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Agreement number: 791N7700191

Final Performance Report

Reporting Period: March 2, 2017 to September 30, 2018

Submitted: October 31, 2018

Project Title: *The Worst of the Worst MI Nursery Weeds: Evaluation of Adjuvant + Herbicide Combinations*

Project Impact and Findings

The Michigan Nursery and Landscape Association that led and executed this project was concerned in 2016 about the invasive nature and lack of controls available for the five "worst weeds" identified in this grant. A primary outcome was to find one single and one combination control for each weed, for the target audience of MI nursery growers, so that a total of 10 optimum controls were discovered. Yet, by the conclusion of the grant, we had found 17 controls, surpassing grant outcomes by 70%. To enhance the competitiveness of nursery, in the MI specialty crop industry, 2000 growers were educated in several new-science based tools (i.e. herbicides/herbicide timings) via two trade presentations, two workshops and three trade magazine articles, exceeding outcome by 6.7 times. Lontrel T&O was a component of the optimum herbicide combinations for three of the five "worst weeds," achieving 83% or better control, even into the next spring. In a target audience survey, 63% of nursery growers had never heard of Lontrel before this research. Pyroxasulfone as a component of V-10233 or Fierce which was part of the optimum herbicide combinations for all five "worst weeds," achieving 70% or better control, even into the next spring. Before this program, 100% of growers had never heard of pyroxasulfone. Another major objective of this grant was evaluating herbicides with and without adjuvants. The addition of a silicon adjuvant was found essential to control and/or extended control of all five "worst weeds" and 81% of growers had never heard of using silicon adjuvants before this research.

Beneficiaries

Number of project beneficiaries: 2000

Activities Performed

A. Research activities:

Table 1 (page 3-4), summarizes the 117 herbicide tests conducted as the research activities of this grant, at six Michigan nurseries, for six difficult weeds. Four of the original five "worst weed" species, *Equisetum arvense* (Field horsetail), *Cyperus esculentus* (Yellow nutsedge), *Rorippa sylvestris* (Creeping yellow cress) and *Erodium cicutarium* (Red stem filaree) are presented and one additionally species, *Equisetum hyemale* (Scouring rush), not listed in the proposal was investigated. Additionally, a minor study of *Marchantia polymorpha* (Liverwort), another difficult propagation nursery weed in MI was studied. Unfortunately, enough *Artemisia vulgaris* (Mugwort), the fifth of the five original weeds, could not be found. Nonetheless, with the introduction of the scouring rush and liverwort experiments, we were able to exceed the grant objectives and investigate six versus five of Michigan's "worst weeds." Tables 2-15 detail the research activities from March 2017 through September 30, 2018. Table 1 presents the number of new controls, by species, as recorded from tables 2-15, and the herbicides that constituted these new controls. Table 1 also presents the number of sites, treatments and evaluation dates by species, the table number (i.e. table 2-15) of the data source, and the nursery site name. Additionally, the efficiency rating, on a scale of 0-10, where 10 is perfect control, 0 is no control and $\geq$ 7 is commercially acceptable and on what date (weeks after treatment, WAT) is given. Because so many new controls were developed in the

grant, we decide to provide the "best of the best" or optimum controls in bolded text. In tables 2-15, phytotoxicity is also indicated where conducted and if ratings above 0 (no injury) occurred.

B. Survey activities:

Fig. 1, 2 and 3 summarizes workshop activities conducted. Survey responses we gathered in order to meet Outcome 4, indicator 2a and 2b (Fig. 1); Outcome 5, indicator 5,6 and 8 (Fig. 2-3). Originally, these outcomes were to be meet with field days; however, we found workshops were a better way to collect the survey data required for the outcomes. Originally, we had hoped to 50 growers/ producers at the first field day. We had 50 attendees at the first workshop; however, only 38 participants submitted completed surveys to tally into the results in Fig. 1. Likewise, for the second field day we had hoped to get 30 first responders to train. We got the 55 attendees at our second workshop but only 17 completed the survey to be tallied in Fig. 2 and 3.

The questions (1-12) asked for the data represented in Fig. 1 are listed below and indicated by their respective numbers on the X axis of Fig. 1 i.e. (1-12). On the Y axis the number of survey participants responding with the **incorrect** answer are listed. Where no bar is presented above a question number, on the X axis, there were no incorrect answers. At the end of this workshop 100% of people responded that they had improved their weed identification abilities by 50%.

The questions (1-16) asked for the data represented in Fig. 2, 3 and 4 are listed below and indicated by their respective numbers on the X axis of Fig. 2, if the responses required a Yes or No response (i.e. 5-10 and 13). The X-axis of Fig. 3 lists the responses to questions 11-12, where the answers were categorized as correct or incorrect responses. The responses to questions (14-16) are summarized below. Qu. 14 - 88% of participants indicated they are spending more than 50% of their current work time on weed control. Qu. 15. – 47% or respondents thought one thing learned from the program was worth up to $3,000.00 to the business they own or work at, and 12% thought one new thing was worth up to $26,000. Qu. 16. – 71% indicated they can tolerate a 10% weed cover and no one could tolerate more than 20%. Qu. 1-4 responses were presented in **impact and findings**.

<u>Second workshop survey questions:</u>

1. Before this program had you, heard of Lontrel T&O (Clopyralid)? Yes No (Circle)
2. Before this program had you, heard of Pyroxasulfone? Yes No (Circle)
3. Before this program had you, heard of Silcon adjuvants? Yes No (Circle)
4. Before this program …….ProSedge (Halosulfuron-methyl)? Yes No (Circle)
14. How important is weed control in your business. Answer based on time spent by self or other staff engaged in weed control activities including weeding hoeing, applying herbicides, etc.:

a) 0-25% of time -- 47% responded A
b) 26-50% of time --- 41% responded B
c) 50-75% of time -- 12% responded C

15. How much money do you think one thing you learned in this program will save you/your boss?
    a) 1,000 to 3,000 ---- 47% responded A.
    b) 4,000 to 8,000 ----- 41% responded B
    c) 9,000 to 12,000
    d) 13,000 to 26,000 --- 12% responded D
    e) More than $27,000
16. What tolerance (in percent cover) do you have for weeds in your nursery/landscape operation:
    a) 10% or less
    b) 20% or less
    c) 30% or less
    d) 40% or less

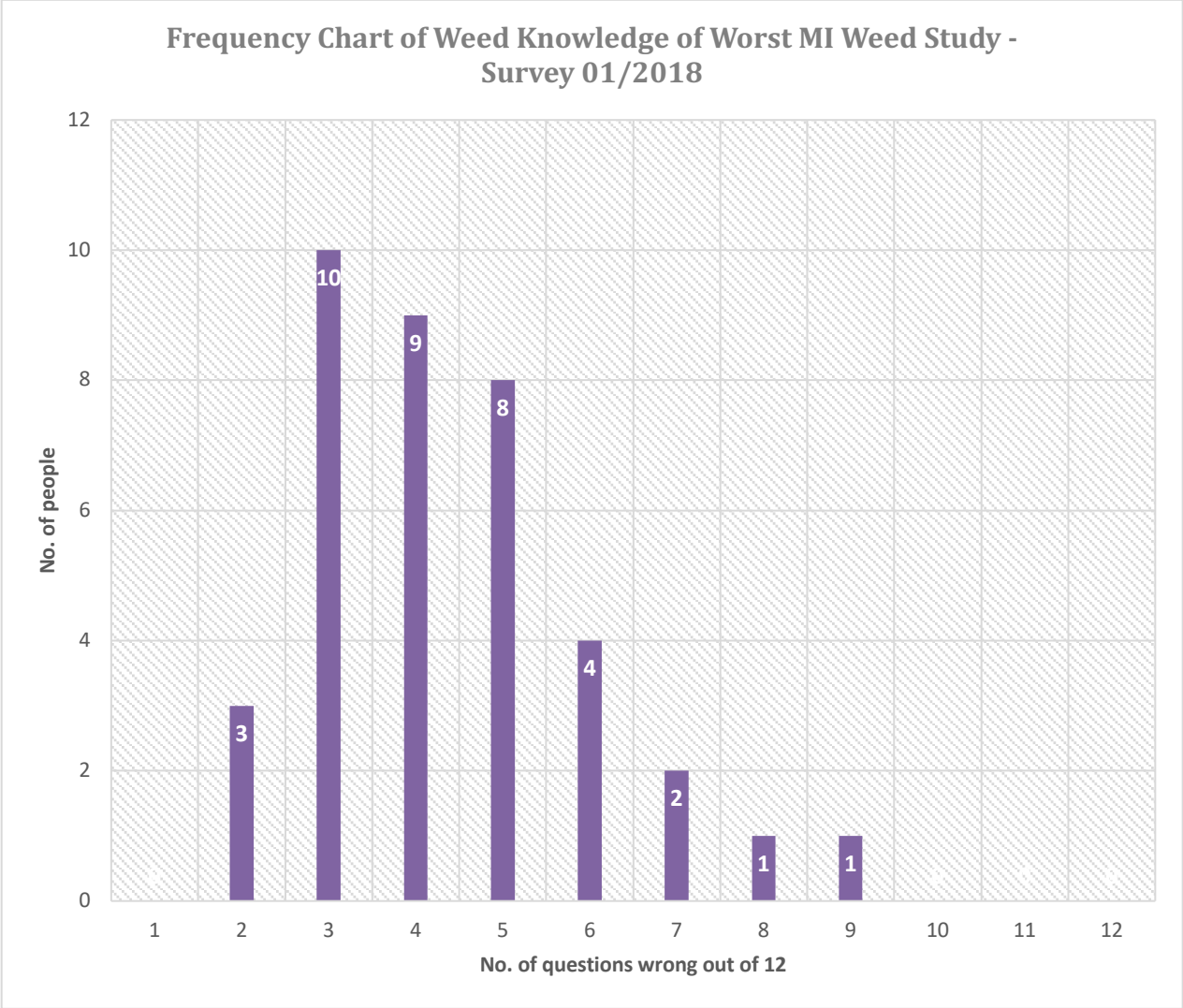

Fig. 1. Survey responses gathered from our first workshop to meet Outcome 4, indicator 2a and 2b. The number of survey participants responding with the **incorrect** answers are listed. Where no bar is presented there were no incorrect answers for that question. Questions were: 1. Is this a monocot or dicot weed? 2. Does this grass have a membranous, hairy, or fringed membranous ligule, or none? 3. Are the leaves on this weed sessile? 4. What type of perennial structure does this weed have? 5. Name the weed? 6.Name the weed family? 7. Name the weed? 8. Name the weed? 9. Name the weed? 10. Are the leaves on this weed opposite, alternate, or whorled? 11. What type of auricles does this weed have? 12. Is this weed a perennial, winter annual or biennial?

