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

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Effects of bulb undercutting 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 undercutting onion bulbs at the end of the season on management of bacterial bulb rot caused by *Pantoea agglomerans* and *Burkholderia gladioli* pv. *alliicola* in storage onion 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 three undercutting treatments (early, standard, and none) 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. Undercutting was done with a tractor-mounted rod-weeder on 10 Aug (early timing) or 24 Aug (standard timing), or there was no undercutting (control treatment). Plots were rated for incidence (%) of plants with bacterial leaf blight and severity of foliar symptoms (%) on 1, 8, 15, and 22 Aug; and for percentage tops down on 1 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 (40°F, 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.

Inoculation of onion plots with *P. agglomerans* and *B. gladioli* pv. *alliicola* at 5% tops down had no effect on incidence of tops down rated on 1 Aug. Bacterial leaf blight was observed on 1 Aug, 4 days after the first inoculation, at a very low incidence (<1.3% averaged across all plots). By 8 Aug, foliar disease incidence and severity were greater in inoculated plots (14.0 and 2.4%, respectively) than non-inoculated plots (3.3 and 0.4%, respectively). Bacterial leaf blight increased further following a second inoculation at 50% tops down. By 22 Aug, inoculated plots averaged 92.0% incidence of bacterial leaf blight vs. 29.0% in non-inoculated plots, with 43.3 vs. 8.5% severity, respectively. Inoculated plots had approximately half the marketable bulb yield (17.8 t/A) of non-inoculated plots (35.2 t/A), as a result of inoculations increasing the weight of bulbs culled at harvest because of bacterial rot (19.3 vs. 6.1 t/A culled in inoculated vs. non-inoculated plots, respectively). Inoculated plots had 3.3 times as many bulbs with bacterial rot at harvest (48.7%) than non-inoculated plots (14.4%). In addition, more bulbs harvested from inoculated plots rotted in storage (19.9%) than those harvested from non-inoculated plots (14.5%). The total loss of bulbs to bacterial rot (harvest + storage) was 68.6% in inoculated plots vs. 28.9% in non-inoculated plots. Undercutting treatments had no effect on percentage tops down on 1 Aug because undercutting was done after 1 Aug. Undercutting also had no effect on bacterial leaf blight at any of the ratings. However, in inoculated plots, marketable bulb yield was greatest in plots undercut early (22.3 t/A), followed by plots not undercut (18.4 t/A), and was least in plots with the standard timing of undercutting (12.7 t/A). In non-inoculated plots, marketable bulb yield was similar for all undercutting treatments (34.1 to 36.3 t/A). Plots undercut early had less bacterial culls at harvest (9.8 t/A) than plots with the standard timing (13.4 t/A) or no undercutting (14.8 t/A), as the percentage of bulbs with bacterial rot at harvest was less in plots undercut early (23.9%) than those with standard undercutting timing (36.1%) or no undercutting (34.7%); and similarly for the total amount of bulbs lost to bacterial rot (harvest + storage): 40.8% for plots undercut early vs. 50.4-55.2% for plots with standard timing of undercutting or no undercutting. In summary, late-season inoculation of onion plants grown with overhead irrigation very effectively increased bacterial leaf blight and bacterial bulb rot. Undercutting bulbs at 50% tops down decreased the losses compared to undercutting 2 weeks later (100% tops down) or not undercutting. Careful timing of undercutting may be a valuable tool to speed field curing of bulbs and reduce losses to bacterial diseases in onion crops in the Columbia Basin.

Main plot and split plot treatments	Tops down (1 Aug)	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 (% at harvest + storage)
		Incidence (% of plants)	Severity (% of canopy)	Marketable bulbs	Bacterial culls	Incidence (% of bulbs)	Severity (% per bulb)	Incidence (% of bulbs)	Severity (% per bulb)	
Main plots										
Inoculated	0.1	92.0 a[y]	43.3 a	17.8 b	19.3 a	48.7 a	42.8	19.9 a	23.3 a	68.6 a
Non-inoculated	0.5	29.0 b	8.5 b	35.2 a	6.1 b	14.4 b	30.4	14.5 b	7.2 b	28.9 b
LSD	Rank[z]	18.3	9.4	3.8	Rank	Rank	14.5	4.9	Rank	8.5
P value	0.2596	0.0001	0.0001	0.0001	0.0001	0.0001	0.0752	0.0333	0.0001	0.0001
Split-plots (undercutting)										
Early	0.6	-----[x]	-----[x]	29.3	9.8 b	23.9 b	34.8	16.9	12.4	40.8 b
Standard	0.2	56.0	23.8	24.0	13.4 a	36.1 a	32.4	14.3	13.8	50.4 ab
None (control)	0.2	65.0	28.0	26.2	14.8 a	34.7 a	42.6	20.6	19.5	55.2 a
LSD	Rank	18.3	9.4	4.7	Rank	Rank	17.7	6.0	Rank	10.5
P value	0.9408	0.3059	0.4272	0.0878	0.0102	0.0183	0.5485	0.1146	0.4644	0.0287
Inoculated plots (undercutting treatments)										
Early	0.0	-----	-----	22.3 a	15.6	38.8 b	42.2	21.1	18.5	59.9
Standard	0.2	90.0	40.9	12.7 c	20.7	58.0 a	38.6	16.9	21.5	74.9
None (control)	0.2	94.0	45.7	18.4 b	21.4	49.3 ab	47.6	21.8	29.8	71.1
LSD	Rank	16.7	21.8	3.9	7.0	12.9	Rank	4.8	13.4	12.1
P value	0.5665	0.4554	0.5090	0.0015	0.1749	0.0265	0.7983	0.0982	0.1903	0.0509
Non-inoculated plots (undercutting treatments)										
Early	1.2	-----	-----	36.3	4.0	9.1	27.3	12.7 b	6.3	21.8
Standard	0.2	22.0	6.7	35.3	6.0	14.2	26.1	11.6 b	6.1	25.8
None (control)	0.2	36.0	10.2	34.1	8.1	20.1	37.7	19.3 a	9.1	39.4
LSD	1.8	Rank	13.1	9.0	Rank	Rank	34.4	6.4	6.4	16.7
P value	0.3751	0.4609	0.4989	0.8537	0.2621	0.2621	0.7080	0.0488	0.5091	0.0919

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

[y] For inoculation treatments and the undercutting 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] Bulbs were undercut on 1 Aug for the early undercutting treatment, before the 22 Aug foliar ratings.