EVALUATION OF REFLEX® AND BICYCLOPYRONE FOR WEED CONTROL IN DIRECT-SEEDED ONION

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Introduction

Evaluation of recently registered herbicides for weed control in specialty crops is a necessary step before the product can be granted a label for use on the targeted crop. Herbicides are essential to control weeds in direct-seeded onion in order to realize acceptable size and bulb yield. Reflex® was recently registered for use to control weeds in potato and bicyclopyrone is a new product on the market that is being evaluated for weed control in various crops. Reflex would fit well into onion production in the Treasure Valley because of its ability to suppress yellow nutsedge. There is an indication that bicyclopyrone might also suppress yellow nutsedge. Both products provide residual weed control and could reduce the amount of postemergence herbicides used in onion production. The objectives of this study were to evaluate onion tolerance of Reflex and bicyclopyrone and the herbicides' weed efficacy under local conditions in a field free of yellow nutsedge.

Materials and Methods

A field study was conducted in 2015 at the Malheur Experiment Station, Ontario, Oregon to evaluate onion response and weed control with Reflex and bicyclopyrone herbicide. The field, previously planted to wheat, was prepared in 2014 to create a seedbed suitable for onion production. Based on soil tests, fertilizer to supply 75 lb phosphorus/acre, 200 lb potassium/acre, 17 lb elemental sulfur/acre, 7 lb manganese/acre, and 3 lb boron/acre was applied and the field was ripped, moldboard plowed, and groundhogged. On October 31, 2014, the soil was fumigated using Vapam® at 15 gal/acre and simultaneously bedded following local practices. Beds 22 inches wide were made to facilitate furrow irrigation. The beds were harrowed and flattened on March 10, 2015. Onion seeds of variety 'Vaquero' were planted on March 13 in double rows spaced 3.7 inches apart and 3.9 inches within the row on 22-inch beds. Lorsban® 15G (Chlorpyrifos) was banded at 3.7 oz/1,000 ft of row (0.125 lb ai/acre) over the entire field on March 20 as a preventive measure against onion maggot.

The study had a randomized complete block design with 4 replications of all herbicide treatments and individual plots were 7.33 ft wide (4 rows) by 27 ft long. Preemergence treatments were applied on March 19 while late preemergence treatments were applied on March 26. Plots for postemergence-applied Reflex or bicyclopyrone (except the untreated control) were sprayed with Prowl® H_2O at 2.1 pt/acre (pendimethalin at 1 lb ai/acre) on March 26. Postemergence treatments were applied on May 8 and 29 when onion plants were at the 2-leaf and 4- to 6-leaf stages,

respectively. Herbicide treatments and evaluated rates are contained within the results in Tables 1-5. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer fitted with a boom equipped with four EVS8002 flat-fan nozzles at a spray volume of 20 gal/acre.

The first irrigation was applied on April 13, 2015. All subsequent irrigations were scheduled based on six Watermark soil moisture sensors (Irrometer Co., Riverside, CA) connected to an AM400 data logger (M.K. Hansen Co., Wenatchee, WA) to prevent the soil at 8-inch depth from drying beyond 25 kPa soil water tension. Fertilizer was applied on June 11 to supply 170 lb nitrogen/acre.

Plants were sprayed with Movento® at 5 fl oz/acre (spirotetramat 1.25 oz ai/acre) on June 4 for thrips control. Subsequent sprayings for thrips control were delivered aerially based on local trap counts.

Visual evaluations for onion injury and weed control were conducted on May 8 and June 18. Estimates were based on a 0-100% visual scale; where 0% = no injury or no weed control and 100% = total crop damage or complete weed control. Weeds in the two center rows were enumerated by species and removed on July 13. Onion plant tops were flailed and bulbs were lifted on September 9, 2015. Bulbs were hand-harvested from the two center beds on September 10 and graded on September 14. The bulbs were graded according to quality as follows: bulbs without blemishes (No. 1s), split bulbs (No. 2s), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. The No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼-3 inches), jumbo (3-4 inches), colossal (4-4¼ inches), and supercolossal (>4¼ inches). Marketable yield consists of No.1 bulbs over 2¼ inches. The data were subjected to analysis of variance and means compared using the least significance difference (LSD, $P = 0.05$).