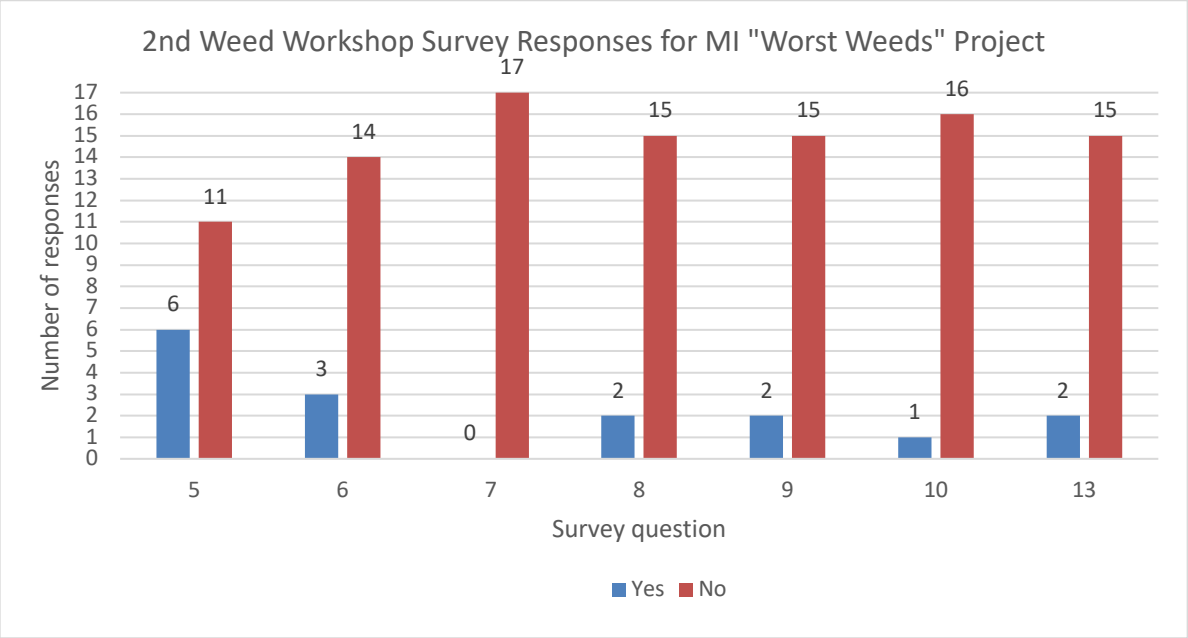

Fig. 2. Survey responses gathered from our second workshop to meet Outcome 5, indicator 5, 6 and 8. The number of survey participants responding with Yes or No answers to questions 5 -10 and 13 listed below. Qu. 5. Before this program had you, heard of *Rorippa sylvestris,* Creeping Yellow Cress or KIK? 6. Do you have *Rorippa sylvestris* in your fields, containers or landscapes? 7. Before this program did you know how to control *Rorippa sylvestris?* 8. Before this program had you, heard of *Erodium cicutarium,* Red Stem Filaree? 9. Do you have *Erodium cicutarium* in your fields, containers or landscapes? 10. Before this program did you know how to control *Erodium cicutarium*? 13. Do you think more than one preemergence herbicide application is necessary/yr.?

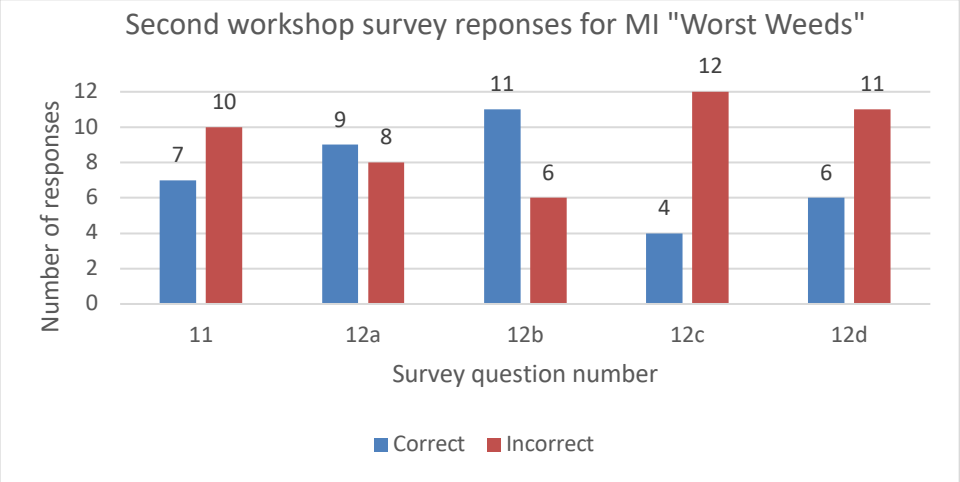

Fig. 3. Survey responses gathered from our second workshop to meet Outcome 5,indicator 5, 6 and 8. Qu. 11. What characteristics define field horsetail **but not** scouring rush: a)Two distinct stem types one for reproduction and one for the vegetative stage. B. There are no differences between field horsetail and scouring rush they are the same species. C. The roots look much like the stems, without chlorophyll. D. Stems can reach 5 ft. tall. E. Stems are whorled with repeat branching and can take on the appearance of a small pine tree. A and F were correct. Qu. 12. Indicate true or false about the following statements: A. Yellow nutsedge emergences occurs only in the spring. False was correct. B. Yellow nutsedge is not a true tuber? False was correct. C. Sandea, Permit and SedgeHammer are other herbicides with halosulfuron? True was correct. D. ProSedge is excellent alone for nutsedge control year one and into year two? False was correct.

C. *Outreach activities:* Presentations (3) and Articles (5)

Presentations:
Mathers, H.M. 2018. The worst of the worst MI nursery weeds. Presented at Great Lakes Trade Exposition (GLTE) by the Michigan Nursery and Landscape Association to 140 industry members. Lansing, MI. (January 22). (120 attendees)

Mathers, H.M. 2018. Weed identification 3-hour hands-on session. Presented at Great Lakes Trade Exposition (GLTE) by the Michigan Nursery and Landscape Association to 40 industry members.(Attendance was limited to first come). Lansing, MI. (January 22). (50 attendees)

Mathers, H.M. 2018. A beginner's guide to herbicide modes of action. Presented at Great Lakes Trade Exposition (GLTE) by the Michigan Nursery and Landscape Association to 120 industry members. Lansing, MI. (January 23). (100 attendees)

Articles:

Michigan Nursery and Landscape Association. The Michigan Landscape	Circ. 8,200

Mathers, H.M. 2018. Bindweed and its look a-likes. Michigan Landscape: 61(5):31-36.

Mathers, H.M. 2018. The primitives. Part 1: Liverwort. Michigan Landscape: 61(1):34-38.

Mathers, H.M. 2017. The five most unwanted Midwest nursery weeds. Part 5. Field Horsetail. The Michigan Landscape. 60(4):44-47.

Mathers, H.M., E.J. Beaver. 2016. The five most unwanted Midwest nursery weeds. Part 4. Red stem filaree (Erodium cicutarium) The Michigan Landscape. 59(6):44-47

Mathers, H.M. 2016. The five most unwanted Midwest nursery weeds – Part 3: Yellow nutsedge. The Michigan Landscape. 59(5): 32-34.

Results.

Table 1. Summary table of results of 117 herbicide tests (Tables 2-15) conducted at six Michigan (MI) nurseries, Kluck Nursery (K), Inc., Saginaw, MI (Tables 2 and 8); Ray Wiegand's Nursery (RW), Lenox, MI (Tables 3, 5, 9 and 13); Northland Farms (NF), LLC, West Olive, MI (Tables 4 and 7); Gardens Alive Farms (GA), Grand Haven, MI (Tables 4, 7 and 9); Walters Gardens (WG), Inc., Zeeland, MI (Tables 11 and 14); and Spring Meadow (SM) Nursery, Inc., Grand Haven, MI (Table 15) for control of six noxious weed species *Equisetum arvense* and *Equisetum hyemale*; *Cyperus esculentus, Rorippa sylvestris, Erodium cicutarium* and *Marchantia polymorpha*, during the period of May 2017 to Sept. 30, 2018. The note Re A indicates reapplication is required, as at the next evaluation the treatment was providing below commercially acceptable efficacy. A new control is only listed if it was above commercially acceptable at all sites tested. Optimum controls are highlighted in bold.

Scientific name	Common name	No. of Sites & /Treatments &/ Evals	No. of new controls	New Control Product	Table No./ Nursery	Rating/ Eval date	Notes
Equisetum arvense	Field Horsetail	2/ 14/ 3	**2**	Lontrel + V-10233 + Vestis 1X	3/ RW	**9.0 -14 WAT**	
		/ 2		Tower 6EC + Dimension 2EW 1X	2/ K	7.5 – 6 WAT	Re A
Equisetum hyemale	Scouring Rush	1/ 9/ 1	**1**	Prosedge + V-10233 + Vestis 1X	4/ NF	**7.0 – 5 WAT**	
Cyperus esculentus	Yellow Nutsedge	4/ 30/ 3 / 3 / 1	**5**	Prosedge 1X Prosedge 2X	5/ RW 6/ GA 7/ NF	**9.0 – 9 WAT** 9.3 – 5 WAT 7.3 – 5 WAT	ReA ReA
				Prosedge + Vestis 1X	5/ RW 6/ GA 7/ NF	**9.6 – 9 WAT** 7.0 – 44 WAT 7.5 – 5 WAT	Re A
				Rodeo (2X) + V-10233 + Vestis Rodeo (1X) + V-10233 + Vestis Rodeo + V-10233 1X	6/ GA 7/ NF 7/ NF	**10 – 44 WAT** 9.3 -5 WAT 7.5 – 5 WAT	
		/ 2 / 2		Rodeo+MarengoSC + V10233 (1X) Rodeo+MarengoSC + V10233 (2X)	8/ K 8/ K	7.7 – 11 WAT 8.5 – 11WAT	
				Prosedge + V-10233 + Vestis (1X) Prosedge + V-10233 (2X)	6/ GA 7/ NF 8/ K	**9.0 – 44 WAT** 10 – 5 WAT **7.5 – 11 WAT**	

