

ONION RESPONSE TO TALINOR[®] HERBICIDE RATE AND APPLICATION TIMING

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Introduction

Herbicides are the primary tool to manage weeds in onion. Timely control of weeds is essential in order to achieve better onion yield and bulb quality. However, herbicides registered for weed control in onion are limited, largely due to seedling sensitivity at the early growth stage. Repeated use of the same few registered products could result in selection of herbicide-resistant weeds. Therefore, in order to broaden the tool kit, it is vital to evaluate new products on the market for suitability to manage weeds in onion. Additionally, growers lack an efficacious herbicide that is safe to use in onions at the early growth stage.

Talinor[®] is a premix herbicide composed of bicyclopyrone and bromoxynil, which is registered for weed control in cereals. The choice of this herbicide premix was because bromoxynil is already registered for weed control in onion, and we have previously observed onion tolerance to bicyclopyrone. The objective of this study was to evaluate onion response to Talinor herbicide applied at various rates to onions starting at the 1- or 2-leaf stages and the level of weed control achieved.

Materials and Methods

A field study was initiated during spring 2021 at the Malheur Experiment Station to evaluate the response of direct-seeded onion variety ‘Vaquero’ to Talinor herbicide and the level of weed control at various application rates and timings. The predominant soil was an Owyhee silt loam with a pH of 7.8 and 2.78% soil organic matter. Land was prepared the previous fall by flailing wheat stubble; the field was then irrigated, disked, ripped, plowed, and groundhogged. Based on soil analysis, fertilizer was broadcast applied during fall 2020 at 100 lb nitrogen (N)/acre, 100 lb phosphorus/acre, 4 lb zinc/acre, and 2 lb boron/acre. The field was fumigated with K-Pam[®] at 15 gal/acre (Potassium N-methyldithiocarbamate 5.8 lb ai/gal) and beds were formed at 22-inch spacing on October 2, 2020.

The study area was sprayed with Roundup[®] at 1 quart/acre (1.13 lb ae/acre) on March 18, 2021 to control all emerged weed prior to establishing the study. Beds were harrowed down on March 24 and onion seed of variety ‘Vaquero’ was planted on March 26, 2021, in double rows spaced 3 inches apart with 3.71-inch seed spacing within each row. Each pair of rows was planted on beds spaced 22 inches apart. On March 26, 2021, each onion bed received a 7-inch band of Lorsban[®] 15G at 3.7 oz/1000 ft of row (chlorpyrifos 0.101 lb ai/acre) and the soil surface was rolled. The irrigation drip tape was installed thereafter.

The study had a randomized complete-block design with four replicates. Individual plots were 7.33 ft wide (4 beds) by 27 ft long. Herbicide treatments were applied using a CO₂-pressurized

backpack sprayer fitted with a boom calibrated to deliver 20 gal/acre for delayed pre-emergence treatments or 35 gal/acre for post-emergence treatments. Treatments with Talinor[®] applied at the 1-leaf onion growth stage were preceded by a delayed pre-emergence application of glyphosate at 22 fl oz/acre (glyphosate 0.77 lb ae/acre), whereas Talinor[®] treatments applied at the 2-leaf stage and the grower standard received a delayed pre-emergence application of glyphosate 22 fl oz/acre + Prowl[®] H₂O at 2 pints/acre (pendimethalin 0.95 lb ai/acre). Untreated and hand-weeded checks were included.

Delayed pre-emergence herbicide treatments were applied on April 12, 2021. Talinor[®] herbicide at 4, 8, or 10 fl oz/acre (bicyclopyrone 0.155 oz ai/a + bromoxynil 0.73 oz ai/a, bicyclopyrone 0.312 oz ai/a + bromoxynil 1.47 oz ai/a or bicyclopyrone 0.385 oz ai/a + bromoxynil 1.81 oz ai/a, respectively) was applied to onions at the 1-leaf stage on May 5, 2021. Onions at the 2-leaf stage were sprayed with Talinor[®] herbicide at 10, 12, 15, or 18 fl oz/acre (bicyclopyrone 0.385 oz ai/a + bromoxynil 1.81 oz ai/a, bicyclopyrone 0.466 oz ai/a + bromoxynil 2.2 oz ai/a, bicyclopyrone 0.58 oz ai/a + bromoxynil 2.72 oz ai/a or bicyclopyrone 0.7 oz ai/a + bromoxynil 3.3 oz ai/a, respectively) on May 13, 2021 (see details in Tables 1–5). Treatments sprayed with Talinor[®] at the 1- or 2-leaf onion growth stages received a tank-mix of Brox[®] 2EC at 12 fl oz/acre (bromoxynil 0.188 lb ai/acre) plus GoalTender[®] at 4 fl oz/acre (oxyfluorfen 0.125 lb/ai acre) when onion plants were at the 4-leaf stage (June 1, 2021). On May 11, all treatments (except the hand-weeded and untreated control) were sprayed with Poast[®] herbicide at 1.5 pints/acre (sethoxydim 0.287 lb ai/acre) plus COC at 1 pint/a (0.41 % v/v) to control grassy weeds.

