

DEVELOPMENT OF NEW HERBICIDE OPTIONS FOR WEED CONTROL IN POTATO PRODUCTION

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Introduction

Weed control in potatoes is essential for production of high yielding marketable tubers. Herbicide options in potato production are limited. Outlook[®], Spartan[®], and Chateau[®] (previously Valor[®]) demonstrate great promise for use in potato. Spartan and Chateau represent a mode of action that is not currently used in potatoes and offer excellent hairy nightshade control. Outlook (dimethenamid-p) has the same mode of action as Dual[®] but controls a wider spectrum of weeds. Trials were conducted to evaluate new herbicides for weed control in potatoes. The results of our research have been provided to herbicide companies, the IR4 program, and state regulators in support of additional herbicide registrations in potatoes. Spartan was registered for use in potato in 2004 and Outlook is registered for use in potato in 2005. Chateau is also registered for use in potato and will be available in limited quantities for commercial evaluation for 2005. The registration of these herbicides gives producers additional tools for controlling weeds and may increase economic returns through improved weed control.

Materials and Methods

Three trials were conducted at the Malheur Experiment Station to evaluate new herbicides for weed control efficacy and crop tolerance in potatoes: Spartan alone and in 2- and 3-way tank mixtures; comparisons of standard 2-way tank mixtures with Chateau or Matrix[®] added in 3-way tank mixtures; and Outlook in 2- and 3-way tank mixtures. In fall 2003, 50 lb nitrogen (N) and 100 lb phosphorus (P)/acre was applied prior to bedding in all trial areas. On October 17, 2003, Telone II[®] (20 gal/acre) and Vapam[®] (20 gal/acre) were applied and the ground was bedded. Potatoes were planted April 27, 2004 in an Owyhee silt loam soil with pH 7.6, 2.7 percent organic matter content, and a cation exchange capacity of 19. 'Russet Burbank' seed pieces were planted every 9 inches in 36-inch-wide rows. Seed pieces were treated with Tops-MZ[®] plus Gaucho[®]. Experimental plots were 4 rows wide and 30 ft long. Plots were sidedressed with 102 lb N, 4 lb P, 9 lb potassium (K), 8 lb sulfate, 32 lb elemental sulfur (S), 5 lb zinc (Zn), and 1 lb boron (B)/acre on May 3 and rehilled on May 11. Preemergence herbicides were applied with a CO₂-pressurized backpack sprayer delivering 20 gal/acre at 30 psi and incorporated with approximately 0.5 inch of sprinkler irrigation on May 13. Petiole samples were taken and sent for nitrate analysis on July 13. On July 16, 25 lb N/acre was applied through the sprinkler. Aerial fungicide applications included Bravo[®] and Ridomil Gold[®] on June 12, Headline[®] (12 oz/acre) on

June 26, Topsin-M[®] (20 oz/acre) plus liquid sulfur (6 lb/acre) on July 17, and Headline (12 oz/acre) plus liquid sulfur (6 lb/acre) on August 8. In addition, 1.5 lb P and 0.2 lb Zn/acre were added to the July 17 fungicide application.

Visual potato injury and weed control were evaluated throughout the growing season and tubers were harvested from the center two rows of each plot on September 13-15. Potatoes were graded for yield and size on September 20-27.

Herbicide screening for activity on dodder

Herbicides were screened in a petri dish assay to determine effects on dodder germination and elongation. Dodder seeds were scarified using sandpaper and 10 seeds were placed in each petri dish. Each dish was treated with 6 ml of water containing herbicides at rates equivalent to what would be applied in the field. Dodder germination was counted 4 and 5 days after treatment (DAT), and dodder shoot length was measured 5 DAT.

Results and Discussion

Spartan alone and in 2- and 3-way tank mixtures

Control of all weeds present in this trial was 93 percent or greater by treatments with Spartan alone or combined with other herbicides (Table 1). Spartan caused potato injury on June 9, consisting of interveinal chlorosis and necrosis on one set of leaves, and injury tended to be greater with higher rates of Spartan (Table 1). No differences in potato yield were observed between herbicide treatments, suggesting that the injury was transient (Table 2).

