

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

Problem Weed Management in Onions: Report 3: Onion Crop Tolerance to Clopyralid (Stinger)

Funding Period and Amount Allocated:
April 1, 2013 to March 31, 2014 - \$4,000

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OBJECTIVE:

To evaluate onion tolerance to clopyralid (Stinger) at various rates, timings and combinations.

PROCEDURES:

Trial Design: The trial was established in a field of direct seeded yellow onions 'Centerstone' that were planted in mid-April. The trial was arranged as a randomized complete block design (RCBD) with 23 treatments and 3 replications. Each plot consisted of a single 10 foot row with a guard row on either side. Plots were established in areas with good stand. Stinger 4 fl oz (EPA No. 62719-73; Dow AgroSciences, a.i. clopyralid 40.9%) and 8 fl oz were applied when onions were at the 2-, 4-, 5-, 6- and 7-9 leaf 1" bulb stages. Stinger 16 fl oz was applied when onions were at the 4-, 5-, 6- and 7-9 leaf with 1" bulb stages. In addition, the following programs were trialed starting at the 2- and 4-leaf stages: 1) Stinger 4 fl oz 4 times weekly; 2) Stinger 8 fl oz twice 2 weeks apart; 3) Stinger 8 fl oz followed by 4 fl oz 1 and 2 weeks later; and 4) Stinger 4 fl oz followed by 8 fl oz 1 week later and 4 fl oz 1 week after that (Table 1). Applications were made using a CO₂ backpack sprayer with 40 gpa, 2.6 mph and Teejet 8004XR nozzles under conditions described in Table 2.

Evaluations: Plots were evaluated for foliar injury on June 28 and July 29. On July 29, roots were examined for injury in treatments that exhibited foliar injury. Bulbs were harvested on Sep-5 and windrowed. On Oct-11, they were topped and graded into boiler (<1.75"), small (1.75 – 2.25"), medium (2.25 – 3") and jumbo (>3") size classes, and bulb decay and other culls. Within each bulb class, Stinger bulb injury was categorized into "Minor" where injury was present but the onion was still marketable; "Moderate" where the basal plate was obviously swollen and pushing out of the basal plate; and "Major" where bulbs were grossly misshapen, scales cracked and inner scales clearly visible (Figure 1). Minor injury was classified as injured but marketable while moderate and major injury was classified as unmarketable. One 50 lb bag of bulbs exhibiting minor injury from Stinger were collected from a mix of treatments was put into storage to determine if the bulb injury would progress in storage. After 3.5 months, the onions were removed and rated for degree of injury, without regard to their grade.

RESULTS:

Leaf Injury (Table 3). Minor leaf injury consisted of slight leaf twisting and possibly some stunting. Moderate injury consisted of more obvious leaf twisting, while severe leaf injury involved improper leaf development where younger leaves develop inside of the previous leaf. The highest individual score per plot was 5 (moderate-severe). The greatest average leaf injury rating was 4.66 in “Max 16 8 x 2 start 2-leaf” (trt # 27) and “Max 16 Hi-Lo start 2-leaf” (trt #29), followed by 4.33 in 8 fl oz at 2-leaf (trt #4), which all received 8 fl oz of Stinger at the 2-leaf stage and all had “leaf in leaf” developmental problems and root pruning. The only treatment other than the untreated that had no injury was 4 fl oz at 4-leaf (Trt #7). In general, for the single applications, there is a trend that at any given leaf stage, as the rate of Stinger increased from 4 to 8 to 16 fl oz, leaf injury increased. Also, leaf injury was similar per rate when applied at the 4 to 6 leaf stages, but was slightly higher at the 2 leaf and 1” bulb stages. Aside from treatments No. 27 and No. 29, none of the other Max 16 treatments provided significant leaf injury.

Bulb Injury (Table 4 & 5). Minor injury from Stinger consisted of the basal plate just starting to push out from the bulb, but would still be considered marketable. Bulbs exhibiting moderate injury had the basal plate pushing out of the bulb and major Stinger injury was considered when the bulb was grossly distorted (Figure 1). Only bulbs with moderate and major injury were considered unmarketable. Of the 22 Stinger treatments, 12 (= 54%) had some degree of unmarketable bulbs. Stinger 16 fl oz applied at the 1” bulb stage (trt #18) had significantly the highest unmarketable bulbs (51.8% = 293 cwt/A) due to Stinger injury. Stinger 8 fl oz applied at 1” bulb (trt #17) had significantly the second highest proportion of unmarketable bulbs (18.2% = 128 cwt/A), which was not significantly different from “Max 16 Lo-Hi @ 2-leaf” (trt #31) (11.8% = 120 cwt/A).

Of the single application treatments (#3, 4, 7-18), the 4-leaf stage was the only stage that did not result in unmarketable bulbs from 4, 8 or 16 fl oz of Stinger. At the 5-leaf stage, an insignificant amount of unmarketable bulbs only occurred with the 16 fl oz rate (1.5% = 4.6 cwt/A), and at the 6-leaf stage only the 8 fl oz resulted in unmarketable bulbs (0.6% = 7 cwt/A). In general, the 4 to 6-leaf stages were the safest for applying a single application of up to 16 fl oz of Stinger. At the 2-leaf stage, single applications of 4 fl oz (2.3% = 14 cwt/A) and 8 fl oz (3.0% = 5.2 cwt/A) of Stinger resulted in insignificant unmarketable bulbs. At the 1” bulb stage, 4 fl oz resulted in insignificant unmarketable bulbs (1.8%).

The two most effective Max 16 treatments for controlling perennial sow thistle, “8 x 2” and “Hi-Lo” did not cause significant unmarketable bulbs when applied at the 2-leaf stage (8 x 2 (trt #27): 0%; Hi-Lo (trt # 29): 6.3% = 24 cwt/A) or 4-leaf stage (8 x 2 (trt #28): 1.9% = 4 cwt/A; Hi-Lo (trt #30): 0%). The “Max 16 Lo-Hi @ 2-leaf” (trt# 31) is the only treatment in the trial where application of Stinger to onions up to the 6-leaf stage had more than 10% unmarketable bulbs. Max 16 4 x 4 (trt #25 – 7.4% & #26 – 4.8%) had slightly more injury than the single applications of 16 fl oz at the 4-leaf (0%), 5-leaf (1.5%) and 6-leaf (0%) stages.