In-season fertilizer was applied according to soil and tissue test results. Fertilizer was applied through drip irrigation on June 1 and June 22 to supply 100 lb N/acre on each incident.

The following insecticide combinations were used on the indicated dates to control onion thrips:

- June 4, 2021 — M-Pede 5.6 pints/acre + Aza-Direct[®] 12 fl oz/acre (azadirachtin 0.0093 lb ai/acre)
- June 11, 2021 — Aza-Direct[®] 16 fl oz/acre (azadirachtin 0.0123 lb ai/acre) + Movento[®] 5 fl oz/acre (spirotetramat 0.078 lb ai/acre)
- June 14, 2021 — Aza-Direct[®] 16 fl oz/acre (azadirachtin 0.0123 lb ai/acre) + Persist[®] Ultra 1% v/v (methyl esters of canola oil 85% + alkyl phenol ethoxylate 12%).
- June 22, 2021 — Movento[®] 3.5 fl oz/acre (spirotetramat 0.051 lb ai/acre) + Exirel[®] 13.5 fl oz/acre (cyantraniliprole 0.0875 lb ai/acre) + Persist Ultra 1% v/v (methyl esters of canola oil 85% + alkyl phenol ethoxylate 12%).
- July 2, 2021 — Exirel[®] 20 fl oz/acre (cyantraniliprole 0.13 lb ai/acre) + Dyne- Amic[®] adjuvant 0.25% v/v (methyl esters of C16-C18 fatty acids, polyalkyleneoxide modified polydimethylsiloxane, alkylphenol ethoxylate 99%).
- July 12, 2021 — Exirel[®] 20 fl oz/acre (cyantraniliprole 0.13 lb ai/acre) + HSMOC 0.125% v/v.
- July 21, 2021 — Agri-Mek[®] 3.5 fl oz/acre (abamectin 0.0191 lb ai/acre) + Dyne- Amic[®] adjuvant 0.125% v/v (methyl esters of C16-C18 fatty acids, polyalkyleneoxide modified polydimethylsiloxane, alkylphenol ethoxylate 99%).

All other operations followed recommended local production practices for drip-irrigated onion. Visible plant injury and weed control were assessed based on a scale of 0% (no onion injury or weed control) to 100% (complete onion plant killed or total weed control). Onion response to Talinor® herbicide was assessed on May 7, May 12, May 20, and June 8, 2021 (Table 1). Weed control was assessed on May 8, May 20, and June 8 (Table 2). Weeds were counted in the center rows on June 29, 2021 (Table 3) and the study was hand-weeded (except for untreated control) thereafter.

The field was drip irrigated from April 5 to August 17, 2021. Plant tops were flailed on August 30, and onion bulbs were lifted on August 31. Bulbs were hand harvested from 15 ft length of the two center beds on September 3, 2021, placed in burlap bags, and kept in the storage barn until graded. Bulbs were graded for yield and quality on September 20 based on USDA standards as follows: bulbs without blemishes (U.S. No. 1), split bulbs (No. 2), 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 U.S. No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼–3 inches), jumbo (3–4 inches), colossal (4–4¼ inches), and super colossal (>4¼ inches). Marketable yield consisted of U.S. No.1 bulbs greater than 2¼ inches in diameter.

After harvest, bulbs from a section of two center rows in each plot were rated for single centers. Twenty-five onions ranging in diameter from 3½ to 4¼ inches were rated. The onions were cut equatorially through the bulb middle and separated into single-centered (bullet) and multiple-centered bulbs. The multiple-centered bulbs had the long axis of the inside diameter of the first single ring measured. These multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small had diameters less than 1½ inches, medium had diameters from 1½ to 2¼ inches, and large had diameters greater than 2¼ inches. Onions were considered "functionally single centered" for processing purposes if they were single centered (bullet) or had a small multiple center.

Data were subjected to analysis of variance and the treatment means were compared using protected LSD at the 0.05% level of confidence.

