Environmental Horticulture Program Research Summaries

IR-4 Environmental Horticulture Program
Bittercress Efficacy

Cardamine flexuosa
Cardamine hirsuta

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Abstract

Nursery growers have had a longstanding battle to control weeds in environmental horticulture crops. Bittercress (*Cardamine* spp.) is one of the most difficult weeds to control in container grown ornamentals. It grows aggressively in containers and can outcompete ornamental crops for water, nutrients, and light. Several chemical tools are available for preemergent control. However, there remains a need for effective control of emerged weed seedlings. At the 2007 Environmental Horticulture Workshop, IR-4 initiated a study to determine whether preemergent herbicides could provide efficacy for bittercress, and other weeds, up to the 2-4 leaf stage. Research was conducted from 2008 through 2019. This report is a brief summary of available data from 18 experiments received through the IR-4 Environmental Horticulture Program. Early postemergence applications of Casoron, Certainty, Gallery, Marengo/Indaziflam, and V-10142 provided significant control of emerged bittercress. These findings benefit growers by identifying select preemergence herbicides which control specific weeds at early emergence stages in container grown ornamental horticulture crops.

Introduction

Nursery growers have had a longstanding battle to control weeds in environmental horticulture crops. Bittercress (*Cardamine* sp.) is one of the most difficult weeds to control in container grown ornamentals. It grows aggressively in containers and can outcompete ornamental crops for water, nutrients, and light. Several chemical tools are available for preemergent control. However, there remains a need for effective control of emerged weed seedlings. At the 2007 Environmental Horticulture Workshop, IR-4 initiated a study to determine whether preemergent herbicides could provide efficacy for bittercress, and other weeds, up to the 2-4 leaf stage. Research was conducted from 2008 through 2019.

Materials and Methods

Between 2008 and 2019, several products were tested as preemergence or over-the-top foliar applications against bittercress. In many experiments, researchers also included other important weeds although this report is a summary of bittercress data. A minimum of 4 plants (replicate treatments) were required with many researchers exceeding this minimum. Evaluations of percent cover and percent control were estimated at various intervals after treatment. For more detailed materials and methods, please see Appendix 1: Protocols and Appendix 3: Research Reports. For IR-4 2018 and 2019 testing, the following protocols were used: 18-019 and 19-019. Please visit https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols to view and download these protocols.

Products were supplied to researchers (See list of researchers in Appendix 1) by their respective manufacturers.

For all research data tables, product names have been updated where manufacturers have established trade names and tables have been rearranged by product alphanumeric order.

Table 1. List of Products and Rates Tested from 2008 to 2019.

Product [1]	Active Ingredient(s)	Manufacturer	Rate(s) Tested/Acre	
			Pounds Active Ingredient	Product
Basagran	bentazon	BASF	0.75	24 fl oz
			1.0	32 fl oz
Biathlon	Oxyfluorfen + prodiamine	OHP	2.75	100 lb
			5.5	200 lb
			11.0	400 lb
Broadstar 0.25G original formulation	flumioxazin	Valent	0.19	75 lb
			0.375	150 lb
			0.75	300 lb
Broadstar VC1604 0.25G	flumioxazin	Valent	0.19	75 lb
			0.38	150 lb
Casoron 4G	dichlobenil	Chemtura Corp.	1.0	25 lb
			2.0	50 lb
Certainty	sulfosulfuron	Valent	0.035	0.75 oz
			0.094	2.0 oz
Dismiss 4F	sulfentrazone	FMC	0.25	8 fl oz
			0.375	12 fl oz
EXC3898 2.1G	mesotrione + prodiamine + s-metolachlor	Syngenta	2.10	100 lb
			3.15	150 lb
Fiesta	iron HEDTA	Neudorff		25/1 ksf
				50/1 ksf
FreeHand 1.75G	pendimethalin + dimethenamid-p	BASF	2.6	150 lb
			5.25	300 lb
			10.5	600 lb
Gallery 75DF	isoxaben	Dow AgroSciences	1.0	1.33 lb
HGH-63 2G	oxyfluorfen	Harrold's	1.0	50 lb
			2.0	100 lb
Indaziflam	indaziflam	Bayer	50 g/ha	150 lb
			100 g/ha	300 lb
Marengo 0.622SC	indaziflam	Bayer	0.04	9 fl oz
Rout	oxyfluorfen + oryzalin	Scotts	3	100 lb
Tower 6.0EC (BAS 656h EC)	dimethenamid-p	BASF	0.97	21 fl oz
			1.5	32 fl oz
			1.94	42 fl oz
			3.0	64 fl oz
V-10142	imazosulfuron	Valent	0.375	75 lb
			0.75	150 lb

[1] In some cases surfactant such as crop oil concentrate (COC) or non-ionic surfactant (NIS) were used and noted in individual experiments.

Results and Summary

Comparative Efficacy on Bittercress

Thirteen experiments were conducted on bittercress from 2008 to 2019. Some researchers conducted the experiments within greenhouses; others held weeds in containers outdoors. For this summary, commercial or acceptable weed control is defined as >70% efficacy as to be expected. Products varied in efficacy depending on the stage treated (See Table 2). The summary table below lists the number of trials where commercial control was observed in at least one evaluation compared to the total number of trials.

Stage 0: In general, most treatments demonstrated an effect on bittercress when applied at Stage 0 or prior to emergence with the exception of Casoron, HGH-63 and Tower which were only evaluated in limited experiments and did not demonstrate effective control at this stage of growth.

Stage 1: Certainty, EXC3898, Gallery 75 DF, and V-10142 consistently provided effective postemergence bittercress control when applied in the early stages of growth. EXC3898 applied at 2.10 to 3.15 lb ai/A delivered commercially acceptable control of greater than 70% for both rates; however, this product will not be registered. In a single trial Indaziflam/Marengo provided very effective control at this stage (Table 19, Table 20). Casoron was tested by two researchers at Stage 1 but was ineffective in controlling bittercress at this stage (Table 17, Table 18). Tower treatments were significantly different from the untreated but not at commercially acceptable levels of control. Neither formulation of Broadstar, 0.25G or VC1604, at 0.19 and 0.375 lb ai/A or either rate of HGH-63 provided consistent control of bittercress.

Stage 2: Only Certainty, Gallery 75 DF, EXC3898, and V-10142 consistently provided effective postemergence bittercress control across trials when applied at the 2 to 4 leaf growth stage. Dismiss, Fiesta and Marengo provided effective control in single trials when applied at this stage. Broadstar VC1604 at 0.375 controlled bittercress in three of eight experiments at this stage while the 0.25G formulation provided no control at this stage. Casoron, HGH-63, indaziflam and Tower showed no significant impact on bittercress at Stage 2.

Table 2. General Summary of Early Postemergence Efficacy for Bittercress.

Product (active)	Rate (lb ai/A)	Number of Experiments with Acceptable Control (>70%)		
		Stage 0: Preemergence	Stage 1: Cotyledon to 1 Leaf	Stage 2: 2 to 4 Leaves
Basagran T&O 4F (bentazon)	0.75	-	0 of 1	1 of 1
	1.0	-	1 of 1	1 of 1
Broadstar 0.25G (flumioxazin)	0.19	1 of 1	0 of 1	0 of 1
	0.375	1 of 1	1 of 1	0 of 1
Broadstar VC1604 0.25G	0.19	4 of 6[1]	1 of 8	0 of 8
	0.375	5 of 6	2 of 8	3 of 8
Casoron 4 G (dichlobenil)	1.0	0 of 1	0 of 2	0 of 2
	2.0	0 of 1	0 of 2	0 of 2
Casoron 1.4 CS (dichlobenil)	1.0	0 of 1	---	0 of 1
Certainty (sulfosulfuron)	0.035	---	2 of 2	2 of 2
	0.094	---	2 of 2	2 of 2
Dismiss 4F (sulfentrazone)	0.25	-	0 of 1	1 of 1
	0.375	-	1 of 1	1 of 1
EXC3898 (mesotrione + prodiamine + s-metolachlor)	2.1	6 of 6	6 of 6	4 of 6
	3.15	6 of 6	5 of 6	4 of 6
Fiesta (Iron HEDTA)	25/1 ksf	-	0 of 1	1 of 1
	50/1 ksf	-	1 of 1	1 of 1
Gallery 75 DF (isoxaben)	0.5	1 of 1	1 of 1	0 of 1
	1.0	2 of 2	4 of 4	3 of 4
HGH-63 2G (oxyfluorfen)	1.0	0 of 1	0 of 2	0 of 2
	2.0	0 of 1	1 of 3	0 of 3
Indaziflam	50 g/ha	1 of 1	1 of 1	0 of 1
	100 g/ha	1 of 1	1 of 1	0 of 1
Marengo 0.622SC (indaziflam)	0.04	-	1 of 1	1 of 1
Tower EC (dimethenamid-p)	0.97	0 of 2	0 of 4	0 of 4
	1.5	----	0 of 2	0 of 2
	1.94	0 of 2	0 of 2	0 of 2
V-10142 (imazasulfuron)	0.38	7 of 7	7 of 9	7 of 9
	0.75	7 of 7	8 of 9	7 of 9

[1] Highlighted numbers indicate efficacious treatments in the majority (≥ 66%) of the trials where at least two trials were conducted.

