EFFECT OF IRRIGATION SYSTEMS AND CULTURAL PRACTICES ON POTATO PERFORMANCE

Andre B. Pereira, Clinton C. Shock, Eric P. Eldredge,
Cedric A. Shock, and Lamont D. Saunders
Malheur Experiment Station
Oregon State University
Ontario, OR

Introduction

Methods of irrigation used in potato production must ensure adequate and uniform application of water with minimum losses, such as deep percolation and runoff. Maintenance of a proper balance between soil water and soil air in the root zone for ideal root and tuber growth can be achieved by careful management of irrigation scheduling with properly designed furrow-, sprinkler-, and drip-irrigation systems.

Surveys of growers in the Treasure Valley of southeastern Oregon and southeastern Idaho indicated that 'Russet Burbank' tends to produce better quality tubers under sprinkler irrigation than with furrow irrigation (Shock et al. 1989, Trout et al. 1994). Shock conducted two replicated plot trials and two field demonstrations in growers' fields and Trout et al. (1994) carried out irrigation plot studies over 3 years on two sites to determine if the differences observed between sprinkler and furrow were an inherent result of the irrigation method. With precise irrigation scheduling, irrigation method did not affect yields, but sprinkler irrigation produced tubers with slightly better grade and much lower incidence of sugar ends.

Although potato is still most often irrigated using sprinkler irrigation, drip systems are used in potato production in a few areas where water is in short supply. Sammis (1980) compared sprinkler, surface drip, subsurface drip, and furrow irrigation for the production of potato and lettuce in New Mexico. The subsurface drip system with an irrigation criterion, meaning the point at which the next irrigation must be applied, corresponding to a soil water tension (SWT) of 20 kPa was the most productive among the irrigation systems assessed.

Shock et al. (2002) investigated the performance of 'Umatilla Russet' under drip irrigation in silt loam. The factors considered in the study were tape placement (one tape per row or one tape per two rows) and four SWT levels for automatically starting irrigation (15, 30, 45, and 60 kPa). Tape placement and irrigation criterion interacted to influence total yield, total marketable potatoes, and U.S. No. 2 yield. Results from this study indicated that potato should be irrigated at 30 kPa SWT, given the silt loam soil and 2.5 mm water applied at each irrigation. Eldredge et al. (1996) and Shock et al. (2002) determined that the ideal potato SWT irrigation criterion for furrow and sprinkler irrigation was 50-60 kPa on silt loam in the Treasure Valley.

Over the last 4-5 years, drip-irrigated potato trials carried out at the Malheur Experiment Station (MES) have shown reasonable tuber yields and grade (Shock et al. 2002, 2004, 2005; Akin et al. 2003). Although potato production normally uses hilled planting, our drip-irrigated trials have used flat beds. The flat beds have been used by preference, since we have studied the relative lateral placement of potato rows and drip tapes (Shock et al. 2002, 2004, 2005) along with other variables. If growers were to adopt drip irrigation, it would be more convenient if they could use drip irrigation in normal hilled beds.

Consequently, in 2004 hilled beds for sprinkler- and drip-irrigated potatoes were compared with flat beds with drip-irrigated potatoes (Shock et al. 2005). Potatoes planted in flat beds with one drip tape above the rows were more productive and of better quality than drip-irrigated potatoes grown in conventional beds. These results led us to propose that part of the benefits in potato quality observed with drip irrigation at Ontario over the past years might be associated with flat bed configuration and not with drip irrigation alone, per se.

Midmore et al. (1986) showed that mulch increased tuber yield by 20 percent during the summer in Peru. In the same country, Manrique and Meyer (1984) studied the impact of mulch on potato production during winter and summer seasons and found no effect on yields during the winter, but observed yield increases of 58 percent and improvements in soil moisture retention in the summer with surface mulch. Mahmood et al. (2002) reported that the use of mulch in Pakistan decreased daily maximum soil temperature at 6-inch depth, resulting in faster emergence, earlier canopy development, and higher tuber yields.

Since tuber yield and grade are affected by soil water status and heat stress, the main goal of this research was to investigate whether irrigation systems, irrigation criteria, bed configuration, and use of straw mulch can generate differences in soil temperature regime around the developing tubers, and quantify the influence of such management practice factors on the performance of six potato cultivars grown during the crop season of 2005 at Ontario, Oregon.

