

Potential for Phytotoxicity of  
Pendulum 2G (Pendimethalin)  
On Common Sneezeweed  
(*Helenium autumnale*)

By

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Project: Interregional Research Project #4  
Project Number 23759A – June 21, 2004

Acknowledgements: Ahmet Gulcu

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PR.NO. :	23759A
TRIAL:	1
DATE:	6/21/04

**IR-4 ORNAMENTAL DATA REPORTING FORM**

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<b>Location of Trial</b>	University of California, Davis CA
<b>TRIAL TYPE:</b> (field, container, greenhouse, etc)	Field Container
<b>Chemical - Common Name</b>	Pendimethalin
- Formulation	Granular, 2%
- Batch Number	
- Product	Pendulum 2G
- EPA Registration Number	241-375
- Manufacture	BASF
<b>USE INFORMATION</b>	
- Plant Common Name	Common Sneezeweed
- Plant Scientific Name	<i>Helenium autumnale</i>
- Pest (s)	Weeds
<b>Soil Type or Type of Potting Mix:</b>	<b>UC Mix</b> a)%Sand: 30 b)%Silt: c)%Clay: d)%OM: 70 e)%pH: 6.5
Enter each <b>DATE</b> for:	<b>Seedling: Emergence: Transplanting: 3/22/04</b>
Enter each <b>SPACING</b> for:	<b>Plant or Pot: 6 inches Row: 6 inches</b>
Enter each <b>SIZE</b> for:	<b>Pot: 4-inch Plot: 50 sq ft</b>
<b>Experimental Design:</b>	Randomized complete block (3 blocks X 4 reps)
<b>Number of Reps:</b>	12 reps total for each treatment

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**APPLICATION PARAMETERS**

<b>Type of Application:</b> (aerial, ground, foliar, drench, ppi, chemigation, broadcast, directed, etc)	Broadcast over the top
<b>Number of Applications:</b>	2, 30 days apart
<b>Application Type:</b>	Shaker container
<b>Nozzle Type/Size:</b>	
<b>Nozzle Pressure:</b>	
<b>Delivery Rate:</b>	
<b>Calibration Date(s):</b>	

**APPLICATION SUMMARY**

<b>APPLICATION DATE</b>	<b>RATES (a.i./A)</b> (Be sure to provide units)	<b>Brief Description of Growth Stage</b> (Dormant, New Growth Present, Bud, etc)
5/10/04	0, 2, 4, 8 lb. a.i./A	7 weeks post- transplant, actively growing
6/9/04	0, 2, 4, 8 lb. a.i./A	11 weeks post- transplant, actively growing

**RAINFALL/IRRIGATION RECORDS:** INCLUDE RAINFALL/IRRIGATION INFORMATION  
(printouts, IR-4 forms, etc.)  
See Table 1

**OTHER PESTICIDES, FERTILIZER, LIME AND ADJUVANTS USED:**

<b>PRODUCT</b>	<b>AMOUNT</b>	<b>DATE</b>
Osmocote 19-6-12	3 grams per 4-inch pot	5/6/04

**NARRATIVE SUMMARY OF METHODS AND RESULTS:** (Use more pages if needed)

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**Materials and Methods**

**Plant Material and Culture.** Young plants of *Helenium autumnale* were received from Yoder Bros. on March 15, 2004. These were transplanted to 4-inch pots containing UC Mix on March 22, 2004 and maintained in a greenhouse under natural day length for 7 weeks until the experiment began on May 10, 2004. For the experiment, the plants were transferred to a 60% shade house in the outdoor nursery at the Environmental Horticulture Dept. at UC Davis. The plants were watered as needed (at least once daily) during the 6-week experiment with tap water. Fertilizer in the form of Osmocote (19-6-12) was added at the rate of 3 grams per 4-inch pot on May 6, 2004. Environmental conditions during the 6-week experiment from May 10, 2004 to June 21, 2004 are summarized in Table 1 as data recorded at the nearest CIMIS (California Irrigation Management Information System) station (Davis #6).

**Experimental Procedure.** Forty-eight plants were randomly chosen and individually tagged for treatment with 0, 2 lb/A (1X), 4 lb/A (2X) or 8 lb/A (4X) Pendulum 2G (granular pendimethalin) with 12 replicates per treatment. These dosages were prescribed in IR4 Ornamental Protocol 001 dated 3/04 (Appendix A). The plants received the first of two applications of the material broadcast over the top on May 10, 2004 using a quart jar with perforated lid to distribute the granules over the plants (Figure 1). The second application was made 30 days later on June 9, 2004 using the same method. The plants were arranged in a randomized complete block design with 3 blocks and 4 treatment replicates per block. Phytotoxicity ratings, plant height and plant width measurements were taken at days 0, 7, 14, 30 and 42 (June 21, 2004). Visual phytotoxicity evaluations were based on a numerical rating scale ranging from 0 (no injury) to 10 (complete kill) (Table 2). Plant height (cm) was measured from the container soil surface to the top of the canopy. Width (cm) was measured twice along perpendicular lines at the widest part of the plant, resulting in  $W_1$  and  $W_2$ . For the first four observation dates, only the average of the width measurements was recorded ( $W$ ). For each observation a canopy volume index was calculated so as to be able to determine if canopy volume was affected by the application of the herbicide. The calculation was made as  $H*W_1*W_2$  for observations where two width measurements were available and as  $H*W*W$  where only one width measurement was available. The usefulness of this index is based on the fact that many of the models for such a volume calculation are of the form  $a*H*W_1*W_2$ , where  $H$  is the height,  $W_1$  and  $W_2$  are two width measurements. The constant “a” depends on the assumption of the shape of the canopy. Since analyses of variance are scale-independent, the conclusion will thus be for the volume of the plant canopy.

