

EVALUATION OF OUTLOOK[®] APPLIED THROUGH DRIP IRRIGATION TO CONTROL YELLOW NUTSEdge

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Introduction

Yellow nutsedge (YNS) continues to be a severe problem weed of direct-seeded onion in the Treasure Valley of eastern Oregon and southwestern Idaho. Studies have shown a 31 to 63% reduction in onion marketable yield in heavily infested fields. Poor YNS control is partially attributed to the application timing of herbicides Outlook[®] and Dual Magnum[®] (dimethenamid-p and *s*-metolachlor). Because of plant sensitivity, the current registration allows application of Outlook starting when onions have attained the 2-true-leaf stage, and by that time YNS has already emerged. However, in order for dimethenamid-p and *s*-metolachlor to control YNS they have to be applied preemergence because these products generally do not control emerged weeds. Recently we discovered that application of Outlook through drip irrigation starting when onions are at the 2-leaf stage provides better YNS control compared to standard postemergence surface broadcast applications of Outlook at the same rate.

Materials and Methods

A field study was conducted in 2014 and 2015 at the Malheur Experiment Station, Ontario, OR to evaluate the response of direct-seeded onion to dimethenamid-p herbicide applied through drip irrigation to control YNS. Applications were initiated when onion plants were at the 2-leaf stage. Onion seed of variety ‘Vaquero’ was planted on March 26, 2014 and March 18, 2015 in double rows spaced 3 inches apart with 4-inch seed spacing within each row. Each double row was planted on beds spaced 22 inches apart. Planting was done with customized John Deere Flexi Planter units equipped with disc openers. Immediately after planting, the onion rows received a narrow band of Lorsban[®] and the soil surface was rolled. The soil was a Greenleaf silt loam with a pH of 7.2 and 1.8% organic matter in both years.

Dates for major field activities in these field trials in 2014 and 2015 are presented in Table 1.

In order to achieve uniform herbicide distribution in the top soil layer, dimethenamid-p herbicide was mixed into 35 or 5 gal of water and metered into the irrigation drip at a continuous uniform rate during the middle irrigation period (see treatment list in Table 2). On July 8, 2014, 10 plants were chosen randomly from each plot and measured from the ground to the tip of the longest fully extended leaf to determine the average plant height. The same procedure was followed to determine plant height on July 8, 2015.

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Plant tops were flailed and onion bulbs were lifted on September 3, 2014, and on September 9, 2015. Bulbs were hand-harvested from the two center beds on September 10 and graded on September 12, 2014. Harvesting and grading in 2015 was done on September 11 and September 14. Bulbs were graded for yield and quality based on USDA standards. Another batch of onions was harvested at the same time, bagged and placed in storage. The storage shed was ventilated and the temperature was slowly decreased to maintain air temperature as close to 34°F as possible. Onions were graded out of storage on December 11, 2015. 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.

After grading, the bulbs were cut longitudinally and evaluated for the incomplete scales, internal bacterial rot, internal *Fusarium proliferatum* rot, and neck rot. Incomplete scales were defined as scales that had an internally dry length extending inward more than 0.25 inch from the neck.

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 Discussion

Rainfall and drip irrigation activities during the season are presented in Tables 3 and 4 for 2014 and 2015, respectively. Visual evaluations in 2014 and 2015 indicated plant injury of less than 6% characterized by twisting of leaves (known as rattail) (Tables 5 and 6). In 2014, YNS control on July 7 ranged from 80 to 89% for the treatments that included dimethenamid-p through the drip compared to 21% for the conventional application to the soil when onions are at the two-leaf stage (Table 5). The average plant height on July 8, 2014 ranged from 31 to 33 inches for the treatments that included dimethenamid-p through the drip compared to 35 inches for the standard application to the soil. In 2015, the plant height on July 8 ranged from 32 to 35 across herbicide application treatments. The increase in plant height for the plants that received conventional application of Outlook to the soil was probably due to excessive competition with YNS.

Mid-season YNS control on July 9, 2015 was estimated between 70 and 90% compared to 9% for the standard postemergence application (Table 6). The respective YNS control for evaluations on August 12, 2015 ranged from 59 to 79% for drip-applied treatments compared to 3% for the standard postemergence application.

In 2014, the yield of small onion bulbs was similar across herbicide treatments and ranged from 11 to 18 cwt/acre (Table 7). The standard application of dimethenamid-p on the soil when onions were at the two-leaf stage produced a higher number of medium grade onions (179 cwt/acre) compared to 55 to 91 cwt/acre for the treatments that included dimethenamid-p through the drip. The higher medium grade onions for the standard application of dimethenamid-p reflected the

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increased effect of onion/YNS competition compared to the other treatments. Season long YNS competition tends to reduce onion size. Yield for jumbo, colossal, and supercolossal onion grades were similar across herbicide treatments (Table 8). In 2015, yield for all bulb grades was similar across herbicide application treatments.