All of the treatments had some degree of minor bulb injury caused by Stinger (Table 5). Of bulbs that had minor injury going into a commercial onion storage, 13.3% exhibited moderate injury after 3.5 months in storage (data not shown). Of the treatments that did not have any unmarketable bulbs due to Stinger injury, 8 fl oz (trt #8) and 16 fl oz (trt #9) applied at 4-leaf, “Max 16 8 x 2 @ 2-leaf” (trt # 27), “Max 16 Hi-Lo 2 4-leaf” (trt #30) and “Max 16 Lo-Hi @ 4-leaf” (trt #32) all had greater than 20% minor bulb injury, while the only treatments that had less than 5% minor bulb injury were 4 fl oz at the 5-leaf (trt #10) and 6-leaf (trt #13). Figure 2 shows the total percentage of bulbs resulting in unmarketable injury both out of the field and after storage where an estimated 13.3% of the bulbs with minor injury going into storage progressed to moderate unmarketable injury after 3.5 months. After storage, the only treatments that increased to greater than 5% loss were “Max 16 4 x4 start 2-leaf” (trt #26) and “Max 16 8 x 2 start 4-leaf” (trt # 28).

Yield and bulb size distribution (Table 4, 6 & 7). There were no significant differences among treatments for total number of bulbs per plot, which indicates that Stinger did not result in stand reduction (Table 5). There was a significant negative correlation between the percentage of marketable yield and unmarketable yield ($R = -0.7131$; $p = 0.0000$), which indicates that yields increased as Stinger injury decreased. Due to the small plot sizes, there was a lot of variability in total marketable yield. The highest yield was “Max 16 Hi-Lo start 4-leaf” (trt #30) with 815 cwt/A and 97% marketable bulbs, which was not significantly different than the untreated and 14 other treatments, which ranged from 619 to 772 cwt/A (Table 4). Stinger 16 fl oz at 1” bulb (trt #18) had significantly the lowest yield of all treatments (217 cwt/A) because it had the highest Stinger injury (51.8%). “Max 16 8 x 2 start 2-leaf” (trtr #27) had one of the lowest yields (450 cwt/A) despite 0% bulb injury and decent bulb number due to a skew in bulb size distribution to smaller bulb sizes (Table 6). “Max 16 Hi-Lo start 2-leaf” (trt # 29) also had a significantly lower yield than the top group (436 cwt/A), which was due to 12.6% bulb decay and a slight skew towards smaller bulb sizes (Table 4 & 5). These treatments along with Stinger 8 fl oz at 2-leaf (trt #4) all exhibited “leaf-in-leaf” injury and root pruning, which may have caused reduced bulb size and lent itself to bacterial bulb decay. Treatment No. 4 was also slightly skewed towards smaller bulb sizes. These results suggest that Stinger did not affect marketable yield, except when 8 fl oz and 16 fl oz were applied to the 1” bulb stage of onions, and possibly when 8 fl oz is applied to the 2-leaf stage.

The majority of bulbs fell into the medium and jumbo size classes in both marketable (Table 6) and unmarketable/injured (Table 7) categories. In the marketable category, there were only significant differences among treatments in the percentage of total bulbs that fell into the jumbo size class. However, there was also a positive correlation between total marketable yield and marketable jumbo bulbs ($R = 0.6175$; $p = 0.0000$). Aside from the exceptions described above, in general, Stinger injury does not affect bulb size.

Bacterial bulb decay. Of the Stinger-injured bulbs, the highest incidence of bulb decay was 4.2% and 9 out of the 22 treatments (= 41%) had 0% bulb decay (Table 5). Of the uninjured bulbs, there were no significant differences among treatments for bacterial bulb decay and every treatment had some degree of bacterial bulb decay, which ranged from 0.7% to 10.2% (Table 4). Since there were not higher levels of bulb decay in the Stinger-injured onions, this suggests that Stinger generally does not increase bacterial rot problems in onions. There were also no differences among treatments in other types of culls among treatments (Table 4).

SUMMARY

All applications of Stinger resulted in some degree of injury to onion bulbs. Although in several treatments, the injury was minor and the bulbs were marketable. However, after 3.5 months of bulbs that exhibited minor injury being in storage, 13.3% came out with moderate and unmarketable injury. Even when this progression of injury during long-term storage is taken into consideration, the majority of the treatments that we tested resulted in less than 5% loss due to injury caused by Stinger.

Single applications of 4, 8 and 16 fl oz of Stinger applied at the 4, 5 and 6-leaf stages resulted in less than 5% loss out of storage. In general, leaf and bulb injury increased as the rate of Stinger increased in these treatments.

Application of Stinger at 8 fl oz to onions at the 2-leaf stage resulted in “leaf-in-leaf” injury, root pruning, reduced bulb size and total yield, and 5% or greater loss due to injured and unmarketable bulbs, especially when this treatment was followed with additional applications of Stinger. Application of 4 fl oz at the 2-leaf stage resulted in 3.2% loss from injured bulbs.

Application of Stinger at 8 fl oz and 16 fl oz to onions at the 1" bulb stage resulted in 24% and 55% loss from unmarketable bulbs injured by Stinger. Although losses with the 4 fl oz at this stage were significantly lower, it was still 5.1%. Application of Stinger after bulbing has commenced is very risky for crop safety.

The most effective treatment for managing perennial sow thistle, "Max 16 Hi-Lo" was only safe when applied to onions starting at the 4-leaf stage. The other most effective treatment, "Max 16 8 x 2" resulted in 6% loss when applied at the 2-leaf stage.

In general, multiple applications of Stinger caused more injury than single applications.

