Weed control in ornamental bulbs (2000-2001).

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Three studies were conducted in ornamental bulbs during 2000-2001: (1) bulb herbicide plant-back study, (2) nonselective, postemergence herbicide timing trial, (3) new herbicide trial, and Plant materials for all these studies were kindly donated by Washington Bulb Co., LeFeber Bulb Co., Skagit Valley Bulb Farm, and Hulbert Farms.

Materials and Methods.

Bulb herbicide plant-back study. In the first phase of the study, plots were established in the fall of 1999 (1999-2000 study) at WSU Mount Vernon. Visor, Prowl, Devrinol, diuron, Surflan, and Gallery herbicides (each mixed with 3 pints Roundup/acre) plus a Roundup-only check were applied preemergence to 'Negrita' tulip, 'Dutch Master' narcissus, and 'Blue Ribbon' iris. The second phase of the study involved planting rotational crops into these plots and monitoring them for potential injury from carryover of the bulb herbicides.

In the fall of 2000, tulips (cv. 'Blenda'), winter wheat, and cabbage seed plants were planted into the 1999-2000 herbicide trial for the rotational crop phase of this study. Potato, green pea, cucumber, and spinach seed were planted in spring 2001. Weed control in these rotational crops were conventional herbicide programs typical for each crop. Injury assessment was based on crop density, height, biomass, and/or yield.

Herbicide timing study. Weed control studies were conducted on 'Merry Widow' tulip, 'Dutch Master' daffodil, and 'Blue Diamond' iris at WSU Mount Vernon beginning in the fall of 2000. Visor, Prowl, diuron, Gallery, and Surflan was applied in combination with Roundup or Finale. Application timing will be (1) all in the fall, (2) all in the spring (preemergence), (3) all in the spring (early postemergence), (4) half in the fall/half in the spring (preemergence), or (5) half in the fall/half in the spring (early postemergence). The spectrum and efficacy of weed control and crop safety was evaluated.

Initial "fall" treatments were made on December 5, preemergence (PRE) to all bulbs. The "spring" PRE treatments were made January 23, when iris averaged 3 inches tall and tulip and daffodil were just starting to emerge from soil (leaf tips barely visible). The "spring" postemergence (POST) treatments with Roundup were made February 22 and with Finale February 27. Average iris height at this timing was 5 inches, while daffodils were 3 inches, and tulip were 2 inches.

Weed control was estimated February 20 (PRE only), March 7, April 17, and June 15. Injury to bulb foliage was estimated March 7 and April 17. Flowers were counted in each plot and height of five typical flowers was measured April 2 (daffodil), April 17 (tulip), and May 22 (iris). Bulbs were dug at maturity, then cleaned, sorted, counted, and weighed.

New herbicide trial. Several new herbicides were tested PRE and early POST in 'Gander's Rhapsody' tulip, 'Standard Value' daffodil, and 'Blue Diamond' iris at WSU Mount Vernon. Products tested were Balance (isoxaflutole), Valor (flumioxazin), Milestone (azafenidin), Spartan (sulfentrazone), First Rate (chloransulam), Broadstrike (flumetsulam), and Resource (flumiclorac). Treatments were made December 4 (PRE) and February 21 (POST). Average iris height at the POST timing was 5 inches, while daffodils were 3 inches, and tulips were 2 inches.

Weed control and foliar injury was estimated February 20 (PRE only), March 7, and March 26. Flowers were counted in each plot and height of five typical flowers was measured April 9 (daffodil), April 17 (tulip), and May 21 (iris). In plots were weed control was good and crop damage was limited, bulbs were dug at maturity, then cleaned, sorted, counted, and weighed.

Statistics. The statistical design for all field studies was a randomized complete block design with four replicates. Means were separated using Fisher's Protected LSD (P = 0.05).

Results.

Bulb herbicide plant-back study (Tables 1 and 2). There were no significant effects of these herbicides used in bulbs the preceding year (November, 1999) on rotational crops during the 2000-01 growing season. The only significant response in last year's rotational crops (1999-2000 growing season) was in cucumber weights, in which all yields were at least statistically equal to the Roundup-only treatment. Based on these two years of data, then, it does not appear that these herbicides used in bulbs will significantly impact rotational cropping during the following year.

Herbicide timing study.
Weed control was generally excellent for all treatments (Table 3). Only Gallery tank mixtures did not provide adequate weed control by June 15. It is not clear why the spring applications with Gallery did not perform as well as other residual tank mixtures.

Foliar Injury. There was a pattern to foliar injury depending upon timing of the applications and which residual product was used.