Results for the number of harvested onion bulbs per acre are presented in Tables 9 and 10 for the 2014 and 2015 studies, respectively. The trend for the number of bulbs was similar to the yield. In 2014, the standard application of dimethenamid-p on the ground resulted in a higher number of medium bulbs compared to treatments that had dimethenamid-p applied through drip irrigation. In 2015, the number of small, medium, colossal, and supercolossal bulb grades was similar across herbicide application treatments (Table 10). The number of jumbo bulbs ranged from 67,555 to 83,678 bulbs/acre across herbicide application treatments. The highest number of bulbs was realized when dimethenamid-p was applied sequentially at 11 fl oz/acre followed by 10 fl oz/acre 2 weeks later through the drip tape.

Results for stored onion graded on December 11, 2015 are presented in Tables 11, 12, and 13. Small and colossal bulbs varied across treatments while there was no difference for medium and supercolossal (Table 11). The number of bulbs per grade followed a similar pattern as the yield (Table 12). Bulbs with incomplete scales ranged from 27 to 38% across herbicide application treatments (Table 13). Internal bacterial rot ranged from 2 to 10%, while bulbs infested with *Fusarium proliferatum* ranged from 3 to 7%. Overall, there was no difference among herbicide application treatments for the total internal rot that ranged from 8 to 15% for treatments applied through the drip compared to 11% for the standard treatment.

These results indicated improved YNS control when dimethenamid-p was applied through drip irrigation compared to standard postemergence surface application at the same rate. Furthermore, the results suggested no adverse effects to onion quality and yields when dimethenmid-p was applied through the drip tape starting at the two-leaf stage. If registered, this use would improve YNS control in direct-seeded onion in the Treasure Valley and would not affect onion yield. More studies are needed to evaluate the response of other popular onion varieties and types.

Acknowledgements

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Table 1. List of major field operations for the study to evaluate Outlook (dimethenamid-p) applied through irrigation drip at the Malheur Experiment Station, Ontario, OR, 2014 and 2015.

Operation	2014	2015
Onion variety 'Vaquero' planted	3/26	3/18
Lorsban 15G 3.7 oz/1,000 ft of bed (0.82 lb ai/acre)	3/26	3/20
Pendimethalin 0.95 lb ai/acre (Prowl H2O 32 fl oz/acre)	4/1	3/31
Pendimethalin 0.95 lb ai/acre (Prowl H2O 32 fl oz/acre) + glyphosate 0.77 lb ae/acre	4/8	3/31
Onion emergence	4/11	4/6
Bromoxynil 0.125 lb ai/acre (Buctril 8 oz/acre) + oxyfluorfen 0.25 lb ai/acre (GoalTender 8 fl oz/acre)	5/21	5/12
Bromoxynil 0.125 lb ai/acre (Buctril 8 oz/acre) + oxyfluorfen 0.25 lb ai/acre (GoalTender 8 fl oz/acre) + Poast 16 oz/acre		6/1
Injected fertilizer to supply 100 lbs N/acre		6/15
Injected fertilizer to supply 70 lbs N/acre		7/8
Thrips control		
Movento 5 oz/acre (spirotetramat 0.078 lb ai/acre) plus Radiant 8 oz/acre (spinetoram 1 oz ai/acre) and Pierce (crop oil concentrate) 16 oz/100 gal of water	5/29; 6/3	5/26*; 6/3
Agri-Mek 3.5 oz/acre plus NIS 10 oz/100 gal of water	6/12 & 6/17	6/17
Agri-Mek 3.5 oz/acre plus NIS at 10 oz/100 gal of water	6/30	--
Lannate 3 pt/acre (methomyl 0.9 lb ai/acre)	7/6 & 7/13	7/15
Radiant 10 oz/acre (spinetoram 1.25 oz ai/acre)	7/22 & 27	--

*Only Movento at 5 oz/acre was used for the first application in 2015.

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Table 2. List of herbicide treatments to evaluate Outlook (dimethenamid-p) applied through drip irrigation to control yellow nutsedge at the Malheur Experiment Station, Ontario, OR, 2014 and 2015.

