FINAL PROJECT REPORT TEMPLATE

PROJECT INFORMATION

Project Title	New Herbicides and New Uses for MI Nursery Shrub Containers			
Recipient Organization Name:	Michigan Nursery and Landscape Association			
Period of Performance:	**Start Date:**	12/10/2021	**End Date:**	9/8/2023

PERFORMANCE NARRATIVE

PROJECT BACKGROUND

Provide enough information for the reader to understand the importance or context of the project. This section may draw from the background and justification contained in the approved project proposal.

Side-by-side comparisons are common in other industries but had never been conducted in MI for the past 25 years until this study. Container production is more common than field production in the US nursery industry, but in MI, the opposite is true possibly due to a lack of knowledge of newer granular herbicides for containers (Fig. 1). At the 2022 Great Lakes Trade Exposition (GLTE) of MNLA, survey results from a nursery grower audience indicated Marengo SC was the best-known herbicide (field liquid formulation); whereas granular formulations Fuerte and Gemini G were the least known (Fig. 3). Additionally, MI has seen a rise in production of traditionally west coast grown crops. Via container production, MI growers could take advantage of regional production shifts more readily, decrease production costs, increase product turn-around, and increase skilled labor requirements. Phytotoxicity and efficacy results of this study, together, indicate Marengo G and FreeHand were the best granular products. However, liquid formulations of Tower 6EC and Pethoxamid (an unexplored herbicide for nursery) plus Pendi-Pro applied at 4.8 pt./A offered superior weed control (Table 1).

ACTIVITIES PERFORMED

At Gardens Alive Farm, West Olive, MI phytotoxicity evaluations of seven granular herbicides (combination products) and one liquid combo (the result from 3 years of SCBG testing) were applied to two cultivars of June 2021 planted roses. Six replications of 3-gallon pots were used, and the two cultivars evaluated were i. Rosa 'Belinda's Blush' PP27244: and ii. Rosa 'Meidomonac' 'Bonica®' which was an All-America Rose Selection (AARS) winner in 1987. Both are vigorous growers. The trial was initiated 03/09/2022, including measures of height (Ht) and two perpendicular widths, (W1) and (W2), respectively. Final Ht and widths were taken at

21 WAT and compared to the initial measures for quantitative measures of treatment impact. Roses at time of application were dormant and in an enclosed polyhouse. In the 1st Summary Performance report (ending 4/30/2022), we reported the 0 and 6 WAT findings. In the 1st Annual report data for the entire trial, we included the findings for 0, 6, 10, 13 and 21 WAT (Table 1). At the five evaluation dates, rated scores were conducted on a scale of 0 to 10, where ≤ 3 was commercially acceptable, 0 was no injury and 10 represented a dead plant. Data was subjected to an ANOVA, and LSD was used to separate means. An efficcay study was also conducted that evaluated the herbicides: Fuerte 100 lb/ac [Flumioxazin (0.125%) + Prodiamine (0.75%) (EPA Reg. No. 59807-20) (OHP, Inc., Bluffton, SC)]; Fortress 100 lb/ac [(dithiopyr 10.25 % + isoxaben 0.50%, by wt.) (OHP, Inc., Mainland, PA 19451)]; Biathlon (100 lb/ac) [(oxyfluorfen + prodiamine) (OHP, Inc., Mainland, PA)]; FreeHand 1.75G 150 lb/ac [(dimethenamid-p + pendimethalin) (BASF Corporation, Research Triangle Park, NC)]; Marengo G [(indaziflam) (Bayer Environmental Science, Cary, NC)]; Gemini G 200 lb/ac [(prodiamine 0.40% and isoxaben 0.25%) (Everris NA, Inc.)] and a liquid Tower 6EC [(dimethenamid-p) (BASF Corporation, Research Triangle Park, NC)]. Additionally, Broadstar 150 lb [(flumioxazin 0.25%) (Valent USA, LLC, San Ramon, CA)], a combination of Tower 6EC 21 oz/ac + Pennant Magnum 21 oz/ac (developed from previous funded SCBGs) and an untreated control (UTC) were evaluated for a total of nine treatments.

A greenhouse experiment with controlled maximum and minimum temperatures, 80 and 70 ºF, respectively, was also conducted at the Horticulture Teaching and Research Center (HRTC), Michigan State University, East Lansing (not dormant) in summer and fall 2022. Results of this trial were not reported in either the 1st Summary Performance report (ending 4/30/2022) or the 1st Annual report. The containers used were half the size of the Gardens Alive study at 1.5-gallon capacity. One rose was evaluated, *Rosa* 'Radrazz' PP #11836. 'Radrazz' was the first of 10 roses hybridized as Knock Out® Roses. This Knock Out® Rose was not a new crop in MI. After a week of establishing growth, plants were removed from the greenhouse for herbicide application outside. The same herbicides were evaluated at Gardens Alive as at MSU. However, only Tower 6EC [(dimethenamid-p) (BASF Corporation, Research Triangle Park, NC)] was evaluated at MSU, and Tower 6EC 21 oz/ac + Pennant Magnum 21 oz/ac was evaluated only at Gardens Alive. The MSU trial also did not include Broadstar, but it did at Gardens Alive. Therefore, the total treatments at MSU were eight, including the control. Four replications in completely randomized block design (CRBD) were used at MSU versus six at Gardens Alive. Data collection at MSU included visual ratings of phytotoxicity based on a scale ranging from 0% (no phytotoxic effect) to 100% (complete death of the plant). Data were collected at 4, 8, 12, and 16 WAT. In spring 2023, all data were analyzed in SAS 9.4 by using ANOVA, and the means will be separated out by Tukey's HSD test.

Table 1. Efficacy evalaution with nine treatments and six common container weeds. Normally, nurseries expect atleast 12 weeks of control, 14 is considered best. We had several prodcuts that provided ≤70% control at 12 WAT or 90 DAT. Summarized are the best and worst products by species. Further the best treatments as granular are indictated. As to comparing product <6 years from registration to >6 years, it seems species is more important than being newer.

Species	Worst treatment	Best overall treatment	Best Granular
Chickweed	Pethoxamid	Pethoxamid + Pendi-Pro (PP)	All were not statistically (NS) different to PP.
Bittercress	Fortress	Tower, Pethoxamid + Pendi-Pro	Fuerte, FreeHand, Marengo G and Gemini were all providing commercially acceptable control at 90 DAT
Spurge	Biathlon	Tower, Pethoxamid + Pendi-Pro, Marengo G	Marengo G NS to PP and Tower
Groundsel	Fuerte, Marengo G	Tower	FreeHand
Oxalis	Fuerte	Tower, Pethoxamid + Pendi-Pro	Marengo and Gemini G
Foxtail	Fuerte, Marego G	Tower, Pethoxamid + Pendi-Pro, Pethoxamid	FreeHand

OBJECTIVES

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*
1	Evaluate efficacy in on-site MI nursery container operations over the year at two locations	100%	
2	Evaluate phytotoxicity in on-site MI nursery container operations over the year at two locations	100%	
3	Discover much needed information for MI growers regarding the development of environmentally sound herbicide programs for container shrub crops.	100%	
4	Determine the effectiveness of seven newly developed herbicides versus less environmentally sound older herbicides, at control of common and emerging container weed species.	100%	

**If no is selected for any of the listed objectives, you must expand upon this in the challenges and lessons learned sections.*

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 or Impact	Relevance to Objective, Outcome, and/or Indicator
1	FreeHand and Marengo G both were the best granular products with four of six species, each, evaluated (Table 1).	This finding is relevant to objectives 1 and 3. Finding two granular products that can be used safely in containers. In regard to Objective 4, FreeHand is an older product than Marengo, and we consider newness of a product is not as important as species to be controlled in containers.
2	Completed seeded weed trial at Mathers Environmental Science (MESS) with native MI weed seed with evaluations at 30, 60 and 90 DAT. Plus fresh weed weights taken at 90 DAT.	Objective 1, 3 and 4– evaluate efficacy with 9 herbicides not seven as indicated in grant proposal, at one site with six weed species for a total of ten treatments. Efficacy was evaluated at two sites, however, the efficacy from MSU was not received.
3	Evaluations by rated score were conducted at each evaluation. Growth measures of height and two widths were also conducted at the trial start and finish 21 WAT.	Objective 2, 3 and Outcome 4– evaluate phytotoxicity at two sites. Evaluations at two sites and with three roses crops help growers determine the best herbicide to use in their operations. Height and width measures were used in a growth index to determine plant volume as a fourth growth measure that accounts for plant quality quantitatively vs subjectively.
4	Phytotoxicity trial at Gardens Alive Farms, West Olive, MI showed 'Bonica' rose was 11.7 % larger in volume than the 'Belinda Blush' at the trial's conclusion (Table 2 i and ii) (21 WAT). The only herbicide showing phyto with the 'Bonica' was Gemini G which is not labelled for roses (Table 1ii). The only herbicide with phytotoxicity on the 'Belinda's Blush' was Fuerte which is labelled for roses and may have been due to their smaller size causing susceptible (Table 2i).	These findings relate to objectives 2, 3 and 4. Indicating five of the granular herbicides evaluated were safe to use on roses including Biathlon, Broadstar, Fortress, Freehand and Marengo G. Additionally the liquid combination of Tower + Pennant that has been developed over 3 SCBG's for herbaceous plants was found safe applied dormant to roses. Again, of the granular products listed above only Broadstar is an older formulation. Therefore again, the newness of the herbicide does not determine its environmental sound use.