**Statistical Analysis.** For each variable, the change in the variable from the start of the experiment was computed. Statistical analyses were carried out on these variables to determine if the application of herbicide affected growth and phytotoxicity index values.

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**Results**

**Phytotoxicity.** Phytotoxicity index values were generally not significantly different between the control group and the Pendulum-treated groups (Table 3, Figure 2, Appendix B). Only one mean value, at week 4 for the 2X treatment rate, was significantly greater than those of the other groups. This difference was 0.73, representing a very minimal level of phytotoxicity.

**Plant size.** The *Helenium* plants grew in height by 15 to 22 cm over the 6-week period of the experiment (Table 3, Figures 2 and 3, Appendix C). No treatment effects were observed for height changes. The increase in width for plants treated with Pendulum was significantly less than that for the control plants (Table 3, Figures 2 and 3, Appendix D). The volume index showed no significant differences due to treatment with Pendulum at any of the observation dates (Table 3, Figure 2).

**Discussion**

No significant phytotoxicity was observed for Pendulum on *Helenium*. There was also no effect of Pendulum on *Helenium* plant size.

**GOOD RESEARCH PRACTICE STATEMENT:**

I acknowledge that I have read and followed the IR-4 Research protocol and completed this trial following good agricultural practice, or reported any deviations (note any changes from authorized protocol in narrative).

**SIGNATURE (PRINCIPAL INVESTIGATOR)** \_\_\_\_\_

**Date Completed:**

**If submitted, using e-mail, please provide e-mail address and send confirming receipt.**

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**Table 1. Environmental conditions during the phytotoxicity trial of Pendulum 2G on *Helenium autumnale*. Data recorded at the nearest CIMIS station (Davis #6).**