Treatment	Rate (lb ai/acre)	Product rate (fl oz/acre)	Growth stage	Application		
				Timing ^a	Description	Duration ^b
1 Outlook	0.516	11	2-leaf	B	2-leaf stage	Mixed in 35 gal of water and applied for 7 hours
Outlook	0.47	10		C	2 weeks after B	
2 Outlook	0.516	11	2-leaf	B	2-leaf stage	Mixed in 5 gal of water and applied for 1 hour then water only
Outlook	0.47	10		C	2 weeks after B	
3 Outlook	0.328	7	2-leaf	B	2-leaf stage	Mixed in 35 gal of water and applied for 7 hours
Outlook	0.328	7		C	1 week after B	
Outlook	0.328	7		D	1 week after C	
4 Outlook	0.328	7	2-leaf	B	2-leaf stage	Mixed in 5 gal of water and applied for 1 hour then water only
Outlook	0.328	7		C	1 week after B	
Outlook	0.328	7		D	1 week after C	
5* Outlook	0.516	21	2-leaf	B	2-leaf stage	Mixed in 35 gal of water and applied for 7 hours
Outlook	0.47	21		C	1 week after B	
6 Outlook	0.516	21	4-6 leaf	B	2-leaf stage	Mixed in 35 gal of water and applied for 7 hours
7 Outlook	0.98	21	2-leaf	B	Grower standard	

^aApplication timing: A = preemergence on March 31, 2015; B = dimethenamid-p applied through drip irrigation when onions were at the 2-leaf stage on May 18, 2015; ** treatment 6 was the standard application of dimethenamid-p on the ground when onions were at the 2-leaf stage; C = dimethenamid-p applied through irrigation drip on May 26, 2015; D = dimethenamid-p applied through irrigation drip on June 3, 2015.

^bTreatments 1, 3, 5, and 6 were drip irrigated for 1 hour with water followed by 7 hours of herbicide mixture and 1 hour of water to flush out the herbicides. Treatments 2 and 4 were drip irrigated for 7 hours with water followed by the herbicide mixture for 1 hour and 1 hour to flush the herbicide through the system. Treatment 7 was broadcast applied in 20 gal of water/acre when onions were at the 2-leaf stage.

* In 2014, treatment 5 was composed of weekly sequential applications of Outlook at 11, 10, 11, 10 fl oz/acre to mimic a 2x use rate. In 2015, treatment 5 received Outlook 21 fl oz/acre, 2 weeks apart to evaluate the effect of 2x rate on onion.

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Table 3. Irrigation and rain dates for the study to evaluate Outlook (dimethenamid-p) through the irrigation drip in onion at the Malheur Experiment Station, Ontario, OR 2014.

Rain or irrigation date, 2014	Duration (hours)	Amount (inches)	Description
Apr 2		0.22	rain
Apr 23		0.13	rain
Apr 24		0.18	rain
Apr 25		0.18	rain
Apr 26		0.11	rain
Apr 28		0.10	rain
May 6		0.04	rain
May 9		0.28	rain
May 9	20		drip irrigation system
May 10		0.09	rain
May 11		0.02	rain
May 15	24		drip irrigation system
May 18		0.01	rain
May 19		0.01	rain
May 22	24		drip irrigation system
May 30	24		drip irrigation system
Jun 5	24		drip irrigation system
Jun 18	24		drip irrigation system
Jun 24	24		drip irrigation system
Jul 1	24		drip irrigation system
Jul 10	24		drip irrigation system

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Table 4. Irrigation and rain dates for the study to evaluate Outlook (dimethenamid-p) through the irrigation drip at the Malheur Experiment Station, Ontario, OR 2015.

Rain or irrigation date, 2015	Amount (inches)	Description
May 13	0.19	rain
May 15	0.14	rain
May 16	0.23	rain
May 17	0.01	rain
May 18	0.35	rain
May 18		drip irrigation system
May 19	0.03	rain
May 20	0.25	rain
May 21	0.13	rain
May 23	0.18	rain
May 26	0.09	rain
May 26		drip irrigation system
May 27	0.22	rain
Jun 3		drip irrigation system
Jun 7		drip irrigation system
Jun 15		drip irrigation system
Jun 18		drip irrigation system
Jun 24		drip irrigation system
Jun 30		drip irrigation system
Jul 8		drip irrigation system
Jul 20		drip irrigation system
Jul 23		drip irrigation system
Jul 30		drip irrigation system
Aug 5		drip irrigation system
Aug 12		drip irrigation system
Aug 17		drip irrigation system

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Table 5. Yellow nutsedge control and direct-seeded onion response (on July 7, 2014) to Outlook (dimethenamid-p) applied through drip irrigation at the Malheur Experiment Station, Ontario, OR.

