 100 where 0 = no control and 100 = complete control.

[y]Days after treatment.

[x]Means separated with a column. Means with the same letters are similar according to Duncan's multiple rage test (alpha = 0.05).

Table 3. Shoot dry weight of annual bluegrass (*Poa annua*) six months after application to seed free soil.

Herbicide	Rate (lb ai/acre)	Dry weight (g)
Goal	1.00	80 a[z]
	2.00	16 b
SureGuard	0.13	112 a
	0.25	91 a
Control	-	94 a
Contrast		
Goal vs. control		0.2251[y]
SureGuard vs. control		0.8351
Goal vs. SureGuard		0.0905

[z]Means separated with a column. Means with the same letters are similar according to Duncan's multiple rage test (alpha = 0.05).

[y]Days after treatment.

Tolerance of Four Ornamental Grass Genera to Selected Preemergence Herbicides

Glenn B. Fain, Peter M. Hudson, and Keri L. Paridon
Mississippi State University
Truck Crops Branch Experiment Station
Crystal Springs, MS 39059

Index words: container production, weed control

Nature of Work: Weed control is a top priority in the production of container landscape plants. Ornamental grasses are becoming an increasingly significant portion of many container nurseries' product lines. Information is limited, if available at all, on herbicide safety on many of the grass species in production today. Previous research has shown that ornamental grasses differ in their tolerance to preemergent herbicides (1,2,5).

This experiment was conducted to determine tolerance of five ornamental grass genera to eight commonly used preemergence herbicides. None of the herbicides used in this study were labeled for four of the five genera tested. This experiment was conducted at the Mississippi State University Truck Crops Branch Experiment Station in Crystal Springs, MS. The ornamental grasses (Emerald Coast Growers, Pensacola, FL 32524) tested were 'Karl Foerster' feather reed grass (*Calamagrostis acutiflora* 'Karl Foerster'), northern sea oats (*Chasmanthium latifolium*), pink pampass grass (*Cortaderia sellowana* 'Rosea'), 'Heavy Metal' switch grass (*Panicum virgatum* 'Heavy Metal'), and 'Indian Steel' Indian grass (*Sorghastrum nutans* 'Indian Steel'). Herbicides and rates tested were Gallery 75DF at 1.1, 2.2, and 4.4 kg ai/ha (1.0, 2.0, and 4.0 lb ai/A), Snapshot 2.5G at 2.8, 5.6, and 11.2 kg ai/ha (2.5, 5.0, and 10.0 lb ai/A), Ronstar G at 4.5, 9.0, and 18.0 kg ai/ha (4.0, 8.0, and 16.0 lb ai/A), RegalStar G at 2.7, 5.4, and 10.8 kg ai/ha (2.4, 4.8, and 9.6 lb ai/A), Corral 2.68G at 2.2, 4.4, and 8.8 kg ai/ha (2.0, 4.0, and 8.0 lb ai/A), Rout 3G, Regal O-O, and OH II at 3.4, 6.8, and 13.6 kg ai/ha (3.0, 6.0, and 12.0 lb ai/A). On April 1, 2002, all grasses were planted into #1 containers from 2-1/4" liners using an 8:1 (v:v) pinebark:sand substrate amended per m^3 (yd^3) with 0.9 kg (1.5lb) micromax, 2.97 kg (5.0 lb) dolomitic limestone and 8.3 kg (14 lb) Osmocote 17-7-12. Plants were placed in full sun under overhead irrigation and watered as needed. Herbicides were applied on April 9, 2002, and reapplied on July 11, 2002. Granular herbicides were applied with a hand-held shaker and spray herbicides were applied using a CO_2 sprayer with a single 8004 flat fan nozzle calibrated to deliver 187 liters/ha (20 gal/A) at 235 kPa (34 psi). Plants received 1.2 cm (0.5 in) of water by overhead irrigation one hour after herbicide applications. Experimental design was a randomized complete block with 6 single plant replications. Data collected was plant injury at 14 days after first application (DAF) and 21 days after second application (DAS) on a scale of 0 to 10, where 0 = no injury and 10 = plant death. Plant height was measured at 51 DAF and shoot fresh weight (SFW) was determined at the conclusion of the study on August 28, 2002.

Results and Discussion: All herbicides at all rates provided acceptable weed control throughout the study: however, weed pressure was extremely low and few weeds were present even in the controls. There were no significant differences in injury, height or SFW with any herbicide at any rate for northern sea oats, 'Karl Foerster' feather reed grass, or 'Heavy Metal' switch grass (data not shown).

Rout 3G at 13.6 kg ai/ha (12.0 lb ai/A) caused significant injury to pampass grass and Indian grass at 14 DAF and 21 DAS (Table 1). At 51 DAF pampas grass were significantly shorter than controls among all rates of Rout 3G. Rout 3G also caused plant lodging and poor root development in the top portions of the container substrate on pampass grass (data not shown). This is supported by previous research that reports similar injuries to pampass grass from spray-applied oryzalin (3,4,5), which is one of the active ingredients in Rout 3G. Rout 3G at four times the labeled rate (12.0 lb ai/A (13.6 kg ai/ha)) also reduced the height of Indian grass 51 DAF. At the termination of the study SFW was significantly lower for pampass grass at all rates of Rout 3G and for Indian grass at the 13.6 kg ai/ha (12.0 lb ai/A) rate (data not shown). At 21 DAS plant injury was significant on Indian grass for the 5.6 (5.0 lb ai/A), and 11.2 kg ai/ha (10.0 lb ai/A) rates of Snapshot 2.5G.

Significance to the Nursery Industry: Little information exists about crop tolerances of many of the ornamental grasses now in production at container nurseries, as is evident by the lack of grass species on herbicide labels. This study was conducted in an effort to expand herbicide labels to include more grass species. Most ornamental grasses tested exhibited good tolerance to many, if not all, herbicides tested even at significantly higher than labeled rates. The only grass to exhibit a lack of tolerance at a label recommended rate was pampass grass treated with Rout 3G. The lack of tolerance of some species and not others is not surprising since previous studies have shown that grass species vary in their tolerance to herbicides (1,2,3). This study, as well as these previous studies, suggest that ornamental grasses exhibit tolerance to many herbicides and further testing of new species of grasses may aid growers in management of these increasingly important crops.

Literature Cited:

1. Catanzaro, C.J., W.A. Skroch, and J.D. Burton. 1993. Resistance of selected ornamental grasses to graminicides. Weed Technol. 7:326-330.
2. Derr, J.F. 2002. Tolerance of ornamental grasses to preemergent herbicides. J. Environ. Hort. 20:161-165.
3. Green, J.C., G.J. Keever, C.H. Gilliam, C.K. Palmer, J.W. Olive, and J.D. Eakes. 1997. Effects of preemergence-applied herbicides on pampass grass in containers. J.Environ. Hort. 15:77-80.
4. Hayes, C.K., C.H. Gilliam, G.J. Keever, and D.J. Eakes. 1999. Effects of herbicide and time of application on pampass grass grown in containers. J. Environ. Hort. 17:185-189.
5. Neal, J.C. and A.F. Senesac. 1991. Preemergent herbicide safety in container-grown ornamental grasses. HortScience 26:157-159.

Table 1. Effects of selected herbicides on injury and growth of ornamental grasses.

