

FINAL REPORT  
New York State Onion Research and Development Program  
(Marketing Order)  
2013-2014

**Problem Weed Management in Onions:  
Report No. 2: In-Season Management of Perennial Sow Thistle**

**Funding Period and Amount Allocated:**  
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**OBJECTIVE:**

**To evaluate in-season management of Perennial Sow thistle in onions using growth regulator herbicide, clopyralid (Trade name Stinger).**

**PROCEDURES:**

Perennial sow thistle easily escapes onion growers' standard spray program, which suggests that none of the commonly used PRE- or POST-emergent herbicides used in onions provide control of this weed; thus, leaving hand weeding as growers' only management strategy. Unfortunately, hand weeding stimulates bud-break, and the rhizomes produce even more plants. After 2-3 passes across the field of hand weeding, growers unfortunately can have an even worse problem than they started with. Thus, it is critical to find an in-season chemical management strategy that can be used either in combination with hand weeding or alone to prevent significant buildup of perennial sow thistle during the growing season.

Stinger (a.i. clopyralid 40.9%) is a WSSA group 4 synthetic auxin (i.e. growth regulator) herbicide with known activity against Perennial sow thistle. Although it is not labeled in onions, we used it as a representative synthetic auxin to determine whether Perennial sow thistle could effectively be managed in onions with such chemistry. A crop tolerance trial was also conducted to learn when onions were most tolerant to injury from Stinger – see Report No. 3.

Trial Design: This trial was conducted in the Elba muck in a field with an early infestation of Perennial sow thistle. The trial was set up after yellow onions (variety unknown) were seeded in late April (date unknown). **Stinger** (EPA No. 62719-73; Dow AgroSciences, a.i. clopyralid 40.9%) 4 fl oz was applied to onions at the loop, flag and 1-leaf stages, when weeds were newly emerged to mid-rosette stages (6" diameter). Starting at the 2.5 leaf stage, three different spray regimes totaling 16 fl oz included: i) 4 fl oz weekly, ii) High-Low: 8 fl oz, followed by 4 fl oz 2 weeks later and 4 fl oz 1 week after that, and iii) Low-High: 4 fl oz, followed by 8 fl oz 2

weeks later and 4 fl oz 1 week after that. Also starting at the 2.5 leaf stage, 8 fl oz of Stinger was applied every spray until all the weeds were dead (= “kill plot”). At the 4-leaf stage, 16 fl oz was applied in one treatment and in another, 4 fl oz followed by a second app 2 weeks later. Starting at early to mid-bud stage, Stinger 4 fl oz and 8 fl oz were followed with 8 fl oz two weeks later. One treatment was hand weeded on Jun-18 when the Perennial sow thistle was in the early to mid-bolt stage and the onions were at the 4-leaf stage. An untreated weedy check was also included. The trial was arranged as a randomized complete block design (RCBD) with a total of 14 treatments and 4 replications. Each treatment-replicate was 5 feet wide x 10 feet long. At another location, added on to the simulated fall chemical burn down trial at Mortellaro’s, **Nortron SC** (EPA No. 264-613; Bayer CropScience; a.i. ethofumesate 42%) was applied at 16 fl oz starting when the weeds were at the rosette stage and continuing every two weeks for a total of four applications and 64 fl oz. Nortron is labeled on onions in WA, OR and MI and was applied according to the label. Norton is not labeled currently in onions in NY. **Chateau SW** (EPA No. 59639-99; Valent; a.i. flumioxazin 51%) 2.0 oz was applied when weeds were at the rosette stage and when re-growth occurred 2 weeks later Stinger 4 fl oz was applied. Finally, **Garlon 4** (EPA No. 62719-40; Dow AgroSciences; a.i. triclopyr 61.6%) was applied when weeds ranged from rosette to flowering stage. A treatment list is outlined in Table 1. Treatments were applied using a CO<sub>2</sub> backpack sprayer with 40 gpa, 2.6 mph and Teejet 8005XR nozzles from May-9 to Jul-31. Table 2A and 2B detail specific spray conditions. The growers maintained the trial according to their standard practices for weed, disease and insect control.

Evaluations: On May-31, 2 weeks after the flag-leaf application, on 10 randomly selected plants per plot plant height was measured and number of leaves counted. Unfortunately, due to serious wind injury that occurred throughout the trial, it was impossible to collect accurate stand count data. On Jun-27, 2 weeks after the applications were made to the 4-leaf stage, weed control was rated based on visual observation and comments made on the stages of the weeds that were killed and on those that escaped treatment. Similar assessments were made on Jul-17 (12 days after the 7-8 leaf apps were made) and Jul-30 (13 days after the 8-9 leaf apps were made). Also on Jul-30, below-ground plant parts were inspected for injury and death and % ground cover was estimated by counting the number of live plants every foot on two diagonal transects per plot. On Aug-13, fresh weight of weed biomass was taken from a representative 0.5 m<sup>2</sup> section per plot. At the Mortellaro site, weed mortality and injury was observed on both above and below-ground plant parts, and % ground cover was estimated on Jul-30. On Aug-21, fresh weight of weed biomass was quantified.

