DRIP IRRIGATION TO ACTIVATE HERBICIDES IN SEASON-LONG, DRIP-IRRIGATED POTATO PRODUCTION SYSTEMS

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Introduction

Currently, season-long potato production under drip irrigation conditions utilize temporary solid set sprinkler irrigation systems to activate herbicides applied prior to potato emergence. Solid set sprinklers are removed once the ground is dry enough not to disturb the herbicide-treated soil layer. The objective of this study was to evaluate the potential use of drip irrigation from the first irrigation to activate herbicides in a season-long drip-irrigation system.

Studies at the Malheur Experiment Station have developed soil water tension criterion of 25 to 30 cb for initiating irrigations for potato grown under drip irrigation (Shock et al. 2002). This criterion was used for the current study.

Materials and Methods

A field study was conducted at the Malheur Experiment Station Ontario, Oregon, in 2019 to evaluate the potential to activate herbicides using drip irrigation on an Owyhee silt loam soil previously planted to wheat. Based on the soil analysis, fertilizer was broadcast applied to supply 50 lb/acre nitrogen (N), 50 lb/acre phosphorus (P), 11 lb/acre manganese (Mn), 3 lb/acre boron (B), and 150 lb/acre potassium (K) during fall 2018. Thereafter, the area was fumigated using Telone® at 20 gal/acre and beds were formed at 36-inch spacing. In spring 2019, fertilizer was applied to supply 100 lb N/acre and Admire® at 7 oz/acre (imidacloprid at 0.25 lb ai/acre) was injected at 6-inch depth in each bed.

On April 22, 2019, seed of Clearwater Russet potato cultivar previously cut by hand into 2.5-oz seed pieces, treated with Maxim® MZ (fludioxonil, mancozeb) dust, and temporarily stored to suberize were planted. Potato planting was accomplished using a 2-row assist-feed planter with 9-inch seed spacing in 36-inch spaced rows. The drip irrigation tape was installed on April 26 at 4-inch depth directly over the potato seed.

On May 1, 2019, the Lilleston rolling cultivator was used to reshape potato beds and control all emerged weeds. Herbicide treatments (Table 1) were applied using a CO_2 pressurized backpack sprayer fitted with a boom equipped with six EVS8002 flat-fan nozzles to provide a spray volume of 20 gal/acre. Herbicides were immediately incorporated in the soil using the Lilleston rolling cultivator with tines set at 2-inch depth on a tractor moving at 5 MPH.

The experimental design was a randomized complete block with six treatments (including an untreated control) and four replicates. Each plot was comprised of three beds 9-ft wide by 37-ft long. Herbicide treatments are indicated in Table 1.

Irrigation scheduling was based on soil water tension using six granular matrix sensors (GMS, Watermark soil moisture sensors model 200SS, Irrometer Co., Riverside, CA) placed at 8-inch depth. Irrigation was turned on manually when soil water tension was at 25 to 30 cb. The water for the drip system was supplied by a well that maintained a continuous and constant water pressure of 30 psi. Water applied to the study was measured using a Neptune T-10 (sizes 5/8 and 1 inch) meter installed at the main study irrigation line. The study was irrigated 21 times starting May 1 to September 13, 2019.

Potato plants were sprayed aerially with fungicide and insecticides as recommended for local production practices.

Plots were evaluated subjectively for weed control on May 30, June 25, July 15, and September 16, 2019, based on a scale of 0% (zero control) to 100% (completely weed free).

Potato vines were flailed on September 27, 2019. Potatoes were harvested from the middle row of each plot on October 1 or 2, 2019. All tubers from each plot were placed into burlap sacks and placed in a barn where they were kept under tarps until they were graded. Tubers were graded by market class using USDA standards (U.S. No. 1 and U.S. No. 2) and weight (<4 oz, 4–6 oz, 6–10 oz, 10–20 oz, and >20 oz). Tubers were graded as U.S. No. 2 if any of the following conditions occurred: growth cracks, bottleneck shape, abnormally curved shape, or two or more knobs. Marketable tubers are U.S. No. 1 and U.S. No. 2 larger than 4 oz.

Data were subjected to analysis of variance using PROC GLM in SAS, and means were compared using Fisher's protected least significant difference procedure at $P \leq 0.05$.

