

EFFECT OF HARVEST TIMING ON ONION YIELD AND STORABILITY, 2009

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Introduction

Onion harvest for long-day varieties in the Treasure Valley generally extends from mid-August into early October. Optimal dates for onion harvest are not known. Harvest timing guidelines (calendar date or percentage of tops that are down) need to be determined. The effect of harvest timing on yield at harvest and storage losses due to decomposition is unknown. This trial evaluated the effect of harvest timing on bulb yield and storability.

Materials and Methods

Trials were conducted in furrow- and drip-irrigated fields at the Malheur Experiment Station in 2008 with storage prolonged into 2009. The furrow-irrigated field was managed to maintain soil water tension below 25 cb. The last irrigation was on August 27. Varieties 'Calibra' (Bejo), 'Montero' (Nunhems), and 'Joaquin' (Nunhems) were replicated five times. The drip-irrigated field was managed with three irrigation criteria: 10, 20, and 30 cb. Varieties 'Vaquero' (Nunhems) and Joaquin were sampled from each irrigation treatment (10, 20, and 30 cb) and were replicated four times at each irrigation criterion. The last irrigation was on September 5. Optimal soil water tension for onions on silt loam is in the range of 20-25 cb for furrow irrigation and 15-20 cb for drip irrigation (Shock et al. 2005).

Each sample consisted of all bulbs from 6.8 ft of one double row in each 23-ft long, four double-row plot. The samples were taken weekly starting on August 15 and ending on September 12. The bulbs from each sample were topped, put in burlap bags, and placed on bare dry soil adjacent to the field to cure for 7 days. After curing the bulbs were graded. During grading, bulbs were separated according to quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), neck rot (bulbs infected with the fungus *Botrytis allii* in the neck or side), plate rot (bulbs infected with the fungus *Fusarium oxysporum*), and black mold (bulbs infected with the fungus *Aspergillus niger*). The No. 1 bulbs were graded according to diameter: small (<2.25 inches), medium (2.25-3 inches), jumbo (3-4 inches), colossal (4-4.25 inches), and supercolossal (>4.25 inches). Bulb counts per 50 lb of supercolossal onions were determined for each plot of every variety by weighing

and counting all supercolossal bulbs during grading. At each sampling date, the onions in each plot were visually rated for the percentage of tops that were down.

After grading, one slice from each of ten bulbs from each sample was placed in a pre-weighed can for each plot. The wet onion tissue plus can was weighed, dried in a forced-air oven at 140°F, and weighed again. The remaining bulb sample was weighed again and put in a cooler at 34°F. Starting on October 21, all samples were taken out of storage monthly and the rotten bulbs from each sample were removed and weighed. The remaining sample was weighed and put back in storage. The final weighing and removal of rotten bulbs was on February 25, 2009. The actual total storage durations were 6.25, 6, 5.75, 5.5, and 5.25 months for the August 15, August 22, August 29, September 5, and September 12 harvests, respectively.

Results and Discussion

Yield

Furrow-irrigated Field

For Calibra and Montero, most of the tops were down by September 5 (Table 1). For Joaquin, the highest percentage of tops down occurred at the last harvest date of September 12. Marketable yield at harvest increased up to September 5 for Joaquin and Montero. The percentage of tops down on September 5 was 22 percent for Joaquin and 84 percent for Montero. Marketable yield of Calibra at harvest did not significantly increase after the first harvest date of August 15. From the first harvest on August 15 to the last harvest on September 12, the percentage of tops down for Calibra ranged from 20 to 90 percent and marketable yield at harvest ranged from 523 to 576 cwt/acre.

For Calibra and Montero, total yield after storage increased as the percentage of tops down at harvest increased (Fig. 1). For Joaquin, yield after storage was highest when onions were harvested with 27 percent tops down.

Averaged over the three varieties, the percentage of tops down increased up to the last harvest date of September 12 (70 percent tops down). Surprisingly, averaged over the three varieties, total yield after 5 months of storage increased up to the last harvest date of September 12. Averaged over the three varieties, the percent total losses during storage decreased with successive harvest date and were lowest at the last harvest date, September 12.

Drip-irrigated Field

Averaged over irrigation treatments, the percentage of tops down continued to increase up to the last harvest date of September 12 for Vaquero and Joaquin (Table 2). Averaged over irrigation treatments and varieties, the percentage of tops down increased up to the last harvest on September 12. Averaged over irrigation treatments and varieties, marketable yield at harvest did not significantly increase after September 5. Averaged over irrigation treatments and varieties, total yield and losses after storage were similar for the first three harvest dates (Aug. 15, 22, and 29). Total yield after

storage was significantly higher for the September 5 and September 12 harvests. Storage losses were lowest with the last harvest on September 12.

