Weed Management Research in Ornamentals, Turfgrass, Vegetables & Fruit

2019 Data Summary

Cornell University Cooperative Extension of Suffolk County
Long Island Horticultural Research and Extension Center
Riverhead, New York

Weed Science Research Report No. 32

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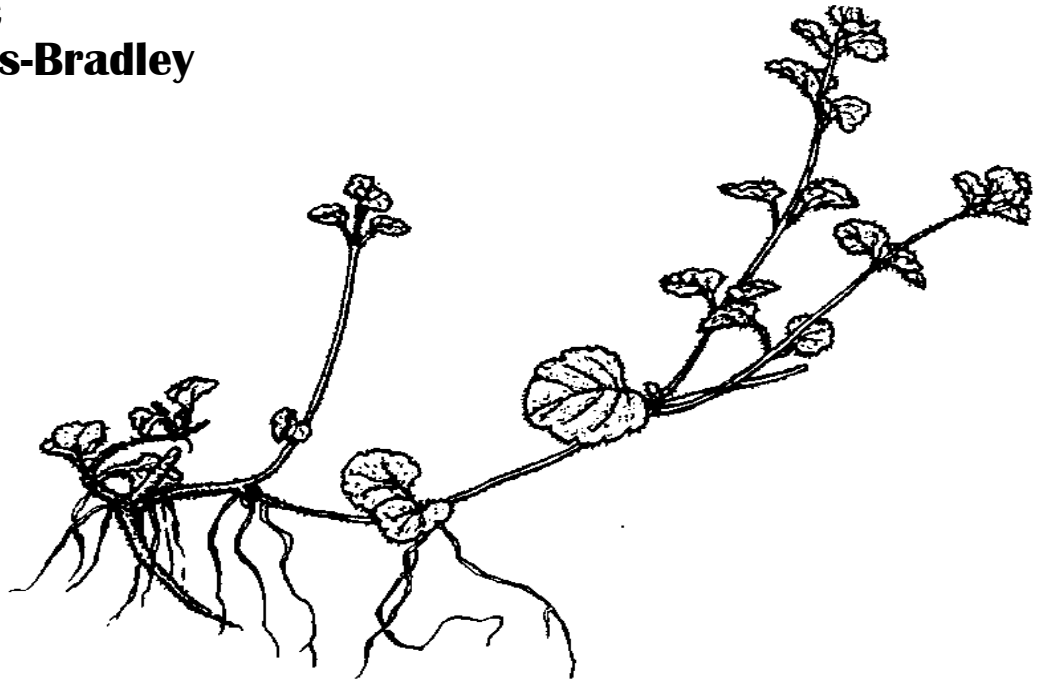

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ACKNOWLEDGMENTS

We wish to thank all of the individuals and organizations who contributed financial support, materials, and personnel to assist in the execution of these experiments.

The following companies and organizations provided financial and material contributions. Without such contributions, the experiments summarized herein would not have been possible.

IR-4 Center for Minor Crop Pest Management

New York State, Department of Integrated Pest Management

New York State Department of Agriculture and Markets

Cornell University, Department of Horticulture

USDA Sustainable Agriculture Research & Education Project

New York State Department of Transportation

US Department of Agriculture CSREES

Bayer Corporation

New York Farm Viability Institute

Everris NA, Inc.

Nassau Suffolk Landscape Gardeners Association

Suffolk County Agricultural Stewardship Program

New York City Parks Department

FMC Global Professional Solutions

Valent USA

Lebanon Seaboard Corporation

Chief Equipment

Olympic Horticultural Products

Weedingtech

Syngenta Corporation

American Tower Corporation

Nufarm

Friends of Long Island Horticulture

TDA Research

BASF Corporation

Duke Energy

We thank the following growers and individuals for providing plant material fertilizers, potting mixes, chemicals, and other support for the weed science program.

Half Hollow Nursery

Van de Wetering Greenhouses

North Fork Nursery

Pride's Corner Nursery

Schlecht Nursery

DeLalio Sod Farm

Pinewood Perennials

Peat & Sons Nursery

Kurt Weiss Greenhouses

Forest Farms Nursery

We also gratefully acknowledge the support of the staff of the Long Island Horticultural Research and Extension Center.

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INTERNET RESOURCES

Cornell University Cooperative Extension of Suffolk County Weed Science Program
ccesuffolk.org/agriculture/weed-science

Cornell University Cooperative Extension of Suffolk County
ccesuffolk.org

Long Island Horticultural Research and Extension Center
cuaes.cals.cornell.edu/farms/lihrec

Cornell University Department of Horticulture
hort.cals.cornell.edu

GENERAL COMMENTS

Unless otherwise noted, liquid applications were made with a C02 backpack sprayer and granular herbicides were applied with hand held shakers. Long Island weather data is included in the back of this document.

Weed control and crop response ratings vary among experiments due to local conditions at the time of evaluation. However, unless otherwise noted, the evaluations follow the guidelines below.

Crop: 0%-100% (or 0-10) Crop Injury Scale
An initial survey of the entire test area is conducted. The condition and appearance of the untreated, handweeded plots is presumed to be the standard for no injury or a '0%' rating. A rating of '50%' represents plants or a plot that is 50% injured, reduced in vigor, stunted, or delayed (in germination, flower production, etc.) compared to the untreated plants. A rating of '100%' represents dead plants. If plants are dead or injured due to non-treatment effects, they are ignored in the rating and removed from the test.

Weeds: 0%-100% (or 0-10) Weed Cover or Control
A survey of the test area is conducted to assess the weed population. In unseeded field plots, weed species that are present in less than 50% of the test plots and border area are generally omitted from the rating. Ratings include general or overall weed control for Grasses and Broadleaves as well as individual weed species.

Percent weed cover or control is evaluated depending on the crop. A '100%' weed cover rating represents a very weedy plot indeed, where the weeds cover 100% of the plot area. If a percent weed control rating is used, then a '100%' represents a clean, weed-free plot, and '0%' means no apparent weed control was observed. A rating of '50%' represents plants or a plot where the weeds are 50% injured, suppressed, reduced in vigor, stunted, or delayed (in germination, flower production, etc.) or where there are 50% fewer weeds, or a combination of these factors, compared to the untreated plants.

Generally, the container potting media used for these trials was a nursery mix containing 70:20:10 fine bark:compost:sand with Harrell's 20-4-10 (8-9 month) and granular lime with an approximate pH of 6.4. Field tests were conducted at the Long Island Horticultural Research and Extension Center in Riverhead, New York in Riverhead Sandy Loam (65% sand, 26% silt, 9% clay) with approximately 2.2% organic matter and an approximate pH of 5.9.

The abbreviations DAT, WAT, and MAT stand for days, weeks, and months after treatment respectively, indicating the time that has elapsed since treatment application. A number appearing after the abbreviation, refers to the time that has elapsed since a subsequent treatment timing. For example, DAT2 stands for days after the second treatment timing.

Additional information, such as weather at time of application, irrigation and maintenance regime, and plant culture is available upon request.

The authors hope you will find the information within this document helpful, but caution the reader not to extend undue interpretations from this single season's data. Important findings will be duplicated and reported as appropriate.

TABLE OF CONTENTS

Preemergence Crop Safety with Granular Herbicides: IR-4
Investigators: Senesac, Tsontakis-Bradley
Location: Long Island Horticultural Research and Extension Center

The safety of three granular herbicides when applied to a variety of ornamental plants was tested at the Long Island Horticultural Research and Extension Center in 2019 under the USDA IR-4 Project. Fortress 0.75G (isoxaben+dithiopyr), Gemini 0.65G (prodiamine+isoxaben), and SP1770 0.15G (fluridone) were applied at the 1, 2, and 4X label rates on June 26 within seven days of transplant and again on August 6, six weeks later.

Fortress at 150, 300, and 600 lb prod/A was applied to *Muhlenbergia capillaris*, *Nassella tenuissima*, *Pennisetum setaceum* 'Fireworks', *Chrysanthemum* x *rubellum* 'Clara Curtis', *Digitalis grandiflora*, *Liriope muscari* 'Super Blue', *Perovskia atriplicifoli*a 'Filigran', and *Hydrangea macrophylla* 'Paraplu'. SP1770 at 100, 200, and 400 lb prod/A was applied to *Andropogon gerardii* , *Carex morrowii* 'Ice Dance', *Eragrostis spectabilis* , *Juncus effusus*, *Muhlenbergia capillaris*, *Nassella tenuissima*, *Panicum virgatum*, and *Pennisetum orientale*. Gemini at 200, 400, and 800 lb prod/A was applied to *Sedum hybridum*, and *Pelargonium* x 'Salmon'. Visual assessment of phytotoxicity was performed at 1, 2, and 4 weeks after each treatment. Height was measured at commencement and conclusion of trial.

In plants treated with Fortress little or no injury was observed except for Digitalis in which major injury and necrosis was observed. For SP1770, injury at the highest rate was observed in Muhlenbergia and Carex. Sedum was injured by the higher rates of Gemini.

PERCENT INJURY			1 WAT	2 WAT	4 WAT	1 WAT2	2 WAT2	4 WAT2
Treatment	Rate (lb ai/A)	Timing	Chrysanthemum x rubellum 'Clara Curtis'					
Untreated	~	~	0	0	0	0	0	0
Fortress 0.75G	1.125	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	2.25	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	4.5	Pre + 6 WAT	0	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*
Treatment	Rate	Timing	Digitalis grandiflora					
Untreated	~	~	0	0	0	0	0	0
Fortress 0.75G	1.125	Pre + 6 WAT	0	10	83	90	93	95
Fortress 0.75G	2.25	Pre + 6 WAT	0	10	90	90	93	95
Fortress 0.75G	4.5	Pre + 6 WAT	0	30	90	95	95	98
		Fisher's LSD @ 0.05	*na*	*<1*	*4*	*5*	*7*	*7*

PERCENT INJURY			1 WAT	2 WAT	4 WAT	1 WAT2	2 WAT2	4 WAT2
Treatment	Rate (lb ai/A)	Timing	Liriope muscari 'Super Blue'					
Untreated	~	~	0	0	0	0	0	0
Fortress 0.75G	1.125	Pre + 6 WAT	0	8	5	10	10	10
Fortress 0.75G	2.25	Pre + 6 WAT	0	15	10	15	15	15
Fortress 0.75G	4.5	Pre + 6 WAT	0	15	10	20	20	18
		Fisher's LSD @ 0.05	*na*	*6*	*6*	*5*	*5*	*5*

Treatment	Rate	Timing	Pennisetum setaceum 'Fireworks'					
Untreated	~	~	0	0	0	0	0	0
Fortress 0.75G	1.125	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	2.25	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	4.5	Pre + 6 WAT	0	0	0	0	13	10
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*4*	*<1*

Treatment	Rate	Timing	Perovskia atriplicifolia 'Filigran'					
Untreated	~	~	0	0	0	0	0	0
Fortress 0.75G	1.125	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	2.25	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	4.5	Pre + 6 WAT	0	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*

Treatment	Rate	Timing	Muhlenbergia capillaris					
Untreated	~	~	0	0	0	0	0	0
Fortress 0.75G	1.125	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	2.25	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	4.5	Pre + 6 WAT	0	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*

Treatment	Rate	Timing	Hydrangea macrophylla 'Paraplu'					
Untreated	~	~	0	0	0	0	0	0
Fortress 0.75G	1.125	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	2.25	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	4.5	Pre + 6 WAT	0	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*

Treatment	Rate	Timing	Nassella tenuissima					
Untreated	~	~	0	0	0	0	0	0
Fortress 0.75G	1.125	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	2.25	Pre + 6 WAT	0	0	0	0	0	0
Fortress 0.75G	4.5	Pre + 6 WAT	0	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*

PERCENT INJURY			1 WAT	2 WAT	4 WAT	1 WAT2	2 WAT2	4 WAT2
Treatment	Rate (lb ai/A)	Timing	Eragrostis spectabilis					
Untreated	~	~	0	0	0	0	0	0
SP1770 0.15G	0.15	Pre + 6 WAT	0	0	0	0	0	0
SP1770 0.15G	0.3	Pre + 6 WAT	0	0	0	0	0	0
SP1770 0.15G	0.6	Pre + 6 WAT	0	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*
Treatment	Rate	Timing	Juncus effusus					
Untreated	~	~	0	0	0	0	0	0
SP1770 0.15G	0.15	Pre + 6 WAT	0	0	0	0	0	0
SP1770 0.15G	0.3	Pre + 6 WAT	0	0	0	0	0	0
SP1770 0.15G	0.6	Pre + 6 WAT	0	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*
Treatment	Rate	Timing	Panicum virgatum					
Untreated	~	~	0	0	0	0	0	0
SP1770 0.15G	0.15	Pre + 6 WAT	0	0	0	0	0	0
SP1770 0.15G	0.3	Pre + 6 WAT	0	10	0	0	0	0
SP1770 0.15G	0.6	Pre + 6 WAT	0	10	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*10*	*na*	*na*	*na*	*na*
Treatment	Rate	Timing	Pennisetum orientale					
Untreated	~	~	0	0	0	0	0	0
SP1770 0.15G	0.15	Pre + 6 WAT	0	0	0	0	0	0
SP1770 0.15G	0.3	Pre + 6 WAT	0	0	0	0	0	0
SP1770 0.15G	0.6	Pre + 6 WAT	0	0	10	3	3	3
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*
Treatment	Rate	Timing	Carex morrowii 'Ice Dance'					
Untreated	~	~	0	0	0	0	0	0
SP1770 0.15G	0.15	Pre + 6 WAT	0	13	10	8	8	18
SP1770 0.15G	0.3	Pre + 6 WAT	0	13	13	13	20	23
SP1770 0.15G	0.6	Pre + 6 WAT	0	18	18	18	20	25
		Fisher's LSD @ 0.05	*na*	*6*	*8*	*7*	*4*	*9*
Treatment	Rate	Timing	Andropogon gerardii					
Untreated	~	~	0	0	0	0	0	0
SP1770 0.15G	0.15	Pre + 6 WAT	0	0	0	0	0	0
SP1770 0.15G	0.3	Pre + 6 WAT	0	0	0	0	0	0
SP1770 0.15G	0.6	Pre + 6 WAT	0	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*

