

# ONION VARIETY TRIALS 2010-2020

---

*Erik B. G. Feibert, Clinton C. Shock, Stuart Reitz, Alicia Rivera, and Kyle D. Wieland, Malheur Experiment Station, Oregon State University, Ontario, OR*

## Introduction

Direct-seeded yellow, white, and red onion varieties have been evaluated at the Malheur Experiment Station in Ontario, OR since 1985. Varieties are evaluated in the field for plant disease, thrips, maturity, bolting, and bulb single centers. Out of storage, the varieties are evaluated for yield, grade, and bulb decomposition. The varieties are planted in March, harvested in September, and usually graded out of storage in January of the following year. Each year, growers and seed industry representatives have the opportunity to examine the varieties at our annual Onion Variety Field Day in late August and during bulb evaluations in January. Ten seed companies have participated in the trials since 2010 (Table 1). This report presents data for onion varieties from 2010 through 2020.

## Materials and Methods

Onions were grown on Owyhee silt loam or Greenleaf silt loam previously planted to wheat. The fields were in a five year rotation following wheat. Some years, rotations also included sweet corn, potatoes and soybeans. After wheat was harvested, the stubble was shredded and the fields were irrigated to sprout unharvested wheat kernels and then the fields were disked. Before fall plowing, the fields were fertilized based on soil analyses. Nitrogen (N) was not applied in the fall, except in the fall of 2018, when 50 lb N/acre as urea was applied. Starting with the 2017 trial, in addition to the chemical fertilizer, 10 ton/acre of composted cattle manure was broadcast before plowing in the fall. Based on analyses of the manure, averaged over the years 2017-2019, 193 lb of N/acre, 140 lb of phosphorus (P)/acre, and 353 lb of potassium (K)/acre were added from the manure each year. After plowing and groundhogging, the fields were fumigated within the bed with Vapam<sup>®</sup> at 15 gal/acre and bedded at 22 inches.

From 2010 through 2018, all varieties of all bulb colors were planted in one trial. Starting in 2019, the varieties were planted in three adjacent trials based on bulb color (yellow, white, red) in order to coordinate harvest timing and improve statistical analyses. The experimental designs each year were randomized complete blocks with five replicates. A sixth non-randomized replicate was planted for demonstrating onion variety performance to growers and seed company representatives at the Onion Variety Day held in late August. The seed was planted as close as possible to the middle of March in plots 4 double rows wide and 27 ft long (Table 1).

A high seeding rate and thinning were used to provide uniform plant populations. Seed was planted in double rows spaced 3 inches apart at 9 seeds/ft of single row. Pairs of double rows were planted on beds spaced 22 inches apart on 44-inch beds. Planting was done with customized John Deere Flexi Planter units equipped with disc openers. Not all seed companies provide insecticide treated seed, so immediately after planting, the fields received a narrow band of Lorsban 15G<sup>®</sup> (chlorpyrifos) over the seed rows at 3.7 oz/1000 ft of row (0.82 lb ai/acre) for preventative control of onion maggot and the soil surface was cultipacked. Onion emergence

started in early April. About mid-May, alleys 4 ft wide were cut between plots, leaving plots 23 ft long. The seedlings were hand thinned in mid-May at a 2 to 3 leaf growth stage. From 2010 through 2012, the seedlings were thinned to a target spacing of 6 inches between individual onion plants in each single row, or 95,000 plants/acre. Due to a reduction in the market for super colossal bulbs (> 4.25 inches), starting in 2013 the seedlings were thinned to a target spacing of 4.75 inches between individual onion plants in each single row, or 120,000 plants/acre.

From 2010 through 2014, the trial was furrow-irrigated. Starting in 2015, the trial was drip-irrigated with tape laid at 4-inch depth between pairs of beds during planting. The drip tape had emitters spaced 12 inches apart and an emitter 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. This distance was possible due to the favorable lateral wetting properties of the soils.

Furrow irrigations were run manually using a soil water tension (SWT) irrigation onset criterion of 25 cb (Shock et al. 1998). Drip irrigations were run automatically using a SWT irrigation onset criterion of 20 cb (Shock et al. 2000). Soil water tension was measured with eight granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrrometer Co. Inc., Riverside, CA) installed at 8-inch depth in the center of the double row of onions. Sensors had been calibrated to SWT (Shock et al. 1998).

For the drip irrigations, the GMS were connected to the datalogger via multiplexers (AM 16/32, Campbell Scientific, Logan, UT). The datalogger (CR1000, Campbell Scientific) read the sensors and recorded the SWT every hour. The datalogger automatically made irrigation decisions every 12 hours. The fields were irrigated if the average of the eight sensors was at a SWT of 20 cb or higher. The irrigations were controlled by the datalogger using a controller (SDM CD16AC, Campbell Scientific) connected to a solenoid valve. Irrigation durations were 8 hours, 19 min to apply 0.48 inch of water. Previous research showed that smaller and more frequent irrigations resulted in poorer onion performance (Shock et al., 2005). The water was supplied from a well and pump that maintained a continuous and constant water pressure of 35 psi. The pressure in the drip lines was maintained at 10 psi by a pressure-regulating valve. The automated drip irrigation systems were started in late April and irrigations ended in early September.

The onions were managed to minimize yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. Most years, Roundup (glyphosate) was applied before onion emergence. For weed control after onion emergence, the following herbicides were broadcast: oxyfluorfen (GoalTender<sup>®</sup>), bromoxynil (Brox 2EC<sup>®</sup>), pendimethalin (Prowl<sup>®</sup> H<sub>2</sub>O), clethodim (Shadow 3EC), and sethoxydim (Poast).

For thrips control, the following insecticides were applied by ground until late June, then by air: azadirachtin (Aza Direct), potassium salts of fatty acids (M-Pede), spirotetramat (Movento<sup>®</sup>), spinetoram (Radiant<sup>®</sup>), abamectin (Agri-Mek<sup>®</sup> SC), cyantraniliprole (Exirel), and methomyl (Lannate). Insecticide applications were made every 7 to 10 days from late May to early August, totaling 5 to 10 applications per year (Table 3).

In-season onion nutrition was based on root tissue and soil samples. When the trial was drip irrigated, root tissue and soil samples were taken every week starting in early June from field borders and analyzed for nutrients by Western Laboratories, Inc., Parma, Idaho. Root tissue was analyzed for nitrate concentration and soil was analyzed for concentrations of nutrients in the soil

solution. Nutrients were applied only if both the root tissue and soil solution concentrations were simultaneously below the critical levels. Nitrogen was applied through the drip tape as urea ammonium nitrate solution. When the trial was furrow irrigated, in-season nutrient applications were limited to sidedressing in May and later in the furrow irrigation water. Furrow-irrigation complicated frequent in-season applications, so nutrient management was less intensive and based on a few soil and tissue samples and standard amounts of N applied.

In late August, onions were evaluated for iris yellow spot virus (IYSV) severity. Evaluations of IYSV damage were done by rating onions in each plot on a subjective scale of 0 to 5 of increasing severity of IYSV symptoms. The rating was 0 if there were no symptoms, 1 if 1-25% of foliage was diseased, 2 if 26-50% of foliage was diseased, 3 if 51-75% of foliage was diseased, 4 if 76-99% of foliage was diseased, and 5 if 100% of foliage was diseased.

Onions in each plot were evaluated subjectively for maturity by visually rating the percentage of onions with the tops down and the total percent of dry leaves in the plot.

The red varieties were topped and bagged to field cure in late August due to earlier maturation than the yellow and white varieties. The red varieties were allowed to cure in burlap bags for about 7 days and then were put in storage. After lifting in early September, the yellow varieties were cured for about 7 days in the field, then were topped, bagged, and placed in storage. Only onions from the middle two rows in each plot were bagged for yield evaluations. 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 in early January.

During grading, bulbs were separated according to external quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. 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 consisted of No.1 bulbs larger than 2¼ inches.

After harvest, bulbs from one of the border rows in each plot of both trials were rated for single centers. Twenty-five consecutive onions ranging in diameter from 3½ to 4¼ inches were cut equatorially through the bulb middle and separated into single-centered (bullet) and multiple-centered bulbs. The multiple-centered bulbs had the long axis of the inside diameter of the first single ring measured. These multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small had diameters less than 1½ inches, medium had diameters from 1½ to 2¼ inches, and large had diameters greater than 2¼ inches. Onions were considered "functionally single centered" for processing if they were single centered (bullet) or had a small multiple center.

Varietal differences were determined using analysis of variance. Means separation was determined using a protected Fisher's least significant difference test at the 5% probability level, LSD (0.05). The least significant difference LSD (0.05) values in each table should be considered when comparisons are made between varieties for significant differences in their performance characteristics in an individual year. Differences between varieties equal to or greater than the LSD value for a characteristic should exist before any variety is considered

different from any other variety in that characteristic. Variety performance varies by year, consequently, a review of variety performance over a number of years is important.

## Results

In all years, except 2011 and 2017, onion seed was planted in the last two weeks of March (Table 1). In 2011 and 2017, onion planting was delayed until April due to excessively wet soils. On average, emergence occurred on April 12 and it took 20 days from planting for seedlings to emerge.

Root nitrate levels often remained below the critical level until late June or early July (Figure 1). Both soil solution N and total available soil N showed large year to year variation (Figures 2 and 3). Most years, soil available N remained below the critical level of 59 lb N/acre (Sullivan et al., 2001) until late June, when large increases occurred. Soil solution N also remained below the critical level until late June, when large increases occurred. These soil N increases are consistent with previous studies showing high N mineralization rates in Treasure Valley soils (Stieber et al., 1995).

Total amounts of N applied varied each year, but generally, half as much was applied with drip irrigation than with furrow irrigation (Table 2). With drip irrigation, the frequent root tissue and soil sampling allowed fertilizer amounts to be more easily adjusted. Generally, nitrogen applications were terminated in late June due to the large increases in soil N at this time.

Data for the yellow varieties can be found in Tables 7 to 13, red variety data can be found in Tables 14 to 20, and white variety data can be found in Tables 21 to 27.

