ONION (*Allium cepa* 'Calibra')
Center rot; *Pantoea agglomerans*
Slippery skin; *Burkholderia gladioli* pv. *alliicola*

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Effects of rolling tops on bacterial leaf blight and bulb rot in an onion crop in Pasco, WA, 2022-23.

A field trial was planted on 31 Mar 22 at the Washington State University Pasco Vegetable Extension Farm, using pelleted seed of the onion cv. Calibra (210,000 plants/A), to evaluate the effects of rolling the tops of onion plants at the end of the season on management of bacterial bulb rot caused by *Pantoea agglomerans* and *Burkholderia gladioli* pv. *alliicola* in storage onion bulb crops in the Columbia Basin of central Washington and northcentral Oregon. The trial was a split plot, randomized complete block design with five replications of a factorial treatment design: two inoculation treatments (inoculated or not inoculated) applied to main plots, and two rolling treatments (tops rolled or not rolled) applied to split plots. Each split plot consisted of a 34-in.-wide bed (with 2 double-rows of onion plants) x 15 ft long, including 5 ft of bed as a buffer between adjacent plots. Inoculum consisting of an equal ratio of the two pathogens, produced as overnight shake cultures in nutrient broth yeast extract medium and diluted to 10^8 CFU/ml in 0.0125M phosphate buffer plus 0.01% Tween 20, was applied to relevant main plots on 28 Jul (5% tops down) and 11 Aug (50% tops down). Inoculum was applied in the evening with a CO_2-pressurized backpack sprayer and 3-nozzle boom (XR8003 tips, 34.65 gpa, 20 psi). The trial was irrigated by center-pivot and managed with typical practices for the region. Plots also were irrigated with 0.12 in. water in the late afternoon every other day from mid-Jul through Aug to favor bacterial infection. Rolling was done manually by pulling a 35 lb plastic roller (36-in. wide, 18-in. diameter) over relevant split plots on 3 Aug. Plants were undercut on 24 Aug with a tractor-mounted rod-weeder. Plots were rated for incidence (%) of plants with bacterial leaf blight and severity (%) of foliar symptoms on 1, 8, 15, and 22 Aug. Plots were rated for percentage tops down on 15 Aug. Bulbs were harvested from a 5-ft section/split plot on 12 Sep, and then sorted into bulbs culled because of external symptoms of bacterial rot, bulbs culled for other reasons (split bulbs, green shoulders, double-bulbs, or bolted), and marketable bulbs. Marketable bulbs were sized (pre-pack, medium, jumbo, and colossal), and counted and weighed by size to calculate marketable yield (t/A). Marketable bulbs were placed in a commercial onion storage facility (40ºF, 70% relative humidity) for 5 months. On 2 Feb 23, bulbs were cut vertically and rated for incidence (%) of bulbs with bacterial rot and severity of bacterial rot (% of cut surface area of each bulb with symptoms). Data were subjected to analyses of variance (ANOVAs) and means comparisons using Fisher's protected least significant difference (LSD). The project was funded by Specialty Crops Research Initiative Award 2019-51181-30013 of the USDA National Institute of Food and Agriculture.

