

2018 Mid-Year Report – Multi-State Weed Research in Mint

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Statement of purpose. Determine the comparative efficacy of saflufenacil (Sharpen powered by Kixor herbicide) to currently registered broadleaf herbicides on local broadleaf weeds in dormant peppermint, native spearmint, or Scotch spearmint at five locations representing the major U.S. mint production regions.

Summary of objectives.

1. Determine the comparative crop safety and efficacy of several rates and timings of saflufenacil on local broadleaf weeds in mint at five locations; California, Indiana, Oregon, Washington, and Wisconsin.

Actions to be taken.

1. Test saflufenacil and currently labeled broadleaf herbicides on broadleaf weeds in dormant mint in field trials in California, Indiana, Oregon, Washington, and Wisconsin.

Anticipated Results.

1. Provide new efficacy and crop safety data to support the potential registration of saflufenacil in mint in the major U.S. mint production regions.

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Principle Researchers

- Andrew Hulting, Associate Professor, Weed Science, Oregon State University, Corvallis, OR. Dr. Hulting has 11 years of experience conducting research on weed management in peppermint and other agronomic and specialty crops.
- Rob Wilson, Center Director, University of California Intermountain Research and Extension Center, Tulelake, CA. Mr. Wilson has 6 years of research experience related to pest management in peppermint and over 14 years of weed science research experience.
- Jed Colquhoun, Professor, Department of Horticulture, University of Wisconsin, Madison. Dr. Colquhoun has 15 years of research and outreach experience in mint and other specialty crops.
- Lynn Sosnoskie, Assistant Research Faculty, Washington State University has 12 years of research and extension related to specialty crops.
- Petrus Langenhoven, Horticulture Specialist, Purdue University, West Lafayette, IN. Dr. Langenhoven has 14 years of research and outreach experience related mint and other specialty crops.

Statement of Research. Uncontrolled weeds lower mint oil yield and quality and managing weeds represents a major production cost for growers. The ultimate goal of this research is to develop new tools for weed management in spearmint and peppermint production. The research will identify the efficacy and benefits of saflufenacil (Sharpen) on important broadleaf weed problems in mint in five representative mint production regions in the U.S. and contribute to the potential registration of saflufenacil in mint.

BASF is supportive of efforts to register saflufenacil herbicide in numerous crops in the U.S. including mint. Additional field trials are needed to document and verify the efficacy of saflufenacil on broadleaf weeds in dormant mint as well as document adequate crop safety at a range of application rates and timings. These trials will compare the efficacy of saflufenacil with currently labeled postemergence broadleaf herbicides on regional broadleaf weeds that are problems in mint.

Research Methods for Tulelake, CA

The California trial was conducted in an established peppermint (Black Mitcham) field in a grower field near Tulelake, CA. The field was irrigated with solid-set sprinklers and managed for one cutting per season. The soil type is silty clay loam with 4% organic matter. Winter weeds at the trial site included prickly lettuce, tansy mustard, and common groundsel. Summer weeds included redroot pigweed, kochia, and common lambsquarter. Saflufenacil was applied postemergence (POST) to dormant mint on February 7th, 2018 at 0.045 lbs ai/a (proposed 2.0 oz/a product labeled rate) with MSO

at 1% (v/v) plus AMS at 2% (w/v). A 2X and 3X rate of saflufenacil along with the local standard (Gramoxone + Zeus) was included in the treatment list. Dormant tank mix partners (Chateau, Zeus, and Zidua) were also applied with the saflufenacil. To further test crop safety and efficacy of saflufenacil on emerged weeds, Sharpen was applied 0, 2, 4, and 8 weeks following mint green-up. The entire treatment list is shown in Table 1.

Plots were 10 by 30 feet and herbicide treatments were replicated four times in a randomized complete block design. Herbicides were applied with a small plot CO₂ sprayer at 20 GPA. Crop injury and weed control were evaluated six separate times from May 1st to July 12th. Mint hay yield was measured in mid-August by harvesting a known area in each plot and weighing. A subsample of hay from each plot was weighed, dried and steam distilled to determine oil yield.