Yields for the yellow and white varieties each year after the switch to drip irrigation were higher than before drip irrigation except 2015, a high IYSV year. Yields for the red varieties were higher starting in 2017, when composted cattle manure started being applied in the prior fall.

Iris yellow spot virus has been among the most important factors influencing onion yield since it first appeared in the Treasure Valley in the early 2000's (Figure 4). Table 26 displays IYSV and yield data for 4 varieties since 2005. A part of the year to year variability in yield can also be attributed to degree days. Vaquero has been in the variety trial every year since 1992 (Figure 5). Vaquero marketable yield tended to be higher in years with higher growing degree days (50-86°F, Figure 6).

## Acknowledgements

This project was funded by the Idaho-Eastern Oregon Onion Committee, cooperating onion seed companies, Oregon State University, the Malheur County Education Service District, and supported by Formula Grant nos. 2020-31100-06041 and 2020-31200-06041 from the USDA National Institute of Food and Agriculture.

## References

- Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 1998. Onion yield and quality affected by soil water potential as irrigation threshold. *HortScience* 33:1188-1191.
- Shock, C.C., J. Barnum, and M. Seddigh. 1998. Calibration of Watermark soil moisture sensors for irrigation management. Irrigation Association. Proceedings of the International Irrigation Show. Pages 139-146. San Diego, CA.
- Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 2000. Irrigation criteria for drip-irrigated onions. *HortScience* 35:63-66.
- Shock, C.C., E.B.G. Feibert, and L.D. Saunders. 2005. Onion response to drip irrigation intensity and emitter flow rate. *HortTechnology* 15:652-659.
- Stieber, T.D., C.C. Shock, E. Feibert, M. Thornton, B. Brown, W. Cook, Mir-M Seyedbagheri, and D.T. Westerman. 1995. Nitrogen mineralization in Treasure Valley soils. 1993 and 1994 results. Malheur Experiment Station Special Report 947: 194-207.
- Sullivan, D.M., B.D. Brown, C.C. Shock, D.A. Horneck, R.G. Stevens, G.Q. Pelter, and E.B.G. Feibert. 2001. Nutrient Management for Sweet Spanish Onions in the Pacific Northwest. Pacific Northwest Extension Publication PNW 546:1-26.

Table 1. Participating seed companies in the onion variety trials at the Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Location	Website
American Takii	Salinas, CA	<a href="http://www.takii.com/">www.takii.com/</a>
Bejo	Oceano, CA	<a href="http://www.bejoseeds.com/">www.bejoseeds.com/</a>
D. Palmer	Yuma, AZ	<a href="http://www.dpseeds.com/">www.dpseeds.com/</a>
Crookham	Caldwell, ID	<a href="http://www.crookham.com/">www.crookham.com/</a>
Enza Zaden	Salinas, CA	<a href="http://www.enzazaden.com/">www.enzazaden.com/</a>
Hazera	The Netherlands	<a href="http://www.hazera.com/">www.hazera.com/</a>
New Zealand Onion	Pukekohe, New Zealand	<a href="http://www.nzonion.co.nz/">www.nzonion.co.nz/</a>
Nunhems	Parma, ID	<a href="http://www.nunhems.com/us/en.html">www.nunhems.com/us/en.html</a>
Sakata	Morgan Hill, CA	<a href="https://sakatavegetables.com/">https://sakatavegetables.com/</a>
Seminis	St. Louis, MO	<a href="http://www.seminis-us.com/">www.seminis-us.com/</a>

Table 2. Dates for planting, emergence, lifting, topping and bagging, and start of storage for the onion variety trials, Malheur Experiment Station, Oregon State University, Ontario, OR.

Year	Planting	Emergence	Days to emergence			
			from planting	Lift	Top/bag	Storage
2010	16-Mar	15-Apr	30	10-Sep	17-Sep	24-Sep
2011	12-Apr	2-May	20	13-Sep	19-Sep	3-Oct
2012	27-Mar	16-Apr	20	12-Sep	27-Sep	27-Sep
2013	14-Mar	4-Apr	21	9-Sep	17-Sep	19-Sep
2014	21-Mar	7-Apr	17	10-Sep	16-Sep	22-Sep
2015	19-Mar	6-Apr	18	31-Aug	7-Sep	11-Sep
2016	17-Mar	5-Apr	19	12-Sep	16-Sep	26-Sep
2017	4-Apr	20-Apr	17	22-Sep	2-Oct	11-Oct
2018	20-Mar	9-Apr	20	10-Sep	15-Sep	21-Sep
2019	21-Mar	9-Apr	19	10-Sep	16-Sep	23-Sep
2020	20-Mar	11-Apr	22	11-Sep	19-Sep	30-Sep

Table 3. Total amounts of nitrogen applied during the growing season and total number of insecticide applications for thrips control by year. Malheur Experiment Station, Oregon State University, Ontario, OR.

Year	N, lb/acre	Irrigation Method	Number of insecticide applications
2010	200	Furrow	5
2011	220	Furrow	5
2012	250	Furrow	8
2013	200	Furrow	7
2014	180	Furrow	10
2015	100	Drip	9
2016	80	Drip	10
2017	120	Drip	9
2018	120	Drip	10
2019	152	Drip	8
2020	116	Drip	7

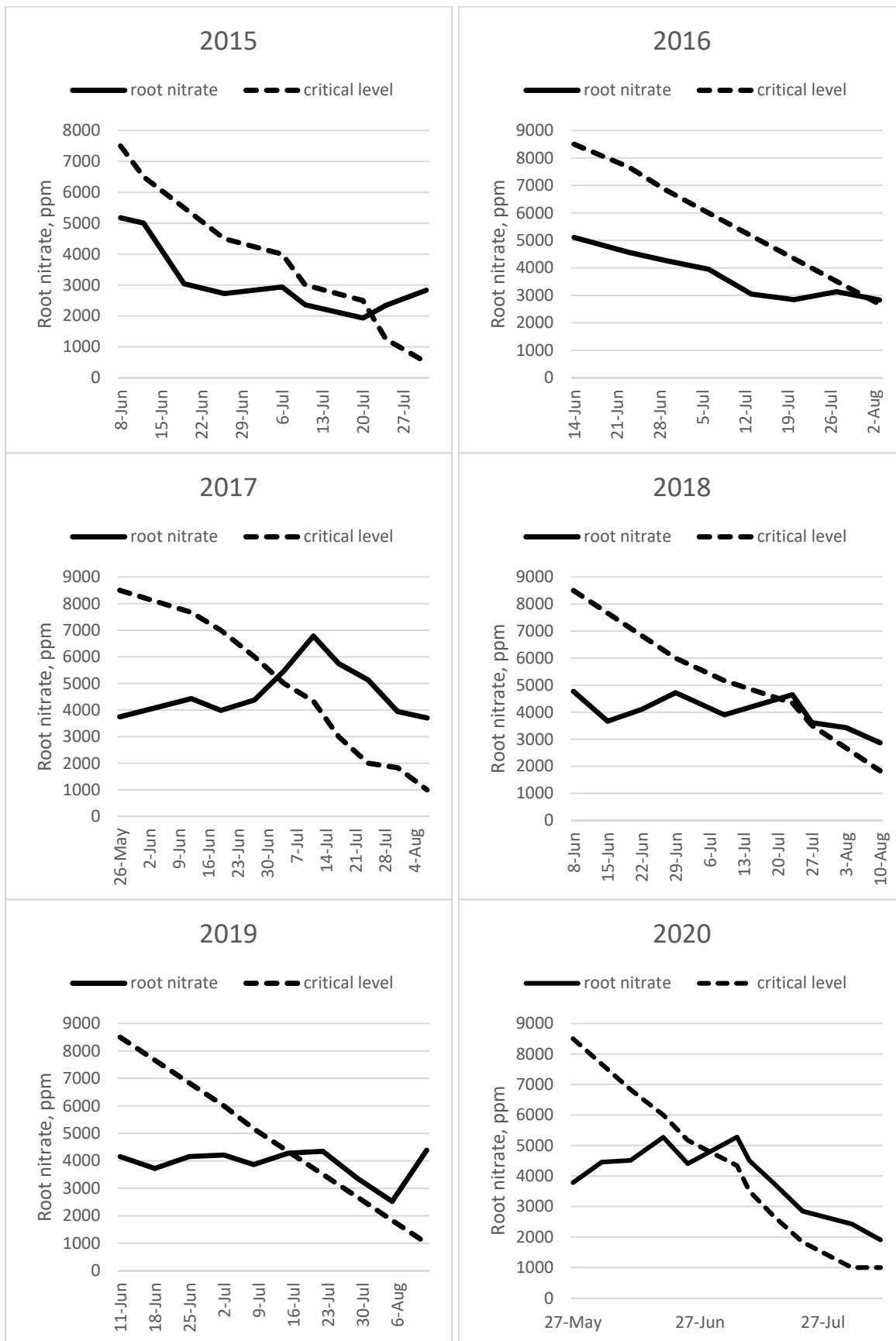


Figure 1. Root nitrate during the season from 2015 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