Date	CIMIS ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Pt (°F)	Avg wSpd (MPH)	Wnd Run (miles)	Avg Soil Temp (°F)
5/12/2004	0.28	0	669	7.8	81.8	54	66.4	67	19	35	38.1	7.7	186	57.8
5/13/2004	0.24	0	661	10.8	82.9	46.7	65.1	86	17	51	46.7	4.3	103.4	58.4
5/14/2004	0.24	0	630	11.2	85.2	47.4	66.3	87	26	51	47.5	4.3	104.7	58.9
5/15/2004	0.23	0	591	12	82.2	52.3	66.5	79	36	54	49.4	5	120.1	59.3
5/16/2004	0.26	0	650	10.6	81.4	51.1	65.4	79	28	50	46.1	6.7	161.1	59.6
5/17/2004	0.25	0	656	10.8	73.2	50.3	60.5	82	42	60	46.5	9.9	239.4	58.5
5/18/2004	0.22	0	651	10.4	74.8	48	61.6	88	30	55	45.5	4.4	106.9	58.2
5/19/2004	0.24	0	638	11	78.5	46.8	63.9	86	35	54	47	5.6	134.2	58.7
5/20/2004	0.23	--	--	--	--	--	--	--	--	--	--	--	--	--
5/21/2004	0.23	--	--	--	--	--	--	--	--	--	--	--	--	--
5/22/2004	0.23	--	--	--	--	--	--	--	--	--	--	--	--	--
5/23/2004	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--
5/24/2004	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--
5/25/2004	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--
5/26/2004	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--
5/27/2004	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--
5/28/2004	0.24	--	--	--	--	--	--	--	--	--	--	--	--	--
5/29/2004	0.25	--	--	--	--	--	--	--	--	--	--	--	--	--
5/30/2004	0.25	--	--	--	--	--	--	--	--	--	--	--	--	--
5/31/2004	0.25	--	--	--	--	--	--	--	--	--	--	--	--	--
6/1/2004	0.25	0	845	12	91.7	--	81.8	84	21	32	49.3	4.8	115.8	--
6/2/2004	0.27	0	685	13.3	91.7	55.1	72.8	81	24	48	52.2	4.3	103	60.8
6/3/2004	0.24	0	646	12.9	87	52.7	68.3	86	31	55	51.4	5	119.7	61.4
6/4/2004	0.24	0	634	12.8	87.8	50.3	68.3	88	34	54	51	4.5	109	61.6
6/5/2004	0.25	0	665	12.7	88.9	49.9	70.5	73	30	50	50.9	4.1	99	61.9
6/6/2004	0.3	0	682	11.1	90.7	58.2	74.2	72	23	38	47.2	6.1	148.2	62.5
6/7/2004	0.27	0	695	10	81.2	50	66.3	81	21	45	44.4	6.1	148.4	61
6/8/2004	0.23	0	641	9.1	74.9	49	62.3	79	31	48	42.2	4.6	111.6	--
6/9/2004	0.25	0	661	11.3	78.7	46.7	63.5	86	35	56	47.8	6.5	156.1	--
6/10/2004	0.23	0	669	12.6	79.3	51.5	64.6	85	37	61	50.8	5.4	130.8	--
6/11/2004	0.25	0	672	11.8	83.1	50.2	67.3	86	26	52	48.9	4.1	99.5	--
6/12/2004	0.25	0	666	12.4	87.6	52.2	70.1	83	27	49	50.2	4.4	106.2	--
6/13/2004	0.26	0	674	13	89.6	54.3	72.6	76	27	48	51.5	3.8	92.2	60.9
6/14/2004	0.33	0	680	11.9	95.9	58	77.1	78	14	38	49.2	6.6	160.1	61
6/15/2004	0.39	0	681	10.5	97.7	67.7	83.5	49	17	27	45.7	9.5	228.4	--
6/16/2004	0.33	0	873	12.9	94.6	--	80.7	64	22	36	51.4	8.3	200.1	60.9
6/17/2004	0.28	0	759	13.2	81.6	56.3	67.5	75	40	57	51.9	7.4	179.5	60.6
6/18/2004	0.27	0	755	13.3	83.6	52.8	67	84	32	59	52.1	6.6	158.8	60.8
6/19/2004	0.27	0	758	13.8	83.1	52.1	66.9	85	38	61	53.2	5.9	142.6	61.2
6/20/2004	0.27	0	742	13.7	87.2	51.9	68.2	86	33	58	53	5.4	129.3	61.9
6/21/2004	0.28	0	732	14.2	88.3	53.7	70	83	35	57	53.9	5.9	142.2	62.4
6/22/2004	0.27	0	736	13.9	84	55.1	67.7	83	39	60	53.3	7	169.4	62.5
6/23/2004	0.28	0	723	13.2	87.3	53.1	67.9	86	29	57	51.8	6.6	159.5	62.4
6/24/2004	0.28	0	742	12.7	87.4	53.9	69.4	82	30	52	50.8	5.5	133.4	62.5

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**Figure 1. Pendulum 2G was broadcast over the top of the plants using a modified shaker made from a quart-sized Mason jar with perforated lid.**

**Table 2. Numerical plant damage rating scale used for phytotoxicity determinations.**

Rating	Description of plant damage
0	No damage
1	No visible damage but unintended (non-permanent) impact
2	Slight leaf/tissue damage (curling leaves, necrosis, etc.)
3	Marginal chlorosis on some leaves (damage on up to 10% of plant)
4	10% – 20% of plant damaged
5	Significant damage to much of plant (30% - 40%)
6	40% – 60% of plant damaged
7	Chlorosis or necrosis on most of plant (60% - 70%)
8	Abscised leaves, branch dieback
9	Tissue severely damaged (80% - 100% of plant)
10	Complete kill

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**Table 3. Summary of results for *Helenium autumnale* treated with 0, 2, 4 or 8 lb./A Pendulum 2G. Cumulative changes over time are reported for phytotoxicity index, plant height, plant width and volume index. Different litters within a column indicate significant differences between treatments (P < 0.05). “Yes”/”No” refers to significant treatment effects at the 5% level. Means ± SE (n = 12).**

**Helenium**

Herbicide: Pendulum

Phytotoxicity Increase after:

Treatment	1 week	no	2 weeks	no	4 weeks	yes	6 weeks	no
0	0.00 ± 0.00	a	0.17 ± 0.11	a	0.00 ± 0.00	a	0.00 ± 0.00	a
1X	0.00 ± 0.00	a	0.08 ± 0.08	a	0.25 ± 0.13	a	0.00 ± 0.00	a
2X	0.00 ± 0.00	a	0.17 ± 0.11	a	0.73 ± 0.14	b	0.17 ± 0.17	a
4X	0.00 ± 0.00	a	0.08 ± 0.08	a	0.25 ± 0.13	a	0.00 ± 0.00	a

Height Increase after:

Treatment	1 week	no	2 weeks	no	4 weeks	no	6 weeks	no
0	1.92 ± 0.61	a	3.08 ± 0.84	a	7.33 ± 2.31	a	19.50 ± 3.18	a
1X	1.04 ± 0.55	a	3.17 ± 1.03	a	9.33 ± 2.30	a	21.83 ± 3.37	a
2X	0.58 ± 0.48	a	1.42 ± 0.83	a	5.86 ± 2.32	a	15.38 ± 3.55	a
4X	2.38 ± 1.12	a	2.08 ± 1.25	a	8.00 ± 2.72	a	19.42 ± 3.80	a

