MANAGEMENT OF BACTERIAL BULB ROTS IN ONION–2020

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Objective

Evaluate bactericides for management of bacterial bulb rots in dry bulb onions.

Introduction

Dry bulb onions are subject to various bacteria that may cause bulb rots. Because onions in the Treasure Valley are almost exclusively grown under drip or furrow irrigation, they are typically less vulnerable to bacterial diseases than onions grown under overhead irrigation. However, bacterial infections can be triggered by rain or hail storms, or when onion leaves are damaged by windstorms. Copper-based bactericides are often applied after such events when conditions favor bacterial infection. This study was undertaken to determine the effects of various copper-based bactericides on bacterial bulb rot incidence and onion yield in dry bulb onions.

Materials and Methods

Onions were grown in 2020 on a Greenleaf silt loam soil previously planted to wheat. After the wheat was harvested in 2019, the stubble was shredded, the field was irrigated to sprout unharvested wheat kernels, and then the field was disked. A soil analysis taken in the fall of 2019 showed a pH of 8.2, 3.9% organic matter, 2 ppm nitrogen (N) as nitrate, 1 ppm N as ammonium, 28 ppm phosphorus (P), 661 ppm potassium, 47 ppm sulfur (S), 3086 ppm calcium, 751 ppm magnesium, 173 ppm sodium, 4.3 ppm zinc, 3 ppm manganese (Mn), 1.2 ppm copper, 7 ppm iron, and 0.4 ppm boron (B). Based on the soil analysis, 100 lb N/acre, 44 lb P/acre, 200 lb S/acre, 9 lb Mn/acre, and 2 lb B/acre were broadcast before plowing. After plowing and groundhogging, the field was fumigated with Vapam® at 15 gal/acre and bedded at 22 inches.

Onion seed of cultivar ‘Granero’ (Nunhems, Parma, ID) was planted at 150,000 seeds/acre on March 19, 2020. Seed was planted in double rows spaced 3 inches apart on beds spaced 22 inches apart. Immediately after planting, the field received a narrow band of Lorsban® 15G at 3.7 oz/1000 ft (0.82 lb ai/acre) over the seed rows and the soil surface was cultipacked. Onion emergence started on April 11. On May 13, alleys 4 ft wide were cut between plots, leaving plots 23 ft long.

The field had drip 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.

The following herbicides were applied: glyphosate at 0.77 lb ai/acre (Roundup® PowerMax at 22 oz/acre) on April 8; sethoxydim at 0.28 lb ai/acre (Poast® at 24 oz/acre) on May 7; pendimethalin at 0.95 lb ai/acre (Prowl® H_2O at 2 pt/acre) on May 11; pendimethalin at 1 pint/acre on June 5; and sethoxydim at 31 oz/acre, oxyfluorfen at 8 oz/acre, and bromoxynil at 24 oz/acre on June 10.

For thrips control, the following insecticides were applied by ground: spirotetramat at 0.078 lb ai/acre (Movento® HL at 2.5 oz/acre) and azadirachtin at 0.0093 lb ai/acre on May 29 and June 5; cyantraniliprole at 0.13 lb ai/acre (Exirel® at 20 oz/acre) on June 18 and June 26; spinetoram at 0.078 lb ai/acre (Radiant® at 8 oz/acre) on July 3 and July 14; and abamectin at 0.019 lb ai/acre (Agri-Mek® SC at 3.5 oz/acre) on July 22.

The experimental design was a randomized complete block with eight bactericide treatments (Table 1) and non-inoculated and inoculated treatments as split plots within main plots. The inoculated split plots had a solution of *Pantoea agglomerans* broadcast on August 7 and August 19. The eight main treatments were replicated four times. Each main plot was eight double onion rows wide by 23 feet long. Each split plot with main plots were 4 double rows wide.