2018 Tulelake, CA Saflufenacil Treatment List

Trt #	Product Name	Active Ingredient	Appl. Code	Product per acre (fl oz or oz)
1	Nontreated			
2	Gramoxone + Zeus + NIS	paraquat + sulfentrazone	Dormant mint	32 + 6
3	Sharpen 1X + MSO + AMS	saflufenacil	Dormant mint	2
4	Sharpen 2X + MSO + AMS	saflufenacil	Dormant mint	4
5	Sharpen 3X + MSO + AMS	saflufenacil	Dormant mint	6
6	Sharpen + Zeus + MSO + AMS	saflufenacil +sulfentrazone	Dormant mint	2 + 6
7	Sharpen + Chateau + MSO + AMS	saflufenacil + flumioxazin	Dormant mint	2 + 4
8	Sharpen + Zidua + MSO + AMS	saflufenacil + pyroxasulfone	Dormant mint	2 + 1.69
9	Sharpen 1X + MSO + AMS	saflufenacil	green-up	2
10	Sharpen 2X + MSO + AMS	saflufenacil	green-up	4
11	Gramoxone + NIS	paraquat	green-up	32
12	Sharpen 1X + MSO + AMS	saflufenacil	2 wks post green-up	2
13	Sharpen 2X + MSO + AMS	saflufenacil	2 wks post green-up	4
14	Gramoxone + NIS	paraquat	2 wks post green-up	32
15	Sharpen 1X + MSO + AMS	saflufenacil	4 wks post green-up	2
16	Sharpen 2X + MSO + AMS	saflufenacil	4 wks post green-up	4
17	Sharpen 1X + MSO + AMS	saflufenacil	8 wks post green-up	2
18	Sharpen 2X + MSO + AMS	saflufenacil	8 wks post green-up	4

Nonionic surfactant (NIS) added at 0.25 % v/v;

Methylated seed oil (MSO) added 1% v/v;

Ammonium sulfate (AMS) added at 2% v/v

Preliminary Tulelake, CA Results

Peppermint Response to Saflufenacil- Saflufenacil (Sharpen) exhibited good crop safety when applied at or before peppermint green-up. 1X and 2X rates caused minimal early season injury that was comparable with the current standard, paraquat (Gramoxone) + sulfentrazone (Zeus). Tank-mixing dormant preemergence herbicides with Sharpen was safe in established peppermint. Delaying Sharpen application until 4 weeks and 8 weeks after peppermint green-up increased crop injury compared to earlier applications. These treatments caused significant stunting in July especially Sharpen applied 8 weeks after mint green-up. The injury carried into harvest delaying peppermint bloom compared to other treatments. Few treatment differences were observed in mint biomass and oil yield except for lower biomass and oil yields in the untreated and Gramoxone treatments due to excessive weed competition.

Saflufenacil Weed Control- The best control of winter annual weeds and summer weeds was achieved by applying Sharpen at a 1X rate in combination with Zeus or Chateau. Tank-mixing Sharpen with Zeus or Chateau greatly improved control of summer annual weeds. Sharpen gave similar or better control of winter annual weeds (prickly lettuce, tansy mustard, and groundsel) and early emerging summer annuals (lambquarter and kochia) compared to Gramoxone. Improved weed control from Sharpen compared to Gramoxone was especially apparent when the herbicide application was delayed until shortly after mint green-up.

Potential Fit of saflufenacil for Weed Control in Peppermint – Saflufenacil appears to be an excellent alternative to Gramoxone for early season weed control in peppermint. Crop injury from saflufenacil at 1X and 2X rates was similar to Gramoxone. Saflufenacil provided similar or better weed control compared to Gramoxone at all application timings especially later applications. UC testing of saflufenacil in alfalfa and peppermint over the last couple years suggest saflufenacil provides improved control of large winter annual broadleaf weeds and dandelion compared to Gramoxone.

Established Peppermint Injury from 2018 Saflufenacil (Sharpen) Treatments in Tulelake, CA.