Application of Stinger did not affect stand or bulb size, except when it was applied at 8 fl oz (or higher theoretically) to the 2-leaf stage of onions.

Application of Stinger did not appear to affect bacterial bulb decay.

Reminder! *Stinger is not labeled for use in onions, and it has a 10.5 month plant back restriction for onions.*

FUTURE RESEARCH PLANS:

In-season crop tolerance work with Stinger at the 1-3 leaf stage and 7-8 leaf stage prior to bulbing and at the 6 and 12 oz rates would provide a better picture of crop safety and lead to better pairing of crop tolerance with effective application timing to enhance control of perennial sow thistle. Crop tolerance studies may also be established for other group 4 herbicides showing in-season activity against problem perennial weeds, such as Starane and Garlon (a.i. triclopyr).

Table 1. Onion Crop Tolerance to Clopyralid (Stinger), Triple G, Elba, NY, 2013: Treatments.

Treatment		Onion stage and spray date	Notes
No.	Product and Rate (per acre)		
1	Untreated check		
3	Stinger 4 fl oz	2 leaf (A)	
4	Stinger 8 fl oz	2 leaf (A)	
7	Stinger 4 fl oz	4 leaf (B)	
8	Stinger 8 fl oz	4 leaf (B)	
9	Stinger 16 fl oz	4 leaf (B)	
10	Stinger 4 fl oz	5 leaf (C)	
11	Stinger 8 fl oz	5 leaf (C)	
12	Stinger 16 fl oz	5 leaf (C)	
13	Stinger 4 fl oz	6 leaf (D)	
14	Stinger 8 fl oz	6 leaf (D)	
15	Stinger 16 fl oz	6 leaf (D)	
16	Stinger 4 fl oz	1" bulb (E)	
17	Stinger 8 fl oz	1" bulb (E)	
18	Stinger 16 fl oz	1" bulb (E)	
25 4 fl oz repeat (max 16) Start @ 2 leaf	Stinger 4 fl oz Stinger 4 fl oz Stinger 4 fl oz Stinger 4 fl oz	2 leaf (A) 4 leaf (B) 5 leaf (C) 6 leaf (D)	Treatment #8 in efficacy trial
26 4 fl oz repeat (max 16) Start @ 4 leaf	Stinger 4 fl oz Stinger 4 fl oz Stinger 4 fl oz Stinger 4 fl oz	4 leaf (B) 5 leaf (C) 6 leaf (D) 7-leaf (E)	Treatment #8 in efficacy trial
27 8 fl oz repeat(max 16) Start @ 2 leaf	Stinger 8 fl oz Stinger 8 fl oz	2 leaf (A) 4 leaf (B)	Treatment #9 in efficacy trial
28 8 fl oz repeat(max 16) Start @ 4 leaf	Stinger 8 fl oz Stinger 8 fl oz	4 leaf (B) 6 leaf (D)	Treatment #9 in efficacy trial
29 High Low (Max 16) Start @ 2 leaf	Stinger 8 fl oz Stinger 4 fl oz Stinger 4 fl oz	2 leaf (A) 4 leaf (B) 5 leaf (C)	Treatment #11 in efficacy trial
30 High Low (Max 16) Start @ 2 leaf	Stinger 8 fl oz Stinger 4 fl oz Stinger 4 fl oz	4 leaf (B) 5 leaf (C) 6 leaf (D)	Treatment #11 in efficacy trial
31 Low High (Max 16) Start @ 2 leaf	Stinger 4 fl oz Stinger 8 fl oz Stinger 4 fl oz	2 leaf (A) 4 leaf (B) 5 leaf (C)	Treatment #12 in efficacy trial
32 Low High (Max 16) Start @ 4 leaf	Stinger 4 fl oz Stinger 8 fl oz Stinger 4 fl oz	4 leaf (B) 5 leaf (C) 6 leaf (D)	Treatment #12 in efficacy trial

Spray Dates: A – Jun 7; B – Jun 20; C – Jun 27; D – Jul 5; E – Jul 10; F – Jul 17.

Table 2. Onion Crop Tolerance to Clopyralid (Stinger), Triple G, Elba, NY, 2013: Application Conditions

Spray	A	B	C	D	E	F
Date	7-Jun	20-Jun	27-Jun	5-Jul	10-Jul	17-Jul
Time start	3:00P	4:30P	10:50A	4:15P	11:45A	3:00P
Time finish	3:08P	5:00P	11:15A	4:25P	11:50A	3:10P
Onion stage	2 to 2.5-leaf	4 leaf	5 to 5.5-leaf	6 to 7-leaf	7.5-leaf	8-leaf (1-in bulbs)
Sky	overcast	Sunny	overcast	sunny	partly sunny	sunny
Foliage	barely dry	dry	dry	wet	dry	dry
Soil	wet	dry	dry	wet	dry	dry
Wind speed (max)	8.9 mph	5.3	4.5 mph	10 mph	13.5 mph	11.5 mph
Wind speed (avg)	6.8 mph	7.7	2.1 mph	5.4 mph	7.4 mph	8.0 mph
Temperature	60.7°F	76°F	81°F	88°F	81.4°F	93°F
Relative humidity	82%	66%	67%	75%	74%	58%
Pressure	28 psi	30 psi	32 psi	30 psi	29 PSI	28 psi
Notes	Just had 1.25 in of rain		just calibrated, rain forecast	just rained, just calibrated	just calibrated	just calibrated

All sprays made with a CO₂ backpack sprayer with **40 gpa, 2.6 mph** and an **Teejet 8004VS nozzle**.