Results

Onion emergence started on April 6, 2015. Reflex and bicyclopyrone application timing affected onion emergence (Table 1). Reflex at 1 or 2 pt/acre (0.25 or 0.5 lb ai/acre) applied preemergence (PRE) resulted in fewer than 659 plants/acre compared to 116,384 plants/acre for the hand-weeded control. Plant stand in plots sprayed PRE with bicyclopyrone at 0.16 or 0.214 pt/acre (37.5 or 50 g ai/acre) was 38,355 and 77,150 plants/acre compared to 116,274 to 118,143 plants/acre for ProwlH_2O applied late preemergence (LPRE). Onion injury for the surviving plants ranged from 90 to 100% for Reflex applied PRE and 60 to 84% for bicyclopyrone applied PRE. Onion injury in the other treatments was less than 5%. As expected, the number of harvested bulbs/acre reflected plant stand for each herbicide treatment.

Evaluations at 14 days after the last herbicide application indicated that control of common lambsquarters ranged from 76 to 100% across herbicide treatments, with standalone Reflex at 1 pt/acre providing the least control (Table 2). Control for pigweed species ranged from 89 to 99% across treatments. Hairy nightshade control was estimated at 78 to 100%, kochia control was 97 to 100%, and spotted ladysthumb and grass weeds control were both greater than 95%.

The number of weeds in the two center rows at 45 days after the last herbicide application is presented in Table 3. Postemergence application of Reflex at 1 pt/acre or bicyclopyrone at 0.16 or 0.214 pt/acre when onions were at the 2-leaf stage reduced the number of weeds/plot.

Standalone postemergence application of Reflex at 1 pt/acre resulted in the highest number of weeds. The results indicate that Reflex and bicyclopyrone have a potential to be applied postemergence to control weeds in onion without adversely affecting the crop. Bicyclopyrone could be used alone to control weeds when onions are at the 2-leaf stage followed by a tank mixture of Buctril at 0.75 pt/acre plus GoalTender at 0.50 pt/acre at the 4- to 6-leaf stage.

Marketable onion yield reflected the level of herbicide injury and weed control (Table 4). Postemergence application of Reflex at 1 pt/acre tank-mixed with Buctril at 0.75 pt/acre when onions were at the 2-leaf or 4- to 6-leaf stages resulted in 1162 or 1046 cwt/acre, respectively, compared to 1148 cwt/acre for the hand-weeded treatment. Marketable onion yield was equally high when bicyclopyrone at 0.16 pt/acre plus NIS at 0.25% v/v or a tank mixture of bicyclopyrone at 0.16 pt/acre plus Buctril at 0.75 pt/acre was applied postemergence when onions were at the 2-leaf stage. Marketable yield was a reflection of the number of harvested bulbs (Table 5).

These results indicate the potential for Reflex and bicyclopyrone to be used postemergence to control weeds in direct-seeded onion. These results will be used to refine the treatments for the 2016 study.

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Table 1. Onion response to Fomesafen (Reflex) and bicyclopyrone at the Malheur Experiment Station, Ontario, OR, 2015.