Rorippa sylvestris	Creeping Yellow Cress	3/ 23/ 3 / 3 / 3	**5**	Rodeo + V-10233 + Vestis 1X Rodeo + V-10233 (2X)	9/ RW 10/ GA 11/ WG	**10 -14 WAT** **7 – 40 WAT** **9.6 – 16 WAT**	Re A
				Prosedge + Vestis (1X)	9/ RW 11 /WG	**10 -14 WAT** **9.6 – 16 WAT**	
				Prosedge + V-10233 + Vestis (1X)	11/ WG	9.6 – 16 WAT	
				Lontrel + V-10233	10/ GA	7.3 – 40 WAT	ReA
				Lontrel + V-10233 + Vestis	**10/ GA**	**8.3 – 44 WAT**	
Erodium cicutarium	Red stem filaree	3/ 23/ 1	**4**	Rodeo + V-10233 + Vestis	12/ GA	10 – 5 WAT	
		/ 3		V-10233 + Vestis	12/ GA 13/ RW	10 – 5 WAT **9.0 – 14 WAT**	
		/ 4		Prosedge + V-10233 (2X)	14/ WG	7 – 16 WAT	
				Lontrel + V-10233 + Vestis	12/ GA 13/ RW	10 – 5 WAT **10 – 14 WAT**	
Marchantia polymorpha	Liverwort	1/ 16/ 2	2	1701B + CT + E Mn	15/ SM	9 -3 WAT	
				1701B	15/ SM	6 – 15 WAT	
Total							

Table 2. Horsetail (*Equisetum arvense*) at Kluck Nursery, Inc., Saginaw, MI weed fresh weight at trial initiation on March 29, 2018 under light rain and 45°F, and efficacy ratings taken at 6 and 11 WAT. Various herbicides applied alone or combined with surfactants to fulfill Obj. 1 & 4. The legend for all tables is after table 13. The study was conducted between rows of white spruce which showed no phytotoxicity.

No.	Treatment		**Rate/ac** (unless noted otherwise)	**Initial fresh wt. (g)**	**Eff. 6WAT 05/11/18**	**Eff. 11WAT 06/14/18**	**Average Efficacy**
1	Rodeo + Vestis	1X	2 qt/100 gal + 0.75 pt/100 gal	67.51	5.0	1.3ab	3.2a
		2X	4 qt/100 gal + 1.5 pt/100 gal		5.5	1.8bc	3.7ab
2	Rodeo + V-10233 + Vestis	1X	2 qt/100 gal + 7.5 oz/ac + 0.75 pt/100 gal	88.5	6.8	5.3de	6.1cd
		2X	4 qt/100 gal + 15 oz/ac + 1.5 pt/100 gal		**8.0**	3.0c	5.5cd
3	Tower 6EC + Dimension 2EW	1X	0.98 lb ai/ac + 0.38 lb ai/ac		**7.5**	5.8de	6.7d
		2X	1.96 lb ai/ac + 0.76 lb ai/ac		6.5	6.5e	6.5d
4	Tower 6EC + Basagran + Vestis	1X	0.98 lb ai/ac + 2 qt + 0.75 pt/100 gal		6.5	3.3c	4.9bc
		2X	1.96 lb ai/ac + 4 qt + 1.5 pt/100 gal		6.0	4.8d	5.4cd
5	Control			70.1	5.3	0a	2.7a

Table 3. Horsetail (*Equisetum arvense*) at Ray Wiegand's Nursery, West Farm, Lenox, MI, weed fresh weight at trial initiation on May 31, 2017 and efficacy ratings taken at 3, 9 and 14 WAT. Various herbicides applied alone or in combination with different surfactants to fulfill Obj. 1 & 4 of the grant as directed applications to the base of blue spruce which showed no phyto. The legend for all tables is after table 13.

Table 4. Scouring rush (*Equisetum hyemale*) at Northland Farms, LLC, West Olive, MI weed fresh weight at trial initiation on August 9, 2017 and efficacy ratings taken at 5 WAT. Various herbicides applied alone or in combination with different surfactants to fulfill Obj. 1 and 4.

No.	**Treatment**	**Rate/ac** (unless noted otherwise)	**Initial fresh weed wt. (g)**	**Initiation Weed Calc. GI (in^3)**	**Efficacy 3 WAT[Z]**	**Efficacy 9 WAT[Z]**	**Efficacy 14 WAT[Z]**	**Average Efficacy**
1-3	Lontrel™	16 oz	191.83a	89.7b	0.0a [X]	0.0a	0.0a	0.0a
1-1	Lontrel™ + Vestis™*	16 oz + 0.75pt/100 gal			2.0b	0.0a	0.0a	0.7a
3-3	Rodeo®	2qt/100gal	265.0ab	32.8a	0.0a	0.0a	0.0a	0.0a
3-1	Rodeo® + Vestis™*	2qt/100gal + 0.75pt/100 gal			6.0c	4.5c	5c	5.2c
5-1	Lontrel™ + V-10233✓ + Vestis™*	16 oz + 7.5 oz+ 0.75pt/100 gal			**9.0 d**	**10.0d**	**9.0d**	**9.3d**
7-3	Nufarm Prosedge™ 2	2 oz	336.0b	98.8b	0.0a	0.0a	0.0a	0.0a
7-2	Nufarm Prosedge™ 2 + Persist® Ultra≠	2 oz + 3 pt/100 gal			0.0a	2.0b	0.0a	0.0a
7-1	Nufarm Prosedge™ 2 + Vestis™*	2 oz + 0.75 pt/100 gal			2.0b	3.3bc	2.0b	2.4b
10	Control	0	264.3ab	73.8b	0.0a	0.0a	0.0a	0.0a

Mowing of the application area which was a ditch bank, had occurred 2 weeks before. The legend for all tables is after table 13.

No.	Treatment	Rate/ac (unless noted otherwise)	Initial fresh weed wt. (g)	Efficacy 5 WAT[Z]
1.	V-10233 + Vestis™	7.5 oz + 0.75 pt/100 gal	67.51b	0.3a
2.	Lontrel™ + V-10233 + Vestis™	16 oz + 7.5 oz + 0.75 pt/100 gal		2b
3.	Lontrel™ + V-10233	16 oz + 3 pt/100 gal		2.3b
4.	Rodeo® + V-10233 + Vestis™*	2 qt/100gal + 7.5oz/ac + 1.5pt/100 g		2.3b
5.	Rodeo® + Vestis™*	2 qt/100 gal + 0.75 pt/100 gal		2.3b
6.	Rodeo® + V-10233	2 qt/100 gal + 0.75 pt/100 gal		2.8b
7.	Nufarm Prosedge™ 2	2 oz	88.5b	3.3c
8.	Nufarm Prosedge™ 2 + Vestis™*	2 oz + 0.75 pt/100 gal.		5.5d
9.	Prosedge™ + V-10233 + Vestis™	2 oz + 7.5 oz/ac + 0.75 pt/100 gal.		**7.0e**
10.	Tower + Vestis + OHP 1701B	0.98 lb ai/ac + 0.75 pt/100 gal + 150 lb		0.0a
11.	Control	0	38.77a	0.0a

Table 5. Yellow Nutsedge (*Cyperus esculentus*) at Ray Wiegand's Nursery, Main Growing Farm, Lenox, MI, weed fresh weight at trial initiation on May 31, 2017 and efficacy ratings taken at 3, 9 and 14 WAT. Various herbicides applied alone or in combination with different surfactants to fulfill Obj. 1 and 4 of the grant.

Table 6. Yellow Nutsedge (*Cyperus esculentus*) at Gardens Alive Farms, Grand Haven, MI, weed heights and growth index (GI) at trial

No.	Treatment	Rate/ac (unless noted otherwise)	Initial fresh weed wt. (g)	Initiation Weed Calc. GI (in^3)[t]	Eff. 3 WAT [Z]	Efficacy 9 WAT[Z]	Efficacy 14 WAT[Z]	Average Efficacy
1-3	Lontrel™	16 oz	56.31b	2.64c	0.0a [X]	0.0a	0.0a	0.0a
1-2	Lontrel™ + Persist® Ultra[≠]	16 oz + 3 pt/100 gal			3.3b	0.3a	0.0a	1.2ab
1-1	Lontrel™ + Vestis™*	16 oz + 0.75pt/100 gal			2.6b	2.6bc	2.7b	2.6b
6-3	Marengo® SC	9 oz	38.82ab	4.16d	0.0a	1.0ab	1.7b	0.9ab
6-1	Marengo SC + Vestis™*	9 oz + 0.75pt/100 gal			0.0a	2.0bc	2.0b	1.3ab
7-3	Nufarm Prosedge™ 2	2 oz	31.89a	0.70a	**9.0c**	**9.0d**	5.3c	**7.8c**
7-1	Nufarm Prosedge™ 2 + Vestis™*	2 oz + 0.75 pt/100 gal			**8.6c**	**9.6d**	6.7c	**8.3d**
9-3	FreeHand® 1.75G	150 lb			2.3b	3.3c	1.0ab	2.2b
10-3	Control	0	42.34ab	2.50c	0.0a	0.0a	0.0a	0.0a

initiation on August 9, 2017 and efficacy ratings taken at 5 WAT, 40 and 44 WAT. Various herbicides applied alone or in combination with

different surfactants to fulfill Obj. 1 and 4. The trial area was ditch bank and was mowed just before application and collection of measures. The legend for all tables is after table 13.

No.	Treatment	Rate/ac (unless noted otherwise)	Initiation Ht.[i] (in)	Initiation Weed Calc. GI (in^3)	Efficacy 5 WAT[Z]	Efficacy 40 WAT[Z]	Efficacy 44 WAT[Z]	Average Efficacy
4.	(2X) Rodeo® + V-10233 + Vestis™*	4qt/100gal + 15oz + 1.5pt/100 gal	15.3a	514.50b	**10.0a** [X]	**10.0 a**	**10a**	**10a**
7.	(2X) Nufarm Prosedge™ 2	4 oz	16.3a	1155.0c	**9.3ab**	5.5c	4.0c	6.3b
8.	Nufarm Prosedge™ 2 + Vestis™*	2 oz + 0.75 pt/100 gal.			**8.0b**	**8.0b**	**7.0b**	**7.7b**
9.	Prosedge™ + V-10233 + Vestis™	2 oz + 7.5 oz + 0.75 pt/100 gal.			**9.8a**	**9.5a**	**9.0a**	**9.4a**
11.	Control	0	13.3a	148.7a	0.0c	0.0d	0.0d	0.0c

Table 7. Yellow Nutsedge (*Cyperus esculentus*) at Northland Farms, LLC, West Olive, MI weed fresh weight at trial initiation on August 9, 2017, mowed July 27 and efficacy ratings taken at 5 WAT. Various herbicides applied alone or in combination with different surfactants to fulfill Obj. 1 and 4. Mowing of the application area which was a ditch bank, had occurred 2 weeks before. The legend for all tables is after table 13.