For Vaquero and Joaquin, averaged over irrigation treatments, total yield after storage increased as the percentage of tops down at harvest increased (Fig. 2).

Bulb Nutrient Content

Furrow-irrigated Field

Averaged over varieties, there were significant differences in bulb nutrient content between harvest dates for P, K, S, Ca, Mg, Zn, and Mn (Table 3). However, only Ca content showed a clear trend in response to harvest date. Calcium content decreased with successive harvest date.

Drip-irrigated Field

Averaged over varieties and irrigation regimes, there were significant differences in bulb nutrient content between harvest dates for P, K, S, Ca, Mg, Zn, and Mn (Table 4). However, only P, S, Ca, Mg, and Mn content showed a clear trend of decreasing nutrient content with successive harvest date.

Conclusions

For furrow-irrigated onions, yields at harvest did not increase after the August 29 harvest, about 2 days after the last irrigation on August 27. For long term storage of furrow irrigated onion, harvest needed to be delayed until September 12, about two weeks after the last irrigation. For the drip-irrigated onions, yields increased until September 5, the same date as the last irrigation. For the drip-irrigated onions, storage losses were lowest at the last harvest on September 12, about 1 week after the last irrigation.

References

Shock, C.C., R. Flock, E. Feibert, C.A. Shock, A. Pereira, and L. Jensen. 2005. Irrigation monitoring using soil water tension. Oregon State University Extension Service EM 8900.

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Table 1. Yield and grade for three furrow-irrigated onion varieties harvested on five dates in 2008, and marketable yield after storage ending on February 25, 2009. Malheur Experiment Station, Oregon State University, Ontario, OR.

Harvest date	At harvest						After storage to February 25		
	Tops down	Marketable yield by grade					Total yield	Marketable yield out of storage	Storage loss
		>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Total			
%	cwt/acre					%			
Calibra									
Aug. 15	20.0	0.0	0.0	364.5	158.9	523.4	548.5	285.3	48.3
Aug. 22	54.0	16.1	37.9	395.5	108.6	558.1	573.5	316.6	45.7
Aug. 29	68.0	0.0	0.0	540.1	50.1	590.2	601.0	384.6	36.0
Sept. 5	86.0	0.0	6.2	524.7	45.5	576.3	576.8	484.6	16.0
Sept. 12	90.0	0.0	7.7	503.1	64.7	575.5	594.8	546.0	8.4
average	63.6	3.2	10.4	465.6	85.6	564.7	578.9	403.4	30.9
Joaquin									
Aug. 15	5.0	0.0	63.7	472.5	74.2	610.3	616.2	350.9	42.1
Aug. 22	10.0	36.2	62.4	512.4	81.2	692.2	703.9	397.0	43.5
Aug. 29	16.0	10.8	184.1	656.4	18.5	869.8	879.9	550.4	26.8
Sept. 5	22.0	85.5	259.6	439.2	8.6	792.9	808.7	500.1	28.4
Sept. 12	32.0	28.5	263.5	453.8	2.5	748.3	763.7	610.5	16.6
average	17.0	32.2	166.7	506.8	37.0	742.7	754.5	481.8	31.5
Montero									
Aug. 15	16.0	0.0	4.1	491.9	62.3	558.3	569.7	343.8	40.2
Aug. 22	48.0	0.0	14.0	568.7	37.2	620.0	632.7	371.7	34.7
Aug. 29	66.0	0.0	26.2	577.1	24.7	627.9	636.1	442.5	30.7
Sept. 5	84.0	0.0	58.6	627.9	27.1	713.6	713.9	500.5	29.9
Sept. 12	90.0	0.0	67.8	592.5	34.7	694.9	704.2	645.6	8.3
average	60.8	0.0	34.1	571.6	37.2	642.9	651.3	460.8	28.7
Average									
Aug. 15	13.7	0.0	22.6	443.0	98.5	564.0	578.1	326.7	43.5
Aug. 22	37.3	17.4	38.1	492.2	75.6	623.4	636.7	361.7	41.8
Aug. 29	50.0	3.6	70.1	591.2	31.1	696.0	705.6	459.2	31.5
Sept. 5	64.0	28.5	108.1	530.6	27.1	694.3	699.8	495.1	23.8
Sept. 12	70.7	9.5	113.0	516.5	34.0	672.9	687.6	600.7	10.7
LSD (0.05)									
Variety	5.4	NS	66.1	76.2	29.3	80.1	73.6	50.6	NS
Harvest date	3.6	NS	47.3	60.0	30.8	47.6	48.0	66.7	9.9
Variety X harv. date	6.3	NS	81.9	104.0	NS	82.5	83.2	NS	NS

Table 2. Yield and grade for two onion varieties submitted to three drip-irrigation regimes and harvested on five dates in 2008, and marketable yield after storage ending on February 25, 2009. Oregon State University, Ontario, OR.