	Treatment	Rate	Unit	Amount per acre	Application timing[a]		Onion[b] Plant stand 5/7/2015	Onion[b] Injury 5/8/2015	Onion[b] Injury 6/12/2015	Harvested bulbs
							no/acre	%	%	no/acre
1	Reflex	0.25	lb ai/a	1.0 pt	PRE	A	659 d	90 b	97 b	2,077 fg
	Buctril	0.187	lb ai/a	0.75 pt	2 leaf	B				
	GoalTender	0.125	lb ai/a	0.25 pt	2 leaf	B				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
	GoalTender	0.125	lb ai/a	0.25 pt	4-6 leaf	C				
2	Reflex	0.5	lb ai/a	2.0 pt	PRE	A	0 d	97 a	100 a	0 g
	Buctril	0.187	lb ai/a	0.75 pt	2 leaf	B				
	GoalTender	0.125	lb ai/a	0.25 pt	2 leaf	B				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
	GoalTender	0.125	lb ai/a	0.25 pt	4-6 leaf	C				
3	Prowl H_2O	0.95	lb ai/a	2.0 pt	PRE	A	118,582 a	0 d	5 ef	106,526 bc
	Reflex	0.25	lb ai/a	1.0 pt	2 leaf	B				
	Reflex	0.25	lb ai/a	1.0 pt	4-6 leaf	C				
4	Prowl H_2O	0.95	lb ai/a	2.0 pt	PRE	A	117,263 a	0 d	8 e	95,844 cd
	Reflex	0.5	lb ai/a	2.0 pt	2 leaf	B				
	Reflex	0.5	lb ai/a	2.0 pt	4-6 leaf	C				
5	Prowl H_2O	0.95	lb ai/a	2.0 pt	PRE	A	116,274 a	0 d	0 g	108,900 ab
	Reflex	0.25	lb ai/a	1.0 pt	2 leaf	B				
	Buctril	0.187	lb ai/a	0.75 pt	2 leaf	B				
	Reflex	0.25	lb ai/a	1.0 pt	4-6 leaf	C				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
6	Prowl H_2O	0.95	lb ai/a	2.0 pt	PRE	A	118,143 a	0 d	5 ef	118,989 a
	Reflex	0.5	lb ai/a	2.0 pt	2 leaf	B				
	Buctril	0.187	lb ai/a	0.75 pt	2 leaf	B				
	Reflex	0.5	lb ai/a	2.0 pt	4-6 leaf	C				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
7	Prowl H_2O	0.95	lb ai/a	2.0 pt	PRE	A	118,143 a	0 d	0 g	114,835 ab
	Buctril	0.187	lb ai/a	0.75 pt	2 leaf	B				
	GoalTender	0.125	lb ai/a	0.25 pt	2 leaf	B				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
	Reflex	0.25	lb ai/a	1.0 pt	4-6 leaf	C				
8	Prowl H_2O	0.95	lb ai/a	2.0 pt	PRE	A	117,923 a	0 d	0 g	120,472 a
	A16003 (bicyclopyrone)	50	g ai/ha	0.214 pt	2 leaf	B				
	NIS	0.25	% v/v	0.7 pt	2 leaf	B				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
	GoalTender	0.125	lb ai/a	0.25 pt	4-6 leaf	C				
9	A16003 (bicyclopyrone)	37.5	g ai/ha	0.16 pt	PREPRE	A	77,150 b	60 c	55 d	85,755 d
	GoalTender	4	oz ai/a	0.50 pt	2 leaf	B				
	Buctril	0.187	lb ai/a	0.75 pt	2 leaf	B				
	GoalTender	4	oz ai/a	0.50 pt	4-6 leaf	C				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
10	A16003 (bicyclopyrone)	50	g ai/ha	0.214 pt	PRE	A	38,355 c	84 b	80 c	45,103 e
	GoalTender	4	oz ai/a	0.50 pt	2 leaf	B				
	Buctril	0.187	lb ai/a	0.75 pt	2 leaf	B				
	GoalTender	4	oz ai/a	0.50 pt	4-6 leaf	C				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
11	Prowl H_2O	0.95	lb ai/a	2.0 pt	PRE	A	116,604 a	0 d	5 ef	114,538 ab
	A16003 (bicyclopyrone)	37.5	g ai/ha	0.16 pt	2 leaf	B				
	Buctril	0.187	lb ai/a	0.75 pt	2 leaf	B				
	GoalTender	4	oz ai/a	0.50 pt	4-6 leaf	C				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
12	Prowl H_2O	0.95	lb ai/a	2.0 pt	PRE	A	117,483 a	0 d	4 f	118,099 ab
	A16003 (bicyclopyrone)	37.5	g ai/ha	0.16 pt	2 leaf	B				
	NIS	0.25	% v/v	0.7 pt	2 leaf	B				
	GoalTender	4	oz ai/a	0.50 pt	4-6 leaf	C				
	Buctril	0.187	lb ai/a	0.75 pt	4-6 leaf	C				
13	Handweeded						116,384 a	0 d	0 g	116,912 ab
14	Untreated						115,725 a	0 d	0 g	13,056 f
LSD (P = 0.05)							4,276	8	3	10,842