PERCENT INJURY			1 WAT	2 WAT	4 WAT	1 WAT2	2 WAT2	4 WAT2
Treatment	Rate (lb ai/A)	Timing	Muhlenbergia capillaris					
Untreated	~	~	0	0	0	0	0	0
SP1770 0.15G	0.15	Pre + 6 WAT	0	0	10	10	10	10
SP1770 0.15G	0.3	Pre + 6 WAT	0	10	20	20	20	20
SP1770 0.15G	0.6	Pre + 6 WAT	0	20	30	30	30	30
		Fisher's LSD @ 0.05	*na*	*10*	*10*	*10*	*10*	*10*

Treatment	Rate	Timing	Nassella tenuissima					
Untreated	~	~	0	0	0	0	0	0
SP1770 0.15G	0.15	Pre + 6 WAT	0	5	0	0	0	8
SP1770 0.15G	0.3	Pre + 6 WAT	0	10	8	8	8	10
SP1770 0.15G	0.6	Pre + 6 WAT	0	13	8	10	10	13
		Fisher's LSD @ 0.05	*na*	*7*	*na*	*4*	*4*	*6*

PERCENT INJURY			1 WAT	2 WAT	4 WAT	1 WAT2	2 WAT2	4 WAT2
Treatment	Rate (lb ai/A)	Timing	Pelargonium x 'Salmon'					
Untreated	~	~	0	0	0	0	0	0
Gemini 0.65G	1.3	Pre + 6 WAT	0	0	0	0	0	0
Gemini 0.65G	2.6	Pre + 6 WAT	0	0	0	0	0	0
Gemini 0.65G	5.2	Pre + 6 WAT	0	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*	*na*

Treatment	Rate	Timing	Sedum hybridum					
Untreated	~	~	0	0	0	0	0	0
Gemini 0.65G	1.3	Pre + 6 WAT	0	0	0	10	10	10
Gemini 0.65G	2.6	Pre + 6 WAT	0	0	0	20	20	20
Gemini 0.65G	5.2	Pre + 6 WAT	0	0	0	30	30	30
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*10*	*10*	*10*

Postemergence Crop Safety with two Herbicides: IR-4
Investigators: Senesac, Tsontakis-Bradley
Location: Long Island Horticultural Research and Extension Center

A trial was conducted at the Long Island Horticultural Research and Extension Center in 2019 to determine the safety of over-the-top applications of three herbicides to a variety of ornamentals. Treatments included Basagran T/O 4F (bentazon) at 32, 64, and 128 oz prod/A (with COC at 1 qt/A) and Fiesta 26.52% (FeHEDTA) at 8.5, 16, and 24 gal/A.

Ornamentals treated with Basagran were *Astilbe* x *arendsii* 'Erica', *Dianthus deltoides* 'Flashing Light', *Festuca glauca* 'Elijah Blue', O*phiopogon planiscapus* 'Nigrescens', *Panicum virgatum*, *Pennisetum setaceum* 'Fireworks', and *Sedum spurium* 'John Creech'. Plants treated with Fiesta were *Andropogon gerardii*, *Carex cherokeensis*, *Ligustrum ovalifolium*, *Muhlenbergia capillaris*, *Ophiopogon planiscapus* 'Nigrescens', *Pachysandra terminalis*, *Panicum virgatum*, *Pennisetum alopecuroides*, and *Pennisetum setaceum* 'Fireworks'. Treatments were applied to actively growing plants on June 12 and again, two weeks after treatment, on June 26. Visual assessment of phytotoxicity was performed at 1, 2, and 4 weeks after treatment. Height was measured at commencement and conclusion of trial.

For Basagran treated plants, significant injury was observed in *Astilbe, Ophiopogon, Pennisetum,* and *Dianthus*. Minor to moderate injury was observed in Sedum and Panicum. No injury was observed in Festuca. For Fiesta treated plants, significant injury was observed in *Pennisetum setaceum* and *Pachysandra*. Moderate injury was observed in *Ophiopogon, Carex, Panicum,* and *Ligustrum*. Minor injury was observed in *Andropogon*.

PERCENT INJURY			1 WAT	2 WAT	1 WAT2	2 WAT2	4 WAT2
Treatment	Rate (lb ai/A)	Timing	Dianthus deltoides 'Flashing Light'				
Untreated	~	~	0	0	0	0	0
Basagran 4F *	1.0	Post + 2 WAT	1	1	30	28	23
Basagran 4F *	2.0	Post + 2 WAT	8	8	53	65	85
Basagran 4F *	4.0	Post + 2 WAT	10	15	98	100	100
		Fisher's LSD @ 0.05	*4*	*7*	*17*	*9*	*7*

Treatment	Rate	Timing	Festuca glauca 'Elijah Blue'				
Untreated	~	~	0	0	0	0	0
Basagran 4F *	1.0	Post + 2 WAT	0	0	0	0	0
Basagran 4F *	2.0	Post + 2 WAT	0	0	0	0	0
Basagran 4F *	4.0	Post + 2 WAT	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*

Treatment	Rate	Timing	Sedum spurium 'John Creech'				
Untreated	~	~	0	0	0	0	0
Basagran 4F *	1.0	Post + 2 WAT	8	8	8	5	0
Basagran 4F *	2.0	Post + 2 WAT	9	9	10	10	5
Basagran 4F *	4.0	Post + 2 WAT	10	10	33	28	13
		Fisher's LSD @ 0.05	*3*	*3*	*4*	*7*	*5*

*Basagran with COC 1%

PERCENT INJURY			1 WAT	2 WAT	1 WAT2	2 WAT2	4 WAT2
Treatment	Rate (lb ai/A)	Timing	Ophiopogon planiscapus 'Nigrescens'				
Untreated	~	~	0	0	0	0	0
Basagran 4F *	1.0	Post + 2 WAT	0	0	20	35	50
Basagran 4F *	2.0	Post + 2 WAT	0	8	30	45	68
Basagran 4F *	4.0	Post + 2 WAT	0	13	53	73	83
		Fisher's LSD @ 0.05	*na*	*5*	*4*	*8*	*8*

Treatment	Rate	Timing	Panicum virgatum				
Untreated	~	~	0	0	0	0	0
Basagran 4F *	1.0	Post + 2 WAT	0	0	10	8	3
Basagran 4F *	2.0	Post + 2 WAT	0	0	10	15	9
Basagran 4F *	4.0	Post + 2 WAT	0	10	33	30	28
		Fisher's LSD @ 0.05	*na*	*na*	*4*	*5*	*9*

Treatment	Rate	Timing	Pennisetum setaceum 'Fireworks'				
Untreated	~	~	0	0	0	0	0
Basagran 4F *	1.0	Post + 2 WAT	0	10	10	5	0
Basagran 4F *	2.0	Post + 2 WAT	0	18	25	28	23
Basagran 4F *	4.0	Post + 2 WAT	0	33	48	65	58
		Fisher's LSD @ 0.05	*na*	*9*	*5*	*19*	*9*

Treatment	Rate	Timing	Astilbe x arendsii 'Erica'				
Untreated	~	~	0	0	0	0	0
Basagran 4F *	1.0	Post + 2 WAT	8	28	98	98	98
Basagran 4F *	2.0	Post + 2 WAT	23	38	98	98	100
Basagran 4F *	4.0	Post + 2 WAT	43	55	100	100	100
		Fisher's LSD @ 0.05	*11*	*13*	*5*	*5*	*4*

*Basagran with COC 1%

PERCENT INJURY			1 WAT	2 WAT	1 WAT2	2 WAT2	4 WAT2
Treatment	Rate	Timing	Pennisetum alopecuroides				
Untreated	~	~	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	8.5 gal/A	Post + 2 WAT	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	16 gal/A	Post + 2 WAT	0	0	0	4	0
Fiesta (26.52% FeHEDTA)	24 gal/A	Post + 2 WAT	0	0	0	8	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*3*	*na*

Treatment	Rate	Timing	Carex cherokeensis				
Untreated	~	~	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	8.5 gal/A	Post + 2 WAT	0	6	9	9	10
Fiesta (26.52% FeHEDTA)	16 gal/A	Post + 2 WAT	0	13	13	23	25
Fiesta (26.52% FeHEDTA)	24 gal/A	Post + 2 WAT	0	18	18	25	38
		Fisher's LSD @ 0.05	*na*	*6*	*5*	*5*	*7*

Treatment	Rate	Timing	Ligustrum ovalifolium				
Untreated	~	~	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	8.5 gal/A	Post + 2 WAT	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	16 gal/A	Post + 2 WAT	0	10	10	10	10
Fiesta (26.52% FeHEDTA)	24 gal/A	Post + 2 WAT	0	18	18	20	20
		Fisher's LSD @ 0.05	*na*	*4*	*4*	*na*	*na*

Treatment	Rate	Timing	Muhlenbergia capillaris				
Untreated	~	~	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	8.5 gal/A	Post + 2 WAT	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	16 gal/A	Post + 2 WAT	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	24 gal/A	Post + 2 WAT	0	0	0	0	0
		Fisher's LSD @ 0.05	*na*	*na*	*na*	*na*	*na*

Treatment	Rate	Timing	Pachysandra terminalis				
Untreated	~	~	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	8.5 gal/A	Post + 2 WAT	13	13	13	13	35
Fiesta (26.52% FeHEDTA)	16 gal/A	Post + 2 WAT	18	18	23	23	48
Fiesta (26.52% FeHEDTA)	24 gal/A	Post + 2 WAT	20	20	40	40	60
		Fisher's LSD @ 0.05	*5*	*5*	*5*	*5*	*10*

PERCENT INJURY			1 WAT	2 WAT	1 WAT2	2 WAT2	4 WAT2
Treatment	Rate	Timing	Ophiopogon planiscapus 'Nigrescens'				
Untreated	~	~	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	8.5 gal/A	Post + 2 WAT	0	6	9	9	10
Fiesta (26.52% FeHEDTA)	16 gal/A	Post + 2 WAT	0	13	20	20	25
Fiesta (26.52% FeHEDTA)	24 gal/A	Post + 2 WAT	0	20	20	23	25
		Fisher's LSD @ 0.05	*na*	*5*	*2*	*4*	*7*

Treatment	Rate	Timing	Panicum virgatum				
Untreated	~	~	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	8.5 gal/A	Post + 2 WAT	0	0	9	9	8
Fiesta (26.52% FeHEDTA)	16 gal/A	Post + 2 WAT	0	8	20	15	13
Fiesta (26.52% FeHEDTA)	24 gal/A	Post + 2 WAT	0	10	28	28	25
		Fisher's LSD @ 0.05	*na*	*2*	*5*	*5*	*6*

Treatment	Rate	Timing	Pennisetum setaceum 'Fireworks'				
Untreated	~	~	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	8.5 gal/A	Post + 2 WAT	0	11	30	38	18
Fiesta (26.52% FeHEDTA)	16 gal/A	Post + 2 WAT	0	18	30	43	25
Fiesta (26.52% FeHEDTA)	24 gal/A	Post + 2 WAT	0	30	50	55	50
		Fisher's LSD @ 0.05	*na*	*7*	*na*	*13*	*9*

Treatment	Rate	Timing	Andropogon gerardii				
Untreated	~	~	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	8.5 gal/A	Post + 2 WAT	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	16 gal/A	Post + 2 WAT	0	0	0	0	0
Fiesta (26.52% FeHEDTA)	24 gal/A	Post + 2 WAT	0	6	6	9	9
		Fisher's LSD @ 0.05	*na*	*4*	*4*	*2*	*2*

Managing Young Seedling Weeds: IR-4
Investigators: Senesac, Tsontakis-Bradley
Location: Long Island Horticultural Research and Extension Center

A trial was conducted at the Long Island Horticultural Research and Extension Center in 2019 to determine the efficacy of four postemergence herbicides in managing several common weeds at the young seedling stage. Treatments included Basagran T/O 4F (bentazon) at 24 and 32 oz prod/A (with COC at 1 qt/A), Fiesta 26.52% (FeHEDTA) at 25 and 50 oz prod/1ksf, Dismiss 4F (sulfentrazone) at 8 and 12 oz prod/A, and Marengo SC (indaziflam) at 9 oz prod/A.

Seeds of yellow woodsorrel, willowherb, spurge, bittercress, and chickweed (*Oxalis stricta, Epilobium ciliatum, Chamaesyce maculata, Cardamine hirsuta, Stellaria media*) were sown in flats of a commercial nursery media on May 21, 2019. Germination was evident in all species on June 3. Treatments were applied on June 24 when all species were at the 2-4 leaf stage. Percent

control data was collected at 3, 7, and 14 DAT (days after treatment). Biomass data was collected at 21 DAT by harvesting above soil line.

According to the data collected, all rates of all herbicides yielded good to excellent control of bittercress. Excellent control of spurge was seen for the high rate of Fiesta. In yellow woodsorrel, excellent control was achieved for Marengo and both rates of Fiesta. Willowherb was well controlled by both rates of Basagran, the high rates of Dismiss and Fiesta, and by Marengo. For Chickweed (a contaminant in the yellow woodsorrel seed) good to excellent control was observed for plots treated with Marengo and both rates of Basagran.