No.	Treatment	Rate/ac (unless noted otherwise)	Initiation Weed Calc. GI (in^3)	Efficacy 5 WAT[Z]
1.	V-10233 + Vestis™	7.5 oz + 0.75 pt/100 gal	514.50b	0.3a
2.	Lontrel™ + V-10233 + Vestis™	16 oz + 7.5 oz/ac + 0.75 pt/100 gal		4.7b
3.	Lontrel™ + V-10233	16 oz + 3 pt/100 gal		3.5b
4.	Rodeo® + V-10233 + Vestis™*	2 qt/100gal + 7.5oz + 1.5pt/100 g		**9.3d**
5.	Rodeo® + Vestis™*	2 qt/100 gal + 0.75 pt/100 gal		**7.0c**
6.	Rodeo® + V-10233	2 qt/100 gal + 0.75 pt/100 gal		**7.5c**
7.	Nufarm Prosedge™ 2	4 oz	1155.0c	**7.3c**
8.	Nufarm Prosedge™ 2 + Vestis™*	2 oz + 0.75 pt/100 gal.		**7.5c**
9.	Prosedge™ + V-10233 + Vestis™	2 oz + 7.5 oz/ac + 0.75 pt/100 gal.		**10.0**
10.	Tower + Vestis + OHP 1701B	0.98 lb ai/ac + 0.75 pt/100 gal + 150 lb/ac		0.0a
11.	Control	0	148.7a	0.0a

Table 8. Yellow Nutsedge (*Cyperus esculentus*) at Kluck Nursery, Inc., Saginaw, MI weed fresh weight at trial initiation on March 29, 2018 and efficacy ratings taken at 6 and 11 WAT. Various herbicides applied alone or combined with surfactants to fulfill Obj. 1 & 4. The legend for all tables is after table 13. The trail was conducted within the rows of White pine which showed no phytotoxicity at any time.

No.	Treatment		Rate/ac (unless noted otherwise)	Initial fresh wt. (g)	Eff. 6WAT 05/11/18	Eff. 11WAT 06/14/18	Average Efficacy
1	V-10233	1X	7.5 oz		9.0bc	6.0b	7.5b
		2X	15 oz		8.0b	6.8bc	7.4b
2	ProSedge + V-10233	1X	2 oz + 7.5 oz		8.3bc	6.5bc	7.4b
		2X	4 oz + 15 oz		**8.8bc**	**7.5c**	**8.2b**
3	Marengo SC + Basagran + Vestis	1X	7.5 oz + 24 oz + 0.75 pt/100 gal		4.7a	0.0a	2.4a
		2X	15 oz + 48 oz + 1.5 pt/100 gal		5.5a	0.0a	2.8a
4	Rodeo + Marengo SC + V-10233	1X	2 qt/100 gal + 7.5 oz + 0.75 pt/100 gal		**9.7c**	**7.7c**	**8.7b**
		2X	4 qt/100 gal + 15 oz + 1.5 pt/100 gal		**9.0bc**	**8.5c**	**8.8b**
5	Control			373.38	5.3a	0.0a	2.7a

Table 9. Creeping Yellow Cress (*Rorippa sylvestris* L.), at Ray Wiegand's Nursery, Lenox, MI, weed fresh weight at initiation on May 31, 2017 and efficacy ratings taken at 3, 9 and 14 WAT. Various herbicides applied as directed applications to blue spruce without injury.

No.	Treatment	Rate/ac (unless noted otherwise)	Initial fresh weed wt. (g)	Initiation Weed GI (in^3)	Efficacy 3 WAT[Z]	Efficacy 9 WAT[Z]	Efficacy 14 WAT[Z]	Average Efficacy
1-3	Lontrel™	16 oz	82.46a	1672.76a	2.3b [X]	0.0a	0.0a	0.8ab
1-2	Lontrel™ + Persist® Ultra[≠]	16 oz + 3 pt/100 gal			3.0b	0.0a	0.0a	1.0ab
1-1	Lontrel™ + Vestis™*	16 oz + 0.75 pt/100 gal			5.3c	1.4a	0.0a	2.2b
2-3	V-10233[✓]	7.5 oz	230.15c	2138.10b	**7.7de**	6.3c	3.0b	5.7c
2-1	V-10233[✓]+ Vestis™*	7.5 oz + 0.75 pt/100 gal			**9ef**	**7.7cd**	**7.6c**	**8.1d**
4-1	Rodeo® + V-10233 + Vestis™*	2qt/100gal + 7.5 oz/ac + 0.75 pt/100 gal	143.48b	1560.60a	**10f**	**10e**	**10d**	**10e**
7-3	Nufarm Prosedge™ 2	2 oz/ac			6.6cd	4b	3b	4.5c
7-2	Nufarm Prosedge™ 2 + Persist® Ultra[≠]	2 oz/ac + 3 pt/100 gal			**7.3d**	**8d**	**7.0c**	**7.4d**
7-1	Nufarm Prosedge™ 2 + Vestis™*	2 oz/ac + 0.75 pt/100 gal			**10f**	**10e**	**10d**	**10e**
9-3	FreeHand® 1.75G	150 lb/ac			1.7b	0.0a	0.0a	0.6a
10-3	Control	0 + 0	152.03b	1790.49a	0.0a	0.0a	0.0a	0.0a

Table 10. Creeping Yellow Cress (*Rorippa sylvestris* L.), at Gardens Alive Farms, , Grand Haven, MI, weed heights and growth index (GI) at trial initiation of August 9, 2017 and efficacy ratings taken at 5, 40 and 44 WAT. Various herbicides applied alone or in combination with different surfactants to fulfill Obj. 1 and 4. The application area which was a ditch bank was mowed 2 days before application and collection of weed measures. The legend for all tables is after table 13.

No.	Treatment	Rate/ac (unless noted otherwise)	Initiation Ht.[i] (in)	Initiation Weed Calc. GI (in^3)[t]	Efficacy 5 WAT[Z]	Efficacy 40 WAT[Z]	Efficacy 44 WAT[Z]	Average Efficacy
1.	V-10233 + Vestis™	7.5 oz/ac + 0.75 pt/100 gal	7.0a	588.9a	6.0c	6.0c	5.8c	5.9cd
2.	Lontrel™ + V-10233 + Vestis™	16 oz + 7.5 oz/ac + 0.75 pt/100 gal			**9.0d**	**9.0d**	**8.3d**	**8.8e**
3.	Lontrel™ + V-10233	16 oz + 3 pt/100 gal			**9.3d**	**7.3c**	**4.3c**	**7.0d**
4.	Rodeo® + V-10233 + Vestis™*	2 qt/100gal + 7.5oz/ac + 1.5pt/100 g	5.7a	408.7a	**8.0b**	**7.0c**	0.8a	5.3c
5.	Rodeo® + Vestis™*≠	2 qt/100 gal + 0.75 pt/100 gal			3.3b	1.5a	0.8a	1.4a
6.	Rodeo® + V-10233	2 qt/100 gal + 0.75 pt/100 gal			5.5c	4.0b	2.8b	3.1b
11.	Control	0	9.0a	350.6a	2.5a	1.5a	0.0a	1.2a

Table 11. Creeping Yellow Cress (*Rorippa sylvestris* L.), also known as Kik, at Walters Gardens, Inc., Zeeland, MI. There were no weeds present at time of initiation on 02/22/2018, so no weed weights could be taken; however, the trail was conducted as over-the-top applications on established dormant *Hemerocallis* 'Passion Return' planted rows 06/29/2015. The field was abandoned in 2017 due to infestation from Kik. Starting and ending measures of daylily heights were conducted. Phytotoxicity and efficacy is presented at 5, 12 and 16 WAT.

No	Treatment		Rate/ac (unless noted otherwise)	Start Ht.[i] (in)	Ending Ht (in)	Eff. 5 WAT[Z]	Phyto. 5 WAT[Z]	Eff. 12 WAT[Z]	Phyto. 12 WAT[Z]	Eff. 16 WAT[Z]	Phyto. 16 WAT[Z]	Av. Eff.	Av. Phyto.
1	Rodeo® + V-10233	1X 2X	2qt/100gal + 7.5oz + 0.75 pt/100 4qt/100gal + 15oz + 1.5 pt/100gal	0.6	15	**9.6** **10**	6.6 7.0	**9.6** **10**	4.4 3.6	**7.2** **9.6**	4.6 2.4	**8.8** **9.9**	5.2 4.3
2	Nufarm Prosedge™ 2	1X 2X	2 oz 4 oz	0.8		**10** **10**	7.0 5.8	**9.8** **9.8**	4.4 5.2	**9.8** **8.4**	3.8 2.2	**9.9** **9.4**	5.1 4.4
3.	Nufarm Prosedge™ 2 + Vestis™*	1X 2X	2 oz + 0.75 pt/100 gal. 4oz + 1.5 pt/100 gal	0.6	12	**10** **9.8**	7.6 6.4	**10** **9.8**	3.6 5.6	**9.6** **9.2**	4.6 4.8	**9.9** **9.6**	5.3 5.6
4	Prosedge™ + V-10233 + Vestis™	1X 2X	2 oz + 7.5 oz + 0.75 pt/100 gal. 4 oz + 15 oz + 0.75 pt/100 gal	0.8	24	**10** **10**	6.2 5.6	**9.6** **10**	4.2 5.2	**9.6** **8.6**	3.6 2.0	**9.7** **9.5**	4.7 4.3
5	Control		0	1.0	18	**9.6**	3.0	4.2	2.9	3.2	2.8	5.7	2.9

Table 12. Red stem filaree (*Erodium cicutarium*) at Gardens Alive Farms, Grand Haven, MI, weed fresh weight at trial initiation on May 31, 2017 and efficacy ratings taken at 5 WAT. Various herbicides applied alone or in combination with different surfactants to fulfill Obj. 1 and 4. The area was a ditch bank and was mowed 2 days before application and collection of measures.

