SECTION 9
WEED CONTROL

Dr. Walter A. Scroch
Section Chairman and Moderator

Herbicide Movement in Container Media

Charles Gilliam, Donna Fare, and Danny LeCompte
Alabama

Nature of Work: Water quality is a major concern with container nursery crop production. One area with limited information is herbicide movement in container media. Since container effluent contributes to water movement into containment systems and water leaving the nursery, it is important to understand the extent of herbicide movement occurring in container media.

A greenhouse study was conducted to provide controlled irrigation. Water collection modules were constructed to allow application of individual irrigation volumes to a given module. Five commonly used preemergence applied herbicides were selected for evaluation: Rout 3G, Ronstar 2G, Southern WeedGrass Control (SWGC) 1.68G, Derby and Pennant 5G. All herbicides were applied at the manufacturers' recommended use rate. Three volumes of irrigation were applied: 0.25, 0.50, and 1.0 inch per irrigation. The statistical design was completely randomized with three replications (water modules). Each experimental unit consisted of five trade gallon containers per herbicide treatment. No plants were grown in the containers. Medium used was pinebark amended with sand (6:1, v:v). Samples were collected after irrigations 1, 3, 6, 12, 25, and 40. Immediately after sample collection, samples were packed in ice for transport to the Alabama Department of Agriculture and Industries Pesticide Residue Laboratory, Auburn, Ala. for analysis. Detection limits were 0.2 ppb for each of the respective herbicides. In addition, the volume of container leachate was measured with each sampling.

Results and Discussion: With Ronstar, maximum oxadiazon levels occurred in the container effluent in the first and third irrigations after application (Figure 1). Thereafter, oxadiazon container effluent levels were about 10 ppb (parts per billion) or less. Maximum container effluent levels of oxadiazon were about 100 ppb. Irrigation volumes had little influence on oxadiazon concentrations in the container effluent.

Pendimethalin is used in the granular form in container nursery crop production under the trade name of Southern WeedGrass Control (SWGC). Of the five herbicides tested, pendimethalin had the lowest levels detected in container effluent (less than 3 ppb). Irrigation volume had no influence on total pendimethalin container effluent levels (Figure 1).

Oxyfluorfen is a component of Rout, one of the major herbicides used in container nursery crop production. Rout 3G is a preemergence herbicide composed of oryzalin (Surflan-1%) and oxyfluorfen (Goal-2%). Oxyfluorfen container effluent levels were less than 5 ppb regardless of irrigation sampling or irrigation volume applied. From irrigations 6-40, there was a trend for the total container effluent in the one inch irrigation treatment to have the lowest oxyfluorfen levels (Figure 1).

Metolachlor is a component of two herbicides used in container nursery production. Pennant 5G has metolachlor as its active ingredient and Derby 5G has metolachlor (4%) and simazine (1%) as its components. Maximum metolachlor container effluent levels occurred with the first irrigation and declined thereafter. With the first irrigation, metolachlor container effluent levels ranged from about 50 - 200 ppb for Derby and 40-115 ppb for Pennant. Derby appeared to be more sensitive to irrigation levels with the one inch treatment consistently having the highest total container effluent levels(Figure 1). This trend of higher metolachlor levels with higher irrigation treatments was less apparent with Pennant. Metolachlor container effluent levels were generally above 20 ppb throughout the sampling period.
These data confirm highest total container effluent levels occur by the third irrigation following herbicide application. While a limited number of herbicides were evaluated, these data show herbicides differ in their leachability from a pinebark container medium.

Significance to Industry: Herbicide movement through container media occurs at low levels (ppb), most likely as a result of herbicide adsorption to the organic media. Reduced herbicide levels in nursery runoff water may be obtained by selecting a herbicide that is minimally affected by irrigation volume, applying herbicides while containers are jammed, and staggering herbicide application over time in the nursery.

Figure 1. The influence of irrigation volume on total herbicide movement in container medium.

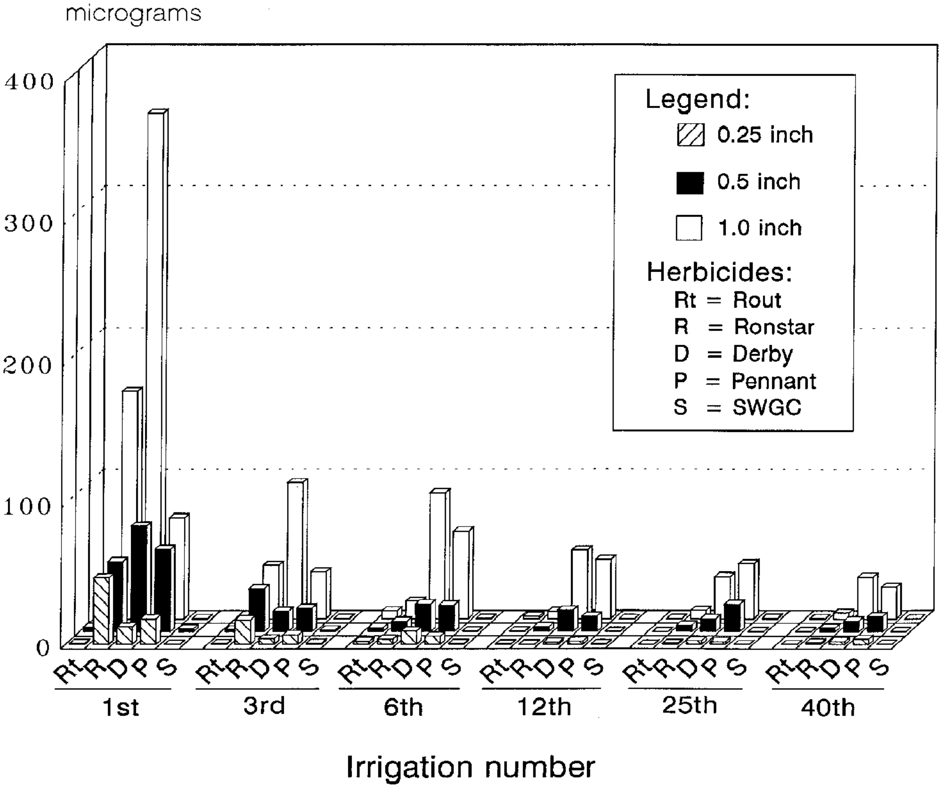

Fig. 1. Herbicide effluent in container leachate.

Weed Management Options For Wildflower Meadows and Beauty Spots

W.L. Corley, T.R. Murphy, and K.R. Reynolds
Georgia

Nature of Work: Popularity of wildflower beautification in public and private landscapes continues due to environmental concerns and strained landscape management budgets. The phenomenon of plant succession in Southeastern landscapes presents a serious problem of weed invasion in wildflower plantings. Many landscape managers envision wildflowers as a panacea for landscape color in a minimal management regime. Weed control has become a primary concern for those involved in wildflower beautification efforts on roadsides, parks, and backyard color spots.