The bactericide treatments and the bacterial inoculations were applied with a CO_2 backpack sprayer with a 4 nozzle boom with 11004 nozzles at 30 PSI and 35 gallons per acre. The first application was made preventatively before the first bacterial inoculation. The second and third applications were made shortly after each of the bacterial inoculations. The fourth application was made when the majority of plants had fallen down (>50% tops down).

To simulate rainfall, the field was sprinkler irrigated, applying 0.25 inches weekly from July 24 to August 28, totaling 1.5 inches. The sprinkler system had laterals along each side of the trial (30 ft apart) and risers spaced 30 ft apart along the laterals. The sprinkler system used Nelson Rotator R2000LP sprinklers and applied 0.10 inch per hour.

Table 1. Bactericide treatment specifications, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020. Bactericides were applied A July 30, B August 10, C August 20, and D August 31.

Treatment	Product	Rate	Unit	Application date	Active ingredient
1	Untreated control				
2	Cueva	1	qt/acre	ABCD	Copper octanoate
3	Badge	1	qt/acre	ABCD	Copper hydroxide and copper oxychloride
4	Badge	2.75	pt/acre	B	Copper hydroxide and copper oxychloride
4	Badge	2	pt/acre	C	Copper hydroxide and copper oxychloride
5	Previsto	2.75	pt/acre	BD	Copper hydroxide
6	Mastercop	1.5	pt/acre	ABCD	Copper sulfate pentahydrate
7	Mastercop	2.5	pt/acre	ABCD	Copper sulfate pentahydrate

Onions were irrigated automatically by drip line to maintain the soil water tension (SWT) at 8-inch depth in the onion root zone below 20 cb. Soil water tension was measured with eight granular matrix sensors (GMS, Watermark soil moisture sensor model 200SS, Irrometer Co. Inc., Riverside, CA) installed at 8-inch depth in the center of the double row of onions in plots in the adjacent trial. Sensor readings were not influenced by the sprinkler irrigations. The GMS were connected to the datalogger via multiplexers (AM16/32, Campbell Scientific, Logan, UT). The datalogger (CR1000, Campbell Scientific) read the sensors and recorded the SWT every hour. The field was irrigated if the average of the eight sensors was 20 cb or higher. The datalogger automatically made irrigation decisions every 12 hours. 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 minutes, to apply 0.48 inch of water. 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 irrigation system was started on April 22, and irrigations ended on September 3.

Starting on May 27, root tissue and soil samples were taken every week from plot border rows representing the whole field and analyzed for nutrients by Western Laboratories, Inc., Parma, ID. Root tissue was analyzed for nitrate concentration, and soil samples were 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. Until June 18, N was applied weekly based on Western Labs recommendations. After June 18, both root tissue and soil solution levels went above the critical level (Figures 1 and 2), so N applications were continued at a reduced rate until early July. A total of 123 lb N/acre was applied as urea ammonium nitrate solution (URAN) injected through the drip tape.