Results and Conclusions

Weather condition in the Treasure Valley was generally warm and dry during winter 2020, which extended to dry conditions during onion planting time in spring 2021. Consequently, onions were irrigated within 10 days of seeding (April 5). Onion emergence was observed on April 20, 2021. Plant count on May 7 indicated variable plant population density ranging from 121,220 to 136,180 plants/acre across herbicide treatments (Table 1). The variability in plant stand was likely attributable to dry soil conditions during spring 2021. Evaluation on May 12 (7 days after application of Talinor to onion at 1-leaf) indicated no visible injury (Table 1). Onion injury on May 20 (15 days after 1-leaf and 7 days after 2-leaf application timings) was <3% across herbicide treatments. Subsequent evaluation on June 8 (34 days after 1-leaf and 21 days after 2-leaf applications) indicated no visible onion injury (Table 1).

There were notable variations in weed control across herbicide treatments during ratings on May 12, 2021 (Table 2) suggesting superior weed control with Talinor applied to onion at the 1-leaf stage compared to the grower standard of delayed-preemergence application of Prowl plus glyphosate. On May 12, control for common lambsquarters ranged from 69 to 100% suggesting improvement in control when Talinor herbicide rate increased from 4 to 10 fl oz/acre, compared to 40 to 65% for treatments that received Prowl 32 fl oz/acre at the delayed pre-emergence timing (Table 2). A similar trend was observed for hairy nightshade control on the same evaluation date. Evaluations on May 20 (7 days after application of Talinor to onion at the 2-leaf stage) indicated common lambsquarters control at 70 to 100% for Talinor applied at 1-leaf compared to complete control when applied at the 2-leaf stage. Control for hairy nightshade on May 20 was similarly high. It is important to note here that Talinor herbicide was applied at a lower rate of 4, 8, or 10 fl oz/acre when onions were at the 1-leaf stage, compared to 10, 12, 15, or 18 fl oz/acre when onions were at the 2-leaf stage. On June 8, 2021, control for common lambsquarters and hairy nightshade with Talinor applied to onion plants at 1- or 2-leaf stage was still high, comparable to the level of control with the grower standard of Brox 2EC plus Goal Tender.

The number of weeds counted in the two center rows on June 29 (55 days after Talinor application at 1-leaf or 47 days after Talinor application at 2-leaf stage) varied across herbicide application rates and application timing (Table 3). The total number of weeds on June 29 ranged from 68 to 224 weed plants/99 ft² (two center rows) in plots treated with Talinor herbicide at 4 to 10 fl oz/acre to onions at the 1-leaf stage and 9 to 33 weed plants across the plots treated with Talinor at 10 to 18 fl oz/acre when onion plants were at the 2-leaf stage, compared to 60 plants/99 ft² for the grower standard, which was composed of Prowl H₂O followed by Brox 2EC plus GoalTender (Table 3). It is important to note that plots treated with Talinor when onions were at the 1-leaf stage received a subsequent tank-mixture of Brox 2EC plus Goal Tender only at the 4-leaf stage. In hindsight, application of Brox 2EC plus Goal Tender at the 2-leaf stage would have significantly improved weed control in those plots.

Onion yield reflected the level of weed control (Table 4). The marketable yield for US No. 1 bulbs was generally comparable to the grower standard herbicide practice. Marketable yield averaged 856.9 to 1,117.1 cwt/acre for treatments that received Talinor herbicide at the 1-leaf stage and 1,036.7 to 1,134 cwt/acre when Talinor was applied to onions at the 2-leaf stage compared to 1,119.9 cwt/acre for the grower standard herbicides and 1,049.6 cwt/acre for the hand weeded control. The total onion yield (all grades combined) followed a similar trend.

Bulb single centeredness is very important for growers contracting with processors for production of onion rings. The percentage of single-centered bulbs (bullet plus small multiple center bulbs) was varied across herbicide treatments and ranged from 70.1 to 87.4% across treatments that included Talinor at either the 1-leaf or 2-leaf stage compared to 72% for the grower standard and 77.4% for the hand weeded control (Table 5).

These results suggested that onion variety Vaquero could tolerate Talinor herbicide applied as early as the 1-leaf stage. Therefore, there is potential to use Talinor at 4 to 10 fl oz/acre to manage weeds in direct-seeded onion. Further studies will be conducted to explore onion response when Talinor is applied pre-emergence immediately after seeding or delayed pre-emergence as it is routine for the use of Prowl in the Treasure Valley in Oregon and Idaho.