Harvest date	At harvest						After storage to February 25		
	Tops down %	Marketable yield by grade					Total yield	Marketable yield out of storage	Storage loss %
		>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Total			
----- cwt/acre -----									
Vaquero 10 cb									
Aug. 15	10	60.2	146.4	580.1	44.9	831.6	831.6	473.3	39.8
Aug. 22	35	180.8	258.3	484.5	5.8	929.4	932.2	598.5	30.8
Aug. 29	42.5	166.4	322.2	339	19.7	847.2	851.4	523.6	46.7
Sept. 5	60	64.5	470.9	352.5	2.9	890.8	928.6	794.5	14.5
Sept. 12	77.5	120.4	287	494.1	9.6	1023.4	1042.7	971.9	6.7
average	45	118.5	297	450	16.6	904.5	917.3	672.3	27.7
Vaquero 20 cb									
Aug. 15	8.8	86	136.6	517	30.4	770.1	785.3	549	33.3
Aug. 22	22.5	128.4	116.1	460.1	21.9	726.5	731.9	492.8	42
Aug. 29	32.5	61.1	215.5	424.7	18.2	719.5	725.1	501.4	43.4
Sept. 5	52.5	188.8	203.2	471.9	0	863.9	914.1	821.7	20.3
Sept. 12	62.5	236.9	399.7	302.4	8.7	947.7	972.7	886.3	9.1
average	35.8	140.2	214.2	435.2	15.8	805.5	825.8	650.2	29.6
Vaquero 30 cb									
Aug. 15	17.5	58.8	120.5	446.2	42.1	667.6	671.4	488.3	29.9
Aug. 22	37.5	36.9	87.1	352.6	166	642.6	657.8	491.3	33.1
Aug. 29	52.5	19.7	122.8	440.1	50.5	633.1	640.8	505.1	40.6
Sept. 5	65	42.4	100.2	486.3	25.4	654.3	688.6	577.9	10.3
Sept. 12	77.5	30.8	225.4	395.8	67.4	719.4	734.8	670.6	8.8
average	50	37.7	131.2	424.2	70.3	663.4	678.7	546.6	24.5
Vaquero average									
Aug. 15	12.1	68.3	134.5	514.4	39.2	756.4	762.8	506.3	30.6
Aug. 22	31.7	115.4	153.8	432.4	64.5	766.1	774	521.1	28.9
Aug. 29	42.5	82.4	220.2	401.3	29.5	733.3	857.8	510	39.8
Sept. 5	59.2	98.6	258.1	436.9	9.4	803	843.8	731.3	13.6
Sept. 12	72.5	129.4	304	397.4	28.6	885.3	878.3	831.2	8.4
average	43.6	98.8	214.1	436.5	34.2	788.8	823.3	620	24.3
Joaquin 10 cb									
Aug. 15	7.5	129.8	103.5	428.8	27.5	689.7	697.7	450.3	35.1
Aug. 22	12.5	94.3	175.4	444.9	20.5	735.1	738.4	420.7	34.6
Aug. 29	17.5	195.8	134.1	315.2	2.9	648	650.4	462.2	45.3
Sept. 5	27.5	236	357.3	236	6.7	835.9	853.9	687.5	15.9
Sept. 12	40	192.6	300.5	264.8	9.6	767.6	792.8	721.7	5.3
average	21	169.7	214.2	337.9	13.5	735.3	746.6	548.5	27.2

Table 2. Yield and grade for two onion varieties submitted to three drip-irrigation regimes and harvested on five dates in 2008, and marketable yield after storage ending on February 25, 2009. Oregon State University, Ontario, OR, (continued).

