ONION RESPONSE TO IRRIGATION CRITERIA FOR TWO VARIETIES UNDER TWO PLANT POPULATIONS, 2013

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Introduction

Past research at the Malheur Experiment Station demonstrated the sensitivity of onion yield and grade to soil water tension (Shock et al., 2000). The ideal soil water tension for initiating irrigations for drip-irrigated onion was determined to be close to 20 cb. In many other countries onions are grown at higher plant populations than in the Treasure Valley. A higher plant population might require a different soil water tension. This trial tested four soil water tensions with two varieties and two plant populations.

Materials and Methods

Onions were grown in 2013 on an Owyhee silt loam. The field was planted to wheat in 2012. In the fall of 2012, the wheat stubble was shredded and the field was irrigated. The field was then disked, moldboard plowed, and groundhogged. A soil analysis taken in the fall of 2012 showed a pH of 7.3, 1.6 percent organic matter, and 22 ppm of P. Based on the soil analysis, 49 lb of phosphorus/acre, 200 lb of sulfur/acre, and 1 lb of boron/acre were broadcast before plowing. After plowing, the field was fumigated with Vapam® at 15 gal/acre and bedded at 22 inches.

Seed was planted on March 13 in double rows spaced 3 inches apart at 9 seeds/ft of single row. Each double row was planted on beds spaced 22 inches apart. Planting was done with customized John Deere Flexi Planter units equipped with disc openers. Immediately after planting, the onions 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 4.

The field had drip tape laid at 4-inch depth between two pairs of double rows during planting. The drip tape had emitters spaced 12 inches apart and a flow rate of 0.22 gal/min/100 ft (Toro Aqua-Traxx, Toro Co., El Cajon, CA). The distance between the tape and the center of each double row of onions was 11 inches.

The experimental design was a split-split plot randomized complete block with six replicates. The four irrigation treatments were the main treatments. Four treatments tested different soil water tensions for initiating irrigations; 10, 20, 30, and 50 cb. The main plots were 4 double rows wide by 54 feet long.

Two onion varieties (Vaquero, Nunhems, Parma, ID) and an anonymous variety (Variety X) were planted as split plots within each main plot. Each variety split plot was divided into two plant population split-split plots (120,000 plants/acre and 450,000 plants per acre). Variety split plots were 27 feet long and plant population split-split plots were 13 feet long.

On March 21, a mixture of humic acid (CHB Premium 6, BioGro, Mabton, WA, 5 percent humic acids, 6 gallons per acre), phosphoric acid (NUE 0-30-0, Bio-Gro, 26 lb P/acre), and Avail (Simplot, Caldwell, ID, 0.5 percent of the final volume) was sidedressed between the seed row and the drip tape at 3 inch depth.

On May 16, the population split-split plots were thinned by hand. The plots thinned to 120,000 plants per acre had onions thinned to 4.75 inches between plants in each single row. The plots thinned to 450,000 plants per acre had onions thinned to 1.4 inches between plants in each single row.

In order to monitor plant nutrient status, every 2 weeks, starting on May 22, bulbs from the border rows in each split-split plot of 10 cb treatment of Vaquero from the 450,000 plants per acre population were removed and the roots washed in deionized water. A sample consisting of a composite of roots from all replicates was sent to Western Labs (Parma, ID) for nutrient analysis.

Soil solution analysis is an estimate of the amount of each nutrient that the soil can supply to the crop per day. Soil solution analysis uses an extraction method that simulates the extraction capacity of plant roots. Every week starting on June 24, soil samples were taken from the same split-split plots as the root issue samples and were sent to Western Labs for soil solution analysis. Each sample consisted of a composite of 7 cores to 9 inch depth from border rows in each plot.

Nutrients were applied based on root tissue analysis and soil solution analysis (Table 1). Nutrients were injected into the drip irrigation system using an Ozawa Precision Metering Pump (Ozawa R and D, Ontario, OR).

Table 1. Nutrients applied (lb/acre) through the drip tape. All nutrients were applied based on root tissue analysis, except as indicated. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Date	N	P	K	B	Ca	Mg	Cu
28-May	40						
10-Jun			20	0.2	3.5		
20-Jun	20		20	0.2			
3-Jul	20		20				
18-Jul		5	20			5	
25-Jul							0.1*
30-Jul							0.7*
1-Aug	20		20			5	
16-Aug		10	20				
19-Aug						5	
total	100	15	120	0.4	3.5	15	0