Tulip (Table 4):
A. When applied all in the fall, only Gallery + Roundup caused above average injury.
B. When applied all in the spring, Gallery + Roundup (PRE) and Visor + Roundup (POST) caused 13 and 41% injury, respectively, by March 7, while all POST combinations caused 20 to 65% injury by April 17.
C. When split between fall and spring, Visor + Roundup (POST), Gallery + Roundup (PRE and POST), and Prowl + Roundup (POST) caused 11 to 43% injury by March 7, while all POST combinations caused 16 to 58% injury.

Daffodil (Table 5):

A. When applied all in the fall, products were safe for daffodil.
B. When applied all in the spring, Visor + Roundup (POST), Gallery + Roundup (POST), and Surflan + Roudup or Finale (POST) caused slight damage by April 17.
C. When split between fall and spring, Prowl + Roundup (POST) and Surflan + Finale caused slight injury at both the March 7 and April 17 ratings.

Iris (Table 6):
A. When applied all in the fall, products were safe for iris.
B. When applied all in the spring, Surflan + Roundup (PRE) and all POST combinations caused 13 to 30% injury by April 17.
C. When split between fall and spring, Prowl + Roundup (POST) caused 13% injury by March 7, and all POST combinations caused 13 to 30% injury by April 17.

Flower number and flower height (Tables 4-6) generally followed the same pattern as foliar injury in tulip. In iris, flower measurements showed that plants had mostly recovered from POST Finale injury, but POST Roundup injury was still apparent. Daffodil flowers were not significantly affected by herbicide treatment.

Yield. Based on average bulb data, there were some clear trends in the 2001 yield data.

Tulip (Table 7): Despite foliar injury, Gallery treatments did not significantly influence bulb yield. Tulips treated with diuron in the spring yielded poorer than fall treated tulips. Visor and Prowl caused reduced bulb size if applied POST with Roundup or Finale, as did Surflan + Roundup applied POST. In fall treatments, Visor decreased tulip bulb production compared to diuron or Prowl, while tulips treated with Gallery and Surflan also yielded less than diuron-treated tulips. Visor also reduced bulb number compared to Prowl-treated tulips.

Daffodil (Table 8): Diuron applied in the spring reduced bulb size, as did Gallery + Finale in the spring. Visor, Prowl, and Surflan combinations were safe for daffodil. There were no significant differences in bulb number or yield between fall treatments.

Iris (Table 9): All Prowl and Surflan combinations in the spring reduced bulb size, as all spring Diuron treatments except split with Roundup. Gallery + Roundup in the spring also reduced bulb size, as did Visor combinations applied POST. There were no significant differences in bulb number or yield between fall treatments.

Based on these single-season results, the following observations can be made:

(1) Fall treatments of residual herbicide + Roundup were the safest for all bulb types, although weed control with Gallery was poor by springtime.

(2) Combinations with Roundup applied all PRE in the spring to tulips were generally safe, except for Gallery (foliar burn) and diuron (yield response).
(3) Split Gallery and Surflan applications with Finale (POST) to tulips were generally

safer than with Roundup (POST).

(4) Spring applications of diuron to all bulb types should be used with caution.

(5) Prowl, Surflan, and Visor combinations applied in the spring were hard on iris.

This study is being repeated in 2001-02 to verify these results.

New herbicide trial.

Weed Control. Several treatments provided good to excellent weed control. Fall applications of Valor, Milestone, and Spartan were still nearly weed-free by the March 26 evaluation. Valor, Milestone, Spartan, and Broadstrike applied POST to weedy plots in February also gave good levels of weed control by March 26.

Foliar and Floral Injury. Fall-applied Spartan and Milestone caused moderate to severe injury to foliage of all bulb types by March 26. Valor in the fall injured tulip foliage 28 to 39% by spring. Most POST applications severely injured tulip, while Valor, Milestone, Spartan, and Resource also severely injured daffodil and iris foliage. Tulip flowers were fewer and shorter after treatment with Valor, Milestone, Spartan, and FirstRate applied either PRE or POST. Daffodil flowers were more tolerant to these treatments, and iris was generally tolerant to fall treatments.

Yield. Four treatments were harvested in this trial: Milestone (PRE or POST), Spartan (POST), and Broadstrike (POST). Of these, Broadstrike was easily the best treatment for all types of bulbs.

Balance, Valor, First Rate, and Broadstrike will be tested again in 2001-02. Spring treatments will be tested in combination with other products applied in fall or mixed with Roundup in the spring and applied PRE.

Table 1. Effect of herbicides used in ornamental bulbs (1998) on rotational crops (1999-2000).