Harvest date	At harvest						After storage to February 25		
	Tops down	Marketable yield by grade				Total yield	Marketable yield out of storage	Storage loss	
		>4¼ in	4-4¼ in	3-4 in	2¼-3 in				Total
%	cwt/acre					%			
Joaquin 20 cb									
Aug. 15	6.3	100.2	122.2	420.8	34.1	677.3	687.1	445.9	24.5
Aug. 22	15	165.1	91.3	422.4	26.1	704.8	707.1	454.5	23.3
Aug. 29	20	141.1	133.4	306.7	33	614.2	791.3	431.4	32.1
Sept. 5	32.5	163.7	291.8	447.8	15.4	918.8	918.8	758.6	16
Sept. 12	32.5	140.6	287	367.9	5.8	801.3	823.6	779.8	9.4
average	21.3	142.1	185.1	393.1	22.9	743.3	785.6	574.1	21.1
Joaquin 30 cb									
Aug. 15	10	62.8	108.4	318.5	69.1	558.8	583.8	315.6	48.8
Aug. 22	22.5	99.3	184.5	247.5	33.2	564.6	570.5	385.6	30.8
Aug. 29	22.5	51.9	136.9	320.8	28.1	537.7	547.5	398.3	36.7
Sept. 5	32.5	98.2	292.8	319.7	4.8	715.6	716.5	620.3	14.3
Sept. 12	45	88.6	252.3	301.4	29.9	672.2	695.5	635.3	7.7
average	26.5	80.2	195	301.6	33	609.8	622.8	471	27.6
Joaquin average									
Aug. 15	7.9	97.6	111.4	389.4	43.6	641.9	656.2	404	39
Aug. 22	16.7	119.6	150.4	371.6	26.6	668.1	672	420.3	35.8
Aug. 29	20	129.6	134.8	314.2	21.3	599.9	749.4	430.7	41.8
Sept. 5	30.8	166	314	334.5	9	823.4	829.7	688.8	16.8
Sept. 12	39.2	140.6	279.9	311.4	15.1	747	770.6	712.3	7.4
average	22.9	130.7	198.1	344.2	23.1	696.1	735.6	531.2	28.2
Average									
Aug. 15	10	83	122.9	451.9	41.4	699.2	709.5	452.9	35
Aug. 22	24.2	117.5	152.1	402	45.6	717.1	723	468.5	32.5
Aug. 29	31.3	106	177.5	357.7	25.4	666.6	803.6	470.3	40.8
Sept. 5	45	132.3	286	385.7	9.2	813.2	836.7	710.1	15.2
Sept. 12	55.8	135	292	354.4	21.8	813.2	824.5	769.1	7.9
LSD (0.05)									
Variety	9.2	NS	NS	NS	NS	61.1	50.2	60.7	6.3
Harvest date	4.2	NS	57.8	NS	NS	65.7	66.7	81.6	6.9
Variety X harv. date	5.9	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Nutrient content of onion bulbs from three varieties harvested on five dates and grown under furrow irrigation in 2008. Malheur Experiment Station, Oregon State University, Ontario, OR.

Harvest date	Tops down n %	N	P	K	S	Ca	Mg	Zn	Mn	Cu	Fe	B	Na
		----- % fresh weight -----					----- ppm fresh weight -----						
Calibra													
Aug. 15	20.0	0.144	0.030	0.136	0.045	0.050	0.015	2.35	2.73	0.352	17.06	1.58	0.007 2 0.005
Aug. 22	54.0	0.153	0.031	0.142	0.047	0.042	0.014	1.68	2.22	0.252	11.65	1.33	7 0.007
Aug. 29	68.0	0.151	0.029	0.135	0.043	0.043	0.014	1.88	2.95	0.312	46.42	1.22	2 0.005
Sept. 5	86.0	0.186	0.031	0.143	0.047	0.039	0.013	1.84	1.84	0.268	8.27	1.15	7 0.005
Sept. 12	90.0	0.194	0.033	0.145	0.052	0.039	0.014	1.40	1.31	0.308	6.93	1.80	9 0.006
average	63.6	0.166	0.031	0.140	0.047	0.043	0.014	1.83	2.21	0.298	18.07	1.42	4
Joaquin													
Aug. 15	5.0	0.179	0.041	0.160	0.055	0.070	0.020	3.42	3.56	0.481	37.60	2.17	0.009 1 0.008
Aug. 22	10.0	0.179	0.043	0.180	0.059	0.066	0.019	2.08	3.17	0.466	13.93	2.22	7 0.009
Aug. 29	16.0	0.167	0.032	0.142	0.047	0.063	0.019	2.12	4.79	0.408	45.81	1.74	2 0.008
Sept. 5	22.0	0.211	0.040	0.176	0.059	0.057	0.017	2.05	2.22	0.397	10.66	1.74	6 0.007
Sept. 12	32.0	0.221	0.037	0.167	0.057	0.048	0.016	1.85	1.75	0.314	8.07	1.76	4 0.008
average	17.0	0.191	0.039	0.165	0.055	0.061	0.018	2.30	3.10	0.413	23.21	1.93	6
Montero													
Aug. 15	16.0	0.182	0.041	0.166	0.062	0.058	0.019	4.36	4.37	0.536	34.59	2.17	0.008 4 0.008
Aug. 22	48.0	0.196	0.033	0.163	0.059	0.055	0.018	2.13	3.76	0.664	23.61	2.05	4 0.008
Aug. 29	66.0	0.187	0.035	0.153	0.055	0.053	0.019	2.35	5.53	0.524	47.27	1.82	5 0.007
Sept. 5	84.0	0.204	0.034	0.165	0.060	0.045	0.016	1.91	2.83	0.473	15.20	2.00	8 0.009
Sept. 12	90.0	0.245	0.039	0.188	0.061	0.054	0.018	1.98	2.04	0.379	34.59	2.27	0 0.008
average	60.8	0.203	0.037	0.167	0.059	0.053	0.018	2.55	3.71	0.515	31.05	2.06	4
By harvest date averaged over varieties													
Aug. 15	13.7	0.168	0.038	0.154	0.054	0.059	0.018	3.38	3.55	0.456	29.41	1.97	0.008 2 0.007
Aug. 22	37.3	0.178	0.036	0.163	0.056	0.055	0.017	1.98	3.11	0.475	16.21	1.91	7 0.008
Aug. 29	50.0	0.171	0.033	0.145	0.049	0.054	0.018	2.15	4.65	0.43	46.50	1.65	5 0.007
Sept. 5	64.0	0.200	0.035	0.161	0.055	0.047	0.015	1.93	2.30	0.379	11.37	1.63	4 0.007
Sept. 12	70.7	0.220	0.036	0.167	0.057	0.047	0.016	1.74	1.70	0.334	16.53	1.95	4