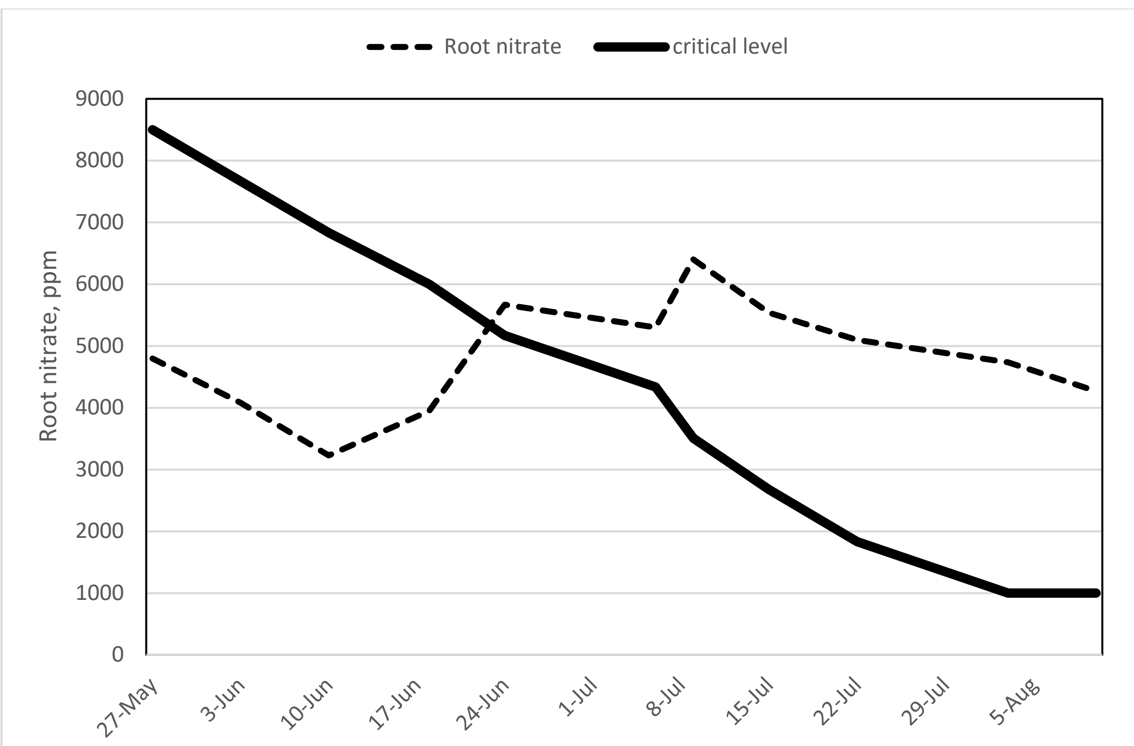

Figure 1. Root nitrate over time, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