PERCENT CONTROL			3 DAT	7 DAT	14 DAT	3 DAT	7 DAT	14 DAT
TREATMENT	Rate	Timing	Bittercress			Yellow Woodsorrrel		
Untreated	~	~	0	0	0	0	0	0
Basagran 4F *	24 oz/A	Early Post	73	73	87	100	67	33
Basagran 4F *	32 oz/A	Early Post	73	73	100	100	67	67
Dismiss 4F	8 oz/A	Early Post	70	70	100	100	33	33
Dismiss 4F	12 oz/A	Early Post	77	77	100	100	100	67
Fiesta 26.52%	25 oz/1ksf	Early Post	70	70	97	100	100	100
Fiesta 26.52%	50 oz/1ksf	Early Post	80	93	100	100	100	100
Marengo SC	9 oz/A	Early Post	80	100	100	100	100	100
		Fisher's LSD @ 0.05	*8*	*9*	*15*	*na*	*56*	*73*

TREATMENT	Rate	Timing	Chickweed			Spurge		
Untreated	~	~	0	0	0	0	0	0
Basagran 4F *	24 oz/A	Early Post	77	87	83	43	77	43
Basagran 4F *	32 oz/A	Early Post	77	90	93	43	77	70
Dismiss 4F	8 oz/A	Early Post	50	57	60	0	37	20
Dismiss 4F	12 oz/A	Early Post	57	57	63	0	53	57
Fiesta 26.52%	25 oz/1ksf	Early Post	13	30	23	93	80	63
Fiesta 26.52%	50 oz/1ksf	Early Post	23	47	40	93	100	97
Marengo SC	9 oz/A	Early Post	30	60	87	97	80	80
		Fisher's LSD @ 0.05	*7*	*32*	*32*	*32*	*24*	*35*

TREATMENT	Rate	Timing	Willowherb		
Untreated	~	~	0	0	0
Basagran 4F *	24 oz/A	Early Post	100	100	100
Basagran 4F *	32 oz/A	Early Post	100	100	100
Dismiss 4F	8 oz/A	Early Post	100	100	67
Dismiss 4F	12 oz/A	Early Post	100	100	100
Fiesta 26.52%	25 oz/1ksf	Early Post	100	67	67
Fiesta 26.52%	50 oz/1ksf	Early Post	100	100	100
Marengo SC	9 oz/A	Early Post	100	100	100
		Fisher's LSD @ 0.05	*na*	*36*	*47*

*Basagran with COC @ 1 qt/A.

Non-selective Weed Control in Bare Ground
Investigators: Senesac, Tsontakis-Bradley
Location: Long Island Horticultural Research and Extension Center

The efficacy of several non-selective herbicides in bare ground was tested in 2019 at the Long Island Horticultural Research and Extension Center. The trial area of Riverhead Sandy Loam was rototilled on June 5, 2019 and the local population of weeds allowed to grow to less than 6" high. Treatments, applied on June 30, were RazorGuard (flumioxazin+glyphosate) at 42 fl oz/A, RazorGuard at 64 fl oz/A, Razor Pro (glyphosate) at 64 fl oz/A, and a combination of Razor Pro + Diquat SPC + Barricade (prodiamine) at 64 + 13 + 21 fl oz/A respectively. Dominant weeds at time of treatment application were pigweed, annual grasses (especially crabgrass), dandelion, wild radish, purslane, and white clover.

Percent cover and percent control data were collected at 3, 7, 14, 28 DAT, continuing to 2 and 3 MAT (months after treatment). Based on this data, both rates of RazorGuard were highly effective at controlling all local weeds and maintaining bare ground throughout the trial. The higher rate of RazorGuard was not significantly more effective than the low rate for any weed population present. Razor Pro and the Razor Pro combination were also effective with some loss in efficacy in annual grasses, pigweed, purslane, and dandelion at 2 and 3 MAT.

PERCENT COVER		3 DAT	7 DAT	14 DAT	1 MAT	2 MAT	3 MAT
Treatment	Rate (fl oz / A)	All Vegetation					
Untreated	~	48	60	75	90	100	100
RazorGuard	42	11	0	0	1	5	5
RazorGuard	64	9	0	0	1	3	3
Razor Pro	64	25	2	2	4	35	48
Razor Pro + Diquat SPC + Barricade	64+13 +21	10	4	5	8	23	28
Fisher's LSD @ 0.05		*9*	*13*	*12*	*8*	*16*	*19*

PERCENT CONTROL		3 DAT	7 DAT	14 DAT	1 MAT	2 MAT	3 MAT
Treatment	Rate (fl oz/A)	Nutsedge					
Untreated	~		0	0	0	0	0
RazorGuard	42		100	100	99	99	98
RazorGuard	64		100	98	98	99	99
Razor Pro	64		88	95	95	99	99
Razor Pro + Diquat SPC + Barricade	64+13 +21		100	100	99	99	99
Fisher's LSD @ 0.05			*17*	*7*	*7*	*3*	*4*
Treatment	Rate	Purslane					
Untreated	~	0	0	0	0	0	0
RazorGuard	42	100	100	100	100	100	100
RazorGuard	64	100	100	100	100	100	100
Razor Pro	64	83	100	100	98	95	95
Razor Pro + Diquat SPC + Barricade	64+13 +21	100	100	100	98	81	81
Fisher's LSD @ 0.05		*15*	*0*	*0*	*4*	*24*	*24*

Treatment	Rate	Pigweed					
Untreated	~	0	0	0	0	0	0
RazorGuard	42	100	100	100	100	100	100
RazorGuard	64	100	100	100	100	100	100
Razor Pro	64	90	100	100	94	73	68
Razor Pro + Diquat SPC + Barricade	64+13 +21	100	100	100	98	95	93
Fisher's LSD @ 0.05		*10*	*0*	*0*	*2*	*18*	*22*

Treatment	Rate	White Clover					
Untreated	~	0	0	0	0	0	0
RazorGuard	42	88	100	98	98	98	98
RazorGuard	64	88	100	100	100	99	99
Razor Pro	64	60	93	98	98	100	100
Razor Pro + Diquat SPC + Barricade	64+13 +21	93	95	94	94	94	94
Fisher's LSD @ 0.05		*20*	*11*	*6*	*6*	*5*	*5*

PERCENT CONTROL		3 DAT	7 DAT	14 DAT	1 MAT	2 MAT	3 MAT
Treatment	Rate (fl oz/A)	Wild Radish					
Untreated	~	0	0	0	0	0	0
RazorGuard	42	98	100	100	100	100	100
RazorGuard	64	98	100	100	100	100	100
Razor Pro	64	85	100	100	100	99	99
Razor Pro + Diquat SPC + Barricade	64+13 +21	100	100	100	100	100	100
Fisher's LSD @ 0.05		*17*	*0*	*0*	*0*	*2*	*2*

TREATMENT	Rate	Annual Grasses					
Untreated	~	0	0	0	0	0	0
RazorGuard	42	65	100	100	100	98	98
RazorGuard	64	88	100	100	100	99	99
Razor Pro	64	38	100	100	93	75	68
Razor Pro + Diquat SPC + Barricade	64+13 +21	88	90	90	89	76	76
Fisher's LSD @ 0.05		*27*	*6*	*6*	*5*	*25*	*28*

TREATMENT	Rate	Dandelion					
Untreated	~	0	0	0	0	0	0
RazorGuard	42	88	100	100	100	99	99
RazorGuard	64	88	100	100	99	98	98
Razor Pro	64	15	80	79	95	94	94
Razor Pro + Diquat SPC + Barricade	64+13 +21	95	95	95	95	80	79
Fisher's LSD @ 0.05		*15*	*23*	*22*	*5*	*24*	*23*

Evaluation of Weed Control in Containized Ornamentals
Investigators: Senesac, Tsontakis-Bradley
Location: Long Island Horticultural Research and Extension Center

A trial was conducted in 2019 at the Long Island Horticultural Research and Extension Center to determine the efficacy of several herbicides when applied at preemergence and early postemergence timings. Treatments were applied on June 24, 2019 to flats containing weeds at the 2-4 leaf stage and to flats that had been seeded immediately before treatment. The flats contained standard potting media that had been settled by irrigation.

Preemergence treatments included SureGuard 4SC (flumioxazin) at 12 fl oz/A, Piper 76WDG (flumioxazin+pyroxasulfone) at 10 oz/A, and Marengo 0.622 SC (indaziflam) at 15 fl oz/A.

Early postemergence treatments included those listed above plus a combination treatment of Piper at 10 oz/A + Razor Pro 4L (glyphosate) at 12 fl oz/A. Weeds tested were crabgrass, annual bluegrass, groundsel, and bittercress. Percent control data was collected at 3, 7, 14, 28, 56, and 70 DAT. According to observations, all preemergence treatments provided excellent control of all weeds. Early post emergence treatments delivered good to excellent control with the exception of Marengo applied to crabgrass.

PERCENT CONTROL			3 DAT	7 DAT	14 DAT	28 DAT	56 DAT	70 DAT
Treatment	Rate	Timing	Crabgrass					
Untreated	~	Early Post	0	0	0	0	0	0
SureGuard 4SC	12 fl oz / A	Early Post	33	78	90	98	100	100
Piper 76WDG	10 oz / A	Early Post	30	83	98	100	100	100
Marengo 0.622 SC	15 fl oz / A	Early Post	0	28	30	68	63	50
Piper +Razor Pro 4L	10 oz + 12 fl oz	Early Post	0	65	100	100	100	100
Untreated	~	Pre	No Emerg-ence	0	0	0	0	0
SureGuard 4SC	12 fl oz / A	Pre		100	100	100	100	100
Piper 76WDG	10 oz / A	Pre		100	100	100	100	100
Marengo 0.622 SC	15 fl oz / A	Pre		100	100	100	100	100
		Fisher's LSD @ 0.05	*4*	*21*	*7*	*8*	*5*	*8*
Treatment	Rate	Timing	Groundsel					
Untreated	~	Early Post	0	0	0	0		
SureGuard 4SC	12 fl oz / A	Early Post	45	93	98	100		
Piper 76WDG	10 oz / A	Early Post	78	98	98	100		
Marengo 0.622 SC	15 fl oz / A	Early Post	55	68	85	95		
Piper +Razor Pro 4L	10 oz + 12 fl oz	Early Post	90	95	100	100	Senesced	
Untreated	~	Pre	0	0	0	0		
SureGuard 4SC	12 fl oz / A	Pre	100	100	100	100		
Piper 76WDG	10 oz / A	Pre	98	100	100	100		
Marengo 0.622 SC	15 fl oz / A	Pre	100	100	100	100		
		Fisher's LSD @ 0.05	*8*	*11*	*7*	*3*		
Treatment	Rate	Timing	Annual Bluegrass					
Untreated	~	Early Post	0	0	0	0	0	0
SureGuard 4SC	12 fl oz / A	Early Post	18	33	38	38	55	80
Piper 76WDG	10 oz / A	Early Post	8	75	93	100	100	100
Marengo 0.622 SC	15 fl oz / A	Early Post	0	13	25	30	68	83
Piper +Razor Pro 4L	10 oz + 12 fl oz	Early Post	3	60	100	100	100	100
Untreated	~	Pre	No Emergence			0	0	0
SureGuard 4SC	12 fl oz / A	Pre				100	100	100
Piper 76WDG	10 oz / A	Pre				100	100	100
Marengo 0.622 SC	15 fl oz / A	Pre				100	100	100
		Fisher's LSD @ 0.05	*13*	*28*	*12*	*5*	*18*	*9*
Treatment	Rate	Timing	Bittercress					
Untreated	~	Early Post	0	0	0	0		
SureGuard 4SC	12 fl oz / A	Early Post	25	93	98	100		
Piper 76WDG	10 oz / A	Early Post	18	95	100	100		
Marengo 0.622 SC	15 fl oz / A	Early Post	8	75	85	85		
Piper +Razor Pro 4L	10 oz + 12 fl oz	Early Post	20	83	100	100	Senesced	
Untreated	~	Pre	No Emergence			0		
SureGuard 4SC	12 fl oz / A	Pre				100		
Piper 76WDG	10 oz / A	Pre				100		
Marengo 0.622 SC	15 fl oz / A	Pre				100		
		Fisher's LSD @ 0.05	*7*	*17*	*17*	*12*		

Yellow Nutsedge Management with Dichlobenil: Year 1 and 2
Investigators: Senesac, Tsontakis-Bradley
Location: Long Island Horticultural Research and Extension Center

Dichlobenil (Casoron) is a preemergence herbicide that is used for residual weed control in a number of crops, primarily field nurseries on Long Island. An intermediate metabolite of dichlobenil (BAM) is mobile in the soil profile and has been detected in the aquifer. Dichlobenil is quite highly relied on by several stakeholders for its unique ability to suppress and sometimes control two very difficult weeds, yellow nutsedge and mugwort. The goal of this project is to determine if varying rates, application timings, and formulations might allow for adequate efficacy of yellow nutsedge control with the least amount of active ingredient applied to the soil. To that end we conducted field trials in 2018 and 2019.

In 2018, we conducted a field study to evaluate the efficacy of the two dichlobenil formulations compared to standard postemergence treatments for yellow nutsedge control. The results of the evaluations indicate that the granular Casoron formulation was superior to the 1.4CS (sprayable). The low rate of the granular Casoron provided very good early season nutsedge control. However, the higher rate (8.0 lb.) was needed to extend the control to the end of the season. There was no statistical difference between the two high rates of the granular Casoron. Both provided very good to excellent nutsedge control. The post emergence treatments results were also interesting. It was necessary for all three post emergence treatments to be applied twice in order to maintain a high level of control. However, all three, glyphosate, paraquat, and halosulfuron, provided about the same level of season long control when they were applied twice.

In 2019, we evaluated the low labeled rate of the 1.4CS formulation when it is applied at two times, in mid-March and again in early May. Early May is the time when the very first shoots of nutsedge begin to emerge. Because there is flexibility in application timing of the 1.4 CS that allows for air temperature applications of up to 70°F, it may be possible to improve the level of control with this formulation by making two applications. The trial was conducted at the LIHREC on nutsedge-infested soil different from the 2018 area. We compared this unique timing to standard formulation and timings as well as to the standard postemergence treatment, glyphosate applied at the 7-leaf stage.