4	Conducted phytotoxicity trials at Gardens Alive and MSU is 100% complete towards determining sound environmental herbicide programming.	Objective 2, 3 and Outcome 4 (100% complete)
5	Conducted efficacy trials at two locations only one reported here. However, the one was conducted with six replicates, nine treatments versus 7 required and six weed species (# not specified in proposal) with fresh weights collected from all pots.	Objective 1, 3 and 4. 100 % complete.
6	Survey conducted in January 2022 indicated nursery growers in MI were unfamiliar with granular herbicides commonly used in container production.	Relevant to objective 1,2, 3 and 4, by showing the validity of side-by-side comparisons of herbicides on six common weed species to help MI growers take better advantages of production shifts from the west coast and adopt the overall advantages of increasing container production.
7	Significant weed control data as % cover of containers and fresh weed weights was collected for MI weeds. This data has previously been unreported for MI and represents a large step forward towards achieving more container production in MI.	Objectives 1, 3 and 4 are relevant to this achievement.

CHALLENGES AND DEVELOPMENTS

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this project. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objectives, outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column.

#	Challenge or Development	Corrective Action or Project Change
1	Common chickweed and Pennsylvania bittercress, winter annuals, germinated poorly until temperatures reduced in the late summer to early fall, limiting actual efficacy evaluation time.	The weed control information gathered was of interest as the trail was conducted later than other research reports. This is significant as some growers do often apply products later than recommended. However, the trial should be repeated in spring to compare results.
2	A host nursery for a six weed species seeded for efficacy evaluations could	Since not even one host site could be found for the efficacy trial in MI only one

	not be found. No nursery owner wanted 324 containers filled with weeds on their property for 90 DAT.	site was used at Mathers Environmental Science Services, LLC, Gahanna, OH. This was the only site willing to accept weed species invasion. However, all seed was collected in MI to ensure providence.

LESSONS LEARNED

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

Earlier trial initiation in the year for winter annuals or extending trial evaluations to 120 DAT for winter annuals when summer annuals are also being evaluated side-by-side, may provide improved efficacy evaluations for a broad range of species.

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

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

Further GLTE presentations will be made regarding these results in the 2024 program (https://www.glte.org/), and one further MNLA magazine article will be published (https://www.mnla.org/resources/publications/michigan-landscapetm-magazine). Results will also be made available on the Mathers Environmental website under resources (https://www.mathersenvironmental.com/resources-publications/). A repeated trial conducted in the spring could lead to a publication in the Weed Technology journal (https://www.cambridge.org/core/journals/weed-technology).

BENEFICIARIES

Number of project beneficiaries: 10,000.00

OUTCOME(S) AND INDICTATOR(S)/SUB-INDICATOR(S)

Provide the results of the project outcome(s) and indicator(s) as approved in your application and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the Program 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
- ☑ **Outcome 3**: Enhance the competitiveness of specialty crops through increased access
- ☑ **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

- ☑ **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)

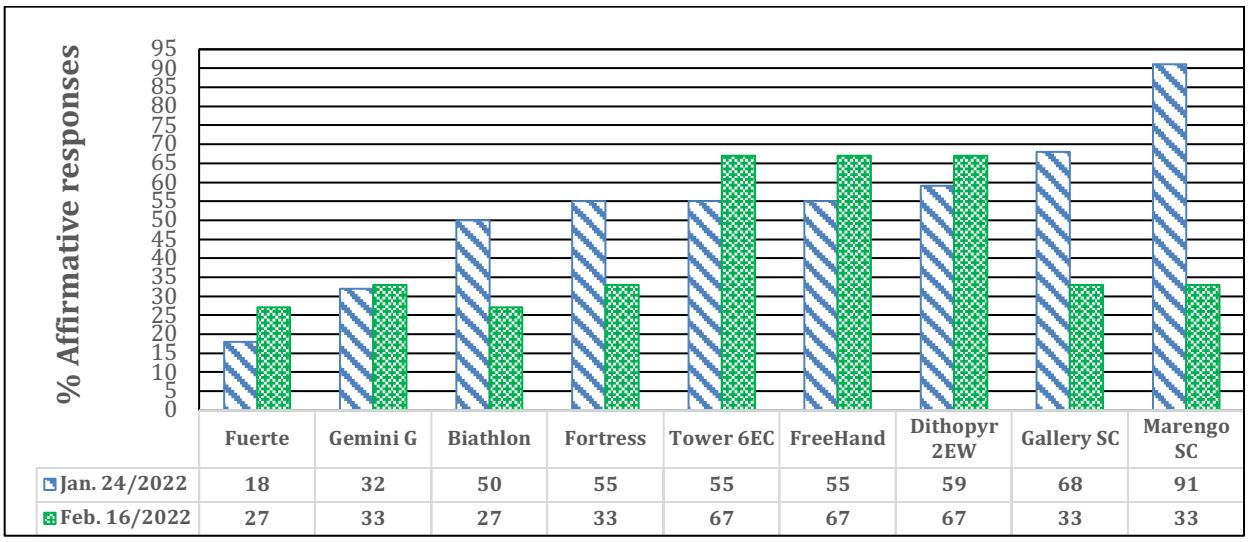
Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator (add more rows as needed).

#	Outcome and Indicator	Quantifiable Results
1	Outcome 3, Indicator 1.a. Of the 300-total number of consumers or wholesale buyers reached, 300 will gain knowledge about producing and preserving specialty crops.	An estimated 1,200 consumers/wholesale buyers have gained knowledge about producing and preserving specialty crops from the three publications produced and six trade presentations made, exceeding the original estimate of 300 consumers/wholesale buyers by 75%.
2	Outcome 4, Indicator 2.a. Adoption of best practices and technologies resulting in increased yields, reduced inputs, increased efficiency, increased economic return and conservation of resources. 40 growers/producers will indicate adoption of recommended practices.	In a presentation given at GLTE and presented with the Grassy weed SCBG final report, 44 survey participants indicated they plan on using an herbicide that they learned about from the presentation in the future as well as 28 survey participants indicated that they would use less herbicide in the future (100% complete).
3	Outcome 4, Indicator 2.b. 40 growers/producers will be reporting reduction in pesticides used per acre.	In the same survey indicated in No. 2 (above) 28 survey participants indicated that they would use less herbicide in the future (100% complete).
4	Outcome 4, Indicator 2.c. 40 producers will be reporting reduced costs per acre.	Again, in the survey cited above, 44 survey participants indicated they plan on using an herbicide that they learned about from the presentation in the future. Therefore, overall, FreeHand at 150 lb/ac and Marengo G 200 lb/ac should be adopted for use to achieve desired efficacy and low phytotoxicity in container shrub roses.

5	Outcome 4, Indicator 2.d. 250 acres will be in best management practices developed in this grant.	Out of 57 survey participants at the outreach program at MNLA, GLTE, 26 survey participants learned 3 to 4 science-based tools from the presentation (100% complete).
6	Outcome 5, Indicator 2. Number of innovations adopted: 7.	The research trial investigated which granular herbicides should be adopted (100% complete) with FreeHand at 150 lb/ac and Marengo G being the best overall herbicides with good efficacy and low phytotoxicity. Then, administered surveys at MNLA, GLTE, revealed that 32 out of 57 participants estimated each new science-based tool learned would save them $2,000 to $6,000 (100% complete).
7	Outcome 5, Indicator 6. Number of first respondents trained in early detection and rapid response to combat pests (i.e., weeds): 8.	Identification of weeds was conducted with three staff at GA and via various email communications with five other nursery growers during the course of the grant for a total of 8 first respondents trained in early detection and rapid response to combat pests.
8	Outcome 5, Indicator 8. Number of growers/producers that gained knowledge about science-based tools through outreach and education programs: 180.	Six presentations were conducted during this grant period with an average of 30 participants each for a total of 180 producers reached who indicated they learned on average four science-based tools worth $2,000-$6.000 each.
9	Outcome 8, Indicator 5. Increased revenue/ increased savings (in dollars) $5,000,000.	So, assuming between the six presentations and three magazine article we reached a conservatively 360 members of the MI industry, who learned 4 new tools on average, worth on average $4,000.00 that would be $5,760,000 dollars in increased revenue for the MI industry exceeding expected outcomes.

DATA COLLECTION

1. Two surveys were conducted to determine current knowledge of herbicides used primarily in container production with the exception of Marengo SC (a field herbicide).