Treatments[a]	Rate	Potato weight	Pea yield	Wheat weight	Spinach biomass	Cabbage biomass	Tulip number	Tulip height	Cuke number	Cuke weight
	product/A	kg/plot	tons/a	kg/plot	g/5 pl.	g/2 pl.	per plot	inches	per plot	kg/plot
Visor	3 pt	3.2	1.9	2.0	144	532	43	12	76	4.0
Prowl	7.3 pt	3.0	2.3	2.3	186	514	46	10	68	3.2
Devrinol2 lb	3.4	2.0	2.4	153	507	41	11	60	2.4	
Diuron	4 lb	3.5	2.2	2.2	154	485	43	11	62	2.8
Surflan	3 pt	3.1	2.1	2.2	129	421	40	11	81	3.8
Gallery	10.7 oz	2.6	2.4	1.8	120	495	47	11	74	4.3
Untreated	—	3.2	2.1	2.4	85	401	47	11	60	3.3
$LSD_{0.05}$	—	ns	ns	ns	ns	ns	ns	ns	ns	1.2

[a]All treatments, including the check, were mixed with 3 pts/a Roundup Ultra.

Table 2. Effect of herbicides used in ornamental bulbs (1999) on rotational crops (2000-01).

Treatments[a]	Rate	Potato weight	Pea yield	Wheat weight	Spinach biomass	Cabbage biomass	Tulip number	Tulip height	Cuke number	Cuke weight
	product/A	kg/plot	tons/a	kg/plot	g/5 pl.	g/2 pl.	per plot	inches	per plot	kg/plot
Visor	3 pt	4.2	6.0	2.1	103	326	36	10	73	3.5
Prowl	7.3 pt	4.4	4.7	2.0	99	370	36	11	68	3.2
Devrinol2 lb	4.3	5.4	2.1	97	385	37	11	77	3.1	
Diuron	4 lb	5.2	4.8	1.9	81	346	38	11	64	2.6
Surflan	3 pt	4.5	5.5	1.5	102	357	36	10	62	2.1
Gallery	10.7 oz	4.5	5.6	2.0	79	312	31	9	74	2.4
Untreated	—	4.2	5.9	1.9	143	338	39	11	73	2.8
$LSD_{0.05}$	—	ns	ns	ns	ns	ns	ns	ns	ns	ns

[a]All treatments, including the check, were mixed with 3 pts/a Roundup Ultra.

Table 3. Weed control in ornamental bulbs treated with various herbicide combinations and timings.

Residual herbicide	Nonselective herbicide[a]	Timing[b]	Weed control 2/20/01	3/7/01	4/17/01	6/15/01
			---------- % ----------			
Visor	Roundup	Fall	100	100	100	99
(3 pts/a)	Roundup	Spring, PRE	93	100	100	98
	Roundup	Spring, POST	—	86	100	97
	Finale	Spring, POST	—	84	100	97
	Roundup	Fall + Spring, PRE	100	100	100	100
	Roundup	Fall + Spring, POST	98	100	100	98
	Finale	Fall + Spring, POST	97	100	100	100
Diuron	Roundup	Fall	100	100	100	99
(4 lbs/a)	Roundup	Spring, PRE	94	99	100	99
	Roundup	Spring, POST	—	60	100	98
	Finale	Spring, POST	—	56	100	100
	Roundup	Fall + Spring, PRE	100	100	100	100
	Roundup	Fall + Spring, POST	100	100	100	100
	Finale	Fall + Spring, POST	100	100	100	100
Gallery	Roundup	Fall	75	88	75	59
(10.7 oz/a)	Roundup	Spring, PRE	94	99	100	78
	Roundup	Spring, POST	—	80	100	92
	Finale	Spring, POST	—	74	95	78
	Roundup	Fall + Spring, PRE	99	100	100	81
	Roundup	Fall + Spring, POST	98	100	100	76
	Finale	Fall + Spring, POST	99	100	100	84
Prowl	Roundup	Fall	97	99	100	94
(7.3 pts/a)	Roundup	Spring, PRE	91	99	100	96
	Roundup	Spring, POST	—	75	100	96
	Finale	Spring, POST	—	88	98	94
	Roundup	Fall + Spring, PRE	98	100	100	97
	Roundup	Fall + Spring, POST	97	100	100	97
	Finale	Fall + Spring, POST	99	100	100	98
Surflan	Roundup	Fall	99	100	100	96
(3 pts/a)	Roundup	Spring, PRE	91	93	96	89
	Roundup	Spring, POST	—	83	100	97
	Finale	Spring, POST	—	89	95	92
	Roundup	Fall + Spring, PRE	98	100	100	96
	Roundup	Fall + Spring, POST	98	100	100	96
	Finale	Fall + Spring, POST	100	100	100	98
$LSD_{0.05}$			17	12	ns	7

[a]Roundup applied at 1.5 pts/a; Finale applied at 6 pts/a.