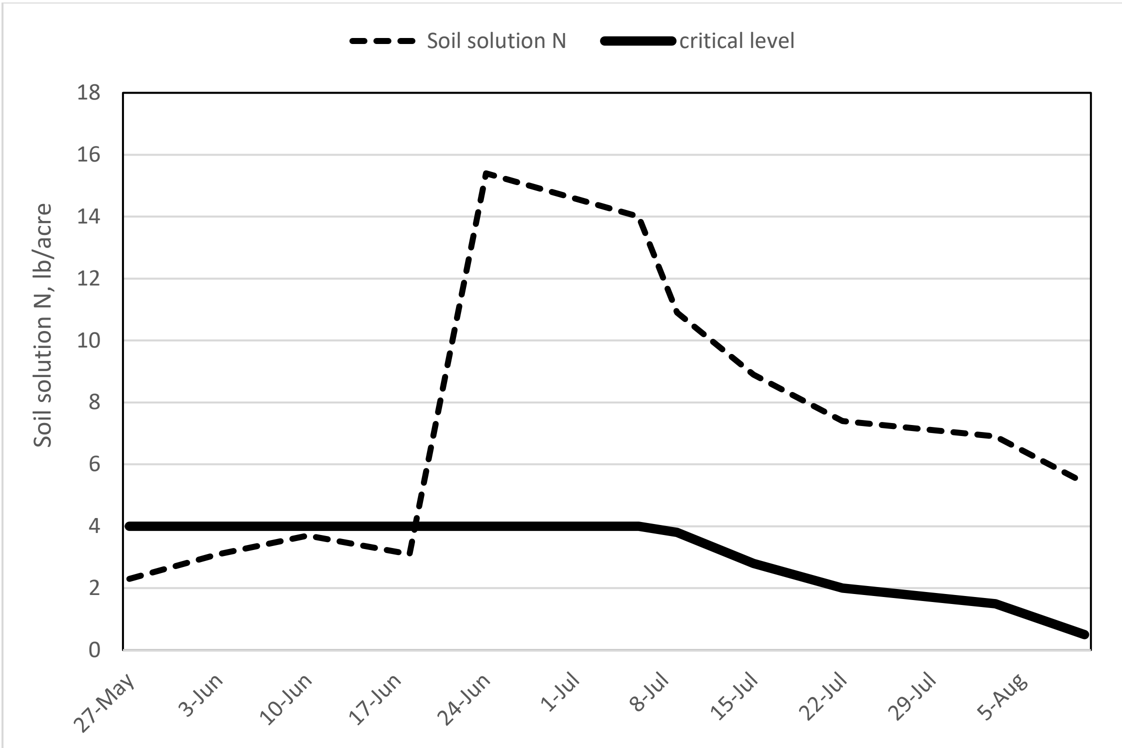

Figure 2. Soil solution nitrogen over time, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

The onions were lifted on September 9 to field cure. Onions from the middle two rows in each plot were topped by hand and bagged on September 19. The bags were moved into storage on September 24. 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 January 2021.

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). Marketable yield consisted of No.1 bulbs larger than 2¼ inches.

After grading, 100 No. 1 bulbs from each plot were cut longitudinally and evaluated for the presence of incomplete scales, dry scales, internal bacterial rot, and internal rot caused by *Fusarium proliferatum* or other fungi. Incomplete scales were defined as scales that had more than 0.25 inch from the center of the neck missing or any part missing lower down on the scale. Dry scales were defined as scales that had either more than 0.25 inch from the center of the neck dry or any part dry lower down on the scale. Yield data were adjusted to account for rots detected during the internal evaluations.

Results and Conclusions

Precipitation in June was substantially higher (2.1 inches) than the 77-year average (0.8 inches). Total precipitation from the start of automated irrigations to irrigation termination totaled 4 inches. From April through August there were a total of 2537 growing degree days, slightly higher than the 28-year average of 2458 growing degree days. The automated drip irrigation system maintained the soil water tension at 8-inch depth close to the target of 20 cb (Figure 3). A total of 26.9 inches of irrigation water plus precipitation was applied from the start of automated irrigations to the last irrigation. Another 1.5 inches was applied with the sprinkler system. Water applications tracked onion evapotranspiration during the season (Figure 4). Onion evapotranspiration from the start of automated irrigations to the last irrigation totaled 26.8 inches.

Bacterial and fungal infections were present in all treatments. There was no increased bacterial rot incidence in plots inoculated with a suspension of the bacterium *Pantoea agglomerans.* Because there was no effect of the inoculation treatment, the following results for the treatments are pooled across the inoculation treatments.

Onions treated with Mastercop® (copper sulfate pentahydrate) or with Previsto® (copper hydroxide) had significantly less bacterial rot than the untreated control (Table 2). Bacterial rots in the Badge® (copper hydroxide and copper oxychloride) and Cueva® (copper octanoate) treatments were not significantly different from the untreated control. Cueva treatment showed no reduction in bacterial rot incidence compared with the untreated control. Although not significantly different from the untreated control, the Badge treatments had 14 and 17% less bacterial rot than the untreated control. In contrast, the Previsto treatment and treatment with Mastercop at the high rate had over 50% less bacterial rot than the untreated control.

The Cueva treatment had significantly more bacterial rot than the Previsto and Mastercop treatments. The Badge treatments had significantly more bacterial rot than the Previsto treatment. Although not statistically different, the Mastercop treatments had less bacterial rot than the Badge treatments.

Marketable yield (medium- and larger-sized bulbs) did not differ among the treatments. However, the size profiles were shifted towards larger size classes for the treatments with Previsto and the lower rate of Mastercop (Table 2, Figure 5). Treatments that had greater amounts of copper applied (Badge treatments and the high rate of Mastercop) had reduced yields, suggesting there may have been phytotoxic effects of the higher amounts of copper.