Boydston, 2008

In 2008, Boydston at the USDA facility in Prosser, Washington studied whether EXC3898 and V-10142 provided postemergence efficacy for bittercress grown in field containers under shade with overhead irrigation.

In 2008 Boydston found EXC3898 applied preemergent at 2.1 and 3.15 lb ai/A controlled bittercress 97% and 98% 5 WAT, respectively (Table 3). EXC3898 applied to bittercress between the cotyledon to 1 leaf stage at 2.1 and 3.15 lb ai/A controlled bittercress 76 and 97% 4 WAT, respectively (Table 4). EXC3898 2.1G applied to bittercress between the 2 to 4 leaf stage at 2.1 and 3.15 lb ai/A controlled bittercress 88 and 99% 4WAT, respectively.

Although the number of weeds did not differ significantly at Stage 0 and 1 for either rating date for V- 10142 0.5 G (0.375-0.75 lb ai/A) those seedlings that emerged received high ratings for chlorosis and necrosis suggesting good to excellent control of bittercress at all three stages (Table 3, Table 4). At stage 2 both efficacy ratings and weed numbers were significantly different from the untreated.

Table 3. Efficacy of Pre-emergent Herbicides Applied to Bittercress (*Cardamine sp.*) - Stage 0, Boydston, 2008.

	Efficacy Rating[1]		Number of Weeds per pot[2]	
Product - Rate (lb ai/A)	**3 WAT[3]**	**5 WAT**	**3 WAT**	**5 WAT**
Preemergent				
EXC3998 - 2.1	91.67 a	97.00 a	25.33 a	5.00 b
EXC3898 - 3.15	91.67 a	98.00 a	17.33 a	4.67 b
Untreated Check	0.00 a	0.00 b	33.33 a	33.33 a
LSD (P=.05)	5.973	2.267	28.021	5.474
V-10142 - 0.375	16.67 a	80.00 a	40.00 a	69.00 a
V-10142 - 0.75	26.67 a	83.33 a	39.33 a	49.00 a
Untreated Control	0.0 b	0.0 b	41.00 a	55.33 a
LSD (P=.05)	38.893	24.336	55.270	47.838

[1]Efficacy Rating: stunting and chlorosis, 0= live plant, 100= dead
[2]No significant difference in number of live plants per pot on Day of Application
[3] WAT = weeks after treatment

Table 4. Efficacy of Pre-emergent Herbicides for Stages 1 and 2 Bittercress (*Cardamine hirsuta*), Boydston, 2008.

	Efficacy Rating[1]		Number of Weeds per pot[2]	
Product Rate (lb ai/A)	**2 WAT[3]**	**4 WAT**	**0 WAT**	**4 WAT**
Cotyledon to one leaf stage				
EXC3898 - 2.1	78.33 b	75.67 a	21.00 b	9.67 b
EXC3898 - 3.15	96.67 a	96.67 a	28.00 ab	2.67 b
Untreated Check	0.00 c	0.00 b	33.33 a	31.67 a
LSD (P=.05)	15.567	24.212	7.996	8.730
V-10142 - 0.375	83.33 a	91.67 a	56.67 a	23.67 a
V-10142 - 0.75	88.33 a	90.00 a	50.67 a	27.00 a
Untreated Control	0.00 b	0.00 b	41.00 a	49.00 a
LSD (P=.05)	11.014	13.621	28.077	20.746
Two to four leaf stage				
EXC3898 - 2.1	66.67 a	88.33 a	19.00 a	6.67 b
EXC3898 - 3.15	81.67 a	99.33 a	12.00 a	2.00 b
Untreated Check	0.00 b	0.00 b	33.33 a	31.67 a
LSD (P=.05)	51.033	21.356		8.811
V-10142 - 0.375	93.33 a	94.67 a	37.67 b	12.67 b
V-10142 - 0.75	95.67 a	98.33 a	30.33 b	3.00 b
Untreated Control	0.00 b	0.00 b	55.33 a	49.00 a
LSD (P=.05)	*4.7*	*6.477*	*16.673*	*16.38*

[1]Efficacy Rating: 0= live plant, 100= dead
[2]No significant difference in number of live plants per pot on Day of Application
[3] WAT = weeks after treatment

Gilliam, 2008

Gilliam, in 2008, compared the impact of Broadstar VC1604 0.25G, EXC3898 G, and V-10142 G to Gallery for postemergent control of bittercress. This experiment was conducted in the Auburn University greenhouse located in Auburn, AL. Overhead sprinklers were the source of irrigation.

Stage 0: No bittercress was present at 7 or 14 DAT in any containers. At the 21 DAT evaluation the mean weed numbers remained low in all treated containers (Table 5). Bittercress was observed only in pots receiving Broadstar VC1604 at 0.19 lb ai or V-10142 at 0.75 lb ai/A (0.1 weeds/pot for each treatment). Untreated control containers had a mean weed number of 5.1.

Stage 1: EXC3898 G at 3.15 lb ai/A, Gallery (1.0 lb ai/A) and V-10142 G (0.375 and 0.75 lb ai/A) provided good to excellent control throughout the experiment. There was no injury to bittercress treated with Broadstar VC1604 G at 7 DAT. Plants treated with the high rate of Broadstar VC 1604 (0.375 lb ai/A) demonstrated injury but not at a commercially acceptable level.

All treated bittercress, except those treated with Broadstar VC1604 at the lower rate, had significantly less fresh weed weights than that of the non-treated control group (15.9 g vs. 17.9 g). Other fresh weights ranged from 0.0 g, for plants receiving V-10142 at the higher rate, to

11.6 g for bittercress treated with Broadstar VC1604 at 0.38 lb ai/A.

Stage 2: Excellent control of seedlings with 2 to 4 leaves was observed with the high rate of EXC 3898, Gallery and both rates of V-10142. Bittercress receiving Broadstar VC1604 at the lower rate (0.19 lb ai/A) fully recovered by 14 DAT and exhibited no injury symptoms for the rest of the study. Damage to weeds treated with Broadstar VC1604 at 0.375 lb ai/A was greater but did not reach an acceptable level of control during the evaluation period.

Fresh weed weights for all treated containers were significantly smaller than that of the non-treated control group (15.4 g). Containers treated with Gallery, EXC3898, and V-10142 had mean weights less than 3.0 g. Fresh weed weights ranged from 0.0g for pots treated with either rate of V-10142 to 12.0 g for containers receiving Broadstar VC1604 at 0.19 lb ai/A.

Table 5. Efficacy of Pre-emergent Herbicides for Bittercress (*Cardamine* sp.), Gilliam, 2008.

Product - Rate (lb ai/A)	Number of emerged weeds or Efficacy			Fresh Weights[2]
	7 DAT[3]	14 DAT	21 DAT	21 DAT
Preemergent **Number of emerged weeds**				
Broadstar VC1604 - 0.19	0.0 a[4]	0.0 a	0.1 b	0.0 b
Broadstar VC1604 - 0.375	0.0 a	0.0 a	0.0 b	0.0 b
EXC3898 - 2.1	0.0 a	0.0 a	0.0 b	0.0 b
EXC3898 - 3.15	0.0 a	0.0 a	0.0 b	0.0 b
V-10142 - 0.375	0.0 a	0.0 a	0.1 b	0.0 b
V-10142 - 0.75	0.0 a	0.0 a	0.0 b	0.0 b
Gallery - 1.0	0.0 a	0.0 a	0.0 b	0.0 b
Untreated Control	0.0 a	0.0 a	5.1 a	4.1 a
Cotyledon to one leaf stage **Efficacy Rating[1]**				
Broadstar VC1604 - 0.19	1.0 d	1.0 d	1.0 e	15.9 a
Broadstar VC1604 - 0.375	1.1 d	3.6 c	6.7 d	11.6 b
EXC3898 - 2.1	6.0 c	6.8 b	7.9 c	7.5 c
EXC3898 - 3.15	6.8 b	7.2 b	8.4 bc	5.8 c
V-10142 - 0.375	7.1 b	8.4 ab	9.1 ab	1.8 d
V-10142 - 0.75	7.0 b	9.4 a	10.0 a	0.0 d
Gallery – 1.0	8.4 a	9.9 a	10.0 a	0.6 d
Untreated Control	1.0 d	1.0 d	1.0 e	17.9 a
Two to four leaf stage **Efficacy Rating[1]**				
Broadstar VC1604 - 0.19	1.8 e	1.0 d	1.0 d	12.0 b
Broadstar VC1604 - 0.375	2.9 d	4.6 c	5.2 c	8.4 c
EXC3898 - 2.1	6.4 c	7.1 b	7.9 b	3.0 d
EXC3898 - 3.15	7.6 b	8.8 a	9.7 a	1.9 de
V-10142 - 0.375	8.0 ab	9.0 a	10.0 a	0.0 e
V-10142 - 0.75	8.0 ab	8.9 a	10.0 a	0.0 e
Gallery - 1.0	8.4 a	8.9 a	10.0 a	0.07 de
Untreated Control	1.0 f	1.0 d	1.0 d	15.4 a

[1] Plant injury ratings on scale of 1 to 10. 1 = no injury, 10 = dead
[2] Fresh weights measured in grams.
[3] DAT = Days after treatment
[4] Means separated using Duncan's Multiple Range Test at p = 0.05

Neal, 2008

In North Carolina, Neal initiated two field container experiments in 2008. The summer experiment had poor germination of bittercress and significant insect feeding which reduced data quality. Only data from the fall experiment are presented in this report although comments are included from both the summer and fall experiments.