[b]Fall = all residual applied in fall; Spring = all residual applied in spring;
Fall + Spring = half residual applied in fall, half applied in spring;
PRE = preemergence; POST = postemergence.

Table 4. 'Merry Widow' tulip injury after treatment with various herbicide combinations and timings.

Residual herbicide	Nonselective herbicide[a]	Timing[b]	Foliar injury 3/7/01	Foliar injury number 4/17/01	Flower height 4/17/01	Flower 4/17/01
			%	%	per plot	inches
Visor	Roundup	Fall	0	5	33	11
(3 pts/a)	Roundup	Spring, PRE	5	3	36	12
	Roundup	Spring, POST	41	53	21	8
	Finale	Spring, POST	3	43	32	9
	Roundup	Fall + Spring, PRE	1	0	32	13
	Roundup	Fall + Spring, POST	15	43	26	9
	Finale	Fall + Spring, POST	0	28	34	11
Diuron	Roundup	Fall	0	0	35	13
(4 lbs/a)	Roundup	Spring, PRE	1	5	32	11
	Roundup	Spring, POST	1	20	34	10
	Finale	Spring, POST	3	40	29	9
	Roundup	Fall + Spring, PRE	0	9	31	12
	Roundup	Fall + Spring, POST	4	28	32	10
	Finale	Fall + Spring, POST	0	16	35	11
Gallery	Roundup	Fall	10	3	31	12
(10.7 oz/a)	Roundup	Spring, PRE	13	10	29	11
	Roundup	Spring, POST	4	55	17	7
	Finale	Spring, POST	3	43	28	9
	Roundup	Fall + Spring, PRE	11	8	34	11
	Roundup	Fall + Spring, POST	19	40	24	8
	Finale	Fall + Spring, POST	4	30	32	9
Prowl	Roundup	Fall	3	4	33	12
(7.3 pts/a)	Roundup	Spring, PRE	1	8	38	12
	Roundup	Spring, POST	4	60	17	8
	Finale	Spring, POST	4	38	33	9
	Roundup	Fall + Spring, PRE	0	8	31	11
	Roundup	Fall + Spring, POST	43	58	15	7
	Finale	Fall + Spring, POST	1	35	27	9
Surflan	Roundup	Fall	0	5	32	11
(3 pts/a)	Roundup	Spring, PRE	4	6	33	12
	Roundup	Spring, POST	4	65	18	8
	Finale	Spring, POST	3	30	30	11
	Roundup	Fall + Spring, PRE	1	10	33	12
	Roundup	Fall + Spring, POST	5	58	19	7
	Finale	Fall + Spring, POST	1	45	28	10
$LSD_{0.05}$			6	13	8	2

[a]Roundup applied at 1.5 pts/a; Finale applied at 6 pts/a.

[b]Fall = all residual applied in fall; Spring = all residual applied in spring; Fall + Spring = half residual applied in fall, half applied in spring; PRE = preemergence; POST = postemergence.

Table 5. 'Dutch Master' daffodil injury after treatment with various herbicide combinations and timings.

Residual herbicide	Nonselective herbicide[a]	Timing[b]	Foliar injury 3/7/01	Foliar injury number 4/17/01	Flower height 4/02/01	Flower 4/02/01
			%	%	per plot	inches
Visor	Roundup	Fall	0	1	16	14
(3 pts/a)	Roundup	Spring, PRE	0	5	15	14
	Roundup	Spring, POST	1	9	13	13
	Finale	Spring, POST	0	3	17	15
	Roundup	Fall + Spring, PRE	0	0	16	15
	Roundup	Fall + Spring, POST	0	3	14	14
	Finale	Fall + Spring, POST	0	3	16	14
Diuron	Roundup	Fall	0	0	15	15
(4 lbs/a)	Roundup	Spring, PRE	0	0	13	14
	Roundup	Spring, POST	0	1	14	15
	Finale	Spring, POST	0	0	17	15
	Roundup	Fall + Spring, PRE	0	0	15	14
	Roundup	Fall + Spring, POST	0	1	20	15
	Finale	Fall + Spring, POST	0	1	12	16
Gallery	Roundup	Fall	1	0	15	15
(10.7 oz/a)	Roundup	Spring, PRE	0	3	15	14
	Roundup	Spring, POST	0	8	15	14
	Finale	Spring, POST	0	5	16	15
	Roundup	Fall + Spring, PRE	0	0	16	14
	Roundup	Fall + Spring, POST	1	5	17	15
	Finale	Fall + Spring, POST	1	3	17	15
Prowl	Roundup	Fall	0	0	15	14
(7.3 pts/a)	Roundup	Spring, PRE	0	0	17	15
	Roundup	Spring, POST	1	0	16	14
	Finale	Spring, POST	1	5	15	14
	Roundup	Fall + Spring, PRE	0	0	14	14
	Roundup	Fall + Spring, POST	6	10	15	14
	Finale	Fall + Spring, POST	1	5	16	15
Surflan	Roundup	Fall	0	3	13	14
(3 pts/a)	Roundup	Spring, PRE	0	3	15	14
	Roundup	Spring, POST	0	10	13	14
	Finale	Spring, POST	0	8	15	15
	Roundup	Fall + Spring, PRE	0	0	14	14
	Roundup	Fall + Spring, POST	1	3	13	14
	Finale	Fall + Spring, POST	4	10	13	13
$LSD_{0.05}$			2	7	ns	ns