LSD (0.05)

Variety	5.4	0.005	0.004	0.002	0.004	0.003	0.001	0.406	0.687	0.054	NS	0.320	0.000
Harvest date	3.6	NS	0.003	0.009	0.003	0.005	0.001	0.408	1.267	NS	NS	NS	NS
Var. X harv. date	6.3	NS	0.006	0.015	NS	NS	NS	0.707	NS	NS	NS	NS	NS

Table 4. Nutrient content of onion bulbs from for two onion varieties grown under three drip irrigation regimes and harvested on five dates in 2008. Malheur Experiment Station, Oregon State University, Ontario, OR.

Harvest date	Tops dow n	N	P	K	S	Ca	Mg	Zn	Mn	Cu	Fe	B	Na
	%												
Vaquero 10 cb													
Aug. 15	10.0	0.155	0.040	0.153	0.057	0.067	0.018	2.67	2.71	0.529	29.36	2.10	0.012
Aug. 22	35.0	0.174	0.038	0.144	0.053	0.064	0.018	7.03	3.62	0.55	69.46	1.81	0.011
Aug. 29	42.5	0.162	0.036	0.144	0.055	0.054	0.016	3.06	2.29	0.442	35.52	1.82	0.008
Sept. 5	60.0	0.187	0.036	0.147	0.052	0.055	0.016	2.05	2.23	0.483	30.28	1.97	0.011
Sept. 12	77.5	0.160	0.034	0.148	0.052	0.053	0.014	1.73	1.14	0.438	21.81	1.78	0.011
average	45.0	0.167	0.037	0.147	0.054	0.059	0.016	3.31	2.40	0.489	37.29	1.90	0.010
Vaquero 20 cb													
Aug. 15	8.8	0.196	0.053	0.199	0.077	0.079	0.022	2.92	2.81	0.586	17.31	2.58	0.012
Aug. 22	22.5	0.184	0.045	0.155	0.058	0.070	0.018	4.86	2.29	0.601	28.64	2.13	0.011
Aug. 29	32.5	0.177	0.037	0.141	0.054	0.056	0.015	2.69	2.05	0.438	20.30	1.76	0.008
Sept. 5	52.5	0.192	0.036	0.166	0.057	0.064	0.016	2.63	1.83	0.579	15.57	2.18	0.012
Sept. 12	62.5	0.182	0.037	0.151	0.055	0.057	0.014	1.84	1.25	0.453	8.94	1.86	0.009
average	35.8	0.186	0.041	0.162	0.060	0.065	0.017	2.99	2.05	0.532	18.15	2.10	0.010
Vaquero 30 cb													
Aug. 15	17.5	0.186	0.048	0.181	0.066	0.069	0.018	2.68	2.44	0.563	14.96	2.07	0.009
Aug. 22	37.5	0.178	0.044	0.158	0.060	0.071	0.017	5.29	2.04	0.601	15.18	2.12	0.009

Table 4. Nutrient content of onion bulbs from for two onion varieties grown under three drip irrigation regimes and harvested on five dates in 2008. Malheur Experiment Station, Oregon State University, Ontario, OR.

