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Response of Bedding Plants and Weeds to Herbicides[1]

D.A. Gilbertz and B.J. Johnson[2]
University of Georgia
Georgia Station
Experiment, GA 30212

Abstract

Preemergence and postemergence herbicides were evaluated for summer weed control and for phytotoxicity of 6 commonly used annual bedding plant species. Dacthal (dimethyl 2,3,5,6-tetrachloro-1,4-benzenedicarboxylate), Enide (*N,N*-dimethyl-*a*-phenyl benzene acetamide), Devrinol (*N,N*-diethyl-2-(1-naphthalenyloxy) propanamide), Surflan (4-(dipropylamino)-3,5-dinitro-benzenesulfonamide), Ronstar (3-[2,4-dichloro-5-(1-methylethoxy)phenyl]-5-1(1,1-dimethylethyl)-1,3,4-oxadiazol-2-(3*H*)-one), Kerb (3,5-dichloro(*N*-1,1-dimethyl-2-propynyl)benzamide), and Treflan (2,6-dinitro-*N,N*-dipropyl-4-(trifluoromethyl)benzenamine) at 3.3 kg/ha (3.0 lb/A) applied as preemergence treatments and Poast (2-[1-(ethoxyimino)-butyl]-5-[2-ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one) and Fusilade (+)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy] propanoic acid) applied as postemergence treatments effectively controlled large crabgrass [*Digitaria sanguinalis* (L.) Scop.] throughout a two-month period. Effective prostrate pigweed (*Amaranthus blitoides* S. Wats.) control was achieved by use of Dacthal at 14.0 kg/ha (12.5 lb/A), Surflan at 1.1 kg/ha (1.0 lb/A) and Ronstar at 3.3 kg/ha (3.0 lb/A) and postemergence application of Escort (2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]-amino]sulfonyl]benzoic acid) at 0.07 kg/ha (0.06 lb/A). SC 1084 (methyl 3-hydroxy-4-[4-[[5-(trifluoromethyl)-2-pyridinyl]-oxy]-phenoxy]-pentanoate at 0.13 kg/ha (0.12 lb/A) was ineffective in controlling either weed. Plant vigor of salvia was reduced by Dacthal at 11.2 kg/ha (12.5 lb/A), while vigor of ageratum and geranium was reduced by Enide at 4.4 kg/ha (4.0 lb/A). The vigor of geranium and salvia was lower than untreated plants when treated with Devrinol at 3.3 kg/ha (3.0 lb/A). The vigor of petunia, marigold, and salvia was also lower than untreated plants when treated with Ronstar at 3.3 kg/ha (3.0 lb/A) while vigor of geranium, salvia, marigold, and zinnia was lower when treated with Surflan at 2.2 kg/ha (2.0 lb/A). Kerb at 1.6 kg/ha (1.5 lb/A) reduced the vigor of geranium, petunia, and salvia when compared with untreated plants. Poast at 0.28 kg/ha (0.25 lb/A) did not injure any of the annuals while marigold and zinnia were injured with Fusilade at 0.2 kg/ha (0.18 lb/A). Escort at 0.07 kg/ha (0.06 lb/A) and Oust (2-[[[[(4,6-dimethyl-2-pyrimidinyl)amino]-carbonyl]amino]sulfonyl]benzoic acid) at 0.07 kg/ha (0.06 lb/A) applied as postemergence applications severely injured all annuals.

Index words: large crabgrass, preemergence, postemergence, prostrate pigweed, weed control, bedding plants, herbicides, annuals

Introduction

Weeds can be a severe problem in newly transplanted flowering annual beds. Freshly tilled soil, high moisture and nutrient levels for growth of the transplants create an ideal environment for invading weed seeds. Herbicides can be effectively used for weed control (3, 4, 5, 7, 8) in such instances, although injury to the transplanted annuals often occurs.

Researchers have reported effective preemergence crabgrass control in summer annuals with Treflan, Dacthal, Enide, Surflan, Ronstar and Devrinol (2, 3, 4, 5, 6, 7) while effective postemergence control was obtained with either Fusilade or Poast (9). In past studies, herbicides generally did not injure petunia, ageratum, marigold, or zinnia, but injury to salvia varied with herbicide application. Salvia was severely injured when treated with Surflan and Ronstar (4), while the injury varied with Treflan from slight (7) to moderate and severe (3, 5). The injury of salvia treated with Dacthal varied from none (4) to moderate and severe (2, 7). Devrinol did not injure salvia in New York (3) but slight injury occurred in an Ohio test (7). Tolerance of geranium from Devrinol in New York varied from none (6) to moderate injury (3). These results indicate that herbicides were effective in controlling crabgrass, but tolerance of selected plant species varied with herbicide rates and locations.