Width Increase after:

Treatment	1 week	no	2 weeks	no	4 weeks	yes	6 weeks	yes
0	6.33 ± 0.42	a	3.83 ± 0.77	a	2.90 ± 0.42	a	5.81 ± 0.57	a
1X	4.88 ± 0.49	b	2.33 ± 1.06	a	1.38 ± 0.50	b	3.52 ± 0.85	b
2X	5.75 ± 0.56	ab	3.00 ± 0.93	a	1.23 ± 0.55	b	3.81 ± 0.69	b
4X	5.29 ± 0.38	ab	2.54 ± 0.99	a	1.10 ± 0.51	b	3.13 ± 0.48	b

Relative Volume Index Increase after:

Treatment	1 week	no	2 weeks	no	4 weeks	no	6 weeks	no
0	5063 ± 763	a	3944 ± 701	a	5634 ± 1601	a	16276 ± 2268	a
1X	3562 ± 472	a	3298 ± 978	a	5774 ± 1271	a	15257 ± 1787	a
2X	4053 ± 623	a	2830 ± 994	a	3423 ± 1153	a	11934 ± 2356	a
4X	4898 ± 976	a	3026 ± 1411	a	4749 ± 1470	a	13464 ± 2550	a

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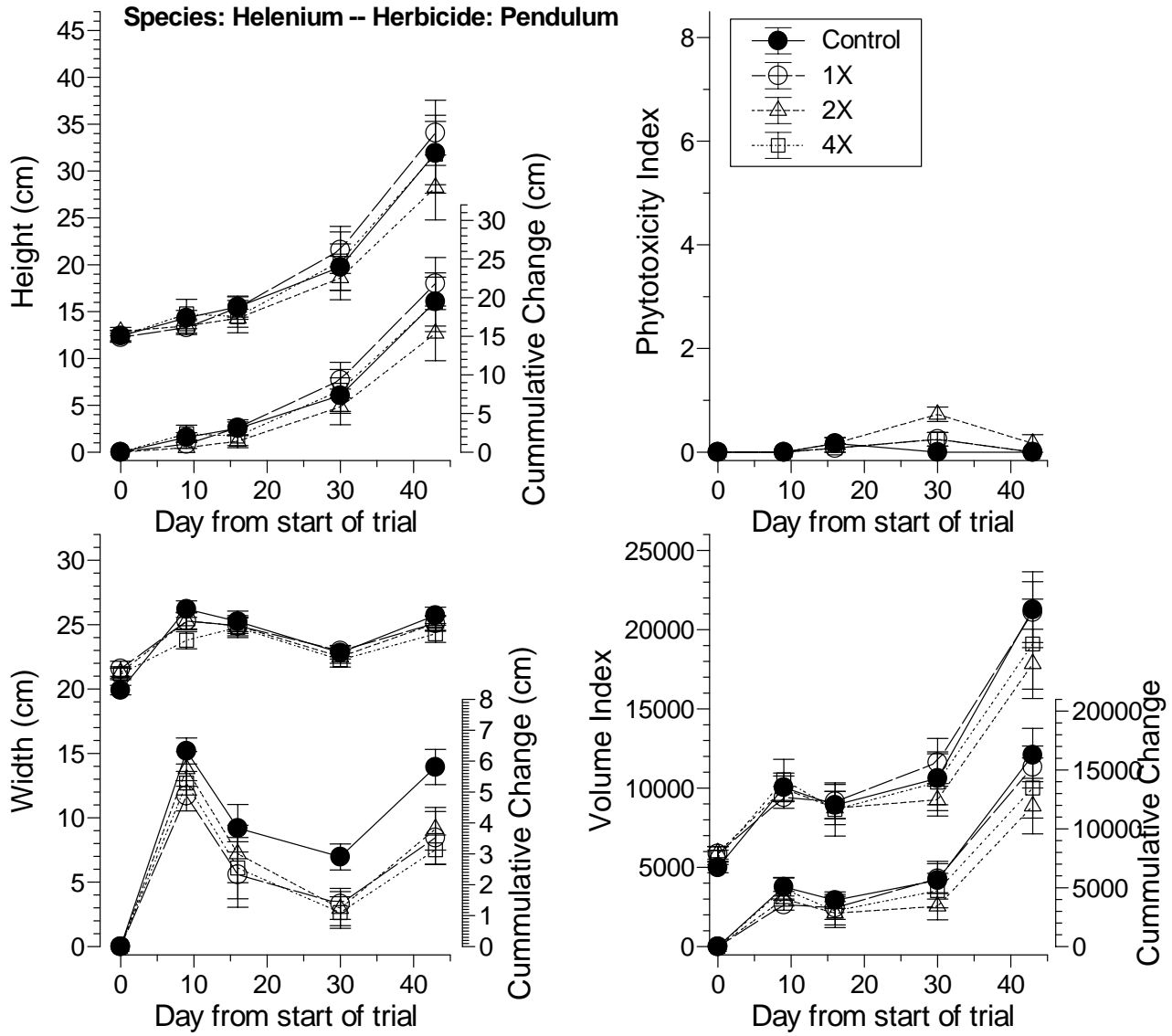
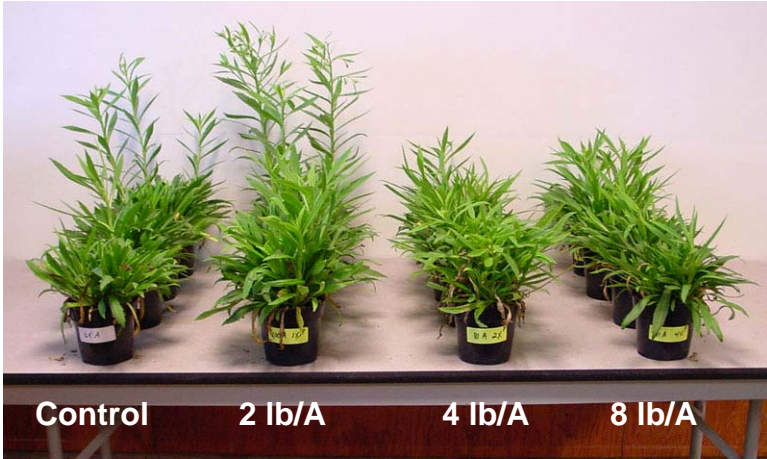


