DRIP-IRRIGATED RED AND RUSSET POTATO VARIETIES HARVESTED EARLY OR LATE

Clinton C. Shock, Eric P. Eldredge, and Lamont D. Saunders
Malheur Experiment Station
Oregon State University
Ontario, OR, 2001

Introduction

This was the third year of testing the adaptation of russet potato varieties to drip irrigation, and the second year of testing red-skinned varieties. The early- and late-harvest russet trials compared the russeted varieties 'Alturas', 'Wallowa Russet', 'Gem Russet', 'Klamath Russet', 'Umatilla Russet', and 'Russet Burbank', to 'Shepody', and two numbered lines, 'A90586-11' and 'AO92023-3'. 'Shepody', a white-skinned variety, was included because it is grown for processing, 'A90586-11' has shown resistance to late blight, and 'AO92023-3' has performed well at this location in previous trials. The early- and late-harvest red-skinned variety trials compared 'Dark Red Norland', 'Mazama', 'Red LaSoda', 'Sangre 14', and 'Winema', the yellow-fleshed variety 'Yukon Gold', and two red-skinned selections, 'CO89097-2', and 'NDO4300-1'.

Water quality and scarcity issues may increase interest in drip irrigation for russet potato production, both for processing and fresh market. The high prices sometimes paid for red-skinned and specialty potato varieties for fresh market may encourage some growers to try to produce them using drip irrigation. The objectives of this study were to evaluate the performance of new varieties and advanced numbered lines in comparison to standard potato varieties under drip irrigation, and to explore the applicability of drip irrigation to potato production in Malheur County.

Materials and Methods

The 2001 drip-irrigated early- and late-harvest red and russet variety trials were grown on a field of Owyhee silt loam where winter wheat was the previous crop. The wheat stubble was flailed, the field was furrow irrigated, then disked, and 100 lb P/acre and 20 lb N/acre were broadcast. In the fall, the field was ripped with Telone II injected at 22 gal/acre, and the field was bedded on 36-inch row spacing. A soil test taken on April 17, 2001 showed available nitrate plus ammonia totaled 67.5 lb N/acre in the top 2 ft of soil. The top ft of soil had 20 ppm extractable P, 272 ppm K, 1 percent organic matter, and pH 7.8.

Seed of all varieties was hand cut into 2-oz seedpieces and treated with Tops-MZ-Gaucho dust. The early-harvest red and russet trials were planted April 12, and the late-harvest red and russet trials were planted April 19 . Each trial had five replicates, with varieties as treatments, in a randomized complete block design. Potato seed was planted using a Parma two-row cup planter (Parma Corp., Parma, ID) with the center

furrowing shovel removed. Seedpiece spacing was 9 inches in the row, with rows 36 inches apart. Plots were two rows wide by 22.5 ft (30 seedpieces) long, with five red seedpieces separating the plots of russeted varieties and five white seedpieces separating the plots of red varieties.

Prowl at 1 lb ai/acre plus Dual at 2 lb ai/acre, in 30 gal/acre spray mix, was applied on May 1, 2001 and incorporated with a spike-tooth bed harrow. The bed harrow had a toolbar on the back carrying wide shovels to lift soil out of the furrows. A 16-ft length of 5/8-inch chain dragged in a “vee” from the shovel shanks pulled soil into the center of the bed. On the second pass with the bed harrow, in the opposite direction from the first pass, drip tube was injected 2-3 inches deep in the center of the level bed between the two potato rows. The drip tube was 1000 Path (Nelson Irrigation, Walla Walla, WA) that was 8 mil thick, 5/8 inches diameter, and had 12-inch emitter spacing, with a flow rate of 0.22 gal/min/100 ft at 10 psi. Matrix herbicide was applied at 1.2 oz/acre on May 7.

