

RESPONSE OF FOUR ONION VARIETIES TO PLANT POPULATION AND IRRIGATION SYSTEM

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Introduction

Changing market opportunities for smaller size onion bulbs and the availability of new onion varieties necessitate evaluations of yield and bulb size response to plant population. These evaluations can aid growers in making planting rate decisions. The objective of this trial was to evaluate the response of four onion varieties to four plant populations under “conventional” drip irrigation, “intense bed” drip irrigation, and furrow irrigation.

Methods

The trial was conducted in a field of Owyhee silt loam previously planted to wheat. In the fall of 2010, the wheat stubble was shredded and the field was irrigated and disked. Based on a soil test, 200 lb phosphorus/acre, 80 lb sulfur/acre, 7 lb manganese/acre, and 1 lb boron/acre were broadcast in the fall of 2010. The field was then moldboard-plowed and groundhogged.

In the spring of 2011, the field was divided into irrigation main plots that were 88 inches wide by 108 ft long. The experimental design was a randomized complete block with split-split plots and six replicates. There were three irrigation treatments: “conventional” drip irrigation, “intense bed” drip irrigation, and furrow irrigation. Intense bed drip irrigation is the name used for beds with three drip tapes and six double rows of onions, while conventional drip irrigation has beds with two drip tapes and four double rows of onions. Each irrigation main plot was divided into 4 split plots that were 27 ft long. Each split plot in each irrigation main plot was planted to one of four varieties (‘Vaquero’, Nunhems, Parma, ID; ‘Barbaro’, Seminis, Payette, ID; ‘Sedona’, Bejo, Oceano, CA; ‘Esteem’, Crookham, Caldwell, ID) on April 7, 2011. The seed was planted in double rows spaced 3 inches apart at 18 seeds/ft of single row. In the conventional drip and furrow-irrigation plots, each double row was planted on beds spaced 22 inches apart (4 double rows on an 88-inch tractor pass). Planting was done with customized John Deere Flexi Planter units equipped with disc openers. In the intense bed drip plots, the double rows were spaced 11 inches apart (6 double rows on an 88-inch tractor pass).

In the conventional drip and furrow-irrigation plots, tape (Toro Aqua-Traxx, Toro Co., El Cajon, CA) with emitters spaced 12 inches apart and flow rate of 0.22 gal/min/100 ft was laid at 4-inch depth between 2 onion beds at the same time as planting (2 tapes on an 88-inch tractor pass). In the intense bed drip plots, tape (Toro Aqua-Traxx) with emitters spaced 8 inches apart and flow rate of 0.17 gal/min/100 ft was laid at 4-inch depth and spaced 22 inches apart before planting (3 tapes on an 88-inch tractor pass). Immediately after planting, the double rows of onion seed

received a narrow band of Lorsban 15G[®] at 3.7 oz/1,000 ft of row (0.82 lb ai/acre) and the soil surface was rolled.

Onion emergence started on April 26. On June 9, alleys 3 ft wide were cut between the variety split plots, leaving plots 24 ft long. Each variety split plot was then divided into 4 population split-split plots 6 ft long. On June 10, the seedlings in each split-split plot of each variety split plot were hand thinned to one of four plant populations (Table 1). After thinning, the drip tape in the furrow irrigation plots was removed and the furrows between onion rows were cultivated to allow for furrow irrigation.

Table 1. Target spacing between onion seedlings after thinning. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Target plant population plants/acre	Spacing in single row	
	Conventional drip and furrow ----- inches -----	Intense bed
120,000	4.8	7.1
160,000	3.6	5.4
200,000	2.9	4.3
240,000	2.4	3.6

The onions were managed to minimize yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. On May 13, Prowl H₂O[®] at 0.95 lb ai/acre was applied for weed control. On May 31, Goal[®] at 0.16 lb ai/acre, Buctril[®] at 0.19 lb ai/acre, and Volunteer[®] at 0.25 lb ai/acre were applied for weed control. The trial was sprayed weekly for thrips control starting on June 14 for a total of 7 applications. The insecticide application sequence included 2 applications of Movento[®] at 5 oz/acre, followed by 2 applications of Radiant[®] at 8 oz/acre, followed by 3 applications of Lannate[®] at 3 pt/acre. Root tissue samples were taken on June 21, July 8, and July 22. Based on the tissue analysis, a total of 155 lb nitrogen/acre, 40 lb potassium/acre, 5 lb magnesium/acre, and 0.4 lb boron/acre were applied during the season. The nutrients were injected through the drip tape or water-run during irrigations in the furrow irrigated plots.

Onions in each conventional and intense bed drip main plot were irrigated automatically and independently to maintain the soil water tension (SWT) in the onion root zone below 20 cb. Soil water tension was measured in each main plot with four granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrrometer Co., Riverside, CA) installed at 8-inch depth in the center of the double row. Sensors had been calibrated to SWT (Shock et al. 1998). The GMS were connected to the datalogger via multiplexers (AM 410 multiplexer, Campbell Scientific, Logan, UT). The datalogger read the sensors and recorded the SWT every hour. The datalogger made irrigation decisions for each drip-irrigated main plot every 12 hours. The individual irrigation decisions for each plot were based on the average SWT. The irrigation durations were 7 hours, 10 min for the conventional drip system and 8 hours, 19 min for the intense bed drip system (0.48 inches of water applied per irrigation). The irrigations were controlled by the datalogger using a controller (SDM CD16AC controller, Campbell Scientific, Logan, UT) connected to solenoid valves in each plot. The water for the drip and sprinkler plots was supplied by a well that maintained a continuous and constant water pressure of 35 psi. The

pressure in the drip lines was maintained at 10 psi by pressure regulators in each plot. The amount of water applied to each plot was recorded daily at 8:00 a.m. from a water meter installed between the solenoid valve and the drip tape. The automated irrigation system was started on July 1 and ended on September 9.

The furrow-irrigated onions were irrigated manually when the SWT at 8-inch depth reached 25 cb. The field in which this trial was conducted had the top soil removed in the process of leveling in the past. This resulted in the soil having reduced lateral permeability of water. To improve the lateral movement of water during furrow irrigations, straw at 900 lb/acre was applied to the furrow bottoms on July 22. The last furrow irrigation was on August 29.

The onions were lifted on September 13 to field cure. Onions from 5 ft of the middle 2 rows in each conventional drip and furrow irrigation split-split plot and from 5 ft of the middle 4 rows in the intense bed drip split-split plots were topped by hand and bagged on September 21. Onions were graded on October 5 and 6.

During grading all bulbs in each split-split plot were counted. After counting, the 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 (<2¼ inches), medium (2¼ - 3 inches), jumbo (3 - 4 inches), colossal (4 - 4¼ inches), and super colossal (>4¼ inches). Bulb counts per 50 lb of super colossal onions were determined for each plot of every variety by weighing and counting all super colossal bulbs during grading. Marketable yield consists of No.1 bulbs larger than 2¼ inches.

After grading, 25 bulbs from each plot were individually weighed and measured for diameter. The bulb diameter was used to calculate the proportion of size categories by diameter and weight for each plot. The yield of each size category was calculated using the bulb proportions by weight and the plot marketable yield measured at grading.

Treatment differences were compared using analysis of variance. Means separation was determined using a protected Fisher's least significant difference test at the 5 percent probability level, LSD (0.05). The least significant difference LSD (0.05) values in each table should be considered when comparisons are made between treatments for significant differences in performance characteristics. Differences between treatments equal to or greater than the LSD value for a characteristic should exist before any treatment is considered different from any other treatment in that characteristic. For the regression analyses, the actual plant population in each split-split plot was calculated from the bulb counts during grading. Regression equations were developed by regression of the yield components against the actual plant population.

Results

Intense bed drip and conventional drip irrigation resulted in more uniform soil moisture over time than furrow irrigation (Fig. 1). Soil moisture management under furrow irrigation was improved after straw mulching on July 22. From onion emergence to the last irrigation, a total of 29.3 inches of water were applied to the conventional drip irrigation plots and a total of 28.9 inches of water were applied to the intense bed drip irrigation plots.

For varieties and irrigation systems, the actual plant population achieved was different than the target population (Tables 2–5).

Irrigation system was not a statistically significant factor in the response of onion bulb size to plant population (Tables 2–4). Averaged over irrigation systems and varieties, marketable yield increased with increasing plant population up to 160,000 plants per acre (Table 5). Yield of medium bulbs increased with increasing plant population up to the highest tested of 208,000 plants per acre. Averaged over irrigation systems and varieties, yield of jumbo bulbs was highest with a plant population of 157,000 plants per acre. Averaged over irrigation systems and varieties, yield of colossal plus super colossal bulbs decreased with increasing plant population. While jumbo bulb yield increased with increasing plant population, the magnitude of the increase was small (10% increase from lowest to highest plant population) compared to the magnitude of increase of medium bulb yield (290% increase from lowest to highest plant population) and small bulb yield (350% increase from lowest to highest plant population).