Because additional information on weed control in summer flowering annuals is needed in Georgia and the Southeast, an experiment was initiated to determine the effects of preemergence and postemergence herbicides

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[2]Horticultural Research Specialist, Dept. of Horticulture and Professor of Agronomy, Dept. of Agronomy.

on control of summer weeds and effects of herbicides on tolerance of 6 summer annual species.

Materials and Methods

Six summer annual species were planted May 20 ± 2 days in 1984 and 1985 in a freshly tilled Lloyd sandy loam soil. Three cultivars of each species were planted both years, except for 2 cultivars of zinnia in 1984 and for 1 cultivar of geranium both years. Species and cultivars are given in Table 1. In some instances, the same cultivar was not available the second year and was replaced with a different cultivar.

Immediately after the annuals were planted, 7 herbicides were applied within ± 2 days of May 20 for preemergence weed control. At 3 weeks after planting, 5 herbicides were applied on June 9 for postemergence weed control. The nomenclature of herbicides is given in Table 2. Large crabgrass was in the 2 to 3 leaf growth stage at time of postemergence treatments. Herbicides and date of application are given in Table 3. Herbicides were applied to the same 1.5 x 2.7 m (5 x 9 ft) plots both years. Treflan, Devrinol, and Ronstar were applied as granules and the other herbicides were applied as a broadcast spray at 376 L water/ha (40 gal/A). A surfactant was applied with Fusilade, SC-1084, and Escort at 0.5% (by vol) and crop oil concentrate was applied with Poast at 0.7% (by vol).

The summer annual species were treated with 487 kg/ha (435 lb/A) of 10N-4.4P-8.3K (10-10-10) fertilizer at planting in May and at monthly intervals in June and July during 1984 and 974 kg/ha (870 lb/A) in 1985. Plots were irrigated with at least 7.6 cm (3 in) of water per week during the growing period.

Table 2. Nomenclature of herbicides used in this study.

Name		
Trade	**Common**	**Chemical**
Dacthal	DCPA	dimethyl 2,3,5,6-tetrachloro-1,4-benzenedicarboxylate
Devrinol	Napropamide	*N,N*-diethyl-2-(1-naphthalenyl-oxy)propanamide
Enide	Diphenamid	*N,N*-dimethyl-*a*-phenyl benzene-acetamide
Escort	Metsulfuron	2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]-amino]sulfonyl]benzoic acid
Fusilade	Fluazifop	(±)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]-propanoic acid
Kerb	Pronamide	3,5-dichloro(*N*-1,1-dimethyl-2-propynyl)benzamide
Oust	Sulfometuron	2-[[[[(4,6-dimethyl-2-pyrimid-inyl)amino]carbonyl]amino]-sulfonyl]benzoic acid
Poast	Sethoxydim	2-[1-(ethoxyimino)butyl]-5-[2-ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one
Ronstar	Oxadiazon	3-[2,4-dichloro-5-(1-methylethoxy) phenyl]-5-1(1,1-dimethylethyl)-1,3,4-oxadiazol-2-(3*H*)one
SC-1084	—	methyl 3-hydroxy-4-[4-[[5-(tri-fluoromethyl)-2-pyridinyl]oxy]-phenoxy]-pentanoate
Treflan	Trifluralin	2,6-dinitro-*N,N*-dipropyl-4-(tri-fluoromethyl)benzenamine
Surflan	Oryzalin	4-(dipropylamino)-3,5-dinitro-benzenesulfonamide

Table 1. Species and cultivars of summer annuals treated with herbicides in 1984 and 1985.

Name		
Common	**Scientific**	**Cultivar[z]**
Ageratum	*Ageratum houstonianum* Mill	Blue Danube[1] Blue Blazer[2] North Sea Spindrift
Geranium	*Pelargonium* x *hortorum* L.H. Bailey	Sunbelt Rose[1] Sincerity[2]
Petunia	*Petunia hybrida* Hort. Vilm Andr.	Star Fire[1] Fiesta[2] Coral Cascade Summer Sun
Salvia	*Salvia splendens* F. Sellowey Roem & Schult	Bonfire Red Pillar White Carabiniere
Marigold	*Tagetes erecta* L. *Tagetes patula* L.	Inca Orange Dainty Marietta Queen Sophia
Zinnia	*Zinnia elegans* Jacq.	Peter Pan Mix[1] Cherry Button[2] Thumbelina[2] State Fair Mix

[z]Cultivar marked with a 1 or 2 were planted only in 1984 or 1985, respectively. All other cultivars were planted both years.