* based on soil solution analysis

Onions were irrigated automatically to maintain the soil water tension (SWT) in the onion root zone below the target for each treatment (Figure 1). Soil water tension was measured in each 450,000 plant/acre split-split plot in the Vaquero split plot in each main plot. Soil water tension in each split-split plot was measured with four granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer 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 every 12 hours. The irrigation decisions were based on the average SWT of the four GMS in each plot. The irrigation durations were 8 hours, 19 minutes (0.48 inches of water) for the 20, 30, and 50 cb treatments and 4 hours, 9 minutes (0.24 inches of water) for the 10 cb treatment. The irrigations were controlled by the datalogger using a controller (SDM CD16AC controller, Campbell Scientific, Logan, UT) connected to a solenoid valve in each main plot. The water for the drip system 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 automated irrigation system was started on July 9. Prior to July 9, irrigations were run manually based on sensor readings. Irrigations for the whole trial were terminated on September 3. Onion evapotranspiration (ET_c) was calculated with a modified Penman equation (Wright, 1982) using data collected at the Malheur Experiment Station by an AgriMet weather station. Onion ET_c was estimated and recorded from crop emergence until the onions were lifted.

The onions were managed to avoid yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. Roundup® at 1 lb ai/acre was broadcast on April 2 prior to onion emergence. On May 3, Goal Tender® at 0.06 lb ai/acre (4 oz/acre), Buctril® at 0.25 lb ai/acre (16 oz/acre), and Clethodim® at 0.19 lb ai/acre (12 oz/acre) were applied for weed control. On May 26, Prowl H_2O® at 0.83 lb ai/acre (2 pints/acre) was applied for weed control. On June 10, Goal Tender® at 0.09 lb ai/acre (6 oz/acre), Buctril® at 0.31 lb ai/acre (20 oz/acre), and Clethodim® at 0.25 lb ai/acre (16 oz/acre) were applied for weed control. For thrips control, the following insecticides were applied: Movento® at 5 oz/acre on May 23 and May 31, AgriMek at 16 oz/acre on June 14, June 27, and July 4, Radiant on July 12, and Lannate on July 18, and July 24.

The onions were lifted on September 10 to field cure. Onions from 9 ft of the middle 2 rows in each split-split plot were topped by hand, bagged, and placed in storage on September 19. The storage shed was ventilated and the temperature was slowly decreased to maintain air temperature as close to 34°F as possible. Onions were graded out of storage on November 25.

During grading, all bulbs from each split-split plot were counted. Split bulbs were counted and weighed. Bulbs were then separated according to quality: bulbs without blemishes (No. 1s), double bulbs (No. 2s), bulbs infected with neck rot (*Botrytis allii*) in the neck or side, plate rot (*Fusarium oxysporum*), or black mold (*Aspergillus niger*). The No. 1 bulbs were graded according to diameter: < 30 mm, 30 – 50 mm, 50 – 57 mm, 57 – 70 mm, 70 – 76 mm, 76 – 90 mm, 90 – 102 mm, 102 – 108 mm, > 108 mm. The grade data was analyzed according to U.S. standards: small (<2¼ inches), medium (2¼-3 inches), jumbo (3-4 inches), colossal (4-4¼ inches), and supercolossal (>4¼ inches). The grade data was also analyzed according to Brazilian standards: < 30 mm, 30 – 50 mm, 50 – 70 mm, 70 – 90 mm, > 90 mm. For the purposes of this report, all number one bulbs were considered marketable. In markets where colossal and super colossal bulbs are desired and plant populations are low, very few of the bulbs are small. In markets where medium and small bulbs are desired and plant populations are high, there are very few colossal and super colossal bulbs. 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.

Treatment differences were compared using analysis of variance (ANOVA) and regression analysis. Means separation was determined using Fisher's least significant difference test at the 5 percent probability level, LSD (0.05).

Results

Soil water tension over time oscillated around the target for each treatment, with the amplitude of the oscillations increasing with the increase in the irrigation criteria (Figure 1). The amount of water applied with irrigation at 20 cb paralleled crop evapotranspriation (ET_c) (Figure 2), (Table 2). Irrigation at 10 cb exceeded ET_c. The other treatments applied less than ET_c for the season (35.3 inches).

Irrigation treatment effects

Averaged over varieties, irrigation criterions drier than 10 cb resulted in decreasing colossal yield for the 120,000 plants/acre population (Table 3). For the 450,000 plants/acre population, irrigation criteria drier than 20 cb (30, and 50 cb) resulted in increasingly lower jumbo yield. For the 450,000 plants/acre population, there was no supercolossal yield and colossal yields were very low. Averaged over varieties and populations, irrigation criteria drier than 20 cb (30 and 50 cb) resulted in lower total yield and marketable yield than the 10 or 20 cb treatments.

Averaged over populations, marketable yield for Swale was more sensitive to increasing irrigation criterion than Vaquero. This was due mainly to a greater decline in colossal yield with increasing irrigation criterion for Swale than for Vaquero. Regression analysis shows that, for Vaquero, marketable yield was not responsive to soil water tension, but colossal plus super colossal yields declined with increasing average soil water tension for both plant populations (Figures 3 and 4). For Swale, both marketable and colossal plus super colossal yields declined with increasing average soil water tension for both plant populations (Figures 5 and 6).