The potatoes in both sets of trials were irrigated with one drip tube between two rows of potatoes on a raised bed. Irrigations were automated to maintain the soil water potential at -30 centibar in the root zone measured with Watermark sensors (Irrometer Co. Inc., Riverside, CA). The sensors were positioned between potato plants in the row with the center of the sensor 8 inches deep. All the nitrogen fertilizer was injected through the drip tape. A 120-gal tank was used to hold a solution of 150 lb calcium nitrate dissolved in 111 gal of water. The solution was metered into the irrigation water using a model A30-2.5 Dosmatic metering pump (Dosmatic USA International, Inc., Carrolltown, TX) at a rate of 1 gal of fertilizer solution to 500 gal of irrigation water. Fertilizer was injected to supply 50 ppm NO_3 in the drip irrigation water, beginning with the first irrigation on May 26.

The first petiole test on June 11 showed deficiencies, so on June 17 and 18, 11 lb N/acre, 8 lb S/acre, 0.17 lb Cu/A, and 0.21 lb Mn/acre were injected. From June 18 to July 16, calcium nitrate fertilizer solution was injected to maintain 50 ppm NO_3 in the drip system. On July 17 to 18, 10 lb S/acre, 5 lb Mg/acre, 0.25 lb Zn/acre, and 0.25 lb Mn/acre were injected to correct deficiencies shown in the third petiole test, taken on July 12. From July 18 to July 31, calcium nitrate solution was again injected at 50 ppm NO_3. The total applied N fertilizer was 224 lb N/acre applied to the early-harvest trials, and 191 lb N/acre applied to the late-harvest trials. Irrigations were continued without fertilizer injection until August 12 for the early-harvest trials, for a total of 17 acre-inch/acre of irrigation water, and September 10 for the late-harvest trials, for a total of 20 acre-inch/acre of irrigation water.

Fungicide applications to prevent late blight infection consisted of an aerial application of Ridomil Gold and Bravo at 2 lb/acre on June 14 and Dithane at 4 pint/acre on June 22. Powdered sulfur was applied at 30 lb/acre by aerial application on July 14, and again on July 28, to control powdery mildew.

Early-harvest Trials

Vines were flailed in the early-harvest trials on August 13, 90 days after full emergence. Early-harvest red and russet potatoes were lifted August 24 with a two-row digger that laid the tubers back onto the soil in each row. Potatoes were visually evaluated for desirable traits, such as smooth, uniform shape and size, oblong to long, well russetted tubers, with shallow eyes. Notes were also made of tuber defects such as growth cracks, knobs, curved or irregularly shaped tubers, pointed ends, stem-end decay, stolons that remained attached, folded bud ends, rough skin due to excessive russetting, drab color on red varieties, pigmented eyes, and other defects. The drip tape was dug along with the potatoes. After the potatoes had been picked up, the drip tape was gathered and tied in bundles for disposal. Potatoes were placed into burlap sacks and hauled to a barn where they were kept under tarps until grading on August 27 and 28.

Red varieties should have a high yield of uniformly shaped, small, smooth, brightly colored tubers. The red varieties were graded into categories that reflected their usual culinary, and therefore fresh market, uses. The total yield of tubers under 10 oz was considered the marketable yield. The under 2 oz, and 2- to 5-oz size categories can command premium prices, while tubers over 10 oz are frequently unmarketable.

A 20-tuber sample from each plot of the russet varieties was placed into refrigerated storage for processing quality tests. The storage was kept near 100 percent relative humidity and the temperature was gradually reduced to 45°F. Tubers were removed from storage November 29 and 30 and evaluated for tuber quality traits. Specific gravity was measured using the weight-in-air, weight-in-water method, and 20 tubers per plot were cut lengthwise and examined for internal defects. Center slices from 20 tubers were fried for 3.5 min in 375°F soybean oil. Percent light reflectance was measured on the stem and bud ends of each fried slice using a model 577 Photovolt Reflectance Meter (Seradyn, Inc., Indianapolis, IN), with a green tristimulus filter, calibrated to read 0 percent light reflectance on the black standard cup and 73.6 percent light reflectance on the white porcelain standard plate.