Stage 0: In the summer experiment, the original and new formulations of flumioxazin provided preemergence control of bittercress. Control was greater when applied at the higher dose. In the repeat of the experiment in the fall, all treatments provided effective control of bittercress when applied preemergently.

Stage 1: Significant differences between treatments were observed when applied at early postemergence in the fall (Table 7). EXC3898, the high dose of Broadstar 0.25G and V-10142 controlled bittercress effectively through 12 WAT. Broadstar 0.25G at 0.19 lb ai/A and either rate of Broadstar VC1604 did not provide postemergent control of bittercress.

Stage 2: The two to four leaf stage was evaluated through 6 WAT. Broadstar VC1604 was not included in this evaluation. Bittercress at the 2 to four leaf stage was injured by V-10142 and by EXC3898 (Table 7). The high rate of Broadstar 0.25G provided some control (64%) of bittercress at this growth stage but the new formulation (VC1604 at 0.375 lb ai/A) did not demonstrate adequate efficacy.

In summary, commercial control of emerged bittercress was achieved by V-10142, EXC3898 and the high rate of Broadstar 0.25G, but not by Broadstar VC1604.

Table 6. Efficacy of Pre-emergent Herbicides for Bittercress (*Cardamine flexuosa*) – Stage 0, Neal, 2008

Product – Rate (lb ai/A)	Efficacy Rating[1]			
	8 WAT[3]	12 WAT	14 WAT	18 WAT
Preemergent				
Broadstar 0.25G - 0.19	10.0 a	10.0 a	10.0 a	10.0 a
Broadstar 0.25G - 0.375	10.0 a	10.0 a	10.0 a	10.0 a
Broadstar VC1604 0.25G - 0.19	9.0 ab	9.0 a	8.6 a	9.2 a
Broadstar VC1604 0.25G - 0.375	10.0 a	10.0 a	10.0 a	10.0 a
EXC3898 - 2.1	8.5 b	8.4 a	8.0 a	8.0 b
EXC3898 - 3.15	9.9 a	10.0 a	10.0 a	9.8 a
V-10142 0.5G - 0.375	9.8 a	10.0 a	10.0 a	9.9 a
V-10142 0.5G - 0.75	9.8 a	10.0 a	10.0 a	10.0 a
Untreated Control	0.0 c	0.0 b	0.0 b	0.0 c

[1] Efficacy was rated on a scale of 0 to 10 with 0 being no control and 10 being 100 percent.

Table 7. Efficacy of Pre-emergent Herbicides for Emerged Bittercress (*Cardamine flexuosa*) – Stages 1 and 2, Neal, 2008

Product – Rate (lb ai/A)	Efficacy Rating[1]			
	2 WAT	6 WAT	8 WAT	12 WAT
One leaf stage				
Broadstar 0.25G - 0.19 lb ai/A	1.0 d	4.0 c	4.4 b	5.9 c
Broadstar 0.25G - 0.375 lb ai/A	3.8 c	6.4 b	7.9 a	9.2 ab
Broadstar VC1604 0.25G - 0.19 lb ai/A	0.0 d	0.6 d	0.8 c	0.6 d
Broadstar VC1604 0.25G - 0.375 lb ai/A	1.0 d	0.8 d	2.0 c	3.8 c
EXC3898 - 2.1 lb ai/A	5.0 bc	8.4 a	9.2 a	8.8 ab
EXC3898 - 3.15 lb ai/A	5.6 b	10.0 a	10.0 a	10.0 a
V-10142 0.5G - 0.375 lb ai/A	4.6 bc	4.8 bc	7.6 a	7.6 ab
V-10142 0.5G - 0.75 lb ai/A	7.0 a	9.2 a	9.7 a	9.6 a
Untreated Control	0.0 d	0.0 d	0.0 c	0.0 d
Two to Four leaf stage				
Broadstar 0.25G - 0.19 lb ai/A	0.0 a	2.4 c		
Broadstar 0.25G - 0.375 lb ai/A	1.2 a	6.4 b		
Broadstar VC1604 0.25G - 0.19 lb ai/A	---	---		
Broadstar VC1604 0.25G - 0.375 lb ai/A	0.0 a	0.8 cd		
EXC3898 - 2.1 lb ai/A	0.4 a	7.2 ab		
EXC3898 - 3.15 lb ai/A	0.2 a	8.8 a		
V-10142 0.5G - 0.375 lb ai/A	1.9 a	9.4 a		
V-10142 0.5G - 0.75 lb ai/A	0.6 a	9.4 a		
Untreated Control	0.0 a	0.0 d		

LSD (P=0.05)

[1] Efficacy was rated on a scale of 0 to 10 with 0 being no control and 10 being 100 percent.

Regan, 2008

In 2008, Regan conducted research in Aurora, Oregon using field containers with overhead irrigation. This experiment evaluated Broadstar VC1604 0.25G, EXC3898 G, and V-10142 for postemergent efficacy on bittercress.

EXC3898 and V-10142 G were effective tools for early postemergent control of bittercress (*Cardamine hirsute*). These two herbicides were generally effective at all three stages of early weed growth. Broadstar VC1604 was the least effective herbicide showing poor or no control of the three weed species evaluated (Table 9).

Stage 0: The EXC3898 and V-10142 G treatments were very effective in preventing germination of bittercress at both rates. The higher rate of Broadstar VC1604 significantly reduced the germination rate of bittercress while the lower rate reduced germination by approximately half compared to the control.

Stage 1: The treatments containing both rates of EXC3898 and V-10142 G gave very good to excellent results in controlling weeds at the 1-2 leaf stage. Significant damage to bittercress treated with EXC3898 and V-10142 G was observed only one week after treatment. Broadstar VC1604 at both rates had no effect on 1-2 leaf stage of bittercress.

Stage 2: At the 2-4 leaf stage bittercress was controlled by both EXC3898 and V-10142 G at a similar level when compared to the 1-2 leaf stage. Broadstar VC1604 was only slightly effective in controlling bittercress at the higher rate.

Table 8. Efficacy of Pre-emergent Herbicides for Bittercress (*Cardamine hirsuta*) – Stage 0, Regan 2008.

Product - Rate (lb ai/A)	Percent Germination
	4 WAT
Broadstar VC1604 - 0.19	28.0 c[1]
Broadstar VC1604 - 0.375	9.0 b
EXC3898 - 2.1	0.0 a
EXC3898 - 3.15	0.0 a
V-10142 - 0.375	0.0 a
V-10142 - 0.75	0.0 a
Untreated Control	51.5 d

[1] Column mean numbers followed by the same letter are not significantly different.

Table 9. Efficacy of Pre-emergent Herbicides for Emerged Bittercress (*Cardamine hirsuta*) – Stages 1 and 2, Regan 2008.

Product - Rate (lb ai/A)	Efficacy Rating		
	1 WAT	2 WAT	3 WAT
One to two leaf stage			
Broadstar VC1604 - 0.19	0.0 a[1]	0.0 a	0.0 a
Broadstar VC1604 - 0.375	0.0 a	0.0 a	0.0 a
EXC3898 - 2.1	7.3 c	8.7 d	8.7 d
EXC3898 - 3.15	7.5 c	7.9 c	7.9 c
V-10142 - 0.375	4.3 b	5.1 b	5.1 b
V-10142 - 0.75	9.7d	9.7 e	9.7 e
Untreated Control	0.0 a	0.0 a	0.0 a
Two to four leaf stage			
Broadstar VC1604 - 0.19	0.0 a	0.0 a	0.0 a
Broadstar VC1604 - 0.375	1.2 b	1.7 b	1.7 b
EXC3898 - 2.1	6.9 c	7.9 d	7.9 cd
EXC3898 - 3.15	7.7 c	8.7 de	8.7 de
V-10142 - 0.375	6.7 c	7.5 c	7.5 c
V-10142 - 0.75	9.2 d	9.8 e	9.8e
Untreated Control	0.0 a	0.0 a	0.0 a

[1] Column mean numbers followed by the same letter are not significantly different.