No.	Treatment	Rate/ac	Initiation Ht.[i] (in)	Initiation Weed Calc. GI (in^3)[t]	Efficacy 5 WAT[Z]
1.	V-10233 + Vestis™	7.5 oz/ac + 0.75 pt/100 gal	1	102.1	**10.0c**
2.	Lontrel™ + V-10233 + Vestis™	16 oz + 7.5 oz/ac + 0.75 pt/100 gal			**10.0c**
3.	Lontrel™ + V-10233	16 oz + 3 pt/100 gal			**8.0b**
4.	Rodeo® + V-10233 + Vestis™*	2 qt/100gal + 7.5oz/ac + 1.5pt/100 g	0.8	58.0	**10.0c**
5.	Rodeo® + Vestis™*≠	2 qt/100 gal + 0.75 pt/100 gal			6.8b
6.	Rodeo® + V-10233	2 qt/100 gal + 0.75 pt/100 gal			6.8b
11.	Control	0	0.8	59.8	0.0a

Table 13 . Red stem filaree (*Erodium cicutarium*), at Ray Wiegand's Nursery, West Farm, Lenox, MI, weed fresh weight at trial initiation, May 31, 2017 and efficacy ratings taken at 3, 9 and 14 WAT. Herbicides applied to fulfill Obj. 1 and 4.

No.	Treatment	Rate/ac	Initial fresh weed wt. (g)	Initiation Weed Calc. GI (in^3)	Efficacy 3 WAT[Z]	Efficacy 9 WAT[Z]	Efficacy 14 WAT[Z]	Average Efficacy
1-3	Lontrel™	16 oz/ac	697.0c	25,521.91c	1.0a [X]	0.3	0.0	0.4
1-2	Lontrel™ + Persist® Ultra≠	16 oz + 3 pt/100 gal			0.6a	0.0	0.0	0.2
1-1	Lontrel™ + Vestis™*	16 oz + 0.75pt/100 gal			0.3a	0.0	10	3.4
2-3	V-10233✓	7.5 oz/ac	97.0a	9,907.34a	6c	6	8	6.7
2-1	V-10233✓+ Vestis™*	7.5 oz/ac+ 3pt/100 gal			**9.8d**	**10**	**9**	**9.6**
5-1	Lontrel + V-10233+ Vestis™*	16 oz + 7.5 oz/ac+ 0.75pt/100 g			**10d**	**10**	**10**	**10**
7-3	Nufarm Prosedge™ 2	2 oz/ac	366.0b	15,191.69b	3b	1.7	5	3
7-2	Nufarm Prosedge™ 2 + Persist® Ultra≠	2 oz/ac + 3 pt/100 gal			2.6b	0.0	5	2.5
7-1	Nufarm Prosedge™ 2 + Vestis™*	2 oz/ac + 0.75 pt/100 gal			3b	2.6	5	3.5
9-3	FreeHand® 1.75G	150 lb/ac			0a	0.0	0	0.0
10-3	Control	0	386.0b	16,873.65b	0a	0.0	0	0.0

Table 14. Red stem filaree (*Erodium cicutarium*),at Walters Gardens, Inc., Zeeland, MI. There were no weeds present at time of initiation on 02/22/2018, so no weed weights could be taken. The field was abandoned in 2017 due to an infestation from nutsedge, however, during the trial period no nutsedge was observed. *Erodium* was present on the site and thus this trial became a trial regarding red stem filaree control versus nutsedge. The field was over-seeded with winter wheat, unknown to us at the trial's initiation. We disregard any wheat germination and growth and evaluated the weeds only. Efficacy was evaluated at 5, 12 and 16 WAT by rated score. Treatment 1 and 2 were tested at 1 and 2X rates; however, treatment 3 and 4 were tested at 1X only. Treatment 4 did have a 2X rate of Marengo SC and treatment 3 was a 4-way combination.

No.	Treatment		**Rate/ac** (unless noted otherwise)	Eff. 5WAT 03/30/ 18	Eff. 12WAT 05/17/ 18	Eff 16WAT 06/14/ 18	Eff 25WAT 08/15/ 18	Av. Efficacy
1	V-10233	1X	7.5 oz	9.5	5.0	3.5	.	6.0
		2X	15 oz	10	7.0	3.3	.	6.7
2	ProSedge + V-10233	1X	2 oz + 7.5 oz	10	6.6	3.8	.	6.8
		2X	4 oz + 15 oz	**10**	**7.3**	**7.0**	**7.0**	**7.8**
3	Lontrel + Marengo SC + Vestis + ProSedge	1X	16oz + 9 oz + 7.5oz + 0.75pt/100gal + 2oz	10	4.8	2.5	.	5.8
4	Rodeo + Marengo SC + V-10233	1X	2 qt/100 gal + 18 oz + 7.5 oz	10	6.3	4.8	.	**7.0**
5	Control		0	10	0.6	0.6		3.7

Z = Efficacy (Eff.) ratings are based on a 0-10 scale with 10 being complete control, 0 no weed control, and $\geq$7 commercially acceptable control at weeks after treatment (WAT). Fresh weights and calculated GI are determined by the means of three plants per three replications. Ratings are averaged (Av.) over three replications per species field, per site. X = Treatments with different letters signify efficacy was statistically different at p=0.05 using LS means. ǂPersist is methylated seed oil. *Vestis is an organosilicone wetting agent. ˇV-10233 is not yet registered in the ornamental market and is manufactured by Valent USA it contains Flumioxazin (33.5%) and Pyroxasulfone (42.5%).

y = All measures are in inches and the calculated Growth Index measures are in in^3.

i = HT represents Height at start of trial.

t = GI represents Growth index (in^3) and was calculated as GI=Pi (Ht)(r2), where Ht. (in) was the starting or final height, respectively, r was half of the average of W1+W2 (two perpendicular measurements taken of plant diameter (in)) and Pi was "π". The GI provides a volume measure of the plant which helps with quality determinations not necessarily evident by heights and widths alone or by visual observations.

Table 15 Phytotoxicity evaluated on *Rhamnus frangula* 'Ron Williams', FINE LINE buckthorn and efficacy of various products trialed for liverwort control at Spring Meadow Nursery, Inc. Grand Haven, MI at 3 and 15 WAT. Not all treatment rates and names are shown as the potential of a new marketable product may come out of this study.

Species	Treatment	Rate/ac	Efficacy (3 WAT)	Phytotoxicity (3 WAT)[z]	Efficacy 15 WAT	Phyto. 15 WAT
Preemergence	**1.** CT + E Mn	2x	3.0a[wv]	--	0.0	--
	2. CT + E Mn	1x	3.0a	--	0.0	--
	3. 1701B 100 lb/ac + CT + E Mn	100 lb + 2x	**9.0b**	--	0.0	--
	4. 1701B 100 lb/ac	100 lb	**10.0b**	--	**6.0**	--
	5. Biathlon 100 lb/ac + CT + E Mn	100 lb + 1x	3.0a	--	0.0	--
	6. Biathlon 100 lb/ac + CT + E Mn	100 lb + 2x	**10.0b**	--	3.5	--
	7. Biathlon 100 lb/ac	100 lb	2.0a	--	0.0	--
	8. Control	--	2.0a	--	0.0	--
Postemergence	**1.** CT + E Mn	2x	2.0a	**3.0b**[yw]	0.0	1.0
	2. CT + E Mn	1x	6.0b	0.0a	0.0	0.0
	3. 1701B 100 lb/ac + CT + E Mn	100 lb + 2x	**9.0c**	2.0b	0.0	3.6
	4. 1701B 100 lb/ac	100 lb	6.0b	**3.0b**	3.0	0.5
	5. Biathlon 100 lb/ac + CT + E Mn	100 lb + 1x	5.0b	0.0a	0.0	0.0
	6. Biathlon 100 lb/ac + CT + E Mn	100 lb + 2x	3.0a	2.0b	4.0	0.9
	7. Biathlon 100 lb/ac	100 lb	5.0b	0.0a	0.0	0.0
	8. Control	--	2.0a	0.0a	0.0	0.0

z = weeks after treatment

y = Phytotoxicity Ratings based on a 0-10 scale with 0 being no phytotoxicity and 10 death with ≤3 commercially acceptable.

w = Liverwort control ratings followed by the same letter in the same column are not significantly different, based on lsmeans ($\alpha = 0.05$)

v = Liverwort control ratings based on a 0-10 scale with 0 being no control and 10 perfect control with ≥7 commercially acceptable.

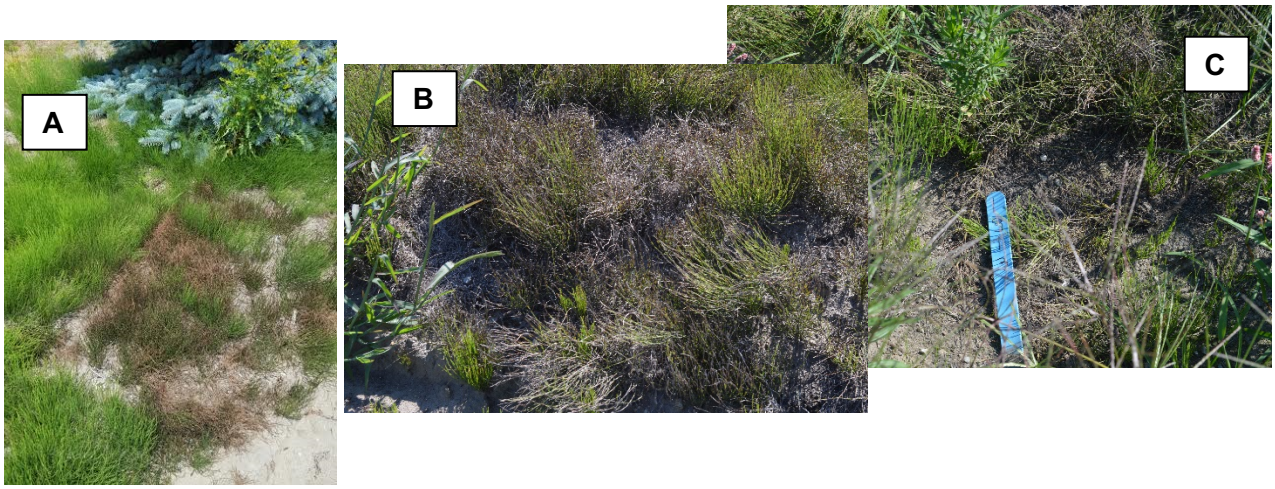

Fig. 4. A, B and C. (**A.** Above left) Field Horsetail (*Equisetum arvense*) at Ray Wiegand's Nursery, West Farm, Lenox, MI trialing Lontrel® + Vestis™+ V-10233 at 3 WAT which is providing almost complete suppression of field horsetail. (**B.** Above middle) Lontrel® + Vestis™+ V-10233 at 9 WAT still providing suppression to just below commercially acceptable. (**C.** Above right) Rodeo + Vestis at 8WAT. Photos taken on June 22, 2017 (3WAT) and July 31, 2017 (8WAT) by H. Mathers.