For the 450,000 plants per acre population, averaged over varieties, the 10 cb and 20 cb irrigation treatments resulted in higher storage rot than the drier treatments. There was no statistically significant difference in storage rot between irrigation treatments for the 120,000 plants per acre population.

Plant population effects

Averaged over varieties and treatments, supercolossal yield, colossal yield, and jumbo yield were higher with the 120,000 plants per acre population (Table 3). Total yield, marketable yield, medium yield, small yield, total rot, and bolting were higher with the 450,000 plants per acre population. A word of caution is that we have defined marketable yield to include small onions for the purpose of this trial. Since small bulbs are not marketable in the US, the 120,000 plants per acre treatment produced more marketable onions for the US market.

Bulb single centers

There was no significant difference in bulb single centeredness between irrigation treatments. The 450,000 plants per acre population resulted in higher single centered and functionally single centered bulbs (Table 5). The 450,000 plants per acre population resulted in a higher percentage of tops down on July 25 than the 120,000 plants per acre population. The percentage of tops down on July 25 increased with the increasing soil water tension (dryness) of the irrigation treatments for the 450,000 plants per acre population. There was no difference in the percentage of tops down on July 25 between irrigation treatments for the 120,000 plants per acre population.

Discussion

The results of this study agree with previous research at the Malheur Experiment Station. Research in 2012 showed that with plant populations up to 200,000 plants per acre (highest tested), total and marketable yield were not very sensitive to plant population, but colossal and supercolossal yield is very sensitive to plant population (Shock et al., 2013). In the current study, plant populations of 318,000 plants per acre resulted in higher marketable yield, but only because we counted small onions as marketable for the purposes of this study. The 2012 research on plant population was consistent with the present trial, where higher plant populations resulted in earlier maturity.

Research in 1997 and 1998 showed that depending on the year, irrigation criterions drier than 10 or 20 cb resulted in reduced marketable yield and bulb size (Shock et al., 2000). In the present study, averaged over two varieties, irrigation criterions drier than 20 cb resulted in reduced marketable yield and bulb size. However, the regression analysis showed that for Vaquero marketable yield was less sensitive to irrigation than for Swale.

Literature cited

Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 2000. Irrigation criteria for drip-irrigated onions. HortScience 35:63-66.

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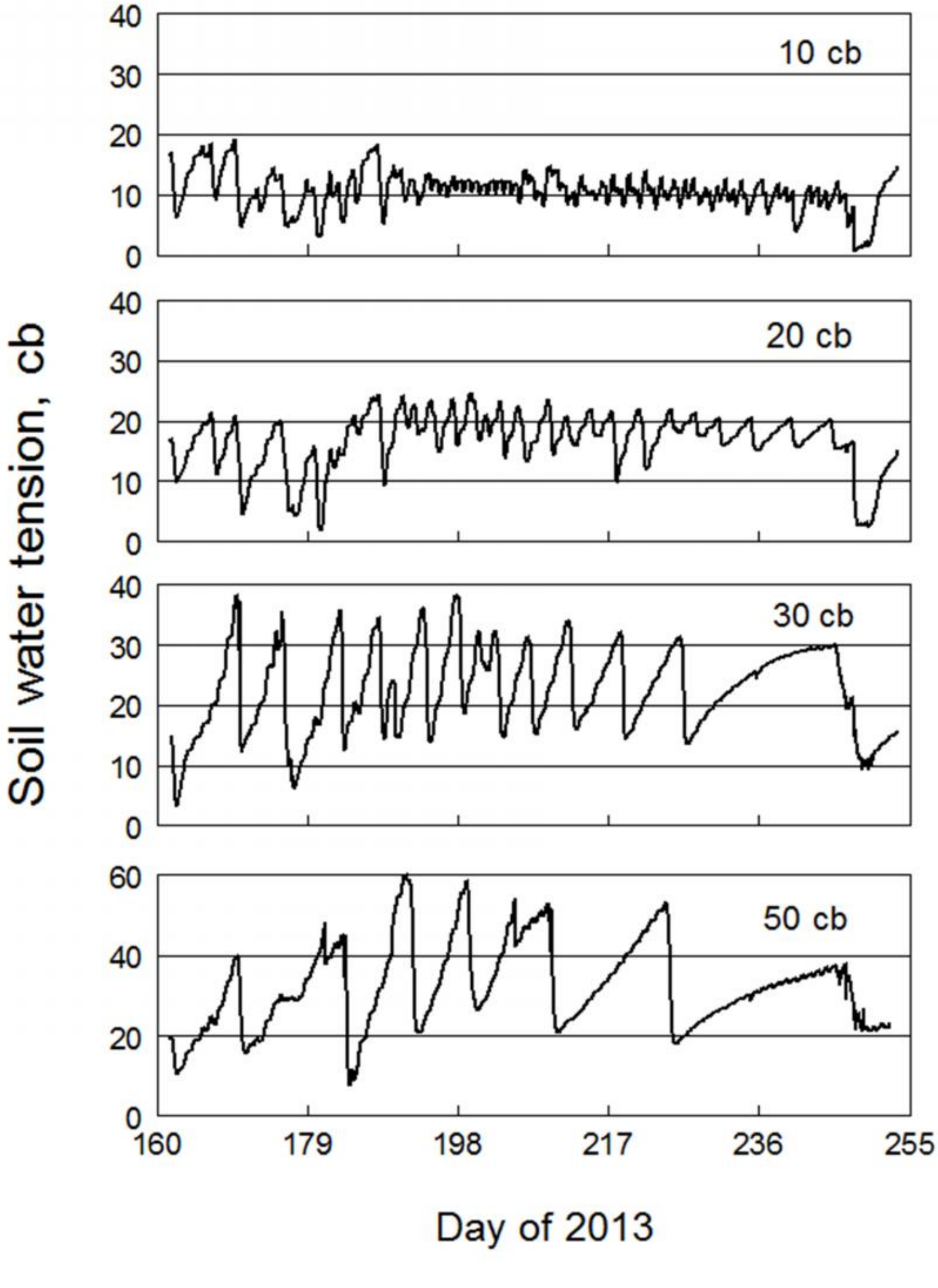