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Table 1. Onion plant stand and injury in response to Talinor® herbicide application rate and timing, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Treatment ¹	Rate fl oz/acre	Growth stage	Application date	Onion injury ²			
				May 7	May 12	May 20	June 8
				----- % -----			
Untreated				136,180 a	0 a	0 b	0 a
Hand weeded				121,990 c	0 a	0 b	0 a
Roundup PowerMax	22	Delayed-PRE	April 14	124,520 abc	0 a	0 b	0 a
Talinor	4	1 leaf	May 5				
Brox 2EC	12	4 leaf	June 1				
GoalTender	4	4 leaf	June 1				
Roundup PowerMax	22	Delayed-PRE	April 14	130,020 abc	0 a	0 b	0 a
Talinor	8	1 leaf	May 5				
Brox 2EC	12	4 leaf	June 1				
GoalTender	4	4 leaf	June 1				
Roundup PowerMax	22	Delayed-PRE	April 14	126,390 abc	0 a	0 b	0 a
Talinor	10	1 leaf	May 5				
Brox 2EC	12	4 leaf	June 1				
GoalTender	4	4 leaf	June 1				
Prowl H ₂ O	32	Delayed-PRE	April 14	127,710 abc	0 a	0 b	0 a
Roundup PowerMax	22	Delayed-PRE	April 14				
Talinor	10	2 leaf	May 13				
Brox 2EC	12	4 leaf	June 1				
GoalTender	4	4 leaf	June 1				
Prowl H ₂ O	32	Delayed-PRE	April 14	131,670 abc	0 a	0 b	0 a
Roundup PowerMax	22	Delayed-PRE	April 14				
Talinor	12	2 leaf	May 13				
Brox 2EC	12	4 leaf	June 1				
GoalTender	4	4 leaf	June 1				
Prowl H ₂ O	32	Delayed-PRE	April 14	121,220 c	0 a	3 a	0 a
Roundup PowerMax	22	Delayed-PRE	April 14				
Talinor	15	2 leaf	May 13				
Brox 2EC	12	4 leaf	June 1				
GoalTender	4	4 leaf	June 1				
Prowl H ₂ O	32	Delayed-PRE	April 14	133,430 ab	0 a	1 ab	0 a
Roundup PowerMax	22	Delayed-PRE	April 14				
Talinor	18	2 leaf	May 13				
Brox 2EC	12	4 leaf	June 1				
GoalTender	4	4 leaf	June 1				
Prowl H ₂ O (Grower std)	32	Delayed-PRE	April 14	129,470 abc	0 a	0 b	0 a
Roundup PowerMax	22	Delayed-PRE	April 14				
Brox 2EC	12	2 leaf	May 13				
GoalTender	4	2 leaf	May 13				
Brox 2EC	12	4 leaf	June 1				
GoalTender	4	4 leaf	June 1				
LSD (P = 0.05)				11,265	NS	1.9	NS

¹Roundup PowerMax 22 fl oz/acre = glyphosate 0.77 lb ae/acre; Talinor 4 fl oz/acre = bicyclopyrone 0.0097 lb ai/acre + bromoxynil 0.0456 lb ai/acre; Talinor 8 fl oz/acre = bicyclopyrone 0.0194 lb ai/acre + bromoxynil 0.092 lb ai/acre; Talinor 10 fl oz/acre = bicyclopyrone 0.0242 lb ai/acre + bromoxynil 0.114 lb ai/acre; Talinor 12 fl oz/acre = bicyclopyrone 0.029 lb ai/acre + bromoxynil 0.137 lb ai/acre; Talinor 15 fl oz/acre = bicyclopyrone 0.0363 lb ai/acre + bromoxynil 0.17 lb ai/acre; Talinor 18 fl oz/acre = bicyclopyrone 0.044 lb ai/acre + bromoxynil 0.206 lb ai/acre; Brox 2EC 12 fl oz/acre = bromoxynil 0.188 lb ai/acre; GoalTender 4 fl oz/acre = oxyfluorfen 0.125 lb ai/acre; Prowl H₂O 32 fl oz/acre = pendimethalin 0.95 lb ai/acre.

²Means within a column followed by same letter do not significantly differ (P = 0.05, LSD).