Results and Discussion: Several approaches can be taken to minimize weed intrusion of wildflower plantings. The most obvious is proper seedbed preparation to suppress existing weed seeds and plants. Research (1,5) has shown that short term preemergent herbicides, multiple tillings, solarization and fumigation result in good weed control during the initial year of wildflower establishment.

Two other steps toward weed management can be taken during establishment of plantings: increased seeding rates and use of aggressive wildflower species. The usual seeding rate of 10 to 15 pounds/acre of a regional mix can be increased to help delay weed encroachment. Using this tactic, economics may become a factor since seed costs are a significant portion of establishment costs. An alternative to higher seeding rates would be the use of aggressive species. Research (2) has revealed that yarrow, cornflower, partridge pea, oxeye daisy, Queen Anne's lace, lanceleaf coreopsis, gaillardia, sunflower, and black-eyed susan seed mixes compete well and persist on difficult sites among several grasses.

Competition from grassy weeds can be easily suppressed by the use of grass specific herbicides. Timing of the herbicide applications is important since juvenile grasses are usually more easily controlled. In a meadow setting where native grasses are present, timing of herbicide applications are critical since invasive exotic grasses are developing faster spring growth than native grasses, giving a window of opportunity for maximum herbicide activity on grassy weeds with little damage to native grasses.

Some landscape managers elect to use annual wildflower species entirely. Beds are renovated and new seedings made each year. The Texas DOT has opted to use several strong reseeding annuals in their wildflower management system. During early summer herbicides are applied to stressed vegetation on highway rights-of-way. The herbicides do not affect desirable grasses and seeds of desired wildflowers. This system results in wildflower color during spring to early summer, but is apparently cost efficient in vegetation management, since new seedings are not made each year.

Weed control in established perennial wildflowers presents a challenge since complete renovation of plantings or the use of reseeding annuals may not be desired or necessary. Weed management tactics largely depend on weed species present in wildflower plantings. Relatively new classes of herbicides are emerging which exhibit specificity on families of dicots (3,4). Weeds of legume or composite families may often be suppressed with newer herbicides which show selectivity between plant families. Undoubtedly, research in the near future will identify herbicides which show promise due to their family specific mode of action.

Significance To Industry: Landscape managers are becoming aware of cost efficient landscape color provided by wildflower meadows and beauty spots. Weed control in established plantings appears to be a significant but not insurmountable challenge to managers of public and private landscapes. Depending on specific weed problems in an area, several options for weed control or suppression are available to decision makers. These options are influenced by available resources and desired effects of wildflower plantings where minimal costs for landscape color are desired.

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Control of Summer Annual Broadleaf Weeds

Jeffrey F. Derr
Virginia

Nature of Work: Weed control is an important nursery production practice. One group of weeds that is often difficult to control in field production is the summer annual broadleaves. These generally large-seeded plants often are not controlled by preemergence grass herbicides. Herbicides varied in their efficacy on summer broadleaf weeds (1). Gallery controlled all broadleaf weeds evaluated except velvetleaf (2).

An experiment was conducted to evaluate the control of troublesome broadleaf weeds by preemergence herbicides currently used in the nursery industry, as well as selected experimental chemicals. Seed of morningglory (mixture of pitted and tall), prickly sida, common ragweed, velvetleaf, and common lambsquarters were planted in rows. The field soil had a pH of 5.8 with 2.1% organic matter. Dry flowable formulations of Gallery, Predict, and Barricade were applied, while liquid formulations of Princep, Surflan and Goal were used. Granular formulations of Ronstar, Ronstar plus butralin, and Stakeout were utilized. Sprayable formulations were applied on April 15, 1992 using a CO_2-pressurized backpack sprayer. Granular herbicide formulations were applied on the same day using a shaker jar. Skies were partly cloudy, with an air temperature of 62 F at treatment. The first rain was 0.1 inches, which occurred the night after treatment. Shoot fresh weight of morningglory was determined on June 17, 1992. Surviving plants of prickly sida, common ragweed, velvetleaf, and common lambsquarters were counted on June 17.

Results and Discussion: Princep and Goal gave the greatest reduction in morningglory shoot fresh weight, although no treatment provided complete control. Most other herbicides gave poor control of morningglory. Treatments were more effective on prickly sida, as the higher rate of Ronstar, Princep, and Stakeout, and both rates of Goal provided complete control. Predict and the higher rate of Gallery, Princep and Goal gave complete control of common ragweed. Both rates of Stakeout and Goal completely controlled velvetleaf. Barricade did not control prickly sida, common ragweed, or velvetleaf. Common lambsquarters was the easiest weed to control of the five species. All herbicide treatments reduced lambsquarters stand by at least 80%, with both rates of Ronstar, Princep, and Goal completely controlling this weed. Ronstar plus butralin, the higher rate of Stakeout, and Surflan also completely controlled common lambsquarters. Gallery appeared to be slightly less effective than the others treatments on this weed.

Significance to Industry: No herbicide gave complete control of all five broadleaf weeds. Most treatments gave good control of certain of the broadleaf weeds evaluated but poor control of others. Nurserymen must match the herbicides available for a particular nursery crop with the specific weeds present at the field site. Combinations could be used to take advantage of the strengths of different herbicides, thereby overcoming the lack of control for a certain weed by a given chemical.

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Table 1. Control of summer annual broadlreaf weeds with preemerqence herbicides.

Herbicide	Rate lb ai/A	Morning glory shoot fresh weight (oz/plot)	Prickly sida	Common ragweed	Velvet-leaf	Common lambs-quarters
			(number per plot)			
Untreated	-	6.7	84.0	41.3	49.0	22.3
Gallery	0.5	4.9	28.5	1.0	73.0	3.3
Gallery	1.0	6.4	19.8	0.0	80.0	4.0
Ronstar	2.0	4.5	19.3	17.3	14.3	0.0
Ronstar	4.0	2.2	0.0	14.0	2.5	0.0
Ronstar +	2.0	4.5	11.5	19.0	26.3	0.0
butralin 3.0						
Princep	1.0	2.9	8.0	0.3	91.3	0.0
Princep	2.0	1.0	0.0	0.0	26.3	0.0
Stakeout	1.0	4.7	0.3	19.8	0.0	0.3
Stakeout	2.0	1.6	0.0	20.8	0.0	0.0
Predict	2.4	3.3	1.3	0.0	17.8	2.8
Surflan	2.0	7.1	25.0	15.5	12.5	0.0
Barricade	0.75	7.1	74.8	31.0	65.3	2.0
Goal	1.0	1.3	0.0	1.5	0.0	0.0
Goal	2.0	0.2	0.0	0.0	0.0	0.0
LSD (0.05)		1.5	31.7	11.2	26.7	6.6

Herbicides for Weed Control in Dormant Daylily

Wayne C. Porter
Louisiana

Nature of Work: Preemergent herbicides used in the production of daylilies are limited. Granular herbicides such as Rout (oxyfluorfen + oryzalin), Ronstar G (oxadiazon), and OH-2 (oxyfluorfen + pendimethalin) that are commonly used in the production of ornamentals cannot be used on emerged daylilies because the granules become trapped in the daylily crowns and cause injury (2, 3, 4). Injury to daylily has also been reported from the use of Pennant (metolachlor)(1), Goal (oxyfluorfen)(4), and Surflan (oryzalin)(4). No reports of research on the response of dormant daylilies to herbicides were found. With the crowns protected by the growing media, injury by herbicides might be avoided.