[a]Roundup applied at 1.5 pts/a; Finale applied at 6 pts/a.

[b]Fall = all residual applied in fall; Spring = all residual applied in spring; Fall + Spring = half residual applied in fall, half applied in spring; PRE = preemergence; POST = postemergence.

Table 6. 'Blue Diamond' iris injury after treatment with various herbicide combinations and timings.

Residual herbicide	Nonselective herbicide[a]	Timing[b]	Foliar injury 3/7/01	Foliar injury number 4/17/01	Flower height 5/22/01	Flower 5/22/01
			%	%	per plot	inches
Visor	Roundup	Fall	0	3	15	16
(3 pts/a)	Roundup	Spring, PRE	1	10	8	12
	Roundup	Spring, POST	3	20	1	8
	Finale	Spring, POST	1	15	11	15
	Roundup	Fall + Spring, PRE	1	8	8	14
	Roundup	Fall + Spring, POST	3	20	1	5
	Finale	Fall + Spring, POST	1	20	11	15
Diuron	Roundup	Fall	3	0	18	16
(4 lbs/a)	Roundup	Spring, PRE	4	5	12	13
	Roundup	Spring, POST	0	8	7	12
	Finale	Spring, POST	0	25	8	13
	Roundup	Fall + Spring, PRE	1	3	14	16
	Roundup	Fall + Spring, POST	1	18	3	9
	Finale	Fall + Spring, POST	0	20	9	13
Gallery	Roundup	Fall	0	5	15	16
(10.7 oz/a)	Roundup	Spring, PRE	1	0	11	14
	Roundup	Spring, POST	3	23	2	5
	Finale	Spring, POST	1	13	11	15
	Roundup	Fall + Spring, PRE	1	3	9	13
	Roundup	Fall + Spring, POST	1	30	1	3
	Finale	Fall + Spring, POST	4	13	14	14
Prowl	Roundup	Fall	0	0	12	15
(7.3 pts/a)	Roundup	Spring, PRE	3	10	8	14
	Roundup	Spring, POST	3	30	3	8
	Finale	Spring, POST	1	18	8	14
	Roundup	Fall + Spring, PRE	0	5	9	14
	Roundup	Fall + Spring, POST	13	20	2	8
	Finale	Fall + Spring, POST	1	18	11	14
Surflan	Roundup	Fall	1	0	10	15
(3 pts/a)	Roundup	Spring, PRE	4	13	5	13
	Roundup	Spring, POST	1	23	2	8
	Finale	Spring, POST	1	26	9	14
	Roundup	Fall + Spring, PRE	3	8	8	14
	Roundup	Fall + Spring, POST	3	18	2	9
	Finale	Fall + Spring, POST	1	23	10	14
$LSD_{0.05}$			4	11	6	4

[a]Roundup applied at 1.5 pts/a; Finale applied at 6 pts/a.

[b]Fall = all residual applied in fall; Spring = all residual applied in spring; Fall + Spring = half residual applied in fall, half applied in spring; PRE = preemergence; POST = postemergence.

Table 7. 'Merry Widow' tulip bulb yield after treatment with various herbicide combinations and timings.