Treatment ^a	Amount (fl oz/acre)	Growth stage	Application timing ^b	Yellow nutsedge ^c		
				Injury	Control	Plant height ^d
				----- % -----		inches
1 Outlook	11	2-leaf	B	0 a	86 ab	33 ab
Outlook	10		C			
2 Outlook	11	2-leaf	B	0 a	80 b	33 ab
Outlook	10		C			
3 Outlook	7	2-leaf	B	0 a	91 a	33 ab
Outlook	7		C			
Outlook	7		D			
4 Outlook	7	2-leaf	B	0 a	86 ab	32 ab
Outlook	7		C			
Outlook	7		D			
5 Outlook	11	2-leaf	B	6 a	89 ab	31 b
Outlook	10		C			
Outlook	11		D			
Outlook	10		E			
6 Outlook (Grower standard)	21	2-leaf	B**	0 a	21 c	35 a
LSD ($P = 0.05$)				5	7	2

^aAll treatments received late-preemergence Prowl H2O 2 pt/acre on Apr 4, 2014, 2-leaf = onion at 2-leaf stage.

^bApplication timing: B = dimethenamid-p applied through drip irrigation when onions were at the 2-leaf stage on May 15, 2014; ** treatment 6 was the standard application of dimethenamid-p on the ground when onions were at the 2-leaf stage; C = dimethenamid-p applied through irrigation drip on May 22, 2014; D = dimethenamid-p applied through irrigation drip on May 29, 2014; E = dimethenamid-p applied through irrigation drip on June 5, 2014.

^cMeans within a column followed by same letter do not significantly differ ($P = 0.05$, LSD)

^dAverage plant height (10 plants/plot measured from base to longest leaf) on Jul 7, 2014.

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Table 6. Yellow nutsedge control and direct-seeded onion response to Outlook (dimethenamid-p) applied through drip irrigation at the Malheur Experiment Station, Ontario, OR, 2015.

Treatment ^a	Amount (fl oz/acre)	Growth stage	Application timing ^b	Injury	Yellow nutsedge ^c		
					Control	Plant height ^d	
					Jul 20	Aug 12	May 7
					----- % -----		inches
1 Outlook	11	2-leaf	B	0a	70 a	66 a	34 abc
Outlook	10		C				
2 Outlook	11	2-leaf	B	0a	81 a	66 a	33 bc
Outlook	10		C				
3 Outlook	7	2-leaf	B	0a	86 a	64 a	33 bc
Outlook	7		C				
Outlook	7		D				
4 Outlook	7	2-leaf	B	0a	71 a	59 a	34 ab
Outlook	7		C				
Outlook	7		D				
5 Outlook	21	2-leaf	B	5a	90 a	79 a	32 c
Outlook	21		C				
6 Outlook	21	4-6 leaf	B	3a	90 a	78 a	33 bc
7 Outlook	21	2-leaf	B**	0a	9 b	3 b	35 a
(Grower standard)							
LSD ($P = 0.05$)				4	33	7	2

^aAll treatments received late-preemergence Prowl H2O at 2 pt/acre on Mar 31, 2015, 2-leaf = onion at 2-leaf stage.

^bApplication timing: B = dimethenamid-p applied through drip irrigation when onions were at the two leaf stage on May 18, 2015; ** treatment 5 represents a 2x rate while treatment 6 was applied when onions were at the 4- to 6-leaf stage. Treatment 7 was the standard application of dimethenamid-p on the ground when onions were at the 2-leaf stage; C = dimethenamid-p applied through irrigation drip on May 26, 2015; D = dimethenamid-p applied through irrigation drip on June 3, 2015.

^cMeans within a column followed by same letter do not significantly differ ($P = 0.05$, LSD)

^dAverage plant height (10 plants/plot measured from base to longest leaf) on May 7, 2015.

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Table 7. Drybulb onion yield in response to Outlook (dimethenamid-p) applied through drip irrigation to control yellow nutsedge at the Malheur Experiment Station, Ontario, OR, 2014.

Treatment	Amount (fl oz/acre)	Growth stage	Application timing ^{bc}	Onion yield per acre ^{ad}						
				Small	Medium	Jumbo	Colossal	Super- colossal	Marketable	Total yield
				----- cwt/acre -----						
1 Outlook	11	2-leaf	B	10.9 a	55.1 b	565.9 a	20.5 a	0.0 a	641.5 a	652.3 a
Outlook	10		C							
2 Outlook	11	2-leaf	B	13.8 a	74.8 b	533.8 a	0.0 a	0.0 a	608.6 a	622.4 a
Outlook	10		C							
3 Outlook	7	2-leaf	B	12.7 a	64.5 b	512.7 a	14.6 a	3.5 a	595.3 a	608.0 a
Outlook	7		C							
Outlook	7		D							
4 Outlook	7	2-leaf	B	12.5 a	84.3 b	488.1 a	3.1 a	0.0 a	575.4 a	587.9 a
Outlook	7		C							
Outlook	7		D							
5 Outlook	21	2-leaf	B	12.2 a	90.9 b	487.1 ab	11.5 a	0.0 a	589.5 a	601.7 a
Outlook	21		C							
Outlook	11		D							
Outlook	10		E							
6 Outlook	21	2-leaf	B**	17.5 a	178.6 a	367.6 b	5.0 a	0.0 a	551.1 a	568.6 a
(Grower standard)										
LSD ($P = 0.05$)				8.4	52.2	135.9	NS	NS	NS	NS