Studies were conducted over 2 years to determine phytotoxicity and weed control efficacy of herbicides when applied to dormant ‘Common Orange’ daylily. Studies were arranged in randomized complete block designs with five replications. Herbicides evaluated were Ronstar 5G (oxadiazon), OH-2 (oxyfluorfen + pendimethalin), Pennant (metolachlor), Barricade (prodiamine), Gallery (isoxaben), Snapshot TG (isoxaben + trifluralin), Snapshot DF (isoxaben + oryzalin), Goal (oxyfluorfen), Dimension (dithiopyr), Surflan (oryzalin), and Treflan (trifluralin). Dormant crown divisions were planted into 3-quart containers containing a pine bark:sand media (7:1 v/v) amended with 14 lb/yd^3 slow release fertilizer (17-7-12), 1.5 lb/yd^3 micronutrients, 6 lb/yd^3 dolomitic lime, and 2 lb/yd^3 superphosphate. After planting, approximately 0.5 inch of water was applied to settle the media. Sprayable treatments were applied the next day with a CO_2 backpack sprayer delivering 13 gpa at 30 psi. Granular treatments were applied with a paper bag applicator. After application of the treatments, 0.5 inch of water was applied.

Results and Discussion: In 1991, not enough weeds were present to evaluate. In 1992, all herbicides controlled large crabgrass. Barricade and Goal did not control hairy bittercress (Table 1).

No evidence of injury by any herbicide was seen on the emerging leaves either year. None of the herbicide treatments affected flowering date, number of flowers, number of flower scapes, or scape height either year (Tables 1 and 2).

Significance to Industry: The granular herbicides Ronstar 5G (oxadiazon), OH-2 (oxyfluorfen + pendimethalin), Snapshot TG (isoxaben + trifluralin), Rout (oxyfluorfen + pendimethalin), and Treflan 5G (trifluralin) can be safely used on daylilies before the crowns emerge. Additionlly, Barricade (prodiamine), Gallery (isoxaben), Goal (oxyfluorfen), Surflan (oryzalin), Pennant (metolachlor), and Dimension (dithiopyr) caused no injury and provided effective weed control.

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Table 1. Flowering of ‘Common Orange’ daylily following application of preemergence herbicides during dormancy, Hammond Research Station, 1991.

Treatment	Rate lb ai/A	DOFB[1]	Scape Ht.(cm)	No. Flowers	No. Scapes	Flowers/ Scape
Check, weed-free	--	120	57.0	21.5	2.2	10.2
Barricade	1.0	119	62.2	21.6	2.2	9.8
Ronstar	4.0	118	55.6	19.8	2.1	9.5
OH-2	2.0	118	56.5	19.2	1.9	10.5
Rout	2.0	116	56.7	22.8	2.3	9.8
Pennant	2.0	117	61.8	31.4	2.7	11.6
Surflan	2.0	117	58.5	24.6	2.5	9.7
Gallery	1.0	120	60.7	22.2	2.0	11.6
Goal	1.0	117	61.9	30.0	2.6	12.0
Snapshot DF	3.0	120	62.1	26.4	2.5	10.8
LSD @0.05		NS	NS	NS	NS	NS

[1] Julian date of first bloom.

Table 2. Weed control in and flowering response of 'Common Orange' daylily following appliation of preemergence herbicides during dormancy, Hammond Research Station, 1992.

Treatment	Rate lb ai/A	DOFB[1]	Scape Ht.(cm)	No. Flowers	No. Scape	% Control[2] CARHI	DIGSA
Check, weed-free	-.-	124	75.0	18.8	1.0	100	100
Check, weedy	-.-	123	73.3	23.8	1.5	0	0
Barricade	1.0	139	76.0	21.3	1.3	38	100
Barricade	2.0	131	77.8	19.0	1.0	63	100
Gallery	0.5	124	66.0	16.5	1.0	100	88
Gallery	1.0	125	73.3	18.0	1.0	100	75
Snapshot TG	2.5	130	73.3	20.8	1.3	100	100
Snapshot TG	5.0	127	72.3	21.0	1.0	100	100
Snapshot DF	2.5	131	79.8	22.8	1.0	100	88
Snapshot DF	5.0	124	77.5	20.0	1.0	100	100
Surflan	3.0	128	74.3	25.5	1.0	71	100
Treflan 5G	3.0	127	73.3	18.3	1.0	75	100
Dimension	1.0	132	74.8	19.5	1.0	96	100
Dimension	2.0	131	71.8	18.3	1.0	100	100
Goal	0.5	123	72.8	18.8	1.0	29	88
Goal	1.0	125	63.8	15.8	1.0	63	100
LSD @0.05		NS	NS	NS	NS	39	24

[1] DOFB - Julian date of first bloom.
[2] CARHI - hairy bittercress, DIGSA - large crabgrass.

Metolachlor and Simazine Movement Through Container Substrates

Gail Mahnken, Ross B. Leidy, and Walter A. Skroch
North Carolina

Nature of Work: Loss of herbicides in runoff water from container ornamental sites has become a concern of many nursery operators. The potential exists for irrigation water to move herbicides through container substrates, and excess leachate could carry herbicides out of the containers. For this study, 3 gallon containers filled with one of four substrates from different areas of the United States were treated with Derby 5G (metolachlor and simazine) at a rate equivalent to 4.5 kg ai/ha (4 lb ai/A) metolachlor and 1.1 kg a/ha (1 lb/A) simazine. Approximately one inch of water was applied per day for 16 days to each container using a CO_2 pressurized sprayer. Leachate samples were collected 0, 1, 2, 4, 8, and 16 days after treatment. Leachate volume was measured daily. Samples were extracted and analyzed for both metolachlor and simazine. The samples were analyzed using gas chromatography, and the detection limits were 5 µg/L (ppb) metolachlor and 0.5 µg/L (ppb) simazine. The study was a completely randomized design with 4 replications, and the study was conducted twice.