Figure 1. Soil water tension at 8-inch depth for onions irrigated at four soil water tensions. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Table 2. Total water applied (includes 1.5 inches of precipitation) from emergence to the last irrigation and average soil water tension. Evapotranspiration from emergence to lifting totaled 35.3 inches. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Irrigation criterion	Total water applied	Average soil water tension
	inches	cb
10 cb	45.3	13.8
20 cb	36.4	17.4
30 cb	24.5	22.9
50 cb	22.0	33.0
LSD (0.05)	6.9	3.3

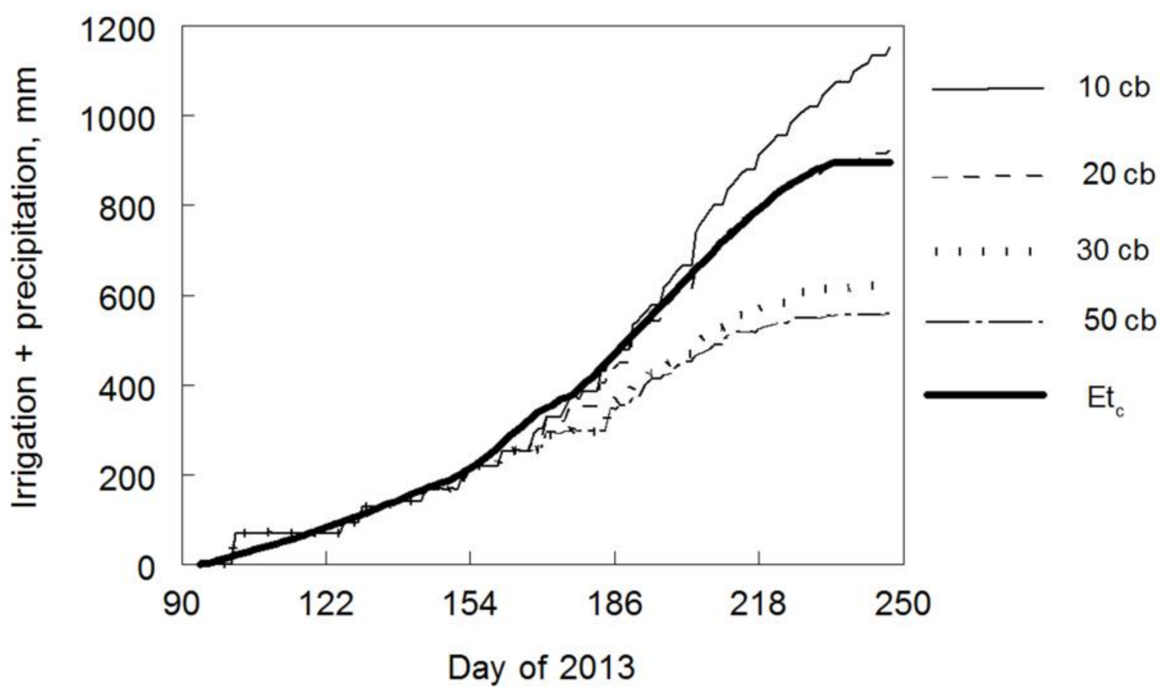

Figure 2. Water applied plus precipitation and evapotranspiration (ET_c) for onions irrigated at four soil water tensions. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Table 3. Onion yield and grade for two varieties under two plant populations in response to soil water tension. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013. Continued on next page.