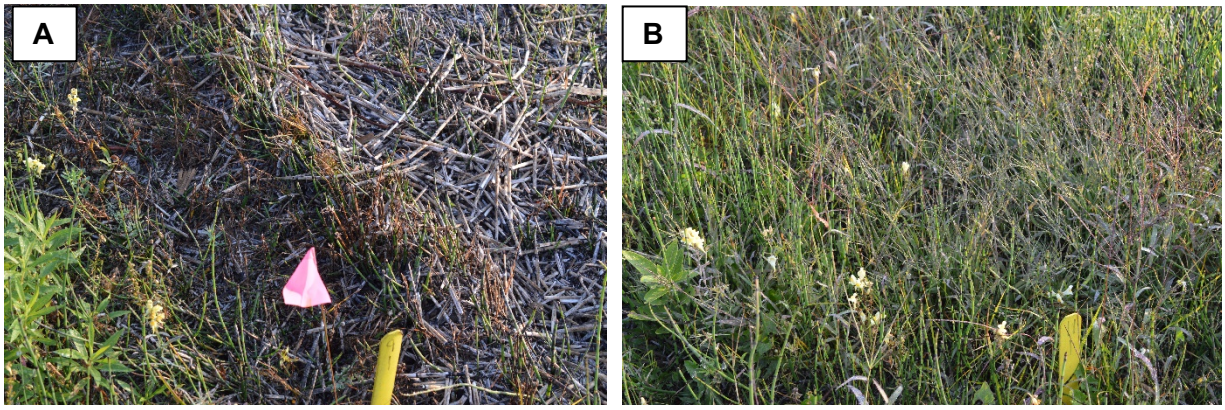

Fig. 5. A and B. (**A.** Above left) Scouring Rush (*Equisetum hyemale*) at Northland Farms, LLC, West Olive, MI trialing Prosedge + V-10233 + Vestis at 5 WAT which is providing a rating of 7 out of 10, or commercially acceptable. (**B.** Above right) Control plot at 5 WAT showing O control. Photos taken on Sept. 11, 2017 (5 WAT) by H. Mathers.

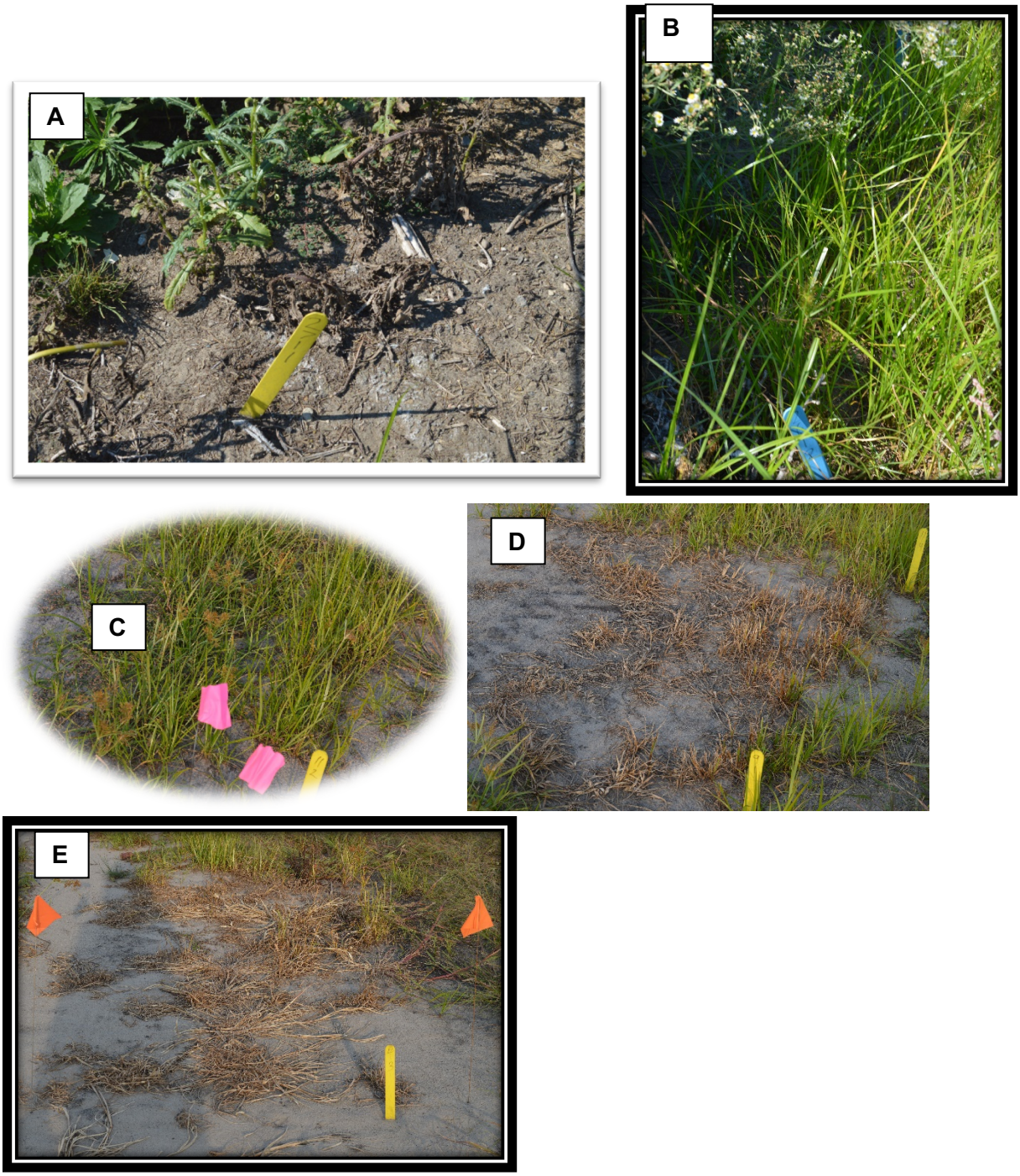

Fig. 6. A, B, C, D and E. (**A.** Top left) Yellow nutsedge (*Cyperus esculentus)* at Ray Wiegand's Nursery, West Farm, Lenox, MI trialing Prosedge + Vestis Lontrel® which is providing a rating of 9 at 9 WAT vs (**B.** Top right) is a Marengo plot with 0 control. (**C. D. and E.** Middle and bottom left) are taken at Gardens Alive Farms, Grand Haven, MI, Lenox, MI, **C.** is a Control plot; **D.** is Prosedge + V-10233 + Vestis at 5 WAT and **E**. Rodeo + V-10233 + Vestis. Photos taken on July 31 and Sept. 11, 2017 (5 WAT) by H. Mathers.

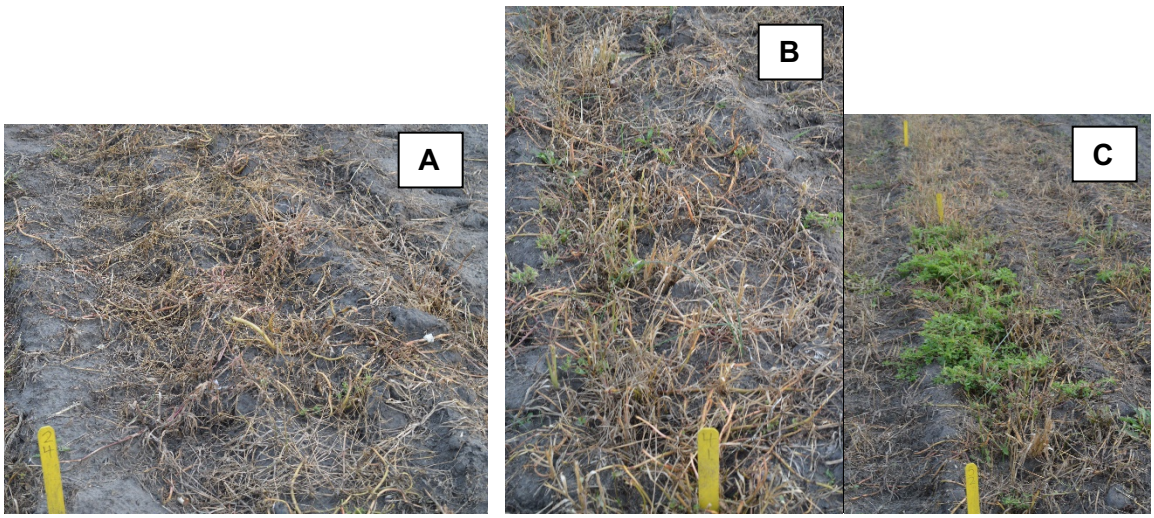

Fig. 7. A, B and C. (**A.** Above left) Creeping yellow cress (*Rorippa sylvestris*) at Gardens Alive Farms, Grand Haven, MI, Lenox, MI, 5 weeks after treatment with Lontrel + V-10233 + Vestis. (**B.** Above middle) is a plot of Rodeo + V-10233 + Vestis showing some growing weeds of which the majority are not cress. **C.** (Above right) is Rodeo + Vestis at 5 WAT showing almost no control of *Rorippa* at 5 WAT. Photos taken on Sept. 11, 2017 (5 WAT) by H. Mathers.

Fig. 8. Red stem filaree (*Erodium cicutarium*) at Ray Wiegand's Nursery, West Farm, Lenox, MI applied with Lontrel + V-10233 + Vestis 14 weeks before. The plot is completely clean with a rating of 10. Photos taken on August 30, 2017 by H. Mathers.

Fig. 9. Liverwort control at 15 WAT with 1701 (left) versus CT + EM (middle and right).

