ONION RESPONSE TO DUAL MAGNUM® APPLICATION RATE AND TIMING

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Introduction

Weed control is an important component of onion production. The most problematic weed in some Treasure Valley fields of southwestern Idaho and eastern Oregon is yellow nutsedge (*Cyperus esculentus*). Yellow nutsedge presents a production challenge in direct-seeded onions grown in the Treasure Valley. Populations in individual fields are influenced by a variety of environmental and management factors; however, given its perennial nature, yellow nutsedge remains a problem once it produces mature tubers in a field.

The current Dual Magnum® (S-metolachlor) label allows post-emergence application after direct-seeded onion seedlings are at the two true leaf stage, but at that time yellow nutsedge may have already emerged. Dual Magnum works best when applied prior to weed emergence and does not control weeds that have already emerged, including yellow nutsedge. Therefore, the use of Dual Magnum or Outlook® (which has the same mode of action) as post-emergence herbicides has largely failed to reduce yellow nutsedge in onion fields.

This study was conducted to evaluate onion response and yellow nutsedge control when Dual Magnum was applied at various timings during the fall preceding onion or banded between mounded beds before harrowing in spring.

Materials and Methods

A field study was initiated during fall 2018 in a field near Ontario, Oregon, previously planted to wheat. The predominant soil was a Greenleaf silt loam with a pH of 7.2 and 1.79% organic matter. Wheat stubble was flailed and the field was irrigated, disked, ripped, and rototilled in August 2018. Fall fertilizer was broadcast on October 4, 2018, based on soil analysis. The field was fumigated with K-Pam at 15 gal/acre and beds were formed at 22-inch spacing on October 18, 2018.

The study had a factorial design and treatments were arranged in randomized complete blocks with four replicates. The factors were herbicide rate (Dual Magnum at 1, 1.33, 2, or 4 pt/acre) and application timing (Table 1). Individual plots were 7.33 ft wide (4 beds) by 27 ft long. All herbicide treatments (except Outlook in 2019) were applied using a CO_2 pressurized backpack sprayer fitted with a boom equipped with 8002EVS TeeJet nozzles calibrated to deliver 20 gal/acre.

Fall treatments were broadcast applied on September 14, September 28, or October 12, 2018. The process involved herbicide application at different rates and immediately incorporated in the soil using a rototiller for the respective timing. Spring treatments were band applied on March 26, 2019, to the area between mounded beds (14-inch band), leaving the top of the beds unsprayed. Beds were then harrowed on March 26, 2019, to create a favorable seedbed for onion.

Onion seed of hybrid 'Vaquero' was planted on April 5, 2019, in double rows spaced 3 inches apart with 4-inch seed spacing within each row. Each pair of rows was planted on beds spaced 22 inches apart. On April 12, each onion bed received a 7-inch band of Lorsban® 15G at 3.7 oz/1000 ft of row (0.125 lb ai/acre) and the soil surface was rolled.

The study received a late pre-emergence application of Prowl® H_2O at 2.0 pt/acre (pendimethalin 0.95 lb ai/acre) on April 17, 2019. Post-emergence applications of Brox® 2EC at 12 fl oz/acre (bromoxynil at 0.188lb ai/acre) plus GoalTender® at 4 fl oz/acre (oxyfluorfen at 0.125 lb/ai acre) were made when onion seedlings were at the 2- and 4-leaf stages on May 23 and June 17, 2019, respectively. Outlook (dimethenamid-P) at 7 fl oz/acre was chemigated through drip irrigation starting when onion seedlings were at the 2-leaf stage on June 6, and again on June 13 and 20, 2019. In-season fertilizer was applied according to soil and tissue test results. Urea ammonium nitrate solution (URAN) was applied through drip irrigation to supply 50 lb nitrogen (N)/acre on June 10 and June 24 and 25 lb N/acre on July 15, 2019.

Preventative sprays for diseases and insects were applied aerially by a commercial contractor using various insecticides including Movento® (spirotetramat), Radiant® (spinetoram), and Lannate® (methomyl). All other operations followed recommended local production practices.