		Sorghastrum nutans 'Indian Steel'			*Cortaderia sellowana* 'Roses'		
		Injury[z]		Height (cm)	Injury		Height (cm)
Herbicide	**Rate (kg ai/ha)**	14DAF	21DAS	51DAF	14DAF	21DAS	51DAF
Gallery 75DF	1.1	1.8	0.3	41.3	0.8	0.5	29.9
Gallery 75DF	2.2	2.8	2.2	31.0	1.2	0.8	32.8
Gallery 75DF	4.4	0.8	0.2	36.8	1.5	1.2	28.2
Snapshot 2.5G	2.8	2.5	2.3	29.5	1.5	1.3	35.3
Snapshot 2.5G	5.6	4.2	4.3*	24.4*	2.5	2.3	29.6
Snapshot 2.5G	11.2	4.5	4.2*	30.6	1.3	1.2	32.2
Ronstar G	4.5	1.5	0.5	38.6	1.3	1.3	36.8
Ronstar G	9.0	0.8	0.5	42.4	1.0	0.8	35.1
Ronstar G	18.0	2.7	2.5	37.2	1.5	1.5	34.0
RegalStar G	2.7	1.0	1.0	44.8	1.3	1.2	27.0
RegalStar G	5.4	2.7	2.2	35.3	1.0	1.0	31.3
RegalStar G	10.8	0.7	0.3	41.9	1.3	1.3	25.6
Rout 3G	3.4	1.7	0.5	37.7	2.3	1.8	20.7*
Rout 3G	6.8	1.7	0.5	36.9	3.2	3.7*	20.8*
Rout 3G	13.6	6.0*	5.6*	20.6*	4.7*	4.5*	11.7*
Regal O-O	3.4	0.8	0.3	44.8	1.0	1.0	29.6
Regal O-O	6.8	4.5	4.2*	29.9	1.2	0.8	35.0
Regal O-O	13.6	3.7	2.0	35.7	1.2	1.2	33.9
OH-II	3.4	2.0	2.0	35.0	1.0	1.0	33.9
OH-II	6.8	1.0	1.2	40.9	1.5	1.2	33.0
OH-II	13.6	1.5	1.0	36.3	1.5	1.8	28.7
Corral 2.68G	2.2	0.5	0.3	42.5	1.3	1.3	33.7
Corral 2.68G	4.4	1.2	0.2	42.7	1.0	1.0	35.1
Corral 2.68G	8.8	2.3	1.3	35.2	0.8	1.2	36.7
Control		1.0	0.2	43.6	1.3	0.8	28.7

[z]Injury rated on a scale from 0-10, where 0 = no injury and 10 = plant death.

*Significantly different from controls (Dunnett's: $\alpha = 0.05$).

Evaluation of Selected Herbicides for Preemergent Control of Cogongrass in Nursery Containers

John W. Olive and Charles H. Gilliam

Index Words: *Imperata cylindrica*, Preemergence Weed Control

Nature of Work: Cogongrass (*Imperata cylindrica* L.) is a serious weed in the landscape, highway maintenance, and forestry industry. It has been designated as the seventh worst weed in the world and due to its aggressive nature in other countries it is included on the Federal Noxious Weeds List (1). When introduced, cogongrass quickly forms a thick stand with a very dense root system. It usually out competes other vegetation creating a monoculture of foliage that is unfit for livestock grazing, difficult to mow and is often a fire hazard. The identifying characteristics of this weed include a white silky plume that is 1 to 8 inches long and 0.2 to 1 inch wide. Plants grow up to 4 feet tall. The midrib of the leaf is off-center and closer to one edge of the leaf blade. Cogongrass often invades areas surrounding container nurseries and the seed is readily spread by wind. It is a concern among nursery growers that cogongrass will blow into the nursery and become a pest in containers. A study was initiated to determine the effectiveness of commonly available preemergent herbicides for the control of cogongrass in a pine bark based soil mix in nursery containers.

Products were evaluated during the summers of 2001 and 2002. Results were similar and only the results for 2002 are presented. Trade gallon (2.8 L) containers were filled with a pine bark and peat (3:1 volume:volume) amended medium, watered in and treated on June 5, 2002. *Imperata cylindrica* seedheads were collected from several sites and thoroughly mixed. Approximately 1/2 teaspoon of uncleaned seed (this was approximately equal to the amount in a single seed head) was placed on the media surface 24 hours after treatments were applied and watered in. Containers were placed in full sun under overhead impact sprinkler irrigation. Cogongrass seedlings were counted at 30 and 60 days after treatments were applied. The product rates and active ingredients evaluated are listed in Table 1.

Results and Discussion: All of the herbicides evaluated provided excellent preemergent control of cogongrass at 30 days after treatment (DAT). The pots treated with the spray formulations of flumioxazin (Sure Guard 51WDG), pendamethalin (Pendulum WDG), and oryzalin (Surflan AS) had no emerging seedlings. The other treated containers had very few, weak seedlings or no cogongrass, while the untreated controls had an average of almost 8 vigorous seedlings per pot. At 60 DAT, the spray formulation of prodiamine (Barricade 4FL) and the granular formulation of the oxyfluorfen and oryzalin (Regal O-O) had similar numbers of cogongrass as the untreated contol containers. All other treatments had significantly fewer weed seedlings than the control treatments. Spray applied flumioxazin (Sure Guard 51WDG) remained weed free at 60 DAT.

Significance to the Industry: Cogongrass is a serious weed pest along the Gulf Coast and it is slowly expanding north. It can be a noxious weed in areas surrounding commercial nurseries. This experiment demonstrated that cogongrass was controlled in containers with preemergent herbicide applications. At 30 DAT, all herbicides evaluated provided significant preemergent control when compared to the untreated pots. At 60 DAT, Broadstar, Sure Guard, Regal O-O, Corral, Pendulum, Regal Kade, and Surflan all provided significant preemergent control of cogongrass in this test. The herbicides evaluated in this test were applied to nursery containers with media only and no plants. Nursery managers should carefully read and follow label recommendations before using any herbicide on nursery crops.

Literature Cited:

1. Byrd, J. D. and C. T. Bryson. 1999. Biology, ecology, and control of cogongrass [*Imperata cylindrica* (L.) Beauv.]. Mississippi Dept. of Agriculture and Commerce-Bureau of Plant Industry Fact Sheet No.1999-01.

Table 1. Effect of selected herbicides on weed counts cogongrass.

Treatment	Active Ingredients	Rate/Acre	Weed Counts[2] 30 DAT[3]	Weed Counts[2] 60 DAT
Broadstar	(flumioxazin)	200 lbs	4.0 bc	0.9 bcd
Sure Guard	(flumioxazin)	2/3 lb[1]	0 c	0 d
Regal O-O	(oxyfluorfen, oxadiazon)	100 lbs	2.0 bc	2.2 bc
Barricade	(prodiamine)	3 pts[1]	3.1 b	4.2 ab
Corral	(pendimethalin)	110 lbs	1.7 bc	1.6 bcd
Pendulum	(pendimethalin)	5 lbs[1]	0 c	1.0 cd
Rout	(oxyfluorfen, oryzalin)	100 lbs	1.1 bc	2.6 ab
Regal Kade	(prodiamine)	300 lbs	2.1 bc	1.8 bcd
Surflan	(oryzalin)	3 qts[1]	0 c	1.4 bcd
Untreated Control	--		7.8 a	6.1 a

[1]Applied in liquid at 20 gal/A.

[2]Average of 10 single plant replications.

[3]DAT = days after treatment.

Means within a column followed by the same letter are not significantly different at the 5% level.

Preemergence Control of Common Groundsel (*Senecio vulgaris*)

Alejandro Bolques[1], Jeffrey G. Norcini[2], and James H. Aldrich[2]
[1]Florida A&M University, Gadsden County Extension,
2140 W. Jefferson St., Quincy, FL 32351
[2]University of Florida/IFAS, NFREC,
155 Research Road, Quincy, FL 32351

Index words: weeds, container production, *Senecio vulgaris*, common groundsel

Nature of Work: The appearance of an undetected weed in the north Florida Big Bend area was identified as common groundsel (*Senecio vulgaris* L.). A woody ornamental container plant producer in Gadsden County reported the occurrence of this weed, previously reported in Escambia County, in the western Panhandle of Florida, and Lake County in central Florida (USDA NRCS, 2002; Wunderlin and Hansen, 2003).

Common groundsel is a member of the sunflower family (Asteraceae) known to germinate and grow from early spring through fall in the northern U.S., but can grow year round in southern climates. Common groundsel grows well on moist, rich soils in gardens and croplands that are shaded, such as those found in container plant production areas and are more vigorous under low temperatures 7.2 to 18.3°C (45 to 65°F). It has an upright and branched growth habit, grows up to 46 cm (18 inches) tall, and can complete its life cycle in as little as 8 weeks. Seeds are tipped with a tuft of silky white hairs that are easily blown by the wind, somewhat like dandelion seeds. In infested areas, common groundsel can increase production costs due to added chemical control inputs and scouting of new container plants before common groundsel can produce seed (Aldrich-Markham, 1994; Penny and Neal 2000, Ayeni et al., 1999). The objective of this study was to evaluate the efficacy of several preemergent herbicides to control common groundsel.