Averaged over irrigation systems, for all four varieties, marketable yield did not respond to plant population (Table 6). Averaged over irrigation systems, for Vaquero, Barbaro, and Sedona, yield of colossal plus super colossal bulbs decreased with increasing plant population. For Esteem, yield of colossal plus super colossal bulbs decreased with increasing plant population, but the differences were not statistically significant. Averaged over irrigation systems, for all four varieties, jumbo yields increased with increasing plant population up to 160,000 plants per acre. Averaged over irrigation systems, for all four varieties, yield of medium and small bulbs increased with increasing plant population.

The regression equations also show that, for the range of populations tested, the most responsive bulb sizes to increasing population were medium and small (Table 7). Marketable and colossal plus super colossal yields were somewhat responsive and jumbo yields were not very responsive to plant population. In general, for all varieties, yield of colossal plus super colossal bulbs decreased and yield of medium and small bulbs increased with increasing plant population (Tables 2–5, Figures 2–10). Averaged over varieties and irrigation systems, jumbo bulb yields did not respond to the range of populations tested (Fig. 10). The responses of the varieties to plant population under the three irrigation had similar trends (Figs. 2–5).

The bulb size percentages and bulb yields for the different size categories for typical onion ring processing can be found in Tables 8 to 17. Irrigation system was not a statistically significant factor in the response of onion yield to plant population (Tables 8–13). Averaged over irrigation systems and varieties, the percentage and yield of bulbs 3¼ - 4½ inches in diameter decreased with increasing plant population up to the highest tested of 208,000 plants per acre (Tables 14 and 15). Averaged over irrigation systems and varieties, the percentage and yield of bulbs 3 - 3¼ inches and less than 3 inches in diameter increased with increasing plant population up to the highest tested of 208,000 plants per acre (Tables 14 and 15).

References

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

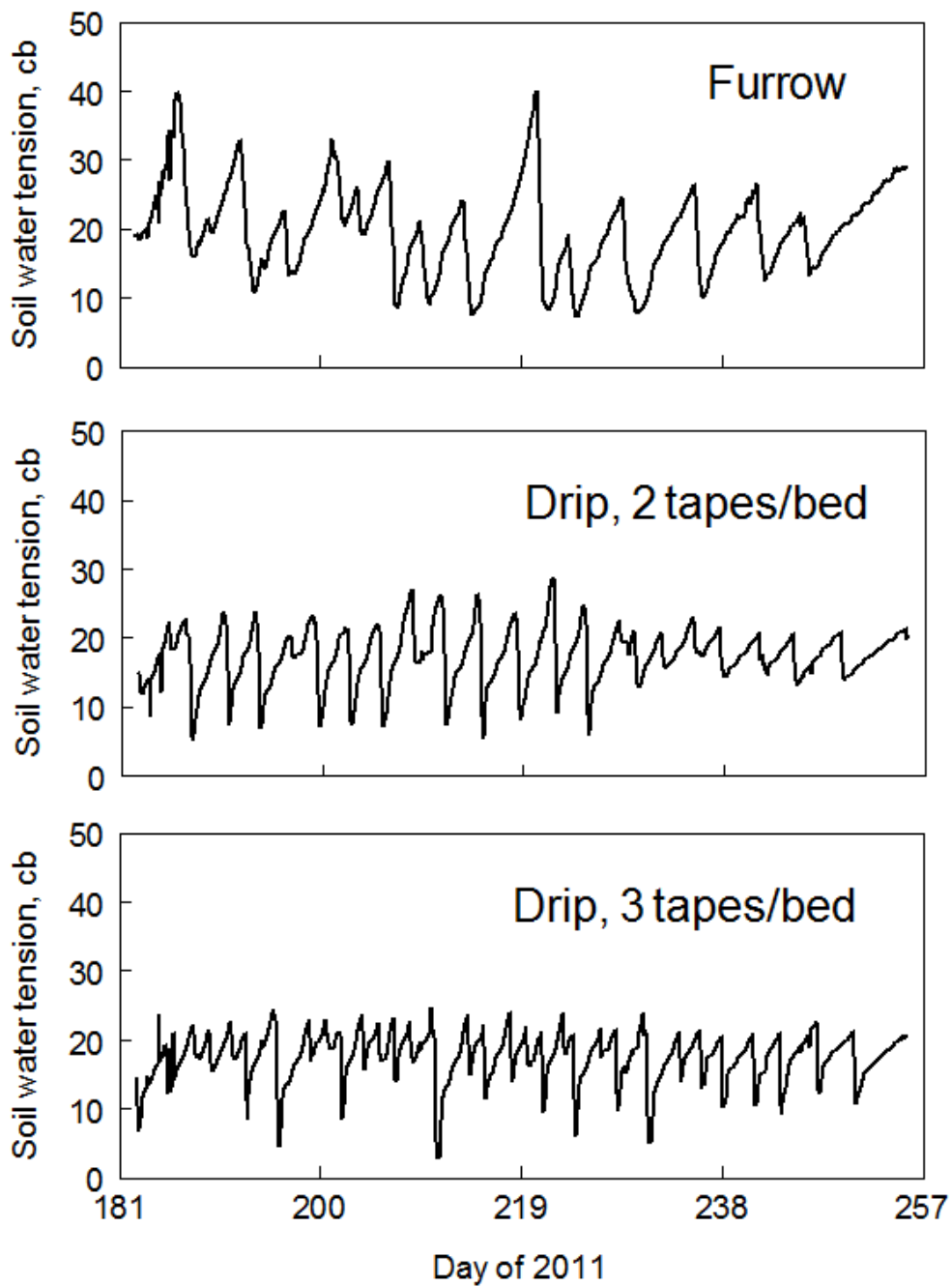


Figure 1. Soil water tension over time for three irrigation systems in onions. Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 2. Onion yield and grade in response to plant population for four varieties grown with conventional drip irrigation. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Plant population		Marketable yield by grade									
		Target	Actual	Total yield	Total	>4 in	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	Rot	
		--- plants/acre ---		----- cwt/acre -----									%
Conventional drip	Vaquero	120,000	121,970	1016.5	1011.3	203.4	9.3	194.0	779.1	28.8	5.1	0.0	
		160,000	161,175	1094.0	1080.3	118.2	0.0	118.2	892.6	69.5	12.3	0.2	
		200,000	194,440	1100.7	1068.4	21.3	0.0	21.3	858.9	188.2	28.5	0.3	
		240,000	215,824	1168.0	1119.9	21.6	0.0	21.6	870.0	228.3	48.1	0.0	
		average	173,352	1094.8	1070.0	91.1	2.3	88.8	850.2	128.7	23.5	0.1	
	Barbaro	120,000	124,346	1009.7	997.4	206.9	18.1	188.8	766.3	24.2	9.7	0.3	
		160,000	164,343	1083.6	1066.4	101.1	9.8	91.3	891.4	73.9	17.1	0.0	
		200,000	195,232	1146.7	1107.4	38.5	10.1	28.4	913.6	155.3	38.1	0.1	
		240,000	220,576	1177.6	1122.4	40.4	0.0	40.4	872.6	209.4	53.4	0.1	
		average	176,124	1104.4	1073.4	96.7	9.5	87.2	861.0	115.7	29.6	0.1	
	Sedona	120,000	129,098	792.2	774.3	38.7	0.0	38.7	654.6	80.9	17.9	0.0	
		160,000	154,839	843.6	805.6	0.0	0.0	0.0	690.1	115.5	34.8	0.4	
		200,000	191,667	905.2	848.6	8.6	0.0	8.6	622.9	217.0	56.6	0.0	
		240,000	203,152	943.0	869.7	15.9	0.0	15.9	633.3	220.5	73.3	0.0	
		average	169,689	871.0	824.5	15.8	0.0	15.8	650.2	158.5	45.7	0.1	
	Esteem	120,000	131,158	869.9	860.9	10.7	0.0	10.7	797.1	53.0	9.0	0.0	
		160,000	163,155	953.8	931.9	4.4	0.0	4.4	793.5	133.9	21.9	0.0	
		200,000	195,628	938.1	902.7	10.9	0.0	10.9	674.2	217.6	35.4	0.0	
		240,000	208,696	971.8	896.4	0.0	0.0	0.0	600.8	295.6	75.4	0.0	
		average	174,659	933.4	898.0	6.5	0.0	6.5	716.4	175.1	35.4	0.0	