Comparisons of standard 2-way tank mixtures with Chateau or Matrix added in 3-way tank mixtures

The 2-way tank mixtures provided the same level of control as 3-way tank mixtures including either Chateau or Matrix (Table 3). The exception was the combination of Prowl[®] plus Eptam[®], where pigweed control was increased with the addition of Matrix. The 3-way combination of Prowl, Eptam, and Chateau had lower pigweed and barnyardgrass control than most other treatments. Plots treated with Chateau exhibited severe injury on May 26 (Table 3). Injury symptoms included stunting and crinkling of newly emerged shoots and leaves. Rainfall events at the time of potato emergence may have increased the contact of Chateau with the emerging foliage. Some treatments were still causing significant injury on June 9. In one instance, the combination of Prowl, Eptam, and Chateau yielded lower than Prowl plus Eptam (Table 4). This could have been a result of the early injury when Chateau was in the tank mixture.

Outlook in 2- or 3-way tank mixtures

Outlook combined with Prowl or Sencor[®] in 2-way tank mixtures or with both in a 3-way tank mixture provided 96 percent or greater control of all weeds (Table 5). Potato yields were not different among herbicide treatments (Table 6).

Herbicide screening for activity on dodder

Only Nortron[®] suppressed dodder germination compared to the untreated check (Table 7). However, all herbicides except Chateau shortened shoot length compared to the untreated check. Nortron caused the greatest reduction followed by Kerb[®], Prowl, Spartan, and Dacthal[®]. Nortron and Kerb are not registered for use in potato. The fact that Prowl and Spartan reduced dodder shoot growth suggests they may be useful in managing dodder in potatoes. In this trial, both Prowl and Spartan rates were higher than those registered for use in potato. Additional research needs to be done with Prowl and Spartan rates that are used in potato production.

Table 1. Effect of Spartan[®] alone and in combinations on crop injury and weed control in potato, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Treatment*	Rate lb ai/acre	Potato injury		Weed control [†]				
		5-26	6-9	Pigweed [‡]	Common lambsquarters	Hairy nightshade	Kochia	Barnyard grass
Untreated check	--	-	-	-	-	-	-	-
Spartan	0.094	0	14	100	100	100	100	98
Spartan	0.14	5	20	100	100	100	100	94
Spartan	0.187	3	20	100	100	100	100	98
Spartan + Prowl	0.094 + 1.0	3	14	100	100	100	100	93
Spartan + Prowl	0.14 + 1.0	6	18	100	100	100	100	100
Spartan + Dual Magnum	0.094 + 1.33	0	11	100	100	100	100	100
Spartan + Dual Magnum	0.14 + 1.33	6	21	100	100	100	100	100
Spartan + Outlook	0.094 + 0.84	3	11	100	100	100	100	100
Spartan + Outlook	0.14 + 0.84	11	15	100	99	100	100	100
Spartan + Eptam	0.094 + 3.94	3	13	100	100	100	100	97
Spartan + Eptam	0.14 + 3.94	4	21	100	100	100	100	99
Spartan + Prowl + Eptam	0.094 + 1.0 + 3.94	3	7	100	100	100	100	99
Spartan + Prowl + Dual Magnum	0.094 + 1.0 + 1.33	0	11	100	100	100	100	100
Spartan + Prowl + Outlook	0.094 + 1.0 + 0.84	9	5	100	100	100	100	100
LSD (P = 0.05)	--	NS	9	NS	NS	NS	NS	NS

*Herbicide treatments were applied preemergence on May 13, 2004.

[†]Weed control evaluations were taken September 2.

[‡]Pigweed species were a combination of Powell amaranth and redroot pigweed.