A weed tentatively identified as common groundsel was collected at a local nursery in Gadsden County, Florida in March 2002. A sample specimen was collected including root system, flowers, and buds. The specimen was identified as Senecio vulgaris L. by two botanists - Dr. Theodore M. Barkley, Botanical Research Institute of Texas and Dr. David W. Hall, Gainesville, Florida. Several plants were collected at the nursery and grown in a greenhouse at the NFREC-Quincy. Seed for this experiment were harvested from these greenhouse grown plants. The following preemergence herbicides were evaluated for efficacy: Gallery 75DF, Goal 2XL, OH II, Princep L, Regal O-O, Ronstar 2G, Ronstar 50WP, Rout, and Snapshot TG. Herbicides were applied at labeled rates for container nursery crops with the exception of Princep L, which was applied at 4.48 kg ai/ha (4.0 lb ai/A) (Table 1). A high rate of Princep was used to determine whether the Gadsden County groundsel was resistant to simazine, as has been reported for some populations (Holliday and Putwain, 1977; Holliday and Putwain, 1980). One day prior to herbicide treatment on May 23, 2002, 3.8-l (1 gal) pots were over-seeded with 50 “deplumed” achenes per pot. Granular herbicides were applied as individual aliquots to each pot. Sprayable herbicides were broadcast applied using a compressed air backpack sprayer that delivered 468 l/ha (50 gal/A) at 35 psi. The potting substrate was an 80:10:10, pine bark: peat:sand (by vol.) amended with 13-6-6 sludge (Graco Fertilizer, Cairo, GA). The containers were arranged in a completely randomized design with four single pot replications per treatment in full sun and overhead irrigated daily. Number of seedlings was recorded at 2, 4, and 12 weeks after treatment.

Results and Discussion: Two weeks after treatment, the best control (compared to nontreated pots) was with Gallery and Snapshot TG (100 and 99% control, respectively), although all treatments except Ronstar 2G (64% control) provided ≥ 74% control. Average number of seedlings in nontreated pots was 22.5.

Four weeks after treatment, the best control (compared to nontreated pots) was with Gallery, Snapshot TG, and Princep L (100, 100, 98% control, respectively), although all treatments except Ronstar 2G (62%) provided ≥ 80% control. Average number of seedlings in nontreated pots was 24.8.

Twelve weeks after treatment, all herbicides reduced the number of groundsel by at least 76%, but only Gallery, Princep, and Snapshot TG provided 100% control (Table 1). Preemergence groundsel control at Rout, Regal O-O, and Snapshot was better than that reported by Fisher et al. (1996) at 60 days after application, especially for Regal O-O. As in our experiment, Gallitano and Skroch (1993) reported 100% groundsel control for Gallery but slightly better control of groundsel than we observed for Goal, Rout and OH-II, and even better for Ronstar G. In their experiment, Ronstar G provided 100% control compared to our 76% control.

Despite substantial reductions in weed number provided by the other herbicides, many of the common groundsel that emerged in those pots had flowered. We observed that common groundsel achenes could mature soon after flowering, spread easily by air currents, and germinate within a few days after settling on a soiless medium under well-irrigated conditions. Hence, our common groundsel exhibited precocious behavior, that is early flowering and fruit set. Relatively rapid development (germination to fruiting) under well-weeded conditions (as would exist under production conditions) seems to be characteristic of at least some populations of common groundsel (Kadereit and Briggs, 1985; Theaker and Briggs, 1993). Thus, herbicides providing any less than 100% preemergent control might result in a common groundsel infestation.

Significance to Industry:
Gallery, Princep, and Snapshot TG provided 100% control of common groundsel for 12 weeks in a typical soilless medium used for container plant production. However, because of its possible precocious nature and easily spread seed, few if any herbicide programs will provide 100% control of common groundsel. Therefore to prevent common groundsel infestation, preemergence herbicide programs should be augmented with frequent hand weeding and sanitation.

Literature Cited:

1. Aldrich-Markham, S. 1994. Common groundsel (*Senecio vulgaris*), (http://eesc.orst.edu/AgComWebFile/EdMat/pnw466.pdf). Oregon State University Extension Service. PNW 466. (accessed May 19, 2003).
2. Ayeni, A.O., B.A. Majek, J.R. Johnson, and R.G. Obal.1999. Container nursery weed control: bittercress, groundsel, and Oxalis, (http://www.rce.rutgers.edu/pubs/pdfs/fs939.pdf). Rutgers Cooperative Extension. FS939. (accessed May 19, 2003).
3. Fisher, B., R. Smith, and T. Whitwell. 1996. Different combinations of preemergence herbicides for weed control in container grown plants. Proc. South. Nurs. Assoc. Res. Conf. 41:29-32.
4. Gallitano, L.B. and W.A. Skroch. 1993. Herbicide efficacy for production of container ornamentals. Weed Tech. 7:103-111.
5. Holliday, R.J. and P.D. Putwain. 1977. Evolution of resistance to simazine in *Senecio vulgaris* L. Weed Res. 17:291-296.
6. Holliday, R.J. and P.D. Putwain. 1980. Evolution of herbicide resistance in *Senecio vulgaris* L: Variation in susceptibility to simazine between and within populations. J. Appl. Ecol. 17:770-791.
7. Kadereit, J.W. and D. Briggs. 1985. Speed of development of radiate and non-radiate plants of *Senecio vulgaris* L. from habitats subject to different degrees of weeding pressure. New Phytol. 99:155-169.
8. Penny, G.M. and J.C. Neal. 2000. Weed scouting in container nurseries. Proc. South. Nurs. Assoc. Res. Conf. 45:387-389.
9. Theaker, A.J. and D. Briggs. 1993. Genecological studies of groundsel (*Senecio vulgaris* L.). IV. Rate of development in plants from different habitat types. New Phytol. 123:185-194.
10. USDA, NRCS. 2002. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA. (accessed May 19, 2003).
11. Wunderlin, R.P. and B.F. Hansen. 2003. Atlas of Florida Vascular Plants (http://www.plantatlas.ufs.edu/). [S. M. Landry and K. N. Campbell (application development), Florida Center for Community Design and Research.] Institute for Systematic Botany, University of South Florida, Tampa.

Table 1. Percent reduction in number of common groundsel (Senecio vulgaris) plants compared to the nontreated at twelve weeks after treatment (12WAT).

Herbicide		Rate		% control[z] 12 WAT compared to nontreated pots
Trade name	Active ingredient	lb ai/A	kg ai/ha	
Gallery 75DF	isoxaben	1.0	1.12	100b[y]
Goal 2XL	oxyfluorfen	0.5	0.56	90ab
OH II	pendimethalin + oxyfluorfen	1.0 + 2.0	1.12 + 2.24	91ab
Princep L	simazine	4.0	4.48	100b
Regal O-O	oxadiazon + oxyfluorfen	1.0 + 2.0	1.12 + 2.24	91ab
Ronstar 2G	oxadiazon	4.0	4.48	76a
Ronstar 50WP	oxadiazon	4.0	4.48	84ab
Rout	oryzalin + oxyfluorfen	1.0 + 2.0	1.12 + 2.24	90ab
Snapshot TG	isoxaben + trifluralin	1.0 + 4.0	1.12 + 4.48	100b

[z]Percent reduction in number of groundsel plants compared to the nontreated control.

[y]Means with the same letter are not significantly different as determined by Duncan's Multiple Range test, 5% level.