Results and Discussion

The seasonal irrigation scheduling resulted in 21 irrigation incidents totaling 23.05 inches or 1.1 inches pre incident (data not shown). The first irrigation incident immediately after herbicide application and incorporation in the soil using a rolling Lilleston cultivator lasted 24 hours and delivered 2.87 inches of water. At the end of the initial 24-hour irrigation there was no visible water on the soil surface, likely because the drip tape was installed at 4-inch depth. It is not clear whether herbicide activation was achieved through the initial drip irrigation incident or by rainfall in the first 2 weeks after herbicide application (Figure 1).

Weeds in the study area were composed of common lambsquarters, redroot pigweed, hairy nightshade, and wild oat (Tables 2 and 3). Evaluations on May 30 and June 25 indicated greater than 95% control for broadleaf weed species across herbicide treatments. Control for wild oat was greater than 97% on May 30 and greater than 90% on June 25, 2019, (Table 2). Evaluation on July 15, 2019 indicated 95-99% control for common lambsquarters, 97 to 100% for pigweed, and 90 to 93% for wild oat (Table 3). Similar levels of weed control were observed on September 16, 2019, just before potato harvest. In a typical grower field, it would have been possible to spray a grass herbicide before potato row closure in order to control wild oats. However, such an operation would disturb the herbicide treated soil layer and possibly result in new flushes of broadleaf and grassy weeds.

Marketable potato tuber yield ranged from 492 to 582 cwt/acre across herbicide treatment compared to 71 cwt/acre for the untreated control (Table 4). These yields are within historical potato yield data at the Malheur Experiment Station for locally adapted potato cultivars produced under sprinkler irrigation. The study will be repeated in 2020 to confirm these results.

References

Shock, C.C., E.P. Eldredge, and L.D. Saunders. 2002. Drip irrigation management factors for 'Umatilla Russet' potato production. Oregon State University, Agricultural Experiment Station Special Report 1038:157-169.

Table 1. Herbicide treatments for the potato drip irrigation study at the Malheur Experiment Station, Ontario, OR, 2019.

	Treatment	Formulation		Rate (lb ai/acre)	Product Rate (units/acre)	
1	Untreated control					
2	Prowl H_2O (pendimethalin)	3.8 LBA/GAL	FL	1	2.1	pt
	Dual Magnum (*S*-metolachlor)	7.62 LBA/GAL	EC	1.27	1.33	pt
	Eptam EC (EPTC)	7 LBA/GAL	EC	4.38	5	pt
3	TriCor (metribuzin)	75%	DF	0.56	12	oz
	Eptam EC (EPTC)	7 LBA/GAL	EC	4.38	5	pt
4	TriCor (metribuzin)	75%	DF	0.56	12	oz
	Prowl H_2O (pendimethalin)	3.8 LBA/GAL	FL	1	2.1	pt
	Outlook (dimethenamid-*p*)	6 LBA/GAL	EC	0.98	21	fl oz
5	TriCor (metribuzin)	75%	DF	0.56	12	oz
	Prowl H_2O (pendimethalin)	3.8 LBA/GAL	FL	1	2.1	pt
	Outlook (dimethenamid-*p*)	6 LBA/GAL	EC	0.98	21	fl oz
	Oro-RZ (soil adjuvant)	29.4%	SL	0.307	1	pt
6	TriCor (metribuzin) +	75%	DF	0.56	12	oz
	Prowl H_2O (pendimethalin) +	3.8 LBA/GAL	FL	1	2.1	pt
	Outlook (dimethenamid-*p*) +	6 LBA/GAL	EC	0.98	21	fl oz
	Ad-here (spray adjuvant)	970 G/L	SL	0.625*	1	pt