## **RESULTS AND DISCUSSION:**

### **Early Season Control (Table 3):**

Perennial sow thistle can be very quick to emerge in the spring; in some fields it emerges before the onions and is bigger than the barley nurse crop. The purpose of making these early applications with Stinger was to determine whether a growth regulator type of herbicide had an effect on small weeds and whether the onions could tolerate it.

Application of Stinger 4 fl oz resulted in unacceptable crop injury to loop stage onions (data not quantified), which resulted in approximately 33 to 50% reduction in stand and slightly twisted, yellow and weak onion plants. Due to the wind damage throughout this trial, it was not possible to determine whether application of Stinger 4 fl oz to flag leaf onions resulted in stand reduction. However, the onions in this treatment were significantly shorter than all other treatments on May-31 (15 days post app). There were no significant differences in the number of leaves per plant among treatments. Visually, the onions appeared to have slight injury similar to that described for the application made at the loop stage, but milder. Application of Stinger 4 fl oz to 1-leaf onions appeared to be relatively safe 4 days post app, although it would have been better to evaluate crop tolerance at 15 days post app. Because of the wind injury that occurred in this trial, we

abandoned the crop tolerance aspect of this trial and moved it to another location (see Report No. 3). Applications in the new trial began at the 2-leaf stage, and we did not evaluate longer term crop tolerance of these early treatments.

In general, weed control improved as the weed stage at the time of application increased from newly emerged to mid-rosette stage. Younger/smaller rosettes were more tolerant to herbicide applications, probably because they are relying on the parent rhizome for nourishment, and the general movement of energy within the plant is from the parent rhizome up to the young rosette, thus herbicides are less likely to move downward into the parent rhizome. Also, smaller weeds have less leaf area to absorb the herbicide. With the exception of the application made at the loop stage, Stinger did not have any effect on new emergence, and the weeds continued to proliferate in these plots. In fact, we let the weeds grow in the plots that were treated at the 1-leaf stage, and used them later in the study to evaluate sprays applied to the bud-stage.

The loop-stage application did not result in new emergence and these plots had excellent control for the remainder of the season. Compared to the untreated weedy control, this treatment provided 99% control based on both ground cover and reduced weed biomass (Table 4). We tried very hard to kill the weed escapes in these plots with three applications of Stinger 8 fl oz, but could not achieve 100% control. Although, eventually most of the escapes were killed, the remaining survivors were held at the rosette stage. When we dug up these specimens, we noticed that they came from parent rhizomes that were buried very deep in the soil profile (> 2 feet deep).

We have two theories as to why new emergence was effectively stopped in the loop-stage spray. First, the timing of this spray may have been early enough that the Stinger prevented dormancy from breaking, so the parent rhizomes were never able to send up any new shoots. The other theory relates to the activity of weeds at the time the herbicide applications were made. At the flag and 1-leaf sprays, the weeds were yellow and the leaves slightly burned, which may have been due to severe wind and/or frost injury. At the loop stage spray, the weeds looked healthy. The night-time low temperatures were 55°F (loop), 28°F (flag) and 38°F (1-leaf) on May 9, May 14 and May 27, respectively. Assuming that the cold temperatures and/or wind injury halted the weeds from active growth, then perhaps there was no movement of Stinger into the plants and into the rhizomes to have any effect.

#### **Main-Season Control with Maximum rate of 16 fl oz of Stinger (Table 4):**

Our strategy to evaluate main-season control of Perennial sow thistle with Stinger was to use up to a total of 16 fl oz in different spray programs starting at the 2-leaf and 4-leaf stages. We learned that the **most susceptible stage of perennial sow thistle to Stinger is the mid-rosette stage**, which has 5-9 leaves and is 4-7 inches in diameter. This appears to be the stage when the weed becomes self-sufficient and does not solely rely on the parent rhizome for food. After the summer solstice, these weeds develop their own rhizomes (first year rhizomes) and roots and can produce shoots from these rhizomes. Younger/smaller rosettes are more tolerant to herbicide applications, because they are relying on the parent rhizome for nourishment, and they have less leaf area to absorb the herbicide. The **late-rosette and early-bolt stages of perennial sow thistle proved to be the most difficult stages to kill with Stinger** prior to the summer solstice when energy flow within the plant is generally upward; thus, movement of herbicide downward is against the general flow.