Table 2. Weed control in onion with Talinor® herbicide applied at variable rate and timing, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Treatment ¹	Rate fl oz/a	Growth stage	Application date	Weed control ²					
				5/12/2021		5/20/2021		6/8/2021	
				C lambs- quarters	Hairy nightshade	C Lambs- quarters	Hairy nightshade	C lambs- quarters	Hairy nightshade
Untreated*				0 -	0 -	0 -	0 -	0 -	0 -
Hand weeded				100 a	100 a	100 a	100 a	100 a	100 a
Roundup PowerMax	22	Delayed-PRE	April 3	69 b	81 ab	70 b	75 b	81 b	84 b
Talinor	4	1 leaf	May 1						
Brox 2EC	12	4 leaf	June 1						
GoalTender	4	4 leaf	June 1						
Roundup PowerMax	22	Delayed-PRE	April 3	91 a	98 a	93 a	89 a	92 ab	93 ab
Talinor	8	1 leaf	May 1						
Brox 2EC	12	4 leaf	June 1						
GoalTender	4	4 leaf	June 1						
Roundup PowerMax	22	Delayed-PRE	April 3	100 a	100 a	100 a	97 a	100 a	96 a
Talinor	10	1 leaf	May 1						
Brox 2EC	12	4 leaf	June 1						
GoalTender	4	4 leaf	June 1						
Prowl H ₂ O	32	Delayed-PRE	April 3	50 bcd	50 c	100 a	98 a	100 a	97 a
Roundup PowerMax	22	Delayed-PRE	April 3						
Talinor	10	2 leaf	May 11						
Brox 2EC	12	4 leaf	June 2						
GoalTender	4	4 leaf	June 2						
Prowl H ₂ O	32	Delayed-PRE	April 3	40 d	46 c	100 a	99 a	100 a	97 a
Roundup PowerMax	22	Delayed-PRE	April 3						
Talinor	12	2 leaf	May 11						
Brox 2EC	12	4 leaf	June 2						
GoalTender	4	4 leaf	June 2						
Prowl H ₂ O	32	Delayed-PRE	April 3	45 cd	49 c	100 a	99 a	100 a	99 a
Roundup PowerMax	22	Delayed-PRE	April 3						
Talinor	15	2 leaf	May 11						
Brox 2EC	12	4 leaf	June 2						
GoalTender	4	4 leaf	June 2						
Prowl H ₂ O	32	Delayed-PRE	April 3	48 cd	45 c	100 a	100 a	100 a	100 a
Roundup PowerMax	22	Delayed-PRE	April 3						
Talinor	18	2 leaf	May 11						
Brox 2EC	12	4 leaf	June 2						
GoalTender	4	4 leaf	June 2						
Prowl H ₂ O (Grower std)	32	Delayed-PRE	April 3	65 bc	61 bc	100 a	92 a	100 a	95 a
Roundup PowerMax	22	Delayed-PRE	April 3						
Brox 2EC	12	2 leaf	May 11						
GoalTender	4	2 leaf	May 11						
Brox 2EC	12	4 leaf	June 2						
GoalTender	4	4 leaf	June 2						
LSD (P = 0.05)				20.8	22.7	14.4	12.5	11.9	9.5

¹ Roundup PowerMax 22 fl oz/acre = glyphosate 0.77 lb ae/acre; Talinor 4 fl oz/acre = bicyclopyrone 0.0097 lb ai/acre + bromoxynil 0.0456 lb ai/acre; Talinor 8 fl oz/acre = bicyclopyrone 0.0194 lb ai/acre + bromoxynil 0.092 lb ai/acre; Talinor 10 fl oz/acre = bicyclopyrone 0.0242 lb ai/acre + bromoxynil 0.114 lb ai/acre; Talinor 12 fl oz/acre = bicyclopyrone 0.029 lb ai/acre + bromoxynil 0.137 lb ai/acre; Talinor 15 fl oz/acre = bicyclopyrone 0.0363 lb ai/acre + bromoxynil 0.17 lb ai/acre; Talinor 18 fl oz/acre = bicyclopyrone 0.044 lb ai/acre + bromoxynil 0.206 lb ai/acre; Brox 2EC 12 fl oz/acre = bromoxynil 0.188 lb ai/acre; GoalTender 4 fl oz/acre = oxyfluorfen 0.125 lb ai/acre; Prowl H₂O 32 fl oz/acre = pendimethalin 0.95 lb ai/acre. *Untreated not included in statistical analysis, ²Means within a column followed by same letter do not significantly differ (P = 0.05, LSD).