Senesac, 2008

During 2008, Senesac tested the impact of Broadstar VC1604, EXC3898, and V-10142 for postemergent control of bittercress at the Long Island Horticulture Research and Extension Center. This experiment was conducted in a greenhouse without temperature controls; weeds were misted hourly during daylight hours.

Broadstar VC1604 (0.375 and 0.75 lb ai/A) yielded 70% or greater weed control, at the first and third timing (Table 10.) EXC3898 was generally more effective providing commercial weed control when applied preemergent or at the cotyledon to 1-leaf stage but not at the 2-4 leaf stage (Table 11). V-10142 generally yielded 70% or greater control of bittercress at 2, 3, and 5 WAT (Table 12).

Table 10. Efficacy of Broadstar VC1604 for Emerged Bittercress (*Cardamine hirsuta)* – Senesac, 2008.

Product - Rate (lb ai/A)	Efficacy Rating			
	1 WAT	2 WAT	3 WAT	5 WAT
Preemergent				
Broadstar VC1604 - 0.190	--	33	40	50
Broadstar VC1604 - 0.375	--	77	83	93
Broadstar VC1604 - 0.75	--	87	90	100
Untreated	--	0	0	0
Cotyledon to one leaf stage				
Broadstar VC1604 - 0.190	13	13	13	5
Broadstar VC1604 - 0.375	20	27	20	27
Broadstar VC1604 - 0.75	37	50	60	53
Untreated	0	0	0	0
Two to four leaf stage				
Broadstar VC1604 - 0.190	23	57	50	
Broadstar VC1604 - 0.375	37	70	73	
Broadstar VC1604 – 0.75	40	77	73	
Untreated	0	0	0	
Fisher's LSD@ 0.05	16	26	27	17

Table 11. Efficacy of EXC3898 for Emerged Bittercress (*Cardamine hirsuta*), Senesac, 2008.

Product	Rate (lb ai/A)	Efficacy Rating			
		1 WAT	2 WAT	3 WAT	5 WAT
Preemergent					
EXC3898	2.10	--	80	77	87
EXC3898	3.15	--	70	67	83
EXC3898	4.20	--	80	87	87
Untreated		--	00	0	0
Cotyledon to one leaf stage					
EXC3898	2.10	40	63	87	70
EXC3898	3.15	40	40	27	17
EXC3898	4.20	53	70	67	53
Untreated		0	0	0	0
Two to four leaf stage					
EXC3898	2.10	27	57	57	
EXC3898	3.15	23	40	53	
EXC3898	4.20	23	47	67	
Untreated		0	0	0	
Fisher's LSD@ 0.05		*16*	*30*	*26*	*28*

Table 12. Efficacy of V-10142 for Emerged Bittercress (*Cardamine hirsuta*), Senesac, 2008.

Product - Rate (lb ai/A)	Efficacy Rating			
	1 WAT	2 WAT	3 WAT	5 WAT
Preemergent				
V-10142 - 0.38	--	83	80	90
V-10142 - 0.75	--	87	83	73
V-10142 - 1.50	--	90	87	97
Untreated	--	0	0	0
Cotyledon to one leaf stage				
V-10142 - 0.38	47	63	67	50
V-10142 - 0.75	47	73	77	73
V-10142 - 1.50	47	77	78	77
Untreated	0	0	0	0
Two to four leaf stage				
V-10142 - 0.38	30	73	80	
V-10142 - 0.75	23	67	73	
V-10142 - 1.50	23	80	80	
Untreated	0	0	0	
Fisher's LSD@ 0.05	20	13	14	26

Wilen, 2008

In 2008 Wilen conducted 2 experiments in the Los Angeles region of California examining Broadstar VC1604 0.25G, EXC3898 and V-10142 for postemergent control of hairy bittercress. The first experiment solely tested Stage1 pots which were seeded on 5/15/09 and grown in a temperature controlled greenhouse. The second experiment examined Stage 0 and 2 pots which were seeded on 6/12/09 and grown under shade in an open lath house with overhead irrigation.

Stage 0: All of the treatments reduced cover and provided some control of hairy bittercress when compared to the untreated control during this stage. Throughout stage 0 Broadstar VC1604 applied at a rate of 0.375 lb ai/A proved to be most effective, achieving over 90% control at 3 and 4 WAT. None of the other treatments provided > 80% control although Broadstar VC1604 at 0.19 lb ai/A showed a trend of increasing percent control over time. There was a purple cast to some emerged bittercress plants treated with V-10142.

Stage 1: At 2 WAT and 3 WAT only Broadstar VC1604 at 0.375 lb ai/A provided acceptable reduction in percent cover (i.e. <10%) and adequate percent control (>80%) of hairy bittercress.

Stage 2: None of the treatments proved successful in adequately controlling hairy bittercress at this stage until 40 DAT. As in the Stages 1 and 2, there was an increase in control over time with Broadstar VC1604 which at 0.375 lb ai/A provided at least 80% control of bittercress 40 DAT.

Summary: Overall, only Broadstar VC1604 at 0.375 lb ai/A was acceptable for preemergence and early post-emergence control of hairy bittercress. Increasing application rates of Broadstar VC1604 provided significantly better results during Stage 1 for percent cover 2 WAT and percent control 3 WAT and for Stage 2 for percent control at 2 WAT and percent cover at 3 WAT. Increasing application rates of EXC3898 only provided significantly better results during Stage 1 for percent cover 2 WAT and percent control at 3 and 4 WAT. Increasing application rates of V-10142 did not improve performance at any stage.

Because of space constraints, weed-containing pots could not be held more than 3 WAT for Stage 2 and 40 DAT for Stage 3. However, based on the limited data obtained, there are indications that possibly EXC3898 and more likely Broadstar VC1604 have post-emergence activity but the activity is slow to develop.

Table 13. Efficacy of Pre-emergent Herbicides for Hairy Bittercress (*Cardamine hirsuta)*, Wilen, 2008.

Product - Rate (lb ai/A)	Percent Cover		Percent Control	Percent Cover	Percent Control
	2 WAT	3 WAT	3 WAT	4 WAT	4 WAT
	Preemergent				
Broadstar VC1604 - 0.19	2.17 bc	3.25 ab	75.83 d	3.67 ab	80.83 de
Broadstar VC1604 - 0.375	0.50 a	1.00 a	91.67 e	0.92 a	93.33 e
EXC3898 - 2.10	2.67 c	5.33 b	52.92 b	14.83 c	47.08 b
EXC3898 - 3.15	1.67 b	4.17 ab	75.00 cd	10.58 bc	63.33 c
V-10142 - 0.375	2.17 bc	4.92 b	72.92 cd	4.58 ab	77.92 d
V-10142 - 0.75	2.00 bc	4.17 ab	61.25 bc	7.92 abc	71.25 cd
Untreated Control	4.42 d	19.17 c	0.00 a	42.92 d	0.00 a
Level of significance	***	***	***	***	***

Mean Separation done by LSD at P=0.05
*** P<0.00

Table 14. Efficacy of Pre-emergent Herbicides for Emerged Hairy Bittercress (*Cardamine hirsuta)* – Stage 1, Wilen, 2008.

Product - Rate (lb ai/A)	Percent Cover	Percent Control	Percent Cover	Percent Control	Percent Cover	Percent Control
	1 WAT[3]	1 WAT	2 WAT	2 WAT	3 WAT	3 WAT
	Cotyledon to one leaf stage					
Broadstar VC1604 - 0.19	14.00	0.56	16.67 ab	59.44 c	16.89 b	74.44 de
Broadstar VC1604 - 0.375	9.89	3.33	7.22 a	81.67 d	4.22 a	86.67 e
EXC3898 - 2.10	11.78	0.00	16.44 ab	71.67 cd	14.78 ab	61.67 d
EXC3898 - 3.15	14.44	5.00	12.44 a	72.22 cd	11.11 ab	72.78 d
V-10142 - 0.375	13.11	0.00	26.11 bc	36.11 b	28.89 c	36.11 c
V-10142 - 0.75	13.89	0.00	32.22 c	27.22 b	38.33 cd	16.11 b
Untreated Control	15.56	0.00	48.89 d	0.00 a	49.44 d	0.00 a
Level of Significance	NS	NS	***	***	***	***

Mean Separation done by LSD at P=0.05
*** P<0.00

Table 15. Efficacy of Pre-emergent Herbicides for Emerged Hairy Bittercress (*Cardamine hirsuta)* – Stage 2, Wilen, 2008.