Late-harvest Trials

Vines were flailed off the late-harvest red and russet trials on September 19, 122 days after full emergence. The potatoes were lifted on September 28 and visually evaluated as described above. Tubers were graded October 10 and a 20-tuber sample from each plot of the russet varieties was placed into storage. Tubers were removed from storage December 3 and 4 and evaluated for tuber quality traits. Specific gravity, internal defects, and percent light reflectance were measured as described above.

Results and Discussion

There were unusually large fluctuations in temperature during April and May of 2001. Potatoes planted on April 12 began to emerge a few days earlier than potatoes planted on April 20, but emerged less uniformly, with some of the red varieties emerging earliest. Some of the early planted russet varieties were slower to emerge than the later

planted reds. The potatoes in the early-harvest trials had fully emerged by May 15, and the potatoes in the late harvest trials had fully emerged by May 20. Dry weather prevented late blight from developing in 2001. Precipitation for April through August was 2.03 inches.

The total pan evaporation in 2001 measured by the U.S. Weather Bureau Class A pan at Malheur Experiment Station in April through September was 58.3 inches, compared to the historical average of 52 inches. Cumulative potato evapotranspiration (Et_c) measured at the Malheur Experiment Station US Bureau of Reclamation (USBR) Agrimet weather station was 21.5 inches for the early-harvest potatoes, and 26.8 inches for the late harvest. The USBR Et_c is based on water use of sprinkler irrigated 'Russet Burbank'. The automated drip irrigation system applied 16.9 inches of water to the early-harvest trials, so including rain, the early-harvest trials received only 88 percent of Et_c. The automated drip irrigation system applied 19.8 inches of water to the late-harvest trials, so including rain, the late-harvest trials received only 81 percent of Et_c.

Red Early- and Late-harvest

Harvested early, the red-skinned varieties (including 'Yukon Gold') average total yield was 569 cwt/acre (Table 1). Among the highest total yields were 'Mazama' at 598 cwt/acre, 'Red LaSoda' and 'Dark Red Norland' at 594 cwt/acre, 'CO89097-2' at 592 cwt/acre, 'NDO4300-1' at 590 cwt/acre, and ‘Winema’ at 582 cwt/acre. The yellow variety 'Yukon Gold' produced 539 cwt/acre, and 'Sangre 14', at 462 cwt/acre, produced the lowest total yield.

Harvested late, the average total yield was 603 cwt/acre, with 'Red LaSoda' producing the highest total yield at 695 cwt/acre. The new Oregon release 'Mazama' produced the highest yield of U.S. No. 1 tubers under 10 oz, with 324 cwt/acre.

In each harvest 'Mazama' and 'NDO4300-1' tubers were smooth and uniformly shaped, with bright red skin. 'Winema' tubers were slightly irregular in shape and generally too large. 'Red LaSoda', ‘Sangre 14’, and 'Dark Red Norland' tubers were rough and very irregular in shape, with a dull, unattractive pink to red skin color. 'CO89097-2' tubers were uniform, with dark red color, but some tubers were too large and had growth cracks. 'Yukon Gold' tubers were irregularly shaped, with scab, growth cracks, and folded bud ends.

Russet Early- and Late-harvest

In the early-harvest russet varieties, the average total yield was 559 cwt, with high yields by 'AO92023-3' at 605 cwt/acre, 'Klamath Russet' at 600 cwt/acre, 'Russet Burbank' at 571 cwt/acre, 'Wallowa Russet' at 570 cwt/acre, and 'Umatilla Russet' at 569 cwt/acre total yield (Table 2). The percentage U.S. No. 1 tubers produced by 'Gem Russet' was 84 percent followed by 'AO92023-3' with 78 percent, 'Alturas Russet' with 72 percent, 'Klamath Russet' with 68 percent, 'Umatilla Russet' with 67 percent, and 'Wallowa Russet' with 66 percent U.S. No. 1. 'Russet Burbank' produced only 36 percent U.S. No. 1.

Marketable yield includes U.S. No. 1 grade tubers over 4 oz and U.S. No. 2 grade tubers. In marketable yield for the early-harvest russets, 'AO92023-3' at 550 cwt/acre, and 'Klamath Russet' at 544 cwt/acre were among the highest. The early-harvest russets with the lightest stem-end fry color were 'Alturas Russet' with 48.6 percent light reflectance, and 'Gem Russet' with 48.5 percent light reflectance.