Table 3. Onion yield and grade in response to plant population for four varieties grown with intense bed drip irrigation. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Plant population		Total yield	Marketable yield by grade							Rot
		Target	Actual		Total	>4 in	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	<2¼ in	
		--- plants/acre ---		----- cwt/acre -----								
Intense bed	Vaquero	120,000	135,731	1007.4	997.1	74.6	0.0	74.6	888.1	34.4	10.3	0.0
		160,000	159,195	1065.5	1047.4	74.7	0.0	74.7	889.9	82.7	18.1	0.0
		200,000	190,677	1098.7	1067.4	25.8	0.0	25.8	910.9	130.7	29.9	0.0
		240,000	196,618	1085.0	1049.2	17.9	0.0	17.9	837.8	193.5	33.1	0.2
		average	170,555	1064.2	1040.3	48.3	0.0	48.3	881.7	110.4	22.9	0.1
	Barbaro	120,000	137,811	998.1	989.0	126.4	2.8	123.6	818.0	44.6	9.1	0.2
		160,000	156,819	1018.7	1000.1	45.3	3.3	42.1	883.1	71.6	16.6	0.1
		200,000	188,539	1074.5	1032.5	16.7	0.0	16.7	876.0	139.8	39.0	0.2
		240,000	205,528	1152.5	1113.2	56.4	0.0	56.4	892.7	164.1	34.0	0.4
		average	172,174	1061.0	1033.7	61.2	1.5	59.7	867.5	105.0	24.7	0.2
	Sedona	120,000	133,058	780.7	761.9	21.3	2.3	19.0	625.8	114.9	17.9	0.1
		160,000	153,255	872.5	848.9	3.3	0.0	3.3	698.0	147.6	23.6	0.0
		200,000	184,440	878.0	815.5	1.7	0.0	1.7	584.8	229.0	61.9	0.1
		240,000	205,825	889.4	829.5	0.0	0.0	0.0	557.7	271.8	58.5	0.2
		average	169,145	855.2	814.0	6.6	0.6	6.0	616.6	190.8	40.5	0.1
	Esteem	120,000	138,702	891.7	883.4	28.1	0.0	28.1	792.1	63.2	7.5	0.1
		160,000	154,443	938.7	918.6	19.8	0.0	19.8	810.0	88.8	14.4	0.6
		200,000	197,509	1044.7	1011.1	10.6	0.0	10.6	795.9	204.5	30.4	0.3
		240,000	213,547	1043.9	984.1	0.0	0.0	0.0	677.2	306.9	59.0	0.1
		average	176,050	979.7	949.3	14.6	0.0	14.6	768.8	165.8	27.8	0.3

Table 4. Onion yield and grade in response to plant population for four varieties grown with furrow irrigation and for the overall average. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Plant population		Marketable yield by grade									
		Target	Actual	Total yield	Total	>4 in	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	Rot	
		--- plants/acre ---		----- cwt/acre -----									%
Furrow	Vaquero	120,000	120,386	936.1	921.9	101.9	4.8	97.1	657.4	162.7	14.2	0.0	
		160,000	160,779	1146.4	1121.7	107.4	0.0	107.4	944.5	69.9	24.7	0.0	
		200,000	185,727	1064.4	1032.0	20.5	0.0	20.5	844.8	166.6	32.4	0.0	
		240,000	201,172	1086.1	1047.5	15.0	0.0	15.0	798.4	234.1	38.6	0.0	
		average	167,016	1058.2	1030.8	61.2	1.2	60.0	811.3	158.3	27.5	0.0	
	Barbaro	120,000	129,098	1009.5	995.6	200.9	5.5	195.5	764.3	30.4	13.9	0.0	
		160,000	157,215	1024.3	993.7	74.1	6.2	68.0	845.2	74.4	23.4	0.7	
		200,000	182,163	1086.6	1053.8	67.6	0.0	67.6	842.7	143.4	32.8	0.0	
		240,000	205,132	1100.0	1045.0	11.3	0.0	11.3	830.0	203.7	55.0	0.0	
		average	168,402	1055.1	1022.0	88.5	2.9	85.6	820.5	113.0	31.3	0.2	
	Sedona	120,000	121,970	770.4	748.8	44.9	5.1	39.8	641.9	61.9	21.6	0.0	
		160,000	151,275	831.4	796.8	7.4	0.0	7.4	644.4	145.0	34.6	0.0	
		200,000	182,163	856.2	795.7	7.2	0.0	7.2	607.6	181.0	60.5	0.0	
		240,000	204,340	934.7	867.7	0.0	0.0	0.0	575.8	291.9	67.1	0.0	
		average	164,937	848.2	802.2	14.9	1.3	13.6	617.4	169.9	46.0	0.0	
	Esteem	120,000	123,158	821.4	815.4	29.7	0.0	29.7	738.9	46.7	6.1	0.0	
		160,000	154,443	895.4	864.2	14.2	0.0	14.2	730.7	119.3	31.3	0.0	
		200,000	193,252	1025.1	996.0	5.6	0.0	5.6	743.1	247.3	26.5	0.2	
		240,000	216,616	949.7	864.2	4.4	0.0	4.4	527.5	332.4	84.8	0.0	
		average	171,867	922.9	884.9	13.5	0.0	13.5	685.1	186.4	37.2	0.1	

Table 5. Onion yield and grade in response to plant population for three irrigation systems averaged over four varieties and for the overall average. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Plant population		Marketable yield by grade									
	Target	Actual	Total yield	Total	>4 in	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	Rot	
	--- plants/acre ---		----- cwt/acre -----									%
Conventional drip	120,000	126,794	930.0	918.9	124.9	7.5	117.4	748.2	45.8	10.3	0.1	
	160,000	160,878	993.7	971.0	56.0	2.5	53.5	816.9	98.2	21.5	0.1	
	200,000	194,242	1022.7	981.8	19.8	2.5	17.3	767.4	194.5	39.7	0.1	
	240,000	212,062	1065.1	1002.1	19.5	0.0	19.5	744.2	238.4	62.5	0.0	
	average	173,494	1002.9	968.5	55.0	3.1	51.9	769.2	144.3	33.5	0.1	
Intense bed	120,000	138,689	930.5	917.3	61.9	1.3	60.6	791.8	63.5	12.3	0.1	
	160,000	154,517	971.9	953.2	39.0	0.8	38.2	816.6	97.5	17.3	0.2	
	200,000	190,368	1021.8	979.4	13.6	0.0	13.6	788.2	177.6	40.3	0.1	
	240,000	205,379	1042.7	994.0	18.6	0.0	18.6	741.4	234.1	46.2	0.2	
	average	172,238	991.7	961.0	33.3	0.5	32.7	784.5	143.2	29.0	0.2	
Furrow	120,000	123,653	875.4	861.1	97.2	4.0	93.2	712.9	51.0	14.3	0.0	
	160,000	155,928	961.8	931.0	47.1	1.8	45.3	779.5	104.4	28.7	0.2	
	200,000	185,826	988.0	945.9	26.1	0.0	26.1	737.3	182.5	41.6	0.0	
	240,000	206,815	1008.2	946.0	8.2	0.0	8.2	671.5	266.4	62.0	0.0	
	average	168,056	958.3	921.0	44.6	1.4	43.2	725.3	151.1	36.7	0.1	
Average	120,000	129,319	911.1	898.3	91.5	4.1	87.4	744.2	62.6	12.3	0.1	
	160,000	157,108	976.4	952.6	47.4	1.7	45.7	805.4	99.9	22.3	0.2	
	200,000	190,142	1016.5	975.4	20.0	0.9	19.1	771.3	184.2	39.8	0.1	
	240,000	208,085	1043.1	985.8	15.4	0.0	15.4	725.6	244.8	56.3	0.1	
LSD (0.05)												
Irrigation		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Population		5485	24.0	23.9	12.7	2.3	12.6	26.8	15.4	5.0	NS	
Irrigation X Population		NS	NS	NS	NS	NS	NS	NS	NS	10.1	NS	