Materials and Methods

The soil preparation for this trial differed from our usual practices. The soil was too wet to work or fumigate in the fall of 2004. Vapam® was applied at 75 gal/acre via sprinklers on March 3, 2005 and the field was spring bedded in April prior to planting. The summer weather pattern in 2005 was similar to 2004 and also similar to the 10- and 60-year averages.

Six irrigation and bed configuration treatments were chosen to try to use irrigation system, bed design, irrigation criteria, and straw mulch to reduce soil temperature, as described below:

T_1 - Sprinkler irrigation, potato seeds planted in ordinary beds (rows bedded into 36-inch hills), with irrigation starting whenever the SWT was equal to 60 kPa;
T_2 – Drip irrigation, potato seeds planted in flat beds, with irrigation criterion based on a SWT of 30 kPa, with the expectation that the total irrigation amounts would correspond to about 70 percent of crop evapotranspiration (ET_c);
T_3 – Drip irrigation, potato seeds planted in flat beds, with daily irrigation matching ET_c;
T_4 – Furrow irrigation, seeds planted in ordinary beds, with irrigation starting when SWT reached a threshold of 60 kPa;
T_5 – Sprinkler irrigation, seeds planted flat in 36-inch rows, irrigation criterion of 60 kPa, and with irrigation amounts to match ET_c;
T_6 – Sprinkler irrigation, seeds planted flat in 36-inch rows, with irrigation starting at a SWT of 60 kPa, soil receiving 2,000 lb/acre of straw mulch at tuber initiation (on June 6), and irrigation amounts to match ET_c.

All 6 treatments were replicated 7 times and the experimental design was split plot in a randomized complete block design, with a total of 42 plots and 252 subplots.

Six potato cultivars ('Russet Burbank', 'Ranger Russet', 'Umatilla Russet', 'GemStar Russet', 'A92294-6', and 'A93157-6LS') were planted on April 19, 2005 in 42 12-ft-wide strips, each 90 ft long at MES, Oregon State University, in Ontario, Oregon. The planted harvest area of each cultivar was 30 seed pieces long.

Potato seed pieces (45 g) were treated with Tops-MZ + Gaucho® dust 1-2 weeks before planting, and then planted using a 2-row cup planter with 9-inch seed spacing in 36-inch rows. Planting depth was adjusted to plant the seed in each flat bed plot deeper than the seed was planted in each hilled treatment plot. After planting, hills were formed over the rows with a Lilliston rolling cultivator for the hilled treatment and a bed harrow for the flat bed treatments. Prowl® at 1 lb/acre plus Dual® at 2 lb/acre herbicide was applied as a tank mix for weed control on May 2 and was incorporated by 1.7 inch of rain over the following 10 days.

The soil temperature was measured continuously throughout the growing season in every plot at 4-inch depth below the surface in the plant row among the developing tubers using Hobo soil thermometers and dataloggers. Twelve of the plots had two additional temperature sensors at 4- and 8-inch depth on NASA SensorWeb Pods (NASA Jet Propulsion Lab, Pasadena, CA). Four pods were located in each of the sprinkler-, drip-, and furrow-irrigated potato plots.

The SWT was measured by granular matrix sensors (GMS, Watermark soil moisture sensors model 200SS, Irrometer, Co., Riverside, CA) at six locations in every plot at 8-inch depth below the surface in the plant row. Sensor data were read automatically using CR10 and 21X dataloggers and multiplexers (Campbell Scientific, Logan, UT). The GMS had been previously calibrated to SWT using tensiometers fitted with pressure transducers (Shock et al. 1998).

Irrigation episodes were scheduled to avoid SWT in the root zone exceeding the threshold of 30 kPa under drip system for treatments 2 and 3, and of 60 kPa under furrow- and sprinkler-irrigation systems for treatments 1, 4, 5, and 6. Crop evapotranspiration (ET_c) was estimated by an automated AgriMet (U.S. Bureau of Reclamation, Boise, ID) station located about 0.25 miles from the trial on the Malheur Experiment Station.

Fungicide applications to control early blight and prevent late blight infection started with an aerial application of Ridomil Gold® and Bravo® at 1.5 pt/acre on June 13. On June 18, Endura® plus Dithane® was applied; on June 28, Dithane fungicide plus liquid sulfur with 6 lb phosphate (P_2O_5)/acre was applied on June 28. On July 20, Bravo was applied again on July 20 and September 6. Dithane plus Tanos® was applied July 28. To prevent two-spotted spider mite and powdery mildew infestation, 6 lb sulfur (S)/acre was applied on August 20.