Figure 2. Summary of results for *Helenium autumnale* treated with 0, 2, 4 or 8 lb./A Pendulum 2G. Both raw data and cumulative changes over time are plotted for phytotoxicity index, plant height, plant width and volume index. SE bars shown (n = 12).

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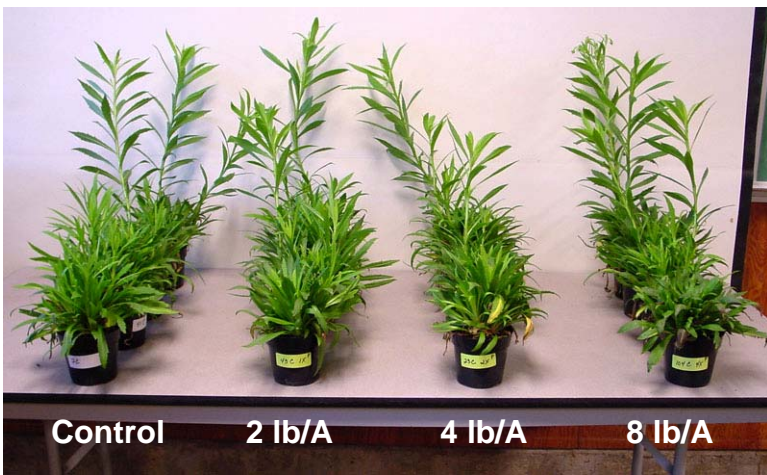
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Block A



Block B



Block C

Figure 3. *Helenium autumnale* plants six weeks after two applications of 0, 2, 4 or 8 lb./A Pendulum 2G. Applications were made at Week 0 and Week 3.

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**APPENDIX A**

**PHYTOTOXICITY TO HERBACEOUS PERENNIAL PLANTS WITH PRE-EMERGENT APPLICATIONS OF PENDULUM, PENNANT MAGNUM AND SNAPSHOT**

Date: 3/04

**Ornamental Protocol Number: 001**

General label directions: Refer to product labels.

Research program:

Pest(s)/Plants – As attached.

Pesticide (common name and trade name) – Refer to treatment list shown below.

**For label, material & if needed spray oil surfactant contact:**

BASF, Kathie Kalmowitz, 919-785-9659, email: [kalmowk@basf-corp.com](mailto:kalmowk@basf-corp.com) (Pendulum)

Dow AgroSciences, Mike Melichar, 317-337-4982, [mwmelichar@dow.com](mailto:mwmelichar@dow.com) (Snapshot)

Syngenta, Dave Ross, 336-632-6411, [david.ross@syngenta.com](mailto:david.ross@syngenta.com) (Pennant Magnum)

Experimental design:

Plot size (must be adequate to reflect actual use condition)

Replicates Minimum of 4 Treatment Units

Controls (untreated controls to be included in all experiments)

<u>Application:</u>	<b>PENDULUM 2G</b>	<b>SNAPSHOT 2.5TG</b>	<b>PENNANT MAGNUM 7.62EC -OR- PENNANT MAGNUM 7.62EC</b>	
<u>Dosages</u> - 1x	2 lbs.ai/A	2.5 lbs.ai/A	2.5 lbs.ai/A (fine soil)	2.1 lbs.ai/A (medium/course soil)
2x	4 lbs.ai/A	5.0 lbs.ai/A	5.0 lbs.ai/A (fine soil)	4.2 lbs.ai/A (medium/course soil)
4x	8 lbs ai/A	10.0 lbs.ai/A	10.0 lbs.ai/A (fine soil)	8.4 lbs.ai/A (medium/course soil)

Active Ingredient: Pendulum (pendimethalin), Pennant Magnum (s-metolachlor), Snapshot (isoxaben+trifluralin).