		Plant population		Total	Marketable yield by grade						Bulb counts		
Variety	Treatment	Target	Actual	yield	Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	>4¼ in	Total rot	Bolting
		--- plants/acre ---		---------- cwt/acre ----------							#/50 lb	% by yield	%
Vaquero	10 cb	120,000	101,277	964.3	934.5	28.9	365.0	498.6	28.3	13.7	31.9	3.0	1.3
	20 cb	120,000	110,331	995.0	976.8	23.8	335.0	587.8	20.6	9.6	33.2	1.8	2.3
	30 cb	120,000	119,587	954.2	938.2	6.0	258.6	632.7	29.0	12.0	36.5	1.6	2.5
	50 cb	120,000	109,677	920.3	913.8	10.1	230.5	619.0	44.4	9.6	32.9	0.8	1.4
		average	110,218	958.4	940.8	17.2	297.3	584.5	30.6	11.2	33.6	1.8	1.9
	10 cb	450,000	343,036	1158.1	1068.2	0.0	14.5	491.2	394.4	168.2		7.7	6.6
	20 cb	450,000	294,484	1196.6	1077.3	0.0	23.5	616.0	283.0	154.8		10.2	9.5
	30 cb	450,000	314,494	1055.5	1033.1	0.0	6.0	477.5	372.7	176.9		2.2	4.5
	50 cb	450,000	286,146	1029.0	992.9	0.0	0.0	436.8	402.7	153.5		3.7	5.0
		average	309,540	1109.8	1042.9	0.0	11.0	505.4	363.2	163.3		5.9	6.4
	10 cb	Average	222,157	1061.2	1001.4	14.5	189.7	494.9	211.4	91.0	31.9	5.3	4.0
	20 cb		202,408	1103.5	1030.9	11.0	167.3	603.0	161.9	87.8	33.2	6.3	5.9
	30 cb		217,041	1004.8	985.6	3.0	132.3	555.1	200.8	94.5	36.5	1.9	3.5
	50 cb		197,911	974.6	953.3	5.1	115.3	527.9	223.5	81.6	32.9	2.2	3.2
	average		209,879	1036.0	992.8	8.4	151.1	545.2	199.4	88.7		4.0	4.2
Swale	10 cb	120,000	103,598	1093.9	1086.5	15.1	325.2	715.4	26.0	4.9	34.7	0.7	1.7
	20 cb	120,000	127,431	990.3	974.6	7.6	159.2	762.7	34.1	11.1	35.0	1.6	2.6
	30 cb	120,000	114,301	897.3	895.0	2.9	142.1	700.7	42.3	7.0	37.9	0.3	1.6
	50 cb	120,000	103,062	789.5	789.5	0.0	45.1	681.9	57.3	5.2		0.0	1.1
		average	112,098	942.7	936.4	6.4	167.9	715.2	39.9	7.0		0.6	1.7
	10 cb	450,000	329,713	1159.8	1104.7	0.0	0.0	515.5	416.6	172.6		4.2	7.8
	20 cb	450,000	331,838	1121.9	1083.8	0.0	1.9	408.4	472.5	201.0		3.6	8.4
	30 cb	450,000	337,836	929.4	922.1	0.0	0.0	264.2	409.3	248.5		0.8	4.6
	50 cb	450,000	330,880	945.4	939.5	0.0	0.0	188.4	468.6	282.5		0.6	4.7
		average	332,567	1039.1	1012.5	0.0	0.5	344.1	441.7	226.1		2.3	6.4
	10 cb	Average	216,656	1126.8	1095.6	7.5	162.6	615.4	221.3	88.7	34.7	2.5	4.7
	20 cb		253,219	1071.3	1041.8	2.9	62.4	544.7	303.9	128.0	35.0	2.8	5.7
	30 cb		226,069	913.3	908.5	1.5	71.1	482.5	225.8	127.8	37.9	0.5	3.1
	50 cb		206,615	867.4	864.5	0.0	22.6	435.2	262.9	143.8		0.3	2.7
	average		225,640	994.7	977.6	3.0	79.7	519.4	253.5	122.1		1.5	4.1