Trt #	Herbicide Treatment	5/1/2018	5/14/2018	5/29/2018	6/22/2018	7/2/2018	7/12/2018
		peppermint injury					
		0-10 scale 10=mint dead					
1	Untreated Control	0 f	0 d	0 e	0.5 bcd	2.25 a *	1.5 abc *
2	Gramoxone + Zeus- dormant mint	1.25 cde	0.5 cd	0.5 cde	0 d	0.5 b	0.75 abc
3	Sharpen 2 fl. oz- dormant mint	0.75 de	0.375 cd	0.25 de	0 d	1.37 ab	0.5 bc
4	Sharpen 4 fl. oz- dormant mint	1.25 cde	0.75 bcd	0.75 cde	0.25 cd	0.5 b	0.5 bc
5	Sharpen 6 fl. oz- dormant mint	1.25 cde	0.875 bcd	1 bcde	0.5 bcd	1 ab	0.25 bc
6	Sharpen 2 fl. oz + Zeus- dormant mint	1 cdef	0.5 cd	1 bcde	0 d	0 b	0.5 bc
7	Sharpen 2 fl. oz + Chateau- dormant mint	0.75 def	0.5 cd	0.5 de	0 d	0 b	0 c
8	Sharpen 2 fl. oz + Zidua- dormant mint	1 cdef	0 d	0.125 de	0 d	0.375 b	0.5 bc
9	Sharpen 2 fl. oz- mint green-up	1.75 cde	0.625 bcd	0.875 bcde	0 d	0.25 b	0.5 bc
10	Sharpen 4 fl. oz- mint green-up	2 bc	0.625 bcd	1 bcde	0 d	0.75 ab	0.25 bc
11	Gramoxone - mint green-up	1.25 cde	0.5 cd	0.25 de	0 d	0 b	0.5 bc
12	Sharpen 2 fl. oz- 2 weeks post mint green-up	3.25 a	1.125 abcd	0.75 cde	0.5 bcd	1 ab	1 abc
13	Sharpen 4 fl. oz- 2 weeks post mint green-up	3.5 a	1.875 ab	1.5 abcd	0.5 bcd	1 ab	0.875 abc
14	Gramoxone- 2 weeks post mint green-up	2.75 ab	1.375 abc	1.25 abcde	0.5 bcd	1.5 ab	1 abc
15	Sharpen 2 fl. oz- 4 weeks post mint green-up	0.25 ef	1.5 abc	1.375 abcde	0.75 bcd	1.5 ab	1.5 abc
16	Sharpen 4 fl. oz- 4 weeks post mint green-up	0.25 ef	2.375 a	1.875 abc	1.63 abc	1.75 ab	1.25 abc
17	Sharpen 2 fl. oz- 8 weeks post mint green-up	0.25 ef	0 d	2.5 a	1.75 ab	2.25 a	2 ab
18	Sharpen 4 fl. oz- 8 weeks post mint green-up	0.25 ef	0 d	2.25 ab	3a	3a	2.5 a

* Crop injury in the untreated control was related to severe stunting caused by excessive weed competition.

Percent Weed Control from 2018 Saflufenacil Treatments in Tulelake, CA

Trt # Herbicide Treatment		5/29/2018 Weed Control						6/22/2018 Weed Control		
		prickly lettuce	tansy mustard	redroot pigweed	common lambsquarter	common groundsel	kochia	redroot pigweed	common lambsquarter	kochia
		% control 100=no weeds						% control 100=no weeds		
1	Untreated Control	0 d	0 f	33 ab	45 bcde	0 e	13 bc	20	13 bc	40 abcde
2	Gramoxone + Zeus- dormant mint	64 abc	95 ab	60 ab	73 abcd	96 a	88 ab	63	73 abc	88 abc
3	Sharpen 2 fl. oz- dormant mint	68 abc	88 abcd	0 b	15 cde	98 a	18	63	0 c	30 bcde
4	Sharpen 4 fl. oz- dormant mint	75 abc	94 abc	20 ab	13 de	100 a	0 c	45	13 bc	0 e
5	Sharpen 6 fl. oz- dormant mint	90 a	100 a	38 ab	65 abcd	100 a	28	50	43 abc	25 cde
6	Sharpen 2 fl. oz + Zeus- dormant mint	83 ab	100 a	73 ab	78 abc	100 a	75 abc	95	75 abc	75 abcd
7	Sharpen 2 fl. oz + Chateau- dormant mint	86 a	95 ab	90 ab	95 a	100 a	75 abc	95	94 a	91 abc
8	Sharpen 2 fl. oz + Zidua- dormant mint	64 abc	90 abcd	45 ab	18 cde	98 a	20 abc	70	18 abc	0 e
9	Sharpen 2 fl. oz- mint green-up	90 a	93 abc	55 ab	40 bcde	21 de	20 abc	40	25 abc	10 de
10	Sharpen 4 fl. oz- mint green-up	86 a	83 abcd	0 b	60 abcde	79 ab	38 abc	45	67 abc	50 abcde
11	Gramoxone - mint green-up	48 bc	46 de	0 b	0 e	35 cde	25 abc	30	13 bc	40 abcde
12	Sharpen 2 fl. oz- 2 weeks post mint green-up	55 abc	55 bcd	58 ab	85 a	38 bcde	88 ab	75	66 abc	88 abc
13	Sharpen 4 fl. oz- 2 weeks post mint green-up	83 ab	84 abcd	83 ab	80 ab	69 abc	98 a	75	57 abc	88abc
14	Gramoxone- 2 weeks post mint green-up	38 cd	48 de	25 ab	50 abcde	28 cde	63 abc	50	37 abc	100 a
15	Sharpen 2 fl. oz- 4 weeks post mint green-up	48 bc	33 ef	38 ab	70 abcd	61 abcd	88 ab	25	45 abc	95 ab
16	Sharpen 4 fl. oz- 4 weeks post mint green-up	60 abc	55 bcd	75 ab	88 a	80 ab	98 a	68	67 abc	88abc
17	Sharpen 2 fl. oz- 8 weeks post mint green-up	90 a	53 bcd	100 a	95 a	81 ab	100 a	95	87 ab	90 abc
18	Sharpen 4 fl. oz- 8 weeks post mint green-up	93 a	50 cde	100 a	100 a	90 a	100 a	100	95 a	100 a

July Weed Density in 2018 Saflufenacil Treatments at Tulelake, CA.