Generally, when the above-ground parts of perennial sow thistle were killed completely with Stinger, the under-ground first-year rhizomes were also dead, especially those that were shallow (< 6 inch deep in the soil profile). Parent rhizomes and other rhizomes that were deep in the soil profile were often not killed with Stinger. Since production of first-year rhizomes can be so prolific, using growth regulator herbicides, like Stinger in-season to kill above-ground parts and first-year rhizomes will reduce vegetative spread and spread by seed, which will ultimately reduce weed density.

Theoretically, a grower standard for using Stinger is 4 fl oz at the 4-leaf stage followed by 4 fl oz 2 weeks later at approximately the 6-leaf stage (treatment #15). In our trial, the largest of the perennial sow thistle weeds were in the mid to late-bolt stages when the onions were at the 4-leaf stage, and this first application failed to control these larger weeds. The second application did not kill any of these larger weeds, but it did stunt them. The standard treatment reduced weed density by 53% on Jul-30 and reduced the fresh weight biomass by 73% on Aug-3, compared to the untreated weedy check. Overall, weed control of the standard treatment was rated as “poor”.

**Pre-summer solstice: Herbicide rate and weed size matter!** At the Jun-27 evaluation, compare Stinger 4 fl oz (trt. #8) to Stinger 8 fl oz (trt. #9), each applied twice at the 2.5- and 4-leaf stages: both treatments killed about 90% of the weeds that were in the rosette stage, but the 8 fl oz rate did a better job of controlling weeds in the early-bolt stage. Therefore, when the second application was made 2 weeks later, 4 fl oz was not strong enough to hold back the even larger bolt-stage weeds and overall weed control was “poor” compared to “good” with the 8 fl oz rate. Similarly, at the Jun-27 evaluation, when you compare the “Hi-Low” (trt. #11) to the “Low-Hi” (trt. #12), starting with 8 fl oz in the Hi-Low treatment resulted in “very good to excellent” control, compared to starting with 4 fl oz in the Low-Hi treatment, which had only “fair” control. At this assessment, 2 applications of 8 fl oz (trt #9) provided improved control over 2 applications of 4 fl oz (trt #8) when the first application was made at the 2-leaf stage.

On Jul-17, 2 and 3 weeks after the third and fourth applications were made, respectively, the Hi-Low treatment (#11) had the best weed control (excellent to very good), which was slightly better than the double app of 8 fl oz (trt. #9), the difference being that the Hi-Low had a third application of 4 fl oz at the 6-leaf stage, while #9 did not, which resulted in some new emergence occurring in #9 that did not occur in #11. At the end of the season, these two treatments had reduced weed density (ground cover) by 92%, but trt. #11 (99.4%) had further reduced weed biomass than trt. #9 (83.5%), because the 4 fl oz application at the 6-leaf stage killed the any newly emerging weeds. Similarly, the third app of 4 fl oz at the 6-leaf stage to the Low-Hi treatment (#12) and the third and fourth 4 fl oz apps to the 6- and 7-8 leaf stages to the 4 fl oz x 4 treatment (#8) continued to improve weed control from Jun-27 through to end of season; both of these treatments provided “very good to good” control with the 4 fl oz x4 (#8) having a slightly higher weed density. After the summer solstice, it is easier to kill larger weeds as the plants are starting to move resources downward within the plant, and with it more herbicide, to the under-ground portions where it can kill the roots and rhizomes.

Stinger 16 fl oz applied all at once (trt. #10) at the 4-leaf stage had the best control of larger weeds pre-solstice and included stages up to mid-bolt stage and more kill of parent rhizomes below-ground. Since it was applied at the 4-leaf stage, some of the larger weeds escaped and without a follow-up 4 fl oz application, they continued to grow and put on new emergence, which resulted in this treatment ending up having higher weed density (ground cover) than #9, #11 and #12.

Best control of perennial sow thistle was achieved with the “kill” treatment (#3B), where we followed up Stinger 4 fl oz applied at the loop stage with Stinger 8 fl oz at the 2.5-leaf, 4-leaf and 7-8 leaf stages, which reduced both ground cover and biomass by 99% compared to the untreated weedy check. The 1% of the weeds that escaped were held at the rosette stage and when they were dug up, we found that they came from parent rhizomes that were buried > 2 feet deep. The loop-stage application of Stinger 4 fl oz gave this treatment an advantage over the treatments that started at the 2.5 or 4-leaf stages, because it reduced weed density and prevented new emergence.

Hand weeding (trt. #2) when the onions were at the 4-leaf stage and the perennial sow thistle ranged from new emergence to early-bolt stages on Jun-18, ultimately resulted in “fair to poor” control. Compared to the untreated weedy check, hand weeding controlled density by 65% and biomass by 58%, which was actually

slightly better the standard treatment (# 15) of Stinger 4 fl oz applied at 4- and 6-leaf stages. At the end of the season, weeds in the untreated check were flowering and setting seed, but were only in the mid-bolt stage in the hand weeded treatment. Hand weeding stimulates bud-break on the rhizomes, and Perennial sow thistle can grow back even thicker than before. Stimulating bud-break by hand weeding is a technique to deplete the parent rhizome. We noticed that in the hand-weeded plots that the parent rhizomes had fewer adventitious roots and buds, and there were fewer 1<sup>st</sup>-year rhizomes, which had fewer adventitious roots which were shorter in length, compared to the untreated. Another benefit of hand weeding is to re-set the weed stage. This may be a strategy that could be used in combination with herbicides to align the onion crop stage that is tolerant to the herbicide application with the weed stage that is most susceptible to the herbicide application.