In the late-harvest russet trial, the overall average total yield was 580 cwt/acre, ranging from 632 cwt/acre for 'Russet Burbank', to 514 cwt/acre for 'Shepody'. 'Wallowa Russet' at 553 cwt/acre had among the highest marketable yield in the late-harvest russet trial along with 'Alturas Russet', 'A90586-11', and 'Klamath Russet'. In the late-harvest russet trial 'Alturas Russet', and 'Gem Russet' were among the lines with the lightest stem-end fry color. 'Klamath Russet' is considered a fresh market variety, and its specific gravity was too low for processing in this trial.

The appearance of the tubers at both harvests showed striking differences. 'Gem Russet' tubers were attractive and uniformly shaped, but rather small and too round. 'AO92023-3' tubers were very nicely sized and shaped, but a little irregular with some growth cracks and knobs. 'Umatilla Russet' tubers were slightly irregular, with some knobs and curved tubers. 'Alturas' tubers were too round, with growth cracks and some pointed ends. 'AO90586-11' tubers were irregularly shaped, curved, and with some heart-shaped double tubers and scab. 'Wallowa' tubers were pointed, irregular, and curved. 'Klamath Russet' tubers were irregularly shaped, pointed, and had deep eyes and some folded bud ends. 'Russet Burbank' tubers were severely irregular, with knobs, pointed ends, curved tubers, and growth cracks. 'Shepody' tubers were very irregular in shape and size, with growth cracks, knobs, and scab.

Difference between Early and Late Harvests

These trials compared two matched sets of plots, grown in the same field but planted and harvested at different times. Any differences among the averages for varieties planted and harvested early when compared to the same variety planted and harvested late cannot be assigned a probability because the sources of variability cannot be evaluated. Some of the differences were large enough to raise questions that could be tested in future research.

In comparing the early- and late-harvest yields of the red-skinned varieties, 'Red LaSoda' increased 100 cwt/acre at the end of the season, mostly by bulking tubers larger than 10 oz. 'Mazama', on the other hand, had the least increase in tubers over 10 oz, suggesting there may be a genetic mechanism limiting tuber size in 'Mazama', a valuable trait in a red potato.

The high proportion of cull tubers in the early-harvest red trial, compared to the late harvest, may be because cool soil temperature at the early planting date slowed emergence and allowed early infection of stems, roots, and stolons with soil pathogens such as *Rhizoctonia* and *Verticillium*. Because the trials were harvested separately, they were on different irrigation zones in the drip system, and irrigation differences may have

led to excessive culls in the early-harvest red trial.

'Alturas Russet' had a large increase in yield of marketable tubers between early and late harvests, 73 cwt/acre. Late season productivity suggests healthier vines or roots in the later part of tuber bulking. Late season plant health may be a reflection of resistance to verticillium wilt or another pathogen that contributes to early vine death. All of the russets except 'Gem Russet' had increased specific gravity in the late-harvest trial. Harvested late, 'AO92023-3' was less productive in all tuber grades, possibly due to PVY infection in the seed, which was not discovered until after these trials had been conducted.

The yields of these drip-irrigated trials were greater in 2001 than in previous years (Shock, et al. 1999, 2000). In 2001, one difference was that the drip-irrigation system was used to inject nutrients that the petiole tests showed were becoming deficient in June and July. Other changes in procedure in 2001 were the use of a seed treatment dust with Gaucho insecticide, instead of Thimet granules in the seed furrow at planting, an aerial application on June 14 of a combination of metalaxyl and chlorothalonyl along with chelated micronutrient metals copper and manganese, and application of Matrix herbicide. Another difference was planting the trials in a field that had not grown a potato crop for 10 years. The 1999 trials were in a field that had grown potatoes in 1987, 1991, and 1995, and the 2000 trials were in a field that had grown potatoes in 1988, 1992, and 1996. The usual 4-year rotation at Malheur Experiment Station, with 3 years out of potatoes, is similar to the rotation used by some growers. Longer rotations out of potatoes can result in lower disease pressure and higher yields.