^aMeans within a column followed by same letter do not significantly differ ($P = 0.05$, LSD). Onions were harvested on September 12, 2014 and graded on September 17, 2014.

^bApplication timing: B = dimethenamid-p applied through drip irrigation when onions were at the 2-leaf stage on May 15, 2014; ** treatment 6 was the standard application of dimethenamid-p on the ground when onions were at the 2-leaf stage; C = dimethenamid-p applied through irrigation drip on May 22, 2014; D = dimethenamid-p applied through irrigation drip on May 29, 2014; E = dimethenamid-p applied through irrigation drip on June 5, 2014.

^cTreatments 1-5 were applied through drip irrigation, while treatment 6 was applied postemergence to the crop and ground.

^dThe 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). U.S. No.1 is comprised of medium, jumbo, colossal and supercolossal. Marketable yield is composed of medium, jumbo, colossal, and supercolossal grades.

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Table 8. Drybulb onion yield in response to Outlook (dimethenamid-p) applied through drip irrigation to control yellow nutsedge at the Malheur Experiment Station, Ontario, OR, 2015.

Treatment	Amount (fl oz/acre)	Growth stage	Application timing ^{bc}	Onion yield per acre ^{ad}						
				Small	Medium	Jumbo	Colossal	Super- colossal	Marketable	Total yield
1 Outlook	11	2-leaf	B	2.1a	15.9a	755.8a	144.4a	0.0a	916.1a	918.3a
Outlook	10		C							
2 Outlook	11	2-leaf	B	4.3a	33.6a	677.0a	86.4a	0.0a	797.0a	801.3a
Outlook	10		C							
3 Outlook	7	2-leaf	B	2.6a	20.6a	602.5a	176.6a	4.7a	804.3a	806.9a
Outlook	7		C							
Outlook	7		D							
4 Outlook	7	2-leaf	B	2.0a	35.9a	647.8a	85.6a	0.0a	769.4a	771.3a
Outlook	7		C							
Outlook	7		D							
5 Outlook	21	2-leaf	B	3.5a	28.5a	682.2a	58.8a	0.0a	769.5a	773.0a
Outlook	21		C							
6 Outlook	21	4-6 leaf	B	3.7a	34.8a	693.8a	70.2a	4.3a	803.1a	806.8a
7 Outlook	21	2-leaf	B**	3.1a	21.9a	686.6a	82.3a	0.0a	790.7a	793.8a
(Grower standard)										
LSD ($P = 0.05$)				5.2	32.6	155.1	159.2	7.32	184.63	182.9

^aMeans within a column followed by same letter do not significantly differ ($P = 0.05$, LSD). Onions were harvested on September 11, 2015 and graded on September 14, 2015.

^bApplication timing: B = dimethenamid-p applied through drip irrigation when onions were at the 2-leaf stage on May 18, 2015; ** treatment 5 represents a 2x rate while treatment 6 was applied when onions were at the 4- to 6-leaf stage. Treatment 7 was the standard application of dimethenamid-p on the ground when onions were at the 2-leaf stage; C = dimethenamid-p applied through irrigation drip on May 26, 2015; D = dimethenamid-p applied through irrigation drip on June 3, 2015.

^cTreatments 1-6 were applied through drip irrigation, while treatment 7 was applied postemergence to the crop and ground using a plot sprayer calibrated to deliver 20 gpa.

^dThe 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). No.1 is comprised of medium, jumbo, colossal and supercolossal. Marketable yield is composed of medium, jumbo, colossal, and supercolossal grades.

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Table 9. Number of harvested drybulb onion/acre in response to application of Outlook (dimethenamid-p) through drip irrigation at the Malheur Experiment Station, Ontario, OR, 2014.