	Fuerte	Gemini G	Biathlon	Fortress	Tower 6EC	FreeHand	Dithopyr 2EW	Gallery SC	Marengo SC
Jan. 24/2022	18	32	50	55	55	55	59	68	91
Feb. 16/2022	27	33	27	33	67	67	67	33	33

Fig. 1. Responses to two surveys regarding herbicide recognition conducted on January 24, 2022, and February 16, 2022, at trade presentations in Lansing, MI GLTE and Port Huron, MI Pesticide Recertification, respectively. The two audiences that were surveyed were primarily composed of nursery growers in January and landscapers in February. Therefore, only the nursery data is reported. The audience at both presentations had an average of 25% of respondents or 22 complete surveys collected in January and 15 in February. Differences in audience composition (nursery or landscape) account for the variation in herbicide recognition between the two venues.

Fig. 2. Initiation 03/09/2022 at Gardens Alive of phytotoxicity and efficacy on dormant roses of two cultivars ‘Bonica’ Shrub Rose

2. Phytotoxicity trials were conducted for the new crop shrub roses at Gardens Alive, Grand Haven, MI and MSU, East Lansing, MI.

Table 2. i. and ii. Gardens Alive Farm, Grand Haven, MI seven granular herbicides and one liquid combo (the result from 3 years of SCBG testing) were applied to two cultivars of Summer 2021 planted Roses on 03/09/22. Six replications of 3-gallon pots were used and the two cultivars evaluated were i. *Rosa* ‘Belinda’s Blush’ PP27244: and ii. *Rosa* 'Meidomonac' ‘Bonica®’. At start and end, measures of height (Ht) and two perpendicular widths, (W1) and (W2) were taken. The roses were either dormant or

just breaking bud in an enclosed polyhouse (Fig. 1) for applications. Phytotoxicity data was collected at 0, 6, 10, 13 and 21 weeks after treatment (WAT).

i. 'Belinda's Blush' Shrub Rose

	Treatment Applied 03/09/2020 Dormant Roses	Rate /ac	Ht (in)	Growth Index (GI)(in³)	Final Ht (in)	Delta Ht	Final GI (in³)	Delta GI (in³)	1st Phyto.y 0 WATz 3/9/22	2nd Phyto. 6 WAT 4/22/22	3rd Phyto. 10 WAT 5/19/22	4th Phyto 13 WAT 06/09/22	Final Phyto 21 WAT 08/02/22
1	Fuerte	100 lb/ac	23.8	9608.0	30.5	9.6	39665.4*	30057.1*	0a	0.5a	1.8b	2.7b	**3.0c**
2	Fortress	150 lb/ac	23.8	7465.3	31.8	9.3	43398.1	35932.8	0a	0.2a	0.3a	0a	0a
3	Tower 6EC + Pennant Magnum	21 oz/ac + 21 oz/ac	24.0	6478.8	27.9*	8.4	49671.7	43192.9	0a	0.2a	0.2a	0a	0a
4	FreeHand	150 lb/ac	24.5	8355.6	33.0	8.5	45570.1	37214.5	0a	0a	0a	0a	0.8a
5	Marengo G	200 lb/ac	23.0	8090.2	40.6	14.3	48019.4	39929.2	0a	0.2a	0.2a	2.0b	2.0bc
6	Biathlon	100 lb/ac	23.0	7345.1	33.0	11.2	50517.9	43172.8	0a	0.5a	0a	0a	0a
7	Gemini G	200 lb/ac	24.0	6089.0*	38.1	7.1*	39994.8*	33905.8	0a	**4.0b**	1.5ab	1.3ab	0.8ab
8	Broadstar	150 lb/ac	23.7	9749.8	35.6	9.6	45454.3	35704.5	0a	0.5a	0a	2.3b	2.0bc
9	Control	.	23.5	8938.4	33.0	9.9	41965.7	33027.3	0a	0a	0a	0.3a	0.3a

ii. 'Bonica' Shrub Rose

1	Fuerte	100 lb/ac	29.7	23747.1	38.1	9.4	61260.4	37513.3	0a	1.0ab	1.7bc	0.6ab	0a
2	Fortress	150 lb/ac	31.0	26348.6	47.0	7.7	65154.8	38806.2	0a	0.7ab	0.7ab	0.7ab	0a
3	Tower 6EC + Pennant Magnum	21 oz/ac + 21 oz/ac	33.8	25335.3	43.2	7.1	58177.4	32842.1	0a	1.0ab	0a	0a	0a
4	FreeHand	150 lb/ac	31.3	22287.5	41.9	11.0	57503.5	35216.0	0a	0.3ab	0a	0a	0a
5	Marengo G	200 lb/ac	31.5	30022.3	38.1	8.3	57888.2	27865.9	0a	0a	0a	0a	0a
6	Biathlon	100 lb/ac	32.2	21542.7	41.9	7.2	55947.5	34404.8	0a	0.6ab	0.3ab	0.3a	0a
7	Gemini G	200 lb/ac	29.8	21141.2	36.8	3.3*	41155.9*	20014.7*	0a	**4.5c**	**4.0d**	**3.0c**	**3.0b**
8	Broadstar	150 lb/ac	30.7	24568.1	35.6	9.8	57935.7	33367.6	0a	**3.2c**	2.5c	2.0bc	2.0b
9	Control	.	32.3	19870.5	36.8	6.6	51184.0	31313.5	0a	0a	0a	0	0

Fig. 3. 21 WAT at Gardens Alive, Grand Haven, MI showing reduction in size of Gemini G (treatment 7) on 'Bonica' Shrub Rose (Species #2).

Fig. 4. 10 WAT at Gardens Alive showing the untreated control (UTC) treatment 9, in 'Belinda's Blush shrub rose (species 1). The weed growth in the controls reduced the rose size.

Fig. 5. Treatment #8 (Broadstar) for *Rosa* 'Belinda's Blush (species #1) at 16 WAT (center) with treatment #9 to the right (UTC) and treatment #7 to the left (Gemini G) at Gardens Alive. Replication 6 shown here shows a smaller plant than the UTC or Gemini treatment and this was reflected in the rated scores; however, by growth measures (Table 1 i) the Broadstar plants were larger than the control averaged across six replicates.

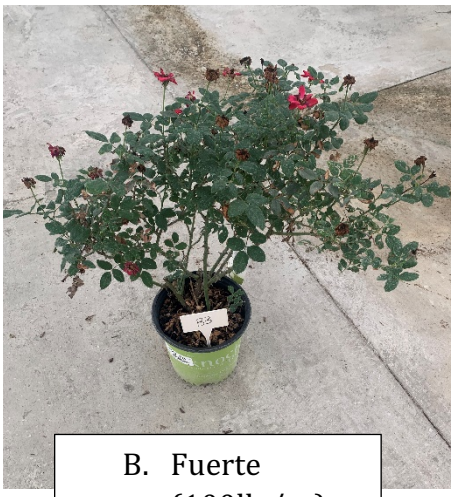
MSU Studies

Table 3. Phytotoxicity rating based on scale (0%-100%), where 0% meaning no injury and 100% meaning complete death of rose plants at 4, 8, 12, and 16 weeks after treatment conducted in a controlled greenhouse at MSU, East Lansing, MI.

Treatments	**Rates**	**Phytotoxicity (0%-100%)**			
		4 WAT**	**8WAT**	**12WAT**	**16WAT**
Control	NA	0a*	0a	0a	0a
Fuerte	100lb./ac	0a	2.5b	6.25c	7b
Fortress	150lb./ac	0a	0a	6.25c	9.5bc
Tower	21fl oz./ac	1.25b	2.5b	6.25c	9bc
Freehand	150lb./ac	3c	3.75c	15e	13.75d
Marengo	200lb./ac	0a	0a	3.25b	8.75b
Biathlon	100lb./ac	0a	0a	6.25c	10c
Gemini	200lb./ac	3.25c	5d	7.5d	11.25cd

*Same letter within a column represents no significant differences when $p < 0.05$; **WAT meaning weeks after treatment.