We noticed that weeded Perennial sow thistle plants when left in a pile in the field, re-rooted and regrew. Also, weeds in flower can still set and finish seed after being uprooted and thrown into piles.

**Efficacy of Stinger applied to bud-stage after summer solstice (Table 5):** Stinger at 4 fl oz was able to kill Perennial sow thistle in the mid-bolt stage when it was applied after the summer solstice (trt. #5), unlike when it was applied to weeds in the early-bolt stage pre-solstice (trt. #15 – table 4). Bolting is when the plant is sending up a seed stalk for reproduction. It is an active period of growth and early in the season weeds in the bolt stage, especially mid-bolt, can be hard to kill, because energy is moving upward within the plant, so it does not move the herbicide down to the below-ground parts. After the summer solstice, the plant begins to transfer more energy, and with it more herbicide, to the underground portions, which results in improved plant mortality.

In addition to killing plants in the bolt stages, Stinger 4 fl oz and 8 fl oz effectively killed buds that were smaller than a pencil in diameter. Control on slightly larger buds was inconsistent and rare once they became raspberry-sized. Open flowers, pollinated flowers and closed flowers proceeded to set visually normal seeds. Plants sometimes exhibited severe injury. Overall control for reducing plant density and biomass was poor, but bud-stage applications may be useful for ditch bank and weed pile sprays, or as an alternative to hand weeding such large weeds in onions to prevent seed shed.

**Novel herbicides to manage Perennial sow thistle in-season (Table 6.):** Nortron SC and Garlon had some activity on perennial sow thistle. As a stand-alone treatment at the maximum rate, Nortron SC provided “poor” control. It stunted and delayed maturity and where it is labeled on onions, it has a PHI of 30 days, which means that it can safely be applied to onions at later crop stages. Perhaps it could be used to hold back Perennial sow thistle later in the season after bulbing when growth regulators cannot be used. Garlon was applied late in the season to large weeds and onions; it has activity on Perennial sow thistle and warrants further investigation.

Our theory behind the Chateau-Stinger strategy (trt # 12) was to apply Chateau to young onions (e.g. 2-leaf) in order to delay maturity or hold Perennial sow thistle at the early to mid-rosette stage until Stinger could safely be applied to the onions. In this trial, Chateau was actually applied to 4-leaf onions, and when Perennial sow thistle resumed growth, Stinger 4 fl oz was applied at the 7-leaf stage, which caused severe bulb injury to the onions. Control of perennial sow thistle was highly variable (30 – 80%) in this treatment, although at the end of the season, weed biomass was reduced by 83%. This strategy warrants further investigation.

#### **SUMMARY AND COMMENTS:**

Onions are not tolerant to Stinger 4 fl oz at the loop or flag leaf stages. Whether the 1-leaf stage is tolerant to Stinger 4 fl oz could not be determined in this trial. A separate trial was set up to evaluate the crop tolerance of Stinger on onions starting at the 2-leaf stage through to 1” bulbs (see Report No. 3).

Since Stinger 4 fl oz applied to healthy newly emerging Perennial sow thistle at the loop-stage prevented new emergence for the remainder of the season, further investigation of applications to newly emerging weeds early in the season warrants further investigation. Although, Stinger causes unacceptable injury to onions when applied at the loop stage, perhaps it could be applied to a tolerant stage of onions once weeds emerge following hand-weeding? However, if prevention of new emergence of Perennial sow thistle was caused by Stinger preventing dormancy from breaking, it is doubtful that applications to early rosettes later in the season after dormancy has broken would have any effect.

Prior to the summer solstice, the most susceptible stage of Perennial sow thistle to Stinger is the mid-rosette with 5-9 leaves and 4-7 inches in diameter, while late-rosette to early-bolt stages were the most difficult to kill.

Pre-solstice, the ability to kill larger Perennial sow thistle weeds increased with higher rates of Stinger. The low rate of 4 fl oz did not kill anything that had bolted, 8 fl oz killed up to the early-bolt stage and 16 fl oz killed some that were in the mid-bolt stage. The 8 fl oz and 16 fl oz rates also killed some below-ground portions.

Effective pre-solstice programs were kept in check with post-solstice applications of Stinger 4 fl oz. Weeds in the bolt stages were easier to kill after the solstice than before.