The automated drip-irrigation system applied 12.9 inches of water to the early-harvest trials in 2000, and 16.9 inches of water in 2001. On the late-harvest trials, the automated drip-irrigation system applied 20.3 inches of water to the trials in 2000, and 19.8 inches of water in 2001. Those differences in irrigation may also have influenced the differences seen in potato variety responses to early- and late-harvest in the 2 years.

References

Shock, C.C., E.P. Eldredge, and L.D. Saunders. 1999. Early and late harvest drip-irrigated red and russet varieties. Oregon State University Agricultural Experiment Station Special Report 1015:127-133.

Shock, C.C., E.P. Eldredge, and L.D. Saunders. 2000. Early and late harvest potato variety response to drip irrigation. Oregon State University Agricultural Experiment Station Special Report 1029:134-144.

Table 1. Red potato varieties harvested after 90 or 122 days of vine growth: yield, grade, and difference between the harvest dates. Malheur Experiment Station, Oregon State University, Ontario, OR 2001.

			U.S. No. 1						U.S. No. 2			
Variety	Total yield	Percent No. 1	Total No. 1	<10 oz	<2 oz	2 to 5 oz	5 to 10 oz	>10 oz	<10 oz	>10 oz	Cull	Rot
	cwt/acre	%	cwt/acre									
Early harvest												
CO89097-2	592	76.2	452	174	8	21	145	278	19	27	85	9
D. R. Norland	594	56.9	337	162	9	36	116	176	11	32	209	4
Mazama	598	82.3	492	296	6	47	243	196	9	41	54	3
NDO4300-1	590	72.7	428	230	8	47	176	198	13	45	99	5
Red LaSoda	595	43.5	258	138	20	43	75	121	10	37	287	2
Sangre 14	462	60.1	275	191	28	63	100	84	15	30	142	0
Winema	582	54.6	317	115	6	16	93	203	13	49	196	7
Yukon Gold	539	70.4	377	185	17	54	114	192	6	40	113	2
Mean	569	64.6	367	186	13	41	133	181	12	38	148	4
LSD (0.05)	57	7.3	39	38	6	15	31	43	7	NS	54	NS
Late harvest												
CO89097-2	625	94.8	591	192	4	30	158	400	1	30	1	1
D. R. Norland	632	96.2	608	234	5	38	191	374	3	20	1	1
Mazama	604	97.1	586	324	4	52	269	263	4	13	0	0
NDO4300-1	636	96.4	613	241	4	40	198	372	2	17	0	5
Red LaSoda	695	92.9	646	185	8	34	143	461	6	36	2	4
Sangre 14	547	86.9	475	192	7	40	145	283	2	70	0	0
Winema	547	93.8	514	145	2	22	121	368	7	24	2	0
Yukon Gold	537	96.9	520	193	2	30	161	327	2	14	0	0
Mean	603	94.4	569	213	5	36	173	356	3	28	1	2
LSD (0.05)	48	3.2	48	35	2	14	33	55	NS	18	NS	4
Difference												
CO89097-2	33	18.5	140	18	-4	9	13	121	-19	3	-84	-8
D. R. Norland	38	39.3	271	73	-4	1	75	198	-9	-12	-209	-3
Mazama	6	14.8	95	27	-3	4	26	67	-4	-27	-54	-3
NDO4300-1	46	23.7	184	11	-4	-7	22	174	-11	-29	-99	-0
Red LaSoda	100	49.4	388	48	-12	-8	68	340	-4	-1	-285	2
Sangre 14	85	26.8	201	1	-21	-23	46	200	-13	40	-142	0
Winema	-34	39.2	196	31	-4	6	28	166	-6	-25	-194	-7
Yukon Gold	-2	26.5	143	8	-14	-24	47	135	-4	-26	-113	-2
Mean	34	29.8	202	27	-8	-5	40	175	-9	-10	-147	-3

Table 2. Russet potato varieties harvested after 90 or 122 days of vine growth: yield, grade, and difference between the harvest dates. Malheur Experiment Station, Oregon State University, Ontario, OR 2001.