Treatment	Amount (fl oz/acre)	Growth stage	Application timing ^{bc}	Drybulb number ^{ad}					Marketable	Total yield
				Small	Medium	Jumbo	Colossal	Super-colossal		
1 Outlook	11	2-leaf	B	5,935 a	14,837 b	82,194 a	1,780 a	0 a	98,811 ab	104,746 ab
Outlook	10		C							
2 Outlook	11	2-leaf	B	6,825 a	20,771 b	77,150 a	0 a	0 a	97,921 ab	104,746 ab
Outlook	10		C							
3 Outlook	7	2-leaf	B	6,825 a	18,101 b	66,764 ab	1,187 a	297 a	86,349 b	93,173 b
Outlook	7		C							
Outlook	7		D							
4 Outlook	7	2-leaf	B	6,825 a	22,848 b	69,732 ab	297 a	0 a	92,877 ab	99,701 b
Outlook	7		C							
Outlook	7		D							
5 Outlook	11	2-leaf	B	7,715 a	25,222 b	69,435 a	1,187 ab	0 a	95,844 ab	103,559 ab
Outlook	10		C							
Outlook	11		D							
Outlook	10		E							
6 Outlook (Grower standard)	21	2-leaf	B**	10,386 a	46,883 a	56,675 a	297 a	0 a	103,856 a	114,241 a
LSD ($P = 0.05$)				NS	13,690	17,347	2,451	NS	13,527	14,071

^aMeans within a column followed by same letter do not significantly differ ($P = 0.05$, LSD). Onions were harvested on September 12, 2014 and graded on September 17, 2014.

^bApplication timing: B = dimethenamid-p applied through drip irrigation when onions were at the 2-leaf stage on May 15, 2014; ** treatment 6 was the standard application of dimethenamid-p on the ground when onions were at the 2-leaf stage; C = dimethenamid-p applied through irrigation drip on May 22, 2014; D = dimethenamid-p applied through drip irrigation on May 29, 2014; E = dimethenamid-p applied through irrigation drip on June 5, 2014.

^cTreatments 1-5 were applied through drip irrigation, while treatment 6 was applied postemergence to the crop and ground.

^dOnion 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). No.1 is comprised of medium, jumbo, colossal and supercolossal. Marketable yield is composed of medium, jumbo, colossal, and supercolossal grades.

Application of Outlook (dimethenamid-p) through drip irrigation to control yellow nutsedge in direct seeded onion in the Treasure Valley is granted under Special Local Need (SLN) registrations in specific counties in Oregon and Idaho. Oregon SLN #160004 in Malheur County only (until December 31, 2021) and SLN #ID 160001 in Ada, Canyon, Gem, Owyhee, Payette, and Washington Counties in Idaho (until December 31, 2019). The user must have the SLN label in possession at the time of application.

Table 10. Number of harvested drybulb onion/acre in response to application of Outlook (dimethenamid-p) through drip irrigation at the Malheur Experiment Station, Ontario, OR 2015.

Treatment	Amount (fl oz/acre)	Growth stage	Application timing ^{bc}	Drybulb number ^{ad}					Marketable	Total yield
				Small	Medium	Jumbo	Colossal	Super-colossal		
1 Outlook	11	2-leaf	B	890 a	5,341 a	83,678 a	11,572 a	0 a	100,592 a	101,482 a
Outlook	10		C							
2 Outlook	11	2-leaf	B	2,374 a	8,605 a	81,007 ab	6,528 a	0 a	96,141 ab	98,514 a
Outlook	10		C							
3 Outlook	7	2-leaf	B	890 a	5,638 a	67,655 b	13,946 a	297 a	87,535 b	88,426 a
Outlook	7		C							
Outlook	7		D							
4 Outlook	7	2-leaf	B	890 a	9,792 a	74,183 ab	7,418 a	0 a	91,393 ab	92,283 a
Outlook	7		C							
Outlook	7		D							
5 Outlook	21	2-leaf	B	1,780 a	7,122 a	74,183 ab	4,748 a	0 a	86,052 b	87,832 a
Outlook	21		C							
6 Outlook	21	4-6 leaf	B	1,780 a	8,308 a	79,227 ab	5,638 a	297 a	93,470 ab	95,250 a
7 Outlook	21	2-leaf	B**	1,484 a	5,638 a	76,853 ab	6,528 a	0 a	89,019 ab	90,503 a
(Grower standard)										
LSD ($P = 0.05$)				2,165	8,094	15,133	12,502	484	13,007	13,784

^aMeans within a column followed by same letter do not significantly differ ($P = 0.05$, LSD). Onions were harvested on September 11, 2015 and graded on September 14, 2015

^bApplication timing: B = dimethenamid-p applied through drip irrigation when onions were at the 2-leaf stage on May 18, 2015; ** treatment 5 represents a 2x rate while treatment 6 was applied when onions were at the 4- to 6-leaf stage. Treatment 7 was the standard application of dimethenamid-p on the ground when onions were at the 2-leaf stage; C = dimethenamid-p applied through irrigation drip on May 26, 2015; D = dimethenamid-p applied through irrigation drip on June 3, 2015.