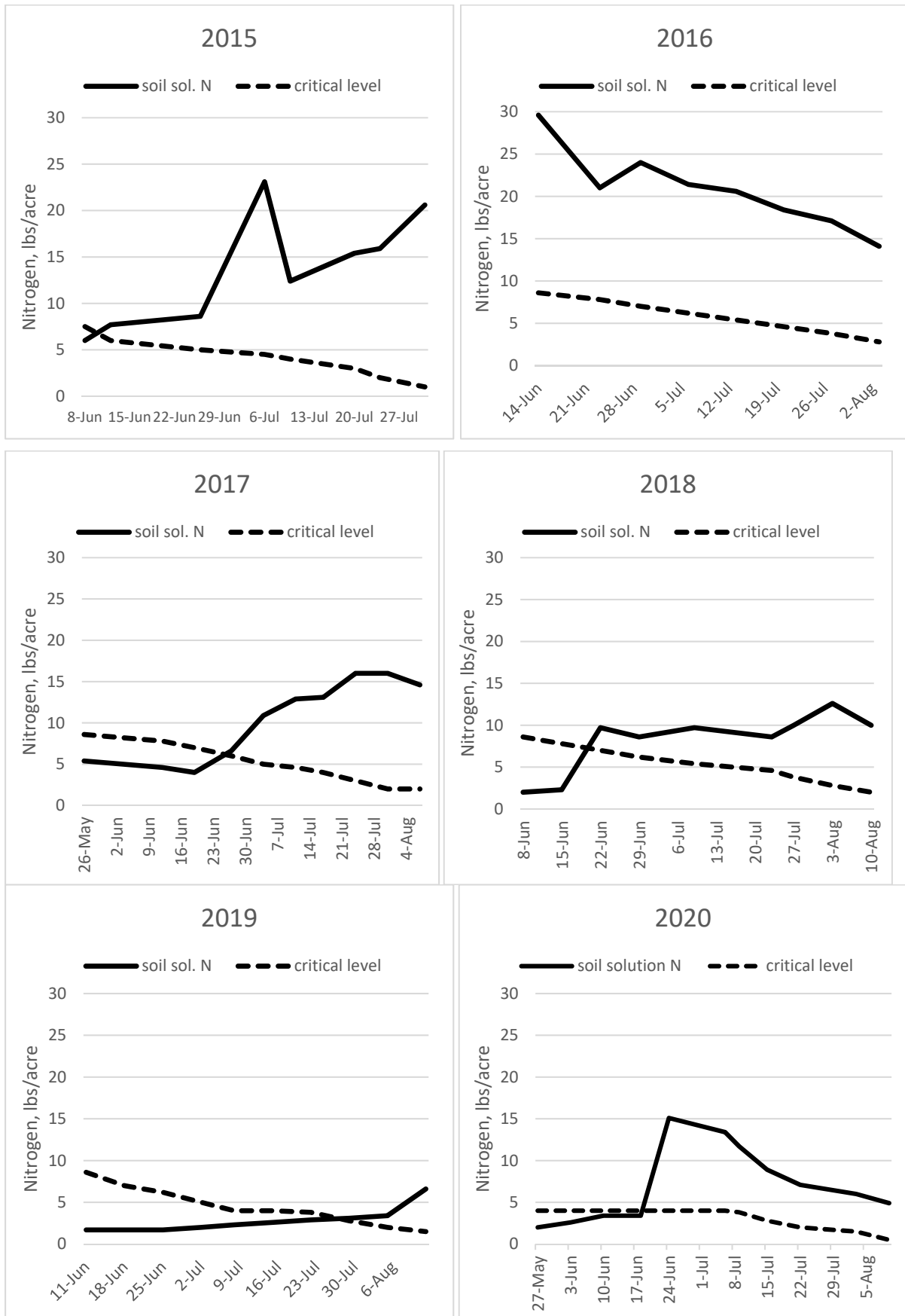


Figure 2. Soil solution N during the season from 2015 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.



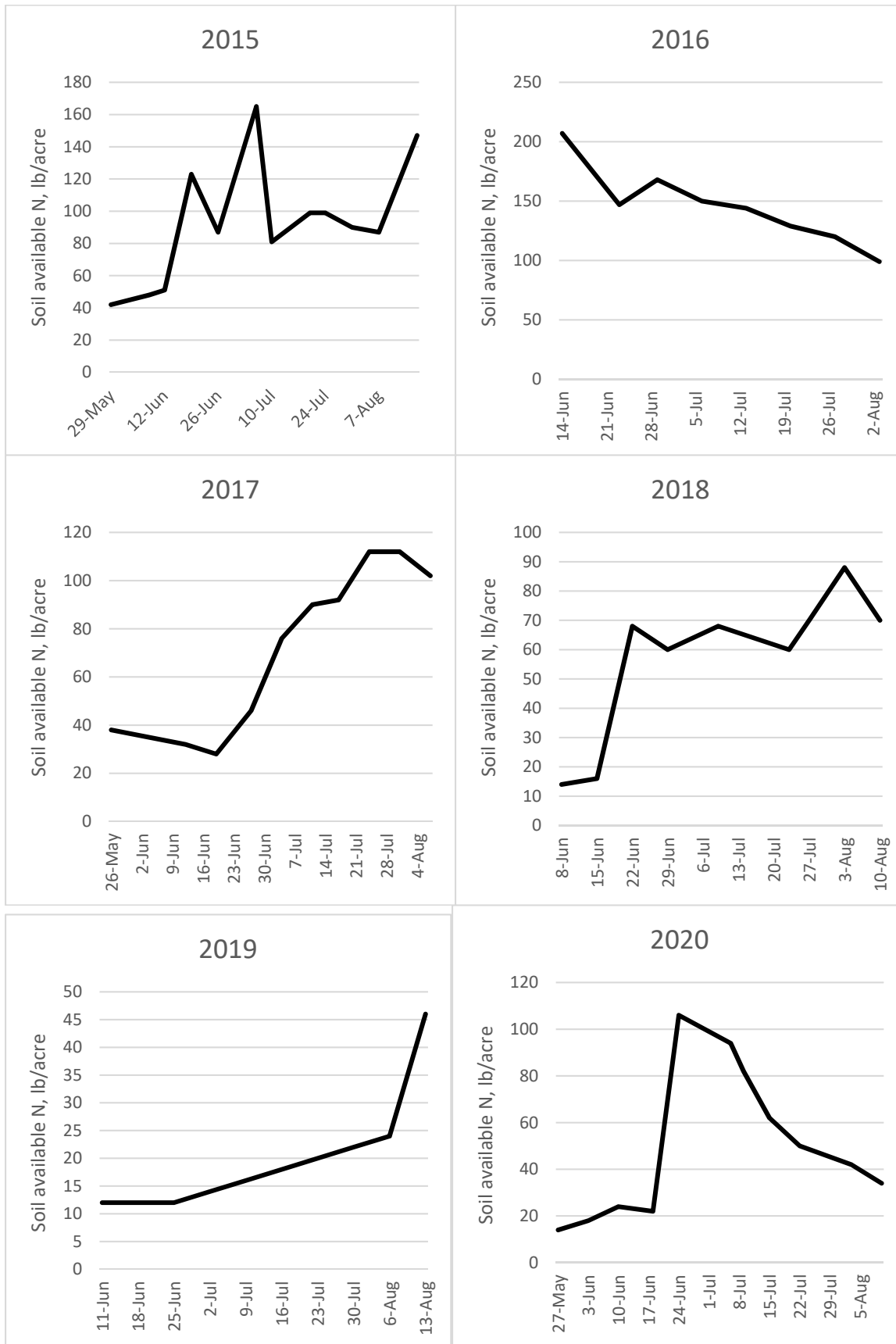


Figure 3. Soil available N ( $\text{NO}_3 + \text{NH}_4\text{-N}$ ) in the top foot of soil during the season from 2015 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 4. Monthly total growing degree days (50–86°F), Malheur Experiment Station, Oregon State University, Ontario, OR.

Year	April	May	June	July	August	Total April-August
2010	159	248	467	671	605	2149
2011	106	272	423	676	699	2176
2012	253	353	484	751	694	2535
2013	226	407	549	745	717	2644
2014	227	424	544	779	685	2659
2015	241	427	674	716	700	2759
2016	305	405	576	680	683	2650
2017	169	380	533	766	706	2554
2018	225	471	516	733	683	2628
2019	213	372	530	698	691	2503
2020	249	386	542	670	689	2537
Average	212	376	530	721	686	2526

Table 5. Average monthly maximum and minimum air temperature (°F) from April through August, Malheur Experiment Station, Oregon State University, Ontario, OR.

Month	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		2020		76-year Avg.	
	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
Apr	61	36	58	35	67	39	65	36	65	36	65	37	70	40	61	38	65	38	64	40	66	37	64	37
May	67	42	68	42	72	45	76	44	76	46	75	48	75	46	73	46	78	51	72	48	73	47	74	45
Jun	78	52	76	49	80	49	83	52	82	53	91	58	86	51	83	56	82	53	82	54	79	54	82	52
Jul	91	57	89	55	95	61	98	59	96	63	92	59	91	56	96	64	96	62	91	60	90	59	92	58
Aug	88	54	93	56	95	57	94	57	90	58	93	56	91	53	93	60	91	59	91	60	92	60	90	56

Table 6. Yield and iris yellow spot severity of four varieties from 2005 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Year	Sedona				Arcero				Joaquin				Vaquero				Average			
	IYSV	Total yield	Marketable yield	Yield > 4 inch	IYSV	Total yield	Marketable yield	Yield > 4 inch	IYSV	Total yield	Marketable yield	Yield > 4 inch	IYSV	Total yield	Marketable yield	Yield > 4 inch	IYSV	Total yield	Marketable yield	Yield > 4 inch
	0-5	- cwt/acre -			0-5	- cwt/acre -			0-5	- cwt/acre -			0-5	- cwt/acre -			0-5	- cwt/acre -		
2005	1.2	529	506	26	1.2	714	678	73	0.7	813	772	179	1.1	666	618	72	1.1	681	643	87
2006	2.8	558	481	4	3.5	620	589	40	1.6	738	714	200	2.9	644	595	54	2.7	640	595	75
2007	1.0	1148	1081	679	0.8	1108	1081	698	0.7	1238	1189	906	0.6	1309	1269	1008	0.8	1201	1155	823
2008	1.2	676	655	47	1.1	767	759	77	1.1	864	858	268	1.4	798	771	117	1.2	776	761	127
2009	2.8	512	413	14	3.1	490	334	9	1.9	630	480	130	2.8	603	424	45	2.7	559	413	49
2010	1.3	605	589	28	1.0	672	658	63	1.0	752	731	200	1.1	781	738	116	1.1	702	679	102
2011	1.0	553	536	43	1.0	648	629	90	1.0	743	721	173	1.0	797	779	174	1.0	685	666	120
2012	1.0	741	720	42	1.0	883	866	197	1.0	946	928	473	1.0	917	899	288	1.0	871	853	250
2013	1.0	761	734	49	1.0	928	913	192	1.0	964	951	306	1.0	1014	991	305	1.0	917	897	213
2014	2.1	751	724	48	2.8	823	808	74	1.0	891	874	176	2.2	865	834	137	2.0	833	810	109
2015	2.2	860	831	145	2.1	941	887	210	1.0	1028	982	413	1.7	926	894	277	1.8	939	898	261
2016	1.0	968	935	517	1.0	985	936	537	1.0	1118	1067	681	1.0	1169	1110	727	1.0	1060	1012	616
2017	1.0	1102	1016	392	1.0	1094	1073	522	1.0	1268	1251	758	1.0	1163	1135	628	1.0	1157	1119	575
2018	1.0	1277	1204	689	1.0	1278	1257	812	1.0	1384	1300	929	1.0	1382	1361	1019	1.0	1330	1281	862
2019	1.0	1160	1055	510	1.0	1175	1131	623	1.0	1325	1283	905	1.0	1305	1236	863	1.0	1241	1176	725
2020	1.0	1077	915	366	1.0	1156	1123	643	1.0	1270	1176	858	1.0	1249	1131	703	1.0	1188	1086	643