Large crabgrass seed were applied to the test site at 10 kg/ha (9 lb/A) prior to herbicide treatment each year to supplement the natural weed population. When final weed control ratings were made, the population of large crabgrass in untreated plots was 57% cover in 1984 and 50% cover in 1985. The population of prostrate pigweed was 43% cover in 1984 and 50% cover in 1985.

Large crabgrass and prostrate pigweed ratings were estimated visually (0 = no control, 100 = complete control) at 3, 5 and 9 weeks after preemergence treatments were made. Weed control below 70 would not be commercially acceptable. Plant vigor ratings for the summer annuals were estimated visually (0 = all plants dead, 100 = optimum growth) at 2, 4, and 6 weeks after planting. A decline in vigor was evident at 4 weeks and data was similar between ratings taken at 4 and 6 weeks, except as noted in the text.

The experimental design was a split-split plot design with three replications. Herbicide treatments were the main plots, subplots were bedding plant species, and sub-subplots were cultivars within each species. Analyses of variance were conducted on all data within each year and across years, and significant differences were determined by Duncan's multiple range test at 0.05 level. There was no herbicide by year interaction on weed control and the data were averaged over years. There were also no differences for cultivars within bedding plant species and the data were pooled into species means. However, due to a herbicide by year interaction, vigor ratings for the annual species are reported for separate years.

Results and Discussion

Weed control. Large crabgrass was effectively controlled with several preemergence herbicides throughout the two-month duration of the study (Table 3). The control during this period was 97% or higher with Dacthal at 12.5 lb/A (14.0 kg/ha), Treflan at 3.3 kg/ha (3.0 lb/A), Ronstar at 3.3 kg/ha (3.0 lb/A), Surflan at 1.1 kg/ha (1.0 lb/A), Devrinol at 3.3 kg/ha (3.0 lb/A), or Enide at 4.4 kg/ha (4.0 lb/A). Kerb at 0.8 kg/ha (0.75 lb/A) provided similar control for one month after treatment, but the effectiveness was reduced slightly when final ratings were made in July. Treflan applied at 1.1 and 2.2 kg/ha (1.0 and 2.0 lb/A) resulted in acceptable large crabgrass control when ratings were made in June one month after treatment, but weed control was unacceptable one month later. These results indicate that Treflan required a minimum rate of 3.3 kg/ha (3.0 lb/A) to maintain control of large crabgrass for 2 months while similar control was obtained with Surflan at 1.1 kg/ha (1.0 lb/A). Generally, there were no differences in large crabgrass control whether Dacthal at 14.0 kg/ha (12.5 lb/A), Enide at 4.4 kg/ha (4.0 lb/A), Ronstar at 3.3 kg/ha (3.0 lb/A), or Devrinol at 3.3 kg/ha (3.0 lb/A) were compared with weed control obtained using Surflan at the lowest rate or Treflan at the highest rate.

Excellent postemergence control of large crabgrass was obtained with Poast when the chemical was applied when the weeds were 2 to 3 leaf growth stage 3 weeks after the annuals were planted (Table 3). The activity of Oust on large crabgrass was acceptable, but the control

Table 3. Effects of herbicides on control of large crabgrass and prostrate pigweed on field-grown summer annuals.

Treatments[z]				% Weed control			
		Rate		Large crabgrass		Prostrate pigweed	
Herbicide	Applied	kg/ha	la/A	June 21	July 21	June 21	July 21
Untreated		—	—	0e[y]	0g	0h	0f
Dacthal	Pre	11.2	10.0	98a	88bcd	91ab	59b
		14.0	12.5	99a	99a	100a	100a
Enide	Pre	4.4	4.0	100a	100a	81cd	37d
Devrinol	Pre	3.3	3.0	100a	97abc	74de	3f
Surflan	Pre	1.1	1.0	100a	99a	99a	96a
		1.7	1.5	100a	99a	100a	98a
		2.2	2.0	99a	100a	99a	99a
Ronstar	Pre	3.3	3.0	100a	98ab	100a	100a
Kerb	Pre	0.8	0.75	95a	82d	64e	17e
		1.6	1.5	98a	87cd	89bc	38cd
Treflan	Pre	1.1	1.0	83b	23f	69e	0f
		2.2	2.0	85b	53e	65e	0f
		3.3	3.0	98a	98ab	94ab	58b
Fusilade	Po	0.2	0.18	72c	51e	30g	0f
Escort	Po	0.07	0.06	8d	0g	100a	100a
SC-1084	Po	0.13	0.12	13d	10g	42f	0f
Poast	Po	0.28	0.25	94a	98ab	0h	0f
Oust	Po	0.07	0.06	71c	85d	98ab	50bc

[z]Data are averages from two years. Preemergence (Pre) herbicides were applied within ± 2 days on May 20 and postemergence (Po) herbicides were applied June 9.