Table 3. Onion yield and grade averaged over two varieties under two plant populations in response to soil water tension. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Variety	Treatment	Plant population		Total yield	Marketable yield by grade						Bulb counts >4¼ in	Total rot	Bolting
		Target	Actual		Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small			
		--- plants/acre ---		----------------------------- cwt/acre -----------------------------							#/50 lb	% by yield	%
Average	10 cb	120,000	102,437	1029.1	1010.5	22.0	345.1	607.0	27.1	9.3	32.8	1.9	1.5
	20 cb	120,000	117,456	992.8	975.8	16.4	255.1	667.3	26.7	10.2	33.6	1.7	2.5
	30 cb	120,000	116,944	925.7	916.6	4.4	200.4	666.7	35.6	9.5	36.8	1.0	2.0
	50 cb	120,000	106,369	854.9	851.6	5.1	137.8	650.5	50.8	7.4	32.9	0.4	1.2
		average	110,802	950.6	938.6	12.0	234.6	647.9	35.1	9.1		1.2	1.8
	10 cb	450,000	336,375	1158.9	1086.5	0.0	7.2	503.3	405.5	170.4		5.9	7.4
	20 cb	450,000	314,406	1156.7	1080.8	0.0	12.0	505.3	384.0	179.5		6.7	9.1
	30 cb	450,000	326,165	992.4	977.6	0.0	3.0	370.9	391.0	212.7		1.5	4.6
	50 cb	450,000	306,480	987.2	966.2	0.0	0.0	312.6	435.6	218.0		2.2	4.6
		average	320,856	1073.8	1027.7	0.0	5.6	423.0	404.0	195.1		4.1	6.4
	10 cb	Average	219,406	1094.0	1048.5	11.0	176.2	555.2	216.3	89.9	32.8	3.9	7.2
	20 cb		226,873	1087.4	1036.3	7.0	114.9	573.8	232.9	107.9	33.6	4.6	9.0
	30 cb		221,555	959.1	947.1	2.2	101.7	518.8	213.3	111.1	36.8	1.2	4.6
	50 cb		202,074	921.0	908.9	2.5	68.9	481.5	243.2	112.7	32.9	1.3	4.8
LSD (0.05)													
Treatment			NS	82.9	83.7	NS	NS	50.7	NS	NS	NS	NS	1.1
Population			17,471	43.1	38.3	6.1	26.9	45.9	25.2	13.2	NS	1.2	0.7
Variety X Population			NS	NS	NS	NS	38.0	64.9	35.6	18.6	NS	NS	NS
Treatment X Variety			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Treatment X Population			NS	NS	NS	NS	53.7	91.7	NS	26.3	NS	2.4	1.4
Treatment X Variety X Population			NS	NS	NS	NS	NS	NS	71	37	NS	NS	NS

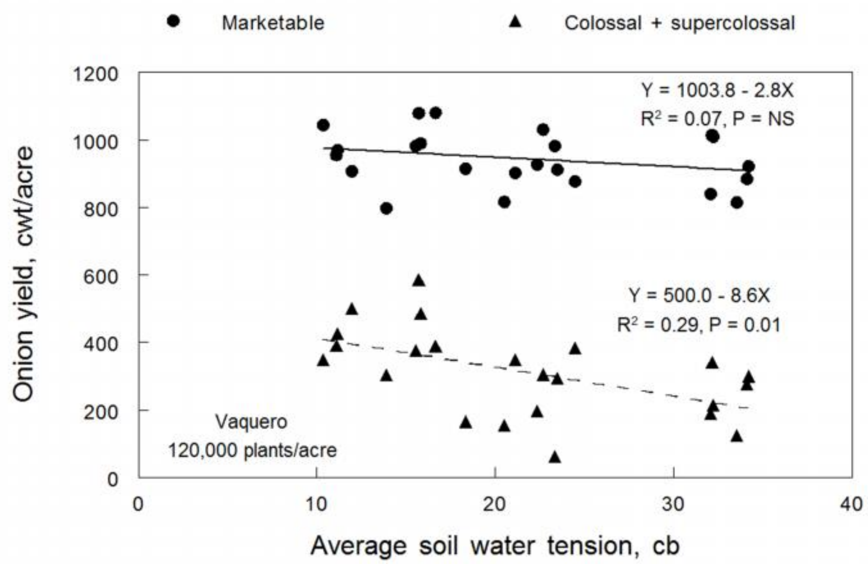

Figure 3. Marketable and colossal plus supercolossal yields in response to average soil water tension for Vaquero grown at 120,000 plants per acre. Malheur Experiment Station, Oregon State University, Ontario, OR.