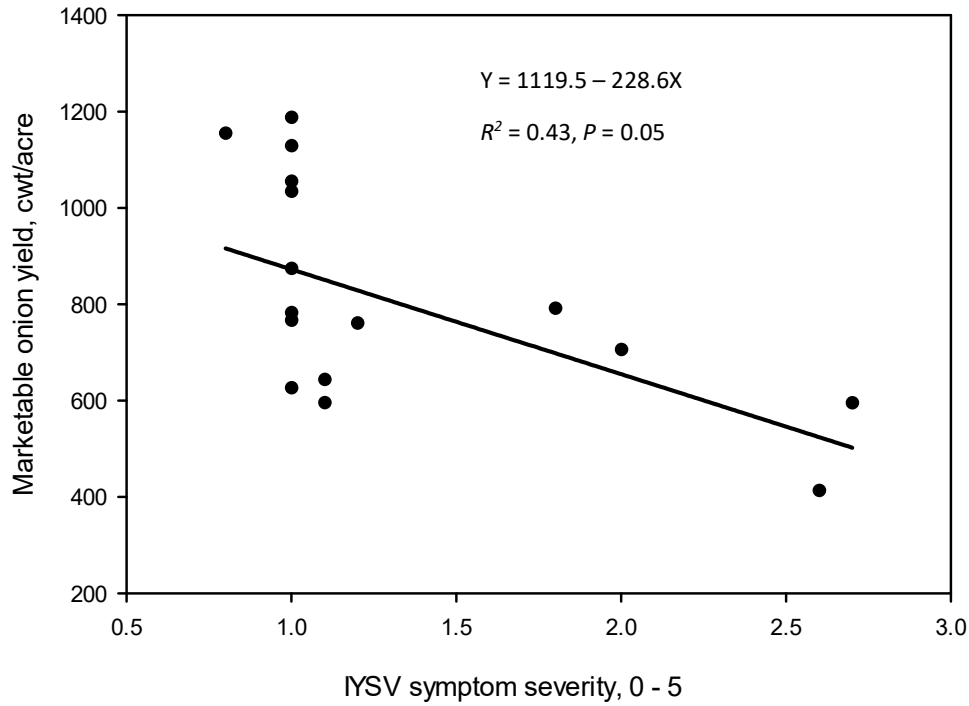


Figure 4. Marketable yield response to IYSV severity from 2006 through 2020 (average of 4 varieties: Sedona, Arcero, Joaquin, Vaquero), Malheur Experiment Station, Oregon State University, Ontario, OR.

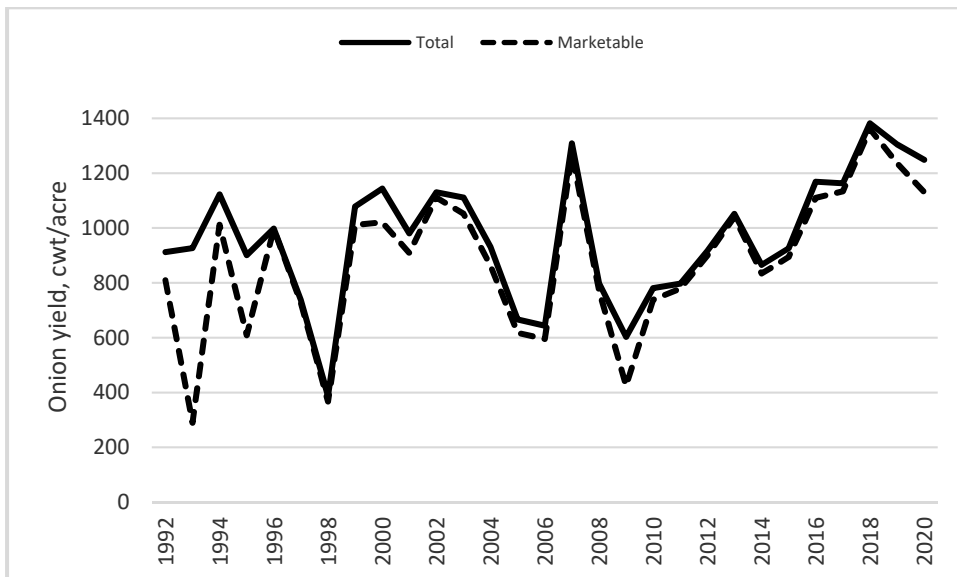


Figure 5. Total and marketable yield for Vaquero from 1992 to 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

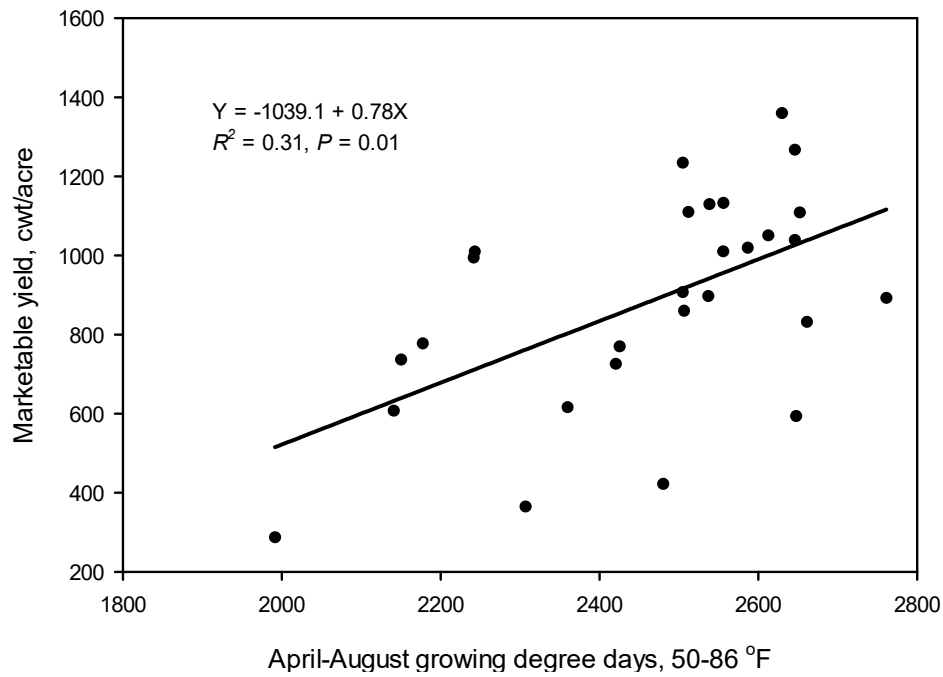


Figure 6. Vaquero marketable yield response to April through August growing degree days from 1993 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 7. Total yield for yellow onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- total yield, cwt/acre -													
A. Takii	Centerstone	403	565	636									535
A. Takii	Grand Perfection						922	974	1183	1275	1255	1124	1122
A. Takii	Ridge Line							745		856	944	834	845
A. Takii	Traverse							651		901	890	815	814
Bejo	Calibra	485	585	658	664	793	620	735					648
Bejo	Crockett	526	553	603	686	746	707	837			1035		712
Bejo	Dawson								940			993	966
Bejo	Delgado	631	720	698	812	831	792	933	1025	1123			841
Bejo	Gunnison	384									901		642
Bejo	Hamilton			715	770	741	809	893	1011	1214	1095	1087	926
Bejo	Legend	576	659	672	791	735	771	883	921	1063	1116	962	832
Bejo	Mondella										962	859	911
Bejo	Sedona	605	553	741	761	751	860	968	1102	1277	1160	1077	896
Crookham	Advantage	803	672	951	905			1180	1193				951
Crookham	Avalon		904	1143	1012	1167	1158		1294	1506	1404		1199
Crookham	Caliber										1215	1164	1189
Crookham	Esteem	529		729	687	754		901					720
Crookham	Morpheus	726		891	955		1022	1062	1237				982
Crookham	OLYX08-640					648	624		811	921	936		788
Crookham	Oracle	736	746	958	948	835	949	1106		1337	1306		991
Crookham	Pontiac		493	526				790					603
Crookham	Scorpion										872		872
Crookham	Scout			1000	1022	1079	1071	1160	1357	1394	1401		1185
Crookham	The Rock	639	656										648
Crookham	Trident										974	932	953
Crookham	Trigger		697	759		856		947					815
D. Palmer	Saffron					599	562	608	760	896	974		733
Enza Zaden	10043								1028				1028
Enza Zaden	10284									1494			1494
Enza Zaden	Caoba								1104				1104
Enza Zaden	Elsye										1298		1298
Hazera	37-120										928	848	888
Hazera	Cruiser			609	649	672	633	801					673
Hazera	Frontino			785	886	748							806
Hazera	Maverick	753		977	998	795							881
Hazera	Rhino								1047	1093	1074		1071
Hazera	Ventura			593	606								599
Nunhems	Annillo			865	845	719	798	899	1032	1254		1073	936
Nunhems	Arcero	672	648	883	928	823	941	985	1094	1278	1175	1156	962
Nunhems	Granero	698	802	842	899		919	1050	1032	1274	1226	1137	988
Nunhems	Joaquin	752	743	946	964	891	1028	1118	1268	1384	1325	1270	1063
Nunhems	Montero					792	721	872	966	1113	1165	941	938
Nunhems	Oloroso					704	764		915	1160	1045	947	922
Nunhems	Pandero			848	922	828	920	1057	1136	1287	1225	1128	1039
Nunhems	Ranchero	790	890	997	1041	985		1107	1249	1386	1393		1093
Nunhems	Vaquero	781	797	917	1014	865	926	1169	1163	1382	1305	1249	1052
Sakata	Aruba	744	799		943	993		1014	1123	1210	1178		1000
Sakata	Dulce Reina				948	920	1000	984	1243	1329	1260		1098
Sakata	Lasso				963	936	887	975	1061	1202			1004
Sakata	Yukon							1106	1201	1327	1231	1045	1182
Seminis	16000					1047	935	1116	1187	1274	1282		1140
Seminis	Tucannon							999	1038	1153	1125	1044	1072
Seminis	Barbaro	722	760	864	846	948	907	1117	1220	1441			981
Seminis	Belmar	569	798	764				994					781
Seminis	SV6646				961	875	878	1103	1210	1372	1259		1094
Seminis	SV6672				1073	1001	961	1123	1252	1531	1269	1299	1189
Seminis	Swale	778	803	873	902	897	838	999	1128	1319			949
Average		650	707	808	880	843	859	972	1104	1243	1149	1045	933
LSD (0.05)	Variety X year	95	121	110	89	100	106	133	90	71	101	92	