[a]Application timing: PRE = preemergence on March 9; 2-leaf = May 8; 4-6 leaf = May 29.
[b]Means followed by same letter do not significantly differ (P = 0.05, LSD).

Table 2. Weed control on June 19 (14 days after herbicide application) with Reflex and bicyclopyrone in direct-seeded onion, Malheur Experiment Station, Ontario, OR, 2015.

Treatment	Amount per acre	Application timing[a]	Weed control[b]					
			Common lambsquarters	Redroot pigweed	Hairy nightshade	Kochia	Spotted ladysthumb	Grass weeds
			%					
Reflex	1.0 pt	PRE	99 a	97 ab	100 a	99 ab	100 a	95 ab
Buctril	0.75 pt	2 leaf						
GoalTender	0.25 pt	2 leaf						
Buctril	0.75 pt	4-6 leaf						
GoalTender	0.25 pt	4-6 leaf						
Reflex	2.0 pt	PRE	97 a	98 a	100 a	100 ab	100 a	97 a
Buctril	0.75 pt	2 leaf						
GoalTender	0.25 pt	2 leaf						
Buctril	0.75 pt	4-6 leaf						
GoalTender	0.25 pt	4-6 leaf						
Prowl H_2O	2.0 pt	PRE	76 b	89 c	78 c	98 ab	93 c	98 a
Reflex	1.0 pt	2 leaf						
Reflex	1.0 pt	4-6 leaf						
Prowl H_2O	2.0 pt	PRE	94 a	93 abc	88 abc	95 c	97 ab	98 a
Reflex	2.0 pt	2 leaf						
Reflex	2.0 pt	4-6 leaf						
Prowl H_2O	2.0 pt	PRE	98 a	91 bc	96 ab	99 ab	100 a	99 a
Reflex	1.0 pt	2 leaf						
Buctril	0.75 pt	2 leaf						
Reflex	1.0 pt	4-6 leaf						
Buctril	0.75 pt	4-6 leaf						
Prowl H_2O	2.0 pt	PRE	100 a	95 abc	99 a	98 ab	100 a	97 a
Reflex	2.0 pt	2 leaf						
Buctril	0.75 pt	2 leaf						
Reflex	2.0 pt	4-6 leaf						
Buctril	0.75 pt	4-6 leaf						
Prowl H_2O	2.0 pt	PRE	99 a	92 bc	100 a	97 abc	100 a	96 a
Buctril	0.75 pt	2 leaf						
GoalTender	0.25 pt	2 leaf						
Buctril	0.75 pt	4-6 leaf						
Reflex	1.0 pt	4-6 leaf						
Prowl H_2O	2.0 pt	PRE	97 a	94 abc	81 bc	97 bc	96 bc	98 a
A16003 (bicyclopyrone)	0.214 pt	2 leaf						
NIS	0.7 pt	2 leaf						
Buctril	0.75 pt	4-6 leaf						
GoalTender	0.25 pt	4-6 leaf						
A16003 (bicyclopyrone)	0.16 pt	PREPRE	98 a	99 a	100 a	99 ab	100 a	90 b
GoalTender	0.50 pt	2 leaf						
Buctril	0.75 pt	2 leaf						
GoalTender	0.50 pt	4-6 leaf						
Buctril	0.75 pt	4-6 leaf						
A16003 (bicyclopyrone)	0.214 pt	PRE	100 a	98 a	100 a	100 a	99 a	94 ab
GoalTender	0.50 pt	2 leaf						
Buctril	0.75 pt	2 leaf						
GoalTender	0.50 pt	4-6 leaf						
Buctril	0.75 pt	4-6 leaf						
Prowl H_2O	2.0 pt	PRE	100 a	95 ab	100 a	99 ab	100 a	97 a
A16003 (bicyclopyrone)	0.16 pt	2 leaf						
Buctril	0.75 pt	2 leaf						
GoalTender	0.50 pt	4-6 leaf						
Buctril	0.75 pt	4-6 leaf						
Prowl H_2O	2.0 pt	PRE	97 a	94 abc	100 a	100 ab	100 a	99 a
A16003 (bicyclopyrone)	0.16 pt	2 leaf						
NIS	0.7 pt	2 leaf						
GoalTender	0.50 pt	4-6 leaf						
Buctril	0.75 pt	4-6 leaf						
Handweeded			99 a	98 a	98 a	100 ab	100 a	96 a
Untreated			0 c	0 d	0 d	0 d	0 d	0 c
LSD (P = 0.05)			15.6	5.8	16.6	2.8	3.4	5.5