Petiole tests were taken from Russet Burbank plants every 2 weeks starting on June 13 for the sprinkler-, furrow-, and drip-irrigated potatoes. Potatoes in each irrigation system received nutrients in accordance with the petiole analyses. A total of 100 lb nitrogen (N)/acre, 40 lb P_2O_5/acre, 20 lb potash (K_2O)/acre, 30 lb sulfate (SO_4)/acre, 3.5 lb magnesium (Mg)/acre, 0.55 lb zinc (Zn)/acre, 0.8 lb manganese (Mn)/acre, 0.05 lb copper (Cu)/acre, 0.1 lb iron (Fe), and 0.02 lb boron (B)/acre was applied via drip irrigation system. The furrow-irrigated potatoes received 100 lb N/acre, 30 lb P_2O_5/acre, 10 lb SO_4/acre, 10 lb Mg/acre, 0.25 lb Zn/acre, 0.5 lb Mn/acre, and the sprinkler-irrigated potatoes received 100 lb N/acre, 50 lb P_2O_5/acre, 20 lb K_2O/acre, 4.5 lb SO_4/acre, 5 lb Mg/acre, 0.3 lb Zn/acre, 0.55 lb Mn/acre, 0.05 lb Cu/acre, 0.1 lb Fe/acre, and 0.02 lb B/acre.

Vines were flailed on September 27 and tubers were harvested on October 18-21 from each replicate, and graded by the U.S. No. 1 and No. 2 for processing standards, sorted by weight, and weighed in each size category. Specific gravity and length-to-width ratio were measured using a sample of 10 tubers. Stem and bud ends fry color was measured on a sample of 20 tubers frying in 375°F soybean oil for 3.5 minutes from a sample of 20 tubers from each cultivar of every irrigation plot. Fry colors were read using a Photovolt Reflectance Meter model 577 (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. Visual evaluations included observations of desirable traits, such as a high yield of large, smooth, uniformly shaped and sized, oblong to long, attractively russeted tubers, with shallow eyes evenly distributed over the tuber length.

Data were analyzed with the General Linear Models analysis of variance procedure in NCSS (Number Cruncher Statistical Systems, Kaysville, UT) using the Fisher's Protected LSD means separation t-test at the 95 percent confidence level.

Results and Discussion

The results and discussion have not been formulated. Most of the data have not been evaluated yet. However, from the potato quality data (Table 1) we observe the following:

Irrigation systems and hilled rows made clear differences in potato performance among the cultivars studied. The drip-irrigation systems were the most conducive to the production of U.S. No. 1 tubers and the furrow irrigation system was the least conducive. Furrow irrigation was the least productive system tested. There was a tendency for flat beds to be advantageous compared to hilled rows. Not all of the statistical comparisons have been made.

None of the varieties tested expressed hollow heart, brown center, internal brownspot, or vascular discoloration in any of the irrigation treatments. The absence of these internal defects is commonplace for potato grown at MES.

The experimental line A93157-6LS was highly productive in every management system and averaged 73 percent U.S. No. 1 tubers under both sprinkler and furrow irrigation, but there were 81 percent U.S. No. 1 tubers under drip irrigation, significantly more, regardless of the irrigation criteria adopted.

As in previous years, the experimental line A92294-6 had very high total and marketable yield under drip irrigation and about 70 percent U.S. No. 1 yield. The total and marketable yields of cultivar A92294-6 were similar between drip- and sprinkler-irrigated treatments with flat beds, but with sprinklers, the proportion of U.S. No. 1 tubers was only 55 percent.

Under drip irrigation, the difference in irrigation criteria did not show effects on total and marketable yields. Therefore, the application of full ET_c for drip-irrigation systems may not be needed to maximize potato yield and optimize crop water use. Firm conclusions will have to wait for the evaluations of how much water was actually applied to each treatment.

As to mulching, there was a tendency for the straw mulch treatment to be advantageous compared to non-strawed potatoes. Nevertheless, further statistical analyses, taking into consideration soil temperature and moisture, need to be made to allow for more consistent inferences on the beneficial effect of mulching for potato production at Ontario. One result is clear: tubers from Umatilla Russet and A93157-6LS sprinkler-irrigated mulched rows planted flat were smoother than conventional sprinkler-irrigated hilled rows without mulch.