Visible plant injury and weed control were assessed based on a scale of 0% (no onion injury or no yellow nutsedge control) to 100% (complete onion plant kill or total yellow nutsedge control). Late season evaluations were done on September 5, 2019 (356, 342, and 328 days after fall 2018 Dual Magnum treatment and 161 days after spring 2019 banded Dual Magnum treatments).

The field was drip irrigated 23 times April 30 to August 26, 2019. Each irrigation event lasted 12 hours.

Plant tops were flailed and onion bulbs lifted on September 11, 2019 and left in the field to cure. Bulbs were hand harvested from the two center beds on September 20, 2019. Bulbs were graded for yield and quality 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.

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

Results

Onion emergence was observed on April 23, 2019. Generally, the seedlings had very low vigor in the fall-applied Dual Magnum treatments regardless of rate or application timing. Onion seedlings displayed visible injury that persisted throughout the growing season. Early injury symptoms were characterized by poor unfurling of new leaves, with the first true leaf trapped in the sheath. As the sheath-trapped leaf pushed to come out, the plants would bend and twist, resulting in distorted growth. Consequently, plants were stunted and developed thick necks

which delayed maturity and affected bulb quality. It was not clear whether or not the seasonably high spring precipitation may have contributed to the observed results.

Late-season evaluations on September 5, 2019, (356, 342, and 328 days after fall 2018 Dual Magnum applications) indicated very high onion injury regardless of the fall application timing (Table 1). Dual Magnum applied at 1 to 4 pt/acre on September 14, 2018, resulted in 34 to 96% onion injury (356 days after fall 2018 application). Treatments applied on September 28, 2018 resulted in 43 to 96% onion injury (342 days after fall application). Not surprising, the last fall-applied treatments of Dual Magnum at 1 to 4 pt/acre on October 12, 2018 resulted in equally high injury, ranging from 53 to 96% (328 days after fall application). The injury was significantly reduced for Dual Magnum banded in between beds at 1 to 4 pt/acre (before harrowing) during spring 2019 (161 days after spring banding). Injury for the grower standard was only 6%.

The corresponding yellow nutsedge control for fall-applied Dual Magnum at 1 to 4 pt/acre was exceptionally high, ranging from 91 to 99% across treatment rates and application timings (Table 1). Unfortunately, the crop was heavily injured from herbicide residues in the soil.

The number of harvested bulbs in response to fall-applied Dual Magnum at 1 to 4 pt/acre varied widely (Table 2). Bulb number was generally lower with fall-applied than spring-banded treatments. The number of marketable bulbs (2¼ to >4¼ inch), which is composed of medium, jumbo, colossal and super colossal grades, ranged from 3,960 to 62,568 bulb/acre across herbicide rates and application timings for fall-treatments compared to 88,704 to 89,100 bulbs/acre for spring-banded treatments. The number of bulbs in the spring-banded treatments was similar to the grower standard (89,100 bulbs/acre) and the untreated control (92,268 bulbs/acre).

Marketable yield reflected the number of harvested bulbs and was significantly reduced when Dual Magnum at 1 to 4 pt/acre was applied the preceding fall compared to treatments in which it was banded in-furrow (before harrowing beds) during spring 2019 (Table 3). Marketable yield for fall-applied Dual Magnum treatments ranged from 37.2 to 623.5 cwt/acre compared to 781.8 to 865.0 cwt/acre for spring in-furrow-banded treatments. The yield for fall-applied treatments declined with an increase in Dual Magnum herbicide rate regardless of the fall application timing. Yield for spring in-furrow banded treatments (before harrowing beds) was similar to the grower standard (880.4 cwt/acre) and the untreated control (802.4 cwt/acre).

The results demonstrated that lightly soil-incorporated Dual Magnum at 1 to 4 pt/acre applied the preceding fall was injurious to onion. Growers are advised to be extra careful with fall-applied Dual Magnum in fields intended for onion production the following spring. Future studies will evaluate spring-banded Dual Magnum and similar products to control yellow nutsedge in direct-seeded onion.