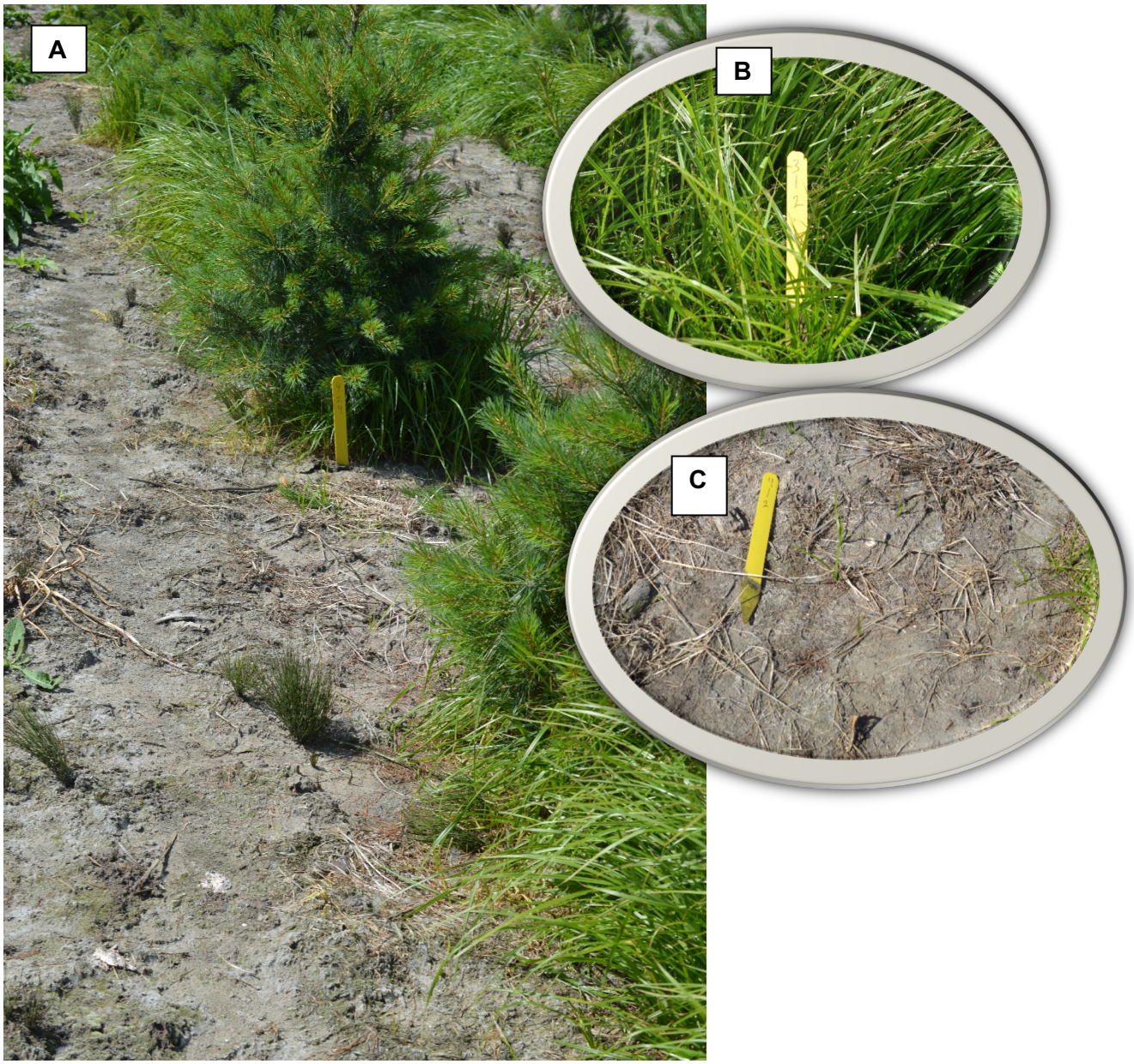

Fig. 10. A, B and C. (**A.** Above left) Yellow nutsedge (*Cyperus esculentus)* at Kluck Nursery, Inc, Saginaw, MI, MI, 11 weeks after treatment with the 2X rate of Rodeo + Marengo SC + Vestis in the clean center area of the photo (rating 8.5). **B.** (Above right) is Marengo SC + Basagran + Vestis at 11 WAT with no more control than the control plots (rating 0). **C.** (Middle right) is 1X rate of Rodeo + Marengo SC + Vestis which is not statistically different from the 2X (rating 7.7). Photos taken on June 14, 2018 (11 WAT) by H. Mathers.

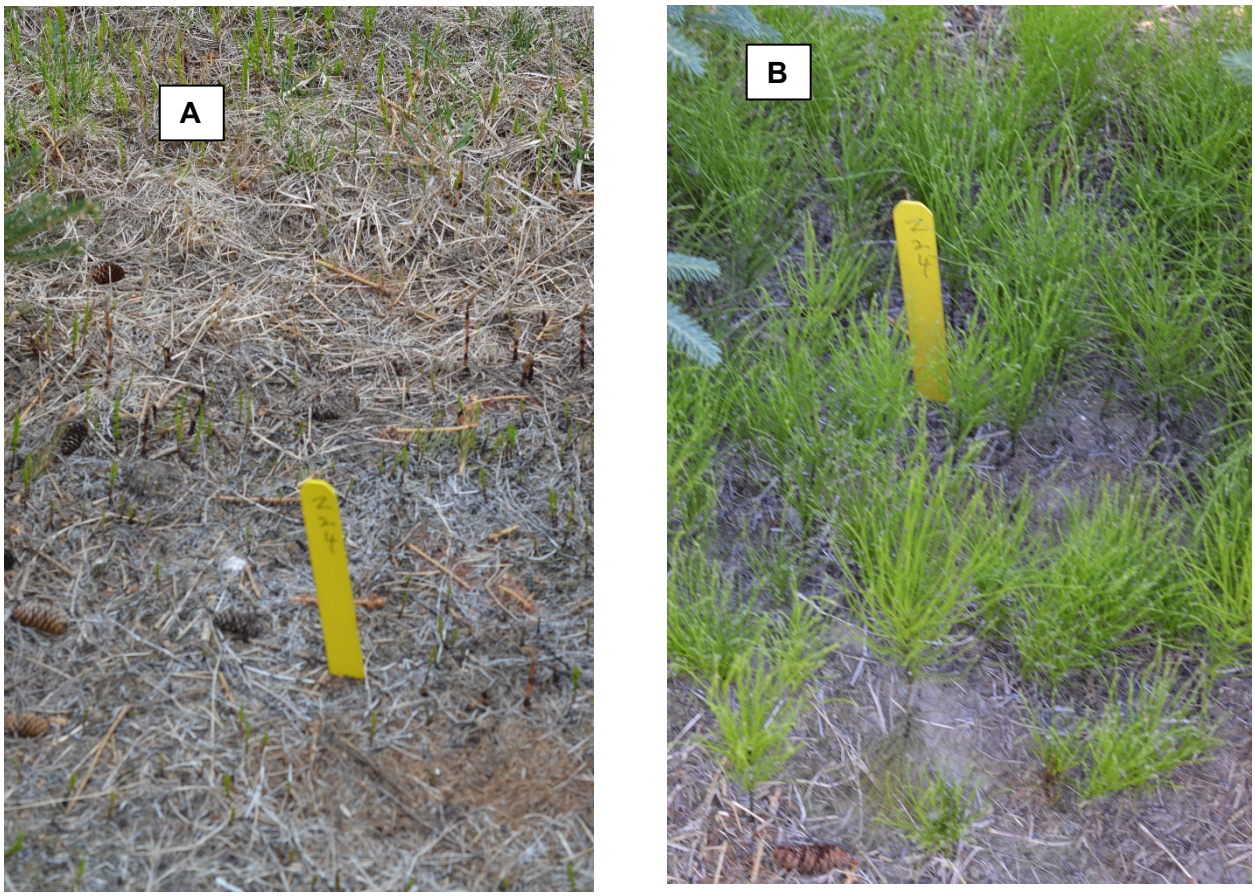

Fig. 11. A and B. (**A.** Above left) Field Horsetail (*Equisetum arvense*) at Kluck Nursery, Inc, Saginaw, MI, MI, 6 weeks after treatment with the 2X rate of Rodeo + V-10233 + Vestis with only reproductive shoots showing (rating 8.0). **B.** (Above right) is the same plot (2X rate of Rodeo + V-10233 + Vestis) but at 11 WAT with little control (rating 3). Photos taken on May 11 (6 WAT) and June 14, 2018 (11 WAT) by H. Mathers.

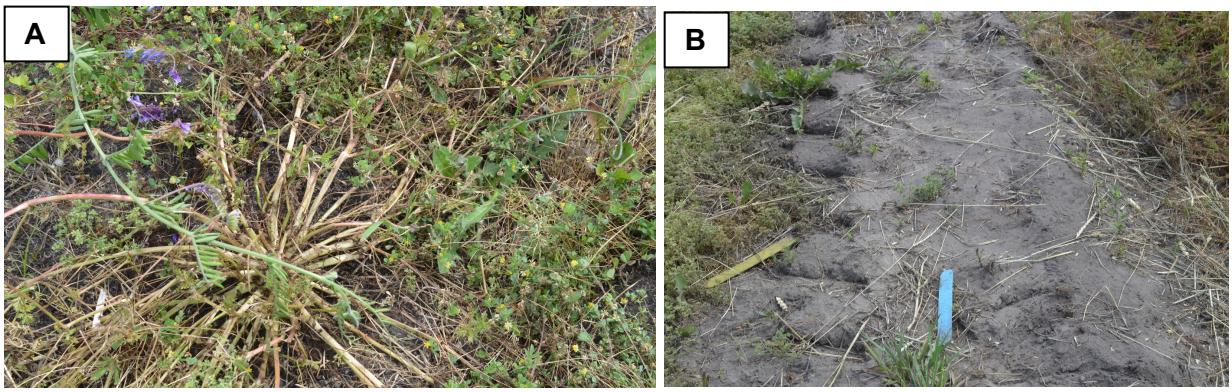

Fig. 12. A and B. (A. Above left) Control plot for Creeping Yellow Cress (*Rorippa sylvestris* L.), at Gardens Alive Farms, Grand Haven, MI at 44 WAT and **B.** a plot treated with Lontrel™ + V-10233 + Vestis™ 44 weeks before. Photos taken on June 14, 2018 (44 WAT) by H. Mathers.