[a]Application timing: PRE = preemergence on March 9; 2 leaf = May 8; 4-6 leaf = May 29.
[b]Means followed by same letter do not significantly differ (P = 0.05, LSD).

Table 3. Number of weeds per plot (3.67 x 27 ft) on July 13 (45 days after herbicide application) in response to application of Reflex and bicyclopyrone in direct-seeded onion, Malheur Experiment Station, Ontario, OR, 2015.

Treatment	Amount per acre	Application timing[a]	Number of weeds/plot[b]						
			Common lambsquarters	Redroot pigweed	Hairy nightshade	Kochia	Spotted ladysthumb	Grass weeds	Total weeds
			---------- no/plot (3.67 x 27 ft) ----------						
Reflex	1.0 pt	PRE	2 b	7 b	0 b	2 b	1 b	13 b	24 b
Buctril	0.75 pt	2 leaf							
GoalTender	0.25 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
GoalTender	0.25 pt	4-6 leaf							
Reflex	2.0 pt	PRE	3 b	7 b	0 b	1 b	3 b	12 b	24 b
Buctril	0.75 pt	2 leaf							
GoalTender	0.25 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
GoalTender	0.25 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	28 b	39 b	39 b	3 b	45 b	5 b	158 b
Reflex	1.0 pt	2 leaf							
Reflex	1.0 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	9 b	29 b	21 b	7 b	18 b	4 b	88 b
Reflex	2.0 pt	2 leaf							
Reflex	2.0 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	2 b	32 b	8 b	2 b	2 b	5 b	50 b
Reflex	1.0 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
Reflex	1.0 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	1 b	18 b	4 b	2 b	2 b	8 b	33 b
Reflex	2.0 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
Reflex	2.0 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	1 b	29 b	1 b	3 b	3 b	9 b	46 b
Buctril	0.75 pt	2 leaf							
GoalTender	0.25 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
Reflex	1.0 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	5 b	25 b	23 b	3 b	28 b	5 b	89 b
A16003 (bicyclopyrone)	0.214 pt	2 leaf							
NIS	0.7 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
GoalTender	0.25 pt	4-6 leaf							
A16003 (bicyclopyrone)	0.16 pt	PREPRE	2 b	5 b	1 b	1 b	2 b	23 b	34 b
GoalTender	0.50 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
A16003 (bicyclopyrone)	0.214 pt	PRE	3 b	8 b	1 b	0 b	5 b	15 b	32 b
GoalTender	0.50 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	0 b	17 b	1 b	2 b	4 b	8 b	31 b
A16003 (bicyclopyrone)	0.16 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	3 b	12 b	1 b	1 b	1 b	3 b	20 b
A16003 (bicyclopyrone)	0.16 pt	2 leaf							
NIS	0.7 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Handweeded			1 b	7 b	4 b	1 b	1 b	11 b	23 b
Untreated			272 a	495 a	297 a	173 a	1833 a	347 a	3,418 a
LSD (P = 0.05)			80	133	57	37	801	68	641