Bamboo Control with Herbicides

Mark Czarnota[1], Frank Linton[2], Mindy Linton[2], Dave Linvill[3]
[1]University of Georgia, Department of Horticulture,
1109 Experiment Street, Griffin GA, 30223
[2]University of Georgia, Bamboo Farm & Coastal Gardens,
#2 Canebrake Road, Savannah, GA 31419
[3]University of Georgia, Cooperative Extension Service,
P. O. Box 9866, Savannah, GA 31412

Index Words: Bamboo, *Phyllostachys rubromarginata*, glyphosate, dichlobenil, imazapyr, herbicides

Nature of Work: As well as having many construction and industrial uses, bamboo can be a beautiful addition to gardens. However, when it is growing in an area were it is not wanted, it can be extremely difficult to eradicate. Homeowners, landscapers, and vegetation management officials often face situations were they are required to eliminate a stand of bamboo. Many opinions exist on herbicide mixtures used to control bamboo; unfortunately, these are backed with little scientific evidence. A study was designed in order to determine the efficacy of several popular herbicides with the potential to control bamboo. In 2002, a study was initiated to determine the degree of control provided by a single application of selected herbicides. In November of 2001, an area 20 feet wide, 240 feet long (4800 ft^2) of bamboo (*Phyllostachys rubromarginata* McClure) was mowed to the ground. After mowing, the perimeter of the area was trenched with a V3550A Vermeer trencher. Perpendicular tenches were also cut the width of the plot every 20 feet. At the completion of the trenching there were 12, 20 ft. by 20 ft. square plots. The trench was approximately 18 inches deep, 6 inches wide. This open trench was cut below the root zone of the bamboo, and prevented any bamboo shoots and/or roots from growing from one treatment to another. Herbicides were applied on April 15, 2002. At time of treatment, bamboo was approximately 18 inches tall. Treatments were arranged in a randomized complete block design with 3 replications. A list of treatments is presented in Table 1. Herbicides were applied with a CO_2 backpack sprayer calibrated to deliver 20 GPA. Percent control was visually estimated 3, 10, and 58 weeks after treatment (WAT). A description of the rating scale is presented in Table 2. Above-ground biomass was collected 58 WAT. One square meter of vegetation was taken from each treatment of each replication. In the one square meter, bamboo foliage was cut to the ground, bagged, dried, and weighted. All data were subjected to analysis of variance (ANOVA) and means were separated using Fisher's least significant difference (LSD) test with a significance level of α=0.05.

Results and Discussion: Three and 10 weeks after treatment, both glyphosate and imazapyr treatments had significantly injured the newly flushing bamboo growth (Table 3). Approximately one year after treatment (58 WAT), glyphosate and the imazapyr were still providing 80% and 99% bamboo control, respectively. Imazapyr-treated plots contained very little regrowth. Dry weight of the bamboo shoots collected 58 WAT modeled the control ratings (Table 3). Dichlobenil provided no visible control of the bamboo during the duration of the test. The granular formulation of dichlobenil normally provides good control of bamboo as long as it is applied when the temperatures are not to exceed 60ºF. It was thought that the micro-encapselated formulation might have activity when applied in warm temperatures. However, with no control provided by this treatment, it is likely that dichlobenil volatilized and reduced the potential for control. Application was made with air temperatures of 88 °F.

Significance to Industry: Glyphosate did not provide complete control of the bamboo with one application. Repeat applications of glyphosate, in combination with mowing, would probably control this plant. Imazapyr provided nearly complete control of bamboo with one application. Unfortunately, the 1.5 lb ai/A rate is extremely high, and could cause severe injury to surrounding plant material. Carryover could also be a major concern, particularly in higher pH soil.

Table 1. List of treatments.

Trade name	Active ingredient	Formulation	Rate
Casoron	dichlobenil	1 ME	8.0 lb ai/A
Roundup	glyphosate	5 L	4.0 lb ai/A
Arsenal	imazapyr	2 L	1.5 lb ai/A
Check			

Table 2. Representations of numeric bamboo control ratings.

Value Ranges	Plant Symptoms
0	No visual injury present
10-30	Minimal injury to desirable plant. Less than 10% of the plant leaf surface area showing chlorosis and necrosis. A 10 to 30% biomass reduction.
40-70	More noticeable plant injury or stunting. Greater than 50% of the leaf area showing symptoms of chlorosis and/or necrosis. A 40 to 70% biomass reduction.
80-90	Plants severely injured. Most of the leaves and leaf surface showing signs of chlorosis and necrosis. An 80 to 90% biomass reduction.
100	Plant appears dead. No signs of regrowth.

Table 3. Bamboo control ratings 3, 10, and 58 weeks after treatment (WAT) and bamboo dry weight taken 58 WAT [a].

	Bamboo Control Ratings[b]			Average bamboo dry weight from 1m² taken 58 WAT
Trade name	3 WAT	10 WAT	58 WAT	
Casoron	6.7 c	0.0 c	0.0 c	775.47 c
Roundup	76.7 a	90.0 a	76.7 b	255.23 bc
Arsenal	50.0 b	75.0 b	98.7 a	43.13 c
Check	0.0 c	0.0 c	0.0 c	559.33 ab

[a]Abbreviations: WAT, weeks after treatment.

[b]Means within a column followed by the same letter are not different according to Fisher's protected LSD at α=0.05.

Roundup Pro and Finale: Can They Be Used on Woody Landscape Groundcovers?

Adam Newby, Charles Gilliam, James Altland, Carey Simpson, Glenn Wehtje
Department of Horticulture, Auburn University, Auburn, AL 36849

Index words: Finale, glufosinate, glyphosate, herbicide tolerance

Nature of Work: Groundcover plants are used extensively in the landscape to fill in beds and prevent erosion. Weed control among groundcovers in nursery production and landscape maintenance is challenging. Nursery growers often use preemergence herbicides, but these are not 100% effective. Often, landscape professionals are called upon to remove weeds from groundcover beds in which hand weeding is the only option. Because of rising labor costs and decreasing availability, hand weeding is costly and time consuming. There are grass-selective postemergence herbicides labeled for use in groundcovers, however selective postemergence controls for perennial broadleaf weeds are generally not available. Work was conducted throughout the 1970s and 1980s addressing the tolerances of woody ornamentals to glyphosate. Although this research was conducted with Roundup, recent formulation changes raise questions related to the validity of research conducted in the time period. Additional research is needed with current Roundup formulations used in the landscape industry. Early research showed that euonymus, variegated liriope, and other crops have tolerance to glyphosate (Self and Washington, 1977). Recent studies have demonstrated that Roundup Pro at 0.45 kg ai/ha (0.4 lb ai/A) caused no short term or long term injury to 'Big Blue' liriope, and Roundup Pro at 1.8 kg ai/ha (1.6 lb ai/A) caused no short or long term injury to 'Variegata' liriope (Altland et al., 2002). However, crop tolerance may vary with differences in time of year and the plant's stage of growth at time of application (Neal and Skroch, 1985).

The objective of this study is to determine tolerances of six landscape groundcovers to post emergence herbicides Roundup Pro (glyphosate) and Finale (glufosinate-ammonium).

Six commonly used landscape groundcovers were used in the study. Asiatic jasmine (*Trachelospermum asiaticum*), wintercreeper euonymus (*Euonymus fortunei coloratus*), variegated liriope (*Liriope muscari* 'Variegata'), English ivy (*Hedera helix*), mondo grass (*Ophiopogon japonicus*), and shore juniper (*Juniperus conferta* 'Blue Pacific') were potted in the spring of 2002 in a 6:1 pine bark to sand substrate amended with 14 pounds of Osmocote 17-7-12, 1.5 pounds of MicroMax, and 5 pounds of dolomitic lime per cubic yard. All plants were potted in one-gallon containers and were of saleable size at time of treatment. Each species was treated with three rates of Roundup Pro (0.8 lb ai/A, 1.6 lb ai/A, and 3.2 lb ai/A, equivalent to concentrations 0.5%, 1.0%, and 2.0% applied at 40 gal/A) and three rates of Finale (0.5, 1.0, and 2.0 lbs ai/A, equivalent to concentrations 1.25%, 2.5%, and 5% applied at 40 gal/A) on 24 September 2002. A non-treated control was also included. Treatments were applied over the top using a CO_2 backpack sprayer with an 8003 flat fan nozzle at 20 PSI and calibrated to deliver 40 gallons per acre. Plants were grown in full sun and irrigated overhead. Injury ratings were recorded 7, 14, 21, and 28 DAT. Injury ratings were also recorded after the spring growth flush on 17 April 2003 (205 DAT). Injury was rated on a 1 to 10 scale where 1 equals no injury and 10 equals death. Plant size was recorded on 22 April 2003 by measuring a growth index [(height + width + width) ÷ 3]. Treatments were arranged in a completely randomized design with 10 single plant replications (8 for juniper). Species were randomized separately. Data were analyzed with regression analysis, and means were separated with Dunnett's multiple comparison test (one-sided, $\alpha = 0.05$).

Results and Discussion: Roundup Pro at 0.8 lb ai/A (0.5%) caused no visual injury on Asiatic jasmine throughout the study, however it reduced growth 205 DAT. Injury increased with increasing rate 28 and 205 DAT. Although there was little to no defoliation of existing foliage, higher rates delayed and reduced new growth the following spring. All rates of Finale caused severe injury and growth reduction.