Table 3. Number and total weight of weeds on June 29 in response to Talinor® herbicide application rate and timing, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Treatment ^a	Rate fl oz/a	Growth stage	Application date	Number of weeds ^c					Total weed wt. lb/99 ft ²	
				lambs- quarters	Pigweeds	Hairy nightshade	Grasses	Other weeds ^b		Total weeds
Untreated*				94 -	0 -	539 -	0-	55 -	729 -	118.3 -
Hand weeded				0 -	0 -	0 -	0-	0 -	0 -	0 -
Roundup PowerMax	22	Delayed-PRE	April 3	30 a	16 a	129 a	14 ab	36 a	224 a	37.5 a
Talinor	4	1 leaf	May 1							
Brox 2EC	12	4 leaf	June 1							
GoalTender	4	4 leaf	June 1							
Roundup PowerMax	22	Delayed-PRE	April 3	20 b	11 ab	62 b	13 ab	11 b	116 b	18.1 b
Talinor	8	1 leaf	May 1							
Brox 2EC	12	4 leaf	June 1							
GoalTender	4	4 leaf	June 1							
Roundup PowerMax	22	Delayed-PRE	April 3	3 c	6 bc	27 bc	29 a	4 b	68 bc	6.4 cd
Talinor	10	1 leaf	May 1							
Brox 2EC	12	4 leaf	June 1							
GoalTender	4	4 leaf	June 1							
Prowl H ₂ O	32	Delayed-PRE	April 3	2 c	7 bc	21 bc	4 b	1 b	33 cde	6.8 cd
Roundup PowerMax	22	Delayed-PRE	April 3							
Talinor	10	2 leaf	May 11							
Brox 2EC	12	4 leaf	June 2							
GoalTender	4	4 leaf	June 2							
Prowl H ₂ O	32	Delayed-PRE	April 3	1 c	2 bc	14 bc	6 b	2 b	24 cde	6.5 cd
Roundup PowerMax	22	Delayed-PRE	April 3							
Talinor	12	2 leaf	May 11							
Brox 2EC	12	4 leaf	June 2							
GoalTender	4	4 leaf	June 2							
Prowl H ₂ O	32	Delayed-PRE	April 3	1 c	2 bc	5 bc	4 b	0 b	12 de	3.4 cd
Roundup PowerMax	22	Delayed-PRE	April 3							
Talinor	15	2 leaf	May 11							
Brox 2EC	12	4 leaf	June 2							
GoalTender	4	4 leaf	June 2							
Prowl H ₂ O	32	Delayed-PRE	April 3	0 c	1 c	2 c	7 b	0 b	9 e	1.0 d
Roundup PowerMax	22	Delayed-PRE	April 3							
Talinor	18	2 leaf	May 11							
Brox 2EC	12	4 leaf	June 2							
GoalTender	4	4 leaf	June 2							
Prowl H ₂ O (Grower std)	32	Delayed-PRE	April 3	3 c	7 bc	38 bc	4 b	8 b	60 cd	13.5 bc
Roundup PowerMax	22	Delayed-PRE	April 3							
Brox 2EC	12	2 leaf	May 11							
GoalTender	4	2 leaf	May 11							
Brox 2EC	12	4 leaf	June 2							
GoalTender	4	4 leaf	June 2							
LSD (P = 0.05)				7.2	8.8	58.1	19.4	12.2	48.5	10.88

^a Roundup PowerMax 22 fl oz/acre = glyphosate 0.77 lb ae/acre; Talinor 4 fl oz/acre = bicyclopyrone 0.0097 lb ai/acre + bromoxynil 0.0456 lb ai/acre; Talinor 8 fl oz/acre = bicyclopyrone 0.0194 lb ai/acre + bromoxynil 0.092 lb ai/acre; Talinor 10 fl oz/acre = bicyclopyrone 0.0242 lb ai/acre + bromoxynil 0.114 lb ai/acre; Talinor 12 fl oz/acre = bicyclopyrone 0.029 lb ai/acre + bromoxynil 0.137 lb ai/acre; Talinor 15 fl oz/acre = bicyclopyrone 0.0363 lb ai/acre + bromoxynil 0.17 lb ai/acre; Talinor 18 fl oz/acre = bicyclopyrone 0.044 lb ai/acre + bromoxynil 0.206 lb ai/acre; Brox 2EC 12 fl oz/acre = bromoxynil 0.188 lb ai/acre; GoalTender 4 fl oz/acre = oxyfluorfen 0.125 lb ai/acre; Prowl H₂O 32 fl oz/acre = pendimethalin 0.95 lb ai/acre.

* Untreated treatment not included in statistical analysis

^b Other weeds = kochia, flixweed, lady's thumb, annual sowthistle, and black medic.

^c Means within a column followed by same letter do not significantly differ (P = 0.05, LSD).