Results and Discussion: Losses of metolachlor and simazine from each container were calculated by multiplying the herbicide concentration by the leachate volume for each of the six sampling dates. The amounts lost on the six sampling dates were totaled. Substrate ranking based on the amount of herbicide leached was 3:1 (v/v) redwood bark and sawdust:sand > 2:1:1 redwood bark and sawdust:Yolo loam:sand > 1:1 composted hardwood bark:sand > 3:1 pine bark:sand. The substrates containing redwood bark are used commonly in California and the northwestern United States. The hardwood bark and sand substrate was obtained from Ohio, and the pine bark and sand substrate was obtained in North Carolina. The largest concentration of simazine detected was 0.0624 µg/mL in leachate from the 3:1 redwood bark:sand substrate. The largest concentration of metolachlor detected was 0.185 µg/mL in leachate from the 3:1 redwood bark:sand substrate.

Significance to Industry: Substrate composition appears to influence herbicide presence in leachate from containers. Herbicide movement through containers could vary greatly between regions of the United States depending on substrate composition. Increased herbicide movement through substrates may influence plant injury by moving the herbicide into the plant rooting zone. Losses of herbicide in the leachate from containers may also decrease the length of time herbicides effectively control weeds in containers. Further research will be necessary to determine the actual effects of herbicide movment within substrates on plant injury and the length of time herbicides provide effective control.

Vegetation Suppression in Field Grown Trees

W. A. Skroch
North Carolina

Nature of Work: Mowing field tree production sites is expensive and time consuming for growers. Many growers in western North Carolina mowed 4 or 5 times per season at costs of $20 to $40 per acre per mowing. An alternative to mowing was large herbicide inputs to eliminate all vegetation except the trees. These programs led to many erosion problems and replant problems for the next rotation of trees. The growth regulators Embark (mefluidide), Royal Slo-Gro (maleic hydrazide), Cutless (flurprimidol), TGR Turf (paclobutrazol) and several others are registered for grass suppression on low maintenance turf (i.e. highway rights of way). Growth regulators have several shortcomings, however, including product use restrictions, high cost, turf discoloration, release of broadleaf weeds, and potential effects on non-target species. These shortcomings led to the studies reported here. For several years, our research has emphasized vegetation suppression in conifers. Our program utilizes low rates of herbicides that are currently labelled for grower use rather than waiting for the approval of new labels for suppression products.

Because tall fescue and orchardgrass are two of the most common grasses in field grown trees in North Carolina and are very competitive with trees, our studies concentrated on the suppression of these grasses. In the mid 1980's vegetation was suppressed in conifers by using Vantage (sethoxydim) at 8 to 16 oz per acre plus Goal (oxyfluorfen) at 32 oz per acre. The herbicides were applied just prior to budbreak when fescue and orchardgrass had 3 to 5 inches of new growth. This treatment effectively suppressed grasses, but ragweed, thistle, and other composites became dominant. The addition of Stinger (clopyralid) at low rates (3 to 5 oz/A) improved this program.

Materials and Methods: In 1992 and 1993, studies emphasized Select (clethodim), Touchdown (sulfosate) and Roundup (glyphosate) as vegetation suppressants. Select is a graminicide in the same chemical family as Vantage. All materials were applied with 8003 LP nozzles at 15 psi delivering 25 gallons per acre of spray solution.

Results and Discussion: When fescue and orchardgrass had developed 3 to 5 new leaves in the spring application of 4 oz of Roundup suppressed seedheads for 4 weeks. Repeat applications with 4 to 8 oz of Roundup look very promising for overall vegetation suppression. Results have been acceptable when directed sprays are applied either prior to mowing in the spring when grass plants have 3 to 5 new leaves, or 5 to 7 days after the first mowing of the season.

Spring applications of Roundup and Touchdown at 1 lb/A severely damaged conifers. Three over-the-top applications of Roundup to Fraser fir and white pine made between 1 week before bud break and 7 weeks after budbreak caused injury at rates as low as 0.125 lb/A. Further research is needed to determine whether an annual spring or summer application for several years of a low rate of Roundup will cause long term injury to conifers.

Late summer and fall applications of Roundup and Touchdown damaged deciduous trees. As long as deciduous plants are treated only in spring or early summer, when deciduous plants are tolerant to Roundup, the potential for damage is minimal.

Significance to Industry: Low rates of certain herbicides are an inexpensive means of reducing weed competition in field tree plantings while maintaining a groundcover to prevent erosion and improve trafficability.

A Comparison of Fumigants for Weed Control

C.J. Catanzaro and W.A. Skroch
North Carolina

Nature of Work: The U.S. Clean Air Act and the Montreal Protocol of the Vienna Convention mandate that substances listed as ozone-depleting, such as methyl bromide, be eliminated from production and use. Furthermore, removal and disposal of the plastic required for methyl bromide fumigation results in additional expenditures of time and money for the grower. The purpose of the present study was to evaluate the effectiveness of several methyl isothiocyanate (MITC) fumigants which are considered possible alternatives to methyl bromide and to determine whether these alternatives could provide effective weed control without the use of plastic. The study was conducted under soil conditions often encountered in the Southeastern U.S. during the late fall.

Materials and Methods: The experiment was conducted on a sandy loam soil near Goldsboro, NC. The experimental design was a randomized complete block design with 18 treatments and 4 replications. Treatments included methyl bromide at 240 and 320 lb ai/A, and Basamid (dazomet), Sectagon (metam sodium), and Vapam (metam sodium) at 260 and 320 lb ai/A. Plots were 10 x 40 feet. The MITC treatments without plastic were applied to the soil surface, incorporated to a depth of either 3 or 6 inches, and the soil surface was sealed with a power roller which sealed the soil surface without compressing the soil beneath. The MITC treatments with plastic were applied only at the 260 lb rate and incorporated 6 inches deep. All treatments were appliecl on November 18, 1992. On the following day, soil temperatures at 0, 2 and 6 inches were 62, 52 and 48 F in plots without plastic, and 79, 60 and 48 F under plastic. Eleven days after treatment, plastic was removed and onehalf of each plot was tilled. Weed counts were taken on April 13, 1993 and May 28, 1993 using 10.8 ft^2 frames. The species counted are listed in Table 1. On April 20, 1993, all plots were sprayed with paraquat and tilled to a depth of 3 inches.

Results and Discussion: Fumigant type, rate, depth of incorporation, and tillage did not affect control of most weed species. Weed control provided by MITC products and methyl bromide was equivalent for most species. Control of henbit was higher with methyl bromide and Basamid than with Sectagon. Control of yellow nutsedge was higher with methyl bromide, Sectagon, and Vapam than with Basamid. Morningglory control was similar with all compounds when the 320 lb ai/A rate was used. However, at the 260 lb ai/A rate, Sectagon did not control morningglory as effectively as the other fumigants. Control of mouse-ear cress was higher with the 320 lb ai/A rate of fumigants than with the lower rate. Methyl bromide and Basamid provided higher control of mouse-ear cress than Sectagon and Vapam in untilled plots, but all fumigants provided similar control in tilled plots. All species except mouse-ear cress were controlled equally in plots with or without plastic. Either plastic or tillage was required to control cress.

Significance to Industry: This research indicates that under late season soil temperature and moisture conditions typical for the Southeastern U.S., Basamid, Sectagon and Vapam can provide weed control similar to that provided by methyl bromide. These MITC products provided adequate weed control either with or without plastic.