Acknowledgements

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Table 1. Estimated visible onion injury and yellow nutsedge control in response to various Dual Magnum (S-metolachlor) herbicide rates applied at various timings between fall 2018 and spring 2019 at the Malheur Experiment Station, Ontario, OR.

			Crop injury	Yellow nutsedge control
Treatment	Rate[a]	Application timing[b]	9/5/2019	9/5/2019
	pt/acre		%	
1. Dual Magnum	1.00	9/14/2018	34	96
2. Dual Magnum	1.33	9/14/2018	63	98
3. Dual Magnum	2.00	9/14/2018	85	99
4. Dual Magnum	4.00	9/14/2018	96	99
5. Dual Magnum	1.00	9/28/2018	43	99
6. Dual Magnum	1.33	9/28/2018	73	98
7. Dual Magnum	2.00	9/28/2018	84	96
8. Dual Magnum	4.00	9/28/2018	96	99
9. Dual Magnum	1.00	10/12/2018	53	99
10. Dual Magnum	1.33	10/12/2018	56	99
11. Dual Magnum	2.00	10/12/2018	83	91
12. Dual Magnum	4.00	10/12/2018	96	99
13. Dual Magnum	1.00	3/26/2019	1	70
14. Dual Magnum	1.33	3/26/2019	4	93
15. Dual Magnum	2.00	3/26/2019	3	93
16. Dual Magnum	4.00	3/26/2019	4	94
17. Grower standard[c]			6.3	96.5
18. Untreated			11.3	72.0
LSD (0.05)	Rate		12.5	NS
	Timing		12.6	8.7
	Rate x Timing		20.8	NS

[a]Herbicide rate: Dual Magnum (S-metolachlor) 1 pt/acre = 0.95 lb ai/acre; 1.33 pt/acre = 1.27 lb ai/acre; 2 pt/acre = 1.9 lb ai/acre; 4 pt/acre = 3.8 lb ai/acre.

[b]Application timing: Treatments 1–12 were applied after flailing of wheat stubble, watering, disking, moldboard plowing, and groundhogging twice. The rototiller was used to incorporate the herbicide in the soil after each application timing. Treatments 13–16 were band applied in the furrows between beds (leaving the top of the mound bed unsprayed) just before harrowing the beds.

[c]Grower standard plots were treated with Prowl H_2O at 2 pt/acre (pendimethalin 0.95 lb ai/acre) late pre-emergence on April 17, 2018. Postemergence applications of Brox 2EC at 12 fl oz/acre (bromoxynil at 0.188 lb ai/acre) plus GoalTender at 4 fl oz/acre (oxyfluorfen at 0.125 lb ai/acre) were made when onion seedlings were at the 2- and 4-leaf stages (May 23 and June 19, 2019).

Table 2. Number of harvested bulbs by grade in response to various Dual Magnum (s-metolachlor) herbicide rates applied at various timings between fall 2018 and spring 2019 at the Malheur Experiment Station, Ontario, OR, 2018/2019.