Variety	Total Yield	Percent No. 1	Total No. 1	Marketable	>12 oz	6 to 12 oz	4 to 6 oz	<4 oz	U.S. No. 2	cull	rot	Specific gravity	Stem-end fry color
	cwt/acre	%	---cwt/acre---										%
Early Harvest													
Alturas (A82360-7)	500	71.5	358	439	76	198	84	40	81	13	2	1.0816	48.6
A90586-11	555	62.8	347	492	145	164	39	24	145	30	2	1.0873	36.7
Wallowa (AO87277-6)	570	65.6	374	504	186	157	30	16	130	36	6	1.0896	42.8
AO92023-3	605	77.5	469	550	335	119	16	10	80	33	5	1.0764	36.8
Gem Russet (A8495-1)	536	83.7	449	478	115	260	74	39	30	3	8	1.0887	48.5
Klamath R(AO85165-1)	600	67.8	406	544	214	166	26	28	137	18	3	1.0714	31.0
Russet Burbank	571	35.9	204	406	72	101	30	28	202	127	3	1.0774	30.6
Shepody	525	51.8	273	420	163	89	21	8	147	86	5	1.0809	41.9
Umatilla Russet	569	67.0	382	491	228	120	33	13	109	53	5	1.0860	41.7
Mean	559	64.9	362	481	171	153	39	23	118	44	4	1.0821	39.9
LSD (0.05)	40	7.0	48	40	35	33	26	8	34	24	NS	0.0043	3.4
Late harvest													
Alturas (A82360-7)	611	70.6	431	512	84	217.7	129	61	81	38	0	1.0859	49.0
A90586-11	614	63.4	389	540	199	150	40	19	151	52	3	1.0960	30.8
Wallowa (AO87277-6)	602	71.8	432	553	205	194	33	12	121	35	1	1.0924	39.2
AO92023-3	545	75.1	410	479	311	81	19	10	69	55	1	1.0788	31.7
Gem Russet (A8495-1)	514	86.4	444	468	129	220	96	35	24	10	1	1.0861	47.6
Klamath R(AO85165-1)	608	66.3	401.6	535	237	126	38	23	133	50	0	1.0722	31.4
Russet Burbank	632	34.3	217	410	103	81	33	30	193	169	24	1.0792	33.1
Shepody	512	52.7	267	385	135	102	31	10	117	118	0	1.0864	36.2
Umatilla Russet	577	61.1	353	479	214	110	29	15	126	82	1	1.0854	42.0
Mean	580	64.6	372	485	180	142	50	24	113	68	3	1.0847	37.9
LSD (0.05)	49	7.5	47	48	40	24	16	10	42	34	4	0.0062	7.5
Difference													
Alturas (A82360-7)	112	-0.9	73	74	8	20	46	21	1	26	-2	0.0043	0.3
A90586-11	59	0.7	42	48	54	-14	2	-5	7	22	1	0.0087	-6.0
Wallowa (AO87277-6)	32	6.2	58	49	19	37	3	-4	-9	-1	-5	0.0028	-3.6
AO92023-3	-60	-2.4	-60	-71	-24	-39	3	0	-11	22	-4	0.0025	-5.2
Gem Russet (A8495-1)	-21	2.7	-4	-10	14	-40	22	-3	-6	6	-7	-0.0026	-0.8
Klamath R(AO85165-1)	8	-1.6	-5	-10	23	-40	12	-5	-5	33	-3	0.0008	0.4
Russet Burbank	62	-1.6	13	4	31	-20	2	3	-10	42	21	0.0018	2.6
Shepody	-13	0.9	-6	-36	-29	13	10	2	-30	32	-4	0.0055	-5.7
Umatilla Russet	8	-5.9	-29	-12	-13	-10	-5	2	17	29	-4	-0.0006	0.4
Mean	21	-0.2	9	4	9	-10	10	1	-5	23	-1	0.0026	-2.0