Table 6. Onion yield and grade in response to plant population for four varieties averaged over three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Variety	Plant population		Total yield	Marketable yield by grade							Small	Rot
	Target	Actual		Total	>4 in	>4¼ in	4-4¼ in	3-4 in	2¼-3 in			
--- plants/acre ---			----- cwt/acre -----							%		
Vaquero	120,000	126,029	990.6	981.7	134.1	5.0	129.1	810.7	37.0	8.9	0.0	
	160,000	160,383	1096.4	1078.3	99.2	0.0	99.2	904.6	74.5	17.6	0.5	
	200,000	190,281	1089.3	1057.4	22.7	0.0	22.7	873.1	161.6	30.1	1.8	
	240,000	204,538	1113.0	1072.2	18.2	0.0	18.2	835.4	218.6	39.9	0.9	
	average	170,308	1072.3	1047.4	68.5	1.2	67.3	855.9	122.9	24.1	0.8	
Barbaro	120,000	130,418	1005.7	994.0	178.1	8.8	169.3	782.9	33.1	10.9	0.8	
	160,000	159,459	1042.2	1020.1	73.5	6.4	67.1	873.2	73.3	19.0	3.1	
	200,000	188,651	1104.2	1066.4	42.4	3.6	38.8	877.5	146.6	36.5	1.3	
	240,000	210,412	1143.4	1093.5	36.0	0.0	36.0	865.1	192.4	47.5	2.3	
	average	172,235	1073.9	1043.5	82.5	4.7	77.8	849.7	111.3	28.5	1.9	
Sedona	120,000	129,383	784.2	763.7	39.3	2.7	36.6	636.8	87.6	20.1	0.3	
	160,000	153,123	849.2	817.1	3.6	0.0	3.6	677.5	136.0	31.0	1.1	
	200,000	186,090	879.8	819.9	5.8	0.0	5.8	605.1	209.0	59.7	0.2	
	240,000	204,439	922.4	855.6	5.3	0.0	5.3	588.9	261.4	66.3	0.4	
	average	168,259	858.9	814.1	13.5	0.7	12.8	627.1	173.5	44.3	0.5	
Esteem	120,000	130,997	850.6	841.5	21.8	0.0	21.8	760.0	59.7	8.8	0.3	
	160,000	157,347	931.3	907.3	12.7	0.0	12.7	780.9	113.7	22.0	2.0	
	200,000	195,463	979.7	943.3	8.9	0.0	8.9	712.7	221.6	34.6	1.8	
	240,000	212,953	975.9	901.5	2.1	0.0	2.1	586.6	312.8	73.9	0.5	
	average	174,190	934.3	898.4	11.4	0.0	11.4	710.0	177.0	34.8	1.1	
LSD (0.05)												
Variety		NS	31.9	33.6	16.5	2.4	15.8	39.9	18.2	5.2	NS	
Variety X Population		NS	NS	NS	22.1	2.3	25.3	53.6	30.7	10.1	NS	

Table 7. Regression equation parameters for regressions of plant population and onion yield categories for four varieties and three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Total marketable				Colossal plus super colossal, >4 in				Jumbo, 3-4 in			
		intercept	slope	R ²	P	intercept	slope	R ²	P	intercept	slope	R ²	P
Conv. Drip	Vaquero	803.0	0.0015	0.35	0.01	395.8	-0.00176	0.46	0.001	649.6	0.0012	0.18	0.05
	Barbaro	822.5	0.0014	0.50	0.001	368.5	-0.00154	0.35	0.01	620.0	0.0014	0.23	0.05
	Sedona	610.8	0.0013	0.49	0.001	71.6	-0.00033	0.13	NS	695.7	0.0003	0.02	NS
	Esteem	675.9	0.0013	0.27	0.05	20.6	-0.00008	0.05	NS	831.1	0.0007	0.05	NS
Intense bed	Vaquero	910.6	0.0008	0.17	0.05	213.0	-0.00097	0.36	0.01	974.7	0.0005	0.04	NS
	Barbaro	740.9	0.0017	0.31	0.01	255.6	-0.00112	0.20	0.05	692.9	0.0010	0.13	NS
	Sedona	627.1	0.0011	0.26	0.05	45.5	-0.00023	0.32	0.01	724.6	0.0006	0.07	NS
	Esteem	583.9	0.0021	0.32	0.01	59.4	-0.00025	0.13	NS	834.5	-0.0004	0.01	NS
Furrow	Vaquero	770.5	0.0015	0.23	0.05	302.7	-0.00142	0.42	0.01	718.0	0.0007	0.03	NS
	Barbaro	771.6	0.0015	0.16	NS	383.6	-0.00175	0.25	0.05	617.0	0.0012	0.13	NS
	Sedona	589.8	0.0013	0.20	0.05	90.3	-0.00046	0.48	0.001	721.2	-0.0006	0.03	NS
	Esteem	600.8	0.0014	0.13	NS	44.6	-0.00019	0.16	NS	826.7	-0.0011	0.05	NS
		Medium, 2¼-3 in				Small, <2¼ in							
		intercept	slope	R ²	P	intercept	slope	R ²	P				
Conv. Drip	Vaquero	-242.4	0.00214	0.83	0.001	-48.8	0.00042	0.70	0.001				
	Barbaro	-166.0	0.00160	0.59	0.001	-43.7	0.00042	0.60	0.001				
	Sedona	-179.0	0.00199	0.73	0.001	-63.7	0.00064	0.77	0.001				
	Esteem	-175.8	0.00202	0.59	0.001	-63.8	0.00057	0.50	0.001				
Intense bed	Vaquero	-277.1	0.00227	0.71	0.001	-44.4	0.00039	0.68	0.001				
	Barbaro	-207.6	0.00181	0.70	0.001	-48.8	0.00043	0.68	0.001				
	Sedona	-143.0	0.00197	0.71	0.001	-49.8	0.00053	0.57	0.001				
	Esteem	-309.9	0.00270	0.65	0.001	-66.8	0.00054	0.52	0.001				
Furrow	Vaquero	-250.2	0.00229	0.63	0.001	-30.6	0.00034	0.43	0.01				
	Barbaro	-229.1	0.00203	0.75	0.001	-51.8	0.00049	0.60	0.001				
	Sedona	-221.6	0.00237	0.76	0.001	-54.7	0.00061	0.72	0.001				
	Esteem	-270.4	0.00270	0.70	0.001	-67.1	0.00064	0.53	0.001				

Table 8. Response of bulb size categories to plant population for four onion varieties under furrow irrigation; data were calculated from bulb diameter measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Plant population		Proportion by weight				
		Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
		--- plants/acre ---		----- % -----				
Furrow	Vaquero	120,000	120,386	15.3	66.3	81.6	17.7	0.7
		160,000	160,779	8.8	52.1	60.9	33.7	5.5
		200,000	185,727	2.4	51.2	53.5	40.3	6.1
		240,000	201,172	2.3	46.4	48.7	47.6	3.6
		average	167,016	7.2	54.0	61.2	34.8	4.0
	Barbaro	120,000	129,098	13.0	67.8	80.8	18.3	0.9
		160,000	157,215	4.6	58.4	63.0	30.7	5.0
		200,000	182,163	2.1	51.0	53.1	41.9	5.0
		240,000	205,132	0.0	47.1	47.1	45.3	7.6
		average	168,402	4.9	56.1	61.0	34.1	4.6
	Sedona	120,000	121,970	3.4	55.2	58.5	38.7	2.8
		160,000	151,275	0.0	45.0	45.0	46.0	9.0
		200,000	182,163	1.2	39.4	40.7	39.3	19.1
		240,000	204,340	1.2	29.8	31.0	51.6	16.6
		average	164,937	1.4	42.4	43.8	43.9	11.9
	Esteem	120,000	123,158	2.5	49.6	52.1	38.9	8.9
		160,000	154,443	0.0	43.6	43.6	45.9	10.4
		200,000	193,252	0.0	34.6	34.6	42.7	22.8
		240,000	216,616	0.0	22.1	22.1	45.8	32.2
		average	171,867	0.6	37.5	38.1	43.3	18.6
Average	120,000	123,653	8.8	60.2	69.0	28.0	3.1	
	160,000	155,928	3.3	49.4	52.7	39.4	7.6	
	200,000	185,826	1.5	44.4	45.9	41.0	12.8	
	240,000	206,815	0.9	37.0	37.9	47.6	14.3	
LSD (0.05)								
Variety		NS	2	5	5.3	4.3	2.9	
Irrigation X Population		15,555	NS	NS	NS	7.7	4	
Irrigation X Var. X Pop.		31,110	NS	NS	NS	NS	NS	