Table 1. Common and scientific names of weeds counted, and dates on which weed counts were taken.

Common Name	Scientific Name	Date Counted
mouse-ear cress	*Arabidopsis thaliana*	4/13/93
henbit	*Lamium amplexicaule*	4/13/93
common venuslookingglass	*Triodanis perfoliata*	4/13/93
carpetweed	*Mollugo verticillata*	5/23/93
common cocklebur	*Xanthium strumarium*	5/23/93
large crabgrass	*Digitaria sanguinalis*	5/23/93
common lambsquarters	*Chenopodium album*	5/23/93
morningglory	*Ipomoea sp.*	5/23/93
yellow nutsedge	*Cyperus esculentus*	5/23/93
prickly sida	*Sida spinosa*	5/23/93
sicklepod	*Cassia obtusifolia*	5/23/93
tropic croton	*Croton glandulosus* var. *septentrionalis*	5/23/93

Root Uptake of Turf Herbicides by Red Maple and Redbud

L.J. Smith, G.E. Mahnken and W.A. Skroch
North Carolina

Nature of Work: Turf herbicides are potentially damaging to landscape trees and other nontarget vegetation. Field-grown red maple *(Acer rubrum)* and Eastem redbud *(Cercis canadensis)* exhibited foliar injury and reduced growth following directed applications of selected turf herbicides at suggested use rates (1). A study utilizing container-grown trees was conducted to provide additional evidence that injury was due to root uptake of turf herbicides.

Bare root liners of red maple and redbud were potted in 3-gallon nursery containers with a 3:1 (v/v) mix of pine bark and sand. A 4 x 4 in piece of Parafilm “M” laboratory film was wrapped around the trunk of each tree prior to potting to prevent herbicide absorption through the trunk. Trees were arranged in a randomized complete block design with five replications. Established trees were treated with Banvel (dicamba) at 0.125 lb ai/A, BAS 514-OOH (quinclorac) at 0.75 and 1.5 lb ai/A, Image (imazaquin) at 0.5 lb ai/A, Redeem (triclopyr) at 0.38 lb ai/A, or Stinger (clopyralid) at 0.25 lb ai/A. Treatments were applied by topdressing containers with substrate that had been thoroughly mixed with diluted herbicides. The study was conducted twice beginning in mid-1992. Percent visual injury was rated at 2 week intervals for 12 weeks after treatment. Plants were harvested in May 1993, at which time shoot fresh weights and stem diameters were recorded. Data means were subjected to the analysis of variance procedure and means separated (LSD @ 0.05) where appropriate.

Results and Discussion: Herbicide applications in July resulted in higher visible injury than applications in August. Visual injury data on redbud and red maple are presented from the July application only (Tables 1, 2). Trees were injured by Stinger and both rates of BAS 514-OOH. Trunk diameter and shoot fresh weight data are presented as a combined analysis from trees treated in July and August (Table 3). Stinger and the 2X rate of BAS 514-OOH reduced shoot fresh weight of redbud. Trunk diameter of redbud was also reduced by the IX rate of BAS 514-OOH. Shoot fresh weight and trunk diameter of red maple were reduced by the 2X rate of BAS 514-OOH. Increased tolerance of trees treated in August may be due to a decrease in growth activity or decreased upward translocation later in the growing season.

Significance to Industry: Results of this study suggest potential problems with the use of turf herbicides within the root zones of trees and shrubs. Herbicide applicators should exercise caution when selecting turf herbicides for use in areas where trees and turf grow near each other. More research is needed on the sensitivity of various tree species to turf herbicides so that off-target injury can be minimized.

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Table 1. Percent visual injury observed on container grown redbuds topdressed with herbicide treated substrates on July 9, 1992.

Rating Dates	7/23/92	8/7/92	8/21/92	9/3/92	9/18/92	10/2/92
Redeem	0	2	0	2	0	2
Image	6	6	4	0	0	0
Banvel	10	14	6	0	10	2
Stinger	32	46	32	52	44	50
BAS 514 OOH (1X)	26	46	32	30	30	26
BAS 514 OOH (2X)	26	38	32	55	45	42
Check	2	0	0	0	0	0
LSD (0.05)	16	13	7	18	18	20

Table 2. Percent visual injury observed on container grown red maples topdressed with herbicide treated substrate on July 9, 1992.

Rating Dates	7/23/92	8/7/92	8/21/92	9/3/92	9/18/92	10/2/92
Redeem	4	8	4	2	8	0
Image	2	0	0	0	4	0
Banvel	10	12	4	0	12	0
Stinger	20	32	12	14	14	12
BAS 514 OOH (1X)	24	62	56	62	56	40
BAS 514 OOH (2X)	24	54	48	62	58	34
Check	4	0	0	0	0	0
LSD (0.05)	14	15	12	13	17	18

Table 3. Shoot fresh weights and stem diameters of container grown redbud and red maple trees ten months after topdressing with herbicide treated substrate.

	Eastern Redbud		Red Maple	
Treatment	Shoot Fresh Weight (g)	Trunk Diam. (mm)	Shoot Fresh Weight (g)	Trunk Diam. (mm)
Redeem	306	13.9	324	16.1
Image	328	15.3	353	16.7
Banvel	345	15.1	356	17.4
Stinger	232	12.3	386	17.7
BAS 514OOH (1X)	261	12.0	318	14.7
BAS 514OOH (2X)	253	12.7	268	14.1
Check	309	14.7	361	16.3
LSD (0.05)	48	1.5	67	1.9

Herbicide Release From Granular Formulations of Rout™ AND OH-2

Renee J. Keese, Melissa B. Riley, N. Dwight Camper and Ted Whitwell
South Carolina

Nature of Work: Oryzalin and oxyfluorfen (Rout, Grace Sierra) and pendimethalin and oxyfluorfen (OH-2, Scotts) are two commonly used commercial herbicides in nurseries (Gilliam et al., 1990). Previous research demonstrated the presence of these compounds in nursery pond water and sediment, moving from their site of application (Keese et al., 1991). Following herbicide application and irrigation, runoff water contained higher concentrations of oryzalin than oxyfluorfen or pendimethalin (Keese et al., 1992).

Objective: Determine the rate of active ingredient release from granular formulations of Rout and OH-2.

Materials and Methods: Aliquots of Rout and OH-2 herbicides (0.5 g) were placed on filter paper in a funnel. Water (200 ml) was passed over the formulations each day to simulate nursery irrigation conditions. Water samples were collected and herbicides were extracted by acidification of water, concentration of herbicides on C-18 columns and elution with 2 ml acetone. Herbicides were quantified by high pressure liquid chromatography (HPLC) using a C-18 column with acetonitrile:water gradient and W detection at 206 nm. Retention times were as follows: oryzalin 8.1 min, oxyfluorfen 21.0 min, and pendimethalin 23.5 min. Detection limits were 1 ppb (1 ng/ml).