Volume - Minimum of 10 gal/A for liquid applications.

Timing - 2 applications, 30 Days Spray Interval. Take initial counts, then efficacy and crop safety at 7, 14, 30 (then 2<sup>nd</sup> appl.) and 42 DAT.

Reports:

Method of application: (treatments should be made over the top of the plants using application equipment consistent with conventional commercial equipment). Report completely on experimental design and method of application. Report plant size height x width before treatment and throughout the experiment.

Weather – Maintain temperature and precipitation (including irrigation) data.

Soil type – Identify soil type used in experimental area.

Product – When submitting data, include EPA registration number of product used.

Efficacy – Data should include both actual counts and percent control as well as an indication that infestation was light, heavy, etc.

Record all application and evaluation dates.

Phytotoxicity – Record phytotoxicity data at all rates. Use a 0-10 scale. 0 = No Phytotoxicity 10 = complete kill.

**Please direct questions data to: Dr. Robert M. Herrick, IR-4 Project, 681 US Highway #1 South, North Brunswick, NJ  
Phone: (732) 932-9575., Ext. 629.**

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**APPENDIX B: PHYTOTOXICITY REPORT FORM: Visual Rating**

Helenium			5/9/2004	5/18/2004	5/25/2004	6/8/2004	6/21/2004
Rate	Block	Rep	Phyto	Phyto	Phyto	Phyto	Phyto
Ctrl	A	1	0	0	0	0	0
Ctrl	A	2	0	0	0	0	0
Ctrl	A	3	0	0	0	0	0
Ctrl	A	4	0	0	0	0	0
Ctrl	B	1	0	0	0	0	0
Ctrl	B	2	0	0	1	0	0
Ctrl	B	3	0	0	1	0	0
Ctrl	B	4	0	0	0	0	0
Ctrl	C	1	0	0	0	0	0
Ctrl	C	2	0	0	0	0	0
Ctrl	C	3	0	0	0	0	0
Ctrl	C	4	0	0	0	0	0
Mean			0.0	0.0	0.2	0.0	0.0
Std Dev			0.0	0.0	0.4	0.0	0.0
P-1X	A	1	0	0	0	1	0
P-1X	A	2	0	0	0	0	0
P-1X	A	3	0	0	0	1	0
P-1X	A	4	0	0	0	0	0
P-1X	B	1	0	0	0	0	0
P-1X	B	2	0	0	0	1	0
P-1X	B	3	0	0	0	0	0
P-1X	B	4	0	0	1	0	0
P-1X	C	1	0	0	0	0	0
P-1X	C	2	0	0	0	0	0
P-1X	C	3	0	0	0	0	0
P-1X	C	4	0	0	0	0	0
Mean			0.0	0.0	0.1	0.3	0.0
Std Dev			0.0	0.0	0.3	0.5	0.0
P-2X	A	1	0	0	0	.	.
P-2X	A	2	0	0	1	1	0
P-2X	A	3	0	0	0	1	0
P-2X	A	4	0	0	0	0	0
P-2X	B	1	0	0	0	1	0
P-2X	B	2	0	0	0	1	0
P-2X	B	3	0	0	1	1	0
P-2X	B	4	0	0	0	1	0
P-2X	C	1	0	0	0	1	0
P-2X	C	2	0	0	0	1	0
P-2X	C	3	0	0	0	0	0
P-2X	C	4	0	0	0	0	0
Mean			0.0	0.0	0.2	0.7	0.0
Std Dev			0.0	0.0	0.4	0.5	0.0
P-4X	A	1	0	0	0	0	0
P-4X	A	2	0	0	1	1	0
P-4X	A	3	0	0	0	0	0
P-4X	A	4	0	0	0	0	0
P-4X	B	1	0	0	0	0	0
P-4X	B	2	0	0	0	1	0
P-4X	B	3	0	0	0	1	0
P-4X	B	4	0	0	0	0	0
P-4X	C	1	0	0	0	0	0
P-4X	C	2	0	0	0	0	0
P-4X	C	3	0	0	0	0	0
P-4X	C	4	0	0	0	0	0
Mean			0.0	0.0	0.1	0.3	0.0
Std Dev			0.0	0.0	0.3	0.5	0.0