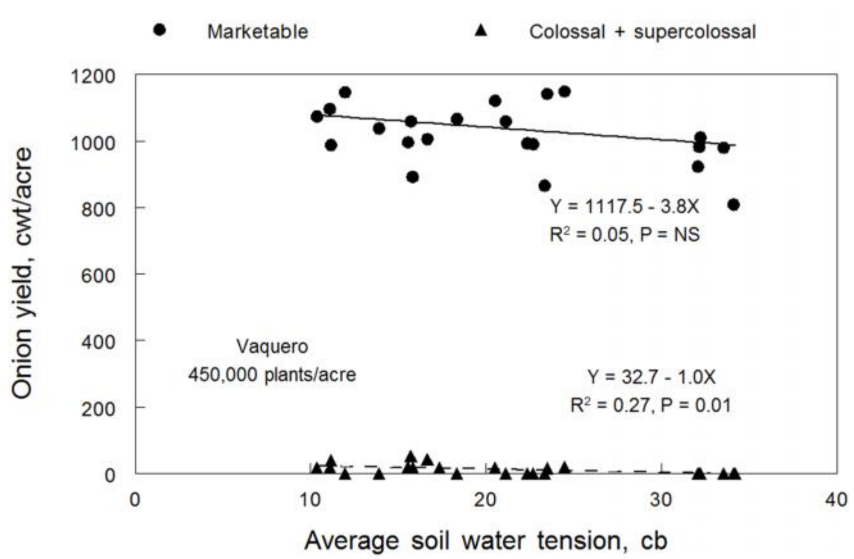

Figure 4. Marketable and colossal plus supercolossal yields in response to average soil water tension for Vaquero grown at 450,000 plants per acre. Malheur Experiment Station, Oregon State University, Ontario, OR.

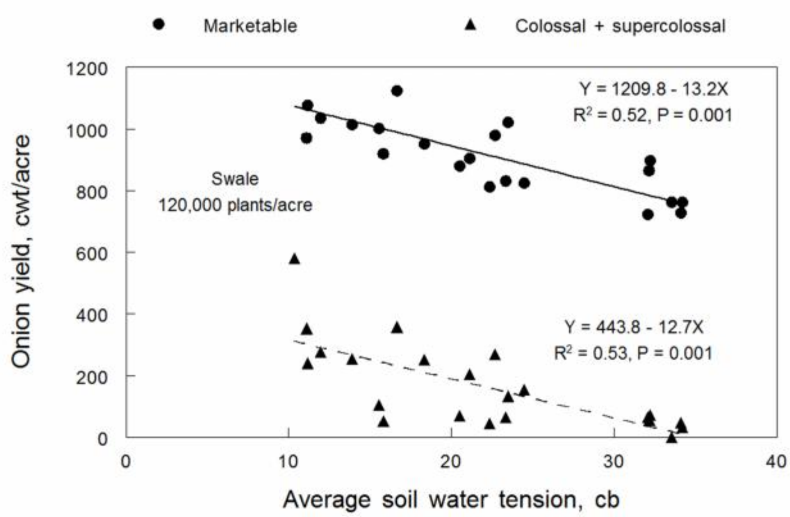

Figure 5. Marketable and colossal plus supercolossal yields in response to average soil water tension for Variety X grown at 120,000 plants per acre. Malheur Experiment Station, Oregon State University, Ontario, OR.

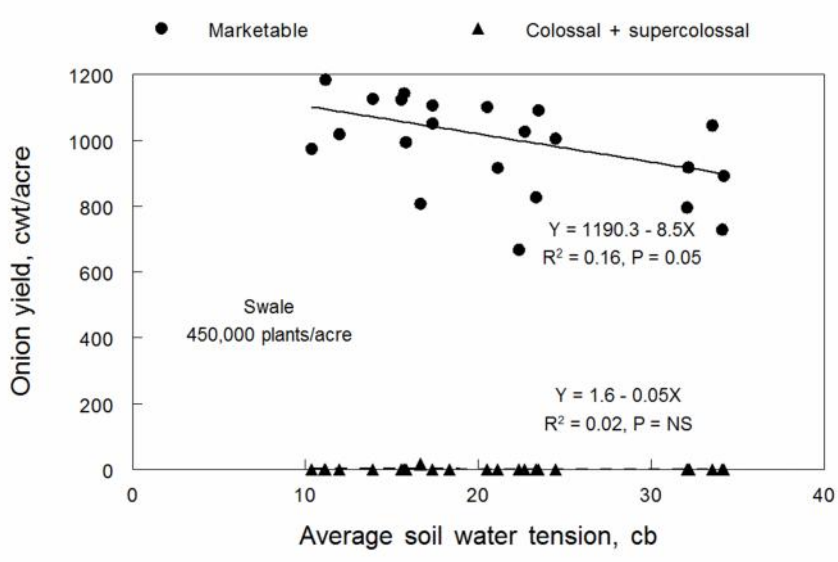

Figure 6. Marketable and colossal plus supercolossal yields in response to average soil water tension for Variety X grown at 450,000 plants per acre. Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 4. Onion single center ratings and maturity for two varieties under two plant populations in response to soil water tension. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013. Continued on next page.