Results and Discussion: Release of oryzalin from Rout was more rapid the first week of collection than during the succeeding two weeks. Oxyfluorfen release was constant over the 3 week period. Cumulative loss accounted for 71% of the active oryzalin and 8% of oxyfluorfen (Figure 1). This formulation yields rapid release of oryzalin, but not oxyfluorfen.

Release of pendimethalin from OH-2 was more rapid than oxyfluorfen. Cumulative release accounted for 19% of the pendimethalin and 6% oxyfluorfen (Figure 2). This herbicide formulation provides slower release of the active ingredient pendimethalin. In general, the dinitroaniline components (oryzalin or pendimethalin), which are more water soluble, are released faster than the less soluble oxyfluorfen in both formulations. Oxyfluorfen had similar release patterns in both formulations.

Significance to Industry: Duration of weed control can be determined by the timing of herbicide release from formulations. Rout and OH-2 are granular herbicide formulations which demonstrate differences in rate of active ingredient release. The fast release pattern of Rout is beneficial; OH-2 provides slower release for control over longer time periods.

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SC Agricultural Experiment Station Publication No. 3435. This research was supported in part by grants from the Horticultural Research Institute, Scotts Chemical Company, and Grace-Sierra Chemical Company. Discrimination/endorsement are not implied in the use of trade or company names.

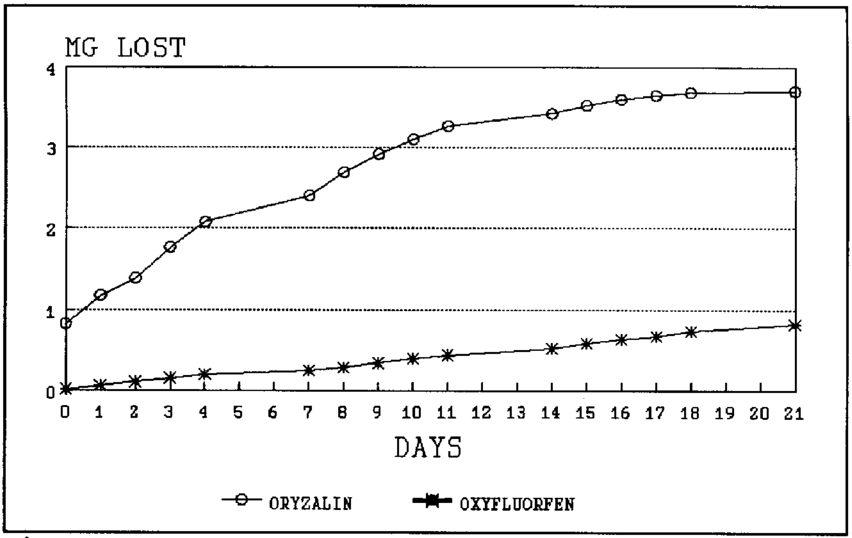

Figure 1: Total release of active ingredients in granular Rout over 3 week period.

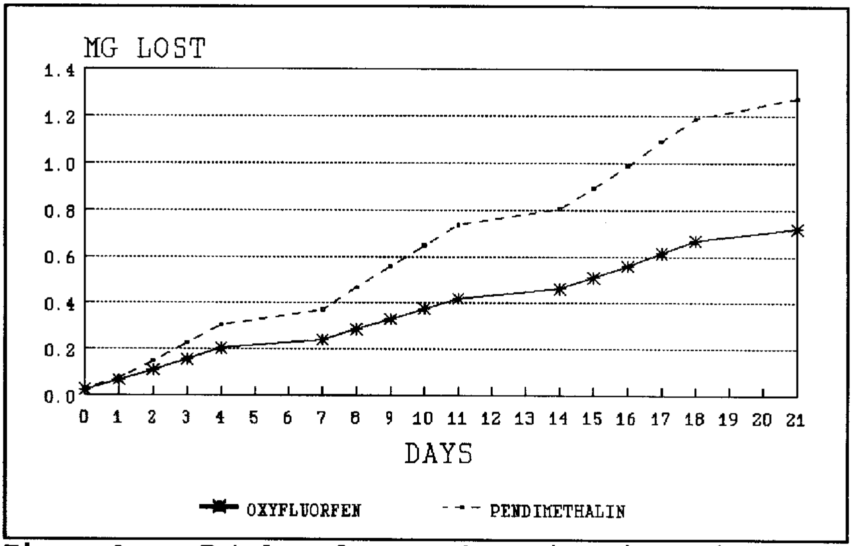

Figure 2: Total release of active ingredients in granular OH-2 over 3 week period.

Herbicide Phytotoxicity on Woody Ornamentals

David H. Tatum and Garry Thompson
Mississippi

Nature of Work: Two studies were conducted to determine the preemergence control of annual broadleaf or grassy weeds and assess phytotoxicity potentials to nine ornamentals growing in containers. Each study consisted of a completely randomized design with three replications. One study was conducted at Wright's Flower Hill Nursery, West Point, MS. The other study was conducted at Rocky Creek Nursery, Lucedale, MS. The following herbicides and rates were used: Chipco Ronstar 2G applied at two and four lb. ai/A, EXP30911A applied at five lb. ai/A, Chipco Ronstar 2G and EXP30909A applied as a combination at two lb. ai/A, Chipco Ronstar 2G applied at two lb. ai/A in combination with EXP30909A at four lb. ai/A. EXP30909A is an experimental 4% granule of butralin (a dinitroanaline herbicide), and EXP30911A is a 5% granule consisting of 3% butralin and 2% oxadiazon. The following four plant species were treated July 7, 1992 at Wright's Flower Hill Nursery with a Gandy drop distributor: golden barberry *(Berberis thunbergii* 'Golden'), showy jasmine *(Jasminum floridum),* glossy abelia *(Abelia grandiflora),* rotundifolia holly *(Ilex crenata* 'Rotundifolia'), and varigated privet *(Ligustrum sinesis* 'Varigatum'). The plants were transplanted into trade gallon containers 2 weeks before treatment. The following plants were treated July 20, 1992 at Rocky Creek Nursery, Lucedale, MS using a shaker. Andorra juniper *(Juniperus horizontalis* 'Plumosa'), trouper azalea *(Rhododendron* 'Trouper'), cape jasmine *(Cardenia Jasminoides),* and compacta holly *(Ilex crenata* 'Compacta') were transplanted into full one gallon containers two weeks before treatment. Injury and weed control ratings were taken two, six and ten weeks after treatment.

Results and Discussion: None of the herbicide treatments resulted in phytotoxicity to any of the ornamentals treated at either site. Preemergence control of grassy weeds and annual broadleaf weeds was siginificant in all treatments when compared to the check. The control of *Oxalis stricta* was improved with the higher rates of Chipco Ronstar treatments. Visual observations reflected no weed growth in containers 10 weeks after treatment where the higher rates of Chipco Ronstar and/or the combination treatments were applied.