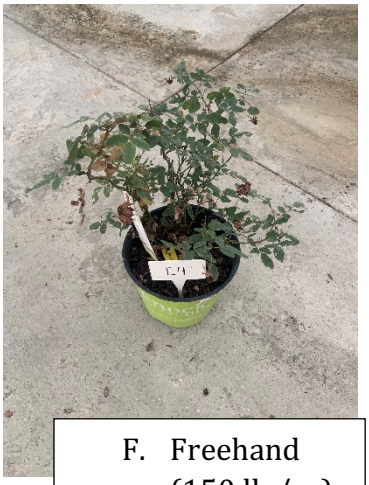
C. Control



B. Fuerte (100lb./ac)

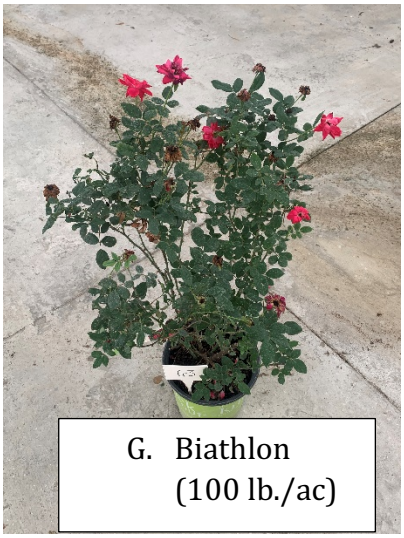
A. Fortress (150lb./ac)

D. Tower (21 fl oz./ac)

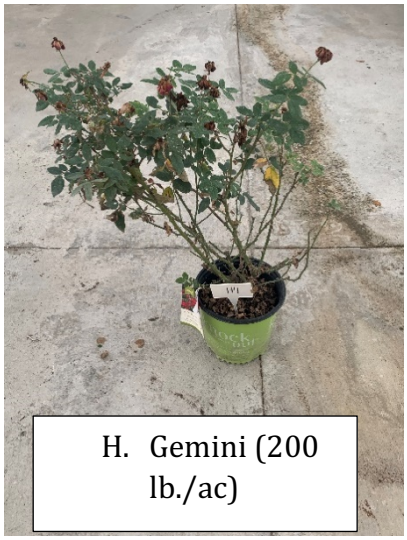


F. Freehand (150 lb./ac)

E. Marengo (200 lb./ac)



G. Biathlon (100 lb./ac)



H. Gemini (200 lb./ac)

Fig. 6 (A-E): Pictorial representation of Rosa 'Radzazz' plant injury at 4 weeks after treatment. Freehand and Gemini (E and H, respectively) show maximum injury among all treatments. Symptoms included browning and discoloration of leaves and parts of stems conducted at MSU, East Lansing, MI.

3. Efficacy study conducted

There was some very sparse germination of common chickweed and *Cardamine pennsylvanica,* Pennsylvania bittercress, in all treatments, but, as July progressed, no seedlings survived (Fig. 7). Both are winter annuals; therefore, germination usually would occur late summer to early fall, which was the situation in this study. The percent cover remained low for these species with chickweed and bittercress never reaching above 7.45% or 16.12 % cover, respectively, over treatments, even at 90 DAT (Fig. 7 and 8) (Table A I and II).

Fig. 7. *Stellaria media* (common chickweed) growth at 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH. Only the control (treatment #1) and the Pethoxamid (treatment #2) (Table A. I) had weed germinating. From left to right, treatments #1 through 10.

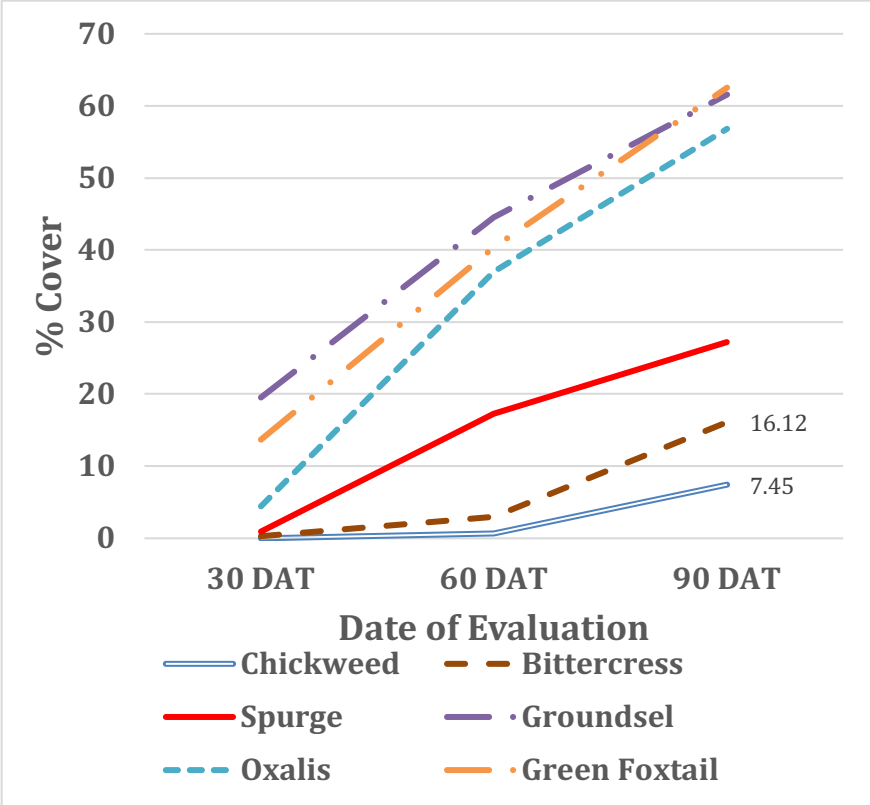


Fig. 8. Graphic representation of % cover growth at 30 (August 8, 2022), 60 (September 7, 2022) and 90 DAT (October 7, 2022) averaged over treatments by species at Mathers Environmental Science Services, LLC, Gahanna, OH. As expected by lifecycle, common chickweed and bittercress germinated very poorly until temperatures decreased in late summer into fall.

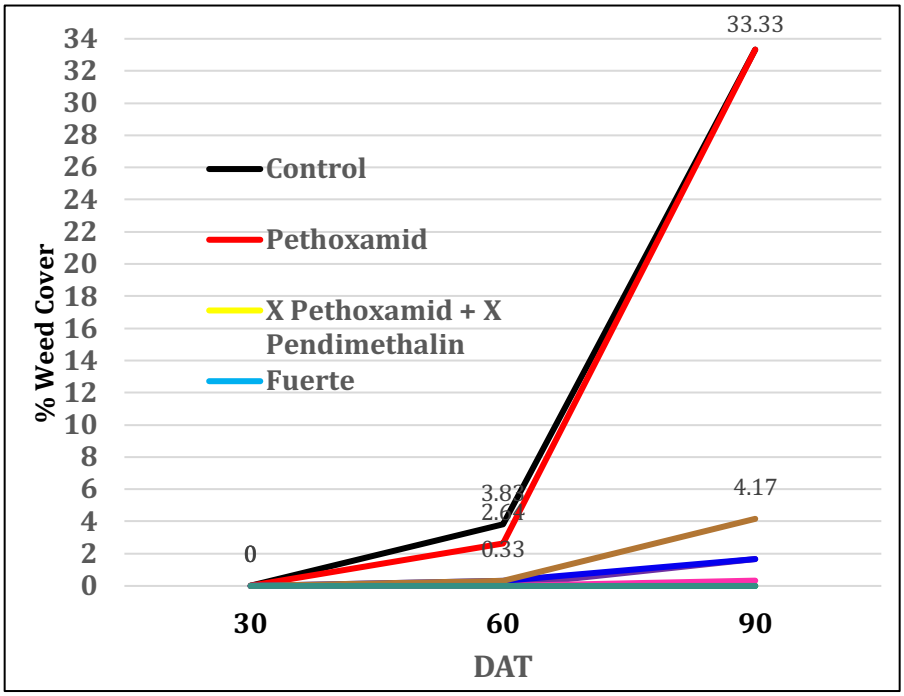


Fig. 9. Graphic representation of *Stellaria media* (common chickweed) % cover increase 30 (August 8, 2022), 60 (September 7, 2022) and 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH. As a winter annual, common chickweed grew poorly until temperatures decreased in late summer into fall. Growth was primarily in the controls.

Based on the limited data gathered from the common chickweed, Pethoxamid is the worst treatment. The best treatments were Pethoxamid + Pendi-Pro 3.3 EC, Fuerte, Fortress, Gemini G and Tower 6EC in a five-way tie by % cover (Table A I). By weed fresh weight, all treatments other than Pethoxamid were better than the control. Since the chickweed was just starting to break thorough in some treatments (even #7, Tower), taking the trial to 120 DAT may have provided a clearer best treatment option.

The growth of *Cardamine pennsylvanica,* Pennsylvania bittercress, was slightly better than with the chickweed (Fig. 9). As with the chickweed, the bittercress increased after the 60 DAT, Fortress especially failed. By 90 DAT, Fortress had more weed weight in the pots than the control pots (Fig. 10). The Tower 6EC applied at 50 gpa and the Pethoxamid + Pendimethalin at 50 gpa were the best treatments and not statistically different from each other (Table A II). Fortress had less % cover at 90 DAT versus the control (Table A II). The discrepancy with weed weight and % cover for treatment #5, Fortress, is best depicted in Fig. 10 where all the OHP treatments are shown side-by-side. The control pots have more cover than the Fortress pots, but the weeds in the Fortress pots are considerably larger and thus would weigh more (Fig. 10).