		Plant population	Multiple center			Single center		Maturity July 25	
Variety	Treatment	Target	large	medium	small	functional[a]	single	tops down	dryness
		plants/acre	%						
Vaquero	10 cb	120,000	2.2	6.5	23.2	91.2	68.0	0.0	0.0
	20 cb	120,000	3.0	6.5	20.1	90.6	70.5	0.0	0.0
	30 cb	120,000	2.8	5.8	17.7	91.4	73.7	0.0	0.0
	50 cb	120,000	3.4	5.9	15.8	90.8	75.0	0.0	0.0
	average	average	2.8	6.2	19.2	91.0	71.8	0.0	0.0
	10 cb	450,000	0.9	1.8	7.8	97.3	89.5	6.0	0.0
	20 cb	450,000	1.0	3.1	11.5	95.9	84.5	4.7	0.0
	30 cb	450,000	0.0	0.0	2.0	100.0	98.0	56.3	0.0
	50 cb	450,000	0.0	1.5	8.9	98.5	89.6	67.0	2.6
	average	average	0.5	1.6	7.5	97.9	90.4	33.5	0.7
	10 cb	Average	1.5	3.9	14.7	94.6	79.9	3.8	0.0
	20 cb		1.9	4.7	15.4	93.5	78.0	2.5	0.0
	30 cb		1.4	2.9	9.9	95.7	85.8	32.1	0.0
	50 cb		1.5	3.4	12.0	95.1	83.1	37.2	1.4
	Average		1.6	3.7	13.0	94.7	81.7	18.9	0.4
Swale	10 cb	120,000	2.2	6.0	20.6	91.8	71.2	0.0	0.0
	20 cb	120,000	1.1	5.8	26.4	93.1	66.7	1.4	0.0
	30 cb	120,000	4.0	7.3	20.1	88.7	68.6	0.0	0.0
	50 cb	120,000	3.7	6.5	18.5	89.8	71.3	0.0	0.0
	average	average	2.8	6.4	21.4	90.8	69.4	0.4	0.0
	10 cb	450,000	0.5	3.1	15.7	96.5	80.8	1.0	0.0
	20 cb	450,000	0.3	2.6	12.6	97.1	84.5	10.0	0.0
	30 cb	450,000	0.4	2.5	10.5	97.2	86.7	51.7	0.0
	50 cb	450,000	0.0	1.6	8.5	98.4	89.9	85.0	2.5
	average	average	0.3	2.4	11.8	97.3	85.5	36.9	0.6
	10 cb	Average	1.3	4.5	18.1	94.1	76.0	0.5	0.0
	20 cb		0.7	4.1	19.0	95.3	76.3	5.7	0.0
	30 cb		2.2	4.9	15.3	92.9	77.6	25.8	0.0
	50 cb		1.9	4.0	13.5	94.1	80.6	42.5	1.3
	Average		1.5	4.4	16.5	94.1	77.6	18.6	0.3

Table 4. Onion single center ratings and maturity for two varieties under two plant populations in response to soil water tension. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

Variety	Treatment	Plant population	Multiple center			Single center		Maturity July 25	
		Target	large	medium	small	functional[a]	single	tops down	dryness
		plants/acre	----------------------------------			%		--------------------------------	
Average	10 cb	120,000	2.2	6.2	21.8	91.5	69.8	0.0	0.0
	20 cb	120,000	2.0	6.1	23.3	91.8	68.6	0.8	0.0
	30 cb	120,000	3.6	6.7	19.2	89.8	70.6	0.0	0.0
	50 cb	120,000	3.6	6.2	17.4	90.2	72.8	0.0	0.0
	average	average	2.8	6.3	20.4	90.8	70.4	0.2	0.0
	10 cb	450,000	0.7	2.4	11.7	96.9	85.2	3.5	0.0
	20 cb	450,000	0.6	2.9	12.0	96.5	84.5	7.4	0.0
	30 cb	450,000	0.2	1.5	7.1	98.3	91.2	53.5	0.0
	50 cb	450,000	0.0	1.6	8.7	98.5	89.8	76.8	2.5
	average	average	0.4	2.1	9.9	97.5	87.7	35.3	0.6
	10 cb	Average	1.4	4.2	16.5	94.4	77.9	1.9	0.0
	20 cb		1.3	4.4	17.2	94.4	77.2	4.2	0.0
	30 cb		1.9	4.1	13.1	94.0	80.9	28.2	0.0
	50 cb		1.7	3.8	12.8	94.5	81.7	40.2	1.3
LSD (0.05)									
Treatment			NS	NS	NS	NS	NS	13.3	NS
Population			0.9	1.0	2.5	1.7	3.5	5.4	NS
Treatment X Population			NS	NS	NS	NS	NS	10.7	1.4
Treatment X Var. X Pop.			NS	NS	7.0	NS	9.9	NS	NS