Harvest date	Tops down n %	N	P	K	S	Ca	Mg	Zn	Mn	Cu	Fe	B	Na
		----- % fresh weight -----					----- ppm fresh weight-----						
Aug. 29	52.5	0.170	0.043	0.168	0.059	0.061	0.017	3.92	3.19	0.556	41.31	2.15	0.0075
Sept. 5	65.0	0.176	0.042	0.166	0.059	0.058	0.015	2.22	2.06	0.542	14.98	1.95	0.0106
Sept. 12	77.5	0.178	0.037	0.150	0.056	0.063	0.015	2.08	2.11	0.546	10.76	2.25	0.0099
average	50.0	0.178	0.043	0.165	0.060	0.065	0.016	3.24	2.37	0.562	19.44	2.11	0.0094
Vaquero average													
Aug. 15	12.1	0.179	0.047	0.178	0.067	0.072	0.019	2.76	2.65	0.56	20.55	2.25	0.0118
Aug. 22	31.7	0.179	0.042	0.153	0.057	0.068	0.018	5.73	2.65	0.584	37.76	2.02	0.0105
Aug. 29	42.5	0.170	0.039	0.151	0.056	0.057	0.016	3.22	2.51	0.479	31.56	1.91	0.0088
Sept. 5	59.2	0.185	0.038	0.160	0.056	0.059	0.016	2.30	2.04	0.535	20.28	2.03	0.0115
Sept. 12	72.5	0.173	0.036	0.150	0.054	0.058	0.014	1.88	1.50	0.479	13.84	1.96	0.0098
average	43.6	0.177	0.040	0.158	0.058	0.063	0.017	3.18	2.27	0.527	24.80	2.04	0.0103
Joaquin 10 cb													
Aug. 15	7.5	0.164	0.034	0.138	0.055	0.069	0.018	2.56	3.41	0.601	39.59	2.29	0.01012
Aug. 22	12.5	0.151	0.036	0.138	0.051	0.073	0.018	3.56	2.82	0.509	38.88	1.89	0.0071
Aug. 29	17.5	0.158	0.032	0.129	0.050	0.055	0.014	3.37	1.86	0.402	19.98	1.83	0.0088
Sept. 5	27.5	0.161	0.034	0.139	0.049	0.050	0.013	1.86	1.84	0.42	14.45	1.72	0.0083
Sept. 12	40.0	0.153	0.036	0.145	0.053	0.053	0.013	1.97	1.59	0.473	8.72	1.60	0.0089
average	21.0	0.157	0.035	0.138	0.052	0.060	0.015	2.66	2.30	0.481	24.32	1.87	0.0094

Table 4. Nutrient content of onion bulbs from for two onion varieties grown under three drip irrigation regimes and harvested on five dates in 2008. Malheur Experiment Station, Oregon State University, Ontario, OR, (continued).

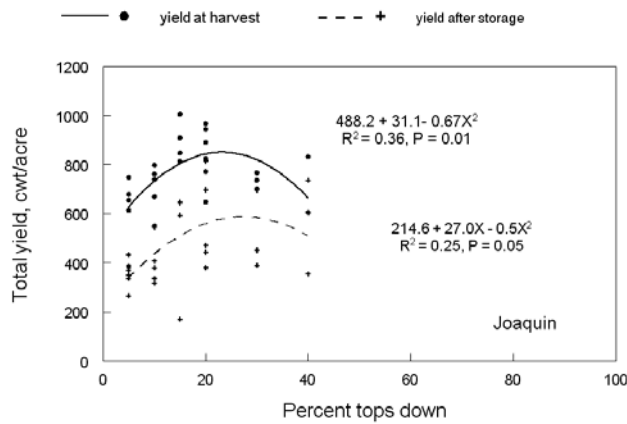
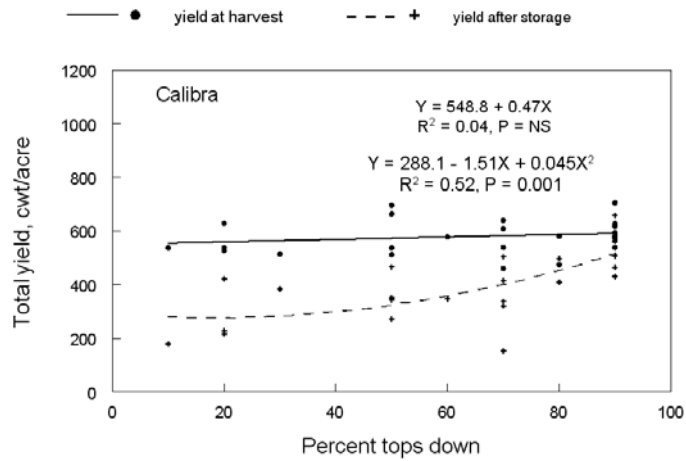
Harvest date	Tops down n %	N	P	K	S	Ca	Mg	Zn	Mn	Cu	Fe	B	Na
		----- % fresh weight -----					----- ppm fresh weight-----						
Joaquin 20 cb													
Aug. 15	6.3	0.186	0.044	0.160	0.064	0.070	0.019	2.58	2.77	0.487	29.61	2.26	0.0117
Aug. 22	15.0	0.193	0.043	0.147	0.055	0.073	0.019	4.73	3.20	0.575	31.35	2.36	0.012

Table 4. Nutrient content of onion bulbs from for two onion varieties grown under three drip irrigation regimes and harvested on five dates in 2008. Malheur Experiment Station, Oregon State University, Ontario, OR, (continued).

