Onion (*Allium cepa*, 'Calibra')
Slippery skin; *Burkholderia gladioli* pv. *allicola*
Bulb rot and leaf blight; *Pantoea agglomerans*

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Effects of irrigation frequency and final irrigation timing on onion bacterial diseases in the Columbia Basin of Washington, 2020.

Two irrigation management trials were conducted with yellow storage onions grown in Pasco, WA on a loamy fine sand to investigate the role of irrigation frequency and the final irrigation timing on bacterial rot development. The first trial was a 3-by-2 factorial, split-plot, randomized complete block design (RCBD) evaluating the impact of three irrigation cut-off timings and inoculation or no inoculation of plants with *B. gladioli* pv. *alliicola* and *P. agglomerans* on onion bacterial disease incidence and severity. The irrigation cut-off treatments included a control treatment representing typical grower practice with irrigation stopped at approximately 50% tops down; an early cut-off with irrigation stopped a week earlier, at 5-10% tops down; and a late cut-off with irrigation stopped a week after the standard cut-off. At the first sign of tops-down and again two weeks later, one of two subplots was inoculated with a mix of *B. gladioli* pv. *alliicola* and *P. agglomerans* applied with a CO_2-pressurized backpack sprayer at 10^8 cfu/ml, and the other subplot was not inoculated, with a 5-ft buffer between adjacent subplots. The second trial evaluated whether applying sprinkler irrigation twice as frequently (2X treatment) but for shorter time periods exacerbates bacterial diseases of onion compared to less frequent but longer irrigations (1X control treatment, as a growers' standard practice). This trial utilized a split-split plot RCBD with five nitrogen rates randomly assigned to sub-plots within the irrigation frequency main plots. Nitrogen trial results are not included in this report because there was no significant interaction with irrigation for any response variable. The 1X control plots were irrigated when 40% of the plant available water in the root zone was depleted, while the 2X treatment plots were irrigated at 20% depletion, based on publicly available weather data and a calculated water balance. Irrigation treatments were initiated after the third- or fourth-leaf growth stage, with 35 and 60 total irrigation events thereafter for the 1X and 2X treatments, respectively, but the same total amount of water applied for both treatments. Inoculation treatments were applied to 10-ft sub-sub plots, as detailed for the irrigation cut-off trial. For both trials, each irrigation treatment was replicated five times. Main plots in the first trial (irrigation cut-offs) and sub-plots in the second trial (irrigation frequency) were 25 ft long and one bed (68 in.) wide with eight rows of onions (four double-rows) per bed. All experimental plots were separated on the ends by a 5-ft buffer. At 90% tops-down, onions were undercut to sever the roots to enhance field curing. Three weeks later (24 Sep), onions were topped and harvested from a 5-ft section of each inoculated and non-inoculated plot. Onions from half of the 5-ft section (four rows of plants) were sorted to determine the number and weight of bulbs in each size category (pre-pack, medium, jumbo, and colossal bulbs plus culled bulbs with defects). Visibly rotten onions (bacterial culls) were tallied, weighed, and discarded. All marketable bulbs (non-culled bulbs) were placed in storage for five months at 34-36ºF and 75-80% relative humidity and then rated for incidence and severity of bacterial rot. The data for culled bulbs with bacterial rot were added to the bacterial rot incidence ratings in Feb 2021. Bulbs from the other half (four rows) of the 5-ft section harvested from each plot were individually assessed for bacterial rot incidence and severity at harvest. The marketable yield, number, and weight of bacterial culls, and bacterial rot incidence and severity at harvest and after five months in storage were subjected to analyses of variance (ANOVAs) using R Studio v. 1.3.1073.