In 2019, the results of visual evaluations of control indicate that an early May application of 4.0 lb/A of Casoron 1.4CS provided significantly better yellow nutsedge control than the same amount applied in late winter or even when the application and amount were spilt between late winter and early May. The best treatment with a reduced rate of Casoron was when it was applied in late winter and followed up with a glyphosate application in late June. The standard application of the Casoron 4G provided good early season nutsedge control (early July), but that level of control was not still evident in mid-August. This suggests that growers can significantly decrease the amount of active ingredient (dichlobenil) that is applied to the soil by choosing a later timing to apply the sprayable formulation and if necessary, follow that up with a postemergence non-selective herbicide such as glyphosate.

Treatment	Rate (lb ai/A)	Application Timing	Percent Control 7/9/19	Percent Control 8/15/19
Untreated	~	~	0	0
Casoron 4G	4.0	Late winter	62	22
Casoron 4G	8.0	Late winter	63	38
Casoron 1.4CS	2.0+2.0	Late winter & Early May	81	64
Casoron 1.4CS	4.0	Late winter	54	28
Casoron CS+Razor Pro 3AE	2.0+1.5	Late winter & 7-leaf stage	98	70
Casoron 1.4CS	4.0	Early May	92	84
Razor Pro 3AE	1.5 + 1.5	7-leave stage	95	65
		Fisher's LSD @ 0.05	*12*	*16*

Japanese Knotweed & Mugwort Management with Foamstream™
Investigators: Senesac, Tsontakis-Bradley
Location: Long Island Horticultural Research and Extension Center

Recent developments in thermal weed control seem to offer an alternative to herbicides for managing weeds in amenity and certain natural areas. The goal of this trial was to determine if the tender emerging shoots from two invasive rhizomatous weeds can be well controlled with exposure to thermal management supplied by Foamstream™. The Foamstream™ equipment combines hot water and foam, made from renewable plant oils and sugars. As the foam emerges from the applicator wand, it creates a layer of insulation that retards cooling and allows the destructive hot water to remain on the foliage longer, optimizing efficacy.

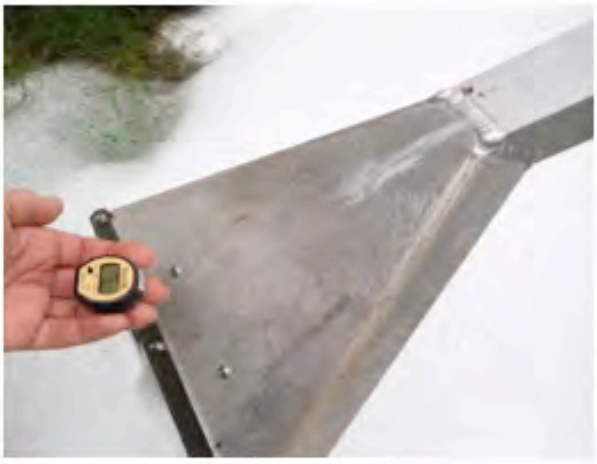
Two of the most troublesome invasive species in the Northeastern United States are mugwort (*Artemisia vulgaris*) and Japanese knotweed (*Reynoutria japonica*). Both spread laterally by rhizomes. The rhizomes and rootstock of the knotweed are highly condensed in the top few inches of soil and almost behave like the crown of a simple perennial. Japanese knotweed and mugwort are both deciduous and new shoots arise during the course of the spring season. This period is the most vulnerable time and offers the greatest opportunity for management these weeds.

A site was identified at a nearby public preserve. The Japanese knotweed was growing along the side of a dirt roadway which allowed for the application vehicle to drive close by. The mugwort was growing adjacent to a parking lot. The knotweed populations were divided into equal sized plots of 10' x 5' while the mugwort plots were 10' x 3'. The treatments were arranged in a randomized complete block design and replicated four times.

Following treatment on April 30, the plots were regularly evaluated for the following six weeks for stem number, plant vigor, and stem height. The treatments consisted of the mowed (control) and two periods of exposure of the shoots. One period (1X) simulated the standard exposure time for managing emerged weed species. The length of time that it took to cover the plot with foam was timed and that figure was used to determine the second period, which was 1.5-2 X the standard exposure period. The data were subjected to statistical analysis to determine if significant differences exist between the treatments.





The results suggest that re-emerging stem number, vigor, and height were significantly reduced for the first two to three weeks following the Foamstream treatments at both rates compared to the mowed control. However, after this period, the Foamstream treated plots began to resume growth on a pace with the mowed plots. Most of the treatment effect was no longer visible by the end of the study at 6 weeks. Reapplication of the Foamstream at three-week intervals for the remainder of the season most likely would have caused a significant reduction in the underground reserves of either weed. In areas where repeated mowing as well as chemical herbicides are not allowed or practical, Foamstream may offer a legitimate alternative. However,

if a large area is to be treated, there would be a necessity for nearby running water to refill the tank. This may be a limiting factor in the practicality of this method. But in amenity areas and hardscapes where water is available, the Foamstream is a potential new tool for landscapes and property managers.

	Stem Number						Quality (0-5 scale)			Height (in)		
	Pre-treat	9 DAT	16 DAT	23 DAT	37 DAT	51 DAT	16 DAT	37 DAT	51 DAT	23 DAT	37 DAT	51 DAT
Treatment	KNOTWEED											
Control (mowed)	15	9	15	12	9	6	4	5	5	11	22	24
Standard Exposure	14	1	6	9	7	8	2	4	5	6	18	17
1.5X Exposure	15	1	9	13	9	9	1	5	5	6	18	17
Fisher's Protected LSD @ 0.05	*ns*	*6*	*7*	*ns*	*ns*	*ns*	*2*	*1*	*ns*	*3*	*ns*	*5*
Treatment	MUGWORT											
Control (mowed)	12	1	11	9	10	10	4	5	5	2	11	17
Standard Exposure	13	2	5	10	11	13	2	4	4	2	5	10
1.5X Exposure	15	1	2	5	7	12	2	3	4	2	4	6
Fisher's Protected LSD @ 0.05	*ns*	*ns*	*6*	*4*	*4*	*ns*	*2*	*1*	*1*	*ns*	*3*	*6*

Horsetail (*Equisetum arvense*) Control with Four Postemergence Herbicides
Investigators: Senesac, Tsontakis-Bradley
Location: Long Island Horticultural Research and Extension Center

A study was conducted at the LIHREC in 2019 to determine if certain postemergence herbicides with contact activity can be effective in managing Field Horsetail (*Equisetum arvense*), a weed species that is well known to be resistant or at least tolerant of standard rates of glyphosate.

Horsetail is an occasional weed in field nurseries and non-crop areas but where it occurs, it usually becomes unmanageable because of its resistance to glyphosate. In this study, three contact herbicides, that were once known as herbicidal soaps, and acetic acid were applied. These 'soft chemistry' herbicides have had a resurgence of interest by organic growers and landscapers because several are now OMRI listed or approved. The treatments were all applied on June 28, 2019 with a CO2 backpack sprayer delivering 30 GPA. The plants were grown from single rhizomes excavated from a nursery in mid-May 2019. At the time of treatment each 4 square inch container had four to six vegetative stems ranging in height from 4- 8 inches. The treatments were not irrigated until 24 hours after treatment. Visual evaluations of percent foliage necrosis (burndown) were measured at 4 and 11 days after treatment. At 33 days after treatment, shoots from each container were harvested at the soil line and counted and weighed. Fourteen days after this, the regrowth was again harvested and weighed.

The results indicate that all four treatments had a similar effect and rapidity of action on the horsetail shoots. Within four days of application the foliage had almost completely desiccated in all treatments. However, since these herbicides have only contact activity, the perennial horsetail quickly regenerated new shoots from rhizomes and the plants appeared no different from the untreated control one month after treatment. The fresh weight data reflects this in showing no significant difference among the treatments and the control. However, allowing for this, repeat

applications on a monthly schedule would most likely eventually weaken and control the horsetail population.

Treatment		Sol'n	Percent 'burndown' (foliage necrosis)	
Trade Name	Active ingredient	Rate	4 DAT	11 DAT
Untreated	~	~	8	~
Scythe	pelargonic acid	7%	96	74
Homeplate	capric/caprylic acid	7%	91	93
Suppress	capric/caprylic acid	7%	98	99
Weed Pharm	acetic acid	20%	98	98
	Fisher's LSD @ 0.05		*8*	*ns*

			No. of shoots (in 4 sq in container)		Shoot fresh wt. (gm)	
Trade Name	Active ingredient	Rate	33 DAT	47 DAT	33 DAT	47 DAT
Untreated	~	~	7	8	4.0	2.4
Scythe	pelargonic acid	7%	7	7	2.4	1.4
Homeplate	capric/caprylic acid	7%	7	6	3.1	1.2
Suppress	capric/caprylic acid	7%	8	7	3.8	1.7
Weed Pharm	acetic acid	20%	6	6	3.5	1.3
	Fisher's LSD @ 0.05		*ns*	*ns*	*ns*	*1.2*

All shoots were cut at soil surface 8/1 and 8/14/19. No. of shoots at 47 DAT is regrowth after cutting.

Efficacy of Glyphosate and SureGuard SC for Vegetation Management
Investigators: Senesac, Boulier, Yeh, Tsontakis-Bradley
Location: Gabreski Airport, S Perimeter Rd, Westhampton Beach, NY 11978

In 2018, a field study was conducted at Gabreski Airport (on the edge of the runway approach) to evaluate the efficacy and longevity of control of combinations of SureGuard SC (flumioxazin) and Roundup PowerMax (glyphosate). The plot area was selected because the resident vegetation consisted of both annual and perennial broadleaf weeds, grasses and other monocots. The goal of the study was to determine if the addition of SureGuard SC to the glyphosate applications would extend or broaden the weed control thus allowing for vegetation managers to make fewer return trips.

Six treatments were replicated 6 times in a RCB design. The plots were 6'x4'. The treatments were applied with a CO2 powered back sprayers with (2)8003LP nozzles delivering 43 GPA. Treatments were applied on May 23, 2018 and/or June 20, 2018. The treatments evaluated a combination of flumioxazin (0.75 lb ai/A) and glyphosate (1.0 lb ai/A) applied once at either timing. A split application of flumioxazin applied at 0.5 lb ai/A and glyphosate at 1.0 lb ai/A on both dates was also evaluated. Single applications of glyphosate were also applied on either date.

The treatment effects were measured by scheduled visual evaluations of percent control and percent ground cover (which approximates the level of recovery from treatment). The data

presented here was recorded 35 and 76 days after the last treatment. The results indicate that glyphosate controlled or suppressed most of the vegetation it contacted. However, the treatments without flumioxazin allowed for abundant emergence of the annual weed Poorjoe or rough buttonweed (*Diodella teres*) soon after treatment. This short lived annual native species thrives in the types of arid, sandy soil conditions that are common along roadsides and unimproved sites. The excellent control of this weed that flumioxazin provided illustrates the efficacy benefit from the combination of flumioxazin with glyphosate.

Year 1: 2018			7/25	9/4	7/25	9/4	9/4
Treatment	Rate lb ai/A	Application Timing 2018	Percent Control		Percent Ground Cover		Percent Cover Diodella teres
Untreated	~	~	0	0	73	100	41
Flumioxazin+Glyphosate	0.75+1.0	5/23	92	86	8	18	0
Flumioxazin+Glyphosate	0.75+1.0	6/20	98	92	2	8	2
Flumioxazin+Glyphosate	0.5+1.0	5/23+6/20	96	93	1	5	0.3
Glyphosate	1.0	5/23	71	21	50	80	79
Glyphosate	1.0	6/20	90	68	10	34	25
		LSD @ 0.05	*11*	*28*	*18*	*27*	*28*

In 2019, an evaluation was conducted approximately one year after the treatments were applied. The plots were relatively undisturbed since treatment in 2018 except for occasional mowing. The results indicate that any treatment containing flumioxazin had a residual effect in suppressing perennial vegetation in 2019. Although this seems like a long time for a pre-emergent application to last, some of this effect might be an artifact of the site that was treated, the edge of asphalt runway in the Pine Barrens. It did not appear that the plant community was very robust or diversified, so there may not have been much of a soil seed bank reserve to grow once the flumioxazin had dissipated in the later part of 2018. In any case, the outstanding treatment was the same that worked the best in 2018, two applications of a reduced rate of flumioxazin tank-mixed with glyphosate. The results of this evaluation further support the notion that the addition of flumioxazin to the tank containing glyphosate will allow for fewer return visits by the vegetation managers.

Year 2: 2019			Percent Ground Cover One Year Post-treatment		
Treatment	Rate lb ai/A	Application Timing 2018	Perennial Species	Annual Species	All Vegetation
Untreated	~	~	84	8	92
Flumioxazin+Glyphosate	0.75+1.0	5/23	11	21	32
Flumioxazin+Glyphosate	0.75+1.0	6/20	19	11	30
Flumioxazin+Glyphosate	0.5+1.0	5/23+6/20	3	9	12
Glyphosate	1.0	5/23	6	86	92
Glyphosate	1.0	6/20	20	41	61
		Fisher's LSD @ 0.05	*11*	*17*	*18*

APPENDIX

WEEDS IN THE NEWS

Weed Science Program Overview

Weather Data, Riverhead, New York

Are there alternatives to glyphosate for weed control in landscapes?

Introduction

Glyphosate is the most widely used postemergence herbicide in landscape plantings for several reasons.

- First and foremost, it is effective. Glyphosate is a systemic (translocated) herbicide that moves from the treated foliage to other plant parts, including the roots. In this way, glyphosate kills annual and perennial weeds.
- Glyphosate is non-selective. This means a single herbicide can be used to control most weeds – grasses, sedges and broadleaves.
- Glyphosate has little or no soil residual. It is rapidly bound by clay particles in the soil rendering it inactive. This means you can spray weeds beneath shrubs and trees without damaging the desirable plants – as long as you keep the spray on the weeds and off of the shrubs.
- Glyphosate is relatively inexpensive – compared to other herbicides.
- And, until recently, it has been considered to be one of the least toxic and environmentally benign herbicides in use.