**NOTE: DEFINE MEASUREMENT OF PHYTOTOXICITY, OR INDEX OF INJURY (0=NO INJURY, 10=COMPLETE KILL)  
See Table 2**

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TRIAL:	1
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### IR-4 ORNAMENTAL DATA REPORTING FORM

#### APPENDIX C: PHTOTOXICITY REPORT FORM: Plant Height (cm)

Helenium			5/9/2004	5/18/2004	5/25/2004	6/8/2004	6/21/2004
Rate	Block	Rep	Height(cm)	Height(cm)	Height(cm)	Height(cm)	Height(cm)
Ctrl	A	1	13.5	14.0	13.5	22.5	37.0
Ctrl	A	2	13.0	15.0	18.0	27.5	40
Ctrl	A	3	11.0	13.0	13.0	13.0	26.5
Ctrl	A	4	9.0	11.0	11.0	12.0	15.5
Ctrl	B	1	11.5	13.5	12.5	13.0	23
Ctrl	B	2	13.0	14.5	15.0	14.5	20.5
Ctrl	B	3	14.5	14.5	16.0	15.5	28.5
Ctrl	B	4	10.5	12.0	11.0	21.0	33
Ctrl	C	1	12.5	18.0	22.5	33.0	51.5
Ctrl	C	2	14.5	21.0	21.5	37.0	53.5
Ctrl	C	3	14.5	14.0	17.0	15.0	26.0
Ctrl	C	4	11.5	11.5	15.0	13.0	28
Mean			12.4	14.3	15.5	19.8	31.9
Std Dev			1.8	2.8	3.7	8.6	11.7
P-1X	A	1	14.0	14.0	15.5	22.5	35.5
P-1X	A	2	11.5	11.0	14.5	18.5	30
P-1X	A	3	13.5	14.0	13.0	15.0	24.5
P-1X	A	4	15.0	18.0	26.0	38.0	45.0
P-1X	B	1	13.0	13.5	17.0	27.0	45.5
P-1X	B	2	9.0	10.0	10.0	11.0	22.0
P-1X	B	3	11.0	10.0	12.0	14.0	26.5
P-1X	B	4	12.0	10.0	14.0	13.0	24.0
P-1X	C	1	13.0	14.5	16.0	26.0	40.5
P-1X	C	2	12.0	14.0	14.5	14.0	17
P-1X	C	3	12.0	14.5	12.0	27.0	41.0
P-1X	C	4	11.0	16.0	20.5	33.0	57.5
Mean			12.3	13.3	15.4	21.6	34.1
Std Dev			1.6	2.6	4.3	8.7	12.0
P-2X	A	1	14.5	14.0	13.0		
P-2X	A	2	10.5	11.0	10.5	13.0	24
P-2X	A	3	12.0	11.0	12.0	13.5	22.0
P-2X	A	4	12.0	11.5	10.0	14.0	23.0
P-2X	B	1	12.0	11.0	15.0	25.5	44.0
P-2X	B	2	13.0	13.5	17.0	14.0	19.0
P-2X	B	3	16.0	19.0	17.0	17.0	24.0
P-2X	B	4	14.0	14.0	13.0	14.5	25
P-2X	C	1	13.0	13.0	15.0	21.5	38
P-2X	C	2	13.5	18.0	22.0	38.0	53.5
P-2X	C	3	13.0	13.0	15.0	12.5	14.5
P-2X	C	4	11.0	12.5	12.0	21.0	36
Mean			12.9	13.5	14.3	18.6	29.4
Std Dev			1.5	2.6	3.3	7.7	11.9
P-4X	A	1	12.0	11.5	9.5	12.5	19.5
P-4X	A	2	12.0	12.0	12.0	12.0	22.5
P-4X	A	3	10.5	11.0	10.0	11.0	17.0
P-4X	A	4	10.0	11.0	8.5	14.0	25
P-4X	B	1	15.5	17.0	18.5	26.5	41
P-4X	B	2	10.5	10.5	11.5	22.0	42.0
P-4X	B	3	14.5	15.0	15.0	15.0	32
P-4X	B	4	11.0	13.0	11.5	12.5	23.0
P-4X	C	1	15.0	28.0	19.5	35.0	51.5
P-4X	C	2	11.0	12.5	12.5	12.5	10.0
P-4X	C	3	10.5	12.5	15.0	27.5	44.0
P-4X	C	4	16.0	23.0	30.0	44.0	54
Mean			12.4	14.8	14.5	20.4	31.8
Std Dev			2.2	5.4	6.0	10.8	14.4

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### IR-4 ORNAMENTAL DATA REPORTING FORM