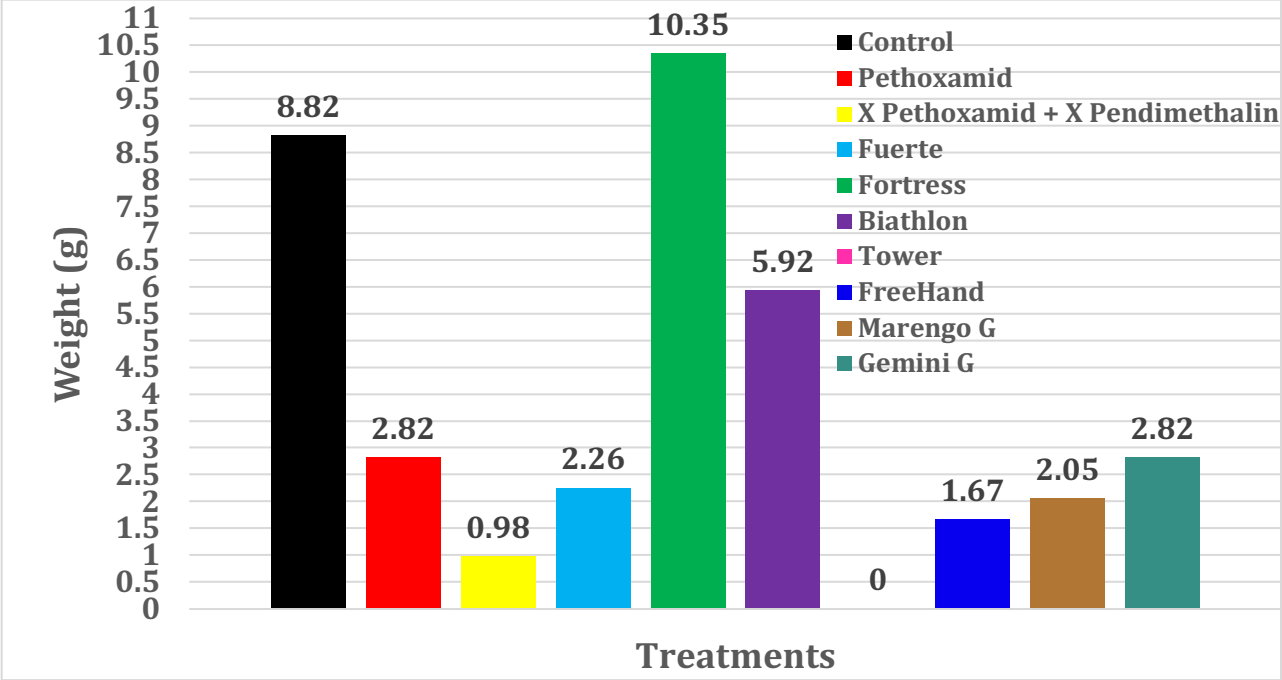


Fig. 10. Weed fresh weights collected at 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH for *Cardamine pennsylvanica*, Pennsylvania bittercress. No weed growth occurred in the Tower 6EC treatment. Fortress was the worst treatment with more weed weight than the control.

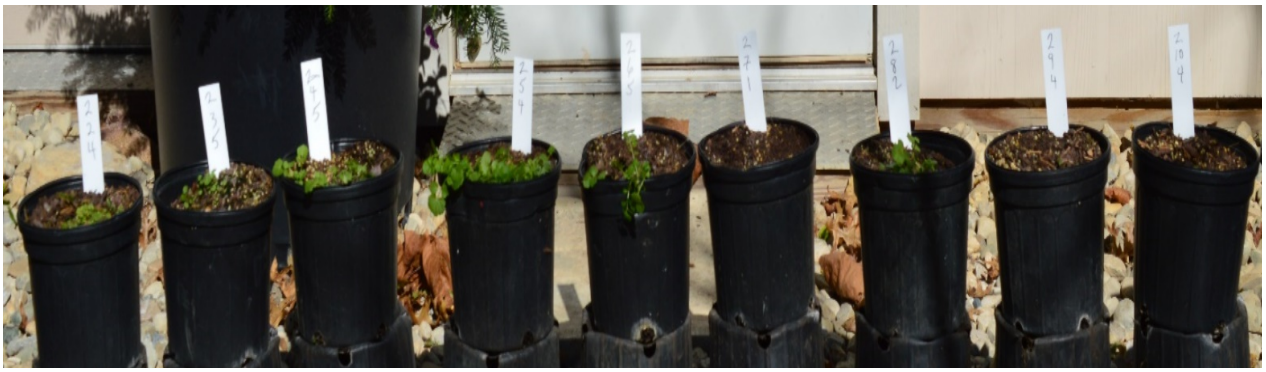


Fig. 11. 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH for *Cardamine pennsylvanica*, Pennsylvania bittercress. From left to right, treatments #1 through 10.

Fig. 12. 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH for *Cardamine pennsylvanica*, Pennsylvania bittercress. From left to right, treatment #1 through 6 (i.e., control, Pethoxamid, Pethoxamid + Pendi-Pro 3.3 EC, Fuerte, Fortress and Biathlon).

Euphorbia maculate, spotted spurge, is a summer annual but it prefers hot conditions to germinate; therefore, more germination occurred between initiation (07/09/2022) and 30 DAT (O8/08/2022) than with the chickweed and bittercress (Fig. 9 and 11, respectively). However, the biggest differences in % cover between chickweed and bittercress versus spotted spurge occurred between 30 and 60 DAT (09/07/2022) (Table A III). Unlike chickweed and bittercress (Table A I and II), spurge reached 100% cover by 90 DAT with a corresponding weed fresh weight of 68.97 grams (Table A III). The worst treatment was Biathlon (#6) (Fig. 13 far right), and the best treatments were again Pethoxamid + Pendi-Pro 3,3 EC (treatment 2) and Tower 6EC (Fig. 14 second from left) by weight. However, with spotted spurge, Marengo G (#9) also provided exceptional control that was not statistically different than the other two best treatments [Fig. 14 (second from left) Table A III]. By % cover, Biathlon and Fuerte are not statistically different (Table A III); nevertheless, by fresh weight, Biathlon does not provide the control of Fuerte (Fig. 15).

Fig. 13. 90 days after treatment (DAT) (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH for *Euphorbia maculate,* spotted spurge. From left to right, treatments #1 through 6 (i.e., control, Pethoxamid, Pethoxamid + Pendi-Pro 3.3 EC, Fuerte, Fortress and Biathlon). With replicate #5 of the control and treatment #6, it appears that the weed weight of Biathlon would surpass the control, but, over the six replicates, Biathlon was not worse than the control.

Fig. 14. 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH for *Euphorbia maculate,* spotted spurge. From left to right, treatments #6 through 10 (i.e., Biathlon, Tower, FreeHand, Marengo G and Gemini G). Biathlon and Gemini G are both performing poorly.

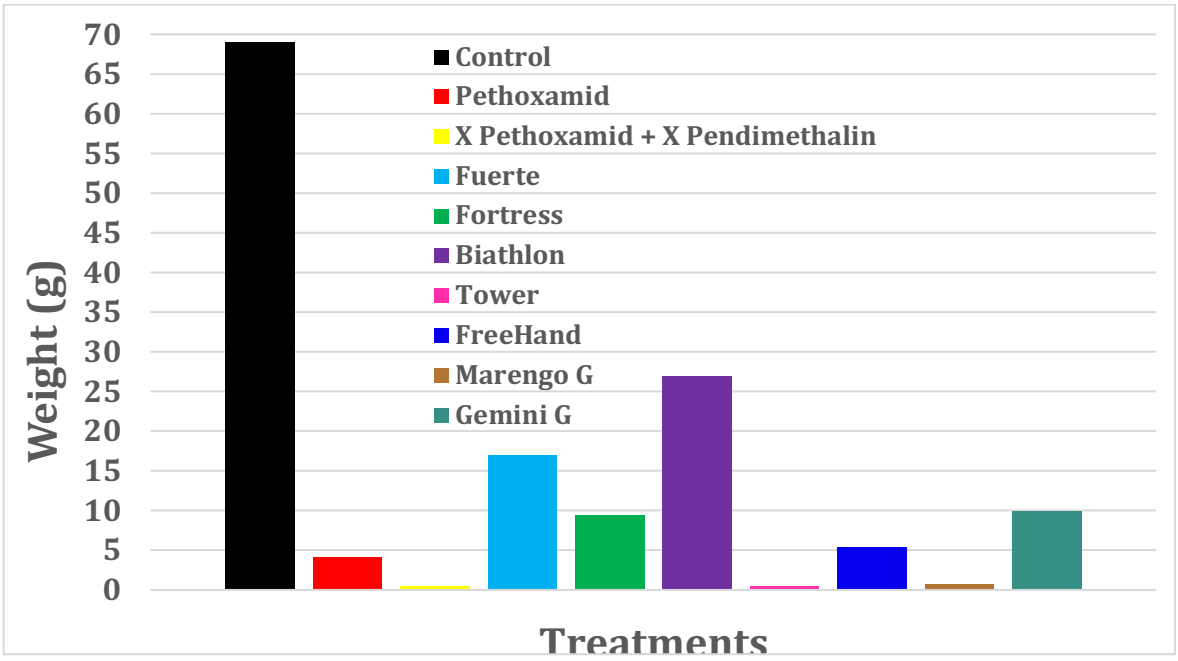


Fig. 15. Fresh weed weights collected at 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH for *Euphorbia maculate,* spotted spurge. By fresh weight, Biathlon provided the worst control of spotted spurge. The best control was with Pethoxamid + Pendi-Pro, Tower 6EC and Marengo G.