Residual herbicide	Nonselective herbicide[a]	Timing[b]	Total bulb number	Total bulb weight	Average bulb weight
			no./plot	g/plot	g/bulb
Visor	Roundup	Fall	149	796	5.3
(3 pts/a)	Roundup	Spring, PRE	143	664	4.6
	Roundup	Spring, POST	122	480	4.1
	Finale	Spring, POST	111	427	4.0
	Roundup	Fall + Spring, PRE	146	680	4.7
	Roundup	Fall + Spring, POST	134	523	4.0
	Finale	Fall + Spring, POST	132	527	4.0
Diuron	Roundup	Fall	179	1129	6.3
(4 lbs/a)	Roundup	Spring, PRE	157	796	5.1
	Roundup	Spring, POST	124	634	5.2
	Finale	Spring, POST	115	465	4.2
	Roundup	Fall + Spring, PRE	167	839	5.0
	Roundup	Fall + Spring, POST	139	619	4.4
	Finale	Fall + Spring, POST	150	689	4.7
Gallery	Roundup	Fall	180	843	4.7
(10.7 oz/a)	Roundup	Spring, PRE	129	778	6.0
	Roundup	Spring, POST	116	434	3.8
	Finale	Spring, POST	122	465	3.9
	Roundup	Fall + Spring, PRE	167	937	5.6
	Roundup	Fall + Spring, POST	154	682	4.5
	Finale	Fall + Spring, POST	121	565	4.8
Prowl	Roundup	Fall	183	991	5.4
(7.3 pts/a)	Roundup	Spring, PRE	191	1007	5.3
	Roundup	Spring, POST	133	494	3.8
	Finale	Spring, POST	120	471	3.9
	Roundup	Fall + Spring, PRE	181	961	5.3
	Roundup	Fall + Spring, POST	129	479	3.8
	Finale	Fall + Spring, POST	145	549	3.8
Surflan	Roundup	Fall	175	913	5.3
(3 pts/a)	Roundup	Spring, PRE	166	930	5.6
	Roundup	Spring, POST	137	549	4.0
	Finale	Spring, POST	128	553	4.3
	Roundup	Fall + Spring, PRE	166	985	6.0
	Roundup	Fall + Spring, POST	145	561	3.9
	Finale	Fall + Spring, POST	123	521	4.7
$LSD_{0.05}$			33	180	1.0

[a]Roundup applied at 1.5 pts/a; Finale applied at 6 pts/a.

[b]Fall = all residual applied in fall; Spring = all residual applied in spring; Fall + Spring = half residual applied in fall, half applied in spring; PRE = preemergence; POST = postemergence.

Table 8. 'Dutch Master' daffodil bulb yield after treatment with various herbicide combinations and timings.

Residual herbicide	Nonselective herbicide[a]	Timing[b]	Total bulb number	Total bulb weight	Average bulb weight
			no./plot	g/plot	g/bulb
Visor	Roundup	Fall	21	1998	97.4
(3 pts/a)	Roundup	Spring, PRE	22	1944	88.9
	Roundup	Spring, POST	16	1581	97.9
	Finale	Spring, POST	21	1893	93.5
	Roundup	Fall + Spring, PRE	20	1929	100.3
	Roundup	Fall + Spring, POST	20	1984	99.7
	Finale	Fall + Spring, POST	25	1913	79.5
Diuron	Roundup	Fall	18	1701	95.9
(4 lbs/a)	Roundup	Spring, PRE	20	1447	72.1
	Roundup	Spring, POST	21	1318	64.3
	Finale	Spring, POST	20	1151	57.4
	Roundup	Fall + Spring, PRE	27	1906	73.2
	Roundup	Fall + Spring, POST	24	1576	67.3
	Finale	Fall + Spring, POST	21	1290	61.3
Gallery	Roundup	Fall	22	2063	96.8
(10.7 oz/a)	Roundup	Spring, PRE	18	1652	90.9
	Roundup	Spring, POST	23	1838	81.4
	Finale	Spring, POST	21	1648	77.3
	Roundup	Fall + Spring, PRE	24	1998	83.7
	Roundup	Fall + Spring, POST	22	1877	85.9
	Finale	Fall + Spring, POST	21	1979	94.8
Prowl	Roundup	Fall	22	1741	83.0
(7.3 pts/a)	Roundup	Spring, PRE	23	1995	89.0
	Roundup	Spring, POST	20	1808	89.3
	Finale	Spring, POST	20	1779	91.5
	Roundup	Fall + Spring, PRE	22	1896	87.3
	Roundup	Fall + Spring, POST	20	1722	85.3
	Finale	Fall + Spring, POST	19	1651	91.1
Surflan	Roundup	Fall	20	1698	85.2
(3 pts/a)	Roundup	Spring, PRE	22	1983	92.3
	Roundup	Spring, POST	20	1923	96.8
	Finale	Spring, POST	25	1775	70.2
	Roundup	Fall + Spring, PRE	21	1896	91.9
	Roundup	Fall + Spring, POST	21	1676	79.2
	Finale	Fall + Spring, POST	24	1924	79.6
$LSD_{0.05}$			ns	394	18.0

[a]Roundup applied at 1.5 pts/a; Finale applied at 6 pts/a.