[a]Application timing: PRE = preemergence on March 9; 2 leaf = May 8; 4-6 leaf = May 29.
[b]Means followed by same letter do not significantly differ (P = 0.05, LSD).

Table 4. Onion yield in response to application of Reflex and bicyclopyrone applied on direct-seeded onion, Malheur Experiment Station, Ontario, OR, 2015.

Treatment	Amount per acre	Timing[a]	Marketable onion yield by grade[b]						Total yield
			Small	Medium	Jumbo	Colossal	Supercolossal	Total	
			cwt/acre						
Reflex	1.0 pt	PRE	0.7 b	0.0 e	3.6 g	21.0 e	0.0 b	24.6 d	25.3 d
Buctril	0.75 pt	2 leaf							
GoalTender	0.25 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
GoalTender	0.25 pt	4-6 leaf							
Reflex	2.0 pt	PRE	0.0 b	0.0 e	0.0 g	0.0 e	0.0 b	0.0 d	0.0 d
Buctril	0.75 pt	2 leaf							
GoalTender	0.25 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
GoalTender	0.25 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	53.6 a	196.4 a	197.1 e	0.0 e	0.0 b	393.5 c	447.1 c
Reflex	1.0 pt	2 leaf							
Reflex	1.0 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	56.7 a	186.0 a	148.2 ef	3.4 e	0.0 b	337.6 c	394.3 c
Reflex	2.0 pt	2 leaf							
Reflex	2.0 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	6.7 b	96.1 b	604.5 c	37.5 de	3.4 ab	741.5 b	748.2 b
Reflex	1.0 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
Reflex	1.0 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	3.7 b	60.2 c	787.7 ab	283.8 ab	26.6 a	1,158.3 a	1,162.1 a
Reflex	1.0 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
Reflex	0.75 pt	4-6 leaf							
Buctril	0.50 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	4.0 b	14.7 de	810.6 a	204.5 bc	12.5 ab	1,042.3 a	1,046.3 a
Buctril	0.75 pt	2 leaf							
GoalTender	0.25 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
Reflex	1.0 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	14.4 b	93.1 b	667.5 bc	26.9 e	0.0 b	787.5 b	801.9 b
A16003 (bicyclopyrone)	0.214 pt	2 leaf							
NIS	0.7 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
GoalTender	0.25 pt	4-6 leaf							
A16003 (bicyclopyrone)	0.16 pt	PREPRE	1.2 b	31.6 cd	435.7 d	356.7 a	16.0 ab	839.9 b	841.2 b
GoalTender	0.50 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
A16003 (bicyclopyrone)	0.214 pt	PRE	5.7 b	5.2 de	254.1 e	152.9 cd	20.2 ab	432.3 c	438.0 c
GoalTender	0.50 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	5.1 b	25.5 de	800.6 a	230.4 bc	5.1 ab	1,061.7 a	1,066.8 a
A16003 (bicyclopyrone)	0.16 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	3.0 b	26.9 de	818.3 a	267.5 abc	21.8 ab	1,134.5 a	1,137.4 a
A16003 (bicyclopyrone)	0.16 pt	2 leaf							
NIS	0.7 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Handweeded			5.0 b	15.9 de	748.4 ab	378.5 a	6.1 ab	1,148.9 a	1,154.0 a
Untreated			10.1 b	0.7 e	29.9 fg	0.0 e	0.0 b	30.6 d	40.7 d
LSD (P = 0.05)			16.0	30.1	127.7	122.8	24.6	149.8	142.6

[a]Application timing: PRE = preemergence on March 9; 2 leaf = May 8; 4-6 leaf = May 29.
[b]Means followed by same letter do not significantly differ (P = 0.05, LSD).