Table 2. Effect of Spartan[®] alone and in combinations on potato yield and quality, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Treatment*	Rate	Potato yield [†]							
		U.S. No. 1					Total No. 2	Total marketable	Total yield
		4-6 oz	6-12 oz	>12 oz	Total	Percent			
lb ai/acre	cwt/acre					%	cwt/acre		
Untreated check	--	106	113	15	234	65	5	239	359
Spartan	0.094	90	316	62	467	75	70	537	616
Spartan	0.14	102	293	79	474	78	58	532	606
Spartan	0.187	87	316	86	488	77	70	558	623
Spartan + Prowl	0.094 + 1.0	91	289	46	427	73	71	497	583
Spartan + Prowl	0.14 + 1.0	91	298	69	457	74	87	544	609
Spartan + Dual Magnum	0.094 + 1.33	91	287	51	429	72	88	516	584
Spartan + Dual Magnum	0.14 + 1.33	77	306	65	447	75	71	518	592
Spartan + Outlook	0.094 + 0.84	81	290	65	435	74	76	511	586
Spartan + Outlook	0.14 + 0.84	85	295	64	444	73	82	525	601
Spartan + Eptam	0.094 + 3.94	93	296	54	443	74	80	522	598
Spartan + Eptam	0.14 + 3.94	81	319	85	484	78	68	552	617
Spartan + Prowl + Eptam	0.094 + 1.0 + 3.94	102	311	64	476	76	71	547	624
Spartan + Prowl + Dual Magnum	0.094 + 1.0 + 1.33	97	275	39	411	72	83	493	572
Spartan + Prowl + Outlook	0.094 + 1.0 + 0.84	90	290	66	446	75	67	513	590
LSD (P = 0.05)	--	NS	53	37	74	6.8	26	72	63

*Herbicide treatments were applied preemergence on May 13, 2004.

[†]Potatoes were harvested September 13 to 15. Total marketable yield = total number ones + total number twos.

Table 3. Comparison of standard 2-way tank mixtures with Chateau® or Matrix® added in 3-way tank mixtures for potato crop injury and weed control, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Treatment*	Rate lb ai/acre	Potato injury		Weed control†				
		5-26	6-9	Pigweed‡	Common lambsquarters	Hairy nightshade	Kochia	Barnyard grass
Untreated check	--	-	-	-	-	-	-	-
Dual Magnum + Sencor	1.33 + 0.5	3	3	99	100	96	100	100
Prowl + Sencor	1.0 + 0.5	0	0	100	100	100	100	100
Dual Magnum + Prowl	1.33 + 1.0	0	0	97	99	99	100	100
Prowl + Eptam	1.0 + 3.94	0	3	93	100	97	100	97
Dual Magnum + Sencor + Chateau	1.33 + 0.5 + 0.048	35	15	100	100	100	100	100
Sencor + Prowl + Chateau	0.5 + 1.0 + 0.048	32	8	99	100	100	100	98
Dual Magnum + Prowl + Chateau	1.33 + 1.0 + 0.048	34	11	99	99	100	100	100
Prowl + Eptam + Chateau	1.0 + 3.94 + 0.048	33	6	93	100	100	100	92
Dual Magnum + Sencor + Matrix	1.33 + 0.5 + 0.0234	1	0	100	100	94	100	100
Sencor + Prowl + Matrix	0.5 + 1.0 + 0.0234	0	0	100	100	98	100	100
Dual Magnum + Prowl + Matrix	1.33 + 1.0 + 0.0234	3	3	100	100	100	100	100
Prowl + Eptam + Matrix	1.0 + 3.94 + 0.0234	0	0	100	100	100	100	100
LSD (P = 0.05)	--	4	5	5	NS	NS	NS	4

*Herbicide treatments were applied preemergence on May 13, 2004.

†Weed control evaluations were taken September 2.

‡Pigweed species were a combination of Powell amaranth and redroot pigweed.

Table 4. Effect of standard 2-way tank mixtures with Chateau[®] or Matrix[®] added in 3-way tank mixtures on potato yield and quality, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Treatment*	Rate	Potato yield [†]							
		U.S. No. 1					Total No. 2	Total marketable	Total yield
		4-6 oz	6-12 oz	>12 oz	Total	Percent			
lb ai/acre	cwt/acre					%	cwt/acre		
Untreated check	--	90	154	4	247	65	20	268	380
Dual Magnum + Sencor	1.33 + 0.5	93	290	69	450	75	76	526	602
Prowl + Sencor	1.0 + 0.5	88	303	68	459	76	67	526	606
Dual Magnum + Prowl	1.33 + 1.0	84	285	87	457	77	70	527	596
Prowl + Eptam	1.0 + 3.94	88	319	87	493	79	64	557	625
Dual Magnum + Sencor + Chateau	1.33 + 0.5 + 0.048	94	290	63	447	74	53	501	602
Sencor + Prowl + Chateau	0.5 + 1.0 + 0.048	103	275	68	445	75	64	509	597
Dual Magnum + Prowl + Chateau	1.33 + 1.0 + 0.048	90	268	66	424	73	60	484	583
Prowl + Eptam + Chateau	1.0 + 3.94 + 0.048	99	272	49	419	74	47	467	568
Dual Magnum + Sencor + Matrix	1.33 + 0.5 + 0.0234	87	294	81	462	74	81	543	624
Sencor + Prowl + Matrix	0.5 + 1.0 + 0.0234	92	306	76	473	76	64	537	625
Dual Magnum + Prowl + Matrix	1.33 + 1.0 + 0.0234	78	315	116	508	78	65	574	649
Prowl + Eptam + Matrix	1.0 + 3.94 + 0.0234	101	284	50	437	72	76	514	603
LSD (P = 0.05)	--	NS	36	28	47	5	30	50	44