Product - Rate (lb ai/A)	Percent Cover 1 WAT	Percent Control 1 WAT	Percent Cover 2 WAT	Percent Control 2 WAT	Percent Cover 40 DAT	Percent Control 40 DAT
	2 to 4 leaf stage					
Broadstar VC1604 - 0.19	27.08 a	19.17 bc	12.08 ab	53.75 c	7.42 ab	69.25 d
BroadstarVC1604 - 0.375	29.17 ab	22.92 c	7.00 a	69.58 c	1.58 a	91.67 e
EXC3898 - 2.10	36.25 bcd	5.42 a	17.67 b	34.17 b	15.81 bc	42.13 bc
EXC3898 - 3.15	41.25 cd	3.75 a	12.33 ab	52.50 c	14.67 bc	56.25 cd
V-10142 - 0.375	37.92 cd	4.58 a	29.17 c	15.83 a	22.50 cd	41.83 bc
V-10142 - 0.75	33.75 abc	10.42 ab	32.92 c	12.08 a	27.50 d	37.92 b
Untreated Control	43.75 d	0.00 a	35.83 c	0.00 a	46.67 e	0.00 a
Level of Significance	***	***	***	***	***	***

Mean Separation done by LSD at P=0.05
*** P<0.00

Gilliam, 2009

In 2009, Gilliam (AL) conducted 2 greenhouse experiments to evaluate selected herbicides for early postemergence bittercress control at two different stages of growth. Experiment 2 included Casoron.

Experiment 1: Stage 1

At 7 DAT, bittercress treated with HGH-63 (2.0 lb ai/A) and Gallery had more injury than any other treatment. Bittercress treated with HGH-63 (1.0 lb ai/A) along with Certainty, Tower (1.5 lb ai/A), and V- 10142 all had similar injury ratings at 7 DAT, and provided only marginal control. Bittercress treated with Broadstar VC1604 provided the least control of any treatment, and were similar to the non-treated control.

By 28 DAT, Gallery provided the greatest control followed by Certainty and V-10142. The only remaining herbicide treatment not statistically similar to the control was Broadstar VC1604 (0.375 lb ai/A) which only provided minimal damage not sufficient for efficacy.

Fresh weights indicate that Gallery provided excellent control, however, V-10142, and Certainty had similar fresh weights. Fresh weights also show Broadstar VC1604 (0.375 lb ai/A) and Tower (1.5 lb ai/A) had some control (fresh weights of 4.6 and 5.5) while HGH-63 and Tower (0.97 lb ai/A) had little effect on bittercress growth. Bittercress treated with Broadstar VC1604 (0.19 lb ai/A) had similar fresh weights to the non-treated control.

Experiment 1: Stage 2

At 14 DAT, bittercress treated with Gallery and V-10142 (0.75 lb ai/A) had higher injury ratings than any other treatment followed by V-10142 (0.375 lb ai/A) and Certainty. Tower (1.5 lb ai/A) provided only marginal control while Tower at 0.97 lb ai/A, Broadstar VC1604 and HGH-63 were similar to non-treated plants.

By 28 DAT Gallery and V-10142 (both rates) again had the highest injury ratings at, followed by Certainty (0.094 lb ai/A) which was similar to V-10142 at 0.375 lb ai/A. Tower,

HGH-63 and Broadstar VC1604 (0.19 lb ai/A) were similar to non-treated plants.

Fresh weights indicate all herbicides provided some degree of efficacy when compared to non-treated plants; however Gallery, Certainty, and V-10142 were the only treatments providing acceptable control.

Table 16. Efficacy of Pre-emergent Herbicides for Emerged Bittercress (*Cardamine hirsuta*), Gilliam, 2009, Experiment 1.

Product - Rate (lb ai/A)	Efficacy Rating[1]				Fresh Weights[2]
	7 DAT[3]	14 DAT	21 DAT	28 DAT	
Cotyledon to one leaf stage					
Broadstar VC1604 - 0.19	1.7 d[4]	1.6 e	2.2 b	2.1 c	4.6 c
Broadstar VC1604 - 0.375	1.0 d	1.1 e	1.0 b	1.1 d	10.4 a
Gallery - 1.0	5.6 a	8.8 a	8.9 a	10.0 a	0.0 d
HGH-63 - 2.0	5.2 a	2.0 de	1.0 b	1.1 d	8.0 b
HGH-63 - 1.0	3.1 bc	1.3 e	1.9 b	1.0 d	7.8 b
Certainty - 0.094	3.9 b	7.7 ab	8.4 a	8.3 b	0.0 d
Certainty - 0.035	3.9 b	7.8 ab	8.9 a	8.9 b	0.0 d
Tower - 1.5	3.1 bc	4.1 c	2.1 b	1.0 d	6.1 bc
Tower - 0.97	2.7 c	3.0 cd	1.0 b	1.0 d	8.0 b
V-10142 - 0.75	3.7 b	7.7 ab	8.8 a	8.9 b	0.0 d
V-10142 - 0.38	3.4 bc	6.9 b	8.2 a	8.1 b	0.1 d
Control	1.0 d	1.0 c	1.0 b	1.0 d	11.4 a
Two to four leaf stage					
Broadstar VC1604 - 0.19	1.2 e	2.1 d	2.9 c	2.8 d	7.3 cd
Broadstar VC1604 - 0.375	1.0 e	1.3 d	1.6 cd	1.7 de	9.0 bc
HGH-63 - 2.0	4.7 ab	1.7 d	1.0 d	1.0 e	9.2 bc
HGH-63 - 1.0	4.1 bc	1.2 d	1.0 d	1.0 e	10.1 b
Certainty - 0.094	4.3 abc	5.9 b	7.1 b	7.1 bc	0.4 e
Certainty - 0.035	4.2 abc	6.6 b	7.3 ab	6.4 c	0.5 e
Tower - 1.5	3.6 bc	3.2 c	1.6 cd	1.1 e	4.9 d
Tower - 0.97	2.6 d	1.4 d	1.0 d	1.0 e	10.1 b
V-10142 - 0.75	4.1 bc	7.7 a	8.3 ab	9.4 a	0.9 e
V-10142 - 0.38	3.6 c	6.0 b	8.2 ab	8.2 ab	0.2 e
Gallery - 1.0	5.1 a	7.7 a	8.9 a	8.9 a	0.0 e
Control	1.0 e	1.0 d	1.0 d	1.0 e	13.0 a

[1] Plant injury ratings on scale of 1 to 10. 1 = no injury, 10 = dead
[2] Fresh weights measured in grams.
[3] DAT = Days after treatment
[4] Means separated using Duncan's Multiple Range Test at p = 0.05

Experiment 2: Stage 1

At 7 DAT, bittercress treated with Gallery or Certainty (0.094 lb ai/A) had higher injury ratings than any other treatments (Table 17). Bittercress treated with Broadstar VC1604 and Casoron had injury ratings that were similar to non-treated plants. At 14 DAT, Gallery, V-10142, and Certainty provided the best control.

At 21 DAT, bittercress treated with Gallery and Certainty (0.094 lb ai/A) had higher injury

ratings than any other treatment, and plants were almost completely dead. V-10142 (0.75 lb ai/A) (injury rating of 8.0) and Certainty (0.035 lb ai/A) also provided acceptable control (rating of 8.8). All other treatments were similar to the non-treated control with the exception of V-10142 (0.75 lb ai/A) which had an injury rating of 6.8.

Injury ratings at 28 DAT were similar to ratings taken at 21 DAT. While all herbicide treated pots had less fresh weights than the nontreated control, Gallery, V-10142, Certainty and Tower (1.5 lb ai/A) provided the best control.

Experiment 2: Stage 2

At 7 DAT, injury ratings were highest in treatments containing Certainty, however Tower (1.5 lb ai/A), V-10142, and Gallery were similar to Certainty at the lower rate (0.035 lb ai/A). Broadstar VC1604, Casoron, and HGH-63 (1.0 lb ai/A), provided the least control at 7 DAT and had similar injury to non- treated plants.

By 21 DAT, bittercress treated with Certainty, V-10142 and Gallery had higher injury ratings than bittercress treated with any other treatment. All other herbicide treatments were similar to the non-treated control plants.

At 28 DAT, Certainty (0.035 lb ai/A), V-10142 and Gallery treatments had the highest injury ratings, followed by Certainty (0.095 lb ai/A) which had slightly lower injury ratings. Broadstar VC1604, Casoron, HGH-63, and Tower (0.97 lb ai/A) provided no control and had similar injury ratings to non- treated plants, while Tower (1.5 lb ai/A) provided very little control with a rating of 2.1.