Trt # Herbicide Treatment		7/2/2018 Weed Density			
		redroot pigweed	common lambsquarter	common groundsel	kochia
		# of weeds per plot			
1	Untreated Control	233 a	23bc	45 a	2 b
2	Gramoxone + Zeus- dormant mint	58 b	12 bcd	1 d	1 bc
3	Sharpen 2 fl. oz- dormant mint	38 b	54 ab	1 d	14 abc
4	Sharpen 4 fl. oz- dormant mint	74 ab	51 abc	0 d	29 a
5	Sharpen 6 fl. oz- dormant mint	61 b	36 abc	0 d	16 abc
6	Sharpen 2 fl. oz + Zeus- dormant mint	10 b	12 cd	0 d	11 abc
7	Sharpen 2 fl. oz + Chateau- dormant mint	12 b	8 cd	0 d	0 c
8	Sharpen 2 fl. oz + Zidua- dormant mint	15 b	43 abc	1 d	14 abc
9	Sharpen 2 fl. oz- mint green-up	72 ab	29 bc	30 abc	21 ab
10	Sharpen 4 fl. oz- mint green-up	54 b	24 bc	10 d	18 ab
11	Gramoxone - mint green-up	101 ab	58 a	37 ab	15 abc
12	Sharpen 2 fl. oz- 2 weeks post mint green-up	178 a	20 bcd	34 abc	2 bc
13	Sharpen 4 fl. oz- 2 weeks post mint green-up	158 a	16 cd	16 cd	1 bc
14	Gramoxone- 2 weeks post mint green-up	127 ab	24 bc	30 abc	1 bc
15	Sharpen 2 fl. oz- 4 weeks post mint green-up	133 ab	14bcd	19 bcd	1 bc
16	Sharpen 4 fl. oz- 4 weeks post mint green-up	133 ab	18 bcd	9 d	1 bc
17	Sharpen 2 fl. oz- 8 weeks post mint green-up	123 ab	7 d	8 d	1 bc
18	Sharpen 4 fl. oz- 8 weeks post mint green-up	116 ab	6 d	4 d	0 c

Peppermint % Bloom, Green Biomass, and Oil Yield at Harvest in Tulelake, CA.

Trt #	Herbicide Treatment	8/9/2018	8/9/218	8/9/2018
		mint bloom	mint biomass yield	mint oil yield
		%	tons/acre (green)	lbs/acre
1	Untreated Control	11 abc	6.7 c	15.4 c
2	Gramoxone + Zeus- dormant mint	16 a	10.5 abc	41.2 abc
3	Sharpen 2 fl. oz- dormant mint	16 a	9.3 abc	38.5 abc
4	Sharpen 4 fl. oz- dormant mint	15 a	10.3 abc	42.8 abc
5	Sharpen 6 fl. oz- dormant mint	15 a	11.4 ab	53.6 ab
6	Sharpen 2 fl. oz + Zeus- dormant mint	15 a	11.7 abc	56.4 ab
7	Sharpen 2 fl. oz + Chateau- dormant mint	16 a	13.5 a	71.3 a
8	Sharpen 2 fl. oz + Zidua- dormant mint	15 a	11.6 ab	52.4 ab
9	Sharpen 2 fl. oz- mint green-up	14 ab	10.0 abc	54.7 ab
10	Sharpen 4 fl. oz- mint green-up	11 abc	12.2 ab	45.5 abc
11	Gramoxone - mint green-up	16 a	8.8 bc	34.2 bc
12	Sharpen 2 fl. oz- 2 weeks post mint green-up	14 ab	9.6 abc	40.0 abc
13	Sharpen 4 fl. oz- 2 weeks post mint green-up	11 abc	11.2 abc	38.0 abc
14	Gramoxone- 2 weeks post mint green-up	13 abc	9.3 abc	38.5 abc
15	Sharpen 2 fl. oz- 4 weeks post mint green-up	11 abc	10.3 abc	36.8 abc
16	Sharpen 4 fl. oz- 4 weeks post mint green-up	9 abc	10.7 abc	41.8 abc
17	Sharpen 2 fl. oz- 8 weeks post mint green-up	5 c	12.2 ab	51.2 abc
18	Sharpen 4 fl. oz- 8 weeks post mint green-up	6 bc	12.1 ab	38.4 abc

* Crop injury in the untreated control was related to severe stunting caused by excessive weed competition.