Applications of Stinger 8 fl oz to the early to mid-bud stages of perennial sow thistle effectively killed buds that were a pencil in diameter and smaller.

Remove hand-weeded weeds from the field when possible, as they tend to re-root.

#### **FUTURE RESEARCH PLANS:**

- Investigate 6 fl oz and 12 fl oz rates of Stinger
- Trial Starane, a close relative of Stinger that is labeled on onions in MI, Nortron and Garlon for feasibility of controlling Perennial sow thistle in onions including efficacy and crop tolerance.
- Investigate strategies to align susceptible weed stage with crop tolerance of growth regulator herbicides.

Table 2. In-season management of Perennial sow thistle, Big O, Elba, NY, 2013: Treatments.

Treatment		Onion and weed stage and spray date
No.	Product and Rate (per acre)	
1	Untreated check	Grower's standard program for PRE- and POST-emergent herbicides, Outlook, Prowl, Buctril and Goal
2	Hand-weeded	Weeds starting to bolt, Onions 4 leaf stage (June 18)
3 A <sup>1</sup>	Stinger 4 fl oz	Weeds newly emerged, onions loop (A)
3 B <sup>1</sup>	Stinger 8 fl oz	Onions 2.5 leaf (D)
Stinger Kill Plot	Stinger 8 fl oz	Onions 4-leaf (E)
	Stinger 8 fl oz	Onions 7-8 leaf (G)
4	Stinger 4 fl oz	Weeds newly emerged to early rosette, Onions flag-leaf (B)
5 A <sup>1</sup>	Stinger 4 fl oz	Weeds newly emerged to early rosette, Onions 1 leaf (C)
5 B <sup>1</sup> Bud:	Stinger 4 fl oz	Weeds at bud stage (G)
Low High	Stinger 8 fl oz	2 weeks later (H)
8	Stinger 4 fl oz	Onions 2.5 leaf (D)
4 fl oz repeat (max 16)	Stinger 4 fl oz	2 weeks later, Onions 4-leaf (E)
	Stinger 4 fl oz	1 week later, Onions 6-leaf (F)
	Stinger 4 fl oz	1 week later, Onions 7-8 leaf (G)
9	Stinger 8 fl oz	Onions 2.5 leaf (D)
8 fl oz repeat (max 16)	Stinger 8 fl oz	2 weeks later, Onions 4-leaf (E)
10	Stinger 16 fl oz	Onions 4-leaf (E)
11	Stinger 8 fl oz	Onions 2.5 leaf (D)
High Low (max 16)	Stinger 4 fl oz	2 weeks later, Onions 4-leaf (E)
	Stinger 4 fl oz	1 week later, Onions 6-leaf (F)
12	Stinger 4 fl oz	Onions 2.5 leaf (D)
Low High (max 16)	Stinger 8 fl oz	2 weeks later, Onions 4-leaf (E)
	Stinger 4 fl oz	1 week later, Onions 6-leaf (F)
13	Stinger 8 fl oz	Weeds at bud stage (G)
Bud: High 2x	Stinger 8 fl oz	2 weeks later (H)
15	Stinger 4 fl oz	Onions 4-leaf (E)
Std	Stinger 4 fl oz	2 weeks later, Onions 7-8 leaf (G)
<b>Treatments set up in Mortellaro Simulated Fall Chemical Burn Down Trial:</b>		
13 <sup>m</sup>	Nortron SC 16 fl oz Nortron SC 16 fl oz Nortron SC 16 fl oz Nortron SC 16 fl oz	Weeds at rosette stage, onions 4.5 leaf (A <sup>m</sup> ) 2 weeks later, onions 7 leaf (B <sup>m</sup> ) 2 weeks later, onions 8 leaf, starting to bulb (C <sup>m</sup> ) 2 weeks later, onions 7 leaf 1 inch bulbs (D <sup>m</sup> )
12 <sup>m</sup>	Chateau 2.0 oz Stinger 4 fl oz	Weeds at rosette stage, onions 4.5 leaf (A <sup>m</sup> ) When weed re-growth occurs, onions 7 leaf (B <sup>m</sup> )
14 <sup>m</sup>	Garlon 4 2 qt	Weeds rosette to flowering (D <sup>m</sup> )
1/15	Untreated	

<sup>1</sup>After weeds grew out of injury from "A" program, "B" program was implemented within same plots.

**Spray Dates:** A – May 9; B – May 14; C – May 27; D – June 7; E – June 20; F – June 27; G – July 5; H – July 17.

**Mortellaro Spray Dates:** A<sup>m</sup> – Jun-20; B<sup>m</sup> – Jul-5; C<sup>m</sup> – Jul-17; D<sup>m</sup> – Jul-31.

Table 2A. In-season management of perennial sow thistle, Big O, Elba, NY, 2013: Spray conditions.