Fresh weights taken at 28 DAT show that Gallery, V-10142 and Certainty provided better control than all other treatments. All other treatments had similar fresh weights to non-treated plants with the exception of Tower at 1.5 lb ai/A (fresh weight of 4.7), and at 0.97 lb ai/A (fresh weight 7.8) which provided slightly more control than Broadstar VC1604, Casoron, or HGH-63.

Summary

In conclusion, data from Gilliam's 2009 studies indicate herbicides Gallery (1.0 lb ai/A), V-10142 (at 0.375 and 0.75 lb ai/A) and Certainty (at 0.035 and 0.094 lb ai/A) provide excellent bittercress control when applied postemergence to weeds in either the cotyledon to one leaf stage or the two to four leaf stage. Fresh weights from both experiments indicate that Broadstar VC1604, Casoron, HGH-63, and Tower herbicides provided some degree of control when compared to the untreated but control was minimal and would not successfully control bittercress. Bittercress treated with these less effective herbicides were slightly smaller than the control plants; however, plants were uninjured in most cases by 28 days after herbicide application and began to produce flowers and seeds which would lead to an escalating weed problem. While no herbicide will provide season-long bittercress control, Gallery, V- 10142, and Certainty could provide effective postemergence bittercress control when applied in the early stages of growth.

Table 17. Efficacy of Pre-emergent Herbicides for Emerged Bittercress (*Cardamine hirsuta*), Gilliam, 2009, Experiment 2.

Product – Rate (lb ai/A)	Efficacy Rating[1]				Fresh Weights[2]
	7 DAT[3]	14 DAT	21 DAT	28 DAT	
Cotyledon to one leaf stage					
Broadstar VC1604 – 0.19	1.0 g	1.0 c	1.0 d	1.0 d	11.7 b
Broadstar VC1604 – 0.375	1.0 g[4]	2.5 bc	1.0 d	1.0 d	9.0 bc
Casoron – 1.0	2.0 gf	1.4 bc	1.0 d	1.0 d	10.3 b
Casoron – 2.0	1.5 g	2.0 bc	1.0 d	1.0 d	9.3 bc
Gallery – 1.0	7.8 ab	7.7 a	9.9 a	9.9 a	0.0 f
HGH-63 – 1.0	2.6 f	3.0 bc	1.0 d	1.0 d	6.7 cd
HGH-63 – 2.0	4.9 e	2.4 bc	1.6 d	1.5 d	4.5 de
Certainty – 0.035	6.9 bc	9.0 a	8.8 b	8.8 b	0.0 f
Certainty – 0.094	8.0 a	8.8 a	9.8 a	9.8 a	0.0 f
Tower – 0.97	4.6 e	2.5 bc	1.0 d	1.0 d	7.5 c
Tower – 1.5	5.4 de	4.1 b	1.4 d	1.4 d	2.5 ef
V-10142 – 0.75	5.5 de	6.6 a	6.8 c	6.8 c	0.6 f
V-10142 – 3.75	6.0 dc	7.0 a	8.0 b	8.0 b	0.0 f
Control	1.0 d	1.0 c	1.0 d	1.0 d	14.5 a
Two to four leaf stage					
Broadstar VC1604– 0.19	1.0 e	1.0 d	1.0 b	1.0 d	11.0 abc
Broadstar VC1604 – 0.375	1.0 e	1.4 d	1.0 b	1.0 d	9.4 bc
Casoron - 1.0	1.0 e	1.3 d	1.0 b	1.0 d	9.6 bc
Casoron - 2.0	1.0 e	1.1 d	1.0 b	1.0 d	13.0 a
Gallery – 1.0	4.9 bc	7.4 b	7.9 a	8.0 a	0.0 e
HGH-63 - 1.0	2.1 de	1.0 d	1.0 b	1.0 d	11.0 abc
HGH-63 - 2.0	3.4 cd	1.0 d	1.0 b	1.0 d	10.5 abc
Certainty - 0.035	6.4 ab	8.6 a	7.9 a	8.1 a	0.0 e
Certainty - 0.094	7.7 a	7.6 ab	7.0 a	6.7 b	0.0 e
Tower - 0.97	3.4 cd	1.4 d	1.0 b	1.0 d	7.8 c
Tower - 1.5	4.9 bc	3.0 c	2.0 b	2.1 c	4.7 d
V-10142 – 0.75	5.0 bc	7.7 ab	7.6 a	7.6 ab	0.1 e
V-10142 – 3.75	5.1 b	8.0 ab	8.1 a	8.4 a	0.0 e
Control	1.0 e	1.0 d	1.0 b	1.0 d	12.1 ab

[1] Plant injury ratings on scale of 1 to 10. 1 = no injury, 10 = dead
[2] Fresh weights measured in grams
[3] DAT = Days after treatment
[4] Means separated using Duncan's Multiple Range Test at p = 0.05

Senesac, 2009

During 2009, Senesac (NY) tested the impact of six herbicides for postemergent control of bittercress. This experiment was conducted in a greenhouse without temperature controls; weeds were misted hourly during daylight hours.

Stage 0: Certainty and V-10142 were the only treatments to provide acceptable control applied preemergence.

Stage 1: At the cotyledon to 1- leaf stage commercially acceptable levels of control (>70%)

were achieved with applications of Broadstar VC1604 (high rate) and both rates of Certainty, HGH-63, and V- 10142 by 4 WAT.

Stage 2: All treatments demonstrated some measure of bittercress control at the 2-4 leaf stage but not to an acceptable degree.

Senesac, 2011

In 2011, Senesac (NY) evaluated Gallery, indaziflam and Tower for postemergent control of bittercress. This experiment was conducted in a greenhouse without temperature controls; weeds were misted hourly during daylight hours.

Stage 0: Both rates of Gallery and indaziflam effectively controlled bittercress applied preemergent. Tower exhibited up to 50% efficacy.

Stage 1: At the cotyledon to one leaf stage commercially acceptable levels of control (>70%) were achieved with applications of Gallery and indaziflam but not Tower.

Stage 2: Interestingly, none of the treatments were effective in controlling bittercress at the 2-4 leaf stage.

Table 18. Efficacy of Pre-emergent Herbicides for Emerged Bittercress (*Cardamine hirsuta*), Senesac, 2009.

Product	Rate (lb ai/A)	Percent Control		
		1 WAT	2 WAT	4 WAT
Preemergent				
Broadstar VC1604	0.19	1	3	0
Broadstar VC1604	0.375	6	3	0
Certainty	0.035	6	68	73
Certainty	0.094	10	70	78
Casoron 4G	1.0	4	10	0
Casoron 4G	2.0	8	10	10
Casoron 1.4CS	1.0	5	20	18
HGH-63	2.0	6	48	33
Tower	0.97	6	10	0
Tower	1.94	10	20	15
V-10142	0.38	3	63	63
V-10142	0.75	6	65	78
Untreated	~	0	0	0
Cotyledon to one leaf stage				
Broadstar VC1604	0.19	5	20	13
Broadstar VC1604	0.375	10	73	78
Certainty	0.035	1	65	88
Certainty	0.094	3	75	93
Casoron 4G	1.0	0	20	0
Casoron 4G	2.0	0	15	5
HGH-63	2.0	10	75	78
Tower	0.97	0	45	33
Tower	1.94	10	45	65
V-10142	0.38	1	58	90
V-10142	0.75	8	80	100
Untreated	~	0	0	0
Two to four leaf stage				
Broadstar VC1604	0.19	50	65	43
Broadstar VC1604	0.375	71	65	48
Certainty	0.035	30	35	53
Certainty	0.094	60	50	60
Casoron 4G	1.0	73	43	15
Casoron 4G	2.0	78	35	20
Casoron 1.4 CS	1.0	100	60	55
HGH-63	2.0	15	33	20
Tower	0.97	23	38	53
Tower	1.94	79	43	53
V-10142	0.38	28	45	55
V-10142	0.75	48	48	60
Untreated	~	0	0	0 i
Fisher's LSD @ 0.05		13	18	20

Table 19. Postemergent Control of Bittercress (*Cardamine hirsuta)* with Selected Pre-emergent Herbicides, Senesac, 2011.