As with weed control in other crops, it is becoming necessary to apply combinations of herbicides to control different weed pressures. Some herbicides may have a synergistic effect when combined with other herbicides. Plant phytotoxicity should be thoroughly evaluated before combinations of herbicides are used for the control of weeds in container plants.

Environmental issues are scrutinizing the pesticide industry with EPA cancellations of various uses of pesticides and the reluctance of chemical companies to apply for registration of many pesticides for use on minor crops.

Significance to Industry: As weed pressures change, the nurseryman must be able to use different herbicides and/or combinations for satisfactory control. Without screening such herbicides and their combinations on test plants before-hand, severe economical losses to a crop could result. Environmental issues are constantly imposing the need to become more conscious of any pesticide used in the production of ornamental crops.

Activity and Selectivity of Dithiopyr (Stakeout) for Weed Control in Woody Ornamentals

Leslie A. Weston and Nanik Setyowati
Kentucky

Nature of Work: Dithiopyr is a selective turf herbicide introduced for preemergence annual grass and broadleaf control and postemergence control of crabgrass spp (2). In susceptible species, dithiopyr interferes with spindle microtubule formation in cells within the root apex (1).

Our past field studies indicated that 1.1 to 2.2 kg ai ha^{-1} dithiopyr provided full season preemergence control of many annual broadleaf and grass weeds in field-grown ornamentals (4, 5). At lower rates, dithiopyr gave excellent control of annual grass species, but was considerably less effective in control of nutsedge, morningglory or field bindweed (5).

Limited information is available concerning the physiological basis for observed sensitivity differences in weed species. Results of greenhouse experiments indicated that ivyleaf morningglory *(Ipomoea hederacea (L.)* Jacq.) was tolerant to >2.2 kg ai ha^{-1} dithiopyr, large crabgrass *(Digitaria sanguinalis* (L.) Scop.) was severely injured or killed with 0.27 kg ai ha^{-1} and velvetleaf *(Abutilon theophrash* Medik.) and barnyardgrass *(Echinochloa crusgalli* (L.) Beauv.) exhibited intermediate sensitivity (4).

Based on these results, detailed time course experiments were conducted to determine whether sensitivity differences in two broadleaf weeds (ivyleaf morningglory and velvetleaf) and two grass species (barnyardgrass and large crabgrass) could be attributed to differences in uptake, translocation or metabolism of root applied 14C dithiopyr. In addition, experiments with postemergence foliar applications of 14C dithiopyr were performed in ivyleaf morningglory and large crabgrass seedlings in an effort to determine the basis for effective postemergence control of seedling large crabgrass following foliar application of ^{14}C dithiopyr.

Uptake, translocation and metabolism from root application: Research was conducted over a 96 or 192 h period. Three-week old seedlings of ivyleaf morningglory, velvetleaf, barnyardgrass and large crabgrass were immersed in beakers containing aerated halfstrength Hoagland s solution with 0.5 µCi ^{14}C-dithiopyr (specific activity 29.24 mCi mM^{-1}) dissolved in solutions as a pulse treatment. Plants were placed under a fluorescent light bench and the appropriate incubation of 12, 24, 48, 96 or 192 h was provided. At harvest, roots, shoots and stems for broadleaves and roots and shoots for grasses were separated and fresh weights were taken. Extraction of methanol-soluble ^{14}C-labeled dithiopyr and polar metabolites of ^{14}C-dithiopyr from plant parts was performed in a similar manner to that of Scott and Weston (3).

Foliar absorption and translocation: Six 3-week old seedlings of ivyleaf morningglory and large crabgrass were placed in Erlenmeyer flasks containing aerated half-strength Hoagland s solution. After a 24 h acclimation period, 3 µCi of ^{14}C-dithiopyr was applied as a droplet to the second true leaf of each species. After 192 h, extraction of plant parts occurred as above.

Results and Discussion: *Uptake, translocation and metabolism from root application:.* At 12, 24 and 48 HAT, large crabgrass shoots accumulated up to 12 times more total ^{14}C (dpm mg^{-1} fresh weight) than did ivyleaf morningglory shoots (Table 1). By 96 and 192 HAT, large crabgrass shoots accumulated greatest total ^{14}C and ivyleaf morningglory the least, while barnyardgrass and velvetleaf ^{14}C shoot activity was intermediate.

The percentage of ^{14}C-dithiopyr present in the root and shoot extracts of all species decreased linearly over time. Barnyardgrass shoots contained greatest levels of the ^{14}C parent followed by large crabgrass, velvetleaf and ivyleaf morningglory. By 192 HAT, ivyleaf morningglory shoot extracts had only 8% of total radioactivity present as ^{14}C-dithiopyr while other species retained greater than 30% as the ^{14}C parent (data not presented). The percentage of total ^{14}C metabolites increased over time in both root and shoot extracts. Ivyleaf morningglory shoots had greater percentages of ^{14}C present as polar metabolites than did other species throughout the experiment. The percentage of ^{14}C distributed as nonextractable forms also increased in root and shoot extracts of all species overtime, indicating a conversion of dithiopyr to insoluble non-extractable forms. HPLC analysis and TLC plate scanning suggested that metabolites present in root and shoot extracts included both the monoacid forms or the diacid form of dithiopyr.

Foliar absorption and translocation: Most of ^{14}C-dithiopyr remained on the surface of the treated leaf of ivyleaf morningglory or large crabgrass (31 or 42%, respectively) and stayed within the treated leaf (33 or 47%, respectively). Only minimal amounts (1 or 8%) of total ^{14}C was translocated out of the treated leaf to surrounding tissues and less than 1% total ^{14}C recovered was translocated to the root of either species (Table 3).

Significance to Industry: These experiments indicate that differences in selectivity observed in ivyleaf morningglory (tolerant) and large crabgrass (susceptible) are likely associated with differential dithiopyr root uptake and translocation, as well as an increased rate of metabolism of dithiopyr in ivyleaf morningglory shoots. Dithiopyr is currently under consideration for development in ornamentals by Monsanto Inc.

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Table 1. Uptake and metabolism of root-absorbed ^{14}C-dithiopyr in shoots of selected weed species over a 96-h period[a].

	^{14}C activity at time after treatment (h)			
Distribution of ^{14}C	**12**	**24**	**48**	**96**
Total recovered:	**-dpm mg^{-1} fresh weight-**			
Morningglory	19	16	16	14
Velvetleaf	33	52	64	48
Large crabgrass	152	103	190	83
Barnyardgrass	110	115	78	65
LSD (0.05)	31	58	76	9
^{14}C-dithiopyr:	**—% of total recovered—**			
Morningglory	49	47	49	22
Velvetleaf	63	51	54	37
Large crabgrass	76	73	66	37
Barnyardgrass	87	85	75	62
LSD (0.05)	18	9	15	13
Methanol-soluble ^{14}C metabolites:	**—% of total recovered—**			
Morningglory	8	10	20	24
Velvetleaf	14	7	10	15
Large crabgrass	8	8	15	14
Barnyardgrass	3	7	13	18
LSD (0.05)	6	NS	5	4

[a]Values for each species within each time period were separated using Fishers Protected LSD Test.