Table 8. Marketable yield for yellow onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- marketable yield, cwt/acre -													
A. Takii	Centerstone	377	548	618									514
A. Takii	Grand Perfection						871	920	1157	1239	1111	1008	1051
A. Takii	Ridge Line							716		826	902	730	793
A. Takii	Traverse							620		887	853	755	778
Bejo	Calibra	457	557	637	630	733	536	687					605
Bejo	Crockett	510	539	583	658	725	669	786			916		673
Bejo	Dawson								905			946	925
Bejo	Delgado	612	698	672	772	787	721	877	983	1056			798
Bejo	Gunnison	354									844		599
Bejo	Hamilton			701	748	711	771	855	980	1163	999	989	880
Bejo	Legend	556	638	641	763	685	708	838	879	1013	1021	826	779
Bejo	Mondella										910	802	856
Bejo	Sedona	589	536	720	734	724	831	935	1016	1204	1055	915	842
Crookham	Advantage	744	653	909	881			1082	1119				898
Crookham	Avalon		880	1115	951	1112	973		1047	1331			1070
Crookham	Caliber										1164	1039	1102
Crookham	Esteem	501		713	656	730		876					695
Crookham	Morpheus	702		864	939		986	1017	1203				952
Crookham	OLYX08-640					623	569		793	883	901		754
Crookham	Oracle	706	721	940	923	808	911	1062		1277	1160		945
Crookham	Pontiac		458	508				748					571
Crookham	Scorpion										849		849
Crookham	Scout			940	979	1044	975	1042	1243	1296	1198		1090
Crookham	The Rock	633	640										637
Crookham	Trident										944	866	905
Crookham	Trigger		684	750		833		914					795
D. Palmer	Saffron					547	495	506	668	803	841		643
Enza Zaden	10043								950				950
Enza Zaden	10284									1287			1287
Enza Zaden	Caoba								1047				1047
Enza Zaden	Elsye										670		670
Hazera	37-120										884	757	821
Hazera	Cruiser			600	622	643	587	760					642
Hazera	Frontino			769	871	697							779
Hazera	Maverick	715		954	974	772							854
Hazera	Rhino								1007	1043	1026		1025
Hazera	Ventura			571	577								574
Nunhems	Annillo			845	825	693	725	859	1014	1240		1026	903
Nunhems	Arcero	658	629	866	913	808	887	936	1073	1257	1131	1123	935
Nunhems	Granero	684	790	824	866		881	1020	997	1247	1150	1057	952
Nunhems	Joaquin	731	721	928	951	874	982	1067	1251	1300	1283	1176	1024
Nunhems	Montero					771	636	830	942	1096	1115	888	897
Nunhems	Oloroso					685	729		893	1131	1022	899	893
Nunhems	Pandero			829	902	803	870	1021	1097	1261	1180	1002	996
Nunhems	Ranchero	771	868	973	1013	959		1053	1204	1347	1348		1059
Nunhems	Vaquero	738	779	899	991	834	894	1110	1135	1361	1236	1131	1010
Sakata	Aruba	698	781		920	960		952	1077	1166	1127		960
Sakata	Dulce Reina				919	887	937	902	1166	1267	1141		1031
Sakata	Lasso				942	912	837	929	992	1158			962
Sakata	Yukon							1060	1115	1271	1116	913	1095
Seminis	16000					1028	859	1076	1168	1234	1200		1094
Seminis	Tucannon							969	1002	1119	1040	964	1019
Seminis	Barbaro	700	742	847	816	906	850	1073	1198	1369			945
Seminis	Belmar	546	785	745				903					745
Seminis	SV6646				945	850	816	1068	1187	1337	1154		1051
Seminis	SV6672				1041	975	875	1068	1204	1493	1192	1177	1128
Seminis	Swale	758	790	858	863	875	790	952	1086	1273			916
Average		625	687	787	853	812	799	921	1053	1189	1052	954	885
LSD (0.05)	Variety X year	87	122	112	89	101	115	139	103	80	117	100	

Table 9. Yield of bulbs larger than 4 inches in diameter (colossal plus super colossal) for yellow onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- > 4 inch yield, cwt/acre -													
A. Takii	Centerstone	3	4	9									5
A. Takii	Grand Perfection						346	565	705	865	728	559	628
A. Takii	Ridge Line							147		184	274	175	195
A. Takii	Traverse							86		113	240	124	141
Bejo	Calibra	6	35	14	40	24	27	162					44
Bejo	Crockett	6	18	7	26	21	39	234			375		91
Bejo	Dawson								318			320	319
Bejo	Delgado	46	120	33	112	77	118	407	367	545			203
Bejo	Gunnison	0									145		72
Bejo	Hamilton			31	25	22	38	329	363	600	478	383	252
Bejo	Legend	17	51	30	68	26	49	288	211	346	505	335	175
Bejo	Mondella										379	185	282
Bejo	Sedona	28	43	42	49	48	145	517	392	689	510	366	257
Crookham	Advantage	184	94	333	212			708	705				373
Crookham	Avalon		356	590	284	525	533		566	981	784		577
Crookham	Caliber									813	734		773
Crookham	Esteem	7		47	26	32		327					88
Crookham	Morpheus	106		288	281		319	559	705				376
Crookham	OLYX08-640					16	18		81	221	255		118
Crookham	Oracle	132	175	351	271	174	406	622		866	782		420
Crookham	Pontiac		15	8				211					78
Crookham	Scorpion										160		160
Crookham	Scout			394	259	418	490	664	830	938	854		606
Crookham	The Rock	111	83										97
Crookham	Trident										323	255	289
Crookham	Trigger		168	166		116		530					245
D. Palmer	Saffron					8	11	111	110	194	318		125
Enza Zaden	10043								328				328
Enza Zaden	10284									986			986
Enza Zaden	Caoba								521				521
Enza Zaden	Elsye										376		376
Hazera	37-120										313	173	243
Hazera	Cruiser			24	15	40	19	226					65
Hazera	Frontino			167	149	100							139
Hazera	Maverick	163		362	328	139							248
Hazera	Rhino								463	598	568		543
Hazera	Ventura			24	11								17
Nunhems	Annillo			124	124	31	163	423	455	839		607	346
Nunhems	Arcero	63	90	197	192	74	210	537	522	812	623	643	360
Nunhems	Granero	76	163	148	145		267	590	419	820	697	643	397
Nunhems	Joaquin	200	173	473	306	176	413	681	758	929	905	858	534
Nunhems	Montero					56	53	343	355	578	622	346	336
Nunhems	Oloroso					8	41		223	592	484	303	275
Nunhems	Pandero			241	172	81	266	580	628	787	765	560	453
Nunhems	Ranchero	207	294	395	351	270		731	677	972	998		544
Nunhems	Vaquero	116	174	288	305	137	277	727	628	1019	863	703	476
Sakata	Aruba	158	278		256	295		537	593	734	688		443
Sakata	Dulce Reina				301	229	448	582	711	914	759		563
Sakata	Lasso				252	245	214	527	453	752			407
Sakata	Yukon							701	672	857	705	446	676
Seminis	16000					422	500	707	739	831	844		674
Seminis	Tucannon							532	461	630	655	510	557
Seminis	Barbaro	167	152	271	173	228	362	685	792	1068			433
Seminis	Belmar	40	131	93				487					188
Seminis	SV6646				272	131	280	686	744	972	877		566
Seminis	SV6672				329	192	418	658	760	1178	895	805	654
Seminis	Swale	205	160	244	81	161	163	520	568	777			320
Average		93	132	186	180	141	229	484	524	733	587	456	341
LSD (0.05)	Variety X year	73	100	105	78	96	70	130	91	98	130	95	