^cTreatments 1-6 were applied through drip irrigation, while treatment 7 was applied postemergence to the crop and ground using a plot sprayer calibrated to deliver 20 gpa.

^dOnion 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). No.1 is comprised of medium, jumbo, colossal and supercolossal. Marketable yield is composed of medium, jumbo, colossal, and supercolossal grades.

Application of Outlook (dimethenamid-p) through drip irrigation to control yellow nutsedge in direct seeded onion in the Treasure Valley is granted under Special Local Need (SLN) registrations in specific counties in Oregon and Idaho. Oregon SLN #160004 in Malheur County only (until December 31, 2021) and SLN #ID 160001 in Ada, Canyon, Gem, Owyhee, Payette, and Washington Counties in Idaho (until December 31, 2019). The user must have the SLN label in possession at the time of application.

Table 11. Stored drybulb yield from the study to evaluate Outlook (dimethenamid-p) applied through drip irrigation to control yellow nutsedge at the Malheur Experiment Station, Ontario, OR, 2015.

Treatment	Rate fl oz/acre	Growth stage	Application timing ^{bc}	Onion yield per acre ^{ad}						
				Small	Medium	Jumbo	Colossal	Super- colossal	Marketable	Total yield
				----- cwt/acre -----						
1 Outlook	11	2-leaf	B	4.3ab	10.3b	672.4a	127.8ab	0.0a	810.5a	814.8a
Outlook	10		C							
2 Outlook	11	2-leaf	B	7.2a	111.5a	483.2a	39.3b	0.0a	633.9a	641.1a
Outlook	10		C							
3 Outlook	7	2-leaf	B	1.0b	15.4b	694.7a	141.7ab	0.0a	851.9a	852.9a
Outlook	7		C							
Outlook	7		D							
4 Outlook	7	2-leaf	B	0.5b	14.4b	695.5a	69.2ab	0.0a	779.1a	779.6a
Outlook	7		C							
Outlook	7		D							
5 Outlook	21	2-leaf	B	5.9a	10.4b	617.4a	138.9ab	0.0a	766.8a	772.7a
Outlook	21		C							
6 Outlook	21	4-6 leaf	B	1.1b	17.9ab	534.8a	251.6a	0.0a	804.3a	805.4a
7 Outlook	21	2-leaf	B**	0.0b	12.6b	681.1a	44.0b	0.0a	737.7a	737.7a
(Grower standard)										
LSD ($P = 0.05$)				4.3	95.7	316.9	196.1	NS	NS	NS

^aMeans within a column followed by same letter do not significantly differ ($P = 0.05$, LSD). Onions were harvested on September 11, 2015 and graded on September 14, 2015.

^bApplication timing: B = dimethenamid-p applied through drip irrigation when onions were at the 2-leaf stage on May 18, 2015; ** treatment 5 represents a 2x rate while treatment 6 was applied when onions were at the 4- to 6-leaf stage. Treatment 7 was the standard application of dimethenamid-p on the ground when onions were at the 2-leaf stage; C = dimethenamid-p applied through drip irrigation on May 26, 2015; D = dimethenamid-p applied through drip irrigation on June 3, 2015.

^cTreatments 1-6 were applied through drip irrigation, while treatment 7 was applied postemergence to the crop and ground using a plot sprayer calibrated to deliver 20 gpa.

^dThe bulbs were graded out of storage on December 11, 2015 according to diameter: small (<2¼ inches), medium (2¼-3 inches), jumbo (3-4 inches), colossal (4-4¼ inches), and supercolossal (>4¼ inches). No.1 is comprised of medium, jumbo, colossal and supercolossal. Marketable yield is composed of medium, jumbo, colossal, and supercolossal grades.

Application of Outlook (dimethenamid-p) through drip irrigation to control yellow nutsedge in direct seeded onion in the Treasure Valley is granted under Special Local Need (SLN) registrations in specific counties in Oregon and Idaho. Oregon SLN #160004 in Malheur County only (until December 31, 2021) and SLN #ID 160001 in Ada, Canyon, Gem, Owyhee, Payette, and Washington Counties in Idaho (until December 31, 2019). The user must have the SLN label in possession at the time of application.

Table 12. Number of stored drybulb onion/acre graded on December 11, 2015 for the study to evaluate Outlook (dimethenamid-p) applied through drip irrigation at the Malheur Experiment Station, Ontario, OR, 2015.