All Roundup Pro rates caused slight injury to euonymus 28 DAT. However, by 205 DAT, plants treated with Roundup Pro at 0.8 lb ai/A (0.5%) were similar to non-treated controls. Injury symptoms were slight and included minor chlorosis and leaf curl. Self and Washington (1977) reported that *Euonymus* sp. 'Marble Queen' showed no immediate injury after treatments of 1.0 and 2.0 lb ai/A Roundup Pro. All Roundup Pro rates reduced plant growth the following spring. Across rates, Finale caused severe injury and growth reduction, though injury decreased substantially from 28 DAT to 205 DAT.

Roundup Pro at 0.8 lb ai/A (0.5%) caused no injury or growth reduction on variegated liriope throughout the study. Roundup Pro at 1.6 lb ai/A (1.0%) caused slight to moderate injury 28 DAT. However, injury ratings and plant size were similar to non-treated controls by 205 DAT. Injury from the high Roundup Pro rates included some initial foliar browning and reduced bib number 205 DAT. Finale at all rates caused significant injury 28 DAT, however plants treated with the two lower rates (0.5 and 1.0 lb ai/A) recovered and had similar injury ratings and plant size compared to non-treated controls by 205 DAT. These findings concur with Altland et al. (2002) who reported 'Big Blue' liriope was not injured by rates of Roundup Pro as high as 1.6 lb ai/A or by rates of Finale as high as 1.0 lb ai/A. Self and Washington (1977) reported that Roundup Pro at 1.0 lb ai/A caused no injury to variegated liriope and that only slight injury was visible on young leaves sprayed with 2.0 lb ai/A.

All rates of Roundup Pro caused significant injury and growth reduction in English ivy by 205 DAT. Injury increased and growth decreased linearly with increasing Roundup Pro rates. Considerable branch dieback occurred in many plants and growth was inhibited the following spring. Plants treated with the low Finale rate (0.5 lb ai/A) were similar to non-treated controls throughout the experiment. However, higher rates caused severe injury and growth reduction.

Roundup Pro at 0.8 lb ai/A (0.5%) caused slight injury on mondo grass 28 DAT. However, plants were similar to non-treated controls with respect to injury and plant size by 205 DAT. Beyond the low Roundup Pro rate, injury increased and plant size decreased linearly with increasing rate. Across rates, Finale caused severe injury and growth reduction throughout the experiment.

Roundup Pro at 0.8 lb ai/A (0.5%) caused no injury or growth reduction on juniper throughout the study. Higher Roundup Pro rates caused significant injury 205 DAT. Despite injury symptoms, only the high Roundup Pro rate reduced juniper growth 205 DAT. Neal and Skroch (1985) found that 'Blue Pacific' juniper was tolerant to Roundup Pro at 0.7 lb ai/A when applied throughout the year except for early spring. All Finale rates injured juniper with no rate response 28 DAT. By 242 DAT, plants treated with the low Finale rate were similar to non-treated controls.

English ivy, mondo grass, and shore juniper had established weeds present at time of treatment, although these weeds were not large enough to interfere with the contact of chemicals to the crops. Weeds present at time of treatment included yellow woodsorrel (*Oxalis stricta*), spotted spurge (*Chamaesyce maculata*), and large crabgrass (*Digitaria sanguinalis*). Though not specifically monitored or statistically analyzed, all rates of Roundup Pro and Finale provided 100% weed control, suggesting that perhaps lower rates could be used to further reduce injury and still provide effective weed control. Previous research by the author demonstrated that Roundup Pro rates as low as 0.4 lb ai/A (0.25%) provided effective weed control on hyssop spurge (*Chamaesyce hyssopifolia*) (Newby, 2003).

Significance to Industry: Hand weeding is a costly and time consuming method for postemergence weed control. Data herein demonstrate that low rates or Roundup Pro and Finale controlled many weeds and caused no significant long term injury to selected groundcovers. Low rates of Roundup Pro have potential for use on Asiatic jasmine, euonymus, liriope, mondo grass, and juniper. Low Finale rates have potential for use on liriope, English ivy, and juniper. Landscape professionals reworking established groundcovers beds have reported difficulty in removing Asiatic jasmine with Roundup. These data show that Finale is more effective than Roundup Pro at removing Asiatic jasmine and mondo grass. Additional trials will be conducted throughout the growing season to determine the effect of application timing on plant tolerance. This work may provide an alternative to hand weeding for growers and landscape professionals dealing with postemergence weed control in groundcovers.

Literature Cited:

1. Altland, J.E., C.H. Gilliam, and J.W. Olive. 2002. Postemergence prostrate spurge (Chamaesyce prostrate) control in container-grown liriope. J. Environ. Hort. 20:41-46.
2. Neal, J.C. and W.A. Skroch. 1985. Effects of timing and rate of glyphosate application on toxicity to selected woody ornamentals. J. Amer. Soc. Hort. Sci. 110:860-864.
3. Newby, A., C. Gilliam, C. Simpson, and G. Wehtje. 2003. Postemergence weed control in groundcovers. HortScience (in press). (abstract).
4. Self, R.L. and O. Washington. 1977. Over-the-top application of Roundup to rooted cuttings, liners, and pot-grown woody ornamentals. Proc. Southern Nurs. Res. Conf. 22:175-176.

		Injury[z]		Growth index[y]	Injury		Growth index	Injury		Growth index
	Rate (lb ai/A)	28 DAT[x]	205 DAT	205 DAT	28 DAT	205 DAT	205 DAT	28 DAT	205 DAT	205 DAT
Roundup Pro[w]	0.8	1.0	1.0	38.3*	2.0*	1.3	50.7*	1.6	1.4	35.0
	1.6	1.6*[v]	1.8	35.1*	2.8*	2.3*	40.1*	3.0*	2.1	29.9
	3.2	2.0	3.0*	33.7*	2.9*	3.4*	35.5*	6.6*	5.6*	17.9*
	Significance[u]	L**	L***	NS	L**Q*	L***	L***Q*	L***	L***	L***
Finale	0.5	5.1*	4.5*	31.7*	4.4*	1.8*	48.2*	2.8*	1.3	31.7
	1.0	6.7*	6.1*	30.3*	7.6*	4.6*	38.6*	4.0*	1.2	35.7
	2.0	8.2*	8.9*	11.5*	7.7*	4.1*	40.3*	6.1*	2.7*	27.4*
	Significance	L***Q*	L***	L***Q*	L***Q***	L***Q**	L*Q**	L***	L**	L*Q**
Control	-	1.0	1.0	53.3	1.0	1.0	68.5	1.0	1.1	33.1

		English Ivy			Mondo grass			Juniper		
		Injury		Growth index	Injury		Growth index	Injury		Growth index
Herbicide	Rate (lb ai/A)	28 DAT	205 DAT	205 DAT	28 DAT	205 DAT	205 DAT	28 DAT	242 DAT	205 DAT
Roundup Pro*	0.8	3.9	5.9*	13.6*	2.0*	1.2	14.3	1.9	1.0	20.8
	1.6	5.2*	9.5*	2.9*	3.6*	4.8*	9.8*	2.0*	3.6*	19.8
	3.2	7.4*	9.9*	0.0*	7.0*	8.8*	3.2*	2.8*	7.3*	15.4*
	Significance	L**	L**Q*	L*	L***	L***	L***	L*	L***	L**
Finale	0.5	4.1	2.2	28.8	6.7*	6.4*	8.1*	3.5*	3.0	19.3
	1.0	7.9*	6.9*	11.4*	8.6*	9.1*	2.9*	3.6*	4.4*	16.8
	2.0	8.6*	8.6*	4.3*	8.9*	9.4*	1.9*	3.8*	3.6*	17.3
	Significance	L**	L***Q*	L***Q*	L***Q***	L***Q**	L***Q*	NS	NS	NS
Control	-	1.9	1.9	29.4	1.0	1.0	13.7	1.0	1.0	19.4

[z]Injury rating where 1 = no injury and 10 = death.

[y]Growth index equivalent to the sum of height , width, with divided by 3.

[x]Days after treatment.

[w]Roundup Pro rates equivalent to 0.5%, 1.0%, and 2.0% solution.

[v]Means within a column with an asterick are different from mom-treated control. Dunnett's multiple comparison test (one-sided. α=0.05).

[u]Regression response non-significant (NS), linear (L), or quadratic (Q) at the 0.05 (*), 0.01 (**), or 0.001 (***) level.