Acknowledgements

We would like to thank Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq) of Brazil for providing a Post-Doctoral scholarship, sabbatical leave granted by the State University of Ponta Grossa, a special grant by the Agricultural Research Foundation of Oregon State University (OSU), equipment donated by NASA Jet Propulsion Laboratory, and also OSU for the logistical support that enabled the completion of this research. Potato seed were both purchased and provided by Rich Novy of ARS Aberdeen, Idaho, and Steve James of the Oregon Potato Development Project, Powell Butte, Oregon.

References

Akin, A.I., L.A. Unlenen, E.P. Eldredge, C.C. Shock, E.B.G. Feibert, and L.D. Saunders. 2003. Processing potato production with low flow drip tape or ultra-low flow tape. Oregon State University Agricultural Experiment Station Special Report 1048:167-172.

Eldredge, E.P., Z.A. Holmes, A.R. Mosley, C.C. Shock, and T.D. Stieber. 1996. Effects of transitory water stress on potato tuber stem-end reducing sugar and fry color. Am. Potato J. 73:517-530.

Mahmood, M.M, K. Farooq, A. Hussain, and R. Sher. 2002. Effect of mulching on growth and yield of potato crop. Asian J. Plant Sci. 1:132-133.

Manrique, L.A., and R.E. Meyer. 1984. Effect of soil mulches on soil temperature, plant growth and potato yields in an aridic isothermic environment in Peru. Turrialba 34:413-420.

Midmore, D.J., J. Roca, and D. Berrios. 1986. Potato (*Solanum* spp) in the hot tropics. III. Influence of mulch on weed growth, crop development, and yield in contrasting environments. Field Crops Res. 15:109-124.

National Aeronautics and Space Administration (NASA). 2005. Available online at http://sensorwebs.jpl.nasa.gov

Sammis, T.W. 1980. Comparison of sprinkler, trickle, subsurface and furrow irrigation methods for row crops. Agron. J. 72:701-704.

Shock, C.C., J. Barnum, and M. Seddigh. 1998. Calibration of Watermark soil moisture sensors for irrigation management. Irrigation Association. Pages 139-146 *in* Proceedings of the International Irrigation Show. San Diego, CA.

Shock, C.C, E.P. Eldredge, and A.B. Pereira. 2005. Planting configuration and plant population effects on drip-irrigated Umatilla Russet yield and grade. Oregon State University Agricultural Experiment Station Special Report 1062:156-165.

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.

Shock, C.C., E.P. Eldredge, and L.D. Saunders. 2004. Planting configuration and plant population effects on drip-irrigated Umatilla Russet yield and grade. Oregon State University Agricultural Experiment Station Special Report 1055:182-186.

Shock, C.C., L.B. Jensen, T.D. Steiber, E.P. Eldredge, J. Vomocil, and Z.A. Holmes. 1989. Cultural practices that decrease potato dark-ends. Oregon State University Agricultural Experiment Station Special Report 848:1-8.

Trout, T.J., D.C. Kincaid, and D.T. Westernmann. 1994. Comparison of 'Russet Burbank' yield and quality under furrow and sprinkler irrigation. Am. Potato J. 71:15-28.

Table 1. Tuber yield, grade, and processing quality of potato entries affected by irrigation systems and cultivars at Malheur Agricultural Experiment Station, Oregon State University, Ontario, OR, 2006. Drip-irrigation system was operated using two different irrigation criteria and sprinkler-irrigation system was evaluated with conventional beds, flat beds, and flat beds with straw mulch.