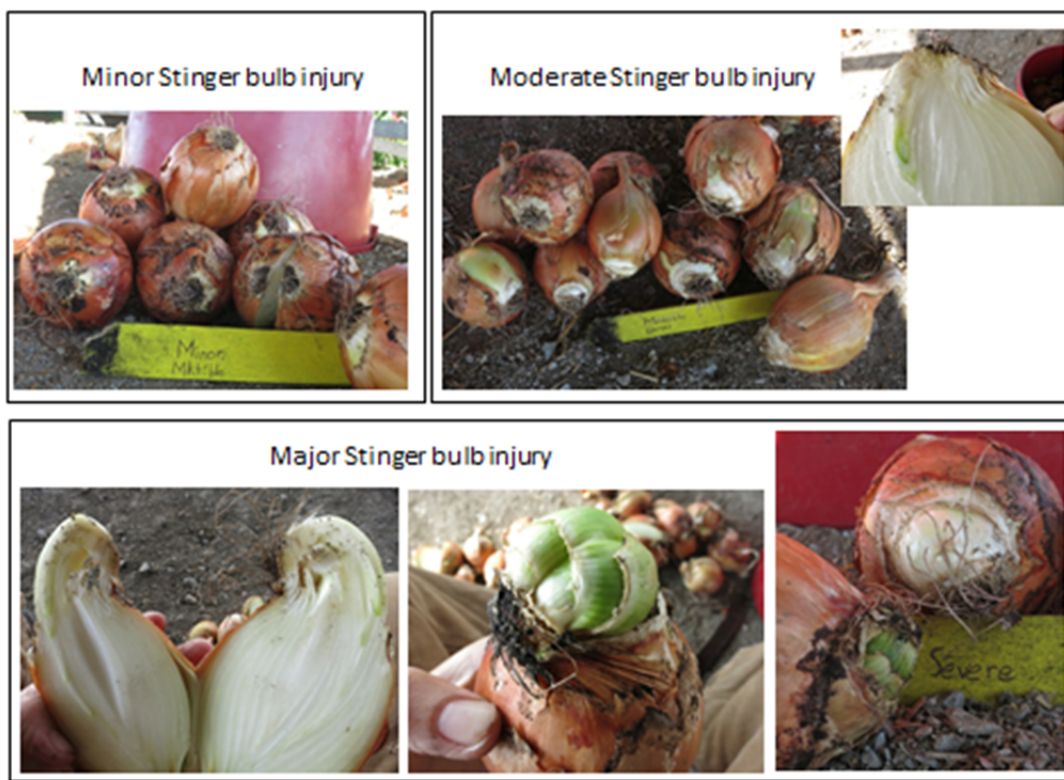


Figure 1. Minor, moderate and major bulb injury caused by Stinger herbicide. Photo credit: E. Buck.

Table 3. Onion Crop Tolerance to Clopyralid (Stinger), Triple G, Elba, NY, 2013: Stinger injury to onion plants.

Treatment (rate of Stinger in fl oz/A & leaf stage at time of app)	Average Leaf Injury Rating (Scale 0-7) ¹		Notes
	5-6 leaf (Jun 28)	2 inch bulbs (Jul 25)	
1. Untreated	0.00 d ³	0.00 b	
3. Stinger 4 fl oz @ 2 leaf	0.33 cd	0.33 b	
4. Stinger 8 fl oz @ 2 leaf	3.66 a	4.33 a	Leaf in leaf ²
7. Stinger 4 fl oz @ 4 leaf	0.00 d	0.00 b	
8. Stinger 8 fl oz @ 4 leaf	2.33 ab	0.33 b	
9. Stinger 16 fl oz @ 4 leaf	3.66 a	1.33 b	
10. Stinger 4 fl oz @ 5 leaf	--	0.33 b	
11. Stinger 8 fl oz @ 5 leaf	--	0.33 b	
12. Stinger 16 fl oz @ 5 leaf	--	1.00 b	
13. Stinger 4 fl oz @ 6 leaf	--	0.66 b	
14. Stinger 8 fl oz @ 6 leaf	--	1.33 b	
15. Stinger 16 fl oz @ 6 leaf	--	1.00 b	
16. Stinger 4 fl oz @ 1" bulb	--	1.33 b	
17. Stinger 8 fl oz @ 1" bulb	--	0.66 b	
18. Stinger 16 fl oz @ 1" bulb	--	1.66 b	
25. Max 16 4 x 4 (start 2 leaf): Stinger 4 fl oz @ 2, 4, 5, 6 leaf	2.33 ab	1.33 b	
26. Max 16 4 x 4 (start 4 leaf): Stinger 4 fl oz @ 4, 5, 6, 7 leaf	1.33 bcd	0.66 b	
27. Max 16 8 x 2 (start 2 leaf): Stinger 8 fl oz @ 2, 4 leaf	3.66 a	4.66 a	Leaf in leaf, root pruning
28. Max 16 8 x 2 (start 4 leaf): Stinger 8 fl oz @ 4, 6 leaf	0.33 cd	0.33 b	
29. Max 16 Hi-Lo (start 2 leaf): Stinger 8, 4, 4 fl oz @ 2, 4, 5 leaf	2.66 ab	4.66 a	Leaf in leaf, Root pruning
30. Max 16 Hi-Lo (start 4 leaf): Stinger 8, 4, 4 fl oz @ 4, 5, 6 leaf	2.00 abc	1.00 b	
31. Max 16 Lo-Hi (start 2 leaf): Stinger 4, 8, 4 fl oz @ 2, 4, 5 leaf	2.00 abc	0.33 b	
32. Max 16 Lo-Hi (start 4 leaf): Stinger 4, 8, 4 fl oz @ 4, 5, 6 leaf	--	1.00 b	
P Value ($\alpha=0.05$)	0.0004	0.0000	

¹Stinger injury scale: 0 = no injury; 1 = very minor; 2 = minor; 3 = minor-moderate; 4 = moderate; 5 = moderate-severe; 6 = severe; 7 = very severe.

²Leaf in leaf injury: inside the forth leaf all of the following leaves are growing.

³Numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test, $p>0.05$.

Table 4: Onion Crop Tolerance to Clopyralid (Stinger), Triple G, Elba, NY, 2013: Marketable and unmarketable yield.