Table 4. Onion yield in response to application of Talinor® herbicide at various rates and timings, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Treatment ^a	Rate fl oz/acre	Growth stage	Application date	Marketable onion yield ^b								
				Rot	US No. 2	Small	Medium	Jumbo	Colossal	Super colossal	Total Marketable	Total Yield
Untreated				0.0 a	0.0 a	0.0 b	0.0 a	0.0 c	0.0 c	0.0 c	0.0 g	
Weed free (hand weeded)				2.4 a	0.0 b	9.6 b	45.0 bc	714.7 a	240.9 a	48.9 a	1,049.6 a	1,061.6 bc
Talinor	4	1 leaf	May 1	0.0 a	1.0 a	24.2 ab	74.1 a	672.1 a	76.3 b	4.3 b	826.9 b	852.1 c
Talinor	8	1 leaf	May 1	0.0 a	0.0 b	17.5 ab	64.5 ab	693.8 a	244.4 a	32.6 ab	1,035.3 a	1,052.8 bc
Talinor	10	1 leaf	May 1	0.0 a	0.0 b	10.5 b	36.9 c	771.0 a	284.5 a	24.8 ab	1,117.1 a	1,127.7 ab
Prowl H ₂ O	32	Delayed-PRE	April 3	1.7 a	0.0 b	12.4 b	45.4 bc	726.3 a	246.6 a	18.3 ab	1,036.7 a	1,050.8 bc
Talinor	10	2 leaf	May 11									
Brox 2EC	12	4 leaf	June 2									
GoalTender	4	4 leaf	June 2									
Prowl H ₂ O	32	Delayed-PRE	April 3	1.9 a	0.0 b	8.7 b	57.5 abc	793.7 a	223.7 a	14.3 ab	1,089.2 a	1,099.9 ab
Talinor	12	2 leaf	May 11									
Brox 2EC	12	4 leaf	June 2									
GoalTender	4	4 leaf	June 2									
Prowl H ₂ O	32	Delayed-PRE	April 3	2.5 a	0.0 b	5.7 b	32.2 c	752.0 a	236.5 a	32.8 ab	1,053.6 a	1,061.8 bc
Talinor	15	2 leaf	May 11									
Brox 2EC	12	4 leaf	June 2									
GoalTender	4	4 leaf	June 2									
Prowl H ₂ O	32	Delayed-PRE	April 3	0.7 a	0.0 b	145.3 a	48.5 abc	782.8 a	257.8 a	45.2 a	1,134.4 a	1,280.4 a
Talinor	18	2 leaf	May 11									
Brox 2EC	12	4 leaf	June 2									
GoalTender	4	4 leaf	June 2									
Prowl H ₂ O (Grower std)	32	Delayed-PRE	April 3	0.0 a	0.0 b	11.4 b	45.5 bc	788.7 a	250.3 a	35.4 ab	1,119.9 a	1,131.3 ab
Brox 2EC	12	2 leaf	May 11									
GoalTender	4	2 leaf	May 11									
Brox 2EC	12	4 leaf	June 2									
GoalTender	4	4 leaf	June 2									
LSD (P = 0.05)				3.98	0.96	131.04	27.06	138.49	117.86	37.14	156.42	210.64

^a All delayed-pre-emergence treatments included Roundup PowerMax 22 fl oz/acre = glyphosate 0.77 lb ae/acre; Talinor 4 fl oz/acre = bicyclopyrone 0.0097 lb ai/acre + bromoxynil 0.0456 lb ai/acre; Talinor 8 fl oz/acre = bicyclopyrone 0.0194 lb ai/acre + bromoxynil 0.092 lb ai/acre; Talinor 10 fl oz/acre = bicyclopyrone 0.0242 lb ai/acre + bromoxynil 0.114 lb ai/acre; Talinor 12 fl oz/acre = bicyclopyrone 0.029 lb ai/acre + bromoxynil 0.137 lb ai/acre; Talinor 15 fl oz/acre = bicyclopyrone 0.0363 lb ai/acre + bromoxynil 0.17 lb ai/acre; Talinor 18 fl oz/acre = bicyclopyrone 0.044 lb ai/acre + bromoxynil 0.206 lb ai/acre; Brox 2EC 12 fl oz/acre = bromoxynil 0.188 lb ai/acre; GoalTender 4 fl oz/acre = oxyfluorfen 0.125 lb ai/acre; Prowl H₂O 32 fl oz/acre = pendimethalin 0.95 lb ai/acre.

^b Means within a column followed by same letter do not significantly differ (P = 0.05, LSD).

Table 5. Single and multiple-center bulb ratings in response to Talinor herbicide application rate and timing, Malheur Experiment Station, Oregon State University, Ontario, OR, 2021.