				Yield by grade category											Fry color		
Irrigation system + criteria	Cultivar	Total yield	Total marketable	U.S. No.1	Total No. 1	>12 oz	6-12 oz	4-6 oz	U.S. No.2	<4 oz	Cull	Rot	Length/ width	Specific gravity	Stem end	Bud end	Average
		--- cwt/acre ---		%	--- cwt/acre ---								ratio	g cm^{-3}	--- % light reflectance ---		
Sprinkler + hilled bed + ET_c at SWT 60 kPa	R. Burbank	668	512	17	117	25	63	29	396	96	8	52	2.10	1.074	36	42	39.0
	Ranger R.	633	534	55	350	121	171	58	185	81	13	5	2.00	1.089	44	45	44.5
	Umatilla R.	620	535	50	309	109	153	47	226	79	6	0	1.90	1.092	49	48	48.5
	GemStar	300	272	69	207	130	56	21	65	28	0	0	1.67	1.087	55	54	54.5
	A92294-6	688	610	53	367	119	195	53	243	68	3	7	1.96	1.101	56	55	55.6
	A93157-6LS	680	623	73	499	228	218	53	124	54	2	1	1.84	1.091	48	44	46.0
	Mean	598	515	53	308	122	143	43	206	68	5	10	1.91	1.089	48	48	48.0
Drip + flat bed + ET_c at SWT 30 kPa	R. Burbank	696	596	52	364	107	191	67	232	84	14	1	1.96	1.080	39	41	40.0
	Ranger R.	639	582	69	444	229	173	42	138	51	6	0	1.92	1.094	45	44	44.5
	Umatilla R.	624	543	67	415	157	198	60	128	71	10	1	1.85	1.089	47	45	46.0
	GemStar	297	270	82	245	148	72	25	25	26	0	1	1.69	1.084	50	51	50.5
	A92294-6	752	684	71	535	109	335	92	149	68	0	0	1.94	1.103	55	53	54.0
	A93157-6LS	688	641	81	553	219	275	58	89	40	7	0	1.86	1.096	46	43	44.5
	Mean	616	553	70	426	161	207	57	127	57	6	1	1.87	1.091	47	46	46.5
Furrow + hilled bed + SWT at 60 kPa	R. Burbank	619	502	20	124	18	67	40	378	79	7	30	2.10	1.081	35	42	38.5
	Ranger R.	541	478	50	270	103	121	46	208	52	8	3	2.05	1.096	44	45	44.5
	Umatilla R.	514	447	47	241	66	128	47	207	64	1	1	1.98	1.093	46	46	46.0
	GemStar	248	216	62	158	76	60	22	58	25	0	7	1.83	1.091	54	53	53.5
	A92294-6	680	605	49	334	69	206	60	271	54	1	20	2.14	1.101	50	51	50.5
	A93157-6LS	593	550	73	434	191	199	44	117	34	4	4	1.93	1.098	45	43	44.0
	Mean	532	467	50	260	87	130	43	207	51	4	11	2.00	1.093	46	47	46.5

Table 1. Continued. Tuber yield, grade, and processing quality of potato entries affected by irrigation systems and cultivars at Malheur Agricultural Experiment Station, Oregon State University, Ontario, OR, 2006. Drip-irrigation system was operated using two different irrigation criteria and sprinkler-irrigation system was evaluated with conventional beds, flat beds, and flat beds with straw mulch.

Irrigation system + criteria	Cultivar	Total yield	Total market-able	Yield by grade category									Length/ width	Specific gravity	Fry color		
				U.S. No.1	Total No. 1	>12 oz	6-12 oz	4-6 oz	U.S. No.2	<4 oz	Cull	Rot			Stem end	Bud end	Average
		--- cwt/acre ---		%	---------- cwt/acre ----------								ratio	g cm^{-3}	--- % light reflectance ---		
Drip + flat bed + ET_c at SWT 30 kPa	R. Burbank	696	596	52	364	107	191	67	232	84	14	1	1.96	1.080	39	41	40.0
	Ranger R.	639	582	69	444	229	173	42	138	51	6	0	1.92	1.094	45	44	44.5
	Umatilla R.	624	543	67	415	157	198	60	128	71	10	1	1.85	1.089	47	45	46.0
	GemStar	297	270	82	245	148	72	25	25	26	0	1	1.69	1.084	50	51	50.5
	A92294-6	752	684	71	535	109	335	92	149	68	0	0	1.94	1.103	55	53	54.0
	A93157-6LS	688	641	81	553	219	275	58	89	40	7	0	1.86	1.096	46	43	44.5
	Mean	616	553	70	426	161	207	57	127	57	6	1	1.87	1.091	47	46	46.5
Drip + flat bed + 70% ET_c at SWT 30 kPa	R. Burbank	638	552	59	370	74	219	77	182	83	3	0	1.93	1.075	36	41	38.5
	Ranger R.	603	554	73	444	251	144	50	110	48	1	0	1.87	1.093	45	43	44.0
	Umatilla R.	530	469	71	379	132	184	64	91	60	0	0	1.93	1.088	47	45	46.0
	GemStar	398	370	81	327	215	84	28	43	29	0	0	1.71	1.088	52	51	51.5
	A92294-6	749	679	69	516	153	287	76	163	70	0	1	1.85	1.099	54	53	53.5
	A93157-6LS	699	654	81	562	248	258	56	93	43	0	2	1.81	1.095	46	42	44.0
	Mean	603	547	72	433	179	196	58	114	55	1	0	1.85	1.090	46	46	46.0
Sprinkler + hilled bed + ET_c at SWT 60 kPa	R. Burbank	668	512	17	117	25	63	29	396	96	8	52	2.10	1.074	36	42	39.0
	Ranger R.	633	534	55	350	121	171	58	185	81	13	5	2.00	1.089	44	45	44.5
	Umatilla R.	620	535	50	309	109	153	47	226	79	6	0	1.90	1.092	49	48	48.5
	GemStar	300	272	69	207	130	56	21	65	28	0	0	1.67	1.087	55	54	54.5
	A92294-6	688	610	53	367	119	195	53	243	68	3	7	1.96	1.101	56	55	55.5
	A93157-6LS	680	623	73	499	228	218	53	124	54	2	1	1.84	1.091	48	44	46.0
	Mean	598	515	53	308	122	143	43	206	68	5	10	1.91	1.089	48	48	48.0