Diuron for *Oxalis stricta* L. Control: Foliar vs. Substrate Activity

Carey V. Simpson, Glenn R. Wehtje, Charles H. Gilliam, Jeff L. Sibley and James E. Altland
Auburn University, Dept of Horticulture, Auburn, AL 36849

Index Words: Postemergence Weed Control, Herbicide Absorption and Translocation.

Nature of Work: Woodsorrels (*Oxalis* spp) are reported to be one of the most difficult to control weeds in container nurseries (4). In the southeastern U.S., *Oxalis* spp is prevalent at all times during the year in nurseries and landscape plantings due to the optimal growing conditions and frequent irrigation (3). Diuron may offer possible postemergence control in dormant nursery crops, or postemergence directed applications in actively growing crops (6). Absorption and distribution of both foliar-applied and root-applied diuron in several crop plants was studied by Bayer and Yamagugchi (2). With foliar applications, rapid killing of treated tissue limited translocation out of the treated area. Root absorption resulted in a xylem-based distribution of diuron through the treated plant. Neither foliar nor root treatment resulted in any phloem-based translocation within treated plants. In a preliminary selective placement study, we determined the majority of postemergence oxalis activity with diuron is the result of foliar absorption with root absorption being a minor factor. However, root absorption is a contributing factor in the total activity of diuron against oxalis. In order for any herbicide to be subject to root absorption, a portion of the herbicide must remain available within the water phase of the substrate (5). Diuron is relatively well absorbed by agricultural soils and adsorption increases as clay and/or organic matter content increases (7). We speculated that diuron adsorption in a pine bark substrate would be high. In unpublished work, we found that diuron rapidly absorbed to the pine-bark substrate. Only 5.8% of applied diuron remained in the water phase of the pine-bark substrate after 3 hours which corresponded to a concentration of 5.2 ppm in the water phase. After one week the diuron concentration equilibrated to 2.4 ppm and remained in the top 1 cm of substrate. Our first objective was to quantify absorption and translocation of foliar-applied diuron in *Oxalis stricta*. Our second objective was to determine the diuron aqueous concentration phytotoxic to hydroponic–grown *Oxalis stricta*.

Trade gallon containers were filled with a pine bark and sand (7:1 v/v) substrate with amendments, seeded with 25 seeds each, and grown in shade for 10 weeks. At treatment plants were 10 cm tall with flowers. For objective one, a 0.5-ml subsample of the normal spray solution (1.0 lb ai/A and 40 gal/A) was spiked with ^{14}C-diuron. A recently-formed, fully-expanded leaf of an individual oxalis plant was selected and single 2-*u*l drop of the radiolabled spray solution was applied to the middle leaflet of the selected leaf using a microapplicator. Treated leaves were harvested at either 24 or 48 hours after treatment. At harvest, the treated leaf was detached. The treated leaflet was excised and washed with a water/methanol solution in a scintillation vial. Treated leaflet was subsequently removed and 10 ml of scintillation fluid added to the vial. Remaining portions of the treated leaf, i.e. the two adjacent, non-treated leaflets and the leaf petiole were also collected. Plant tissue sections were dried, combusted in a biological tissue oxidizer, and recovered radioactivity quantified through scintillation spectrometry. A completely randomized design with 6 single-plant replicates was used. Data were subjected to analysis of variance, and Fisher's protected LSD comparison.

For objective two, *Oxalis stricta* were grown as previously described, except when flower buds were first evident (3 weeks after germination), plants were removed from their container and had the roots washed free of substrate and transferred to hydroponic culture. At the time of treatment plants were 5 cm tall and had about 20 expanded leaves. Plants were fitted with a Styrofoam float with collar which allowed the roots to extend into the hydroponic solution while holding the foliage erect and away from the solution. After 48 h plants were transferred to a series of eleven diuron concentrations ranging from 0.01 to 1000 mg/L, as well as a non-treated control. Oxalis were grown for two weeks in 0.9-L plastic food-storage containers were filled with water spiked with the desired concentrations. Plants were rated for diuron-induced injury 2 WAT. A completely randomized design with 4 single-plant replicates was used. Data were subjected to regression analysis and Fisher's protected LSD comparison.

Results and Discussion:
Objective 1: Diuron was rapidly absorbed by Oxalis. There was no difference in absorption between 24 and 48 hour exposure times; therefore, data for the two times were pooled for further analysis and presentation. Only 14% of the applied amount of diuron was recovered in the leaf wash; indicating that 86% of applied had been absorbed (Table 1). Amounts recovered in the treated leaflet, the two adjacent leaflets and the leaf petiole were 76, 6 and 4% of applied, respectively. These data indicate diuron translocation from foliar application is minimal and suggest that diuron foliar activity on Oxalis is predominately contact in nature. A similar conclusion was reached by Bayer and Yamagugchi (2).

Objective 2: At 2 WAT, all diuron concentrations > 0.50 mg/L were injurious, and concentrations > 10 mg/L were lethal to oxalis (Table 2). Oxalis response to diuron concentration could be readily described by a log-logistic response curve $y = 0.63/(1+ \exp(-(x-4.46)/-0.07))$ ($r^2 = 0.87$). Based on this model the concentration resulting in 50% control (I_{50}) value was estimated to be 1.14 mg/L. When this data is combined with the water phase data, we can conclude that diuron concentration in a pine-bark substrate resulting from a postemergence application provides an additional impact on postemergence Oxalis control, and may provide residual preemergence control.

Significance to Industry: Diuron has strong contact activity against actively growing Oxalis as indicated by rapid absorption with minimal translocation. This research also indicates foliar applied diuron is more effective than substrate applied diuron for post emergence control; however, substrate activity is effective only on small Oxalis (2-5 cm and not flowering). These data evaluated with research by Ahrens et al (1) which reported irrigation soon (30 min) after diuron application reduced nursery crop injury, may greatly expand the opportunity for use of diuron as a postemergence applied herbicide in nursery crops. Additional research will evaluate how rapidly nursery crops absorb diuron. A differential absorption rate between Oxalis and nursery crops would expand the window of opportunity for postemergence control of Oxalis with diuron.

Literature Cited:

1. Ahrens, J.F., S. Barolli, and R. Gray. 2003. Evaluation of sprayable herbicides for container grown ornamentals. Proc. Northeastern Weed Sci. Soc. 57:36.
2. Bayer, D.E. and S. Yamaguchi. 1965. Absorption and distribution of diuron-C^{14}. Weeds 13:232-235.
3. Cross, G.B. and W.A. Skroch. 1992. Quantification of weed seed contamination and weed development in container nurseries. J. Environ Hort. 10:159-161.
4. Gilliam, C.H., W.J. Foster, J.L. Adrain, and R.L. Shumack. 1990. A survey of weed control costs and strategies in container production nurseries. J. Environ. Hort. 8: 133-135.
5. Schmidt, R.R., and W. Pestemer. 1980. Plant availability and uptake of herbicides from soil. p 179-202 in R.J. Hance, ed. Interactions between herbicides and the soil New York, NY., Academic Press, Inc.
6. Simpson, C.V., C.H. Gilliam, J.E. Altland, G.R. Wehtje, and J.L. Sibley 2002. Postemergence oxalis control in container-grown nursery crops. Proc. Southern Nurseryman Assoc. Res. Conf. 47:376-379.
7. Vencill, W. K., ed. 2002. Herbicide Handbook of the Weed Science Society of America, 8th ed., Lawrence, KS, pp 438-439.

Table 1. Absorption of foliar-applied ^{14}C-diuron by oxalis[1].

Recovery location of ^{14}C-diuron	------% of applied------------
Leaflet wash	14
Treated leaflet	76
Adjacent leaflets	6
Petiole	4

[1]Data pooled over 24 and 48 h exposure. Fisher's protected LSD (P = 0.05) between any two means = 3%.

Table 2. Oxalis phytotoxicity after two weeks exposure to root-available diuron in hydroponic culture.

Diuron concentration	Phytotoxicity[1]
mg/L	
0	1.0e[2]
0.01	1.0e
0.05	1.0e
0.10	1.3e
0.50	2.4d
1.00	3.0cd
5.00	3.8bc
10.00	4.5ab
$\geq$ 50.00	5.0a

[1]Rating scale was as follows: 1 = no observable effect, 2 = mild chlorosis, 3 = extensive chlorosis but no necrosis, 4 = extensive chlorosis and some necrosis, and 5 = death.