Senecio vulgaris, common groundsel, grew well in this study, achieving near 100% cover after only 60 DAT (95.0%) in the controls (Table A IV) (Fig. 16). Fuerte had very poor performance with controlling groundsel, with 45% cover at 30 DAT and 78.67 % at 60 DAT (Fig. 16, 17 and Table A IV). By % cover and weed fresh weight, Tower 6 EC outperformed Pethoxamid + Pendi-Pro 3.3EC for only this species in this study (Table A IV versus I, II, II, V and VI). By 90 DAT, Pethoxamid + Pendi-Pro 3.3EC was no longer providing commercially acceptable control for groundsel. Notably, this was the only species where this occurred. The difference in control with Tower 6 EC is clearly visible in Fig. 16 taken at 90 DAT, Fig. 17 and Table A IV.T

Fig. 16. *Senecio vulgaris,* common groundsel, 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH. From left to right, treatments #1 through 10.

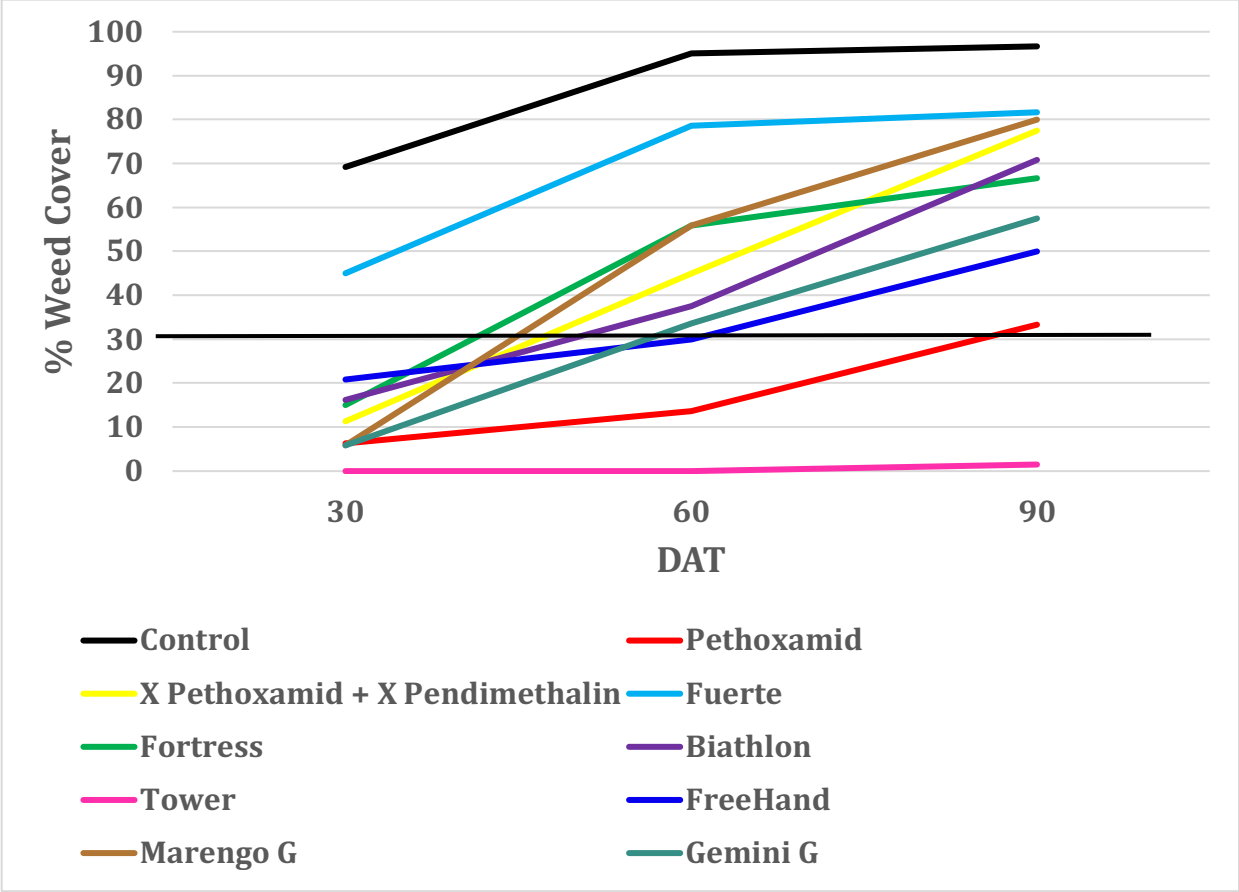


Fig. 17. Percent cover for *Senecio vulgaris,* common groundsel, at 30, 60 and 90 DAT. Even at 30 DAT, the control treatments were not commercially viable at over 30% cover (represented as a solid line). At 60 DAT, Fuerte had lost commercially acceptable control. Tower 6EC provided zero weed control or not statistically different than 0, even at 90 DAT. The fresh weight of Fuerte exceeded that of the control at 90 DAT (Table A IV).

Oxalis corniculate, creeping oxalis, produced the largest control weight at 90 DAT (151.87 g) in the trial (Table A V). At 60 DAT, both the control and Fuerte were no longer providing commercially acceptable control as % cover (Fig. 18) (shown as a line at 30%). At 90 DAT, Fortress also went above 30% cover (Fig. 18 and Table A IV). Again, Pethoxamid + Pendi-Pro 3.3 EC offered the best control as well as Tower (Fig. 18). Although Tower allowed more % weed cover than Pethoxamid + Pendi-Pro 3.3 EC in the previous four species (Fig. 19), Tower was still not significantly different versus Pethoxamid + Pendi 3.3 EC by % cover (Fig. 18) (Table A V). The superior control of Pethoxamid + Pendi-Pro 3.3EC and Tower 6EC is shown in Fig. 20 and Table A VI at 90 DAT. Gemini G showed a constant rate of weakening % weed control for oxalis (Fig. 18). This was also true of FreeHand. However, unlike FreeHand, Gemini G would have

probably provided control for many more weeks after 90 DAT. By far, oxalis was the most problematic weed in the study. With production of stolons in the pots (Fig. 21A), seeding in pot drainage holes (Fig. 21B), sprawling stems and constant re-seeding (Fig. 21C).

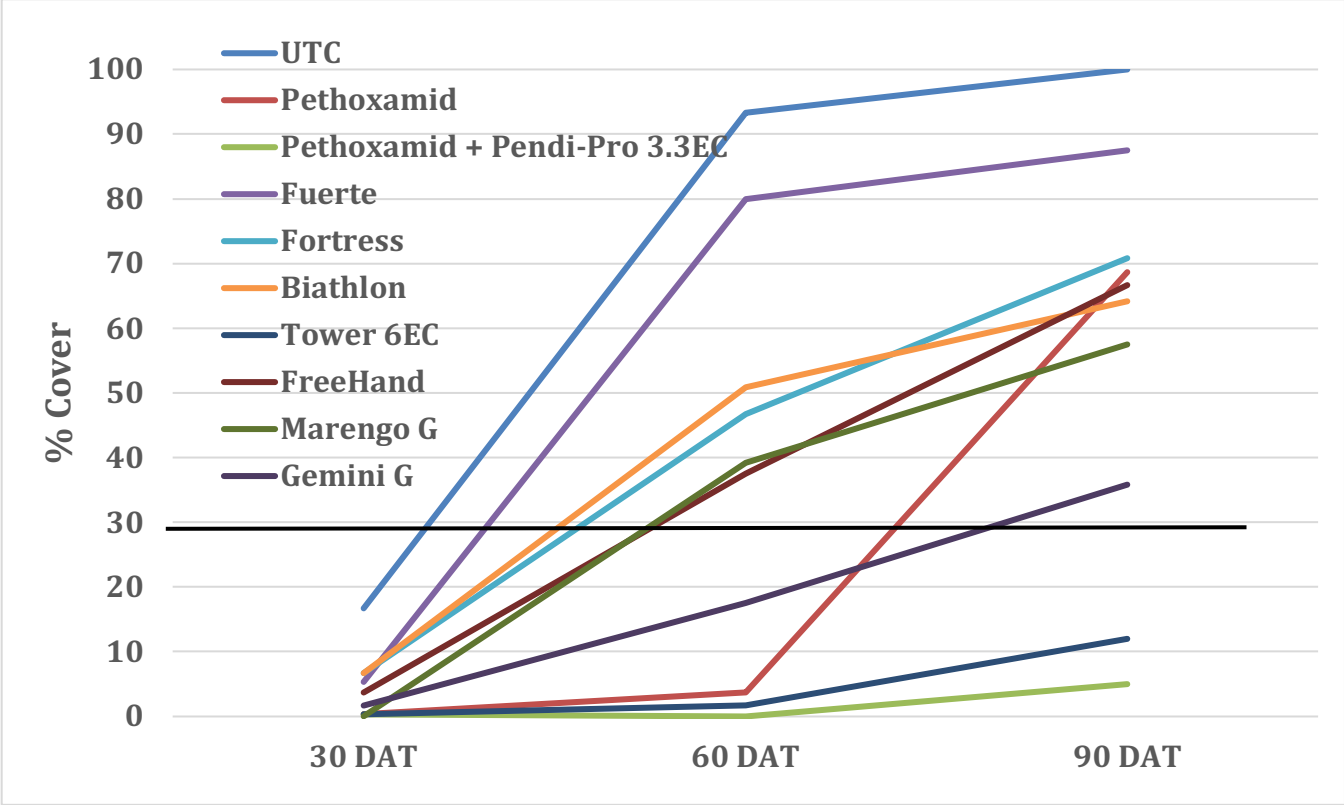


Fig. 18. Percent cover for O*xalis corniculate,* creeping oxalis, at 30, 60 and 90 DAT. Even at 30 DAT, the control treatments were not commercially viable at over 30% cover (represented as a solid line). At 60 DAT, Fuerte had lost commercially acceptable control. Tower 6EC provided zero weed control or not statistically different than 0, even at 90 DAT. The fresh weight of Fuerte exceeded that of the control at 90 DAT (Table A IV).