Treatment (rate of Stinger in fl oz/A & leaf stage at time of app)	Total No. of bulbs ¹	Total Marketable Yield (includes minor Stinger injury)		Total Unmarketable Yield (moderate & major injury)		Marketable Bulbs (no Stinger injury)		Total Rot in Uninjured Bulbs		Total Other Culls	
		% of bulbs	Cwt/A	% of bulbs	Cwt/A	% of bulbs	Cwt/A	% of bulbs	Cwt/A	% of bulbs	Cwt/A
1. Untreated	42.0	95.5 a ²	680.7 abc	0.0 d	0.0 d	95.4 a	680.7 a	2.4	15.1	2.1	6.4
3. Stinger 4 fl oz @ 2 leaf	47.7	87.8 abc	620.3 a-e	2.3 cd	13.9 d	81.1 a-e	592.4 abc	7.2	51.1	2.7	10.5
4. Stinger 8 fl oz @ 2 leaf	52.7	92.0 ab	581.4 b-e	3.0 cd	5.2 d	76.7 a-f	529.7 a-d	1.7	12.2	3.2	5.8
7. Stinger 4 fl oz @ 4 leaf	45.7	94.6 a	745.8 abc	0.0 d	0.0 d	84.5 a-d	670.2 a	4.8	36.0	0.6	5.2
8. Stinger 8 fl oz @ 4 leaf	49.3	93.6 a	627.4 a-e	0.0 d	0.0 d	68.6 d-g	473.5 a-e	4.1	8.7	2.3	9.9
9. Stinger 16 fl oz @ 4 leaf	43.0	95.1 a	536.1 cde	0.0 d	0.0 d	70.4 c-g	446.6 b-e	1.4	8.7	3.5	22.1
10. Stinger 4 fl oz @ 5 leaf	55.3	93.0 ab	717.9 abc	0.0 d	0.0 d	89.1 abc	690.6 a	4.7	29.6	2.3	1.7
11. Stinger 8 fl oz @ 5 leaf	35.6	88.7 abc	570.1 b-e	0.0 d	5.2 d	80.9 a-e	537.3 a-d	9.7	50.9	1.2	7.9
12. Stinger 16 fl oz @ 5 leaf	41.7	92.4 ab	690.6 abc	1.5 d	4.6 d	73.1 c-f	571.5 a-d	6.1	48.8	0.0	0.0
13. Stinger 4 fl oz @ 6 leaf	54.0	91.0 ab	671.1 a-d	0.0 d	0.0 d	86.3 a-d	632.8 ab	4.8	52.9	4.3	26.3
14. Stinger 8 fl oz @ 6 leaf	45.7	87.7 abc	687.1 abc	0.6 d	7.0 d	76.0 b-f	619.1 abc	5.0	41.2	6.6	34.3
15. Stinger 16 fl oz @ 6 leaf	40.2	89.7 ab	618.8 abc	0.0 d	0.0 d	83.5 a-e	578.8 a-d	8.4	50.9	2.7	6.8
16. Stinger 4 fl oz @ 1" bulb	50.0	92.7 ab	753.3 abc	1.8 d	11.0 d	67.9 d-g	537.2 a-d	2.6	16.8	2.8	14.5
17. Stinger 8 fl oz @ 1" bulb	42.3	75.3 c	539.0 cde	18.2 b	128.1 b	33.8 h	260.8 ef	5.0	36.0	1.4	2.9
18. Stinger 16 fl oz @ 1" bulb	37.3	41.3 d	216.7 f	51.8 a	293.1 a	13.9 i	79.0 f	6.8	34.8	0.00	0.0
25. Max 16 4 x 4 (start 2 leaf): Stinger 4 fl oz @ 2, 4, 5 6 leaf	44.3	90.4 ab	628.5 a-e	7.4 cd	35.4 cd	62.0 efg	475.2 a-e	2.2	14.5	0.00	0.0
26. Max 16 4 x 4 (start 4 leaf): Stinger 4 fl oz @ 4, 5, 6, 7 leaf	48.3	80.5 bc	652.8 a-e	4.8 cd	34.3 cd	51.2 gh	437.9 b-e	8.7	65.6	6.0	38.3
27. Max 16 8 x 2 (start 2 leaf): Stinger 8 fl oz @ 2, 4 leaf	51.0	94.8 a	450.1 de	0.0 d	0.0 d	70.2 c-g	398.4 cde	0.7	2.9	4.5	37.8
28. Max 16 8 x 2 (start 4 leaf): Stinger 8 fl oz @ 4, 6 leaf	48.0	93.1 ab	554.1 b-e	1.9 d	4.1 d	62.3 efg	424.6 b-e	0.8	4.1	4.3	20.9
29. Max 16 Hi-Lo (start 2 leaf): Stinger 8, 4, 4 fl oz @ 2, 4, 5 leaf	42.3	80.7 bc	435.7 d	6.3 cd	23.8 d	57.7 fg	350.2 de	10.2	58.1	2.7	7.0
30. Max 16 Hi-Lo (start 4 leaf): Stinger 8, 4, 4 fl oz @ 4, 5, 6 leaf	51.0	96.8 a	814.9 a	0.0 a	0.0 d	74.3 b-f	618.6 abc	2.5	16.8	0.6	0.6
31. Max 16 Lo-Hi (start 2 leaf): Stinger 4, 8, 4 fl oz @ 2, 4, 5 leaf	57.0	86.7 abc	719.8 abc	11.8 bc	120.3 bc	71.3 c-f	617.6 abc	1.0	8.7	0.4	0.1
32. Max 16 Lo-Hi (start 4 leaf): Stinger 4, 8, 4 fl oz @ 4, 5, 6 leaf	49.0	94.6 a	772.5 ab	0.0 d	0.0 d	73.8 b-f	623.8 ab	4.7	38.9	0.7	4.1
P value ($\alpha=0.5$)	NS³	0.0000	0.0020	0.0000	0.0000	0.0000	0.0002	NS	NS	NS	NS

¹Total number of bulbs evaluated in trial. ²Numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test ($p>0.05$). ³NS: not significant, Fisher's Protected LSD test.