[2]Means followed by the same lower case letter are equivallent according to Fisher's potected LSD value; P=0.05. Regression analysis revealed that oxalis response to the log of the diuron concentration could be described by a sigmoid response curve (r^2=0.87).

Predicting Herbicide Losses in Nursery Substrates with Bioassays

Caren A. Judge and Joseph C. Neal
Dept. of Horticultural Science,
NC State University, Raleigh, NC 27695-7609

Index Words: bioassay, container nursery production, herbicide longevity, eclipta, hairy bittercress, large crabgrass, longstalked phyllanthus, *Cardamine hirsuta*, *Digitaria sanguinalis*, *Eclipta prostrata*, *Phyllanthus tenellus*

Nature of Work: Weeds can significantly reduce growth of container nursery crops (1, 3). However, despite the effectiveness of labeled herbicides (4), weeds continue to challenge growers. Few selective postemergence herbicides are currently available for use in nursery crop production; therefore, growers rely heavily upon preemergence herbicides. Although it is common in the southeastern U.S. for preemergence herbicides to be applied every 8 to 10 weeks during the growing season, herbicide concentrations often dissipate to ineffective levels before reapplication and emerged weeds must be removed by hand between herbicide applications, an expensive and laborious task.

Current labor cost estimates of $14.75/hr combined with surveys of nurseries suggest that supplemental hand weeding costs range from $2,389 to $5,506/ha ($967 to $2,228/A), this in addition to three or more yearly herbicide applications (2, 5). At present, weed seedling emergence is the first indication that herbicides have dissipated to ineffective levels. Based on analytical determinations, the half-life of trifluralin in soilless substrates is < 7 d, while providing < 3 weeks control of sensitive species (6). If residuals of other standard preemergence herbicides of container nurseries can be estimated, growers can make more timely herbicide applications; thereby, reducing the need for hand weeding. Therefore, the objective of this experiment was to determine, via bioassay techniques, the length of residual control offered by two standard broad spectrum preemergence nursery herbicides, OH2 and Snapshot, and Broadstar, a broad spectrum preemergence nursery herbicide in development. Four troublesome container nursery weeds were used for the bioassay including eclipta (*Eclipta prostrata* L.), hairy bittercress (*Cardamine hirsuta* L.), large crabgrass [*Digitaria sanguinalis* (L.) Scop], and longstalked phyllanthus (*Phyllanthus tenellus* Roxb.).

The experiment was conducted at two locations in 2002. Herbicides were applied May 30 in Raleigh, NC and June 5 in Castle Hayne, NC using a hand-held shaker jar. Herbicides included Broadstar 0.17G (flumioxazin) @ 0.4 kg ai/ha (0.3 lb ai/A), OHII 3G (oxyfluorfen + pendimethalin) @ 3.4 kg ai/ha (3.0 lb ai/A), and Snapshot 2.5G (isoxaben + trifluralin) @ 5.6 kg ai/ha (5.0 lb ai/A). The experiment was arranged in a randomized complete block design with six replications per location. Weed bioassay species were surface seeded 0, 2, 4, 6, 8, 10, and 12 weeks after treatment (approximately 1/2 teaspoon seed/container). At each seeding date, one 11-L (3 gal) plastic container per plot was seeded half with hairy bittercress and large crabgrass and one container per plot was seeded half with eclipta and longstalked phyllanthus. A potting substrate of 7 pine bark : 1 sand (by volume) was utilized. Containers received approximately 2.5 cm (1 in) overhead irrigation daily.

Percent inhibition was evaluated visually 4 weeks after each seeding date and compared to an non-treated control. At each location, means from each seeding date were subjected to nonlinear regression over time based on a logistic model (7). Based on regression equations, weeks of ≥ 80% control (I80) were determined. Analysis of variance was performed on I80 values with each location treated as a replicate (n = 2). Means across herbicide treatments and within herbicide treatments were separated using the Fisher's protected LSD procedure at $P \leq 0.05$.

Results and Discussion: Based on means separation across herbicide treatments, Broadstar and Snapshot provided statistically longer residual control of eclipta than OH2, though none provided more than 3 weeks residual control. For hairy bittercress, OH2 provided 11.4 weeks residual control, which was statistically greater than both Broadstar and Snapshot. OH2 provided longer residual control (8.6 weeks) of large crabgrass than Broadstar and Snapshot. For longstalked phyllanthus, Broadstar and OH2 provided statistically similar residual control, 9.3 and 10.0 weeks, respectively, which was statistically better than Snapshot.

Based on means separation within herbicide treatments, Broadstar was most effective on longstalked phyllanthus, providing 10.0 weeks residual control (Table 1). Broadstar was less effective on hairy bittercress and large crabgrass, providing statistically equivalent residual control of 6.0 weeks and 5.3 weeks, respectively. Broadstar was least effective on eclipta, providing only 2.9 weeks residual control. OH2 was most effective at controlling hairy bittercress over time, providing 11.4 weeks residual control (Table 1). OH2 was less effective on large crabgrass and longstalked phyllanthus, providing statistically equivalent residual control of 8.6 weeks and 9.3 weeks, respectively. OH2 was least effective on eclipta, providing < 1 week residual control. Snapshot provided statistically similar residual control of hairy bittercress (4.4 weeks) and large crabgrass (4.8 weeks) (Table 1). Snapshot was less effective on eclipta and longstalked phyllanthus, providing 2.7 weeks and 2.6 weeks residual control, respectively.

Considering that southeastern U.S. container nursery production involves herbicide reapplication intervals of 8 to 10 weeks, the herbicides tested here do not always provide enough residual control of common troublesome container nursery weeds. The only treatments that provided residual control equal to or greater than the reapplication interval were Broadstar on longstalked phyllanthus and OH2 on hairy bittercress, large crabgrass, and longstalked phyllanthus. Snapshot provided < 5 weeks control of all bioassay species.

Significance to Industry: In container nursery crop production in the southeastern U.S., some of the most common preemergence herbicides do not provide adequate length of residual control for some of the most troublesome weeds. As a result, hand weeding is still a major component of weed management in container nurseries. By tailoring herbicide choices and reapplication intervals to the weed species present, growers may optimize weed control and thereby reduce hand weeding costs.

Literature Cited:

1. Berchielli-Robertson, D.L., C.H. Gilliam, and D.C. Fare. 1987. Effects of weed competition in container grown plants. Proc. Southern Nurserymen's Assoc. Res. Conf., 32nd Annu. Rpt. p. 301-303.
2. Darden, J. and J.C. Neal. 1999. Granular herbicide application uniformity and efficacy in container nurseries. Proc. Southern Nursery Assoc. Res. Conf., 44th Annu. Rpt. p. 427-430.
3. Fretz, T.A. 1972. Weed competition in container grown Japanese holly. HortScience 7:485-486.
4. Gallitano, L.B. and W.A. Skroch. 1993. Herbicide efficacy for production of container ornamentals. Weed Technol. 7:103-111.
5. Gilliam, C.H., W.J. Foster, J.L. Adrain, and R.L. Shumack. 1990. A survey of weed control costs and strategies in container production nurseries. J. Environ. Hort. 8:133-135.
6. Judge, C.A., J.C. Neal, and R.B. Leidy. 2002. Trifluralin dissipation in a bark-based substrate. Proc. Southern Nursery Assoc. Res. Conf., 47th Annu. Rpt. p. 389-392.
7. Rawlings, J., S.G. Pantula, and D.A. Dickey. 1988. Applied regression analysis: A research tool. 2nd ed. Wadsworth & Brooks/Cole Advanced Books & Software, Pacific Grove, CA.

Table 1. Length of residual control provided by preemergence herbicides, expressed as time (in weeks) of ≥ 80% inhibition for each bioassay species.

	Herbicide		
Bioassay species	Broadstar	OH2	Snapshot
Eclipta	2.9 c[z] A[y]	0.9 c B	2.7 b A
Hairy bittercress	6.0 b B	11.4 a A	4.4 a C
Large crabgrass	5.3 b B	8.6 b A	4.8 a B
Longstalked phyllanthus	10.0 a A	9.3 b A	2.6 b B

[z]Lowercase letters are means separation within herbicide treatments.

[y]Uppercase letters are means separation across herbicide treatments.