Acknowledgments

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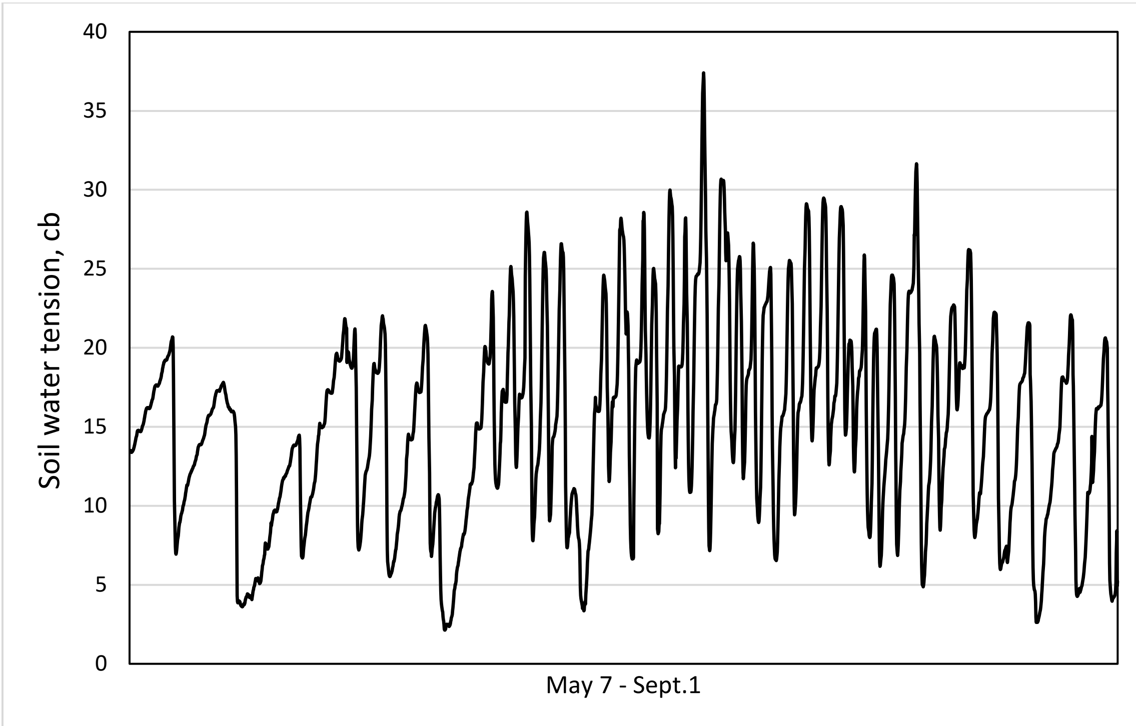

Figure 3. Soil water tension over time, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