Table 9. Response of yield of different bulb size categories to plant population for four onion varieties under furrow irrigation; data were calculated from bulb diameter and bulb weight measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Plant population		Yield by bulb diameter				
		Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
		--- plants/acre ---		----- cwt/acre -----				
Furrow	Vaquero	120,000	120,386	143.8	608.7	752.5	162.6	6.8
		160,000	160,779	100.5	537.9	638.4	328.2	48.5
		200,000	185,727	23.1	515.6	538.7	403.9	55.0
		240,000	201,172	25.1	499.8	524.9	484.8	37.8
		average	167,016	73.1	540.5	613.6	344.9	37.1
	Barbaro	120,000	129,098	141.2	671.9	813.1	174.7	7.8
		160,000	157,215	50.6	593.2	643.9	289.9	45.8
		200,000	182,163	23.7	548.1	571.8	431.4	50.6
		240,000	205,132	0.0	511.2	511.2	461.6	72.1
		average	168,402	53.9	581.1	635.0	339.4	44.1
	Sedona	120,000	121,970	25.8	419.9	445.7	283.5	19.6
		160,000	151,275	0.0	362.7	362.7	362.8	71.2
		200,000	182,163	9.2	323.1	332.3	314.4	142.0
		240,000	204,340	12.3	271.7	284.1	444.5	132.9
		average	164,937	11.8	344.3	356.2	351.3	91.4
	Esteem	120,000	123,158	22.9	377.6	400.5	294.8	61.5
		160,000	154,443	0.0	373.2	373.2	376.2	81.6
		200,000	193,252	0.0	302.5	302.5	363.0	165.9
		240,000	216,616	0.0	186.1	186.1	379.0	235.2
		average	171,867	5.7	309.9	315.6	353.2	136.0
Average	120,000	123,653	86.0	525.7	611.7	226.0	22.3	
	160,000	155,928	37.2	461.3	498.5	341.4	62.5	
	200,000	185,826	14.6	427.5	442.1	378.8	100.7	
	240,000	206,815	9.8	375.1	384.9	445.2	114.5	
LSD (0.05)								
Variety		NS	18.3	50.3	55.5	44.6	22.0	
Irrigation X Population		15,555	NS	NS	NS	NS	NS	
Irrigation X Var. X Pop.		31,110	NS	NS	NS	NS	NS	

Table 10. Response of bulb size categories to plant population for four onion varieties under conventional drip irrigation; data were calculated from bulb diameter measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Plant population		Proportion by weight				
		Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
		--- plants/acre ---		----- % -----				
Conventional drip	Vaquero	120,000	121,970	21.9	64.6	86.5	12.0	0.6
		160,000	161,175	6.3	62.6	69.0	29.5	1.5
		200,000	194,440	5.3	50.9	56.2	37.6	6.3
		240,000	215,824	6.0	54.3	60.2	34.8	4.2
		average	173,352	9.9	58.1	68.0	28.5	3.1
	Barbaro	120,000	124,346	13.1	70.3	83.4	13.5	0.7
		160,000	164,343	4.4	58.9	63.3	31.7	5.0
		200,000	195,232	2.1	56.3	58.4	37.1	3.9
		240,000	220,576	2.4	53.3	55.7	40.9	3.3
		average	176,124	5.5	59.7	65.2	30.8	3.2
	Sedona	120,000	129,098	3.3	50.4	53.7	41.5	4.8
		160,000	154,839	0.0	40.2	40.2	51.7	8.1
		200,000	191,667	1.2	27.4	28.6	61.7	9.7
		240,000	203,152	1.3	25.4	26.7	60.8	12.5
		average	169,689	1.4	35.9	37.3	53.9	8.8
	Esteem	120,000	131,158	1.9	57.5	59.4	37.0	3.7
		160,000	163,155	0.0	41.8	41.8	52.0	6.3
		200,000	195,628	0.0	41.6	41.6	51.8	6.6
		240,000	208,696	0.0	31.8	31.8	54.8	13.3
		average	174,659	0.5	43.2	43.6	48.9	7.5
average	120,000	137,216	10.1	60.7	70.8	26.0	2.4	
	160,000	155,928	2.7	50.9	53.6	41.2	5.2	
	200,000	190,368	2.1	44.0	46.2	47.0	6.6	
	240,000	205,379	2.4	41.2	43.6	47.8	8.4	
LSD (0.05)								
	Variety		NS	2	5	5.3	4.3	2.9
	Irrigation X Population		15,555	NS	NS	NS	7.7	4
	Irrigation X Var. X Pop.		31,110	NS	NS	NS	NS	NS

Table 11. Response of yield of different bulb size categories to plant population for four onion varieties under conventional drip irrigation; data were calculated from bulb diameter and bulb weight measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Plant population		Yield by bulb diameter				
		Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
		--- plants/acre ---		----- cwt/acre -----				
Conventional drip	Vaquero	120,000	121,970	230.3	647.3	877.5	118.5	5.6
		160,000	161,175	72.1	671.9	744.0	320.3	16.0
		200,000	194,440	58.7	546.6	605.3	395.3	67.9
		240,000	215,824	67.5	607.4	674.9	390.7	45.9
		average	173,352	107.1	618.3	725.4	306.2	33.9
	Barbaro	120,000	124,346	133.0	699.0	832.0	134.8	7.0
		160,000	164,343	49.5	628.9	678.4	335.2	52.9
		200,000	195,232	23.0	627.6	650.6	407.5	43.3
		240,000	220,576	29.0	595.4	624.3	461.4	36.7
		average	176,124	58.6	637.7	696.3	334.7	35.0
	Sedona	120,000	129,098	24.5	389.9	414.5	322.7	37.1
		160,000	154,839	0.0	322.4	322.4	417.6	65.5
		200,000	191,667	11.3	233.9	245.2	523.4	80.0
		240,000	203,152	12.0	226.0	238.0	525.0	106.7
		average	169,689	12.0	293.1	305.0	447.1	72.3
	Esteem	120,000	131,158	16.6	470.9	487.4	299.5	27.4
		160,000	163,155	0.0	391.6	391.6	482.8	57.5
		200,000	195,628	0.0	380.0	380.0	480.1	55.9
		240,000	208,696	0.0	279.5	279.5	492.9	110.8
		average	174,659	4.1	380.5	384.6	438.8	62.9
average	120,000	137,216	101.1	551.8	652.9	218.9	19.3	
	160,000	155,928	30.4	503.7	534.1	389.0	48.0	
	200,000	190,368	23.3	447.0	470.3	451.5	61.8	
	240,000	205,379	27.1	427.1	454.2	467.5	75.0	
LSD (0.05)								
Variety		NS	18.3	50.3	55.5	44.6	22.0	
Irrigation X Population		15,555	NS	NS	NS	NS	NS	
Irrigation X Var. X Pop.		31,110	NS	NS	NS	NS	NS	

Table 12. Response of bulb size categories to plant population for four onion varieties under intense bed drip irrigation; data were calculated from bulb diameter measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Plant population		Proportion by weight				
		Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
		--- plants/acre ---		----- % -----				
Intense bed	Vaquero	120,000	135,731	6.6	71.5	78.1	15.7	6.2
		160,000	159,195	2.0	58.9	60.9	34.3	4.8
		200,000	190,677	1.7	47.1	48.8	45.8	5.4
		240,000	196,618	0.0	30.0	30.0	59.0	11.1
		average	170,555	2.6	51.8	54.4	38.7	6.9
	Barbaro	120,000	137,811	11.7	61.9	73.5	24.2	1.2
		160,000	156,819	4.3	61.9	66.2	29.1	4.7
		200,000	188,539	2.1	48.7	50.8	43.7	5.5
		240,000	205,528	0.0	43.3	43.3	49.1	7.5
		average	172,174	4.5	53.9	58.5	36.5	4.7
	Sedona	120,000	136,504	2.8	51.7	54.5	42.6	2.9
		160,000	153,255	1.1	38.8	39.9	52.5	7.6
		200,000	184,440	0.0	26.9	26.9	55.8	17.2
		240,000	205,825	0.0	17.6	17.6	68.2	14.2
		average	170,006	1.0	33.8	34.7	54.8	10.5
	Esteem	120,000	138,702	1.8	47.4	49.1	47.8	3.0
		160,000	154,443	0.7	50.3	51.0	41.6	7.4
		200,000	197,509	0.0	38.1	38.1	52.8	9.1
		240,000	213,547	0.0	26.7	26.7	58.7	14.6
		average	176,050	0.6	40.6	41.2	50.2	8.5
average	120,000	126,794	5.6	58.2	63.8	32.5	3.4	
	160,000	160,878	2.1	52.8	54.9	39.0	6.1	
	200,000	194,242	1.0	40.2	41.2	49.5	9.3	
	240,000	212,062	0.0	29.4	29.4	58.8	11.8	
LSD (0.05)								
Variety		NS	2	5	5.3	4.3	2.9	
Irrigation X Population		15,555	NS	NS	NS	7.7	4	
Irrigation X Var. X Pop.		31,110	NS	NS	NS	NS	NS	