<b>Spray</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>
<b>Date</b>	<b>May, 9, 2013</b>	<b>May 14, 2013</b>	<b>May 27, 2013</b>	<b>June 7, 2013</b>	<b>June 20, 2013</b>	<b>June 27, 2013</b>	<b>July 5, 2013</b>	<b>July 17, 2013</b>
<b>Time</b>	1:50 – 2:00 pm	3:15 – 3:20 pm	9:00 – 9:05 am	3:55 – 4:10 pm	2:25 – 2:40 pm	11:45 – 12:00 pm	1:50 – 2:20 pm	1:25 – 1:35 pm
<b>Onion stage</b>	Loop (poke-flag)	Flag leaf	1 leaf	2.5 leaf	4-4.5 leaf	6 leaf	7-8 leaf, starting to bulb	8-9 leaf, 1-2” bulbs
<b>Weed stage</b>	New emergence to 4” (2-4 leaf)	New emergence to 4” wide (2-4 leaf)	New emergence to 6” wide	New emergence to 12” wide rosettes	New emergence to early/mid-bolt	New emergence to mid-bolt, early bud	Oldest weeds in early to mid-bud	Oldest weeds flowering
<b>General Conditions</b>	Partly cloudy	Mostly cloudy Frost warning night before	Sunny Following cold night	Overcast 1 ¼” rain previous day	Sunny, light breeze	overcast	Mostly cloudy, breezy	Mostly sunny
<b>Foliage</b>	Dry	Dry	Dry	Barely dry	Dry	Dry	Dry	Dry
<b>Soil</b>	moist	dry	Dry	wet	Dry	Dry	damp	Dry
<b>Wind speed Average</b>	4.6 mph	3.4 mph	1.8 mph	5.4 mph	2.3 mph	2.8 mph	3.9 mph	4.4 mph
<b>Wind speed Maximum</b>	7.2 mph	6.9 mph	4.9 mph	6.6 mph	3.8 mph	3.8 mph	8.4 mph	9.6 mph
<b>Temperature</b>	70 °F	63 °F	60 °F	60 °F	82 °F	83 °F	83 °F	96 °F
<b>Relative Humidity</b>	77%	49%	44%	85%	40%	68%	68%	64%
<b>pressure</b>	28 psi	28 psi	28 psi	28 psi	25 psi	20 psi	32 psi	25 psi

All sprays made with a CO<sub>2</sub> backpack sprayer with **40 gpa, 2.6 mph** and **Teejet 8005XR nozzles**.



Table 2B. In-season management of perennial sow thistle: treatments included in Fall chemical burn down trial, Mortellaro, Elba, NY, 2013: Spray conditions.

<b>Spray</b>	<b>A<sup>m</sup></b>	<b>B<sup>m</sup></b>	<b>C<sup>m</sup></b>	<b>D<sup>m</sup></b>
<b>Date</b>	<b>June 20, 2013</b>	<b>July 5, 2013</b>	<b>July 17, 2013</b>	<b>July 31, 2013</b>
<b>Time</b>	5:15 – 5:34 pm	2:45 – 3:00 pm	2:25 – 2:35 pm	8:15 – 8:25 pm
<b>Onion stage</b>	4.5 leaf	7 leaf, starting to bulb	8 leaf, 1 inch bulbs	7 leaf, 1+ inch bulbs
<b>Weed stage</b>	Rosette to early bolt	Early bolt	Bud stage	flowering
<b>General Conditions</b>	Sunny, breezy	Sunny, breezy, rained 10 min after trial sprayed	Sunny, breezy	Calm, partly cloudy
<b>Foliage</b>	Dry	Dry	Dry	dry
<b>Soil</b>	Dry	Damp	Dry	dry
<b>Wind speed Average</b>	5.3 mph	3.6 mph	4.7 mph	0.0 mph
<b>Wind speed Maximum</b>	7.7 mph	6.0 mph	8.1 mph	1.2 mph
<b>Temperature</b>	76 °F	83 °F	100 °F	74 °F
<b>Relative Humidity</b>	66%	65%	53%	89%
<b>pressure</b>	30 psi	32 psi	23 psi	28 psi

All sprays made with a CO<sub>2</sub> backpack sprayer with **40 gpa**, **2.6 mph** and **Teejet 8005XR nozzles**.

Table 3. In-season management of Perennial sow thistle, Big O, Elba, NY, 2013: Early season sprays to onions in the loop through flag-leaf stages targeting weeds when newly emerging to mid-rosette stage.