However, recently the toxicity and environmental safety of glyphosate has been questioned and has also been the subject of litigation. Although hazard analysis by one non-governmental organization has raised concerns, in 2016 the US EPA released a report from a review of glyphosate carcinogenicity and concluded that glyphosate is "**not likely to be carcinogenic to humans."** This conclusion is consistent with conclusions of other similar regulatory agencies. The full EPA report is available. More recently (2017), the US EPA released a draft review of glyphosate human health and ecological risk assessments. This draft human health risk assessment concludes that glyphosate is **not likely to be carcinogenic to humans**. The Agency's assessment found no other meaningful risks to human health when the product is used according to the pesticide label directions. The Agency's scientific findings are consistent with the conclusions of science reviews by a number of other countries, as well as the 2017 National Institute of Health Agricultural Health Survey. The US EPA's human health review evaluated dietary, residential/non-occupational, aggregate, and occupational exposures. Additionally, the Agency performed an in-depth review of the glyphosate cancer database, including data from epidemiological, animal carcinogenicity, and genotoxicity studies. The ecological risk assessment indicated that there is potential for adverse effects on birds, mammals, and terrestrial and aquatic plants.

More recently, in January 2019, Health Canada released a re-review of glyphosate. This statement from the review sums up the conclusions: **"No pesticide regulatory authority in the world currently considers glyphosate to be a cancer risk to humans at the levels at which humans are currently exposed."**

Does this mean glyphosate is "safe"? It is my opinion that we must limit our exposure to all pesticides, including glyphosate. When using any pesticide: wear appropriate protective clothing, use it carefully to avoid off-target deposition, store the pesticide in a safe and secure site, and follow all label directions.

Are there alternatives?

Though the US Environmental Protection Agency continues to maintain that glyphosate does not pose a threat to human health or the environment when used according to directions, many agencies and individuals would prefer an alternative. The question many are asking is: "what can I use instead of glyphosate?" The answer to this question will depend upon the weeds you are trying to control. Seedling annual broadleaf weeds can be easily controlled with other herbicides and herbicidally-active natural products, or even with a hoe or other tool. Perennial weeds, established annual weeds, and grasses are more difficult to control. Regardless of the method or product chosen, the cost for removal will be higher than with glyphosate. This will result from higher chemical costs, more applications, or higher labor costs.

Controlling seedling annual broadleaf weeds without glyphosate

Many options are available to control small broadleaf weeds. The best alternative is to prevent the weeds from emerging by using mulches and sanitation practices that prevent the introduction and spread of weed seeds. Preemergence herbicides may be used to control annual grasses and small-seeded broadleaf weeds. However, even in the best-managed landscapes, some weeds will germinate and establish. These weeds will need to be controlled, manually or with postemergence herbicides, before they go to seed.

Manual removal

There will always be some hand weeding in landscape plantings. Remove weeds before they have a chance to establish a large root system and before they go to seed. This is best accomplished with frequent weeding – about every 2 weeks. Hand weeding frequently is effective for annual weeds but can also control perennial weeds before they become well established. The limitations, of course, include the expense and availability of labor to do so.

Flame, steam or hot-foam weeding

Heat can kill seedling broadleaf weeds. Flame weeding is effective on seedling broadleaf weeds growing in hardscapes but should not be used in areas where flammable mulching materials are present. Sites where flame weeding may be practical include cracks in driveways, between pavers, or in gravel mulch. When using a flame weeder you do not need to actually burn the weeds. A brief exposure to the flame will heat the water inside the plant without flames. The leaf tissues will collapse very rapidly after treatment. Larger weeds will require repeated treatments. Flame weeding will provide only foliar damage to grasses, perennial sedges and perennial broadleaf weeds. These types of weeds re-grow rapidly following treatment.

Where flammable materials are present, steam or hot foam weeding are preferred over flame weeding. The effect is similar to that of flaming. Commercial equipment is available that use pressurized steam (e.g. WeedTechnics™) or hot water + foaming agent (e.g. FoamStream, Weedingtech™). These machines remove the hazard of fire but do use about 60 gal of water per hour of use. Also, the output from these devices is HOT and accidental contact with the foam or steam can cause severe burns.

Steam weeder. Photo credit: C. Wilen, Univ. of California, Area IPM Advisor

Postemergence herbicide alternatives

Several other non-selective herbicides are available for use in landscape plantings. These include: Diquat (Reward™), pelargonic acid (Scythe™), glufosinate (Finale™ and others), and many "natural products" such as vinegar and botanical oils. All of these products have contact-type activity. That means they do not translocate to the roots of treated plants. If applied at the labeled dose and with thorough spray coverage, each of these herbicides will control seedling annual broadleaf weeds. None of these products have residual activity (i.e.: no root uptake and no preemergence weed control) in soils.

Glufosinate (Finale™, Bayer Corp.) is a non-selective, postemergence herbicide that is sometimes described to be a contact action but is "locally systemic" – meaning it moves within

treated foliage but does not translocate throughout the plant. Thus, Finale typically does not control perennial weeds (such as: bindweed, goldenrod, bermudagrass, and mugwort) as well as glyphosate. Yet, reduced translocation of Finale may offer advantages over glyphosate in some trim and edge applications and in landscape beds where one may avoid systemic damage to landscape ornamentals from inadvertent spray drift. Like the other postemergence herbicides described above, glufosinate has little or no potential for root uptake when applied to the soil.

Diquat (Reward™, Syngenta Corp. or Diquat SPC™, Nufarm Ltd.) is a postemergence, contact weed killer. It kills small annual weeds. Large annual weeds and perennials will be injured but not killed. Thorough spray coverage is necessary to achieve optimum results. In our research Reward herbicide was more effective when applied in spray volumes of at least 2 gal per 1000 ft^2 (over 80 gallons per acre). Advantages of Reward include rapid kill of small seedling weeds and relatively low cost. Compared to the other contact herbicides described in this section, diquat is more effective on young seedling grasses. Also, small amounts of spray drift will cause only cosmetic damage to landscape plants and will not translocate to kill desirable plants. Additionally, Reward is not as temperature sensitive as many other herbicides, working well in cool and warm weather. Disadvantages of this herbicide are lack of control of perennial weeds, grasses, or well-established annual weeds

Pelargonic acid (Scythe™, Gowan Co.) is also a postemergence, contact herbicide that controls small seedling broadleaf weeds but only injures larger annual weeds and perennials. In cold weather, Scythe is not as effective as Reward, but in warm weather Scythe provides very rapid weed control. Advantages of Scythe include very rapid symptom development (tissues show symptoms in less than 30 minutes), and Scythe™ is perceived by many people to be an alternative to traditional herbicides. Customers who do not wish to have pesticides applied to their properties will sometimes accept the use of soaps (such as insecticidal soaps) and may accept the use of Scythe, often considered to be a "herbicidal soap." However, users should know that Scythe is not a certified “organic” option. Similar herbicidal soaps are available which are organic certified. As with Reward, spray drift on desirable plants will cause cosmetic damage but will not translocate to kill the entire plant. In all applications, avoid contact with desirable vegetation. The main disadvantages for Scythe are higher cost and it is somewhat less effective than Reward on larger weed seedlings. Additionally, the odor is persistent and offensive to some people, and spray drift can be a severe eye irritant.

Spray drift from contact herbicides cause localized lesions on green tissues. Over-dosing can cause stem and bark damage on landscape plants.

Several OMRI-certified nonselective, contact-action herbicides are available in the marketplace; some of the more commonly-used products are described below and summarized in Table 1. These products generally contain one or more of the following ingredients: fatty acids, acetic acid (vinegar), or natural plant oils. Ammonium nonanoate (Axxe™) is an OMRI certified formulation of pelargonic acid, the same active ingredient as Scythe. Its performance is understandably nearly identical to that of Scythe. FinalSan™ is a mixture of fatty acid soaps with similar contact-activity. Suppress™ is an emulsifiable concentrate of two short chain fatty acids (caprylic and capric acid). These products are fast acting, contact-action herbicides destroying the integrity of the leaf surface and cell walls. They work in the same way that Scythe™ (pelargonic acid) does. But unlike Scythe, Suppress, Axxe and FinalSan have been approved by OMRI for use in organic agriculture and horticultural operations, including in and around landscapes. Suppress is less active when the carrier water pH is greater than 6.0. If water used to dilute the spray has a pH higher than 6.0, the addition of an acidifier like Biolink™ to the dilution water before mixing will improve product efficacy.

Many product formulations containing acetic acid (vinegar) and various botanical oils are available through commercial and retail distributors. These products are non-selective and have contact action similar to fatty acid herbicides. They are effective on seedling annual broadleaf weeds but only burn the foliage of perennial weeds, large annual weeds and grasses. Complete spray coverage is important to obtain optimum results. Symptoms are rapidly visible – within an hour on a sunny, warm day. Users should remember that "natural" does not always mean "safe". Most products containing vinegar and natural oils have higher dermal toxicity than synthetic herbicides and may carry a "Danger" signal word on the label (Table 1). When using these natural products, avoid contact with skin or eyes, and avoid inhaling spray fines.

Contact-action herbicides, including OMRI-certified products, can be effective post emergence tools for small annual broadleaf weeds. They are less effective on grasses and sedges and, at best, will only knock down the top growth of perennial weeds. Still, with regular repeat applications, these products can be useful postemergence tools.

Preemergence herbicides with Postemergence activity

Several residual herbicides labeled for use in landscape plantings also have postemergence activity on some weeds. The most commonly used herbicides in this category are flumioxazin (Sureguard™) and indaziflam (Specticle™). These herbicides will control many small seedling broadleaf weeds and provide residual control of many weeds from seed. Larger annual weeds and perennial weeds may exhibit damage to the foliage or reduced growth, but plants recover.

Controlling seedling and perennial grasses without glyphosate

Selective, postemergence herbicides are available for the control of annual and perennial grasses. Sethoxydim, fluazifop-p, clethodim and fenoxaprop-ethyl are all labeled for the control of grass weeds in and around broadleaf ornamentals. These herbicides are applied to the foliage, translocate throughout the plants killing grasses to the roots. They can be applied over the top of many broadleaf ornamental plants in landscapes. A more thorough discussion of

these products is available in the fact sheet: Postemergence Grass Control in Landscapes and Nurseries.

Controlling perennial weeds without glyphosate

Without glyphosate, controlling perennial weeds will be more difficult and will require a more diversified selection of control options. Perennial grasses can be controlled with selective herbicides (described above). Sedges can be controlled with directed applications of sedge-specific herbicides. Established broadleaf weeds (including woody weeds) may in some circumstances be control with synthetic auxin herbicides. And, manual removal will be part of each weed management plan.

Sedges are generally not well controlled by contact-type herbicides. However, other herbicides are labeled for use in landscape plantings for postemergence control of annual and perennial sedges. The three herbicides most commonly used for this purpose are bentazon (Basagran TO™), halosulfuron (Sedgehammer™), and sulfentrazone (Dismiss™). *Each of these herbicides can damage landscape plants if treatments contact the foliage*. Thus, they must be used as though they are non-selective, avoiding contact with desirable plants. Bentazon is a postemergence herbicide that controls yellow nutsedge, most annual sedges, and some seedling broadleaf weeds, but does not control purple nutsedge. Multiple applications at 10 to 14 day intervals are necessary to achieve acceptable control. Halosulfuron controls both yellow and purple nutsedge, and a few seedling broadleaf weeds. Reapply when regrowth is observed, typically 4 to 6 weeks after the initial application. Sulfentrazone is more effective on yellow nutsedge but will suppress purple nutsedge, morningglory seedlings and some other broadleaf weeds. Re-apply when re-growth is observed. Follow the hyperlinks for more detailed information about each of these herbicides.

Perennial broadleaf weeds are not well controlled by contact-type herbicides that just burn the foliage but do not translocate to the roots or other shoot tissues. Repeated applications of contact-type herbicides can provide seasonal suppression and enough applications can exhaust the plant's ability to recover. More effective means of control may be to manually remove the weeds (root and all), smother the weeds with black plastic, or to use a synthetic auxin herbicide.

Perennial weeds that do not spread by rhizomes or stolons may be manually removed with a shovel or weed wrench. The shovel is fairly self-explanatory. Dig up the weedy plant by the roots, removing as much of the root mass as is feasible. A weed wrench is a useful device to remove woody weeds such as tree saplings or woody shrubs. The weed wrench uses leverage to firmly hold the base of the weed then lift the weed, roots and all, from the ground. These devices are not effective on herbaceous perennials or on woody weeds that spread by rhizomes.

Some weeds are well controlled by cultivation. Tap-rooted perennial weeds, such as dandelion or curly dock, do not survive repeated cultivation. Some rhizomatous weeds with large, shallow

rhizomes (such as Japanese knotweed or goldenrod) may also be controlled with repeated cultivation. However, you must continue cultivation when re-growth is observed. And, you must cultivate the entire infestation. Leaving a non-treated area will result in re-infestation of your treated site.

Some synthetic auxin herbicides can be used in landscape plantings to control perennial broadleaf weeds. Clopyralid (Lontrel) is a synthetic auxin herbicide particularly effective for the control of legume and aster weeds, such as vetch, kudzu, thistles and horseweed. It is labeled for directed applications around many woody landscape plants. But, use this with caution. Small amounts of this herbicide can cause severe damage or death of ornamental plants in the aster or legume families, even from root uptake.

Some formulations of triclopyr (several trade names) are labeled for control of woody weeds in landscape plantings. This herbicide is particularly effective for controlling poison ivy and brambles. But it can also be very injurious to ornamental plants, so the user must be cautious not to contact desirable plants with the spray applications. Triclopyr is typically applied to the foliage of actively growing weeds. However, it is also effective when applied to freshly cut stems. Cut the weed close to the ground then apply triclopyr to the freshly cut stem, wetting the entire cut surface and base of the weed.