Table 1. Continued. Tuber yield, grade, and processing quality of potato entries affected by irrigation systems and cultivars at Malheur Agricultural Experiment Station, Oregon State University, Ontario, OR, 2006. Drip-irrigation system was operated using two different irrigation criteria and sprinkler-irrigation system was evaluated with conventional beds, flat beds, and flat beds with straw mulch.

Irrigation system + criteria	Cultivar	Total yield	Total marketable	Yield by grade category: U.S. No.1	Total No. 1	>12 oz	6-12 oz	4-6 oz	U.S. No.2	<4 oz	Cull	Rot	Length/ width	Specific gravity	Fry color: Stem end	Bud end	Average
		--- cwt/acre ---		%	cwt/acre								ratio	g cm^{-3}	--- % light reflectance ---		
Sprinkler + flat bed + ET_c at SWT 60 kPa	R. Burbank	673	572	28	193	51	102	40	380	91	5	4	2.08	1.080	37	42	39.5
	Ranger R.	631	561	56	359	146	170	43	202	60	10	0	1.92	1.091	45	44	44.5
	Umatilla R.	620	526	54	333	127	162	44	193	84	10	0	1.92	1.093	47	46	46.5
	GemStar	287	264	73	209	122	64	24	55	23	0	0	1.77	1.085	53	53	53.0
	A92294-6	739	664	55	408	122	223	63	256	70	0	5	1.89	1.104	55	55	55.0
	A93157-6LS	691	628	71	489	205	217	67	140	55	8	0	1.79	1.091	48	44	46.0
	Mean	607	536	56	332	129	157	47	204	64	5	2	1.90	1.091	47	47	47.0
Sprinkler + flat bed + straw + ET_c at SWT 60 kPa	R. Burbank	679	572	28	188	57	93	38	385	92	10	5	2.23	1.076	36	43	39.5
	Ranger R.	693	625	57	385	172	160	53	240	56	11	1	1.91	1.093	47	46	46.5
	Umatilla R.	634	559	60	383	149	182	52	176	69	7	0	1.96	1.092	48	47	47.5
	GemStar	257	229	80	202	132	51	19	27	25	3	0	1.69	1.086	54	54	54.0
	A92294-6	754	680	55	422	157	204	60	259	68	4	2	1.99	1.105	56	56	56.0
	A93157-6LS	672	627	74	498	259	196	43	130	42	3	0	1.87	1.092	47	44	45.5
	Mean	615	549	59	346	154	147	44	203	59	6	1	1.94	1.091	48	48	48.0
Overall mean		595	528	60	351	139	163	49	177	59	5	4	1.91	1.091	47	47	47
LSD (0.05) Irrigation		44.3	49.2	3.8	41.9	32.4	16.4	6.6	28.6	10	NS	7.8	0.1	NS	1.7	1.3	-
LSD (0.05) Cultivar		36.4	36	2.4	27.7	22.5	14.6	6.4	19.2	6.7	3.7	5.1	0.1	NS	1.2	1.0	-
LSD (0.05) I x C		NS	NS	5.9	NS	NS	35.7	16	47	NS	NS	NS	NS	NS	NS	NS	-