Table 5. Onion Crop Tolerance to Clopyralid (Stinger), Triple G, Elba, NY, 2013: Bulb injury due to Stinger.

Treatment (rate of Stinger in fl oz/A & leaf stage at time of app)	Minor Stinger Injury		Moderate Stinger Injury		Major Stinger Injury		Total Stinger Injury		Stinger Injury with Rot	
	% of bulbs	Cwt/A	% of bulbs	Cwt/A	% of bulbs	Cwt/A	% of bulbs	Cwt/A	% of bulbs	Cwt/A
1. Untreated	0.0 a ¹	0.0 a	0.0 c	0.0 d	0.0 b	0.0 b	0.0 a	0.0 h	0.0	0.0
3. Stinger 4 fl oz @ 2 leaf	6.7 abc	27.9 abc	2.3 c	13.9 cd	0.0 b	0.0 b	9.0 a-e	41.8 fgh	0.0	0.0
4. Stinger 8 fl oz @ 2 leaf	15.3 b-g	51.7 a-e	3.1 bc	5.2 d	0.0 b	0.0 b	18.4 a-g	56.9 e-h	0.7	2.9
7. Stinger 4 fl oz @ 4 leaf	10.0 a-e	75.5 a-f	0.0 c	0.0 d	0.0 b	0.0 b	10.1 a-e	75.5 d-h	0.0	0.0
8. Stinger 8 fl oz @ 4 leaf	25.0 fgh	153.9 fgh	0.0 c	0.0 d	0.0 b	0.0 b	25.0 d-g	153.9 c-h	0.0	0.0
9. Stinger 16 fl oz @ 4 leaf	24.7 fgh	89.4 a-f	0.0 c	0.0 d	0.0 b	0.0 b	24.7 d-g	89.4 c-h	1.0	7.0
10. Stinger 4 fl oz @ 5 leaf	3.9 ab	27.3 abc	0.0 c	0.0 d	0.0 b	0.0 b	3.9 ab	27.3 gh	0.0	0.0
11. Stinger 8 fl oz @ 5 leaf	7.8 a-d	32.8 abcd	0.8 c	6.4 d	0.0 b	0.0 b	8.3 a-e	38.0 d-h	2.1	16.8
12. Stinger 16 fl oz @ 5 leaf	19.2 c-h	119.1 c-h	1.5 c	4.6 d	0.0 b	0.0 b	20.7 b-g	123.7 c-h	0.0	0.0
13. Stinger 4 fl oz @ 6 leaf	4.6 ab	38.3 a-d	0.0 c	0.0 d	0.0 b	0.0 b	4.6 abc	38.3 fgh	0.0	0.0
14. Stinger 8 fl oz @ 6 leaf	11.7 a-f	68.0 a-f	0.6 c	7.0 d	0.0 b	0.0 b	12.4 a-f	74.9 d-h	1.6	0.7
15. Stinger 16 fl oz @ 6 leaf	6.2 abc	40.0 a-e	0.0 c	0.0 d	0.0 b	0.0 b	5.4 a-d	36.8 c-h	0.0	0.0
16. Stinger 4 fl oz @ 1" bulb	24.8 fgh	216.1 hi	1.8 c	11.0 cd	0.0 b	0.0 b	26.7 efg	227.1 cd	0.0	0.0
17. Stinger 8 fl oz @ 1" bulb	41.6 i	278.2 l	15.5 b	110.7 abc	2.7 b	0.6 b	59.8 h	406.3 ab	1.7	9.1
18. Stinger 16 fl oz @ 1" bulb	27.4 ghi	137.7 d-h	29.1 a	199.6 a	22.7 a	1.9 a	79.3 l	430.7 a	4.2	19.2
25. Max 16 4 x 4 (start 2 leaf): Stinger 4 fl oz @ 2, 4, 5 6 leaf	28.4 ghi	153.3 fgh	5.8 bc	29.0 bcd	1.6 b	0.4 b	35.8 g	188.8 c-g	2.4	11.0
26. Max 16 4 x 4 (start 4 leaf): Stinger 4 fl oz @ 4, 5, 6, 7 leaf	29.3 ghi	214.9 hi	4.8 bc	34.3 bcd	0.0 b	0.0 b	34.1 g	249.2 bc	1.4	11.0
27. Max 16 8 x 2 (start 2 leaf): Stinger 8 fl oz @ 2, 4 leaf	24.5 e-h	51.7 a-e	0.0 c	0.0 d	0.0 b	0.0 b	24.5 d-g	51.7 fgh	0.7	3.5
28. Max 16 8 x 2 (start 4 leaf): Stinger 8 fl oz @ 4, 6 leaf	30.8 hi	129.5 d-h	1.3 c	2.9 d	0.6 b	0.2 b	32.7 g	133.6 c-h	3.5	20.9
29. Max 16 Hi-Lo (start 2 leaf): Stinger 8, 4, 4 fl oz @ 2, 4, 5 leaf	23.0 d-h	85.5 a-f	6.3 bc	23.8 bcd	0.0 b	0.0 b	29.3 fg	109.3 c-h	2.4	8.1
30. Max 16 Hi-Lo (start 4 leaf): Stinger 8, 4, 4 fl oz @ 4, 5, 6 leaf	22.5 d-h	196.3 ghi	0.0 c	0.0 d	0.0 b	0.0 b	22.5 c-g	196.3 c-f	0.6	2.9
31. Max 16 Lo-Hi (start 2 leaf): Stinger 4, 8, 4 fl oz @ 2, 4, 5 leaf	15.5 b-g	102.2 b-g	11.8 bc	120.3 ab	0.0 b	0.0 b	27.3 efg	222.6 cde	1.9	12.2
32. Max 16 Lo-Hi (start 4 leaf): Stinger 4, 8, 4 fl oz @ 4, 5, 6 leaf	20.7 c-h	148.7 e-h	0.0 c	0.0 d	0.0 b	0.0 b	20.7 b-g	148.7 c-h	0.0	0.0
P value ($\alpha=0.5$)	0.0000	0.0000	0.0078	0.0230	0.0078	0.0003	0.0000	0.0001	NS²	NS

¹Numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test ($p>0.05$). ²NS: not significant, Fisher's Protected LSD test.