Table 10. Yield of bulbs 3 to 4 inches in diameter (jumbo) for yellow onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- 3 - 4 inch yield, cwt/acre -													
A. Takii	Centerstone	281	488	538									435
A. Takii	Grand Perfection						507	331	432	359	364	431	404
A. Takii	Ridge Line							511		610	597	533	563
A. Takii	Traverse							490		744	588	605	607
Bejo	Calibra	390	465	582	518	657	467	493				612	523
Bejo	Crockett	433	443	515	560	647	580	504			512		524
Bejo	Dawson								540				540
Bejo	Delgado	534	549	600	608	670	582	444	572	490			561
Bejo	Gunnison	228									670		449
Bejo	Hamilton			625	655	603	690	495	571	543	495	586	585
Bejo	Legend	505	560	561	654	615	622	520	642	639	496	474	572
Bejo	Mondella										515	590	553
Bejo	Sedona	512	440	621	632	639	659	400	597	497	522	532	550
Crookham	Advantage	533	526	512	625			360	398				492
Crookham	Avalon		500	500	598	568	429		450	334	348		466
Crookham	Caliber										335	288	312
Crookham	Esteem	435		626	557	652		519					558
Crookham	Morpheus	573		535	624		645	429	469				546
Crookham	OLYX08-640					508	488		651	630	623		580
Crookham	Oracle	556	513	575	617	586	490	417		392	365		501
Crookham	Pontiac		360	391				468					407
Crookham	Scorpion										654		654
Crookham	Scout			504	682	604	472	354	395	342	332		461
Crookham	The Rock	492	513										502
Crookham	Trident										589	591	590
Crookham	Trigger		480	556		667		361					516
D. Palmer	Saffron					431	425	361	506	554	485		460
Enza Zaden	10043								591				591
Enza Zaden	10284									291			291
Enza Zaden	Caoba								499				499
Enza Zaden	Elsye										279		279
Hazera	37-120										535	540	538
Hazera	Cruiser			524	516	529	513	485					514
Hazera	Frontino			578	679	551							603
Hazera	Maverick	535		568	615	590							577
Hazera	Rhino								521	417	442		460
Hazera	Ventura			458	464								461
Nunhems	Annillo			691	645	603	537	409	532	388		407	527
Nunhems	Ancero	575	494	646	684	691	661	381	522	432	494	460	549
Nunhems	Granero	594	604	653	676		592	407	539	411	444	400	532
Nunhems	Joaquin	505	519	438	615	667	555	362	468	355	368	303	468
Nunhems	Montero					650	538	467	550	503	473	525	530
Nunhems	Oloroso					606	658		631	519	523	581	586
Nunhems	Pandero			548	689	685	585	413	441	457	403	427	516
Nunhems	Ranchero	546	549	548	628	661		311	494	353	338		492
Nunhems	Vaquero	589	583	594	657	657	592	358	469	326	361	411	509
Sakata	Aruba	515	478		619	637		385	448	412	421		489
Sakata	Dulce Reina				582	621	469	294	426	332	367		442
Sakata	Lasso				656	639	597	375	507	390			527
Sakata	Yukon							343	426	392	395	446	400
Seminis	16000					590	348	349	406	387	343		404
Seminis	Tucannon							411	502	463	373	439	438
Seminis	Barbaro	510	567	550	583	638	462	363	383	288			482
Seminis	Belmar	453	616	612				378					515
Seminis	SV6646				647	673	520	365	425	352	268		464
Seminis	SV6672				687	753	447	390	420	308	285	358	456
Seminis	Swale	524	608	583	731	681	614	398	491	483			568
Average		492	517	560	623	624	543	408	497	436	446		515
LSD (0.05)	Variety X year	78	118	123	83	84	95	88	85	82	80	90	

Table 11. Yield of bulbs 2¼ to 3 inches in diameter (medium) for yellow onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- 2¼ - 3 inch yield, cwt/acre -													
A. Takii	Centerstone	93	57	72									74
A. Takii	Grand Perfection						18	24	20	15	20	18	19
A. Takii	Ridge Line							59		32	30	22	36
A. Takii	Traverse							44		29	24	26	31
Bejo	Calibra	60	57	41	72	53	42	32					51
Bejo	Crockett	71	78	61	72	57	50	48			30		58
Bejo	Dawson								47			14	31
Bejo	Delgado	32	29	39	52	39	22	26	44	21			34
Bejo	Gunnison	126									30		78
Bejo	Hamilton			44	69	86	43	32	46	20	27	21	43
Bejo	Legend	34	27	50	42	44	38	30	26	28	20	17	32
Bejo	Mondella										16	27	21
Bejo	Sedona	49	53	57	53	38	26	18	27	18	22	17	34
Crookham	Advantage	27	34	64	45			15	16				33
Crookham	Avalon		25	25	69	19	11		31	16	18		27
Crookham	Caliber										17	17	17
Crookham	Esteem	59		40	73	46		29					50
Crookham	Morpheus	24		41	34		22	29	28				30
Crookham	OLYX08-640					99	64		62	33	23		56
Crookham	Oracle	18	33	15	35	48	15	23		19	12		24
Crookham	Pontiac		84	109				68					87
Crookham	Scorpion										34		34
Crookham	Scout			42	38	21	12	24	18	16	12		23
Crookham	The Rock	30	44										37
Crookham	Trident										32	20	26
Crookham	Trigger		37	28		50		23					35
D. Palmer	Saffron					107	59	34	53	55	38		57
Enza Zaden	10043								30				30
Enza Zaden	10284									11			11
Enza Zaden	Caoba								28				28
Enza Zaden	Elsye										16		16
Hazera	37-120										36	45	40
Hazera	Cruiser			52	90	73	55	49					64
Hazera	Frontino			24	42	46							38
Hazera	Maverick	17		23	31	43							29
Hazera	Rhino								23	28	15		22
Hazera	Ventura			89	103								96
Nunhems	Annillo			31	55	59	25	27	27	13		12	31
Nunhems	Arcero	20	45	23	37	44	17	18	29	13	14	21	25
Nunhems	Granero	14	23	23	46		22	24	40	16	9	14	23
Nunhems	Joaquin	26	29	18	31	31	14	24	25	17	11	15	22
Nunhems	Montero					65	45	20	37	15	21	16	31
Nunhems	Oloroso					71	30		39	20	15	15	32
Nunhems	Pandero			40	41	37	20	28	29	17	13	14	26
Nunhems	Ranchero	18	25	31	33	28		12	32	23	11		24
Nunhems	Vaquero	34	22	17	29	39	25	26	38	16	12	16	25
Sakata	Aruba	25	25		45	28		30	36	20	18		28
Sakata	Dulce Reina				36	38	20	26	29	21	15		26
Sakata	Lasso				35	28	27	27	31	16			27
Sakata	Yukon							15	17	21	17	21	18
Seminis	16000					16	11	21	22	16	14		17
Seminis	Tucannon							26	40	27	11	16	24
Seminis	Barbaro	23	23	26	61	39	26	26	24	13			29
Seminis	Belmar	53	38	40				37					42
Seminis	SV6646				27	47	17	18	19	13	10		21
Seminis	SV6672				25	30	10	21	25	6	12	13	18
Seminis	Swale	30	21	31	51	32	13	34	28	13			28
Average		40	38	41	49	47	28	29	31	20	19	19	33
LSD (0.05)	Variety X year	28	29	28	31	25	13	14	18	11	11	13	

Table 12. Percentage of single centered bulbs for yellow onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- single centers, % -													
A. Takii	Centerstone	16	27	31									25
A. Takii	Grand Perfection						55	42	42	48	32	49	45
A. Takii	Ridge Line							16		28	7	7	14
A. Takii	Traverse							20		38	9	21	22
Bejo	Calibra	7	31	12	14	24	12	9					16
Bejo	Crockett	34	60	47	29	37	31	28			26		37
Bejo	Dawson								58			55	57
Bejo	Delgado	11	35	26	19	34	17	22	22	21			23
Bejo	Gunnison	56									37		46
Bejo	Hamilton			39	34	72	40	38	30	70	46	57	47
Bejo	Legend	6	40	10	9	46	19	9	10	18	6	8	16
Bejo	Mondella										50	56	53
Bejo	Sedona	24	63	45	34	69	40	33	17	45	33	31	39
Crookham	Advantage	70	94	67	70			88	65				76
Crookham	Avalon		48	38	35	55	38		29	50	37		41
Crookham	Caliber										86	88	87
Crookham	Esteem	62		78	58	87		77					72
Crookham	Morpheus	75		78	59		91	81	77				77
Crookham	OLYX08-640					98	91		81	82	82		87
Crookham	Oracle	64	88	72	64	82	70	69		96	72		75
Crookham	Pontiac		86	69				66					74
Crookham	Scorpion										78		78
Crookham	Scout			42	34	64	44	40	29	47	38		42
Crookham	The Rock	78	94										86
Crookham	Trident										86	93	90
Crookham	Trigger		96	81		93		77					87
D. Palmer	Saffron					37	31	17	18	34	14		25
Enza Zaden	10043								14				14
Enza Zaden	10284									12			12
Enza Zaden	Caoba								14				14
Enza Zaden	Elsye										6		6
Hazera	37-120										46	67	56
Hazera	Cruiser			36	40	61	54	44					47
Hazera	Frontino			79	70	90							79
Hazera	Maverick	38		32	34	74							44
Hazera	Rhino								46	77	63		62
Hazera	Ventura			54	52								53
Nunhems	Annillo			88	80	97	75	87	87	90		94	87
Nunhems	Arcero	68	90	86	67	92	94	83	83	94	86	94	85
Nunhems	Granero	54	66	62	56		74	69	54	74	68	65	64
Nunhems	Joaquin	68	90	74	56	83	82	78	67	97	82	86	78
Nunhems	Montero					91	86	80	84	78	68	70	80
Nunhems	Oloroso					97	94		87	90	97	92	93
Nunhems	Pandero			50	41	62	73	53	31	63	54	62	54
Nunhems	Ranchero	60	68	60	52	67		60	38	79	62		61
Nunhems	Vaquero	57	74	53	49	86	86	58	59	78	75	80	69
Sakata	Aruba	49	62		50	82		56	62	77	69		63
Sakata	Dulce Reina				43	67	54	50	48	77	61		57
Sakata	Lasso				44	79	59	40	51	58			55
Sakata	Yukon						41	31	46	34	26		36
Seminis	16000				74	82	60	64	83	62			71
Seminis	Tucannon						51	72	70	81	76		70
Seminis	Barbaro	70	82	73	42	80	76	70	74	91			73
Seminis	Belmar	72	78	65				57					68
Seminis	SV6646				51	73	80	56	60	90	73		69
Seminis	SV6672				52	83	55	58	47	75	48	71	61
Seminis	Swale	34	73	66	48	83	61	47	40	71			58
Average		49	69	56	46	72	61	52	50	65	53	61	58
LSD (0.05)	Variety X year	14	14	15	16	12	13	13	13	12	12	12	