Table 5. Number of harvested onion bulbs in response to Reflex and bicyclopyrone applied to direct-seeded onion, Malheur Experiment Station, Ontario, OR, 2015.

Treatment	Amount per acre	Timing[a]	Number of weeds/plot[b]						
			Small	Medium	Jumbo	Colossal	Supercolossal	Marketable	Total bulbs
			number/acre						
Reflex	1.0 pt	PRE	297 c	0 e	297 e	1484 e	0 b	1,780 e	2,077 fg
Buctril	0.75 pt	2 leaf							
GoalTender	0.25 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
GoalTender	0.25 pt	4-6 leaf							
Reflex	2.0 pt	PRE	0 c	0 e	0 e	0 e	0 b	0 e	0 g
Buctril	0.75 pt	2 leaf							
GoalTender	0.25 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
GoalTender	0.25 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	27,596 a	49,554 a	29,376 d	0 e	0 b	78,930 bc	106,526 bc
Reflex	1.0 pt	2 leaf							
Reflex	1.0 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	27,596 a	44,213 a	23,738 d	297 e	0 b	68,248 c	95,844 cd
Reflex	2.0 pt	2 leaf							
Reflex	2.0 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	3,561 bc	24,925 b	77,150 b	2,967 de	297 ab	105,339 a	108,900 ab
Reflex	1.0 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
Reflex	1.0 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	1,484 bc	13,946 c	81,007 ab	21,068 ab	1,484 a	117,505 a	118,989 a
Reflex	1.0 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
Reflex	0.75 pt	4-6 leaf							
Buctril	0.50 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	2,077 bc	3,857 de	92,283 a	15,727 bc	890 ab	112,758 a	114,835 ab
Buctril	0.75 pt	2 leaf							
GoalTender	0.25 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
Reflex	1.0 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	6,528 bc	23,442 b	88,426 ab	2,077 e	0 b	113,944 a	120,472 a
A16003 (bicyclopyrone)	0.214 pt	2 leaf							
NIS	0.7 pt	2 leaf							
Buctril	0.75 pt	4-6 leaf							
GoalTender	0.25 pt	4-6 leaf							
A16003 (bicyclopyrone)	0.16 pt	PREPRE	890 bc	8,902 cd	48,960 c	26,112 a	890 ab	84,865 b	85,755 d
GoalTender	0.50 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
A16003 (bicyclopyrone)	0.214 pt	PRE	2,374 bc	1,484 de	29,080 d	10,979 cd	1,187 ab	42,729 d	45,103 e
GoalTender	0.50 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	1,780 bc	6,825 cde	88,722 ab	16,914 bc	297 ab	112,758 a	114,538 ab
A16003 (bicyclopyrone)	0.16 pt	2 leaf							
Buctril	0.75 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Prowl H_2O	2.0 pt	PRE	1,484 bc	6,528 cde	88,722 ab	20,178 ab	1,187 ab	116,615 a	118,099 ab
A16003 (bicyclopyrone)	0.16 pt	2 leaf							
NIS	0.7 pt	2 leaf							
GoalTender	0.50 pt	4-6 leaf							
Buctril	0.75 pt	4-6 leaf							
Handweeded			2,374 bc	5,341 de	80,711 ab	28,189 a	297 ab	114,538 a	116,912 ab
Untreated			12,166 b	593 e	297 e	0 e	0 b	890 e	13,056 f
LSD (P = 0.05)			11,310	7,707	14,868	8,511	1,415	12,941	10,842

[a]Application timing: PRE = preemergence on March 9; 2 leaf = May 8; 4-6 leaf = May 29.
[b]Means followed by same letter do not significantly differ (P = 0.05, LSD).