Total Unmarketable Bulbs Due to Stinger Injury

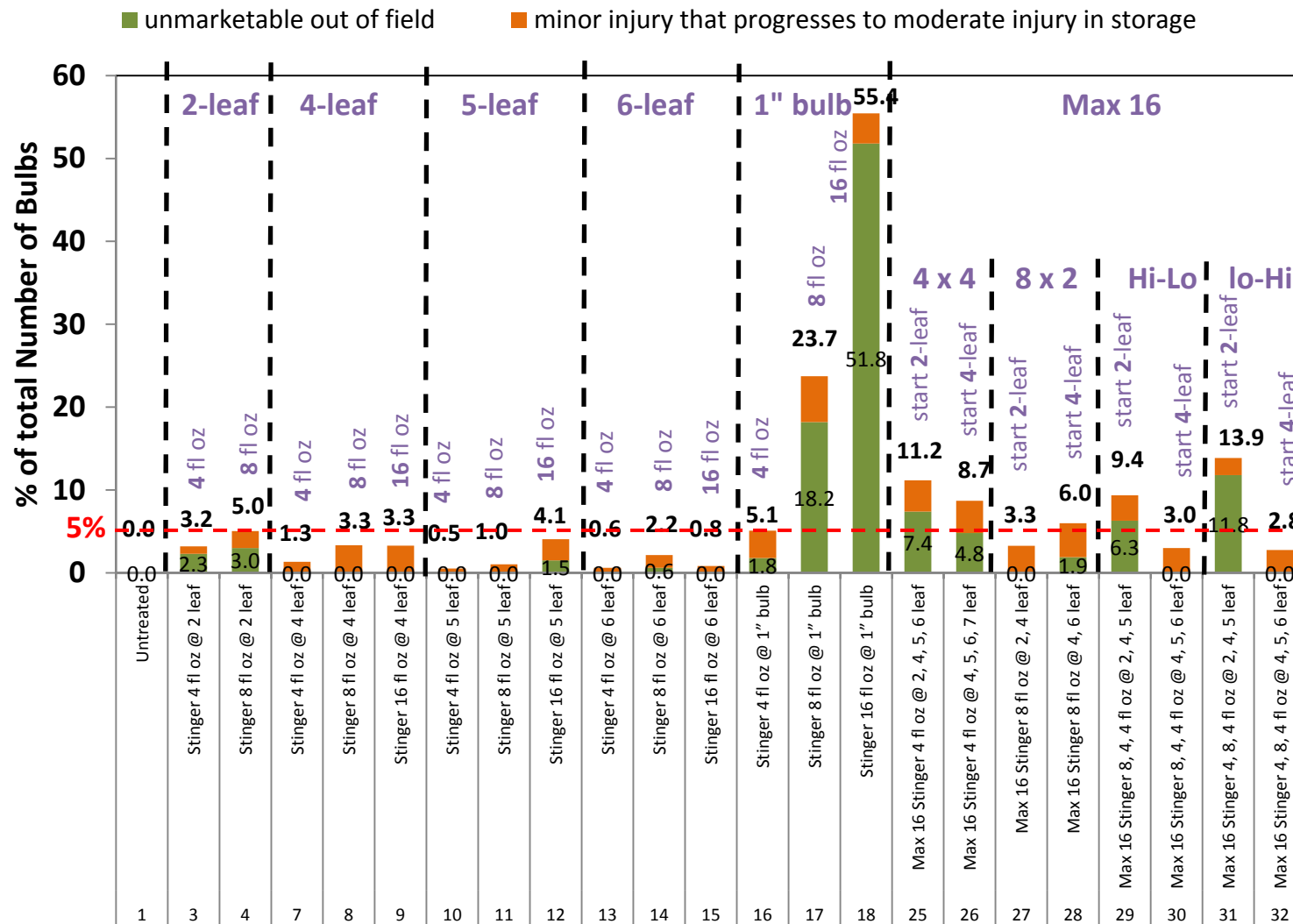


Figure 2. Estimated percentage of total bulbs with unmarketable Stinger injury after 3.5 months in storage. 13.3% of bulbs exhibiting minor yet marketable injury out of the field progressed to moderate unmarketable injury after 3.5 months in storage.

Table 6. Onion Crop Tolerance to Clopyralid (Stinger), Triple G, Elba, NY, 2013: Bulb size distribution of marketable bulbs (includes minor Stinger injury).