*Herbicide treatments were applied preemergence on May 13, 2004.

[†]Potatoes were harvested September 13 to 15. Total marketable yield = total number ones + total number twos.

Table 5. Potato injury and weed control with Outlook[®], Prowl H₂O[®], and Sencor[®] combinations, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Treatment*	Rate lb ai/acre	Weed control [†]						
		Potato injury		Pigweed [‡]	Common lambsquarters	Hairy nightshade	Kochia	Barnyard grass
5-26	6-9	-----%						
Untreated check	--	-	-	-	-	-	-	-
Prowl H ₂ O + Outlook	1.0 + 0.656	6	0	98	100	98	100	100
Prowl H ₂ O + Outlook	1.0 + 0.84	6	0	100	100	100	100	100
Outlook + Sencor	0.656 + 0.5	0	0	100	100	97	100	100
Outlook + Sencor	0.84 + 0.5	1	0	100	100	96	100	100
Prowl H ₂ O + Outlook + Sencor	1.0 + 0.656 + 0.5	1	0	99	100	100	100	100
Prowl H ₂ O + Outlook + Sencor	1.0 + 0.84 + 0.5	1	0	100	100	97	100	100
LSD (P = 0.05)	--	5	NS	NS	NS	NS	NS	NS

*Herbicide treatments were applied preemergence on May 13, 2004.

[†]Weed control evaluations were taken September 2.

[‡]Pigweed species were a combination of Powell amaranth and redroot pigweed.

Table 6. Influence of Outlook[®], Prowl H₂O[®], and Sencor[®] combinations on potato yield and quality, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Treatment*	Rate lb ai/acre	Potato yield [†]							
		U.S. No. 1			Total	Percent	Total No. 2	Total marketable	Total yield
4-6 oz	6-12 oz	>12 oz	----- cwt/acre -----						
Untreated check	--	98	146	9	252	66	16	268	380
Prowl H ₂ O + Outlook	1.0 + 0.656	91	302	74	467	77	67	534	606
Prowl H ₂ O + Outlook	1.0 + 0.84	98	304	67	470	75	73	543	628
Outlook + Sencor	0.656 + 0.5	74	316	84	474	77	71	545	619
Outlook + Sencor	0.84 + 0.5	98	280	57	45	75	56	490	575
Prowl H ₂ O + Outlook + Sencor	1.0 + 0.656 + 0.5	90	279	56	425	72	72	497	589
Prowl H ₂ O + Outlook + Sencor	1.0 + 0.84 + 0.5	90	288	59	437	75	64	501	584
LSD (P = 0.05)	--	NS	55	30	64	6	26	61	54

*Herbicide treatments were applied preemergence on May 13, 2004.

[†]Potatoes were harvested September 13 to 15. Total marketable yield = total number ones + total number twos.

Table 7. Dodder germination and shoot length in response to herbicides in a petri-dish screening trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Treatment*	Equivalent rate lb ai/acre	Rate mg ai/liter	Dodder		Shoot length† ----mm----
			Germination		
			4 DAT ----- % -----	5 DAT ----- % -----	
Untreated	--		85	88	58
Prowl	1.5	170	73	73	16
Kerb	2.0	227	90	93	12
Dacthal	5.0	567	83	85	32
Chateau	0.096	11	80	83	61
Matrix	0.0234	2.7	68	75	46
Spartan	0.25	28	87	87	24
Nortron	3.0	340	0	10	1.3
LSD (P=0.05)	--	--	15	16	3.8

*Herbicide treatments were applied in 5 ml of water on August 12, 2004.

†Dodder shoot length was measured only on shoots that had emerged by 4 DAT.