Harvest date	Tops down n %	N	P	K	S	Ca	Mg	Zn	Mn	Cu	Fe	B	Na
		----- % fresh weight -----					----- ppm fresh weight-----						
Aug. 29	20.0	0.174	0.035	0.136	0.052	0.060	0.015	2.29	2.19	0.412	32.90	1.88	0.008
Sept. 5	32.5	0.163	0.034	0.150	0.052	0.053	0.014	2.26	2.74	0.932	52.51	2.02	0.009
Sept. 12	32.5	0.173	0.035	0.144	0.052	0.052	0.013	1.92	1.63	0.434	11.65	1.63	0.009
average	21.3	0.178	0.038	0.147	0.055	0.062	0.016	2.76	2.51	0.568	31.60	2.03	0.010
Joaquin 30 cb													
Aug. 15	10.0	0.198	0.044	0.181	0.069	0.083	0.020	2.65	3.22	0.584	21.92	2.26	0.011
Aug. 22	22.5	0.181	0.047	0.167	0.062	0.074	0.018	4.97	2.57	0.621	13.52	2.20	0.010
Aug. 29	22.5	0.182	0.042	0.156	0.058	0.055	0.015	5.38	1.99	0.484	12.85	1.96	0.007
Sept. 5	32.5	0.158	0.035	0.144	0.052	0.053	0.012	1.77	1.34	0.48	34.02	1.90	0.007
Sept. 12	45.0	0.157	0.036	0.152	0.054	0.055	0.013	1.87	1.29	0.473	31.06	2.02	0.008
average	26.5	0.175	0.041	0.160	0.059	0.064	0.016	3.33	2.08	0.529	22.67	2.07	0.009
Joaquin average													
Aug. 15	7.9	0.183	0.041	0.160	0.063	0.074	0.019	2.60	3.13	0.558	30.37	2.27	0.011
Aug. 22	16.7	0.175	0.042	0.151	0.056	0.073	0.018	4.42	2.86	0.569	27.92	2.15	0.011
Aug. 29	20.0	0.171	0.036	0.140	0.054	0.057	0.015	3.68	2.02	0.432	21.91	1.89	0.007
Sept. 5	30.8	0.161	0.034	0.144	0.051	0.052	0.013	1.97	1.97	0.611	33.66	1.88	0.008
Sept. 12	39.2	0.161	0.036	0.147	0.053	0.053	0.013	1.92	1.50	0.46	17.14	1.75	0.009
average	22.9	0.170	0.038	0.148	0.055	0.062	0.016	2.92	2.30	0.526	26.20	1.99	0.009
By harvest date averaged over varieties													
Aug. 15	10.0	0.181	0.044	0.169	0.065	0.073	0.019	2.68	2.89	0.559	25.46	2.26	0.011
Aug. 22	24.2	0.177	0.042	0.152	0.056	0.071	0.018	5.08	2.76	0.576	32.84	2.08	0.011
Aug. 29	31.3	0.170	0.038	0.146	0.055	0.057	0.015	3.45	2.26	0.456	26.52	1.90	0.007
Sept. 5	45.0	0.173	0.036	0.152	0.054	0.056	0.014	2.13	2.01	0.573	26.97	1.96	0.01
Sept. 12	55.8	0.167	0.036	0.148	0.054	0.056	0.014	1.90	1.50	0.469	15.49	1.86	0.009
Irrigation average													
10 cb	33.0	0.162	0.036	0.143	0.053	0.059	0.016	2.99	2.35	0.485	30.80	1.88	0.010
20 cb	28.5	0.182	0.040	0.155	0.058	0.063	0.017	2.87	2.28	0.55	24.88	2.07	0.010

Table 4. Nutrient content of onion bulbs from for two onion varieties grown under three drip irrigation regimes and harvested on five dates in 2008. Malheur Experiment Station, Oregon State University, Ontario, OR, (continued).