Natural levels of bacterial infection in the non-inoculated plots were low: bacterial bulb rot incidence at harvest averaged 3% across all non-inoculated irrigation cut-off plots and 8% across non-inoculated irrigation frequency plots. As a result, significant differences among irrigation treatments were only able to be detected in the inoculated plots. After five months of storage, bacterial disease incidence in bulbs from non-inoculated plots averaged 2% for the irrigation cut-off trial and 7% for the irrigation frequency trial. In comparison, the average disease incidence across all inoculated plots at harvest was 44% and 57% for the irrigation cut-off and irrigation frequency trials, respectively. After storage, bacterial disease incidence averaged 41% across inoculated irrigation cut-off plots and 53% across inoculated irrigation frequency plots. For inoculated plots, the early irrigation cut-off treatment resulted in 50% fewer culled bulbs with symptoms of bacterial rot at harvest compared to plots with the late cut-off of irrigation ($P = 0.029$). The early cut-off treatment also significantly reduced the incidence of bacterial rot in bulbs stored for five months, by 16% compared to the control treatment and by 23% compared to the late cut-off ($P = 0.020$ and 0.003, respectively). Although the early irrigation cut-off also resulted in the lowest incidence of rotten bulbs at harvest (15% less than in late cut-off plots), there was not a significant treatment effect ($P = 0.104$). Marketable bulb yield and size class distribution (*data not shown*) were not significantly different across the three irrigation cut-off timings, further indicating that ending irrigation earlier can be used to manage bacterial bulb rot without reducing yield, especially under high disease pressure. The 2X irrigation frequency treatment reduced bacterial rot severity (22% average) for bulbs assessed at harvest compared to the 1X control treatment (30%) ($P = 0.024$). However, there was not a significant difference in bacterial bulb rot incidence at harvest ($P = 0.09$), as the inoculated plots with 1X irrigation frequency had an average of 61% bulbs with bacterial rot while the inoculated plots with the 2X irrigation frequency had an average of 53% bulbs with bacterial rot. No significant differences in bacterial bulb rot incidence after storage, disease severity after storage, marketable yield, or incidence of bacterial culls were observed for the irrigation frequency treatments. For bulb size distribution, the only difference was among pre-pack bulbs from inoculated plots ($P = 0.039$), which averaged 0.3 and 0.7 t/A from the 2X and 1X irrigation frequency plots, respectively. The frequency of irrigation appeared to have minimal impact on the development of bacterial bulb rot under the conditions of these trials. In contrast, a late irrigation cut-off increased the number of bulbs culled at harvest as a result of bacterial rot and led to greater bacterial bulb rot incidence after storage compared to terminating irrigation a week or two earlier.

		Mean bulb weight (t/A)		Bacterial bulb rot incidence (%)		Bacterial bulb rot severity index (%)[y]	
Trial	Treatment[w]	Marketable yield (at harvest)	Bacterial culls (at harvest)	At harvest	After storage	At harvest	After storage[z]
Final irrigation timing	Early	20.5 [x]	4.7 a	34.2	28.4 a	15.9	8.4
	Control	23.9	6.2 ab	48.6	44.4 b	25.6	11.2
	Late	19.9	9.9 b	49.3	51.5 b	26.4	15.8
	P-value	0.625	0.031	0.104	0.003	0.059	0.178
Irrigation frequency	1X (control)	22.6	11.8	61.2	53.6	29.5 b	15.2
	2X	26.6	14.4	53.2	53.3	21.7 a	12.7
	P-value	0.151	0.107	0.090	0.928	0.024	0.248

[w] Only averages for the inoculated plots are shown as differences among treatments for non-inoculated plots were insignificant.

[x] Within each trial, treatment means with the same letters are not significantly different based on post-hoc pairwise comparisons using the Tukey procedure ($P \leq 0.05$). Means without a letter indicate no significant difference among the treatments based on the analysis of variance.

[y] Bacterial bulb rot severity index based on averaging the bulb rot ratings based on the percentage of the cut bulb surface with symptoms of bacterial rot.

[z] Bulbs culled at harvest because of severe symptoms of bacterial rot were not placed in storage, so the severity index after storage only includes bulbs without external symptoms of bacterial rot.