Treatment ¹	Rate fl oz/acre	Growth stage	Application date	Multiple centers ^{2,3}			Single center ²	
				Large	Medium	Small	Bullet	Functional ⁴
				----- % -----				
Hand weeded				6.8 a	15.8 abc	19.8 ab	57.6 a	77.4 ab
Roundup PowerMax	22	Delayed-PRE	April 3	7.1 a	16.1 abc	27.4 a	49.3 a	76.7 ab
Talinor	4	1 leaf	May 1					
Brox 2EC	12	4 leaf	June 1					
GoalTender	4	4 leaf	June 1					
Roundup PowerMax	22	Delayed-PRE	April 3	9.0 a	17.0 abc	18.2 ab	55.8 a	74.0 ab
Talinor	8	1 leaf	May 1					
Brox 2EC	12	4 leaf	June 1					
GoalTender	4	4 leaf	June 1					
Roundup PowerMax	22	Delayed-PRE	April 3	11.9 a	11.9 bc	15.8 b	60.5 a	76.2 ab
Talinor	10	1 leaf	May 1					
Brox 2EC	12	4 leaf	June 1					
GoalTender	4	4 leaf	June 1					
Prowl H ₂ O	32	Delayed-PRE	April 3	5.8 a	6.8 c	27.6 a	59.9 a	87.4 a
Roundup PowerMax	22	Delayed-PRE	April 3					
Talinor	10	2 leaf	May 11					
Brox 2EC	12	4 leaf	June 2					
GoalTender	4	4 leaf	June 2					
Prowl H ₂ O	32	Delayed-PRE	April 3	11.4 a	18.4 ab	15.7 b	54.4 a	70.1 b
Roundup PowerMax	22	Delayed-PRE	April 3					
Talinor	12	2 leaf	May 11					
Brox 2EC	12	4 leaf	June 2					
GoalTender	4	4 leaf	June 2					
Prowl H ₂ O	32	Delayed-PRE	April 3	9.4 a	23.4 a	15.4 b	51.7 a	67.1 b
Roundup PowerMax	22	Delayed-PRE	April 3					
Talinor	15	2 leaf	May 11					
Brox 2EC	12	4 leaf	June 2					
GoalTender	4	4 leaf	June 2					
Prowl H ₂ O	32	Delayed-PRE	April 3	10.5 a	15.5 abc	18.1 ab	55.8 a	74.0 ab
Roundup PowerMax	22	Delayed-PRE	April 3					
Talinor	18	2 leaf	May 11					
Brox 2EC	12	4 leaf	June 2					
GoalTender	4	4 leaf	June 2					
Prowl H ₂ O (Grower std)	32	Delayed-PRE	April 3	11.0 a	17.0 abc	18.6 ab	53.3 a	72.0 b
Roundup PowerMax	22	Delayed-PRE	April 3					
Brox 2EC	12	2 leaf	May 11					
GoalTender	4	2 leaf	May 11					
Brox 2EC	12	4 leaf	June 2					
GoalTender	4	4 leaf	June 2					
LSD (P = 0.05)				NS	11.4	11.4	NS	14.3

¹ Roundup PowerMax 22 fl oz/acre = glyphosate 0.77 lb ae/acre; Talinor 4 fl oz/acre = bicyclopyrone 0.0097 lb ai/acre + bromoxynil 0.0456 lb ai/acre; Talinor 8 fl oz/acre = bicyclopyrone 0.0194 lb ai/acre + bromoxynil 0.092 lb ai/acre; Talinor 10 fl oz/acre = bicyclopyrone 0.0242 lb ai/acre + bromoxynil 0.114 lb ai/acre; Talinor 12 fl oz/acre = bicyclopyrone 0.029 lb ai/acre + bromoxynil 0.137 lb ai/acre; Talinor 15 fl oz/acre = bicyclopyrone 0.0363 lb ai/acre + bromoxynil 0.17 lb ai/acre; Talinor 18 fl oz/acre = bicyclopyrone 0.044 lb ai/acre + bromoxynil 0.206 lb ai/acre; Brox 2EC 12 fl oz/acre = bromoxynil 0.188 lb ai/acre; GoalTender 4 fl oz/acre = oxyfluorfen 0.125 lb ai/acre; Prowl H₂O 32 fl oz/acre = pendimethalin 0.95 lb ai/acre.

² Means within a column followed by same letter do not significantly differ (P = 0.05, LSD).

³ Multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small <1½ inches, medium 1½ to 2¼ inches, and large >2¼ inches.

⁴ "Functionally single centered" are the bullet or and a small multiple center.