*% volume/volume

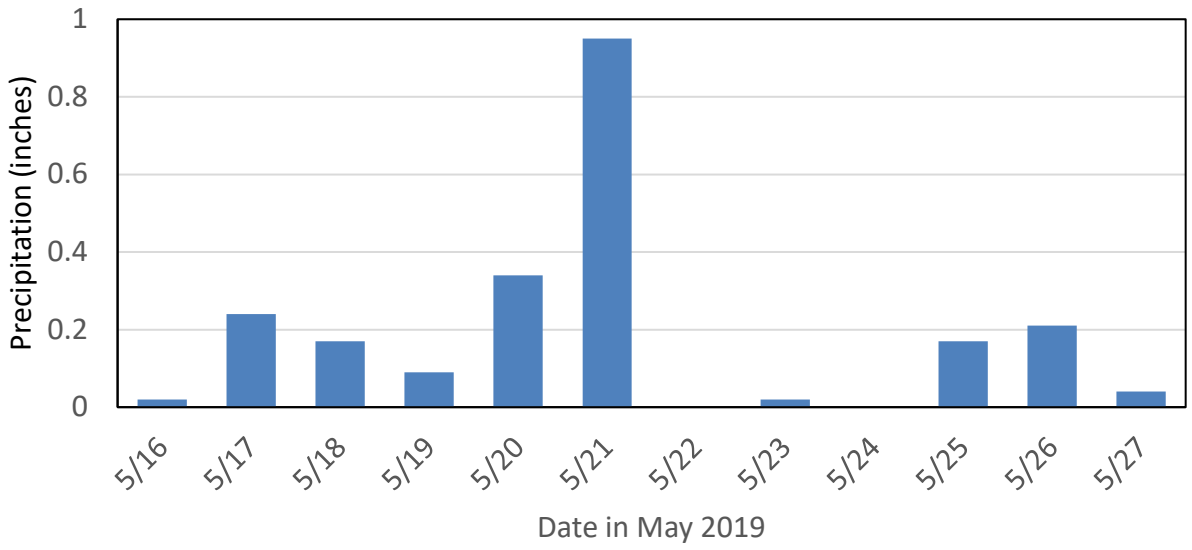

Figure 1. Precipitation during May 16–27 at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

Table 2. Potato injury and weed control on May 30 and June 25, 2019, in a drip-irrigated potato study at the Malheur Experiment Station, Ontario, OR, 2019.

					Weed control (%) on May 30[b]					Weed control and row closure (%) on June 25[b]				
Treatment[a]	Rate	Product rate	Potato injury May 30	Common lambsquarters	Redroot pigweed	Hairy nightshade	Wild oat	Potato injury Jun 25	Common lambsquarters	Redroot pigweed	Hairy nightshade	Wild oat	Row closure
	units/acre	units/acre	%					%					
1 Untreated			0	0 c	0 b	0 c	0 b	0	0 b	0 c	0 c	0 c	64 c
2 Prowl H_2O	1 lb ai	2.1 pt	1	99 ab	99 a	98 a	97 a	0	96 a	90 b	93 b	95 a	94 a
Dual Magnum	1.27 lb ai	1.33 pt											
Eptam EC	4.38 lb ai	5 pt											
3 TriCor	0.56 lb ai	12 oz	1	100 ab	100 a	100 a	99 a	0	96 a	97 ab	99 ab	98 a	91 ab
Eptam EC	4.38 lb ai	5 pt											
4 TriCor	0.56 lb ai	12 oz	0	98 b	99 a	97 ab	100 a	0	99 a	98 ab	99 ab	90 b	90 ab
Prowl H_2O	1 lb ai	2.1 pt											
Outlook	0.98 lb ai	21 fl oz											
5 TriCor	0.56 lb ai	12 oz	3	100 a	100 a	97 ab	100 a	0	100 a	100 a	100 a	95 a	88 b
Prowl H_2O	1 lb ai	2.1 pt											
Outlook	0.98 lb ai	21 fl oz											
Oro-RZ	0.307 lb ai	1 pt											
6 TriCor	0.56 lb ai	12 oz	1	98 b	100 a	95 b	99 a	0	99 a	98 ab	100 a	90 b	93 a
Prowl H_2O	1 lb ai	2.1 pt											
Outlook	0.98 lb ai	21 fl oz											
Ad-here	0.625 % v/v	1 pt											
LSD (P = 0.05)			NS	2	2	3	4	NS	5	9	6	4	4

[a]Prowl H_2O = pendimethalin; Dual Magnum = *s*-metolachlor; Eptam EC = EPTC; TriCor = metribuzin; Outlook = dimethenamid-*p*; Oro-RZ = soil adjuvant (alcohol ethoxylate 19.4% + cold pressed orange oil 10%); Ad-here = spray adjuvant (mineral oil 970 ml/L).

[b]Means followed by same letter do not significantly differ (P = 0.05, LSD).

Table 3. Potato injury and weed control on July 15 and September 16, 2019 in a drip-irrigated potato study at the Malheur Experiment Station, Ontario, OR, 2019.