Treatment	Rate	1 WAT	2 WAT	4 WAT	8 WAT
Preemergent					
Gallery	0.5 lb ai/A	~	100	100	60
Gallery	1.0 lb ai/A	~	100	100	65
Indaziflam	50 g/ha	~	100	100	100
Indaziflam	100 g/ha	~	100	100	100
Tower	0.97 lb ai/A	~	10	50	20
Tower	1.94 lb ai/A	~	10	50	50
Untreated		~	0	0	0
Newly Emerged					
Gallery	0.5 lb ai/A	98	100	100	90
Gallery	1.0 lb ai/A	100	100	100	90
Indaziflam	50 g/ha	93	100	98	90
Indaziflam	100 g/ha	100	100	100	98
Tower	0.97 lb ai/A	48	65	83	73
Tower	1.94 lb ai/A	53	65	93	90
Untreated		0	0	0	0
Cotyledon to one leaf					
Gallery	0.5 lb ai/A	45	90	100	93
Gallery	1.0 lb ai/A	50	90	100	93
Indaziflam	50 g/ha	35	88	93	98
Indaziflam	100 g/ha	40	88	98	98
Tower	0.97 lb ai/A	0	10	10	8
Tower	1.94 lb ai/A	0	10	10	10
Untreated		0	0	0	0
Two to four leaf stage					
Gallery	0.5 lb ai/A	25	40	40	20
Gallery	1.0 lb ai/A	30	43	50	30
Indaziflam	50 g/ha	20	20	15	8
Indaziflam	100 g/ha	25	28	25	8
Tower	0.97 lb ai/A	0	0	0	0
Tower	1.94 lb ai/A	0	0	3	0
Untreated		0	0	0	0
Fisher's LSD @ 0.05		21	8	10	13

Derr 2017

In 2017 Derr tested Biathlon, Freehand and Rout for pre-emergence control of bittercress in field containers. However, the population of bittercress was too low to determine treatment effectiveness. No data were presented.

Senesac 2018 & 2019

In 2018 and 2019, Senesac tested Basagran, Dismiss, Fiesta and Marengo for postemergence control of bittercress at the young seedling and 2-4 leaf stages in field containers. In 2018, Marengo at 9 fl oz/A and Basagran at 32 fl oz/A provided excellent control, Fiesta provided good and excellent control at 25 and 50 oz/A, and Dismiss provided fair control at both rates (Table 20). In 2019, all rates of all herbicides provided good to excellent control of 2-4 leaf bittercress. (Table 21).

Table 20. Efficacy of Herbicides for Emerged Bittercress (*Cardamine hirsuta*), Senesac, NY, 2018.

Treatment	Rate	% Control				Fresh Wt (gm) 21 DAT
		3 DAT	7 DAT	14 DAT	21 DAT	
Young Seedling Stage						
Basagran T&O 4F	24 fl oz/A	30	35	48	55	10
	32 fl oz/A	33	45	70	95	4
Dismiss 4F	8 fl oz/A	35	40	45	60	22
	12 fl oz/A	43	48	53	60	33
Fiesta 26.52%	25 oz/1000 sq ft	53	63	63	60	11
	50 oz/1000 sq ft	70	83	88	90	1
Marengo 0.622SC	9 fl oz/A	25	40	90	100	0
Untreated	-	0	0	0	0	45
Fisher's LSD P =.05		17	8	10	13	14

Table 21. Efficacy of Herbicides for Emerged Bittercress (*Cardamine hirsuta*), Senesac, NY, 2019.

Treatment	Rate	% Control			Fresh Wt (g) 21 DAT
		3 DAT	7 DAT	14 DAT	
2-4 Leaf Stage					
Basagran T&O 4F	24 fl oz/A	73	73	87	1.3
	32 fl oz/A	73	73	100	0
Dismiss 4F	8 fl oz/A	70	70	100	0
	12 fl oz/A	77	77	100	0
Fiesta 26.52%	25 oz/1000 sq ft	70	70	97	0.3
	50 oz/1000 sq ft	80	93	100	0
Marengo 0.622SC	9 fl oz/A	80	100	100	0
Untreated	-	0	0	0	11
Fisher's LSD P =.05		8	9	15	2

Efficacy Summary by Product/Active Ingredient

A brief efficacy summary for select products is given below.

Basagran provided good control when applied postemergence at young seedling or 2-4 leaf stage in 2 experiments.

Broadstar 0.25G In single trials, the original formulation demonstrated effective control when applied preemergence, but not at the cotyledon to 1 leaf and 2-4 leaf stages.

Broadstar VC1604 This formulation provided effective control when applied preemergence but generally not at the cotyledon to 1 leaf and 2-4 leaf stages.

Casoron 4G provided poor control when applied preemergence and postemergence.

Casoron 1.4CS provided poor control when applied preemergence and at the 2-4 leaf stage in one trial.

Certainty provided effective control when applied at the cotyledon to 1 leaf and 2-4 leaf stages in 2 trials.

Dismiss provided good postemergence control in 1 experiment.

EXC3898 provided commercially acceptable control when applied preemergence, and at the cotyledon to 1 leaf and 2-4 leaf stages. This product will not be registered.

Fiesta generally provided good control when applied postemergence in single experiments.

Gallery generally provided good control when applied preemergence and at the cotyledon to 1 leaf and 2-4 leaf stages.

HGH-63 generally provided poor control when applied preemergence and postemergence in 4 experiments.

Indaziflam demonstrated effective control when applied preemergence and at the cotyledon to 1 leaf stage, but not at the 2-4 leaf stage in single experiments.

Marengo provided good control when applied postemergence in single experiments.

Tower provided poor control when applied preemergence and postemergence.

V-10142 generally provided effective control when applied preemergence and postemergence.

Please see Table 22 for a list of all researchable studies and the summary of experiments conducted from 2008 to 2019.

Table 22. Summary of Efficacy By Product

Note: Table entries are sorted by crop Latin name. Only those experiments received by 6/1/2020 are included in the table below.

PR#	Product (Active Ingredient)	MOA Class	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
33811	Basagran T&O Herbicide (Bentazon)	WSSA 6	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2018	Over the top	Excellent control of bittercress with 24 and 32 fl oz per acre.
33811	Basagran T&O Herbicide (Bentazon)	WSSA 6	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2019	Over the top	Good to excellent control with 24 and 32 fl oz + COC per acre.
33510	Biathlon (Oxyfluorfen + Prodiamine)	WSSA 14 + WSSA 3	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Derr	VA	2017	Over the top	Very low weed population to determine product efficacy.
28911	BroadStar 0.25G (Flumioxazin)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None) C. flexuosa	Field Container	Neal	NC	2008	Over the top	Good control pre at 0.19 and 0.38 lb ai per acre; poor to fair control at 1X, good at 2X applied at 1-leaf stage; poor control at 1X, fair at 2X applied at 4-leaf stage
27563	BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Gilliam	AL	2008	Over the top	Excellent control pre at 75 and 150 lb per acre, no control post applied at cotyledon - one leaf or at 2-4 leaf stages at 75, poor at 150 lb
27604	BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 1.Virtually no control applied at cotyledon to 1-leaf and 2 - 4 leaf stages at 75 and 150 lb per acre
27604	BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 2: Virtually no control applied at cotyledon to 1-leaf and 2 - 4 leaf stages at 75 and 150 lb per acre
27563	BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Regan	OR	2008	Over the top	Fair and good control pre, no control post at cotyledon to 1-leaf, no and poor control post at 2 to 4-leaf with 0.19 and 0.375 lb ai per acre.
27563	BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2008	Over the top	Good control pre, poor post at cotyledon to 1-leaf stage, over 70 % control post at 2-4 leaf stage, at 0.375 and 0.75 lb ai per acre; poor at 0.19 lb

PR#	Product (Active Ingredient)	MOA Class	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
27604	BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Senesac	NY	2009	Over the top	Poor control pre at 0.19 and 0.375 lb ai per acre; good post at cotyledon to 1-leaf stage at 2X, fair post at 2-4 leaf stage at both rates
27604	BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Wilen	CA	2008	Over the top	80 and 93 % control pre at 75 and 150 lb per acre; 74 and 87 % control at 1X and 2X applied at cotyledon-1 leaf stage; 61 and 92 % control at 1X and 2X applied at 2-4 leaf stage
27563	BroadStar 0.25G VC1604 (Flumioxazin)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None) C. flexuosa	Field Container	Neal	NC	2008	Over the top	Good control pre at 0.19 and 0.38 lb ai per acre; poor control at both rates applied at 1-leaf or 4-leaf stage
28920	Casoron 4G (Dichlobenil)	WSSA20	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Virtually no control applied at cotyledon to 1-leaf and 2 - 4 leaf stages at 25 and 50 lb per acre
28920	Casoron 4G (Dichlobenil)	WSSA20	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Senesac	NY	2009	Over the top	Poor control pre and post cotyledon to 1-leaf, good control post at 2 to 4-leaf stage with 1 and 2 lb ai per acre.
28921	Certainty Turf Herbicide (Monsanto) (Sulfosulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 1: Excellent control applied at cotyledon to 1-leaf and 2 - 4 leaf stages at 0.035 and 0.094 lb ai per acre; equal to Gallery.
28921	Certainty Turf Herbicide (Monsanto) (Sulfosulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 2: Excellent control applied at cotyledon to 1-leaf and 2 - 4 leaf stages at 0.035 and 0.094 lb ai per acre; equal to Gallery.
28921	Certainty Turf Herbicide (Monsanto) (Sulfosulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Senesac	NY	2009	Over the top	Effective control pre and post at cotyledon to 1-leaf and 2 to 4-leaf stages with 0.035 and 0.094 lb ai per acre.
33812	Dismiss 4F (Sulfentrazone)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2018	Over the top	Moderate control of bittercress with 8 and 12 fl oz per acre.
33812	Dismiss 4F (Sulfentrazone)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2019	Over the top	Excellent control with 8 and 12 fl oz per acre.