What to expect from using glyphosate alternatives

Although there are effective alternatives to glyphosate, each of these alternatives will be, in some way, less effective, less convenient, and / or more expensive. Contact herbicides will be less effective on larger weeds requiring multiple applications. Natural product alternatives will be significantly more expensive. Selective postemergence grass herbicides will be convenient but more expensive and do not control broadleaf weeds. Synthetic auxin herbicides are effective on perennial broadleaf weeds but may result in damage to desirable plants through either spray drift or root uptake. Mechanical controls or hand removal will be labor intensive and expensive.

Many landscape maintenance professionals have grown reliant on glyphosate for weed control. Landscape weed control without glyphosate is certainly possible but will require more planning, careful consideration of alternative treatments, more frequent site visits, and higher costs. But, it can be done.

Table 1. Signal words, PPE and OMRI certifications for glyphosate and chemical alternatives for use in managed landscapes

Herbicide	Trade name(s)	Signal word	Required Applicator PPE*	OMRI certified
glyphosate	Roundup Pro and many more	Caution	Long sleeved shirt, long pants Shoes and socks	No
glufosinate†	Finale	Warning	Long sleeved shirt, long pants Shoes and socks Chemical resistant gloves Eye protection	No
pelargonic acid	Scythe	Warning	Coveralls Chemical resistant footwear Chemical resistant gloves Eye protection	No
ammonium nonanoate (=pelargonic acid)	Axxe	Warning	Coveralls Chemical resistant footwear Chemical resistant gloves Eye protection	Yes, with restrictions
ammonium soaps of fatty acids	FinalSan	Warning	Coveralls Chemical resistant footwear Chemical resistant gloves Eye protection	Yes
caprylic and capric acid	Suppress	Warning	Coveralls Chemical resistant footwear Chemical resistant gloves	Yes
vinegar / acetic acid	WeedPharm, many others	Danger	Long sleeved shirt, long pants Waterproof gloves and footwear Eye protection	Yes, check specific labels
d-limonene	AvengerAG	Caution	Long sleeved shirt, long pants Shoes and socks Chemical resistant gloves Eye protection	Yes
plant oils (clove, cinnamon, citric, others)	many	Danger	Recommended: long sleeved shirt, long pants Waterproof shoes Chemical resistant gloves Eye protection	Yes, check specific labels

Herbicide	Trade name(s)	Signal word	Required Applicator PPE*	OMRI certified
Selective Broadleaf Weed Control and Sedge Control				
triclopyr	Southern Ag Brush Killer, and others	Caution	Long sleeved shirt, long pants Shoes and socks Chemical resistant gloves	No
clopyralid†	Lontrel & others	Caution	Long sleeved shirt, long pants Shoes and socks Chemical resistant gloves Eye protection	No
bentazon	Basagran TO	Caution	Long sleeved shirt, long pants Shoes and socks Chemical resistant gloves	No
halosulfuron	Sedgehammer	Caution	Long sleeved shirt, long pants Shoes and socks	No
sulfentrazone†	Dismiss	Caution	Long sleeved shirt, long pants Shoes and socks Waterproof gloves	No
Selective Grass Control				
clethodim	Envoy, others	Caution	Long sleeved shirt, long pants Shoes and socks Chemical resistant gloves Protective eyewear	No
fenoxaprop-ethyl	Acclaim Extra	Caution	Long sleeved shirt, long pants Shoes and socks Chemical resistant gloves	No
fluazifop-p	Fusilade II, others	Caution	Long sleeved shirt, long pants Shoes and socks Chemical resistant gloves	No
sethoxydim	Segment and others	Caution	Long sleeved shirt, long pants Shoes and socks Chemical resistant gloves	No

* Always consult the label for details. But, even when not required by the label, the authors recommend wearing water proof footwear, eye protection, and chemical resistant gloves when applying pesticides.

† Commercial sales and use are not allowed in Suffolk and Nassau Counties, NY.

Acknowledgement
The authors thank Dr. Cheryl Wilen, University of California Cooperative Extension, and Dr. Chris Marble, University of Florida, for their helpful review and contributions.

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Solving the Mystery of 'Morden Pink' Loosestrife

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Purple loosestrife (*Lythrum salicaria*) is an aggressively invasive perennial weed that is found throughout much of New York State. This attractive summer flowering species has been planted as an ornamental for many years in gardens and amenity areas. Its attractive purple and pink flowers form dense showy spikes. The combination of pink/purple spikes and long-lasting summer flowering has made purple loosestrife a desirable plant over the years. Unfortunately, it is a prolific seed producer and when seeds get established in fresh water wetlands and the edges of ponds and lakes, the mature plants create such a dense underground network of roots and rhizomes that any native vegetation is excluded. Because of this invasive behavior, as of 2015, *L. salicaria* has been prohibited for sale, transport or planting in New York (6 CRR-NY 575). That part is straight forward. Now for the mystery!

The only other Lythrum species that even slightly resembles it is *Lythrum virgatum* L. (wand loosestrife). Although not native to North America, *L. virgatum* is rarely grown and the species is not considered invasive *per se* (in NY). The Lythrum cultivar 'Morden Pink' is supposedly a mutant form of *Lythrum virgatum* L. (wand loosestrife) that was obtained in 1934 from plants grown at the Agricultural Research Station at Morden, Manitoba. However in 1992, Canadian researchers re-examined the original pressed specimens and found that most of them were 'all clearly selections of *L. salicaria'*. So, if this is correct, then the assumption that Morden Pink is an exempt cultivar has been based on false information from the beginning. Since the current regulation in New York (6 CRR-NY 575.8) states that 'a plant cultivar whose parent species is a prohibited invasive species' is also prohibited. This would strongly indicate that the several Morden cultivars 'Morden Pink, Morden Gleam and Morden Rose' are not exempt from prohibition.

In 2018 we had an opportunity to evaluate some plant samples that were brought in by either nurseries or plant inspectors. Each of the three samples were thought to be 'Morden Pink'. I began by trying to find a botanical description of 'Morden Pink'. I simply wanted to know what makes it different from either *L. salicaria* or *L. virgatum*. After reaching out to well-known horticulturists and botanists, I came to the conclusion that it has not ever been described botanically in the literature. That left me to examine the characteristics of the two species. This is where I found a 'litmus test' to separate them. According to six taxonomic sources, all agree that *L. virgatum* is entirely or nearly *glabrous* (smooth) throughout: leaves, stems and inflorescences. They also describe *L. salicaria* as variable but usually mostly pubescent, but occasionally can be nearly glabrous. So…. if a sample has pubescence on the

Pubescence (hairs) cover the leaves and stem of purple loosestrife

Summer flowers of purple loosestrife (prohibited in NY)

leaves or flower parts, then it is likely in *L. salicaria*. If it is even slightly pubescent, it can't be *L. virgatum*. All three samples had some level of pubescence on the leaf margins and the flower parts. Additionally, we were able to have the fresh tissue of each sample (plus a wild type) tested by a colleague at the Cold Spring Harbor Lab for DNA analysis.

The results were that all samples tested positive for being members of *L. salicaria* species.

This confirms the fairly easy test of presence of pubescence as one that can at least eliminate *L. virgatum* as a possibility.

So, it appears that the currently available plants being sold as 'Morden Pink' are in fact selections from *L. salicaria* and therefore are prohibited from sale in New York.

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Weed of Interest: Japanese Stiltgrass

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Japanese stiltgrass (*Microstegium vimineum*) has a number of common names including: Nepalese browntop, Chinese packing grass and others. As these common names would suggest, it is native to several areas of Asia and was accidentally introduced to North America about 100 years ago when it was used as packing material for expensive porcelain shipped from Japan and China. In years past, the packing material was often thrown out on compost piles located at the back of properties usually near woods or wet areas. This environment, shaded and wet, is an ideal location for this weed to germinate and thrive. On Long Island, one of the first confirmed sightings of this plant as a weed problem was in Oyster Bay Cove. It was growing in a shaded wood and was beginning to invade a nearby mowed turf area that was in full sun. Since then it has become a severe problem to turf and landscape managers in several areas of Suffolk and Nassau Counties. In addition to its properties as a weed of horticulture, Japanese stiltgrass has also become highly invasive in natural areas such as woodland edges and along streams. In many parts of the Northeastern and Mid-Atlantic states vast areas of woodlands and forest edges are now covered with this invasive plant. Japanese stiltgrass is now listed as very highly invasive and is banned from being purposefully moved into or around New York State. For more information on this and other invasive plants on the 'prohibited' list see: *https://www.dec.ny.gov/animals/99141.html*.

Pockets of Japanese stlitgrass infesting low maintenance turf.

Japanese stiltgrass seedlings.

Despite the fact that stiltgrass is adapted to low light conditions, it has a C-4 pathway for carbon fixation. Briefly put, in certain conditions, this pathway allows plants to utilize the sun more efficiently to produce energy. Usually this pathway is found in drought tolerant and sun loving species like crabgrass and corn. It may be that while we are experiencing stiltgrass as a shade loving plant, it thrived in sunny, drier conditions in its place and time of origin. What this means to us practically is that stiltgrass is a formidable weed that should not be underestimated. Another interesting aspect of its biology is that stiltgrass flowers develop very late in the season compared to other grassy weeds like crabgrass. Stiltgrass flower stalks begin to be seen in late summer. Viable seeds are produced and dispersed shortly before frost in mid to late October. However, stiltgrass will spread readily into mowed turf. The plants will root at the nodes and grow outward from the original seedling under the height of the mower deck. Stiltgrass begins to emerge in turf and landscaped beds in the spring from 7 to 10 days before crabgrass starts

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to emerge. The young seedlings have a broad, almost rounded blade. This unusual appearance often allows them to be misidentified or mistaken for a broadleaf weed. As the plant grows, short, pointed leaf blades with a distinctive whitish midrib will develop on the stems. The leaves are alternate and often growing at an angle to the stem.

Management Options: In areas that are unmowed, cutting the plant once the flowers stalks start to form in early September can be an effective cultural control. Repeating this practice for a few years will greatly reduce the problem because stiltgrass seed is not very long lived. In mowed areas or landscapes, the preemergence herbicide Dimension (dithiopyr) and the postemergence selective grass herbicide Acclaim Extra (fenoxaprop-p) are the only commonly used turf or landscape herbicides that are labeled to control Japanese stiltgrass. There are several glyphosate products that now have *2ee* exemptions in New York for managing this weed. Careful scouting for this weed in the early spring will allow for targeted spot treatments or hand removal before infestations get too large. ●

Japanese Stiltgrass spreading laterally.

Weed of Interest: Oriental Bittersweet

Andrew Senesac, Weed Science Specialist, Cornell Cooperative Extension of Suffolk County

Celastrus orbiculatus or Oriental Bittersweet is a non-native woody vine or liana. This species was introduced along with many other ornamental plants from Japan in the late 1800s. During much of the twentieth century, Oriental Bittersweet was used as a rapidly growing screening plant and sometimes a ground cover. It was even used for erosion control along highway medians until the 1970s. Oriental Bittersweet is a heavy seed producer with bright red and yellow berries produced in the fall which are spread in several ways, such as by migrating birds and small woodland animals and also unintentionally in dried floral arrangements – which are often discarded in nearby compost piles or woods. There is no doubt that our deliberate use of this plant in the last century contributed greatly to its introduction into our woodlands and forests. Oriental Bittersweet originated in parts of Asia that have a somewhat similar climate to eastern North America. There are many natural enemies (insects and diseases) in its native range that can help keep it in check there. These natural enemies are not present in the regions where it has been introduced. Also, it has a very high growth rate - much faster growing than the native American Bittersweet (*Celastrus scandens*), which unfortunately is now uncommon or rare in most Long Island natural areas. Studies have shown that during the period from 1960 to 1999, Oriental Bittersweet has displaced the slower growing native species in more than 40% of the sites surveyed on Long Island. The invasive species now accounts for 95% of the Bittersweet found in the downstate area. If not removed, the seedlings will grow unchecked and eventually start to twine around and grow on nearby desirable woody shrubs and trees. As the vines or lianas grow on and over the resident vegetation, they add weight and wind resistance to the host plant. The foliage of the Bittersweet interferes with the growth of the host plant, and eventually weakens them – making them susceptible to being knocked over during heavy wind storms. In addition to directly harming the trees that it grows upon, when those trees

(continued on page 4)

Oriental Bittersweet branches with ripe fruit.

Weed of Interest: Oriental Bittersweet
(continued from page 3)

are weakened and eventually killed, the empty spaces in the woods and forests will be quickly filled with other invasives as well. This process radically reduces the quality of the natural areas in many ways. As a result of its highly invasive nature, the NYS DEC has placed it on the "prohibited" list. Along with 65 other invasive species, it is now illegal to possess with intent to sell, import, purchase, transport, introduce or propagate Oriental Bittersweet in New York State. For more information about this regulation go to: *https://www.dec.ny.gov/animals/99141.html.*

Management options: Oriental Bittersweet can be managed with cultural practices or with herbicides in combination with cultural practices. Currently there are three postemergence herbicide active ingredients that are registered for Long Island use for management of this species. These three are: 2,4-D, triclopyr and glyphosate and are marketed under several trade names. Also, in several cases the registration is listed by the NYS DEC as a '2ee' exemption. This means that the DEC has allowed application of these products to control this particular species even though it isn't actually mentioned on the primary label. For more information on which products are labeled, go the NYS DEC website: *http://www.dec.ny.gov/nyspad/products?0.* There are two ways that these herbicides can be applied. One is to cut the vine close to the soil line and paint a concentrated solution directly onto the cut stump. The 'cut stump' method is usually more effective in the dormant season: either in late fall or very early spring. The concentrate placed on the cut stump will inhibit or completely stop the ability of the plant to re-sprout. The other application method which must be used during the active growing season is to spray the foliage with a dilute solution. The potential drawback of this method is that the spray of these non-selective herbicides may unintentionally be deposited on desirable plants. A cultural practice which can have some success in the absence of herbicides is to repeatedly cut the vines at the soil line. Although the vines will start to resprout from the stumps below the cut, the repeated removal of the vines will decrease their ability to produce seed this year and also allow the host trees some time to recover. Hand pulling seedlings in the spring should also be a part of an integrated program managing this highly invasive species. ●

Oriental - Early infestation of Oriental Bittersweet climbing a host tree.