						Weed control on July 15[b]				Weed control on September 16[b]			
	Treatment[a]	Rate	Product rate	Potato injury Jul 15	Common lambsquarters	Redroot pigweed	Wild oat	Potato injury Sep 16	Common lambsquarters	Redroot pigweed	Hairy nightshade	Wild oat
		units/acre	units/acre	%								
1	Untreated			0	0 c	0 b	0 c	0	0 d	0 b	0.0 b	0 b
2	Prowl H_2O	1 lb ai	2.1 pt	0	98 ab	97 a	91 ab	0	93 bc	95 a	97.5 a	85 a
	Dual Magnum	1.27 lb ai	1.33 pt									
	Eptam EC	4.38 lb ai	5 pt									
3	TriCor	0.56 lb ai	12 oz	0	99 a	100 a	97 a	0	98 ab	97 a	85.0 a	98 a
	Eptam EC	4.38 lb ai	5 pt									
4	TriCor	0.56 lb ai	12 oz	0	95 b	97 a	90 b	0	96 abc	98 a	87.5 a	91 a
	Prowl H_2O	1 lb ai	2.1 pt									
	Outlook	0.98 lb ai	21 fl oz									
5	TriCor	0.56 lb ai	12 oz	0	97 ab	100 a	93 ab	0	99 a	97 a	98.3 a	91 a
	Prowl H_2O	1 lb ai	2.1 pt									
	Outlook	0.98 lb ai	21 fl oz									
	Oro-RZ	0.307 lb ai	1 pt									
6	TriCor	0.56 lb ai	12 oz	0	97 ab	97 a	90 b	0	93 c	96 a	95.0 a	93 a
	Prowl H_2O	1 lb ai	2.1 pt									
	Outlook	0.98 lb ai	21 fl oz									
	Ad-here	0.625 % v/v	1 pt									
LSD (*P* = 0.05)				NS	5	4	6	NS	5	3	17	22

[a]Prowl H_2O = pendimethalin; Dual Magnum = *s*-metolachlor; Eptam EC = EPTC; TriCor = metribuzin; Outlook = dimethenamid-*p*; Oro-RZ = soil adjuvant (alcohol ethoxylate 19.4% + cold pressed orange oil 10%); Ad-here = spray adjuvant (mineral oil 970 ml/L).

[b]Means followed by same letter do not significantly differ (P=0.05, LSD).

Table 4. Potato yield (cwt/acre) with season-long drip irrigation at the Malheur Experiment Station, Ontario, OR, 2019.

				Potato yield by grade						
	Treatment[a]	Rate	Product Rate	Culls	US. No.2	<4 oz	4-6 oz	6-12 oz	>12 oz	Marketable[b]
		units/acre	units/acre	cwt/acre[c]						
1	Untreated			0.0	2.2 b	117.1	48.9 b	19.0 b	3.3 b	71.2 b
2	Prowl H_2O	1 lb ai	2.1 pt	0.0	13.8 a	117.5	164.2 a	269.8 a	58.1 a	492.1 a
	Dual Magnum	1.27 lb ai	1.33 pt							
	Eptam EC	4.38 lb ai	5 pt							
3	TriCor	0.56 lb ai	12 oz	0.0	9.5 ab	119.4	175.0 a	329.7 a	77.1 a	581.9 a
	Eptam EC	4.38 lb ai	5 pt							
4	TriCor	0.56 lb ai	12 oz	0.0	17.3 a	106.5	149.7 a	294.3 a	68.1 a	512.1 a
	Prowl H_2O	1 lb ai	2.1 pt							
	Outlook	0.98 lb ai	21 fl oz							
5	TriCor	0.56 lb ai	12 oz	0.0	13.3 a	117.7	167.2 a	302.0 a	76.5 a	545.7 a
	Prowl H_2O	1 lb ai	2.1 pt							
	Outlook	0.98 lb ai	21 fl oz							
	Oro-RZ	0.307 lb ai	1 pt							
6	TriCor	0.56 lb ai	12 oz	0.0	18.6 a	118.9	161.1 a	302.4 a	72.2 a	535.7 a
	Prowl H_2O	1 lb ai	2.1 pt							
	Outlook	0.98 lb ai	21 fl oz							
	Ad-here	0.625 % v/v	1 pt							
LSD (*P* = 0.05)				NS	11.1	NS	28.9	65.3	42.6	91.2

[a]Prowl H_2O = pendimethalin; Dual Magnum = *s*-metolachlor; Eptam EC = EPTC; TriCor = metribuzin; Outlook = dimethenamid-*p*; Oro-RZ = soil adjuvant (alcohol ethoxylate 19.4% + cold pressed orange oil 10%); Ad-here = spray adjuvant (mineral oil 970 ml/L).

[b]Marketable yield was composed of potato grades >4 oz.

[c]Means followed by same letter do not significantly differ (*P* = 0.05, LSD).