#### APPENDIX D: PHTOTOXICITY REPORT FORM: Plant Width (cm)

Helenium			5/9/2004	5/18/2004	5/25/2004	6/8/2004	6/8/2004	6/21/2004	6/21/2004
Rate	Block	Rep	Width(cm)	Width(cm)	Width(cm)	Width(cm)	Width(cm)	Width(cm)	Width(cm)
Ctrl	A	1	20.0	27.5	24.5	24.5	23.5	26.5	22.0
Ctrl	A	2	21.0	28.0	25.0	27.5	23.0	27	28
Ctrl	A	3	18.5	24.5	24.0	20.0	20.0	28.0	28.0
Ctrl	A	4	18.5	24.0	25.0	22.0	22.5	23	23.5
Ctrl	B	1	20.0	23.5	18.5	24.0	22.0	26	23.5
Ctrl	B	2	19.5	24.5	25.0	21.0	20.5	25	24.5
Ctrl	B	3	21.0	27.5	28.0	24.0	22.0	29.5	30.5
Ctrl	B	4	19.5	26.0	19.0	19.0	23.0	22	22
Ctrl	C	1	17.5	25.5	21.0	21.5	24.0	26	23
Ctrl	C	2	20.5	29.5	25.0	23.0	27.5	28.5	24
Ctrl	C	3	21.5	27.0	23.0	23.5	22.0	25.0	28.0
Ctrl	C	4	21.5	27.5	27.0	25.0	22.5	28	26
Mean			19.9	26.3	23.8	22.9	22.7	26.2	25.3
Std Dev			1.3	1.9	2.9	2.4	1.9	2.2	2.8
P-1X	A	1	22.0	25.0	28.5	23.0	24.0	23.0	27.0
P-1X	A	2	20.5	25.0	26.0	26.5	22.0	27	29
P-1X	A	3	24.0	28.0	24.0	23.5	23.0	25.5	28
P-1X	A	4	23.0	26.0	19.0	25.0	22.5	23.0	19.5
P-1X	B	1	24.0	29.0	28.0	23.0	22.5	27	26
P-1X	B	2	17.5	25.5	17.0	22.5	17.0	27.0	22.0
P-1X	B	3	19.0	24.0	20.5	21.0	22.0	25.0	25.0
P-1X	B	4	19.5	26.5	27.0	24.0	23.0	27.0	26.0
P-1X	C	1	23.0	25.5	26.5	24.0	26.0	28.0	24.0
P-1X	C	2	22.5	27.0	22.0	22.0	21.5	24	24
P-1X	C	3	22.5	28.0	21.0	25.0	24.0	27.0	26.0
P-1X	C	4	21.5	28.0	27.5	23.0	21.0	20.0	22.5
Mean			21.6	26.5	23.9	23.5	22.4	25.3	24.9
Std Dev			2.1	1.5	3.9	1.5	2.2	2.4	2.7
P-2X	A	1	21.5	27.0	20.5				
P-2X	A	2	20.5	26.0	22.0	22.0	24.5	28	24
P-2X	A	3	20.5	28.0	25.0	26.5	22.0	26.0	25.0
P-2X	A	4	21.0	24.0	23.0	21.0	19.5	24.0	21.0
P-2X	B	1	19.5	26.5	19.5	24.5	20.0	26.0	27.0
P-2X	B	2	22.0	29.0	27.5	25.0	25.0	26.0	25.5
P-2X	B	3	21.5	29.5	30.0	22.0	23.0	26.0	27.0
P-2X	B	4	25.0	30.0	23.0	25.0	25.0	25	28
P-2X	C	1	21.0	27.5	23.0	21.5	21.0	28.5	27
P-2X	C	2	20.5	25.5	25.5	22.0	21.0	20.5	23
P-2X	C	3	23.0	24.5	26.0	20.5	21.0	22.5	22.5
P-2X	C	4	19.5	27.0	26.5	21.0	22.0	26	24
Mean			21.3	27.0	24.3	22.8	22.2	25.3	24.9
Std Dev			1.5	1.9	3.0	2.0	2.0	2.3	2.2
P-4X	A	1	20.5	25.0	22.5	20.0	21.0	23.5	21
P-4X	A	2	20.0	27.5	25.0	22.0	21.5	23.5	24.0
P-4X	A	3	19.5	25.5	23.0	25.0	20.0	24.0	23.0
P-4X	A	4	23.5	26.5	23.5	24.0	24.0	27	28
P-4X	B	1	23.5	29.0	22.5	26.5	25.0	25	26
P-4X	B	2	19.5	24.5	27.0	19.5	20.0	19.0	22.0
P-4X	B	3	21.5	29.0	29.0	25.5	23.0	26	29
P-4X	B	4	19.0	24.0	19.5	23.0	20.5	22.0	21.0
P-4X	C	1	21.0	27.0	23.0	25.0	23.0	26.5	27.5
P-4X	C	2	22.0	26.5	21.0	21.5	17.0	24.0	25.0
P-4X	C	3	21.5	26.0	19.5	23.5	19.0	24.0	24.0
P-4X	C	4	22.5	27.0	29.0	21.0	24.0	21	27
Mean			21.2	26.5	23.7	23.0	21.5	23.8	24.8
Std Dev			1.5	1.6	3.2	2.3	2.4	2.3	2.7