Treatment	May-31 Evaluation					
	Product, Rate (per acre), Onion Stage and Date of App	DAT <sup>1</sup>	Average Plant Height (cm)	Average No. leaves per Plant	Comments on onions	Comments on weeds
1. Untreated – weedy check		NA	11.7 a <sup>2</sup>	1.5	Wind damage, otherwise healthy	Plenty of new emergence, oldest weeds 6” diameter rosettes
2. Hand weeded check – not yet weeded		NA	11.9 a	1.6	Wind damage, otherwise healthy	Plenty of new emergence, oldest weeds 6” diameter rosettes
3A. Stinger 4 fl oz @ loop (May-9)		20	12.1 a	1.3	Onions injured slightly, stand loss apparent (~ 33-50%)	Twisting & moderate injury in 4” rosettes; minor new emergence compared to other trts; most weeds fine or growing out of injury
4. Stinger 4 fl oz @ flag-leaf (May-14)		15	10.0 b	1.4	Some injury, milder than at loop stage	Slightly more injury than trt. #3, new emergence
5A. Stinger 4 fl oz @ 1-leaf (May-27)		4	11.6 a	1.5	No injury	Evaluation a bit early to see full effect, but appears to have more injury than trt #4, especially on larger weeds
<b>P Value (<math>\alpha=0.05</math>)</b>			<b>0.0260</b>	<b>NS<sup>3</sup></b>		

<sup>1</sup>DAT: Days After Treatment.

<sup>2</sup>Numbers in a column followed by the same letter are not significantly different, Fisher’s Protected LSD test ( $p<0.05$ ).

<sup>3</sup>NS: Not Significant, according to Fisher’s Protected LSD test ( $p>0.05$ ).

Table 4. In-season management of perennial sow thistle, Big O, Elba, NY, 2013: Efficacy of maximum rate of 16 fl oz of Stinger applied to onions starting at the 2.5- and 4-leaf stages.

Treatment	Jun-27		Jul-17			Jul-30	Aug-13		Overall Weed Control Rating <sup>1</sup>
	Weed Control Rating <sup>1</sup>	Comments	Apps	Weed Control Rating <sup>1</sup>	Comments	% weed control <sup>2</sup>	Fresh weight (g/0.5m <sup>2</sup> )	% control (fresh wt)	
<b>1. Untreated</b>	None	Weeds in EB to Bolt <sup>5</sup>		None	Weeds Lbud to flowering	0%	1700 a <sup>4</sup>	0%	Na
<b>2. Hand-weeded</b> on Jun-18	E	NE starting. Stimulates more NE than herbicides.		G	Fewer adventitious roots; No weed death.	64.9% (F)	710 b	58.2% (P)	F-P
<b>3B. Kill-plot:*</b> Stinger 8 fl oz @ 2.5-leaf (D) <sup>6</sup> & 4-leaf (E)	G-VG	90+% kill above-ground; MR-EB injured.	<b>+ Stinger 8 fl oz @ 7-8 leaf (G)</b>	E	Some weeds are impossible to kill; no NE	98.7% (E)	20 c	98.8% (E)	E <sup>3</sup>
<b>8. Max 16 4 x 4:</b> Stinger 4 fl oz @ 2.5 leaf (D) & 4-leaf (E)	P	90% of rosettes are dead, bolts escaped with minor injury.	<b>+ Stinger 4 fl oz @ 6-leaf (F) &amp; 7-8 leaf (G)</b>	G	Escapes starting to out-grow injury	87.0% (VG)	80 c	95.3% (E)	VG-G – 2 <sup>nd</sup>
<b>9. Max 16 8 x 2:</b> Stinger 8 fl oz @ 2.5-leaf (D) & 4-leaf (E)	G	Excellent kill of rosettes, MB escape, injured & surviving.		G-VG	Some NE. Some over-coming injury.	92.2% (VG)	280 bc	83.5% (G)	VG
<b>10. Max 16 16 x 1:</b> Stinger 16 fl oz @ 4-leaf (E)	Too soon to evaluate			VG	Excellent kill up to MB. Dead above & below.	85.7% (G)	70 c	95.9% (E)	VG-G – 3 <sup>rd</sup>
<b>11. Max 16 Hi-Low:</b> Stinger 8 fl oz @ 2.5-leaf (D) + Stinger 4 fl oz @ 4-leaf (E)	VG-E	Very good control, some EB dead, above & below-ground.	<b>+ Stinger 4 fl oz @ 6-leaf (F)</b>	E-VG	Excellent kill up to MB. Escapes are out-growing injury.	92.2% (VG)	10 c	99.4% (E)	VG-E
<b>12. Max 16 Low-Hi:</b> Stinger 4 fl oz @ 2.5-leaf (D) + Stinger 8 fl oz @ 4-leaf (E)	F	Not as good as Hi-Low, more larger weeds escaped.	<b>+ Stinger 4 fl oz @ 6-leaf (F)</b>	G	Higher weed density & less kill than #11.	90.9% (VG)	130 c	92.3% (VG)	VG-G – 1 <sup>st</sup>
<b>15. Standard:</b> Stinger 4 fl oz @ 4-leaf (E)	P	Killed NE to ER; bolts escaped	<b>+ Stinger 4 fl oz @ 7-8 leaf (G)</b>	P	Weeds stunted and held at EB.	42.9% (P)	460 bc	72.9% (F-P)	P
<b>P Value (<math>\alpha=5</math>)</b>							<b>0.0000</b>		

<sup>1</sup>**Control Rating:** E = Excellent (95-100% control); VG = Very Good (87-94% control); G = Good (75-86% control); F = Fair (65-74% control); P = Poor (less than 65% control).