Table 13. IYSV severity rating for yellow onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- IYSV, 0 - 5 -													
A. Takii	Centerstone	1.2	1.0	1.0									1.1
A. Takii	Grand Perfection						1.6	1.0	1.0	1.0	1.0	1.0	1.1
A. Takii	Ridge Line							1.0		1.0	1.0	1.0	1.0
A. Takii	Traverse							1.0		1.0	1.0	1.0	1.0
Bejo	Calibra	1.1	1.0	1.0	1.0	2.0	2.8	1.0					1.4
Bejo	Crockett	1.0	1.0	1.0	1.0	1.8	1.8	1.0			1.0		1.2
Bejo	Dawson								1.0			1.0	1.0
Bejo	Delgado	1.0	1.0	1.0	1.0	2.0	1.9	1.0	1.0	1.0			1.2
Bejo	Gunnison	1.2									1.0		1.1
Bejo	Hamilton			1.0	1.0	2.0	1.4	1.0	1.0	1.0	1.0	1.0	1.2
Bejo	Legend	1.0	1.0	1.0	1.0	1.8	1.9	1.0	1.0	1.0	1.0	1.0	1.2
Bejo	Mondella										1.0	1.0	1.0
Bejo	Sedona	1.0	1.0	1.0	1.0	2.0	1.7	1.0	1.0	1.0	1.0	1.0	1.2
Crookham	Advantage	1.0	1.0	1.0	1.0			1.0	1.0				1.0
Crookham	Avalon		1.0	1.0	1.0	1.8	1.2		1.0	1.0	1.0		1.1
Crookham	Caliber										2.0	1.0	1.5
Crookham	Esteem	1.1		1.0	1.0	2.2		1.0					1.3
Crookham	Morpheus	0.9		1.0	1.0		1.3	1.0	1.0				1.0
Crookham	OLYX08-640					2.0	2.8		1.0	1.0	1.0		1.6
Crookham	Oracle	1.0	1.0	1.0	1.0	2.0	1.0	1.0		1.0	1.0		1.1
Crookham	Pontiac		1.0	1.0				1.0					1.0
Crookham	Scorpion										1.0		1.0
Crookham	Scout			1.0	1.0	1.8	1.3	1.0	1.0	1.0	1.0		1.1
Crookham	The Rock	1.0	1.0										1.0
Crookham	Trident										1.0	1.0	1.0
Crookham	Trigger		1.0	1.0		2.0		1.0					1.3
D. Palmer	Saffron					2.8	2.2	1.0	1.0	1.0	1.0		1.5
Enza Zaden	10043								1.0				1.0
Enza Zaden	10284									1.0			1.0
Enza Zaden	Caoba								1.0				1.0
Enza Zaden	Elsye										1.0		1.0
Hazera	37-120										1.0	1.0	1.0
Hazera	Cruiser			1.0	1.0	2.6	2.5	1.0					1.6
Hazera	Frontino			1.0	1.0	2.6							1.5
Hazera	Maverick	1.1		1.0	1.0	2.3							1.4
Hazera	Rhino								1.0	1.0	1.0		1.0
Hazera	Ventura			1.0	1.0								1.0
Nunhems	Annillo			1.0	1.0	2.8	2.0	1.0	1.0	1.0		1.0	1.4
Nunhems	Arcero	1.0	1.0	1.0	1.0	2.8	2.1	1.0	1.0	1.0	1.0	1.0	1.3
Nunhems	Granero	1.1	1.0	1.0	1.0		1.6	1.0	1.0	1.0	1.0	1.0	1.1
Nunhems	Joaquin	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Nunhems	Montero					2.0	2.6	1.0	1.0	1.2	1.0	1.0	1.4
Nunhems	Oloroso					2.4	1.9		1.0	1.0	1.0	1.0	1.4
Nunhems	Pandero			1.0	1.0	1.8	1.4	1.0	1.0	1.0	1.0	1.0	1.1
Nunhems	Ranchero	1.0	1.0	1.0	1.0	2.0		1.0	1.0	1.0	1.0		1.1
Nunhems	Vaquero	1.1	1.0	1.0	1.0	2.2	1.7	1.0	1.0	1.0	1.0	1.0	1.2
Sakata	Aruba	1.0	1.0			1.0	1.8		1.0	1.0	1.0		1.1
Sakata	Dulce Reina				1.0	1.8	1.1	1.0	1.0	1.0	1.0		1.1
Sakata	Lasso				1.0	1.8	1.2	1.0	1.0	1.0			1.2
Sakata	Yukon							1.0	1.0	1.0	1.0	1.0	1.0
Seminis	16000					1.2	1.2	1.0	1.0	1.0	1.0		1.1
Seminis	Tucannon							1.0	1.0	1.0	1.0	1.0	1.0
Seminis	Barbaro	1.0	1.0	1.0	1.0	2.0	1.8	1.0	1.0	1.0			1.2
Seminis	Belmar	1.1	1.0	1.0				1.0					1.0
Seminis	SV6646				1.0	2.0	1.5	1.0	1.0	1.0	1.0		1.2
Seminis	SV6672				1.0	1.8	1.5	1.0	1.0	1.0	1.0	1.0	1.2
Seminis	Swale	1.0	1.0	1.0	1.0	1.6	1.6	1.0	1.0	1.0			1.1
Average		1.0	1.0	1.0	1.0	2.0	1.7	1.0	1.0	1.0	1.0	1.0	1.2
LSD (0.05)	Variety X year	0.1	NS	NS	NS	0.5	0.4	NS	NS	NS	NS	NS	

Table 14. Total yield for red onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- Total yield, cwt/acre -													
Bejo	Red Mountain							339	604		605		516
Crookham	Purple Haze				389	416	470		633	620	691	601	545
Crookham	Red Beret			534			458	439	613	605		556	534
Crookham	Red Devil					434	442		606				494
D. Palmer	Cherry Mountain					423	426			559	653	545	521
D. Palmer	DPR-3088									566	697		631
Enza Zaden	Monastrell								655		660		657
New Zealand Onion	TAS016								448	460			454
New Zealand Onion	TAS040									585	488	494	522
New Zealand Onion	TAS042									676	603	614	631
Nunhems	Countach	292			338	411							347
Nunhems	Marengo	297	481	451	367	369	462	378	739	607	641		479
Nunhems	Salsa	329							637				483
Seminis	Mercury	395	498										447
Seminis	Red Nugent									643	752		698
Seminis	SV4643NT							406	674	624	724		607
Average		328	490	493	365	411	451	390	623	594	651	562	487
LSD (0.05)	Variety X year	NS	NS	NS	NS	NS	NS	NS	NS	120	80	62	53

Table 15. Marketable yield for red onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- marketable yield, cwt/acre -													
Bejo	Red Mountain							223	507		560		430
Crookham	Purple Haze				335	366	398		607	519	574	540	477
Crookham	Red Beret			511			385	357	569	525		495	474
Crookham	Red Devil					375	381		571				442
D. Palmer	Cherry Mountain					366	362			432	486	545	438
D. Palmer	DPR-3088									463	516		489
Enza Zaden	Monastrell								498		488		493
New Zealand Onion	TAS016								326	358			342
New Zealand Onion	TAS040									477	396	368	414
New Zealand Onion	TAS042									598	523	481	534
Nunhems	Countach	251			280	350							294
Nunhems	Marengo	260	466	421	323	288	365	323	698	522	572		424
Nunhems	Salsa	303							495				399
Seminis	Mercury	337	475										406
Seminis	Red Nugent									412	564		488
Seminis	SV4643NT							307	574	490	590		490
Average		288	470	466	313	349	378	302	538	480	527	486	418
LSD (0.05)	Variety X year	NS	NS	NS	NS	NS	NS	93	123	93	75	62	

Table 16. Yield of bulbs larger than 4 inches in diameter (colossal plus super colossal) for red onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- > 4 inch yield, cwt/acre -													
Bejo	Red Mountain							2	32		10		14.5
Crookham	Purple Haze								14	14	49	7	20.9
Crookham	Red Beret			4			1	5	42	17		2	11.8
Crookham	Red Devil						1		18				9.7
D. Palmer	Cherry Mountain					1	3			23	35	7	13.6
D. Palmer	DPR-3088									46	64		55.0
Enza Zaden	Monastrell								37		17		27.1
New Zealand Onion	TAS016												
New Zealand Onion	TAS040									31	10	30	23.7
New Zealand Onion	TAS042									47	24	16	28.8
Nunhems	Countach												
Nunhems	Marengo		50					12	17	18	36		26.4
Nunhems	Salsa								42				41.5
Seminis	Mercury		5										4.6
Seminis	Red Nugent									26	97		61.7
Seminis	SV4643NT							28	53	39	105		56.4
Average			27.1	4.4		1.3	1.4	11.7	31.9	28.8	44.7	12.4	18.2
LSD (0.05)	Variety X year		NS			NS	NS	14.8	NS	18.6	23.5	11.2	