[y]Values within columns followed by the same letter are not significantly different at the 0.5 level by Duncan's multiple range test.

Table 4. Effects of herbicides on vigor[z] of field-grown annuals.

Treatments[y]				Field grown annuals											
		Rate		Ageratum		Geranium		Petunia		Salvia		Marigold		Zinnia	
Herbicide	Applied	kg/ha	lb/A	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985
Untreated		—	—	93a[x]	57abc	89a	51ab	96ab	84ab	92a	43ab	92abc	93a	89abc	90a
Dacthal	Pre	11.2	10.0	92a	69ab	70abc	41ab	80a-d	71abc	32c	39ab	80a-d	88ab	82a-d	76a-d
		14.0	12.5	92a	79a	76ab	43ab	83ab	70abc	33c	32ab	82a-d	78a-e	93ab	86ab
Enide	Pre	4.4	4.0	70b	33c	41ef	52ab	96ab	69abc	77ab	33ab	48fg	79a-e	83a-d	76a-d
Devrinol	Pre	3.3	3.0	87ab	68ab	23f	56ab	79a-d	87ab	66b	39ab	69b-f	86abc	71bcd	89ab
Surflan	Pre	1.1	1.0	90ab	67ab	72abc	81a	83ab	79ab	15cd	12b	68c-f	78a-e	72bcd	66b-e
		1.7	1.5	79ab	67ab	34ef	38ab	74bcd	68abc	8cd	21ab	56def	71b-e	59de	67a-e
		2.2	2.0	79ab	63ab	46c-f	83a	82abc	67abc	5d	11b	67def	71b-e	69de	65b-e
Ronstar	Pre	3.3	3.0	89ab	64ab	84a	79a	75bcd	47cd	6d	36ab	69c-f	62e	62cde	74a-d
Kerb	Pre	0.8	0.75	97a	67ab	81ab	52ab	90ab	83ab	81ab	38ab	86a-d	89ab	100a	86ab
		1.6	1.5	90ab	64ab	54b-e	43ab	61cd	62bc	68ab	16b	93ab	85abc	83a-d	87ab
Treflan	Pre	1.1	1.0	88ab	78a	90a	71ab	97ab	87ab	88ab	21ab	92abc	92a	90ab	83abc
		2.2	2.0	87ab	67ab	90a	61ab	99a	93a	90ab	66a	92abc	88ab	88abc	79abc
		3.3	3.0	91a	53abc	81ab	13b	99a	87ab	79ab	51ab	88a-d	83a-d	93ab	82abc
Fusilade	Po	0.2	0.18	97a	42bc	91a	39ab	98a	63bc	93a	26ab	79a-d	68c-e	97ab	65b-e
Escort	Po	0.07	0.06	82ab	32c	43def	45ab	6e	32d	4d	7b	20h	38f	37e	49d
SC-1084	Po	0.13	0.12	79ab	39bc	94a	57ab	89ab	66bc	92a	35ab	74a-e	66de	58de	60cde
Poast	Po	0.28	0.25	88ab	56abc	81ab	53ab	96ab	83ab	93a	32ab	94a	84a-d	92ab	82abc
Oust	Po	0.07	0.06	42b	30c	68a-d	39ab	58d	39d	29cd	5b	39gh	37f	43e	54de

[z]Plant vigor ratings were made June 20 and based on 0 to 100 where 0 equals all plants dead and 100 equals optimum growth with no retardation.

[y]Preemergence (Pre) herbicides were applied within ± 2 days on May 20 and postemergence (Po) herbicides were applied June 9.

[x]Values within columns followed by the same letter are not significantly different at 0.05 level by Duncan's multiple range test.

was not as good as with Poast. Neither Escort nor SC-1084 had effective activity on large crabgrass.

Dacthal at 14.0 kg/ha (12.5 lb/A), Surflan at 1.1 kg/ha (1.0 lb/A), and Ronstar at 3.3 kg/ha (3.0 lb/A) were the only preemergence herbicides while Escort at 0.07 kg/ha (0.06 lb/A) was the only postemergence herbicide that gave greater than 90% prostrate pigweed control throughout the study (Table 3). The poor control obtained with Treflan in the present study differs from that reported in New York (5) where excellent control was obtained, possibly due to the coarse soil texture used in the present study. Although neither Enide nor Devrinol was effective throughout the season in the present study, both herbicides provided acceptable control during the first month. Poast did not control prostrate pigweed in the present study and should not be applied for broadleaf weed control (1). Therefore, the selection of herbicides and rates of application are important in obtaining effective prostrate pigweed control in summer annual bedding plants.

