GROWTH OF CONTAINER PERENNIALS AS AFFECTED BY FALL-APPLIED, PRE-EMERGENT HERBICIDES

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In the southern United States, herbaceous perennials are propagated in the spring and summer, repotted to the final container in autumn and over-wintered outdoors, often pot-to-pot without cover (Senesac and Neal, 1992). In such situations, plants are exposed to summer and autumn dispersal of weed seeds. The resulting succession of weed infestations can be severe and dominate the container long before the dormant ornamental species emerge. Hand weeding is laborious and expensive and can result in additional weed seeds being elevated to the top of the container (Agnew and Hatterman-Valenti, 1993; Derr, 1994). The use of post and pre-emergent herbicides in containers during the early spring, and resulting phytotoxicity, has received much attention (Skroch et al., 1990; Staats and Klett, 1993; Whitwell and Kelly, 1989). However, reports of phytotoxicity resulting from herbicides applied to dormant perennials in the fall, are not common.

The application of preemergent herbicide in late fall has several potential advantages over spring applications beyond controlling weeds. Herbicide applications in late fall are less difficult to schedule during fall-winter preparation activities, than during spring activities. Herbicide application to quiescent or dormant plants avoids new spring foliage being damaged just prior to sale from particle or spray contact with new, tender foliage. The potential for damage due to volatilization and noticeable odor should be greatly reduced by cool-season application, avoiding garden center complaints associated with spring applications just weeks before shipping.

We undertook this study to determine if application of four commonly used pre-emergent herbicides applied to dormant perennials during early autumn causes phytotoxicity or adverse growth responses during spring regrowth.

Fifty plants of six species of outdoor-grown herbaceous perennial liners were obtained on November 15. Perennials used in this were *Coreopsis verticillata L.* 'Moonbeam' (Threadleaf Coreopsis), *Helianthus angustifolius L. (*Swamp Sunflower*), Iberis sempervirens L. (*Candytuft*), Lythrum virgatum L.* (Purple Loosestrife), *Phlox maculata L.* 'Omega' (Spotted Phlox), *and Salvia x superba* Straf (Blue Sage). Plants were repotted in #1 3.9 l,(1 gallon), black plastic containers containing a mixture of composted pine bark and part coarse granite sand,(3:1 by volume) with the pH adjusted to 5.7 using 1.8 kg/m^3. Fertility was amended by mixing 10.7 kg/m^3 of (10-N: 10-P: 10-K) per 3 cu yds. Each species was randomly divided into five groups of ten plants and each group was then further randomly divided into two groups of five plants. Plants were then allowed to establish in the pot. On December 18, each group of five plants received one of four herbicides at 1x or 2x rate or a control was applied. Herbicides used in this study were: *Pennant (Metolachlor) 2 chloro-N-(2 ethyl-6-methyl phenyl)-N-(2-methoxy-1-methylethyl) acetamide, Derby (Metolachlor + Simazine) 2 chloro-N-(2 ethyl-6-methyl phenyl)-N-(2-methoxy-1-methylethyl) acetamide + 6-chloro-N,N -diethyl-1,3,5-triazine-2,4-diamine, Ronstar (Oxadiaizon) 3-[2,4-dichloro-5-isopropyloxy phenyl 1,3,4 oxadiazol-2 (3H)-one, and Gallery (Isoxaben) N-[3-(1-ethyl-1-methylpropyl)-5-isoxazolyl]-2,6-dimethoxybenzamide.*

The herbicides were weighed and applied according to manufacturer's label recommendations, and at a 2x rate. All pots were hand-watered in with 2 liters of water. After treatment, pots were placed in outdoor open beds with no cover. No weed seeds were applied as the weed population that occurred naturally around the outdoor beds was very high. Additionally, this provided a natural selection and distribution of cool season and warm season weed seeds. Irrigation was accomplished by natural rainfall, no additional fertilization or other treatment was provided, consistent with common fall production practices in the south.

Spring regrowth as well as any phytotoxicity symptoms (marginal necrosis, chlorosis and deformed foliage) were rated on a discrete scale of 0 to 5 representing overall plant appearance. A growth rating of 5 was considered to be normal, vigorous growth, a rating of 1 was particularly poor regrowth with high incidence of phytotoxicity. A rating of 0 indicated the plant was dead. Plants were harvested for shoot dry weight, plant height (including flowers) and number of vegetative shoots. Analysis of variance and Tukey's w test were used to analyze the data (SAS Institute Inc., 1982)

There were no significant differences between the 1x and 2x herbicide rates used within any experimental measurement for any species. Therefore, all data presented are the pooled data of both concentrations.

Weed control was acceptable for all products tested except isoxaben, and inhibition of weed development extended beyond the marketable period for perennials in the south, that being late June. Individual species however, showed differences in phytotoxicity and growth in response to the herbicides.

Within *Coreopsis*, the lowest shoot dry weight occurred with Isoxaben but was still equivalent to that of the control plants. (Table 1). Isoxaben was also found to be a suitable herbicide for *Coreopsis* by Staats and Klett (1993). Coreopsis dry weight was significantly greater with Metolachlor, Metolachlor + Simazine and Oxadiaizon. The observed tolerance to Metolachlor and Oxadiaizon is consistent with observations by Skroch, et al. (1990),

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and Derr (1994) who reported no adverse effects on Coreopsis. Number of new, spring shoots of *Coreopsis*, however, was significantly reduced by Metolachlor + Simazine, suggesting some sensitivity to Simazine.