Fig. 19. *Oxalis corniculate,* creeping oxalis, growing in treatment seven (Tower 6EC) at 90 DAT at Mathers Environmental Science Services, LLC, Gahanna, OH. The amount of growth in the Tower pots with oxalis had not been seen with the previous four species, indicating oxalis was breaking through at 90 DAT.

Fig. 20. *Oxalis corniculate*, creeping oxalis, 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH. From left to right, treatments #1 through 10. Superior weed control is provided by Pethoxamid + Pendi-Pro 3.3EC (treatment 3) and Tower 6 EC (treatment 7). The worst control of oxalis was seen with Fuerte (treatment 4).

The *Setaria viridis,* green foxtail, seed sourced from MESS had some small contamination with *Poa Annua* seed. The *Poa annua* seed was the only thing that grew in the Tower 6 EC pots (Fig. 22). By weight, Fuerte (156.67 g), Marengo G (132.86 g) and Gemini G (129.05 g) provided less control than the controls (124.73 g) (Table 2 VI). In a rare showing, the Pethoxamid (treatment #2) did better than the Pethoxamid + Pendi-Pro 3.3EC (treatment #3) by weight and was not statistically different than Tower 6EC (treatment #7) by weight (Fig. 22 and Table A VI). However, by % cover, Pethoxamid + Pendi-Pro 3.3EC (treatment #3) was statistically better than the Pethoxamid (Table A VI) (Fig. 23). This discrepancy in weight versus % cover was due to seed heads harvested at 60 DAT. The weight gathered at 60 DAT was greater in treatment #3 than in #2 (data not shown).

Fig. 21. A.B.C. Reasons why oxalis is such a difficult weed in containers. A. Stolon production, B. Sprouting or seeding in drainage hole of pot, and C. Constant re-seeding.

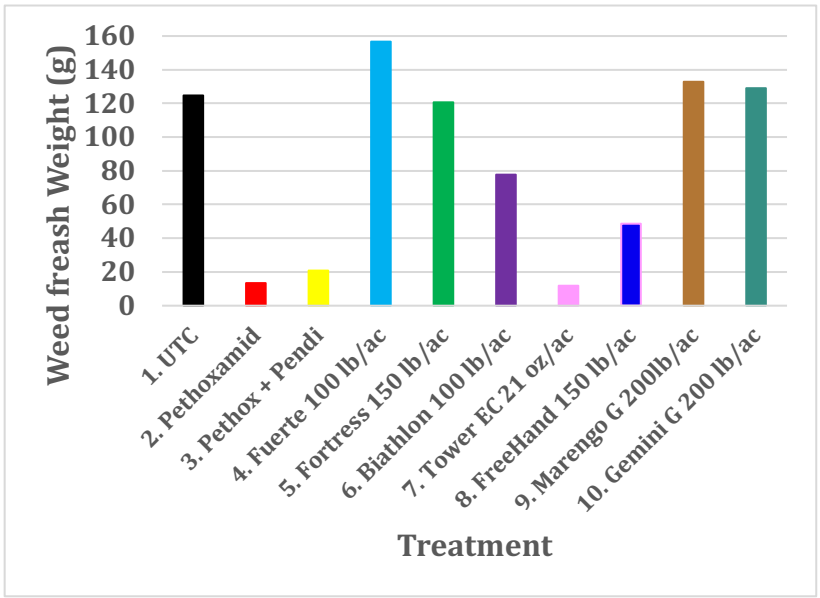


Fig. 22. Fresh weed weights collected at 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH for *Setaria viridis,* green foxtail by fresh weight. Fuerte was significantly the worst treatment, followed by Marengo G and Gemini G, which were not statistically different from each other, and all produced more weed fresh weight than the control.

Fig. 23. *Setaria viridis,* green foxtail at 90 DAT (October 7, 2022) at Mathers Environmental Science Services, LLC, Gahanna, OH. From left to rights treatments #1 through 10. Superior weed control is provided by Pethoxamid + Pendi-Pro 3.3EC (treatment 3) and Tower 6 EC (treatment 7) by % weed cover (Table A VI). The worst control of green foxtail was seen with Fuerte (treatment 4).

Table A. (I, II, III, IV, V, VI.) Six species of weeds were evaluated from trial initiation (July 9, 2022) at 30 DAT (August 8, 2022), 60 DAT (September 7, 2022) and 90 DAT (October 7, 2022) by % cover (0 to 100% where ≥ 30% is commercially acceptable). To minimize weed invasion from this research trial, flowers of three species were cut and fresh weights collected at 60 DAT. These weights were added to the final fresh weed weights conducted at 90 DAT of the whole above ground plant. Only the total weights are given at 90 DAT. The three species where flowers were cut at 60 DAT are IV. *Senecio vulgaris,* common groundsel; V. *Oxalis corniculate*, creeping oxalis; and VI. *Setaria viridis,* green foxtail. Flowers were not collected and weighed for I. *Stellaria media*, common chickweed; II. *Cardamine pennsylvanica*, Pennsylvania bittercress; or III. *Euphorbia maculate,* spotted spurge. The chickweed and bittercress as winter annuals were slow to germinate, thus no flowers were harvested at 60 DAT. Spotted spurge has flowers that form in the axis of upper leaves, so harvesting only flowers would have been problematic and was not conducted. Results are presented by species for the ten treatments listed under products and at the rates provided since the objective of the trial was to find the best and worst herbicide for each species. 50 gpa was used when liquids were applied. This trial was conducted at Mathers Environmental Science Services, LLC, Gahanna, OH. Footnotes at bottom of VI.

I. *Stellaria media* (Common chickweed)

Tmt.[z]	Products	Rate	Use	30 DAT[y]	60 DAT	90 DAT	Wt. (g) at 90 DAT
1	UTC	--	--	0a[x]	3.83b[x]	33.33d	5.73b
2	Pethoxamid – (OHP 2102)	0.75 lb ai/A	50 GPA	0a	2.64b	33.33d	2.40b
3	X Pethoxamid (OHP 2102) + [1]X Pendimethalin (Pendi Pro 3.3 EC)	0.75 lb/ A + 4.8 pt./ac	50 GPA	0a	0aa	0a	0a
4	Fuerte	100 lb/ A	Granular	0a	0a	0a	0a
5	Fortress	150 lb/ A	Granular	0q	0a	0a	0a
6	Biathlon	100 lb/ A	Granular	0a	0a	1.67b	0.17a
7	Tower	21 oz/ac	50 GPA	0a	0a	0.33a	0.08a
8	FreeHand	150 lb/ac	Granular	0a	0.33a	1.67b	0.13a
9	Marengo G	200 lb/ac	Granular	0a	0.33a	4.17c	0.28a
10	Gemini G	200 lb/ac	Granular	0a	0a	0a	0a
Averages				**0**	**0.713**	**7.45**	**0.879**

II. *Cardamine pennsylvanica*, Pennsylvania bittercress

Tmt.[z]	Product(s)/ A.I.(s)	Rate	Use	30 DAT[y]	60 DAT	90 DAT	Wt. (g) at 90 DAT
1	UTC	--	--	1.0a[x]	16.67b[x]	45.83c	8.82d
2	Pethoxamid – (OHP 2102)	0.75 lb ai/A	50 GPA	0a	7.5ab	23.67b	2.82b
3	X Pethoxamid (OHP 2102) + [1]X Pendimethalin (Pendi Pro 3.3 EC)	0.75 lb/ A + 4.8 pt./ac	50 GPA	0a	1.0a	5.25a	0.98a
4	Fuerte	100 lb/ A	Granular	1.0a	1.5a	9.5a	2.26b
5	Fortress	150 lb/ A	Granular	0a	1.2a	37.83c	10.35d
6	Biathlon	100 lb/ A	Granular	1.0a	1.2a	22.0b	5.92c

7	Tower	21 oz/ac	50 GPA	0a	0a	0a	0a
8	FreeHand	150 lb/ac	Granular	0a	0.5a	8.3a	1.67b
9	Marengo G	200 lb/ac	Granular	0a	0a	2.5a	2.05b
10	Gemini G	200 lb/ac	Granular	0a	0a	6.33a	2.82b
Averages				**0.3**	**2.96**	**16.12**	**3.77**