[b]Linear and Quadratic refer to highly significant (**), significant (*) and nonsignificant (NS) linear and quadratic response components over time.

Table 2. Percentage of total ‘4C in separated plant parts 168 h after foliar application of ^{14}C-dithiopyr.

Species	% distribution of total recovered ^{14}C activity[a]				
	LW [b]	TL	RS	RT	NE[c]
Morningglory	31.18	32.61	8.13	0.13	27.93
Large crabgrass	42.09	46.70	0.69	0.08	10.42
Significance	NS	NS	NS	NS	*

[a]Values were analyzed using analysis of variance.

[b]LW=leaf wash of treated leaf; TL=treated leaf; RS=remaining shoot tissue; RT=roots tissue; NE=nonextractable.

[c]Data were transformed using square root transformation. Means were significantly different from one another at the 0.05 level (*).

Preemergence Herbicide Costs Related to Field Nursery Weed Control

Robert E. McNiel
Kentucky

Nature of Work: Several factors from weed species to equipment requirements are among many concerns the nurseryman will need answered before successful weed control can take place around plants in production in a field nursery. Information which has been available has included evaluations reported on percentages of weed control for a variety of herbicides (2). Information on product costs which could be coupled to evaluation performance has not been available. The following is an investigation into the product costs for selected herbicides using the manufacturers recommended low and high rates of application.

Not all preemergence herbicides labelled for use on woody landscape plants during field production are readily available in any one location. One firm (1) was selected which had in its annual inventory 13 of the more common preemergence herbicides labelled for nursery use. Dollar values used reflect one stop purchasing. If additional sources are required to purchase product needed, then additional expenses for transportation would be incurred.

The 13 herbicides (Table 1) were identified as to its normal unit for purchase (case or bag), the unit content(to establish total quantity), the unit price and the rate for application (according to the manufacturer's label.

Results and Discussion: Costs (Table 2) were determined for the recommended unit of application (pint [pt], quart [qt] or pound [lb]), for an acre of production, or for a banded application zone applied only to the production row(in this case 4 feet wide and 1000 feet long). The range in cost of unit of application was from $0.57 to $104.44. Five products were available for less than 2 dollars a unit. The range in cost of herbicide material for application to an entire acre was from $12.99 to $1030.50 at the high rate. The five lowest cost/acre values were under $52.00 and included only one of the five lowest cost per unit herbicides. Since the majority of field production nurseries have sod interrows, weed control may occur only adjacent to the plant row. Thus values are presented which reflect a 1000 foot row with a 4 foot band. The ranking of herbicide costs for this method is equal to that of the cost/acre method. The cost range for the band (4 feet) method was $1.20 to $94.81 per 1000 feet at the high rate. All but one value was less than $27.00/1000 ft. If it is more appropriate to have values per 100 feet of row, divide the per 1000 foot value by 10. If it is more appropriate to have a 3 foot band (3), multiple the per 1000 foot by 4 foot value by 3/4 or .75.

Significance to Industry: As stated previously, quality of weed control is based on several factors. Herbicide application is based on weed species present and not all herbicides will control every weed species. However, newer multiple ingredient products are being produced in order to gain the advantages of each ingredient. When weed species escapes occur or the overall control drops below a threshold value(such as 80%), additional control measures may be needed. Supplemental control measures could include hand hoeing, mechanical removal or postemergence herbicide application. The cost of the preemergence herbicides can be coupled with threshold levels, selected weed species, supplemental control techniques, etc. as part of the management skills necessary for economical and favorable weed control. Finally, the least expensive unit cost does not yield the least expensive application rate on a per acre basis.

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Table No. 1. Units, Prices and Rates of Common Preemergence Herbicides for use in Field Production Nurseries.

HERBICIDE	UNIT	UNIT CONTENT	UNIT PRICE	HERBICIDE RATE (ACRE)
Chipco Ronstar 2G	bag	50 lb	61.33	100 - 200 lb
Devrinol 5G	case	12 x 4 lb	412.20	80 - 120 lb
Gallery 75DF	case	4 x 1 lb	417.76	0.66 - 1.33 lb
Goal 1.6E	case	2 x 2½ gal	408.32	21.25 - 5.00 pt
Kerb 50W	case	14 x 3 lb	1010.80	2.00 - 4.00 lb
Pennant 5G	bag	40 lb	52.80	40 - 80 lb
Pennant 7.8EC	case	4 x 1 gal	407.68	2.00 - 4.00 pt
Princep L	case	2 x 2½ gal	86.60	2.00 - 3.00 qt
Snapshot 80DF	case	6 x 1.25 gal	317.40	2.50 - 5.00 lb
Snapshot 2.5TG	bag	50 lb	60.90	100 - 200 lb
Surflan 4AS	case	5 x 1 gal	409.65	2.00 - 4.00 qt
Treflan 5G	bag	40 lb	22.76	80 lb
XL 2G	bag	50 lb	47.25	200 - 300 lb

Table No. 2. Costs per Unit, per Acre and per band of Common Preemergence Herbicides for use in Field Production Nurseries.

HERBICIDE	HERBICIDE RATE (ACRE)	COST ($)	COST/ACRE ($)	COST/1000' X 4' BAND
Chipco Ronstar 2G	100 - 200 lb	1.23 lb	123.00 - 246.00	11.32 - 22.63
Devrinol 5G	80 - 120 lb	8.59 lb	687.00 - 1030.50	63.20 - 94.81
Gallery 75DF	0.66 - 1.33 lb	104.44 lb	68.93 - 138.90	6.34 - 12.78
Goal 1.6E	1.25 - 5.00 pt	10.21 pt	12.76 - 51.05	1.17 - 4.70
Kerb 50W	2.00 - 4.00 lb	24.07 lb	48.14 - 96.28	4.43 - 8.86
Pennant 5G	40 - 80 lb	1.32 lb	52.80 - 105.60	4.85 - 9.72
Pennant 7.8EC	2.00 - 4.00 pt	12.74 pt	25.48 - 50.96	2.34 - 4.69
Princep L	2.00 - 3.00 qt	4.33 qt	8.66 - 12.99	0.80 - 1.20
Snapshot 80DF	2.50 - 5.00 lb	42.32 lb	105.80 - 211.60	9.73 - 19.47
Snapshot 2.5TG	100 - 200 lb	1.22 lb	122.00 - 244.00	11.22 - 22.45
Surflan 4AS	2.00 - 4.00 qt	10.24 qt	20.48 - 40.96	1.88 - 3.77
Treflan 5G	80 lb	0.57 lb	45.60	4.20
XL 2G	200 - 300 lb	0.95 lb	190 - 285.00	17.48 - 26.22