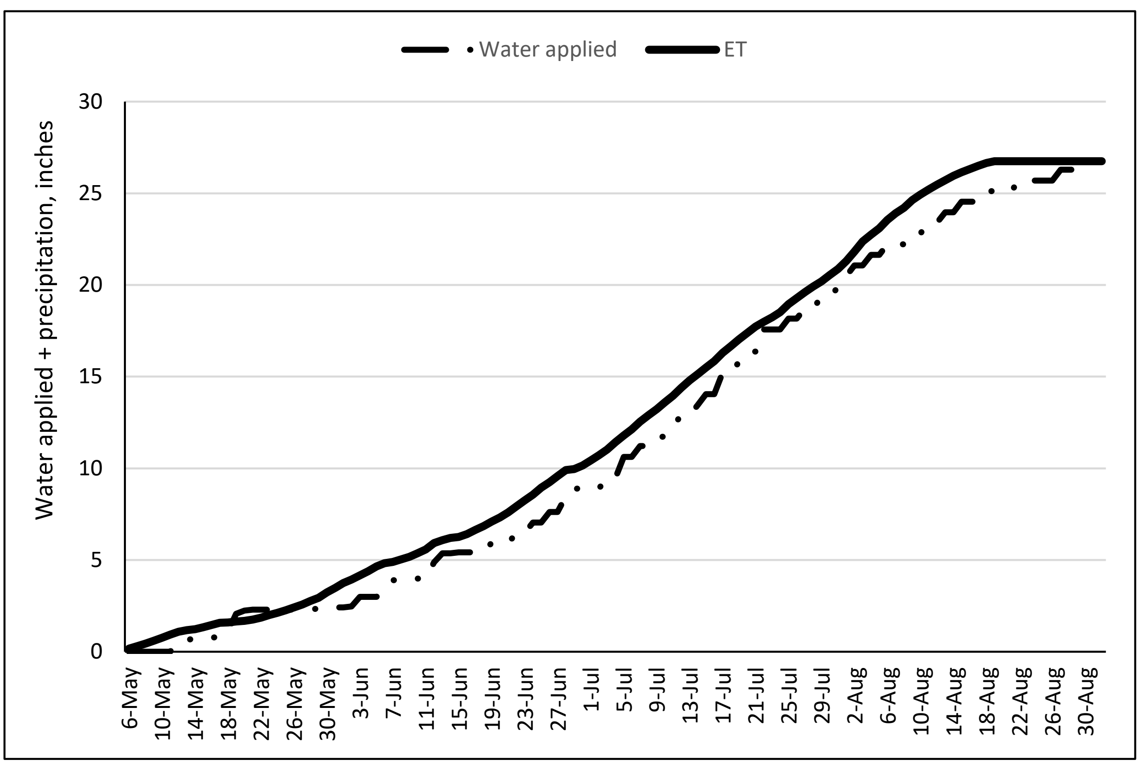

Figure 4. Water applied plus precipitation and onion evapotranspiration over time, Malheur Experiment Station, Oregon State University, Ontario, OR, 2020.

Table 2. Effects of bactericide treatments on yield, grade, and disease incidence in full-season experimental and commercial yellow onion varieties graded out of storage in January 2021, Malheur Experiment Station, Oregon State University, Ontario, OR.

Treatment	Bacterial rot	Neck rot	*Fusarium proliferatum*	Culls	Small	Medium	Jumbo	Colossal	Super colossal	Marketable	Marketable
	--------------- % ---------------			------------------------------------- cwt/acre -------------------------------------							-- % --
1 Control	4.77	1.37	1.29	30.09	4.19	10.43	279.27	478.44	281.77	1,049.91	89.56
	± 0.76	± 0.35	± 0.47	± 4.63	± 0.86	± 0.56	± 23.47	± 25.25	± 18.09	± 32.66	± 0.85
2 Cueva	3.40	1.76	1.77	16.46	3.00	11.27	283.44	489.20	220.34	1,004.25	91.36
	± 0.50	± 0.56	± 0.91	± 5.65	± 0.69	± 1.42	± 34.80	± 28.64	± 16.57	± 62.69	± 1.64
3 Badge	4.12	2.02	3.81	19.69	6.21	13.86	288.23	501.64	242.57	1,046.30	87.82
(4 applications)	± 0.77	± 0.76	± 1.44	± 2.00	± 1.61	± 3.33	± 33.00	± 25.20	± 19.73	± 32.47	± 1.54
4 Badge	3.96	5.18	3.57	24.75	4.31	8.65	278.65	464.04	265.16	1,016.49	84.62
(2 applications, different rates)	± 0.69	± 2.06	± 0.98	± 5.19	± 0.75	± 1.77	± 20.40	± 18.77	± 17.98	± 37.32	± 2.77
5 Previsto	2.14	4.24	2.78	23.35	5.36	14.11	258.19	491.75	306.03	1,070.07	88.50
(2 applications)	± 0.82	± 0.76	± 0.93	± 7.96	± 0.52	± 5.10	± 21.38	± 22.64	± 24.73	± 28.09	± 1.94
6 Mastercop	3.07	0.88	0.44	15.46	3.42	6.64	258.02	477.75	241.41	983.82	93.42
(1.5 pt)	± 1.09	± 0.52	± 0.31	± 3.72	± 0.78	± 1.49	± 29.48	± 17.35	± 23.43	± 27.62	± 1.48
7 Mastercop	2.34	3.80	8.35	19.03	3.91	11.56	272.76	420.41	252.44	957.17	83.01
(2.5 pt)	± 0.75	± 0.98	± 1.47	± 2.79	± 0.55	± 2.36	± 17.16	± 16.87	± 17.13	± 31.64	± 1.63