Symptoms of bacterial leaf blight were observed by 1 Aug, 4 days after the first inoculation, at a very low incidence in most plots. By 8 Aug, foliar disease incidence and severity were greater in inoculated plots (14.0% incidence, 1.7% severity) than non-inoculated plots (8.0% incidence, 0.5% severity). By 22 Aug, inoculated plots averaged 65.0% incidence of bacterial leaf blight vs. 19.0% in non-inoculated plots, with 35.2 vs. 5.2% severity, respectively. Plots with rolled tops had significantly more bacterial leaf blight on 15 Aug (36% incidence and 10.3% severity) compared to plots not rolled (15.0% incidence and 3.1% severity). However, by 22 Aug, the incidence and severity of bacterial leaf blight were similar in rolled and non-rolled plots. Inoculation with *P. agglomerans* and *B. gladioli* pv. *alliicola* increased the percentage tops down by 15 Aug, when 97.7% of tops were down in inoculated plots vs. 82.4% in non-inoculated plots. Rolled plots had 100% tops down on 15 Aug since the tops were rolled manually on 3 Aug, whereas an average of 80.1% of tops were down in plots not rolled (95.4% in inoculated plots and 64.8% in non-inoculated plots). Inoculations reduced marketable bulb yield significantly, from 37.4 t/A in non-inoculated plots to 24.6 t/A in inoculated plots, largely by increasing the weight of bulbs culled because of bacterial rot, from 4.7 t/A in non-inoculated plots to 14.5 t/A in inoculated plots. Inoculating the plots at 5 and 50% tops down increased the incidence of bacterial bulb rot at harvest, from 11.7 to 38.6%, and the incidence of bacterial bulb rot after 5 months in storage, from 12.2 to 23.7%. The total loss of bulbs to bacterial rot (harvest + storage) was 160% greater in inoculated plots (62.3%) vs. non-inoculated plots (23.9%). Rolling onion tops did not affect marketable bulb yield or bacterial bulb rot at harvest or in storage. In summary, inoculation of onion plants at 5 and 50% tops down was highly effective at increasing bacterial leaf blight and bulb rot at harvest and in storage. However, rolling onion tops at the onset of tops down did not affect bacterial leaf blight or bulb rot under the conditions of this trial, both in inoculated plots and non-inoculated plots. Rolling onion tops may not play a role in increasing or minimizing bacterial infections in onion bulb crops in the Columbia Basin.

Main plot and split plot treatments	Tops down (15 Aug)[z]	Bacterial leaf blight (22 Aug)		Bulb yield at harvest (t/A)		Bacterial culls at harvest		Bacterial bulb rot after 5 months in storage		Total bacterial bulb rot incidence (harvest + storage)
		Incidence (% of plants)	Severity (% of canopy)	Marke-table bulbs	Bacte-rial culls	Incidence (% of bulbs)	Severity (% per bulb)	Incidence (% of bulbs)	Severity (% per bulb)	
Main plots										
Inoculated	97.7 a[y]	65.0 a	35.2 a	24.6 b	14.5 a	38.6 a	44.6	23.7 a	19.8 a	62.3 a
Non-inoculated	82.4 b	19.0 b	5.2 b	37.4 a	4.7 b	11.7 b	41.3	12.2 b	4.8 b	23.9 b
LSD	Rank[x]	Rank	11.2	5.2	2.2	6.9	18.9	6.6	5.5	Rank
P value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.7033	0.0026	0.0001	0.0001
Split-plots										
Tops rolled	100.0 a	49.0	23.5	29.8	9.1	25.2	45.4	18.9	13.5	44.1
Tops not rolled	80.1 b	35.0	16.9	32.3	10.1	25.1	40.6	17.0	11.1	42.1
LSD	Rank	Rank	11.2	5.2	2.2	6.9	18.9	6.6	5.5	Rank
P value	0.0001	0.2011	0.1826	0.4934	0.3642	0.9816	0.5893	0.6105	0.3625	0.4930
Inoculated plots										
Tops rolled	100.0	70.0	38.9	23.0	14.6	40.7	46.2	23.5	20.8	64.2
Tops not rolled	95.4	60.0	31.4	26.2	14.5	36.5	43.1	23.9	18.7	60.4
LSD	6.1	48.1	24.9	10.9	5.1	17.7	25.6	11.3	8.1	20.0
P value	0.1052	0.4520	0.4259	0.4157	0.9725	0.5386	0.6707	0.9148	0.5127	0.5704
Non-inoculated plots										
Tops rolled	100.0 a	28.0	8.0	36.5	3.7	9.7	44.6	14.4	6.1	24.1
Tops not rolled	64.8 b	10.0	2.3	38.4	5.7	13.8	38.0	10.0	3.4	23.7
LSD	Rank	23.9	7.4	10.5	3.8	10.2	31.3	Rank	6.8	20.9
P value	0.0001	0.1046	0.1006	0.6433	0.2205	0.3309	0.5903	0.3972	0.3316	0.9587

[z] There was a significant interaction of inoculation treatments with rolling tops treatments on the tops down rating on 15 Aug ($P = 0.0001$).

[y] For inoculation treatments, and for the split plot treatments, means within a column followed by the same letter are not significantly different based on Fisher's protected LSD. If the ANOVA F-test was not significant, means separation letters are not shown.

[x] Rank = data were subjected to Friedman's non-parametric rank test. Original means are shown but means separation is based on the transformed analysis.