[b]Fall = all residual applied in fall; Spring = all residual applied in spring; Fall + Spring = half residual applied in fall, half applied in spring; PRE = preemergence; POST = postemergence.

Table 9. 'Blue Diamond' iris bulb yield after treatment with various herbicide combinations and timings.

Residual herbicide	Nonselective herbicide[a]	Timing[b]	Total bulb number	Total bulb weight	Average bulb weight
			no./plot	g/plot	g/bulb
Visor	Roundup	Fall	74	384	5.1
(3 pts/a)	Roundup	Spring, PRE	75	257	3.5
	Roundup	Spring, POST	58	160	2.7
	Finale	Spring, POST	71	319	4.5
	Roundup	Fall + Spring, PRE	77	315	4.2
	Roundup	Fall + Spring, POST	59	160	2.6
	Finale	Fall + Spring, POST	75	337	4.6
Diuron	Roundup	Fall	88	430	5.0
(4 lbs/a)	Roundup	Spring, PRE	69	284	3.9
	Roundup	Spring, POST	68	258	3.8
	Finale	Spring, POST	62	208	3.3
	Roundup	Fall + Spring, PRE	84	434	5.1
	Roundup	Fall + Spring, POST	65	207	3.3
	Finale	Fall + Spring, POST	65	257	3.8
Gallery	Roundup	Fall	84	410	4.7
(10.7 oz/a)	Roundup	Spring, PRE	74	327	4.4
	Roundup	Spring, POST	39	107	2.3
	Finale	Spring, POST	72	282	3.9
	Roundup	Fall + Spring, PRE	70	283	4.0
	Roundup	Fall + Spring, POST	36	78	2.2
	Finale	Fall + Spring, POST	81	371	4.4
Prowl	Roundup	Fall	74	356	4.9
(7.3 pts/a)	Roundup	Spring, PRE	71	281	4.0
	Roundup	Spring, POST	53	169	3.1
	Finale	Spring, POST	59	217	3.7
	Roundup	Fall + Spring, PRE	73	292	4.0
	Roundup	Fall + Spring, POST	66	186	2.8
	Finale	Fall + Spring, POST	73	284	3.9
Surflan	Roundup	Fall	61	284	4.7
(3 pts/a)	Roundup	Spring, PRE	68	240	3.4
	Roundup	Spring, POST	59	156	2.6
	Finale	Spring, POST	68	237	3.5
	Roundup	Fall + Spring, PRE	78	297	3.7
	Roundup	Fall + Spring, POST	51	124	2.5
	Finale	Fall + Spring, POST	81	294	3.7
$LSD_{0.05}$			ns	149	0.8

[a]Roundup applied at 1.5 pts/a; Finale applied at 6 pts/a.

[b]Fall = all residual applied in fall; Spring = all residual applied in spring; Fall + Spring = half residual applied in fall, half applied in spring; PRE = preemergence; POST = postemergence.

Table 10. Weed control in ornamental bulbs after treatment with various herbicides.

Treatment	Rate	Timing	Weed control 2/20	3/7	3/26
	product/a		---------- % ----------		
Balance	2.6 oz	Fall	50	50	33
Valor	2.2 oz	Fall	98	91	95
Milestone	10 oz	Fall	100	81	100
Spartan	5.3 oz	Fall	99	75	94
FirstRate	0.61 oz	Fall	51	53	63
Broadstrike	1.1 oz	Fall	71	59	48
Resource	6 fl.oz	Fall	20	40	23
Balance	2.6 oz	Spring, POST	–	30	59
Valor	2.2 oz	Spring, POST	–	81	85
Milestone	10 oz	Spring, POST	–	92	99
Spartan	5.3 oz	Spring, POST	–	59	73
FirstRate	0.61 oz	Spring, POST	–	29	20
Broadstrike	1.1 oz	Spring, POST	–	20	70
Resource	6 fl.oz	Spring, POST	–	29	25
Untreated	—	—	0	0	0
$LSD_{0.05}$	—	—	20	49	24

Table 11. ‘Gander’s Rhapsody’tulip injury and bulb yield after treatment with various herbicides.