III. *Euphorbia maculate,* Spotted spurge

Tmt.[z]	Product(s)/ A.I.(s)	Rate	Use	30 DAT[y]	60 DAT	90 DAT	Wt. (g) at 90 DAT
1	UTC	--	--	7.17a[x]	91.67c[x]	100e	68.97
2	Pethoxamid – (OHP 2102)	0.75 lb ai/A	50 GPA	0a	0.17a	7.83b	4.07
3	X Pethoxamid (OHP 2102) + [1]X Pendimethalin (Pendi Pro 3.3 EC)	0.75 lb/ A + 4.8 pt./ac	50 GPA	0a	0a	0.83a	0.39a
4	Fuerte	100 lb/ A	Granular	0a	10a	50.0	16.96
5	Fortress	150 lb/ A	Granular	0a	14.17a	33.7c	9.36
6	Biathlon	100 lb/ A	Granular	0.33a	41.67b	50.8d	26.94
7	Tower	21 oz/ac	50 GPA	0.83a	0a	0.83a	0.46a
8	FreeHand	150 lb/ac	Granular	0a	0a	3.3ab	5.4
9	Marengo G	200 lb/ac	Granular	0.17a	0.17a	1.67a	0.63
10	Gemini G	200 lb/ac	Granular	0.83a	15.0a	23.3c	9.92
Averages				**0.93**	**17.29**	**27.23**	**14.37**

IV. *Senecio vulgaris,* Common groundsel

Tmt.[z]	Product(s)/ A.I.(s)	Rate	Use	30 DAT[y]	60 DAT	90 DAT	Wt. (g) at 90 DAT
1	UTC	--	--	69.2c[x]	95.0e[x]	96.67e	97.12e
2	Pethoxamid – (OHP 2102)	0.75 lb ai/A	50 GPA	6.3a	13.67a	33.33b	20.81b
3	X Pethoxamid (OHP 2102) + [1]X Pendimethalin (Pendi Pro 3.3 EC)	0.75 lb/ A + 4.8 pt./ac	50 GPA	11.3a	45.0c	77.5d	58.69d
4	Fuerte	100 lb/ A	Granular	45.0c	78.67d	81.7de	103.39e
5	Fortress	150 lb/ A	Granular	15.0ab	55.83d	66.7cd	63.05d
6	Biathlon	100 lb/ A	Granular	16.17b	37.5bc	70.83d	55.55cd
7	Tower	21 oz/ac	50 GPA	0.0a	0a	1.50a	1.57a
8	FreeHand	150 lb/ac	Granular	20.83b	30.0b	50.0c	41.83c
9	Marengo G	200 lb/ac	Granular	5.83a	55.83d	80.0d	69.67d
10	Gemini G	200 lb/ac	Granular	5.83a	33.67bc	57.5c	62.56d
Averages				**19.55**	**44.52**	**61.57**	**57.12**

V. *Oxalis corniculate,* Creeping Oxalis

Tmt.[z]	Product(s)/ A.I.(s)	Rate	Use	30 DAT[y]	60 DAT	90 DAT	Wt. (g) at 90 DAT
1	UTC	--	--	16.67b[x]	93.33d	100e	151.87f
2	Pethoxamid – (OHP 2102)	0.75 lb ai/A	50 GPA	0.33a	3.67a	68.67c	49.73c
3	X Pethoxamid (OHP 2102) + [1]X Pendimethalin (Pendi Pro 3.3 EC)	0.75 lb/ A + 4.8 pt./ac	50 GPA	0.33a	0a	5.0a	5.18a
4	Fuerte	100 lb/ A	Granular	5.30a	80.0d	87.5d	122.63e
5	Fortress	150 lb/ A	Granular	6.67a	46.67c	70.83c	89.10d
6	Biathlon	100 lb/ A	Granular	6.67a	50.87c	64.17c	64.45c

7	Tower	21 oz/ac	50 GPA	0.33a	1.67a	12.0a	11.34a
8	FreeHand	150 lb/ac	Granular	3.67a	37.5c	66.7c	53.42c
9	Marengo G	200 lb/ac	Granular	2.83a	39.17c	57.5b	37.24bc
10	Gemini G	200 lb/ac	Granular	1.67a	17.5b	35.83b	20.25b
Averages				**4.45**	**37.04**	**56.82**	**60.52**

VI. *Setaria viridis,* Green Foxtail

Tmt.[z]	Product(s)/ A.I.(s)	Rate	Use	30 DAT[y]	60 DAT	90 DAT	Wt. (g) at 90 DAT
1	UTC	--	--	46.67c[x]	81.7d[x]	98.33d	124.73d
2	Pethoxamid – (OHP 2102)	0.75 lb ai/A	50 GPA	2.0a	9.17a	28.33b	13.40a
3	X Pethoxamid (OHP 2102) + [1]X Pendimethalin (Pendi Pro 3.3 EC)	0.75 lb/ A + 4.8 pt./ac	50 GPA	0a	1.67a	16.67a	20.83b
4	Fuerte	100 lb/ A	Granular	26.0b	78.33d	95.0cd	156.67d
5	Fortress	150 lb/ A	Granular	25.0b	57.5c	80.0c	120.67c
6	Biathlon	100 lb/ A	Granular	8.3a	23.67b	36.67b	77.75d
7	Tower	21 oz/ac	50 GPA	0.0a	0.0a	19.10a	11.84a
8	FreeHand	150 lb/ac	Granular	2.17a	18.67b	37.0b	48.64c
9	Marengo G	200 lb/ac	Granular	20.0b	69.17c	93.3cd	132.86c
10	Gemini G	200 lb/ac	Granular	7.83a	63.67c	86.7cd	129.05c
Averages				**13.70**	**40.35**	**62.53**	**83.64**

X = Efficacy (Eff.) ratings are based on Percent cover 0-100 scale with 100 being complete cover, and ≥30 commercially acceptable control.

y = days after treatment (DAT)

z = Treatment is abbreviated (Tmt.)

≠ = Treatments with different letters signify efficacy was statistically different at p=0.05 using LS means following ANOVA in SAS

Conclusions for efficacy:

Tower 6EC applied at 50 gpa and 21 oz/ac and Pethoxamid (0.75 lb/ac) + Pendi Pro 3.3 EC (4.8 pt. ac) were the best treatments in five of six species with chickweed, bittercress, spurge, oxalis and green foxtail (Table A, I, II, III, V and VI, respectively). Only

with groundsel was Pethoxamid better than the Pethoxamid + Pendi (Table A IV). Perhaps because Pethoxamid can be used as a post-emergence weed control as well as pre-emergence on annual grasses and certain broadleaf weeds, it had an advantage dealing with groundsel. Groundsel has two lifecycles: winter and summer annual. The summer annual form can have seeds that are pre-geminated. Therefore, the Pethoxamid was able to deal with the groundsel on its own. With the other five species, pendimethalin was required with the Pethoxamid to achieve control of the grass (green foxtail) and broadleaf weeds (chickweed, bittercress, spurge and oxalis). The results concur with previous research in that liquids have much higher efficacy than granular herbicides and support that higher water volumes (50 gpa) compared to those normally used (25 gpa) increase efficacy due to larger water droplets. Table 1 summarizes the results.

ADDITIONAL INFORMATION

Provide additional information available (i.e., publications, website links, photographs) that is not applicable to any of the prior sections.

1. Mathers, H.M. 2022. Really bad Weeds. MI St. Clair Co, Pesticide Recertification Program. Port Huron, MI. (Feb. 16, 2022).

2. Mathers, H.M. 2022. Herbicide Drift and Carry Over. MI St. Clair Co, Pesticide Recertification Program. Port Huron, MI. (Feb. 16, 2022).

3. Mathers, H.M. 2022. New Herbicides and New Uses. MI St. Clair Co, Pesticide Recertification Program. Port Huron, MI. (Feb. 16, 2022).

4. Mathers, H.M. 2022. Let's be Pragmatic: Marengo G as an OTT dormant application. *Michigan Landscape*: 65(4):55-59.

5. Mathers, H.M. 2023. Weed control in MI nurseries. IPM Alliance Tour organized by the Michigan Nursery and Landscape Association to 40 EPA, State and Association Regulatory personnel. Grand Rapids, MI. (August 23, 2023).

6. Mathers, H.M. 2023. The right preemergence herbicide for the job. Presented at the Great Lakes Trade Exposition (GLTE) by the Michigan Nursery and Landscape Association to 80 industry members. Grand Rapids, MI. (January 24).

7. Mathers, H.M. 2023. Pre- and Post- Herbicide Combos. Presented at Great Lakes Trade Exposition (GLTE) by the Michigan Nursery and Landscape Association to 60 industry members. Grand Rapids, MI. (January 24).

8. Mathers, H.M. 2023. Time for Alternates: Marengo G as an OTT dormant application. *Michigan Landscape*: 66(5):54-56

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9. Mathers, H.M., and E.J.M. Beaver. 2023. Grassy Weeds: Part 1. *Michigan Landscape*: 66(4):45-48.