Treatment (rate of Stinger in fl oz/A & leaf stage at time of app)	Percent of Total Marketable & Unmarketable Bulbs (%)					
	Boilers (<1.75")	Small (1.75-2.25")	Medium (2.25-3")	Jumbo (>3")	Bulb decay	Other culls
1. Untreated	0.8 b ¹	3.9	43.3	47.4 abc	2.4	2.1
3. Stinger 4 fl oz @ 2 leaf	4.0 ab	9.7	34.8	39.6 a-e	7.2	2.7
4. Stinger 8 fl oz @ 2 leaf	3.5 ab	19.6	40.2	28.8 b-e	1.7	3.2
7. Stinger 4 fl oz @ 4 leaf	0.0 b	1.9	42.3	50.4 abc	4.8	0.6
8. Stinger 8 fl oz @ 4 leaf	2.8 ab	12.0	52.3	26.5 cde	4.1	2.3
9. Stinger 16 fl oz @ 4 leaf	2.8 ab	13.8	46.8	30.6 a-e	2.4	3.5
10. Stinger 4 fl oz @ 5 leaf	1.7 b	15.2	40.5	35.6 a-e	4.7	2.3
11. Stinger 8 fl oz @ 5 leaf	2.0 b	7.5	23.8	51.3 ab	7.8	2.1
12. Stinger 16 fl oz @ 5 leaf	0.7 b	3.2	33.9	54.5 a	6.1	0.0
13. Stinger 4 fl oz @ 6 leaf	3.1 ab	12.5	42.8	32.6 a-e	4.8	4.3
14. Stinger 8 fl oz @ 6 leaf	0.7 b	6.0	35.5	44.0 abc	6.6	6.6
15. Stinger 16 fl oz @ 6 leaf	0.9 b	6.2	31.1	51.7 ab	6.1	1.7
16. Stinger 4 fl oz @ 1" bulb	3.3 ab	0.6	34.1	54.7 a	2.6	2.8
17. Stinger 8 fl oz @ 1" bulb	0.0 b	3.3	28.5	42.6 a-d	5.9	1.4
18. Stinger 16 fl oz @ 1" bulb	2.2 b	0.8	19.4	15.4 e	10.3	0.0
25. Max 16 4 x 4 (start 2 leaf): Stinger 4 fl oz @ 2, 4, 5 6 leaf	2.2 b	7.4	34.7	45.3 abc	3.0	0.0
26. Max 16 4 x 4 (start 4 leaf): Stinger 4 fl oz @ 4, 5, 6, 7 leaf	1.9 b	4.1	31.7	42.0 a-d	9.4	6.0
27. Max 16 8 x 2 (start 2 leaf): Stinger 8 fl oz @ 2, 4 leaf	16.6 a	25.2	36.3	16.0 e	1.3	4.5
28. Max 16 8 x 2 (start 4 leaf): Stinger 8 fl oz @ 4, 6 leaf	2.5 b	12.6	55.4	19.0 de	4.2	4.3
29. Max 16 Hi-Lo (start 2 leaf): Stinger 8, 4, 4 fl oz @ 2, 4, 5 leaf	3.3 ab	13.3	43.7	19.6 de	11.0	2.7
30. Max 16 Hi-Lo (start 4 leaf): Stinger 8, 4, 4 fl oz @ 4, 5, 6 leaf	0.6 b	9.6	38.3	47.6 abc	3.2	0.6
31. Max 16 Lo-Hi (start 2 leaf): Stinger 4, 8, 4 fl oz @ 2, 4, 5 leaf	0.6 b	4.7	43.8	35.8 a-e	2.9	0.4
32. Max 16 Lo-Hi (start 4 leaf): Stinger 4, 8, 4 fl oz @ 4, 5, 6 leaf	0.0 b	5.1	42.0	47.4 abc	4.7	0.7
P value ($\alpha=0.5$)	0.0000	NS²	NS	0.0139	NS	NS

¹Numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test ($p>0.05$). ²NS: not significant, Fisher's Protected LSD test.

Table 7. Onion Crop Tolerance to Clopyralid (Stinger), Triple G, Elba, NY, 2013: Bulb size distribution of unmarketable bulbs (includes moderate and major Stinger injury).

Treatment (rate of Stinger in fl oz/A & leaf stage at time of app)	Percent of Total Marketable & Unmarketable Bulbs (%)				
	Boilers (<1.75")	Small (1.75-2.25")	Medium (2.25-3")	Jumbo (>3")	Bulb decay
1. Untreated	0.0	0.0 b ¹	0.0 d	0.0 c	0.0
3. Stinger 4 fl oz @ 2 leaf	0.0	0.0 b	1.5 cd	0.8 c	0.0
4. Stinger 8 fl oz @ 2 leaf	1.0	1.3 b	0.0 d	0.0 c	0.7
7. Stinger 4 fl oz @ 4 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
8. Stinger 8 fl oz @ 4 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
9. Stinger 16 fl oz @ 4 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
10. Stinger 4 fl oz @ 5 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
11. Stinger 8 fl oz @ 5 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
12. Stinger 16 fl oz @ 5 leaf	0.7	0.0 b	0.7 cd	0.0 c	0.0
13. Stinger 4 fl oz @ 6 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
14. Stinger 8 fl oz @ 6 leaf	0.0	0.0 b	0.0 d	0.6 c	0.0
15. Stinger 16 fl oz @ 6 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
16. Stinger 4 fl oz @ 1" bulb	0.0	0.0 b	0.0 d	1.8 c	0.0
17. Stinger 8 fl oz @ 1" bulb	0.0	0.7 b	9.9 b	6.7 b	0.9
18. Stinger 16 fl oz @ 1" bulb	0.0	4.9 a	25.0 a	21.2 a	0.8
25. Max 16 4 x 4 (start 2 leaf): Stinger 4 fl oz @ 2, 4, 5 6 leaf	2.1	1.4 b	0.0 d	2.3 c	1.6
26. Max 16 4 x 4 (start 4 leaf): Stinger 4 fl oz @ 4, 5, 6, 7 leaf	0.0	0.0 b	3.4 cd	0.8 c	0.6
27. Max 16 8 x 2 (start 2 leaf): Stinger 8 fl oz @ 2, 4 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
28. Max 16 8 x 2 (start 4 leaf): Stinger 8 fl oz @ 4, 6 leaf	1.3	0.6 b	0.0 d	0.0 c	0.0
29. Max 16 Hi-Lo (start 2 leaf): Stinger 8, 4, 4 fl oz @ 2, 4, 5 leaf	0.0	1.6 b	3.2 cd	0.0 c	1.6
30. Max 16 Hi-Lo (start 4 leaf): Stinger 8, 4, 4 fl oz @ 4, 5, 6 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
31. Max 16 Lo-Hi (start 2 leaf): Stinger 4, 8, 4 fl oz @ 2, 4, 5 leaf	0.4	0.9 b	6.6 bc	3.9 bc	0.0
32. Max 16 Lo-Hi (start 4 leaf): Stinger 4, 8, 4 fl oz @ 4, 5, 6 leaf	0.0	0.0 b	0.0 d	0.0 c	0.0
P value ($\alpha=0.5$)	NS²	0.0199	0.0000	0.0000	NS

¹Numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test ($p>0.05$). ²NS: not significant, Fisher's Protected LSD test.