Within *Helianthus*, plant growth rating and number of vegetative shoots were significantly suppressed by Isoxaben. Plants were chlorotic and stunted. Twenty percent of the plants treated with Isoxaben or Oxadiaizon died over the winter, as did 10% of plant treated with Metolachlor. However, differences in plant dry weight for surviving plants were non-significant relative to that of the control (Table 1).

Within *Iberis*, treated plants displayed significant phytotoxicity to Metolachlor + Simazine, resulting in less shoot dry weight and lower growth rating similar to control values. Plants developed small, stunted shoots. However, growth ratings appeared to be enhanced over that of the control plants when Metolachlor, Oxadiaizon or Isoxaben were used alone (Table 1). These observations should be compared to data reported by Skroch et al.(1990) where less than 10% injury was reported for Oxadiaizon or Metolachlor alone. In addition, 30% of the plants treated with Metolachlor + Simazine did not reemerge in the spring.

Within *Lythrum*, plant dry weight was lowest, but equivalent to control in plants treated with Isoxaben. Dry weight was greatest in plants treated with Metolachlor alone. The number of developing shoots was greatest in plants treated with Metolachlor, and lowest in plants treated with Isoxaben. However, all treated perennials developed more shoots than the control plants, suggesting weed competition did affect overall vigor, even within this aggressive species (Table 1).

Within *Phlox*, no significant phytotoxicity occurred with Isoxaben or Metolachlor when used alone. However, the addition of Simazine to Metolachlor resulted in significantly reduced growth rating, number of vegetative shoots and shoot dry weight in Phlox. General plant height was also strongly affected by Simazine to Metolachlor, suggesting Simazine intolerance. Oxadiaizon also significantly reduced plant height of phlox (data not shown). However the height reduction here was expressed as a shortening of internodes, and did not adversely affect appearance. Other studies have shown little to no phytotoxicity in phlox paniculata hybrids treated with Oxadiaizon (Staats and Klett, 1993). Phlox subulata (thrift) treated with Oxadiaizon was reported to sustain 10% injury (Skroch, et al., 1990), suggesting that differences in species must be explored more closely.

Within *Salvia*, dry weight of plants was greater in plants treated with Metolachlor + Simazine, but less than the untreated control. Growth rating of *Salvia* were also significantly reduced by Oxadiaizon and Isoxaben. All Salvia plants treated with herbicide were slightly stunted and developed smaller flowers than the control. Plant mortality and the number of shoots developing in spring were not significantly different than the control group (Table 1).

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In general, all herbicides except Isoxaben provided good weed suppression. Persistence of the herbicide effects lasted beyond June (Data not shown). However, all six perennials studied showed some degree of phytotoxic response to one or more of the herbicides. This study supports the caution statements by Hood and Klett (1993) as to the potential problems in applying herbicides to container grown perennials. Our data suggests that although fall application does have business management advantages, it does not appear to mediate many adverse plant growth responses to pre-emergent herbicides.

Table 1.
The Influence of herbicides on weed suppression and plant growth on 6 herbaceous perennial species

Chemical Treatment	July shoot dry weight(g)	Rating (1-5)	# of New Shoots Per	Plant Mortality-%
	***Coreopsis verticillata* 'Moonbeam'**			
Oxadiaizon	11.9 a[z]	4.8 a	39.9 a	0
Metolachlor	13.2 a	4.4 a	34.3 a	0
Metolachlor + Simazine	12.7 a	4.2 a	23.7 b	0
Isoxaben	10.0 b	4.3 a	34.4 a	0
Control	9.9 b	4.6 a	36.8 a	0
	Helianthus angustifolia			
Oxadiaizon	33.4 a	3.4 ab	10.0 a	20
Metolachlor	28.7 a	4.2 a	10.1 a	10
Metolachlor + Simazine	33.8 a	3.7 ab	9.8 a	0
Isoxaben	24.3 a	2.4 c	5.5 b	20
Control	27.8 a	4.1 a	10.5 a	0
	Iberis sempervirens			
Oxadiaizon	11.5 a	4.1 b	12.2 a	0
Metolachlor	9.8 ab	4.8 a	14.3 a	0
Metolachlor+ Simazine	7.4 c	3.7 c	13.8 a	30
Isoxaben	10.8 a	4.2 b	14.5 a	0
Control	9.1 ab	3.8 c	13.6 a	0
	Lythrum virgatum			
Oxadiaizon	3.2 ab	4.2 a	6.6 a	20
Metolachlor	4.3 a	4.0 a	6.7 a	20
Metolachlor+ Simazine	2.9 ab	4.3 a	6.1 ab	30
Isoxaben	1.4 c	4.5 a	5.3 b	20
Control	1.3 c	4.4 a	5.0 b	20
	***Phlox maculata* 'Omega'**			
Oxadiaizon	8.2 ab	2.7 b	5.6 b	0
Metolachlor	9.8 a	4.4 a	10.0 a	10
Metolachlor + Simazine	5.2 c	1.9 c	3.3 c	0
Isoxaben	7.8 b	4.2 a	9.9 a	0
Control	8.2 ab	4.5 a	8.6 ab	10
	Salvia* x *superba			
Oxadiaizon	3.7 b	2.8 c	4.3 a	0
Metolachlor	4.7 ab	4.0 b	5.2 a	0
Metolachlor + Simazine	5.3 ab	5.1 a	3.9 a	0
Isoxaben	4.1 b	3.3 c	4.0 a	0
Control	6.8 a	4.2 b	4.7 a	0

z - numbers within taxa and columns followed by the same letter(s) are not significantly different using Tukey's w test (p=0.5).

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