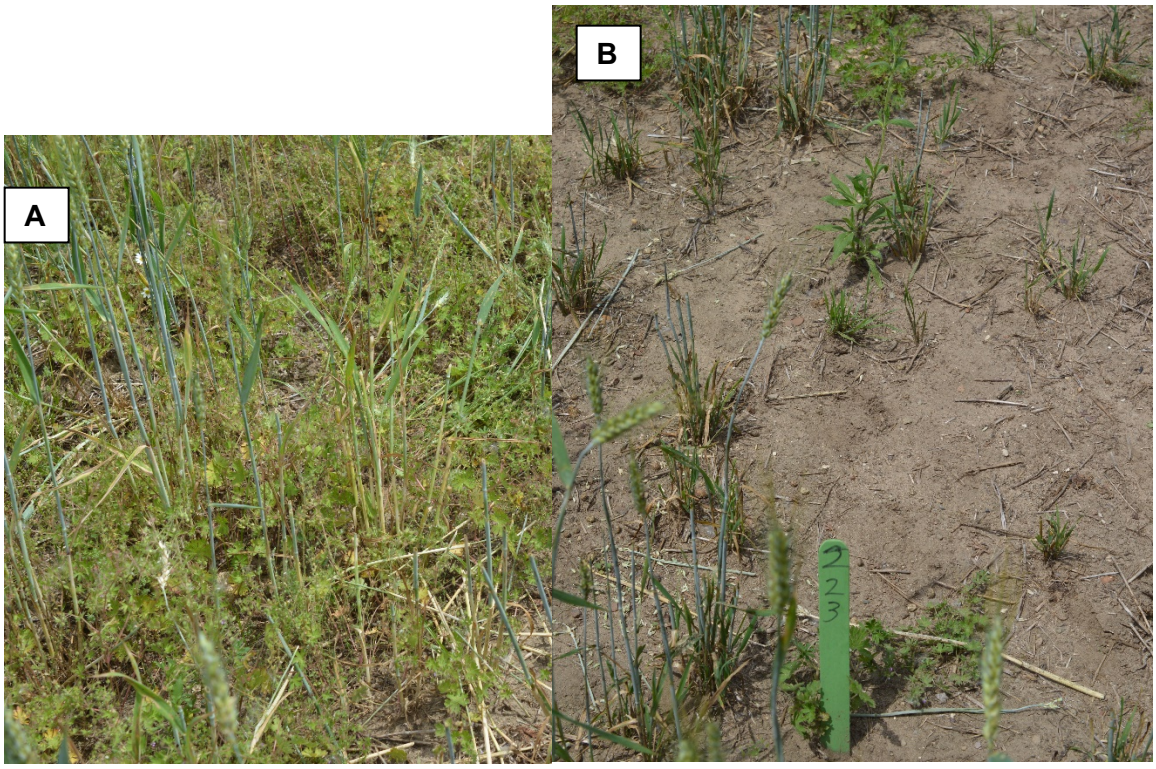

Fig. 13. A and B. Red stem filaree (*Erodium cicutarium*) at Walters Gardens, Zeeland, MI **A.** (above left) is the control plot and **B.** (above right) was applied with the 2X rate of ProSedge + V-10233 16 weeks before. The 2X ProSedge + V-10233 was the only treatment showing commercially acceptable control at 16 WAT and holding into 25 WAT (rating 7.0). Photos taken on June 14, 2018 by H. Mathers.

Fig. 14. A and B. Creeping yellow cress (*Rorippa sylvestris*) at Walters Gardens, Zeeland, MI treated with ProSedge + Vestis at 16 WAT. The Efficacy in the plot is high at 9.6; however, phytotoxicity is also high and unacceptable at 4.6. Phytotoxicity was expressed mainly as stunting (Table 11). Picture by H. Mathers, 06/14/2018.

Fig. 15. Yellow nutsedge (*Cyperus esculentus)* at Gardens Alive, Grand Haven, MI (left) treated ProSedge + V-10233 + Vestis and (right) control at 44 WAT. The Efficacy in the plot is high at 9.0. Picture by H. Mathers, 06/14/2018.

Objectives

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*
1	Evaluate various herbicides with- and without-adjuvants as based on previous SCBG's and other researchers to control each of the five worst MI nursery weeds	X	
2	Identify pre- and post-emergence herbicides safe for over-the-top (OTT), OTT dormant or directed applications.	X	
3	Identify the optimum adjuvant + herbicide combination(s) for directed sprays to control each of the five worst weeds in MI field nurseries	X	
4	Evaluate the biomass and propagule banks at the six nurseries involved in this project for each of the five species pre- and post-study.	X	

Accomplishments

List your accomplishments for the project's period of performance, including the impact they had on the project's beneficiaries, and indicate how these accomplishments assist in the fulfillment of your project's objective(s), outcome(s), and/or indicator(s).

Accomplishment	**Relevance to Objective, Outcome and/or Indicator**
90% control of **Field Horsetail** achieved by combination of Lontrel™ + V-10233✓ + Vestis™ (Table 1, 3 and Fig. 4 and 11).	This meets objective 1, 2, 3 and 4 for this species. This also helps to fulfill outcome 4 and 5 of the research.
70% control of **Scouring Rush** at 5 WAT (Table 1, 4 and Fig. 5) achieved by combination of Prosedge + V-10233✓ + Vestis™.	This meets objective 1, 3 and 4 this species replaced one of the original worst five weeds when Mugwort was unavailable. This also helps to fulfill outcome 4 and 5 of the research and indicates the control of scouring rush is more difficult than field horsetail.
Five new controls were developed for **Yellow nutsedge.** The optimum controls are: Nufarm Prosedge™ 2 (90%) and Prosedge™ 2 + Vestis™ (96%), respectively (Table 1, Table 5 and Fig. 6) at 9 WAT. 100% control at 44 WAT with Rodeo (2X) +V-10233 + Vestis (Table 1, 6) and 90% control with Prosedge™ 2 + V-10233 + Vestis™ at 44 WAT (Table 1, 6 and Fig. 15). Prosedge + V-10233 + Vestis at Kluck Nursery for 11 WAT at 75% control (Table 1, 8 and Fig. 10).	This exceeds objective 1, 2, 3 for this species. Objective 4 is also meet as we have controls offering 100% reduction in biomass out to 44 WAT. Objective 3 is meet as at Kluck Nursery as treatments were applied as direct dormant sprays to White pine and at Ray Wiegand's as direct sprays in spruce. The remarkable finding is control into the next spring (44 WAT) at Gardens Alive. We found for this extended efficacy we required V-10233 to be added with ProSedge. The level of control for this extended period is a breakthrough for the specialty crop industry.
Five products provided above commercially acceptable control to 14, 16 and 44 WAT depending on trial termination per site for **Creeping yellow cress** or Kik (Table 1). Two were providing 100% control at 14 WAT including, Rodeo® + V-10233 + Vestis™ and Nufarm Prosedge™ 2 + Vestis™ (Table 9 and Fig. 7). Additionally, Rodeo® + V-10233 2X and Prosedge + Vestis were at 96% control for each at 16 WAT (Table 11, Fig. 12). The most impressive control, however, was achieved with Lontrel + V-10233 + Vestis at 83% control at 44 WAT (Table 10 and Fig. 12)	To determine five controls exceeds objective 1 and 3 for this species as again two control were hoped for. Additionally, objective 2 was achieved as at Ray Wiegand Nursery these treatments were tested as direct applications under spruce. Unfortunately, as dormant OTT applications on daylilies at Walters Gardens all treatments were phytotoxic. However, again we found the optimum control lasting out to 44 WAT or extending into the next spring with Lontrel + V-10233 + Vestis. Table 9-11 also indicates completion of objective 4 – biomass data collection. This

	also helps to exceed outcome 4 and 5 of the research.
Four products provided above commercially acceptable control at 5, 14 and 16 WAT depending on trial termination and site for red stem filaree (Table 1). Most impressive were V-10233✓+ Vestis with 90% control at 14 WAT (Table 13, Fig. 8) and Lontrel + V-10233+ Vestis™ with 90% control at 14 WAT (Table 13, Fig. 8).	There are no registered products or known successful controls for *Erodium* that have ever been described in ornamental crops. To determine four controls at the levels and duration achieved – exceeds objective 1 and 3 for this species. Table 12, 13 and 14 also lists the completion of objective 4 – biomass data collection. This also helps to exceed outcome 4 and 5 of the research.
Extensive efforts and research dollars have been spent to find a control product for **liverwort** in ornamental containers (Table 10, Fig. 6).	The products we evaluated in this study have never been previously studied for liverwort control. A new product registration may develop from this research. These liverwort findings (Table 10), (Fig. 6) exceed the expectations of this grant and go above and beyond meeting objective 1 and 3 for this study. The results also fulfill outcomes 3, 4, 5 and 8 of this grant.
Outcome 4, indicator 2a, 2b, 2c	A training session was provided to five employees at Ray Wiegand's Nursery, Lenox, MI to four employees at Spring Meadow Nursery. A workshop with 50 attendees (38 completing surveys) with the results listed in Fig. 1.
Outcome 3, indicator 1a.	Five articles regarding the "worst weeds" were published in the MNLA trade magazine and are listed under outreach actives plus 3 trade presentations are listed in this same section.
Outcome 5, indicator 2, 6 and 8.	A second workshop was conducted with results presented in Fig. 2 and 3 where 30 people attended but only 17 completed surveys.
Outcome 8, indicator 5.	47% of the second workshop respondents and 12% indicated if they learned one thing from the program it was worth up to $3,000 and $26,000, respectively. Therefore, we use only the 12% result and a minimum number of grower reached of 300 (Outcome 3, indicator 1a), 12% of 300 = 30 X $26,000 = $936,000 of increased revenue will be

	achieved with this grant. Far exceeding this outcome.

Challenges

If you experienced any challenges during the project's period of performance, provide a listing of them below. Also, provide the corrective actions you took to address these issues. If you did not attain the approved outcome(s) and indicator(s), provide an explanation in the Corrective Actions column.

Challenge	Corrective Actions
Spring of 2017 was challenging for pesticide applications	Used the site Ray Weigand's to expand controls and screen for site in fall 2017 and spring 2018.
Gardens Alive one of our sites went out of business	Were able to salvage early spring results from fall applications by staying in touch with the field manager.

Lessons Learned

Provide recommendations or advice that others may use to improve their performance in implementing similar projects.

Originally set for dormant applications in 2016-2017, which requires knowing where the plants are.	Grower did not know where weeds were as they were not emerged. The next year 2017-18 we had growers mark out sites in the fall before.

Continuation and Dissemination of Results (If Applicable)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

Further presentations and another workshop are planned for 2019 at the GLTE and one summary magazine article will be published.

Outcome(s) and Indicator(s)/Sub-Indicator(s)

Provide the results of the project outcome(s) and indicator(s) as approved in your State Plan and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the SCBGP on a national level.

Outcome Measure(s)

Select the Outcome Measure(s) that were approved for your project.

- ☐ **Outcome 1**: Enhance the competitiveness of specialty crops through increased sales
- ☐ **Outcome 2**: Enhance the competitiveness of specialty crops through increased consumption
- X **Outcome 3**: Enhance the competitiveness of specialty crops through increased access

X **Outcome 4**: Enhance the competitiveness of specialty crops though greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources

X **Outcome 5**: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems

☐ **Outcome 6**: Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety

☐ **Outcome 7**: Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources

* **Outcome 8**: Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

Outcome Indicator(s)

Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator.

- See accomplishments table on p. 25 of this report.

Data Collection

Explain what data was collected, how it was collected, the evaluation methods used, and how the data was analyzed to derive the quantifiable indicator.

- See tables 1-15 and figures 1-15 for the data collected, evaluation methods and analysis for indicator. Se also explanation of survey activities page 3 of this report and Fig. 1-3.