Evaluation of Ornamental Weed Control Using Microencapsulated Herbicide Treated Bark Mulch

H. M. Mathers, L. T. Case, A. A. Stoven, S. B. Johansen and J. A. Pope
Ohio State University, Dept. Horticulture and
Crop Science Columbus, OH 43210

Index Words: Ornamental production, nursery, herbicides, mulches

Nature of Work: The objective of this study was to evaluate micro- and non-encapsulated formulations applied to two bark mulches to determine the presence of increased and/or extended efficacy compared to direct sprays or mulch alone (2001 and 2002) and phytotoxicity of the various treatments (2001). Two Monsanto microencapsulated products, Alachlor 41.5% (Micro-tech) and Acetochlor 42% (Degree), as well as two current formulations of these products Alachlor 45 % (Lasso) and Acetochlor 76% (Harness) in combination with Douglas fir and pine bark were evaluated. Plants were potted June 4, 2001 and 2002 and treatments applied. In 2002 two dilution rates, 10 and 50 gal/ac was used. In 2001 only 10 gal/ ac was evaluated. The Alachlor products were applied at 1 (ai) lb/ac and the Acetochlor was applied at 2.5 (ai) lb/ac. The herbicide treated bark was compared to a control (weedy check), direct sprays of the herbicides and mulch applied alone to the container surface for a total of 27 treatments. A 3:1 mix of bark mulch [I inch (2.54 cm) or less] and peat was used. Plants were watered by over- head irrigation daily for the duration of the trial. One-gallon containers (3.8 L), without an ornamental plant, were used. One-quarter teaspoon (1.167 mL) of seeds per pot of common chickweed (*Stellaria media*), annual bluegrass (*Poa annua*) and prostrate spurge (*Euphorbia maculata*) were broadcast over the container surfaces in the efficacy evaluations, just prior to application of the prepared herbicide-treated carriers. Assessments of efficacy were made at 42 and 107 d after treatment (DAT) of treatments using a visual rating. Efficacy was evaluated using a visual rating of 0 (no control) to 10 (complete control) and 7 (commercially acceptable). Phytotoxicity evaluations were conducted also using a visual rating score of 1 (no injury) to 10 (complete kill) and determination of dry weights.

Results and Discussion: Fourteen of the 27 treatments had commercially acceptable weed control (7 or higher) combined over the two evaluation dates of 42 and 107d after treatment (DAT) (Figure 1). Harness was the most efficacious material in the trial, representing six of those top 14 treatments (Figure 1). Micro-tech was the most non-efficacious material. The control was not significantly different in its efficacy versus the untreated pine nuggets and Douglas fir bark (Figure 1). After 107 d, 8 of these 27 treatments had commercially acceptable weed control (Figure 2). Nine of the top fourteen treatments were combinations of mulch and herbicides (Figure 1). The only direct spray providing commercially acceptable weed control after 107 d was the Harness applied at 10 gallons per acre of water (Figure 2). Dilution rate did not appear to significantly affect the efficacy of sprays onto the barks. Pine Nuggets with Harness at 10 and 50 gal/ac dilution rates were the two most efficacious treatments evaluated (data not shown). During the evaluations in 2001 with *Potentilla fruticosa* there was very low phytotoxicity. Only 3 treatments of 15 at 45 DAT had ratings of higher than

3 (data not shown). Only 2 treatments at 130 DAT had ratings higher than 3 (data not shown). Organic mulches control weeds in two ways, inhibition of germination and suppression of weed growth (5, 1). Integration of two or more methods of weed control may produce a positive interaction (4). The combination of chemical and physical control (mulch) has shown to provide a positive interaction in experiments conducted in 1998 and 2000 (3). The Acetochlor product, Harness worked the best with the two mulches tested in this trail. Phytotoxicity tested in 2001 with *Potentilla* was very low; however, phytotoxicity is being retested in 2003. The Pine nuggets treated with Harness were the most efficacious treatments in 2001 and 2002 evaluations. This combination particularly merits further evaluation.

Significance to Industry: Nursery growers estimate they spend $500 to $4000/acre ($1235 to $9880/ha) for manual removal of weeds, depending upon the weed species being removed (Monrovia Nursery Co., personal communications). Reduction of this expense with improved weed control methodologies would have a significant impact on the industry. Extending the duration of efficacy of preemergent herbicides would benefit the nursery industry. However, reduced phytotoxicity should be an important consideration when new products are developed. Recent studies have indicated that the application of preemergent herbicides onto organic mulches reduced herbicide leaching by 35-74% compared with bare soil preemergent herbicide applications (2).

Literature Cited:

1. Duryea, M.L., English, J., and Hermansen, L.A. 1999. A comparison of landscape mulches: Chemical, allelopathic, and decomposition properties. Journal of Arboriculture 25:88-96.
2. Knight, P.R, C.H. Gilliam, S.L. File and D. Reynolds. 2001. Mulches reduce herbicide loss in the landscape. Proc. South. Nurs. Assn. Res. Conf. 46:461-463.
3. Mathers, H. 2003. Novel Methods of Weed Control in Containers. HortTechnology 13(1): Jan-Mar. 2003
4. Schnick, P.J., S.M. Stewart-Wade, G.J. Boland. 2002. 2, 4-D and *Sclerotina minor* to control commom dandelion. Weed Science 50:173-178.
5. Skroch, WA., Powell, M.A., Bilderback, T.E., and Henry, P.H. 1992. Mulches: Durability, aesthetics value, weed control, and temperature. J. Environ. Hort. 10: 43-45.

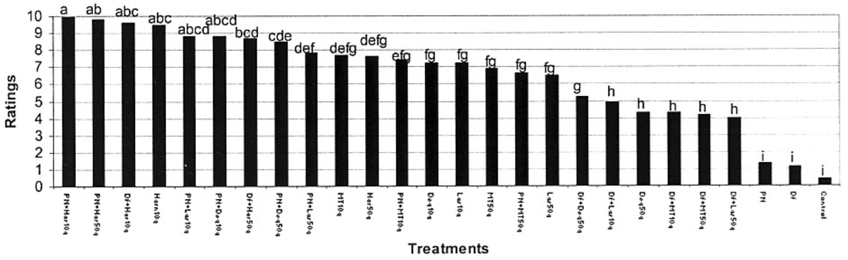

Fig.1. Efficacy for treatments in 2002, evaluated by rated scores, 0-10, where >7 commercially acceptable and 10 is complete control over two evaluation dates. Different letters signify the least significant difference (LSD) *P*=0.05. Bars represent the means of five replicates averaged over two evaluation dates, 42 and 107 DAT. Abbreviations are, Df = <1 inch (2.54 cm) douglas fir nuggets, PN pine nuggets, Har = Harness, Las = Lasso, Deg = Degree, 10g = 10 gal/ ac dilution rate, 50g = 50 gal/ ac dilution rate, MT= Micro-tech.

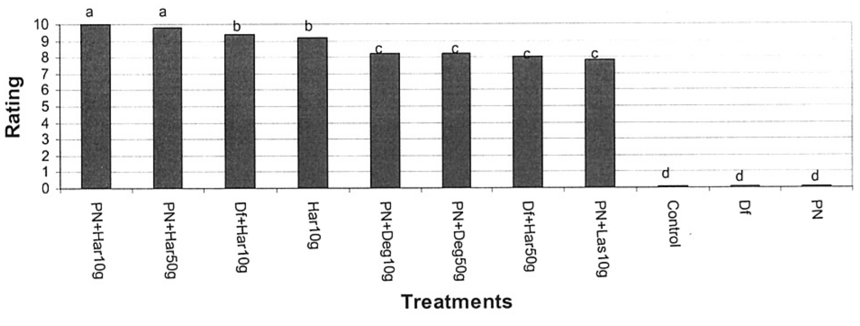

Fig. 2. Comparison of the eight most efficacious treatments in 2002 at 107 DAT compared to the untreated barks and control presented as rated scores, 0-10, where >7 commercially acceptable and 10 is complete control. Different letters signify the least significant difference (LSD) P=0.05. Bars represent the means of five replicates. Abbreviations are, Df = <1 inch (2.54 cm) douglas fir nuggets, PN pine nuggets, Har = Harness, Las = Lasso, Deg = Degree, 10g = 10 gal/ ac dilution rate, 50g = 50 gal/ ac dilution rate.