Table 13. Response of yield of different bulb size categories to plant population for four onion varieties under intense bed drip irrigation; data were calculated from bulb diameter and bulb weight measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Variety	Plant population		Yield by bulb diameter				
		Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
		--- plants/acre ---		----- cwt/acre -----				
Intense bed	Vaquero	120,000	135,731	63.8	689.3	753.1	149.7	57.5
		160,000	159,195	20.5	611.3	631.8	353.1	48.9
		200,000	190,677	18.7	482.4	501.1	485.7	55.6
		240,000	196,618	0.0	319.1	319.1	621.7	116.1
		average	170,555	25.8	525.5	551.3	402.5	69.5
	Barbaro	120,000	137,811	112.4	555.4	667.8	217.5	10.4
		160,000	156,819	43.8	645.2	688.9	303.9	46.8
		200,000	188,539	22.6	512.1	534.6	453.8	56.7
		240,000	205,528	0.0	495.7	495.7	533.4	84.1
		average	172,174	44.7	552.1	596.8	377.2	49.5
	Sedona	120,000	136,504	18.5	395.0	413.5	325.3	21.3
		160,000	153,255	8.6	319.4	328.0	444.0	63.0
		200,000	184,440	0.0	215.7	215.7	455.5	134.4
		240,000	205,825	0.0	151.1	151.1	592.5	121.4
		average	170,006	6.8	270.3	277.1	454.3	85.0
	Esteem	120,000	138,702	16.4	412.5	428.9	424.8	25.7
		160,000	154,443	6.4	501.8	508.2	414.9	77.0
		200,000	197,509	0.0	382.0	382.0	539.5	95.7
		240,000	213,547	0.0	250.6	250.6	523.1	128.8
		average	176,050	5.7	386.7	392.4	475.6	81.8
average	120,000	126,794	51.6	516.5	568.1	280.0	29.9	
	160,000	160,878	20.8	524.5	545.2	376.0	58.4	
	200,000	194,242	10.3	398.1	408.4	483.6	85.6	
	240,000	212,062	0.0	304.1	304.1	567.7	112.6	
LSD (0.05)								
Variety		NS		18.3	50.3	55.5	44.6	22.0
Irrigation X Population		15,555		NS	NS	NS	NS	NS
Irrigation X Var. X Pop.		31,110		NS	NS	NS	NS	NS

Table 14. Response of onion bulb size categories to plant population for three irrigation systems averaged over four varieties; data were calculated from bulb diameter measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Plant population		Proportion by weight				
	Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
	--- plants/acre ---		----- % -----				
Intense bed	120,000	137,216	5.6	58.2	63.8	32.5	3.4
	160,000	155,928	2.1	52.8	54.9	39.0	6.1
	200,000	190,368	1.0	40.2	41.2	49.5	9.3
	240,000	205,379	0.0	29.4	29.4	58.8	11.8
	average	172,223	2.2	45.2	47.3	44.9	7.7
Conventional drip	120,000	126,794	10.1	60.7	70.8	26.0	2.4
	160,000	160,878	2.7	50.9	53.6	41.2	5.2
	200,000	194,242	2.1	44.0	46.2	47.0	6.6
	240,000	212,062	2.4	41.2	43.6	47.8	8.4
	average	173,494	4.3	49.2	53.5	40.5	5.7
Furrow	120,000	123,653	8.8	60.2	69.0	28.0	3.1
	160,000	155,928	3.3	49.4	52.7	39.4	7.6
	200,000	185,826	1.5	44.4	45.9	41.0	12.8
	240,000	206,815	0.9	37.0	37.9	47.6	14.3
	average	168,056	3.6	47.8	51.4	39.0	9.4
Average	120,000	129,176	8.2	59.7	68.0	28.7	3.0
	160,000	157,578	2.7	51.1	53.8	39.9	6.3
	200,000	190,142	1.5	42.9	44.4	45.9	9.5
	240,000	208,085	1.1	35.8	37.0	51.5	11.4
LSD (0.05)							
Population		6,362	1.7	3.9	3.7	3.8	1.8
Irrigation X Population		NS	NS	NS	NS	7.7	3.5
Irrigation X Var. X Pop.		NS	NS	NS	NS	NS	NS

Table 15. Response of yield of different bulb size categories to plant population for three irrigation systems averaged over four onion varieties; data were calculated from bulb diameter and bulb weight measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Irrigation system	Plant population		Yield by bulb diameter				
	Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
	--- plants/acre ---		----- cwt/acre -----				
Intense bed	120,000	137,216	51.6	516.5	568.1	280.0	29.9
	160,000	155,928	20.8	524.5	545.2	376.0	58.4
	200,000	190,368	10.3	398.1	408.4	483.6	85.6
	240,000	205,379	0.0	304.1	304.1	567.7	112.6
	average	172,223	20.7	435.8	456.5	426.8	71.6
Conventional drip	120,000	126,794	101.1	551.8	652.9	218.9	19.3
	160,000	160,878	30.4	503.7	534.1	389.0	48.0
	200,000	194,242	23.3	447.0	470.3	451.5	61.8
	240,000	212,062	27.1	427.1	454.2	467.5	75.0
	average	173,494	45.5	482.4	527.9	381.7	51.0
Furrow	120,000	123,653	86.0	525.7	611.7	226.0	22.3
	160,000	155,928	37.2	461.3	498.5	341.4	62.5
	200,000	185,826	14.6	427.5	442.1	378.8	100.7
	240,000	206,815	9.8	375.1	384.9	445.2	114.5
	average	168,056	36.9	447.4	484.3	347.9	75.0
Average	120,000	129,176	80.3	531.8	612.1	240.8	23.7
	160,000	157,578	29.2	497.4	526.6	369.3	56.2
	200,000	190,142	16.1	424.1	440.2	438.8	82.4
	240,000	208,085	12.3	368.7	381.0	494.1	100.5
LSD (0.05)							
Irrigation		NS	NS	NS	NS	52.8	NS
Population		6,362	17.7	38.4	38.1	36.5	14.7
Irrigation X Population		NS	NS	NS	NS	NS	NS
Irrigation X Var. X Pop.		NS	NS	NS	NS	NS	NS

Table 16. Response of bulb size categories to plant population for four onion varieties averaged over three irrigation systems; data were calculated from bulb diameter measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Variety	Plant population		Proportion by weight				
	Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
	--- plants/acre ---		----- % -----				
Vaquero	120,000	126,029	14.6	67.5	82.1	15.1	2.5
	160,000	160,383	5.7	57.9	63.6	32.5	3.9
	200,000	190,281	3.1	49.7	52.8	41.2	5.9
	240,000	204,538	2.8	43.6	46.3	47.1	6.3
	average	170,308	6.5	54.7	61.2	34.0	4.7
Barbaro	120,000	130,418	12.6	67.0	79.6	18.3	0.9
	160,000	159,459	4.4	59.9	64.3	30.4	4.9
	200,000	188,651	2.1	52.0	54.1	40.9	4.8
	240,000	210,412	0.8	47.9	48.7	45.1	6.2
	average	172,235	5.0	56.7	61.7	33.7	4.2
Sedona	120,000	129,383	3.2	52.5	55.7	40.8	3.5
	160,000	153,123	0.4	41.4	41.7	50.1	8.2
	200,000	186,090	0.8	31.3	32.1	52.3	15.3
	240,000	204,439	0.8	24.3	25.1	60.2	14.4
	average	168,259	1.3	37.3	38.6	50.8	10.4
Esteem	120,000	130,997	2.0	51.6	53.6	41.4	5.0
	160,000	157,347	0.2	45.2	45.5	46.5	8.0
	200,000	195,463	0.0	38.3	38.3	49.5	12.2
	240,000	212,953	0.0	27.2	27.2	53.5	19.3
	average	174,190	0.6	40.6	41.1	47.7	11.1
Average	120,000	129,176	8.2	59.7	68.0	28.7	3.0
	160,000	157,578	2.7	51.1	53.8	39.9	6.3
	200,000	190,142	1.5	42.9	44.4	45.9	9.5
	240,000	208,085	1.1	35.8	37.0	51.5	11.4
LSD (0.05)							
Population		6,362	1.7	3.9	3.7	3.8	1.8
Variety		NS	1.7	5.0	5.3	4.3	2.9
Variety X Pop.		NS	3.3	NS	NS	7.7	3.5

Table 17. Response of bulb size categories to plant population for four onion varieties averaged over three irrigation systems; data were calculated from bulb diameter and bulb weight measurements. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