Table 17. Yield of bulbs 3 to 4 inches in diameter (jumbo) for red onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- 3 - 4 inch yield, cwt/acre -													
Bejo	Red Mountain							149	420		463		344
Crookham	Purple Haze				159	187	299		482	422	452	446	350
Crookham	Red Beret			366			246	269	439	414		403	356
Crookham	Red Devil					228	253		457				313
D. Palmer	Cherry Mountain					216	239			341	379	327	300
D. Palmer	DPR-3088									353	391		372
Enza Zaden	Monastrell								401		407		404
New Zealand Onion	TAS016								141	182			161
New Zealand Onion	TAS040									376	282	266	308
New Zealand Onion	TAS042									488	451	412	451
Nunhems	Countach	110			118	178							135
Nunhems	Marengo	91	358	316	183	172	270	228	612	441	475		315
Nunhems	Salsa	205							387				296
Seminis	Mercury	205	388										296
Seminis	Red Nugent									321	423		372
Seminis	SV4643NT							209	456	383	431		370
Average		153	373	341	153	196	261	214	422	372	415	371	297
LSD (0.05)	Variety X year	NS	NS	NS	NS	NS	NS	NS	111	81	75	72	

Table 18. Yield of bulbs 2¼ to 3 inches in diameter (medium) for red onion varieties from 2010 through 2020. Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- 2¼ - 3 inch yield, cwt/acre -													
Bejo	Red Mountain							72	55		87		71
Crookham	Purple Haze				176	179	99		111	83	73	87	116
Crookham	Red Beret			141			139	83	89	95		89	106
Crookham	Red Devil					147	127		96				123
D. Palmer	Cherry Mountain					149	120			69	72	64	95
D. Palmer	DPR-3088									64	61		62
Enza Zaden	Monastrell								60		65		62
New Zealand Onion	TAS016								185	176			181
New Zealand Onion	TAS040									70	104	53	76
New Zealand Onion	TAS042									64	48	83	65
Nunhems	Countach	141			161	172							158
Nunhems	Marengo	169	58	104	140	116	95	83	68	64	62		96
Nunhems	Salsa	98							66				82
Seminis	Mercury	132	82										107
Seminis	Red Nugent									65	44		55
Seminis	SV4643NT							69	65	68	54		64
Average		135	70	123	159	153	116	77	88	82	67	75	104
LSD (0.05)	Variety X year	NS	NS	NS	NS	35	NS	NS	30	21	32	NS	

Table 19. Percentage of single centered bulbs for red onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- single centers, % -													
Bejo	Red Mountain							46	51		37		44
Crookham	Purple Haze				78	87	78		77	78	64	74	77
Crookham	Red Beret			75			77	74	72	67		72	73
Crookham	Red Devil					83	82		78				81
D. Palmer	Cherry Mountain					66	50			46	18	53	46
D. Palmer	DPR-3088									61	43		52
Enza Zaden	Monastrell								15		14		14
New Zealand Onion	TAS016								13	34			23
New Zealand Onion	TAS040									25	3	23	17
New Zealand Onion	TAS042									25	9	9	14
Nunhems	Countach	37			67	65							56
Nunhems	Marengo	72	79	70	76	66	58	57	47	70	37		63
Nunhems	Salsa	43							31				37
Seminis	Mercury	16	46										31
Seminis	Red Nugent									58	30		44
Seminis	SV4643NT							40	45	53	29		42
Average		42	63	72	74	73	69	54	48	52	28	46	57
LSD (0.05)	Variety X year	19	27	NS	NS	15	16	14	15	22	13	11	

Table 20. IYSV severity rating for red onion varieties from 2010 through 2020, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
- IYSV, 0 - 5 -													
Bejo	Red Mountain							1.0	1.0		1.0		1.0
Crookham	Purple Haze				1.0	2.2	3.0		1.0	1.2	1.0	1.0	1.5
Crookham	Red Beret			1.0			3.0	1.0	1.0	1.0		1.0	1.3
Crookham	Red Devil					2.2	3.0		1.0				2.1
D. Palmer	Cherry Mountain					2.6	2.6			1.2	1.0	1.0	1.7
D. Palmer	DPR-3088									1.0	1.0		1.0
Enza Zaden	Monastrell								1.0		1.0		1.0
New Zealand Onion	TAS016								1.0	1.2			1.1
New Zealand Onion	TAS040									1.0	1.0	1.0	1.0
New Zealand Onion	TAS042									1.0	1.0	1.0	1.0
Nunhems	Countach	1.4			1.0	2.2							1.5
Nunhems	Marengo	1.6	1.0	1.0	1.0	2.2	3.0	1.0	1.0	1.0	1.0		1.4
Nunhems	Salsa	1.3							1.0				1.2
Seminis	Mercury	1.4	1.0										1.2
Seminis	Red Nugent									1.2	1.0		1.1
Seminis	SV4643NT							1.0	1.0	1.0	1.0		1.0
Average		1.4	1.0	1.0	1.0	2.3	2.9	1.0	1.0	1.1	1.0	1.0	1.3
LSD (0.05)	Variety X year	NS	NS	NS	NS	NS	0.3	NS	NS	NS	NS	NS	

Table 21. Total yield for white onion varieties from 2010 through 2019, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
- Total yield, cwt/acre -												
Bejo	Bridewhite										1074	1074
Crookham	Brundage				801		588					694
Crookham	White Cap										1014	1014
Crookham	White Cloud	771	742					1116	1191	1260		1016
D. Palmer	Diamond Swan					771	824	825	1051	1124	1057	942
Hazera	37-127										1327	1327
Nunhems	Cometa	750	763	893	1008	928	833			1207	1261	955
Nunhems	Rhea										1217	1217
Seminis	SV4058					853				1213	1235	1100
Average		761	753	893	904	851	748	971	1121	1201	1169	937
LSD (0.05)	Variety X year	NS	NS		100	NS	NS	236	113	59	126	



Table 22. Marketable yield for white onion varieties from 2010 through 2019, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
- marketable yield, cwt/acre -												
Bejo	Bridewhite										935	935
Crookham	Brundage				753		365					559
Crookham	White Cap										865	865
Crookham	White Cloud	619	706					805	887	1094		822
D. Palmer	Diamond Swan					543	489	620	938	953	813	726
Hazera	37-127										1114	1114
Nunhems	Cometa	665	745	862	958	870	703			1138	1112	881
Nunhems	Rhea										1105	1105
Seminis	SV4058					585				1116	990	897
Average		642	725	862	856	666	519	712	912	1075	991	796
LSD (0.05)	Variety X year	NS	NS		111	122	NS	131	NS	94	116	

Table 23. Yield of bulbs larger than 4 inches in diameter (colossal plus super colossal) for white onion varieties from 2010 through 2019, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
- > 4 inch yield, cwt/acre -												
Bejo	Bridewhite										463	463
Crookham	Brundage				121		92					107
Crookham	White Cap										455	455
Crookham	White Cloud	99	141					417	426	631		343
D. Palmer	Diamond Swan					40	86	327	414	442	379	281
Hazera	37-127										743	743
Nunhems	Cometa	155	141	184	230	157	181			657	677	298
Nunhems	Rhea										682	682
Seminis	SV4058					71				698	618	462
Average		127	141	184	175	89	120	372	420	607	574	281
LSD (0.05)	Variety X year	NS	NS		NS	NS	NS	NS	NS	104	131	

Table 24. Yield of bulbs 3 to 4 inches in diameter (jumbo) for white onion varieties from 2010 through 2019, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
- 3 - 4 inch yield, cwt/acre -												
Bejo	Bridewhite										458	458
Crookham	Brundage				570		251					411
Crookham	White Cap										390	390
Crookham	White Cloud	499	546					369	437	447		460
D. Palmer	Diamond Swan					455	382	272	498	485	408	417
Hazera	37-127										361	361
Nunhems	Cometa	487	577	649	692	695	505			463	423	561
Nunhems	Rhea										411	411
Seminis	SV4058					487				406	353	415
Average		493	562	649	631	546	379	320	467	450	401	490
LSD (0.05)	Variety X year	NS	NS		NS	119	233	63	NS	NS	60	

Table 25. Yield of bulbs 2¼ to 3 inches in diameter (medium) for white onion varieties from 2010 through 2019, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
- 2¼ - 3 inch yield, cwt/acre -												
Bejo	Bridewhite										14	14
Crookham	Brundage				62		21					42
Crookham	White Cap										20	20
Crookham	White Cloud	22	18					19	24	16		20
D. Palmer	Diamond Swan					49	22	20	27	26	26	28
Hazera	37-127										10	10
Nunhems	Cometa	24	27	29	36	17	17			18	12	22
Nunhems	Rhea										12	12
Seminis	SV4058					27				12	20	20
Average		23	23	29	49	31	20	20	25	18	16	25
LSD (0.05) Variety X year		NS	NS		12	21	NS	NS	NS	NS	NS	

Table 26. Percentage of single centered bulbs for white onion varieties from 2010 through 2019, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
- single centers, % -												
Bejo	Bridewhite										10	10
Crookham	Brundage				73		50					62
Crookham	White Cap										91	91
Crookham	White Cloud	20	26					14	28	23		22
D. Palmer	Diamond Swan					72	35	24	26	34	21	35
Hazera	37-127										69	69
Nunhems	Cometa	64	85	76	46	92	75			98	89	78
Nunhems	Rhea										95	95
Seminis	SV4058					82				70	79	77
Average		42	56	76	59	82	54	19	27	56	65	54
LSD (0.05) Variety X year		22	19		27	14	NS	NS	NS	16	8	

Table 27. IYSV severity rating for white onion varieties from 2010 through 2019, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
- IYSV, 0 - 5 -												
Bejo	Bridewhite	1.0										1.0
Crookham	Brundage					1.7		1.0				1.4
Crookham	White Cap	1.0										1.0
Crookham	White Cloud		1.0	1.0	1.0					1.0	1.0	1.0
D. Palmer	Diamond Swan	1.0	1.0	1.0	1.0	1.6	2.4					1.3
Hazera	37-127	1.0										1.0
Nunhems	Cometa	1.0	1.0			1.7	1.8	1.0	1.0	1.0	0.9	1.2
Nunhems	Rhea	1.0										1.0
Seminis	SV4058	1.0	1.0				2.6					1.5
Average		1.0	1.0	1.0	1.0	1.7	2.3	1.0	1.0	1.0	1.0	1.2
LSD (0.05) Variety X year		NS	NS	NS	NS	0.5	NS	NS	NS	NS	NS	