Treatment	Amount fl oz/acre	Growth stage	Application timing ^{bc}	Stored dry bulb number ^{ad}					Marketable	Total yield
				Small	Medium	Jumbo	Colossal	Super-colossal		
1 Outlook	11	2-leaf	B	2374bc	5,935b	77,743a	11,276ab	0a	94,954a	97,328a
Outlook	10		C							
2 Outlook	11	2-leaf	B	5,341a	32,047a	64,094a	3,561b	0a	99,701a	105,043a
Outlook	10		C							
3 Outlook	7	2-leaf	B	593c	8,308b	84,865a	12,463ab	0a	105,636a	106,229a
Outlook	7		C							
Outlook	7		D							
4 Outlook	7	2-leaf	B	593c	7,122b	82,491a	5,935ab	0a	95,547a	96,141a
Outlook	7		C							
Outlook	7		D							
5 Outlook	21	2-leaf	B	3,561ab	5,341b	77,150a	12,463ab	0a	94,954a	98,514a
Outlook	21		C							
6 Outlook	21	4-6 leaf	B	593c	7,715b	67,655a	29,673a	0a	105,043a	105,636a
7 Outlook (Grower standard)	21	2-leaf	B**	0c	6,528b	84,271a	4,154b	0a	94,954a	94,954a
LSD ($P = 0.05$)				2,964	21,626	NS	24,069	NS	NS	NS

^aMeans within a column followed by same letter do not significantly differ ($P = 0.05$, LSD). Onions were harvested on September 11, 2015 and graded on September 14, 2015.

^bApplication timing: B = dimethenamid-p applied through drip irrigation when onions were at the 2-leaf stage on May 18, 2015; ** treatment 5 represents a 2x rate while treatment 6 was applied when onions were at the 4- to 6-leaf stage. Treatment 7 was the standard application of dimethenamid-p on the ground when onions were at the 2-leaf stage; C = dimethenamid-p applied through drip irrigation on May 26, 2015; D = dimethenamid-p applied through drip irrigation on June 3, 2015.

^cTreatments 1-6 were applied through drip irrigation, while treatment 7 was applied postemergence to the crop and ground using a plot sprayer calibrated to deliver 20 gpa.

^dOnion bulbs were graded out of storage on December 11, 2015 according to diameter: small (<2¼ inches), medium (2¼-3 inches), jumbo (3-4 inches), colossal (4-4¼ inches), and supercolossal (>4¼ inches). No.1 is comprised of medium, jumbo, colossal and supercolossal. Marketable yield is composed of medium, jumbo, colossal, and supercolossal grades.

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Table 13. Internal bulb decomposition after out-of-storage grading of onions in December for the study to evaluate Outlook (dimethenamid-p) applied through drip irrigation to control yellow nutsedge at the Malheur Experiment Station, Ontario, OR, 2015.

Treatment	Amount fl oz/acre	Growth stage	Timing ^{bc}	Stored onion ^{ad}				Total internal rot
				Incomplete scale	Incomplete scale + int. bacterial rot	Incomplete scale + fusarium rot	incomplete scale + neck rot	
1 Outlook	11	2-leaf	B	27b	6ab	7a	1a	13a
Outlook	10		C					
2 Outlook	11	2-leaf	B	46a	2b	6a	0a	8a
Outlook	10		C					
3 Outlook	7	2-leaf	B	36ab	7ab	6a	0a	13a
Outlook	7		C					
Outlook	7		D					
4 Outlook	7	2-leaf	B	38ab	10a	8a	0a	18a
Outlook	7		C					
Outlook	7		D					
5 Outlook	21	2-leaf	B	38ab	7ab	9a	0a	15a
Outlook	21		C					
6 Outlook	21	4-6 leaf	B	30ab	5ab	3a	0a	8a
7 Outlook (Grower standard)	21	2-leaf	B	38ab	5ab	7a	0a	11a
LSD ($P = 0.05$)				17	5	NS	NS	NS

^aMeans within a column followed by same letter do not significantly differ ($P = 0.05$, LSD). Onions were harvested on September 11, 2015, placed in storage, and graded on December 11, 2015.

^bApplication timing: B = dimethenamid-p applied through drip irrigation when onions were at the 2-leaf stage on May 18, 2015; treatment 5 represents a 2x rate while treatment 6 was applied when onions were at the 4- to 6-leaf stage. Treatment 7 was the standard application of dimethenamid-p postemergence when onions were at the 2-leaf stage; C = dimethenamid-p applied through irrigation drip on May 26, 2015; D = dimethenamid-p applied through drip irrigation on June 3, 2015.

^cTreatments 1-6 were applied through drip irrigation, while treatment 7 was applied postemergence to the crop and ground using a plot sprayer calibrated to deliver 20 gpa.

^dThe bulbs were graded out of storage on December 11, 2015.

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