Oriental Bittersweet invading a landcape bed.

Weeds of Interest: The Wild Umbellifers- Some Weeds in the Carrot Family

Andrew Senesac, Weed Science Specialist, Cornell Cooperative Extension of Suffolk County

The Apiaceae plant family contains a number of plants that people utilize - as well as avoid! Worldwide, this large family contains more than 3,700 species. There are several species that provide important vegetables like carrot, celery, parsnip, parsley, fennel; as well as commonly grown herbs and spices like anise, caraway, coriander, cumin, dill, chervil and lovage. But, just as in human families, this one also contains a few black sheep; species that can be deadly poison to ingest and toxic to touch. Plants in this family all share a common character. Their inflorescences or flower structures are all called umbels. These are flower clusters with stalks that arise from a central point on the stem and form a flat or sometimes curved surface. These are said to resemble inverted umbrellas and the word is thought to be derived from the Latin word *umbella* (parasol). Six species in this family are often encountered as weedy or undesirable plants. All, except one, were introduced to North America from other parts of the world.

Wild Carrot or Queen Anne's Lace *(Daucus carota)*

Native to southern Europe and southwest Asia, it is an ancestor to the cultivated type, and both have a biennial habit. During the first year of growth the seeds germinate and form stemless rosettes. During this period the taproot will enlarge until the late fall when the roots are full of stored carbohydrates to survive the winter. When cultivated these are the 'carrots' that we harvest. The wild types have edible roots also, but they are usually small, not orange and not as palatable as cultivated carrots. It is often considered a valuable wildflower and mistakenly thought as native because it is so ubiquitous. The name is derived from the reign of Queen Anne when wild carrot was becoming common in England. Her skills in lacemaking were legendary and apparently rivaled Mother Nature's intricate flower structure. A single dark purple floret forms in the center of the umbel. There is debate about the reason for it, but many think it is an insect mimic that attracts pollinators. Upwards of 10,000 seeds can form on a large mature plant. These will dry and fall off in late summer and fall.

Goutweed or Bishop's weed *(Aegopodium podicaria)*

Apparently, it was often found near churches in the old world, hence the name. It was sometimes brewed as a tea for curing gout. A creeping perennial, goutweed, once established becomes a serious garden thug. It respects no boundaries and requires no care. Although this perennial groundcover is still occasionally being planted by the uninitiated, the word has gotten around to most experienced landscapers and designers to avoid this beast.

Poison Hemlock *(Conium maculata)*

This relative of wild carrot has a similar fleshy taproot and biennial habit. However, the stems and leaves of carrot are very hairy and poison hemlock is smooth throughout. Introduced from parts of Europe long ago, poison hemlock is naturalized and a common weed of waste places and roadsides throughout the Northeast. Containing coniine and other alkaloids, all portions of this plant can be toxic to livestock and the unfortunate humans who consume it. Tea made from this plant was the lethal agent that killed Socrates when he was made to drink it in ancient Greece. The plant has an unusual 'mousy' odor which may be responsible for warding off animals that are tempted to eat it. Anyone who encounters this plant should wear protective gloves before attempting to hand pull it.

Wild Chervil *(Anthriscus sylvestris)*

This short-lived perennial can spread by rhizomes as well as its numerous seeds. The foliage looks much like cultivated parsley. Wild chervil is occasionally found on Long Island but is a much greater threat to natural areas in upstate New York and New England. As such, it has been placed on the 'prohibited' list as a highly invasive species that cannot be knowingly propagated, planted or transported in the state.

Wild Parsnip *(Pastinaca sativa)*

The leaves of this biennial are much coarser looking than other weedy species in this family. In addition, the flowers are yellow rather than the white of most of the weedy umbellifers. Introduced from Europe, this species is not commonly found on Long Island. A few years ago, shortly after Hurricane Sandy in 2012, a nascent infestation was spotted growing along the shores of Shelter Island. The seeds had most likely floated there

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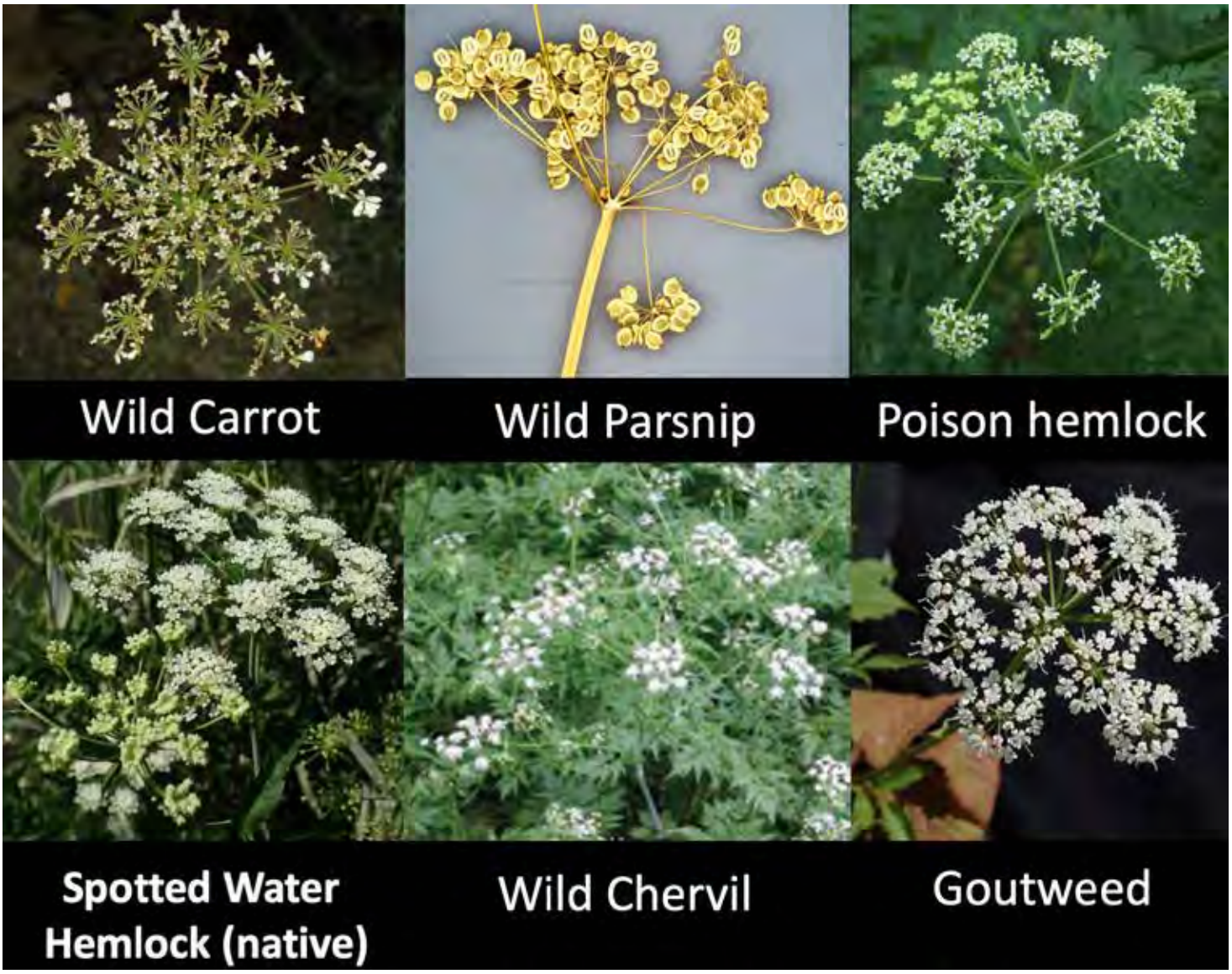

from the mainland. The infestation was initially spotted by a resident who also lived in New Hampshire where this is a common weed. Because the population was isolated and not yet fully established, a concerted effort to cut off the umbels while they were flowering and before seed had ripened allowed the participating volunteers to essentially eradicate this weed from that part of Shelter Island. If encountering wild parsnip, be sure to wear protective gloves and long sleeves. If the sap gets on bare skin which is then exposed to sunlight, a serious case of contact dermatitis can develop.

Spotted Water Hemlock *(Cicuta maculata)*

This species, which is native to most of North America is an uncommon weed, but worthy of note. Spotted water hemlock is a biennial or short-lived perennial that will form large clumps. It is almost exclusively found near the edges of ponds or lakes. Because of its high level of toxicity, touching with bare skin or consuming any portion of the plant can be poisonous within minutes. Recently, a population was spotted growing along the edges of a small 'water feature' pond on private property. Hand removal is an easy option for this species, since even though it can grow several feet high, it is very weakly rooted. Since this is a valued native species, if it is encountered in the woods or on public property, it is best to avoid and leave it alone. If public exposure is likely then report it to the nearest Cornell Cooperative Extension office. ●

Weeds of Interest: Spurges

Andy Senesac, Weed Science Specialist, Cornell Cooperative Extension of Suffolk County

'A common, worthless and prolific little plant, not so much detested as it deserves to be, for it and all its kindred are more or less poisonous, their growth serving merely to impoverish the ground and befoul it with seeds for another generation'. ~ from Ada Georgia, A Manual of Weeds, 1914.

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This eloquent condemnation of a low-growing spurge species was written by a noted botanist and weed scientist more than 100 years ago and really expresses how we often view the world of weeds. With good reason, in some cases, we see weedy species as being worthy of our contempt. And yet, weedy species such as spotted spurge are the ultimate survivors. Often, low growing weeds like this will be able to extract resources from environments that no other species can. There is a good reason that we see spurge and prostrate knotweed growing in the sidewalk cracks but not corn or cotton. They have evolved adaptations to thrive in hostile urban conditions. We can admire them for their tenacity, but still resist their acquisition of new territory.

Spurge is such an odd name that I had to look up its origin. Apparently, it comes from Middle English or Middle French and is a shortened version of 'espurge', which is a noun derivative of 'espurgier' meaning to cleanse or purge. (from *Dictionary.com*). Many species in this group have toxic properties especially when mishandled or consumed in large quantity. In smaller quantities they were used medicinally as emetic or dietary purges.

Spotted spurge (Euphorbia or Chamaesyce maculata)

According to a recent survey of nurseries in the southeast, **Spotted spurge** (*Chamaesyce maculata*; syn. *Euphorbia maculata*) is widespread and the most common summer annual broadleaf weed encountered in container production. This mat-forming prostrate species tolerates traffic and compacted soil. Although more than a few pre-emergence herbicides are registered to control spotted spurge, they are rarely effective unless reapplied on a six-week schedule. This multi-generational species thrives in the high temperatures of the summer. On Long Island, we usually start to see seedlings in mid-June. This is more than a month later than other annuals like crabgrass. Even though it is extremely prostrate, spotted spurge is a prolific seed producer, shedding thousands of seeds over the course of the season. Spotted spurge resembles other mat forming weeds like purslane and prostrate knotweed but can be distinguished by the milky sap that is exuded from broken stems.

Three other weedy spurge or **Euphorbia** species are nonnative and considered highly invasive. Two of them are prohibited from being grown purchased, propagated or transported in New York State. For more information about other prohibited species, visit the NYDEC website: *https://www.dec.ny.gov/animals/99141.html*.

The two prohibited species are **Cypress spurge** (*Euphorbia cyparissias*) and **Leafy spurge** (*E. virgata, synonym: E. esula*). Both species are slowly creeping perennials that form dense clusters in meadows, grasslands and roadsides. If consumed by livestock in hay, the reaction to the toxins within the sap can be fatal. These species are serious rangeland pests as well as being invasives of native ecosystems where diversity is impacted by their aggressive and chemically assisted (by allelopathic means) incursion into new areas.

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Recently, a third invasive Euphorbia species has been spotted in a few areas of Long Island. Called **Caper spurge** (*Euphorbia lathyris*) because the large button-like seedpods resemble capers, this biennial is potentially a serious new pest if left to its own devices. Caper spurge can cause serious dermatitis if skin comes in contact with the milky sap. Although goats stand alone as the only common livestock that are apparently immune to its poison, the toxin can pass unaltered through their milk. ●

Right: Caper spurge (Euphorbia lathyris)

Below: Cypress spurge (Euphorbia cyparissias) Photo by Marilyn Jordan

Weed of Interest

Unintended consequences of a popular ornamental: Fountaingrass

Andrew Senesac, Weed Science Specialist, Cornell Cooperative Extension of Suffolk County

Fountaingrass (*Pennisetum alopecuroides*) has been a popular accent ornamental grass for many years. Its popularity stems from its short stature (1-3 feet), attractive upright but gracefully bending culms and leaves, and the feathery, bristly seadheads that form above the foliage and begin to ripen toward the end of summer. Other synonyms for this species are; *Cenchrus purpurascens* and *Panicum alopecuroides*. Also, it is sometimes called swamp-foxtail, and Chinese fountaingrass. As this last name suggests, this species of fountaingrass is native to China, East Asia and western Australia. Several fountaingrass cultivars are popular, some featuring reddish foliage and seedheads. Two very widely planted cultivars are the dwarf 'Hameln' and the purple 'Moudry'.