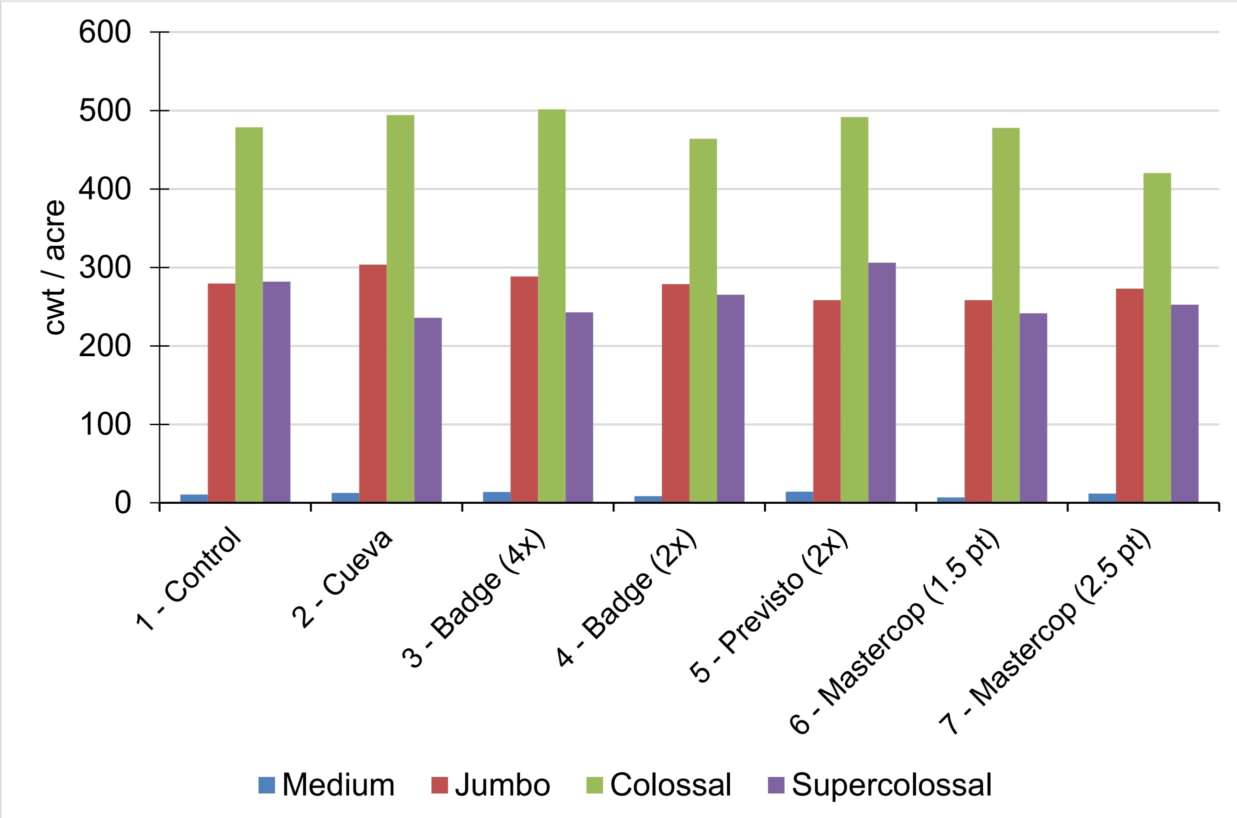

Figure 5. Size profile for onions treated with various bactericides, Malheur Experiment Station, Oregon State University, 2020.