Variety	Plant population		Yield by bulb diameter				
	Target	Actual	4 - 4½ in	3¼ - 4 in	3¼ - 4½ in	3 - 3¼ in	<3 in
	--- plants/acre ---		----- cwt/acre -----				
Vaquero	120,000	126,029	146.0	648.4	794.4	143.6	23.3
	160,000	160,383	64.4	607.0	671.4	333.9	37.8
	200,000	190,281	33.5	514.9	548.4	428.3	59.5
	240,000	204,538	30.9	475.4	506.3	499.0	66.6
	average	170,308	68.7	561.4	630.1	351.2	46.8
Barbaro	120,000	130,418	129.8	647.2	777.0	173.2	8.3
	160,000	159,459	47.6	625.3	672.9	310.4	48.5
	200,000	188,651	23.1	562.6	585.7	430.9	50.2
	240,000	210,412	9.7	534.1	543.7	485.5	64.3
	average	172,235	52.5	592.3	644.8	350.0	42.8
Sedona	120,000	129,383	23.2	402.0	425.2	309.6	26.3
	160,000	153,123	2.9	334.8	337.7	408.1	66.6
	200,000	186,090	6.8	257.6	264.4	431.1	118.8
	240,000	204,439	8.1	216.3	224.4	520.7	120.3
	average	168,259	10.3	302.7	312.9	417.4	83.0
Esteem	120,000	130,997	18.4	422.8	441.2	342.4	36.8
	160,000	157,347	2.1	422.2	424.3	424.6	72.0
	200,000	195,463	0.0	357.9	357.9	466.6	102.3
	240,000	212,953	0.0	241.9	241.9	470.0	153.7
	average	174,190	5.1	361.2	366.3	425.9	91.2
Average	120,000	129,176	80.3	531.8	612.1	240.8	23.7
	160,000	157,578	29.2	497.4	526.6	369.3	56.2
	200,000	190,142	16.1	424.1	440.2	438.8	82.4
	240,000	208,085	12.3	368.7	381.0	494.1	100.5
LSD (0.05)							
Population		6,362	17.7	38.4	38.1	36.5	14.7
Variety		NS	18.3	50.3	55.5	44.6	22.0
Variety X Pop.		NS	35.4	NS	NS	72.9	NS

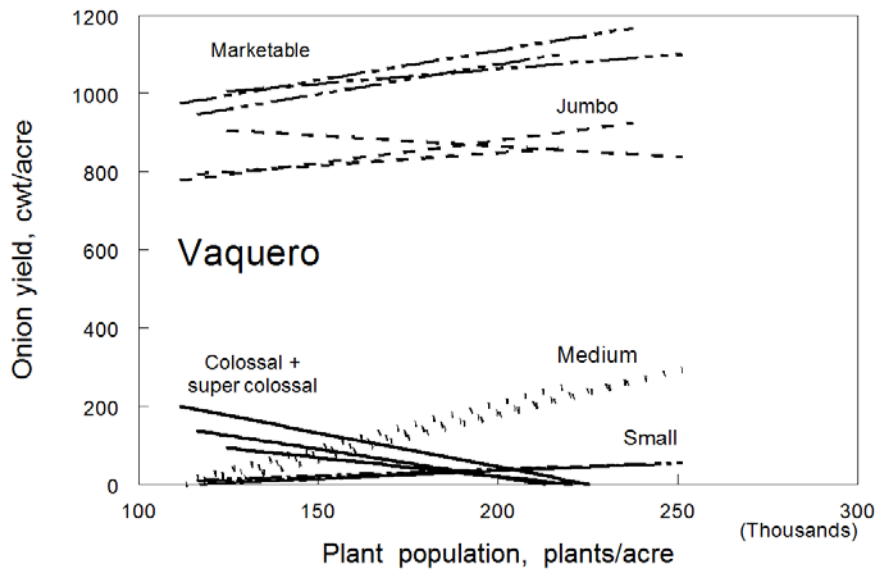


Figure 2. Yield response of onion bulb size categories to plant population for Vaquero under three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

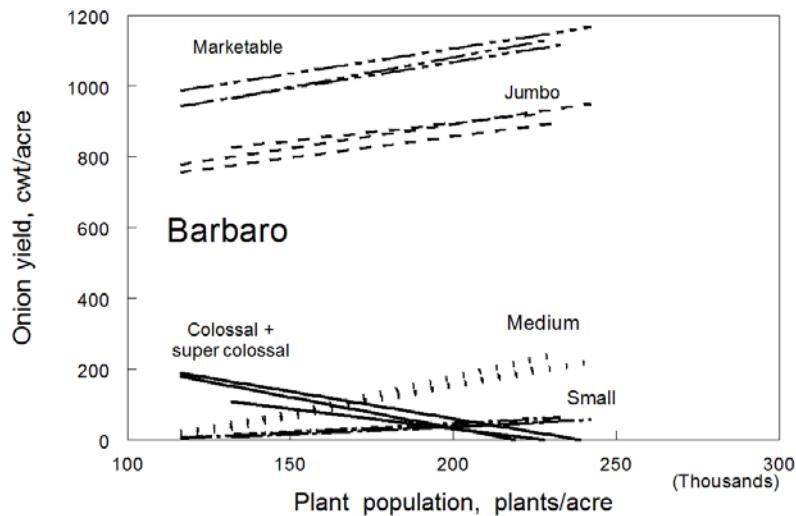


Figure 3. Yield response of onion bulb size categories to plant population for Barbaro under three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

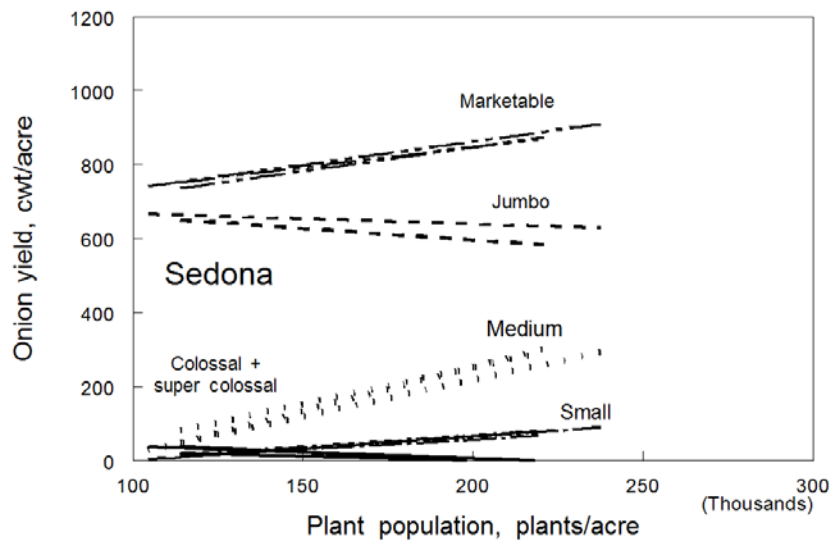


Figure 4. Yield response of onion bulb size categories to plant population for Sedona under three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

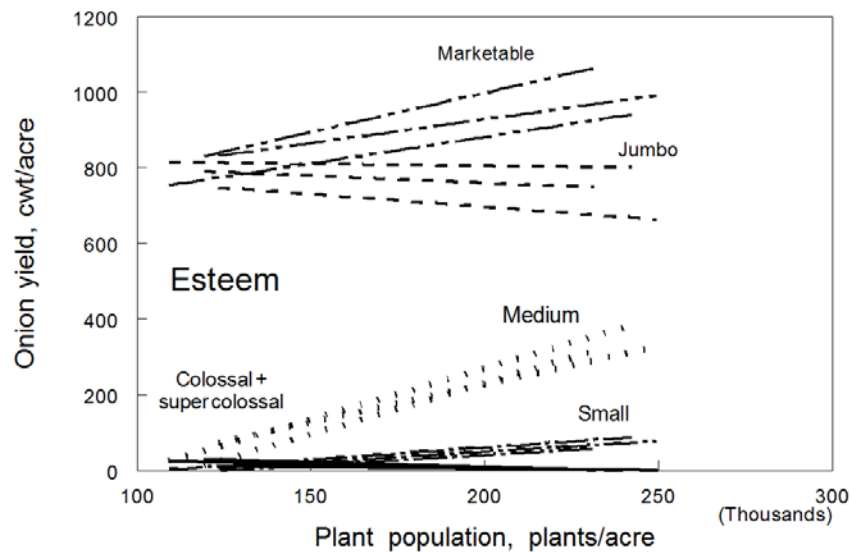


Figure 5. Yield response of onion bulb size categories to plant population for Esteem under three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