Treatment	Rate	Timing	Foliar injury 2/20/01	Foliar injury 3/7/01	Foliar injury 3/26/01	Flower number	Flower height	Total bulb number	Total bulb weight	Average bulb weight
	Product/a		---------- % ----------			no./plot	inches	no./plot	g/plot	g/bulb
Balance	2.6 oz	Fall	1	26	3	39	17	–	–	–
Valor	2.2 oz	Fall	38	39	28	39	15	–	–	–
Milestone	10 oz	Fall	60	45	60	34	8	65	490	7.7
Spartan	5.3 oz	Fall	38	39	40	40	13	–	–	–
FirstRate	0.61 oz	Fall	13	46	41	36	9	–	–	–
Broadstrike	1.1 oz	Fall	1	10	3	38	17	–	–	–
Resource	6 fl.oz	Fall	1	11	9	38	17	–	–	–
Balance	2.6 oz	Spring, POST	–	10	23	35	14	–	–	–
Valor	2.2 oz	Spring, POST	–	61	84	36	9	–	–	–
Milestone	10 oz	Spring, POST	–	71	95	24	4	43	155	3.7
Spartan	5.3 oz	Spring, POST	–	65	70	38	14	56	468	8.3
FirstRate	0.61 oz	Spring, POST	–	25	35	32	6	–	–	–
Broadstrike	1.1 oz	Spring, POST	–	20	5	38	18	72	990	14.0
Resource	6 fl.oz	Spring, POST	–	74	53	37	16	–	–	–
Untreated	—	—	0	0	0	38	17	–	–	–
$LSD_{0.05}$	—	—	8	ns	11	5	2	14	149	2.1

Table 12. 'Standard Value'daffodil injury and bulb yield after treatment with various herbicides.

Treatment	Rate	Timing	Foliar injury 2/20/01	Foliar injury 3/7/01	Foliar injury 3/26/01	Flower number	Flower height	Total bulb number	Total bulb weight	Average bulb weight
	Product/a		---------- % ----------			no./plot	inches	no./plot	g/plot	g/bulb
Balance	2.6oz	Fall	0	0	1	20	16	–	–	–
Valor	2.2 oz	Fall	5	15	6	20	15	–	–	–
Milestone	10 oz	Fall	15	23	19	18	14	23	1224	55.8
Spartan	5.3 oz	Fall	8	11	45	16	11	–	–	–
FirstRate	0.61 oz	Fall	0	0	3	19	14	–	–	–
Broadstrike	1.1 oz	Fall	0	0	3	16	15	–	–	–
Resource	6 fl.oz	Fall	0	0	1	18	16	–	–	–
Balance	2.6 oz	Spring, POST	–	0	0	17	16	–	–	–
Valor	2.2 oz	Spring, POST	–	11	43	18	13	–	–	–
Milestone	10 oz	Spring, POST	–	21	68	14	13	21	912	44.2
Spartan	5.3 oz	Spring, POST	–	20	44	16	14	21	870	42.1
FirstRate	0.61 oz	Spring, POST	–	0	0	18	15	–	–	–
Broadstrike	1.1 oz	Spring, POST	–	0	1	20	16	25	1594	63.5
Resource	6 fl.oz	Spring, POST	–	23	24	17	14	–	–	–
Untreated	—	—	0	0	0	18	16	–	–	–
$LSD_{0.05}$	—	—	4	7	13	3	2	ns	427	21.2

Table 13. 'Blue Diamond' iris injury and bulb yield after treatment with various herbicide combinations and timings.

Treatment	Rate	Timing	Foliar injury 2/20/01	Foliar injury 3/7/01	Foliar injury 3/26/01	Flower number	Flower height	Total bulb number	Total bulb weight	Average bulb weight
			---------- % ----------			no./plot	inches	no./plot	g/plot	g/bulb
Balance	2.6 oz	Fall	0	0	0	19	19	–	–	–
Valor	2.2 oz	Fall	10	23	14	20	18	–	–	–
Milestone	10 oz	Fall	23	30	24	20	17	100	484	4.7
Spartan	5.3 oz	Fall	8	16	54	8	10	–	–	–
FirstRate	0.61 oz	Fall	1	1	8	15	9	–	–	–
Broadstrike	1.1 oz	Fall	0	0	4	23	20	–	–	–
Resource	6 fl.oz	Fall	1	1	4	20	19	–	–	–
Balance	2.6 oz	Spring, POST	–	0	3	18	19	–	–	–
Valor	2.2 oz	Spring, POST	–	35	59	17	15	–	–	–
Milestone	10 oz	Spring, POST	–	53	71	19	15	91	320	3.4
Spartan	5.3 oz	Spring, POST	–	43	63	16	16	58	179	3.1
FirstRate	0.61 oz	Spring, POST	–	0	4	16	11	–	–	–
Broadstrike	1.1 oz	Spring, POST	–	0	1	24	20	98	472	4.9
Resource	6 fl.oz	Spring, POST	–	36	21	18	18	–	–	–
Untreated	—	—	0	0	0	22	20	–	–	–
$LSD_{0.05}$	—	—	5	8	15	6	3	ns	176	2.3