PR#	Product (Active Ingredient)	MOA Class	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
27290	EXC3898 (Mesotrione + prodiamine & S-metolachlor)	WSSA 27 + WSSA 3 + WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Gilliam	AL	2008	Over the top	Excellent control pre, fair to good control post applied at cotyledon - one leaf or at 2-4 leaf stages at 100 and 150 lb per acre.
27290	EXC3898 (Mesotrione + prodiamine & S-metolachlor)	WSSA 27 + WSSA 3 + WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Regan	OR	2008	Over the top	Excellent control pre, good post at cotyledon to 1-leaf and 2 to 4-leaf stages with 2.1 and 3.15 lb ai per acre.
27290	EXC3898 (Mesotrione + prodiamine & S-metolachlor)	WSSA 27 + WSSA 3 + WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2008	Over the top	Generally 70 % or higher control pre and post at cotyledon to 1-leaf stage, less effective post at 2-4 leaf stage, at 2.1, 3.15 and 4.2 lb ai per acre
27602	EXC3898 (Mesotrione + prodiamine & S-metolachlor)	WSSA 27 + WSSA 3 + WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Wilen	CA	2008	Over the top	47 and 63 % control pre at 100 and 150 lb per acre; 62 and 73 % control at 1X and 2X applied at cotyledon to 1-leaf stage; 42 and 56 % control at 1X and 2X applied at 2 to 4-leaf stage
27290	EXC3898 (Mesotrione + prodiamine & S-metolachlor)	WSSA 27 + WSSA 3 + WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None) C. flexuosa	Field Container	Neal	NC	2008	Over the top	Poor to fair control pre at 2.1, fair to good at 3.15 lb ai per acre; good control at both rates applied at 1-leaf stage; fair to good at 1X, good at 2X applied at 4-leaf stage
27290	EXC3898 (Mesotrione + prodiamine & S-metolachlor)	WSSA 27 + WSSA 3 + WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None) 'Hairy'	Field Container	Boydston	WA	2008	Over the top	97 and 98 % control pre at 2.1 and 3.15 lb ai per acre; 76 and 97 % control at 1X and 2X applied at cotyledon-1 leaf stage; 88 and 99 % control at 1X and 2X applied at 2-4 leaf stage
33813	Fiesta Herbicide (Iron HEDTA)		Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2018	Over the top	Excellent control of bittercress with 50 oz per 1000 sq ft.
33813	Fiesta Herbicide (Iron HEDTA)		Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2019	Over the top	Excellent control with 25 and 50 oz per 1000 sq ft.
33511	Freehand G (Dimethenamid-p + pendimethalin)	WSSA 15 + WSSA 3	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Derr	VA	2017	Over the top	Very low weed population to determine product efficacy.

PR#	Product (Active Ingredient)	MOA Class	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
28864	Gallery 75DF (Isoxaben)	WSSA 21	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2008	Over the top	Excellent control pre at 1 lb ai per acre; excellent control post applied at cotyledon - one leaf and 2-4 leaf stages
28864	Gallery 75DF (Isoxaben)	WSSA 21	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Senesac	NY	2011	Over the top	Excellent control at preemergent and cotyledon to 1 leaf stages but unacceptable at 2 to 4 leaf stage with 0.5 and 1.0 lb ai per acre.
28922	HGH-63 2G (Oxyfluorfen)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 1. Poor control applied at cotyledon to 1-leaf and 2 - 4 leaf stages at 50 and 100 lb per acre
28922	HGH-63 2G (Oxyfluorfen)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 2. Poor control applied at cotyledon to 1-leaf and 2 - 4 leaf stages at 50 and 100 lb per acre
28922	HGH-63 2G (Oxyfluorfen)	WSSA 14	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Senesac	NY	2009	Over the top	Fair control pre, good post at cotyledon to 1-leaf, poor post at 2 to 4-leaf stage with 2 lb ai per acre.
30466	Marengo 74SC (Indaziflam)	WSSA 29	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Senesac	NY	2011	Broadcast	Excellent control with 0.045 and 0.089 lb aia at premergent and cotyledon to 1 leaf stages but poor control at 2 to 4 leaf stage.
33814	Marengo 74SC (Indaziflam)	WSSA 29	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2018	Over the top	Excellent control of bittercress with 9 fl oz per acre.
33814	Marengo 74SC (Indaziflam)	WSSA 29	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2019	Over the top	Excellent control with 9 fl oz per acre.
33512	Rout (Oxyfluorfen + Oryzalin)	WSSA 14 + WSSA 3	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Derr	VA	2017	Over the top	Very low weed population to determine product efficacy.
27760	Tower (Dimethenamid-p)	WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 1: Poor control applied at cotyledon to 1-leaf and 2 - 4 leaf stages at 21 and 32 fl oz per acre

PR#	Product (Active Ingredient)	MOA Class	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
27760	Tower (Dimethenamid-p)	WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 2: Poor control applied at cotyledon to 1-leaf and 2 - 4 leaf stages at 21 and 32 fl oz per acre
27760	Tower (Dimethenamid-p)	WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Senesac	NY	2009	Over the top	Poor control pre at 0.97 and 1.94 lb ai per acre; good post at cotyledon to 1-leaf stage with 2X, good post at 2-4 leaf stage with both rates
27760	Tower (Dimethenamid-p)	WSSA 15	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Senesac	NY	2011	Over the top	Good control with 0.97 and 1.94 lb aia at cotyledon to one leaf stage but poor at all other stages.
27293	V-10142 0.5G (Imazasulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Gilliam	AL	2008	Over the top	Excellent control pre, excellent control post applied at cotyledon - one leaf or at 2-4 leaf stages at 75 and 150 lb per acre; best post treatment.
27603	V-10142 0.5G (Imazasulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 1. Excellent control applied at cotyledon t0 1-leaf and 2 - 4 leaf stages at 75 and 150 lb per acre; equal to Gallery.
27603	V-10142 0.5G (Imazasulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Gilliam	AL	2009	Over the top	Trial 2. Excellent control applied at cotyledon t0 1-leaf and 2 - 4 leaf stages at 75 and 150 lb per acre; equal to Gallery.
27293	V-10142 0.5G (Imazasulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Regan	OR	2008	Over the top	Excellent control pre, fair and excellent control post at cotyledon to 1-leaf and 2 to 4-leaf stages with 0.375 and 0.75 lb ai per acre.
27293	V-10142 0.5G (Imazasulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Field Container	Senesac	NY	2008	Over the top	Generally 70 % or higher control pre, post at cotyledon to 1-leaf stage and post at 2-4 leaf stage, at 0.38, 0.75 and 1.5 lb ai per acre
27603	V-10142 0.5G (Imazasulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Senesac	NY	2009	Over the top	Effective control pre and post at cotyledon to 1-leaf and 2 to 4-leaf stages with 0.38 and 0.75 lb ai per acre; higher rate betrter.
27603	V-10142 0.5G (Imazasulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None)	Greenhouse	Wilen	CA	2008	Over the top	78 and 71 % control pre at 75 and 150 lb per acre; 36 and 16 % control at 1X and 2X applied at cotyledon-1 leaf stage; 42 and 38 % control at 1X and 2X applied at 2-4 leaf stage

PR#	Product (Active Ingredient)	MOA Class	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
27293	V-10142 0.5G (Imazasulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None) C. flexuosa	Field Container	Neal	NC	2008	Over the top	Poor to good control pre at 0.375, good at 0.75 lb ai per acre; fair to good control at 1X, good control at 2X applied at 1-leaf stage; good control at both rates applied at 4-leaf stage
27293	V-10142 0.5G (Imazasulfuron)	WSSA 2	Bittercress, Hairy (Cardamine hirsuta)	None (None) 'Hairy'	Field Container	Boydston	WA	2008	Over the top	80 and 83 % control pre at 0.375 and 0.75 lb ai per acre; 92 and 90 % control at 1X and 2X applied at cotyledon-1 leaf stage; 95 and 98 % control at 1X and 2X applied at 2-4 leaf stage

Label Suggestions

The following label suggestions are for use in container grown bittercress provided an acceptable level of crop safety exists.

Certainty at 0.035 and 0.094 lb ai/A for preemergent and early postemergent control.

EXC3898 at 2.1 to 3.15 lb ai/A for preemergent and early postemergent control.

Gallery 75 DF at 1 lb ai/A for early postemergent control.

V-10142 at 0.38 to 0.75 lb ai/A for preemergent and early postemergent control.

Appendix 1: Contributing Researchers

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