<sup>2</sup>**% weed control based on ground cover** as determined by number of live weeds every foot per 2 diagonal transects per plot. <sup>3</sup>This treatment also received Stinger 4 fl oz at the loop stage, which prevented new emergence. The goal was to apply Stinger 8 fl oz until the escapes died = “kill plot”. <sup>4</sup>Numbers in a column followed by the same letter are not significantly different, Fisher’s Protected LSD test (p>0.05). <sup>5</sup>**Weed stage:** NE – New Emergence; ER – Early Rosette; MR – Mid-rosette; LR – Late rosette; EB – Early bolt; MB – Mid-bolt; LB – Late-bolt; Ebud – Early bud stage; Lbud – Late bud stage. <sup>6</sup>**Spray dates:** D – Jun-7; E – Jun-20; F – Jun-27; G – Jul-5.

Table 5. In-season management of Perennial sow thistle, Big O, Elba, NY, 2013: Efficacy of Stinger applied starting when Perennial sow thistle was at the bud stage after summer solstice.

Treatment	Jul-17	Jul-30	Aug-13		Overall Weed Control Rating <sup>2</sup>
	Comments on Weed Control	% weed control <sup>1</sup>	Fresh weight (g/0.5m <sup>2</sup> )	% control (fresh wt) <sup>4</sup>	
<b>5B. Low-Hi (Bud):</b> Stinger 4 fl oz @ Bud (G) <sup>3</sup> + Stinger 8 fl oz 2 weeks later (H)	80% buds < pencil diameter appear dead; larger buds, flowers & seed pods unaffected. ER <sup>5</sup> through MB dead. Some NE. Stunted compared to untreated.	34.4%	1173	31%	Poor
<b>13. Hi-Hi (Bud):</b> Stinger 8 fl oz @ Bud (G) + Stinger 8 fl oz 2 weeks later (H)	95% buds < pencil diameter appear dead; all buds dead in Mbud plants (~ 3 ft tall). Minor injury of EB (difficult stage to kill after solstice). 1 <sup>st</sup> -year rhizomes still active. Parent rhizomes injured and scarred.	20.3%	930	45%	Poor

<sup>1</sup>% weed control based on ground cover as determined by number of live weeds every foot per 2 diagonal transects per plot.

<sup>2</sup>Control Rating: **E** = Excellent (95-100% control); **VG** = Very Good (87-94% control); **G** = Good (75-86% control); **F** – Fair (65-74% control); **P** = Poor (less than 65% control).

<sup>3</sup>Spray dates: **G** – Jul-5; **H** – Jul-17.

<sup>5</sup>Weed stage: **NE** – New Emergence; **ER** – Early Rosette; **MR** – Mid-rosette; **LR** – Late rosette; **EB** – Early bolt; **MB** – Mid-bolt; **LB** – Late-bolt; **Ebud** – Early bud stage; **Lbud** – Late bud stage.

Table 6. In-season management of perennial sow thistle, Mortellaro & Sons, Elba, NY, 2013: Evaluation of novel herbicides to manage perennial sow thistle.

Treatment	Weed Control Comments	Aug-21	
		Fresh weight (g/0.5m <sup>2</sup> )	% control (fresh wt)
<b>1. Untreated</b>		1117	0%
<b>13. Nortron SC 16 fl oz @ 4.5 leaf (A)<sup>1</sup>, 7-leaf (B), 8-leaf start bulb (C), 1" bulb (D)</b>	30–50% reduction in weed density. Major impact is to stunt height and delay maturity. Causes some disruption to growing point. Causes some injury to rhizomes, but does not kill. However, injury appears to have stimulated bud-break on rhizomes.	667	40.3%
<b>12. Chateau 2.0 oz @ 4.5 leaf to rosette weeds (A) + Stinger 4 fl oz @ 7-leaf (B)</b>	Chateau held back rosettes for about 2 weeks. Stinger 4 fl oz was unable to consistently kill the injured plants; control ranged from 30-80%. Rhizomes showed slight injury, plants were stunted.	187	83.2%
<b>14. Garlon 4 2 qt @ 1" bulb (D)</b>	Applied to very large weeds; control ranged from 0 to 85%. Has activity – needs further investigation.	650	41.8%

<sup>1</sup>Spray dates: **A** – Jun-20; **B** – Jul-5; **C** – Jul-17; **D** – Jul-31.