Tolerance of annual bedding plants. Preemergence herbicides affected vigor of ageratum plants less than any of the other annual species (Table 4). Enide was the only preemergence herbicide that caused injury to ageratum when compared with untreated plants. All preemergence herbicides were safe to apply to petunias except for Ronstar at 3.3 kg/ha (3.0 lb/A) in 1985 and Kerb at 1.6 kg/ha (1.5 lb/A) both years. Kerb applied at 0.8 kg/ha (0.75 lb/A) did not cause significant injury to petunias and the injury from the higher rate would probably be commercially acceptable while the injury from Ronstar at 3.3 kg/ha (3.0 lb/A) would not be acceptable.

Surflan at 1.7 kg/ha (1.5 lb/A) or higher injured marigolds and zinnias during both years of the study (Table 4), which differs from results obtained in New York by Bing and Macksel (5). Although Surflan at 1.1 kg/ha (1.0 lb/A) did not significantly reduce marigold vigor, growth of the plants was slightly retarded. A similar pattern occurred for zinnias in 1984 and the vigor was significantly reduced in 1985 when compared with untreated plants. Therefore, the use of Surflan for weed control in marigolds and zinnias is questionable in Georgia. Ronstar also injured marigolds in 1985 and retarded the growth during the previous year.

The vigor of geraniums was reduced in 1984 when treated with all preemergence herbicides included in this study except Dacthal, Ronstar, and Treflan (Table 4). The injury was not evident in plots treated with either Surflan or Kerb at the lowest rates. Therefore, rates of application are important for plant safety when either herbicide is applied to geranium. None of the preemergence herbicides significantly reduced the vigor of geraniums in 1985 when compared with untreated plants. This may be due in part to using different cultivars, but most likely due to high variation among treatments within replications. This is suggested since untreated plants with a 51 vigor rating were not different from plants treated with Treflan at 3.3 kg/ha (3.0 lb/A) with a 13 vigor rating. Certainly the injury to geraniums treated with Treflan at this rate would not be acceptable.

Preemergence herbicides injured salvia plants more severely than any other species (Table 4). Enide, Kerb, and Treflan were the only herbicides that did not injure salvia in 1984 when vigor ratings were made one month after treatment. However, plants treated with Kerb at 1.6 kg/ha (1.5 lb/A) and Treflan at 2.2 kg/ha (2.0 lb/A) or higher were severely injured when ratings were made two weeks later (data not given). Injury from herbicide treatments in 1985 was not as meaningful as the previous year because of high variation among treatments within replications. However, the use of most preemergence herbicides suppressed the growth and reduced vigor of salvia.

Postemergence herbicides applied to summer annuals 3 weeks after transplanting varied in tolerance with herbicide treatment (Table 4). Poast was the only postemergence herbicide that did not reduce the vigor of any species during 1984 and 1985. Fusilade and SC-1084 were almost equal to Poast because they reduced the vigor of marigold and zinnia only slightly below that of untreated plants in one year. Escort and Oust severely injured all species and vigor was further reduced by July 5, compared to all other treatments (data not shown). Therefore, Escort and Oust should not be applied for weed control in summer annuals.

These results indicate that selecting a herbicide for weed control to be used in summer annuals must be done in most instances for each plant species. For preemergence herbicides, Dacthal and Treflan were safe to apply to all species included in this study except salvia, while Surflan injured all species except ageratums and petunias. Unacceptable injury occurred with Ronstar on petunias, salvia, and marigolds and with Enide on ageratum and geraniums. Devrinol did not respond the same each year since geraniums and salvia were injured in 1984, but not the following year. Rates of application were also important for the safety of plant species. For example, Kerb at 0.8 kg/ha (0.75 lb/A) did not injure any of the species, but geranium, petunias and salvia were injured when the rate was increased to 1.6 kg/ha (1.5 lb/A). For postemergence herbicides, Poast was the safest herbicide among the annual species. Fusilade and SC-1084 injured marigolds and zinnias while Escort and Oust severely injured all of the species included in this study.

Significance to the Nursery Industry

Because weed control is usually necessary in annual bedding plants during the summer, the results from this study provide weed control evaluations for several preemergence and postemergence herbicides and phytotoxicity ratings on 6 commonly used summer annual species. For each herbicide evaluated there was no difference between cultivars within each of the species.

(*Ed note:* This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

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