			Unmarketable[c]			Marketable[c]				
Treatment	Rate[a]	Timing[b]	Neck rot	No. 2s	<2¼ in	2¼-3 in	3-4 in	4-4¼ in	>4¼ in	Total
	pt/acr		---------- No. of bulbs/acre[d] ----------							
1. Dual Magnum	1.00	9/14/2018	792 a	792 bcd	5,544 a	5,346 bcd	30,294 bc	12,672 bcd	3,168 a-e	51,480 bc
2. Dual Magnum	1.33	9/14/2018	396 abc	1,980 a	1,188 bc	5,148 b-e	20,394 cd	9,306 def	3,564 abc	38,412 cd
3. Dual Magnum	2.00	9/14/2018	198 bc	792 bcd	2,376 abc	2,970 c-f	15,444 de	3,366 fg	198 g	21,978 de
4. Dual Magnum	4.00	9/14/2018	198 bc	0 d	594 c	1,386 def	3,564 ef	594 h	0 g	5,544 ef
5. Dual Magnum	1.00	9/28/2018	198 bc	990 a-d	5,148 ab	5,346 bcd	37,818 b	15,048 a-d	4,356 ab	62,568 b
6. Dual Magnum	1.33	9/28/2018	0 c	1,188 abc	1,980 abc	3,168 c-f	21,384 cd	13,068 bcd	1,980 c-g	39,600 c
7. Dual Magnum	2.00	9/28/2018	0 c	1,386 ab	594 c	1,584 def	13,266 def	5,148 efg	2,376 b-f	22,374 de
8. Dual Magnum	4.00	9/28/2018	0	198 cd	594 c	594 f	3,366 f	396 h	0 g	4,356 f
9. Dual Magnum	1.00	10/12/2018	0 c	1,188 abc	2,178 abc	3,762 b-f	29,106 bc	16,236 abc	4,752 a	53,856 bc
10. Dual Magnum	1.33	10/12/2018	594 ab	594 bcd	2,376 abc	2,772 c-f	23,760 cd	11,484 cde	2,772 a-e	40,788 c
11. Dual Magnum	2.00	10/12/2018	198 bc	0 d	2,376 abc	792 def	11,088 def	2,574 g	1,188 efg	15,642 ef
12. Dual Magnum	4.00	10/12/2018	0 c	0 d	792 c	396 f	2,574 f	594 h	396 fg	3,960 f
13. Dual Magnum	1.00	3/26/2019	198 bc	990 a-d	4,356 abc	10,890 a	60,984 a	15,642 a-d	1,188 efg	88,704 a
14. Dual Magnum	1.33	3/26/2019	0 c	0 d	4,356 abc	8,118 ab	66,924 a	15,642 a-d	1,386 d-g	92,070 a
15. Dual Magnum	2.00	3/26/2019	0 c	594 bcd	1,782 abc	6,732 abc	66,726 a	18,216 ab	1,782 c-g	93,456 a
16. Dual Magnum	4.00	3/26/2019	396 abc	198 cd	2,970 abc	5,148 b-e	60,786 a	19,800 a	3,366 a-d	89,100 a
17. Grower standard			198 bc	792 bcd	2,376 abc	5,544 bcd	61,974 a	19,206 ab	2,376 b-f	89,100 a
18. Untreated			0 c	396 bcd	5,48 ab	8,118 ab	71,280 a	11,682 c-f	1,188 efg	92,268 a
LSD (0.05)	Rate		NS	495	2,085	2,413	5,160	4,089	1,166	6,129
	Timing		236	495	NS	2,919	8,744	3,249	NS	10,634
	Rate x Timing		NS	965	NS	NS	12,805	6,861	2,286	16,876

[a] Herbicide rate; Dual Magnum (S-metolachlor) 1 pt/acre = 0.95 lb ai/acre; 1.33 pt/acre = 1.27 lb ai/acre; 2 pt/acre = 1.9 lb ai/acre; 4 pt/acre = 3.8 lb ai/acre.

[b] Application timing: Treatments 1–12 were applied after flailing of wheat stubble, watering, disking, moldboard plowing, and groundhogging twice. The rototiller was used to incorporate the herbicide in the soil after each application. Treatments 13–16 were band applied in the furrows between beds (leaving the top of the mound bed unsprayed) just before harrowing the beds.

[c] The 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 is composed of bulbs 2¼ to >4¼ inches (medium, jumbo, colossal, and super colossal grades) in diameter. Unmarketable yield are split bulbs (No. 2s), bulbs infected with the fungus *Botrytis allii* in the neck or side, and bulbs infected with the fungus *Fusarium oxysporum* (plate rot).

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

Table 3. Onion yield by grade in response to various Dual Magnum (S-metolachlor) herbicide rates applied at various timings between fall 2018 and spring 2019 at the Malheur Experiment Station, Ontario, OR, 2018/2019.