Harvest date	Tops down	N	P	K	S	Ca	Mg	Zn	Mn	Cu	Fe	B	Na
	n												
	%												
30 cb	38.3	0.176	0.042	0.162	0.059	0.064	0.016	3.28	2.23	0.545	20.54	2.09	0.009
LSD (0.05)													
Irrigation	NS	0.013	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Variety	9.2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Harvest date	4.2	NS	0.003	0.008	0.004	0.005	0.001	0.750	0.373	NS	NS	0.140	0.001
Var. X harv. date	5.9	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.001
													6



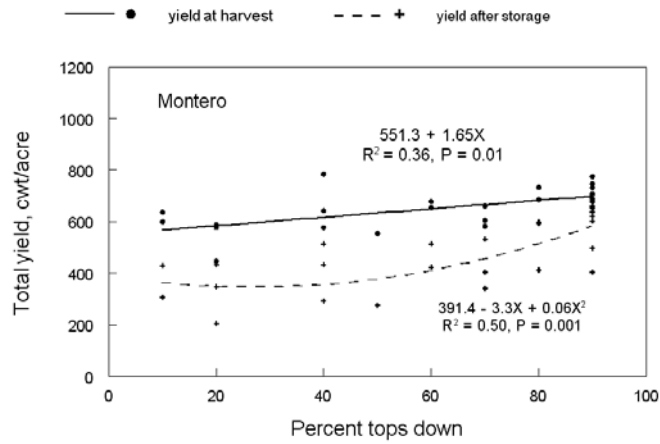
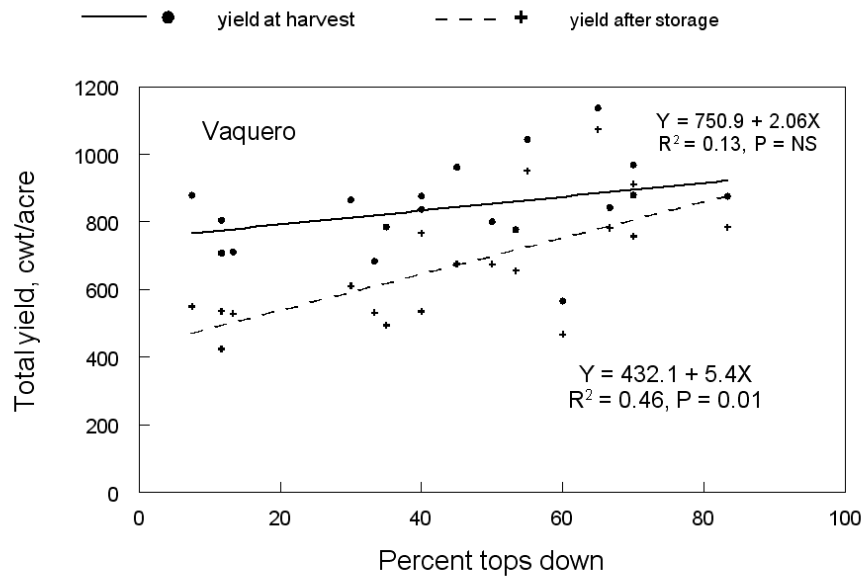


Figure 1. Relationship between percent tops down at harvest and total yield at harvest in 2008 and marketable yield after storage up to 25 February 2009 for three varieties grown under furrow irrigation.



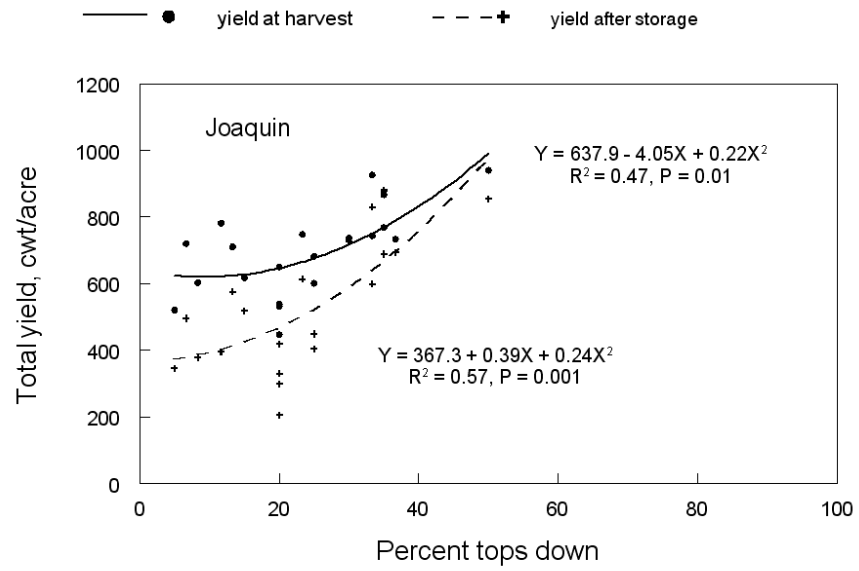


Figure 2. Relationship between percent tops down at harvest and total yield at harvest in 2008 and marketable yield after storage up to 25 February 2009 for two varieties grown under drip irrigation grown under three irrigation criteria.