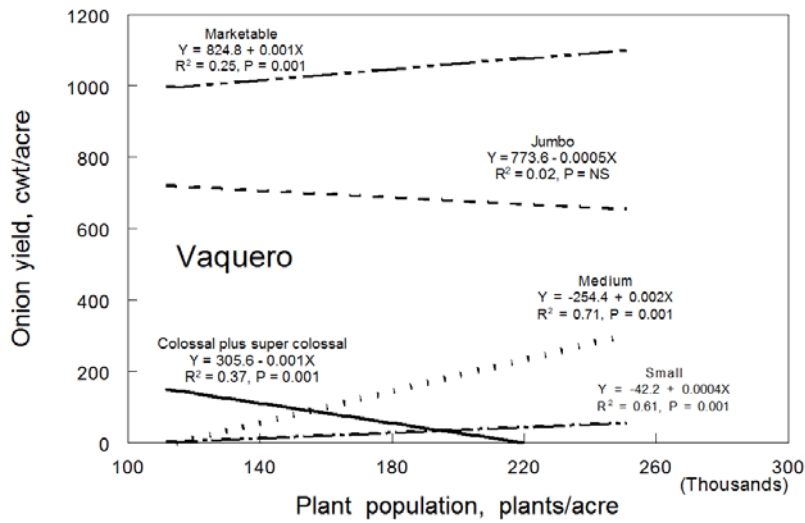


Figure 6. Yield response of onion bulb size categories to plant population for Vaquero averaged over three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

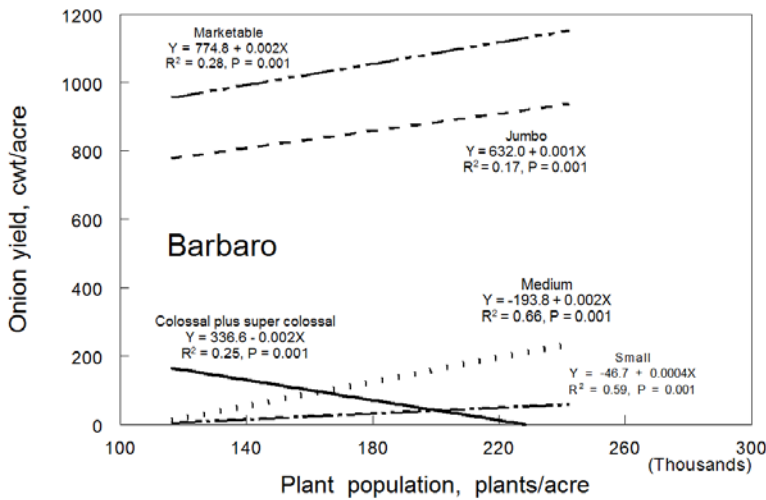


Figure 7. Yield response of onion bulb size categories to plant population for Barbaro averaged over three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

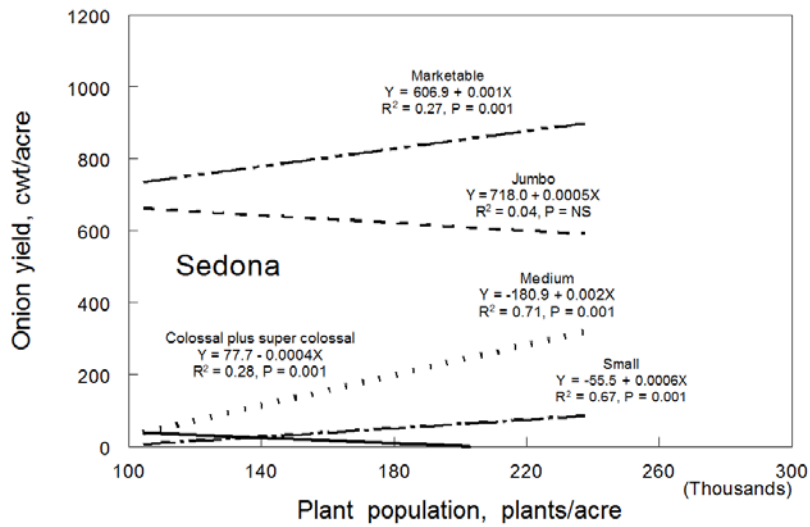


Figure 8. Yield response of onion bulb size categories to plant population for Sedona averaged over three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

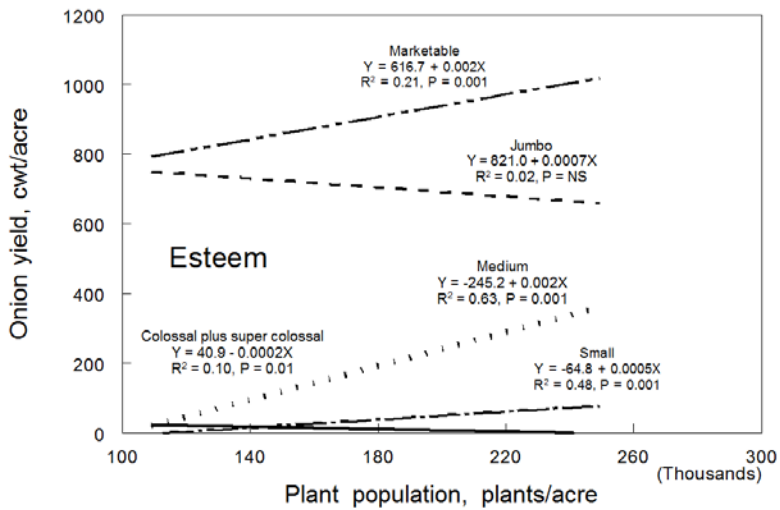


Figure 9. Yield response of onion bulb size categories to plant population for Esteem averaged over three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.

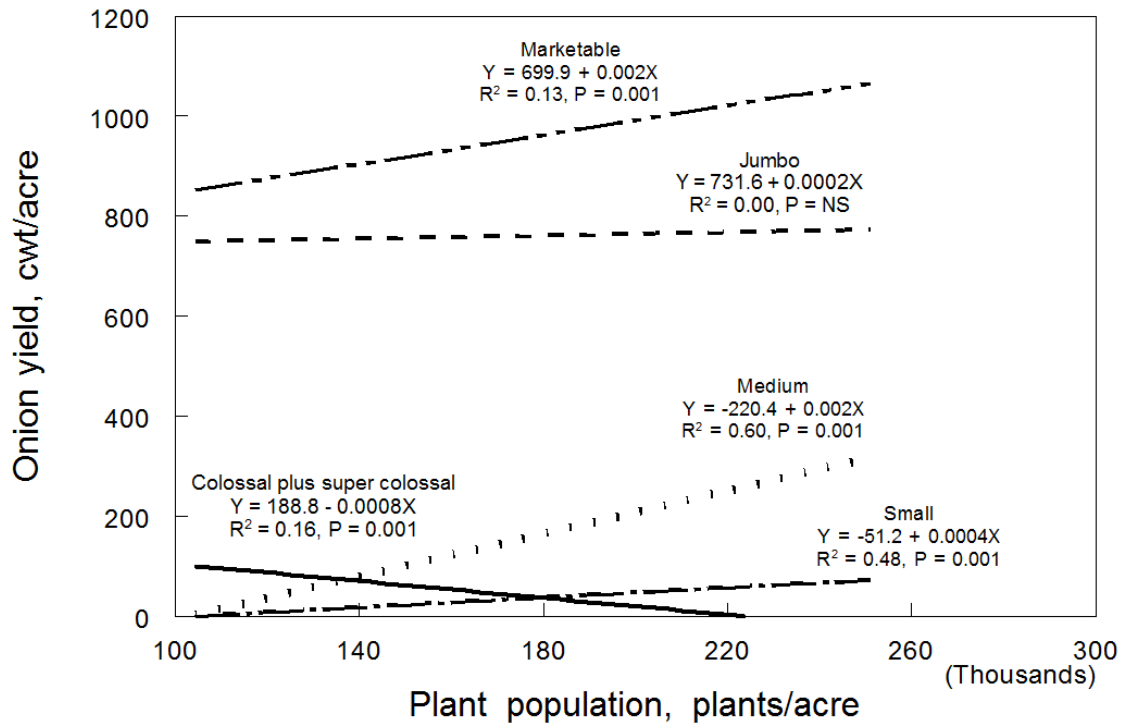


Figure 10. Yield response of onion bulb size categories to plant population averaged over three varieties and over three irrigation systems. Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.