			Unmarketable[c]			Marketable[c]				
Treatment	Rate[a]	Timing[b]	Neck rot	No. 2s	<2¼ in	2¼-3 in	3-4 in	4-4¼ in	>4¼ in	Total
	pt/acre		cwt/acre[d]							
1. Dual Magnum	1.00	9/14/2018	4.0 a	9.2 b-e	11.2 a	19.6 bcd	251.2 bc	162.5 bcd	53.6 a-d	486.9 cde
2. Dual Magnum	1.33	9/14/2018	2.1 abc	24.6 a	3.0 bcd	19.7 bcd	175.6 cde	127.1 def	58.8 abc	381.2 ef
3. Dual Magnum	2.00	9/14/2018	0.4 bc	7.9 b-e	4.2 a-d	10.9 c-f	127.9 def	44.5 fg	3.4 fg	186.6 gh
4. Dual Magnum	4.00	9/14/2018	0.3 c	0.0	1.3 d	5.3 def	30.4 f	8.2 g	0.0 g	43.9 h
5. Dual Magnum	1.00	9/28/2018	1.4 abc	14.6 abc	9.8 abc	18.2 b-e	338.8 b	199.3 a-d	67.1 ab	623.5 bc
6. Dual Magnum	1.33	9/28/2018	0.0 c	13.6 a-d	4.0 a-d	11.8 c-f	192.1 cde	172.9 a-d	32.3 c-g	409.1 de
7. Dual Magnum	2.00	9/28/2018	0.0 c	18.3 ab	1.1 d	6.1 def	121.8 def	66.8 efg	40.6 a-e	235.3 fg
8. Dual Magnum	4.00	9/28/2018	0.0 c	1.5 e	1.4 d	2.4 ef	29.3 f	5.4 g	0.0 g	37.2 h
9. Dual Magnum	1.00	10/12/2018	0.0 c	9.2 b-e	6.3 a-d	13.7 c-f	260.1 bc	215.2 abc	73.5 a	562.5 cd
10. Dual Magnum	1.33	10/12/2018	3.6 ab	8.2 b-e	5.7 a-d	10.5 c-f	211.5 cd	145.2 cde	42.3 a-e	409.4 de
11. Dual Magnum	2.00	10/12/2018	0.4 bc	0.0 e	5.0 a-d	2.8 ef	92.1 ef	35.6 g	20.6 d-g	151.1 gh
12. Dual Magnum	4.00	10/12/2018	0.0 c	0.0 e	1.8 cd	1.4 f	24.8 f	7.4 g	6.6 fg	40.1 h
13. Dual Magnum	1.00	3/26/2019	0.7 bc	7.4 b-e	11.0 ab	41.1 a	518.9 a	202.4 a-d	19.3 efg	781.8 ab
14. Dual Magnum	1.33	3/26/2019	0.0 c	0.0 e	10.5 ab	31.9 ab	568.4 a	194.8 a-d	21.7 d-g	816.8 a
15. Dual Magnum	2.00	3/26/2019	0.0 c	7.5 b-e	4.3 a-d	26.4 abc	580.9 a	230.8 abc	26.9 c-g	865.0 a
16. Dual Magnum	4.00	3/26/2019	2.1 abc	2.5 de	7.4 a-d	19.9 bcd	518.9 a	255.5 a	50.5 a-e	844.7 a
17. Grower standard			0.8 abc	9.7 b-e	5.4 a-d	21.4 bcd	578.9 a	244.0 ab	36.1 b-f	880.4 a
18. Untreated			0.0 c	5.9 cde	10.2 ab	30.4 ab	594.6 a	146.5 cde	30.8 c-g	802.4 a
LSD (0.05)	Rate		NS	6.3	4.3	9.4	36.2	51.1	19.1	58.7
	Timing			5.5	NS	10.3	77.7	40.7	NS	84.9
	Rate x Timing			NS	NS	NS	104.5	93.2	36.4	168.2

[a]Herbicide rate: Dual Magnum (S-metolachlor) 1 pt/acre = 0.95 lb ai/acre; 1.33 pt/acre = 1.27 lb ai/acre; 2 pt/acre = 1.9 lb ai/acre; 4 pt/acre = 3.8 lb ai/acre.

[b]Application timing: Treatments 1–12 were applied after flailing of wheat stubble, watering, disking, moldboard plowing, and groundhogging twice. The rototiller was used to incorporate the herbicide in the soil after each application timing. Treatments 13–16 were band applied in the furrows between beds (leaving the top of the mound bed unsprayed) just before harrowing the beds.

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