Despite, or rather because of its popularity, fountaingrass is not without its problems. The main problem is its prolific production of viable seed that is easily shed at maturity. The seed will begin to ripen and drop in August on Long Island and some of this seed will start to germinate and grow right away. The rest will become dormant and germinate in the spring. Often the seed will not spread too far from the parent plant and start to grow in bare patches of nearby turf. One might say; 'So what? It is a grass like the grasses in the lawn and shouldn't be noticeable if it grows there'. How wrong that is! The seedlings of fountaingrass are very upright and will not normally grow like Kentucky Bluegrass and other cool season turf grasses. The leaves of even small plants are extremely tough, and they will not be sheared by rotary mower blades. Instead they shred and tear and the remnants of the leaves are noticeable and look very ragged. These clumps stand out in the lawn and once established, they will not be controlled or managed by mowing. In addition to this, fountaingrass seed is easily transported by animals or environmental factors (wind, rain) to new areas such as pastures, grasslands and the edges of woods. It is in these areas where it will compete with native plants and become invasive.

Fountaingrass (Pennisetum alopecuroides) seed sheds starts to shed in August. Photo by A. F. Senesac

Management considerations:

If fountaingrass is a problem in lawns or nearby natural areas, it is time to remove any existing plants from the landscape. There are several commercially available native grasses such as little bluestem and shorter cultivars of switchgrass that can offer similar horticultural value.

When small patches of fountaingrass become noticeable in the summer and fall, get out the shovel and dig the fairly shallowly rooted weedy clumps out. The holes should be immediately filled with soil and either re-sodded or overseeded with an appropriate turfgrass that will match the rest of the lawn. This is the simplest and most reliable solution if there only a dozen or so clumps. If there are many more and too many to be removed, then the solution to this weed becomes more problematic.

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Because fountaingrass is an occasional weed of fairly recent importance, there are no current herbicide labels that claim it as a weed that is controlled. In addition, there is only one scientific journal article that has been written about this problem[1]. In that, the two authors located in Illinois and Indiana, conducted some research evaluating a number of postemergence selective herbicides that might manage fountaingrass with minimal injury to the surrounding turf. Of the herbicides they tested, they found that none completely provided reliable control over two years and two locations. However, they found that spot applications of Drive (quinclorac) and wiper (selective application) treatments with glyphosate provided very good control. In 2020, we hope to be able to confirm these findings under Long Island growing conditions. An update will be posted when available. Certain quinclorac products can be used for spot treatment on Long Island and others cannot. To remain up to date, check the NYS DEC website: *http://www.dec.ny.gov/nyspad/products?1*.

Fountaingrass clumps are easily removed from turf. Photo by A. F. Senesac

<u>*Literature cited:*</u>

Voigt, T. B, Reicher, Z. J. (2009). Selectively controlling escaped fountain grass in cool-season turf. Applied Turfgrass Science, Issue: July pp:720-6. ●

Fountaingrass escapes into nearby turf. The leaves are torn rather cut by mowers. Photo by A. F. Senesac

The seed is easily moved to nearby natural areas as well as turf. Photo by A. F. Senesac

Weed Science Program

Program Leader Andrew Senesac, Ph.D.
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Program Objectives

The Weed Science Program assists the agricultural and horticultural industry by developing educational programs and conducting applied research in weed biology and management in several horticultural enterprises including vegetables, grapes, turf, woody and herbaceous perennial production in the field and containers, field-grown cutflowers, container-grown chrysanthemums, and landscape use of woody and herbaceous plant materials.

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Program Summary

The Weed Science program focuses on two major areas:

Applied Research: Several weed management problems are being addressed through research. The program investigates both traditional weed control approaches and alternative and cultural methods that can be integrated and used successfully.

Educational Extension Efforts: Some major areas of focus are the Cornell Pesticide Management Guide for Commercial Production of Trees and Shrubs and the Cornell Pesticide Management Guide for Production of Greenhouse Crops and Herbaceous Ornamentals, as well as other means of disseminating information about the results of recent research such as weed identification display gardens, articles in trade journals, illustrated lectures, fact sheets, and website contributions.

An additional role has been involvement with a consortium of representatives from several other state and regional governmental and non-governmental organizations in the Long Island Invasive Species Management Area (LIISMA) Committee to control and prevent new infestations of invasive weeds.

Rhinoncomimus latipes on *Persicaria perfoliata*

Program Justification

Growers and end-users of horticultural products are constantly confronted with potential loss of quality and economic loss due to weed competition in both the production cycle and in the end-use.

Additionally, great concern about the potential contamination of the single source aquifer from which Long Island draws its drinking water has resulted in fewer registrations of herbicides here and loss of several older materials that were heavily relied upon.

The weed science program is continually evaluating new and alternative methods and measures that will help solve some of these issues.

Impact to Industry

Several recent research projects have had either direct or indirect impact on the industry.

A recent study evaluated the effect that misuse of ready-to-use consumer- oriented 'extended control' herbicide products can have on commonly established landscape tree and shrubs. Our research shows that most of the products available off the shelf have a fairly high level of safety against injury to established plants. However, at least one product can easily cause long lasting plant injury if misapplied. Outreach of these results has been undertaken to reach our commercial landscapers and arborists who may need to diagnose these problems.

Evaluations of alternatives to standard postemergence herbicides such as glyphosate are ongoing. We have been evaluating physical weed control like a foaming steam generator that produces a hot foam which destroys the aboveground portion of weeds. Also, we are evaluating OMRI-listed products for efficacy and practicality.

Mile-a-Minute Weed (Persicaria perfoliata) has invaded natural areas and some farmland in increasing severity over the last 20 years. A program to manage this weed using small plant-eating weevils was developed at the University of Delaware. In the past few years, weevils were released on the East End on highly infested private property. Evaluations will continue, and additional release sites will be established to determine the effectiveness of this biological control.

To help educate the public about invasive weeds, a mobile weed identification display cart, nicknamed the 'Weed Wagon', has been constructed. It is stocked with forty of the worst invasive weed species and is used for educational purposes at stakeholder meetings and public functions.

Program Team

Andrew Senesac, Program Leader
Irene Tsontakis-Bradley, Program Manager
Drew Hoil, Program Assistant

Collaborators:
Jenny Kao-Kniffin, Weed Science, Dept. of Horticulture, Cornell University
Brian Eshenaur, NYS IPM Program
Elizabeth Lamb, NYS IPM Program

Temperature and Rainfall Record - 2019

Long Island Horticultural Research and Extension Center, Riverhead, New York

	January			February			March			April			May			June			July			August			September			October			November			December		
	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain	Temp (°F)		Rain
Day	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)	Hi	Lo	(in)
1	61	40	1.04	20	12	0.00	35	26	0.00	44	33	0.00	54	43	0.00	76	61	0.00	84	65	0.00	85	71	0.00	78	65	0.00	76	59	0.00	69	46	0.10	38	26	0.15
2	45	31	0.00	31	10	0.00	38	30	0.55	49	28	0.00	67	47	0.03	76	58	0.00	83	67	0.00	85	66	0.00	76	60	0.12	91	68	0.15	53	37	0.00	41	37	0.43
3	44	31	0.01	48	23	0.00	42	31	0.00	64	38	0.18	59	47	0.40	73	57	0.40	88	71	0.00	84	66	0.00	81	66	0.25	76	52	0.17	54	42	0.00	38	30	0.14
4	44	27	0.00	58	32	0.00	38	32	1.00	63	42	0.00	62	48	0.51	70	45	0.00	89	68	0.00	86	71	0.00	81	62	0.00	62	53	0.14	55	35	0.00	39	30	0.00
5	46	39	0.74	63	32	0.00	37	21	0.00	52	36	0.04	60	50	0.49	76	59	0.00	86	67	0.00	86	70	0.00	76	64	0.00	63	46	0.00	60	43	0.46	43	33	0.00
6	47	35	0.01	58	34	0.00	29	19	0.00	62	36	0.38	68	47	0.53	81	65	0.16	87	64	0.02	80	67	0.03	71	58	0.29	69	44	0.00	56	46	0.00	47	33	0.00
7	41	22	0.00	41	36	0.45	30	16	0.00	62	38	0.00	67	46	0.00	81	60	0.00	83	72	0.00	84	68	0.02	73	57	0.03	77	68	0.00	58	35	0.00	47	32	0.00
8	48	27	0.02	53	37	0.13	36	17	0.00	65	49	0.26	70	54	0.00	79	57	0.00	80	65	0.00	84	67	0.30	77	59	0.00	71	59	0.04	54	33	0.11	37	27	0.00
9	45	40	0.13	49	24	0.00	46	27	0.00	63	42	0.00	64	47	0.00	75	55	0.00	85	62	0.00	84	65	0.00	79	62	0.00	62	53	1.25	40	30	0.00	56	31	0.60
10	40	32	0.00	34	21	0.00	48	30	0.48	55	38	0.07	67	50	0.00	74	54	0.17	88	67	0.00	81	62	0.00	77	61	0.00	61	56	0.32	52	29	0.00	58	52	0.96
11	32	24	0.00	36	30	0.00	52	36	0.00	54	33	0.00	68	54	0.00	73	64	0.91	85	72	0.00	80	68	0.00	81	67	0.00	60	50	0.22	62	37	0.00	54	28	0.34
12	29	20	0.00	33	26	0.44	50	33	0.00	62	38	0.00	68	43	1.03	75	56	0.00	86	70	0.18	84	61	0.00	78	67	0.22	61	54	0.00	57	32	0.14	34	28	0.00
13	30	24	0.00	42	31	0.41	44	30	0.00	68	54	0.85	50	44	0.45	69	55	0.90	86	70	0.00	82	72	0.35	72	58	0.00	64	50	0.00	32	24	0.00	49	24	0.00
14	32	25	0.00	42	31	0.00	55	34	0.00	68	52	0.00	50	46	0.26	71	56	0.03	89	70	0.00	81	69	0.00	75	54	0.00	69	53	0.01	46	23	0.00	60	48	0.05
15	35	27	0.00	53	33	0.00	59	48	0.00	64	51	0.55	67	48	0.01	76	52	0.00	88	70	0.00	84	66	0.00	77	67	0.05	65	52	0.00	54	34	0.00	56	43	2.29
16	37	22	0.00	50	34	0.00	58	42	0.00	61	42	0.00	71	54	0.00	73	64	0.03	88	64	0.00	80	66	0.00	77	64	0.00	65	43	0.00	45	33	0.00	43	33	0.00
17	36	24	0.00	38	25	0.00	45	31	0.00	61	47	0.00	73	56	0.00	77	67	0.00	92	75	0.05	80	68	0.11	74	60	0.00	63	52	1.56	42	32	0.00	36	30	0.00
18	39	24	0.04	37	30	0.14	43	24	0.00	57	42	0.00	73	55	0.00	76	65	0.17	83	70	0.73	88	70	0.00	72	56	0.00	60	51	0.00	45	39	0.08	38	31	0.73
19	37	33	0.00	36	22	0.00	45	27	0.00	67	56	0.00	72	51	0.00	71	63	0.10	83	68	0.00	90	71	0.00	68	53	0.00	60	46	0.00	47	40	0.18	31	17	0.09
20	52	28	1.55	30	24	0.00	50	27	0.00	66	59	1.08	82	61	0.00	74	63	0.27	96	78	0.00	86	70	0.03	76	47	0.00	61	41	0.00	44	41	0.00	32	21	0.00
21	28	6	0.00	49	27	0.56	47	37	0.00	62	53	0.10	77	56	0.00	71	64	0.42	97	77	0.00	86	71	0.00	78	54	0.00	64	52	0.50	49	39	0.00	33	22	0.00
22	26	11	0.00	44	36	0.00	46	38	0.75	61	48	0.75	72	54	0.00	77	61	0.00	96	74	0.00	90	73	0.02	83	58	0.00	62	52	0.00	53	40	0.12	48	22	0.00
23	43	19	0.00	39	31	0.00	45	33	0.00	70	51	0.20	72	55	0.00	83	64	0.00	82	66	2.32	88	66	0.77	82	68	0.00	65	57	0.40	46	29	0.00	55	31	0.00
24	57	43	1.22	48	35	0.95	54	34	0.00	65	54	0.00	70	59	0.00	83	65	0.00	83	65	0.00	78	65	0.00	77	67	0.20	67	41	0.00	51	37	0.87	48	37	0.00
25	52	31	0.00	45	34	0.00	49	44	0.00	63	46	0.00	70	48	0.00	78	67	0.34	83	64	0.00	77	63	0.00	75	62	0.00	64	45	0.00	51	41	0.00	4	27	0.00
26	35	20	0.00	36	25	0.00	46	33	0.00	57	49	0.26	86	57	0.03	85	67	0.00	85	63	0.00	75	60	0.00	79	58	0.00	63	53	0.00	60	38	0.00	43	31	0.00
27	46	24	0.00	31	20	0.00	45	33	0.00	59	47	0.95	82	62	0.00	87	67	0.00	86	66	0.00	75	55	0.00	72	60	0.44	67	51	1.44	59	40	0.00	53	40	0.00
28	42	24	0.00	37	30	0.00	49	27	0.00	51	43	0.04	78	58	0.00	88	66	0.00	85	69	0.05	73	63	0.30	77	55	0.00	67	52	0.00	55	43	0.00	49	40	0.00
29	39	24	0.00				56	41	0.00	56	42	0.00	66	51	0.00	89	70	0.00	88	70	0.00	81	68	0.00	78	68	0.00	60	51	0.02	43	33	0.00	43	33	0.00
30	42	23	0.25				65	44	0.00	53	45	0.44	68	53	0.62	86	64	0.27	90	73	0.00	82	58	0.00	75	58	0.00	64	57	0.08	41	31	0.00	40	38	1.04
31	31	5	0.00				58	43	0.18				77	56	0.86				87	72	0.00	80	67	0.00				70	60	0.14				43	36	0.38
Avg/ Sum	41	26	5.01	42	28	3.08	46	32	2.96	60	44	6.15	69	52	5.22	77	61	4.17	87	69	3.35	83	67	1.93	77	61	1.60	66	52	6.44	51	36	2.06	43	32	7.20