DRY BULB ONION (*Allium cepa '5 varieties'*)
Bacterial bulb rot; *Burkholderia cepacia*

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Effect of slow curing with artificially heated forced air via a drying wall in a box storage on bacterial bulb rot in onion, 2021.

The objective of this study was to determine whether slow curing onions on a drying wall with artificially heated forced air in a box storage would reduce bacterial bulb rot in field-dried onions. Six commercial onion fields that had exhibited foliar symptoms of bacterial disease during the growing season were selected. Within 0-2 d of when the grower harvested the field, paired 50-lb samples of onion bulbs were collected from eight locations spaced 75-100 ft apart in each field. The number of bulbs per sample averaged 150. In five fields, onions were hand-topped to 3-in necks, rolled in muck soil to simulate dusty harvest conditions, and placed in mesh bags. In Field 4, paired samples were collected from different 1000-lb boxes after they were machine-harvested. In all fields, the neck tissue was mostly dry at harvest. A sub-sample of 96 bulbs per field (6 bulbs/sample in each sample pair in 8 locations) were cut longitudinally within 4-7 d after collection and inspected for incidence and location (neck only or in bulb) of bacterial disease prior to curing. For each of the eight paired samples per field, one sample was cured artificially while the other was cured naturally. Temperature and relative humidity sensors (Onset) were placed inside 2 bags for each curing type per field. Immediately after harvest, the samples were placed in 1000-lb wooden boxes with other onions and stacked outdoors with a sheet of corrugated plastic strapped over the top box for the natural curing treatments and on a drying wall inside a commercial onion storage building along with 5100 other boxes of onions for the artificial curing treatments. For artificial curing, air was heated to 5°F above the ambient air temperature, regulated to 60-70% relative humidity and treated with ozone, then forced through the stacked boxes at 60-80 cfm/ton. The onions from one field were cured in a different onion storage building that did have the ozone treatment. All samples were removed from the drying wall when the curing process was complete and brought to a common storage building. Thus, the duration of artificial curing varied from 11-23 d among fields because they were harvested at different times. The naturally cured samples were brought into the same common storage building when the grower cooperator brought his onions into storage on 4 Nov. Because fields were harvested at different times the duration of natural curing ranged from 29-56 d among field samples. On 4 and 6 Jan 22 onions were counted and weighed. All soft bulbs were cut longitudinally and inspected for bacterial rot. Asymptomatic bulbs were re-bagged and put back into storage until 8-9 Mar 22 when the onions were counted and weighed, and soft bulbs cut to confirm bacterial rot again. An additional sub-sample of 30 asymptomatic bulbs per sample were cut longitudinally and inspected for bacterial rot; the percentage of rot in this sample was extrapolated to the remaining asymptomatic bulbs. Each field was analyzed separately using Student's t-test (2-tailed, type II) with 5% significance (Statistix 10).

At harvest and prior to curing, incidence of bacterial disease already in the bulb ranged from 2.1-20.2% per field, which was predominantly detectable only by cutting bulbs (1.1-15.6%). Additionally, the incidence of bulbs where the bacterial disease was confined to the neck tissue and had not yet entered into the bulb area ranged from 2.1-12.5% per field. Since there is no cure for bacterial rot that is already in the bulb, this trial tested whether artificial curing could prevent bacterial infection in the neck from progressing to the bulbs, presumably by rapidly drying the neck tissue, as bacterial rot does not progress through dry tissue. Nine weeks after curing on 4 and 6 Jan 22, detectable bulb rot ranged from 1.4-12.9%, which did not include bulb rot that could only be detected by cutting bulbs. At this assessment, the only significant difference between curing treatments occurred in Field 5, where artificial curing (3.3%) resulted in 2.4-times higher bulb rot than natural curing (1.4%). After 9 more weeks in storage on 8-9 Mar 22, total bulb rot (detectable externally and by cutting bulbs), an additional 0.1-6.5% of bulb rot occurred, but there were no significant differences between curing treatments in any field. Total bulb rot from January and March evaluations ranged from 1.5-15.6%, which was less than and equal to the total bulb rot detected prior to curing in Fields 3-6 and Field 1, respectively. These results suggest that the bacterial infections that occurred only in the neck prior to curing in storage did not make their way into the bulbs. Except, Field 2 was the only field where bulb rot increased after curing and storage from 2.2% to 5.4-5.7% where some of the neck infections present at harvest could have progressed into the bulbs during storage. Numerically, the three fields with the highest levels of bulb rot at harvest also had the highest levels of rot at the storage assessments (Fields 1, 4 and 6), and the three fields with the lowest bulb rot at harvest also had the lowest bulb rot at the storage assessments (Fields 2, 3 and 5). There were no significant differences between natural and drying wall curing methods for total % bulb rot, except in Field 5, where the drying wall had 3-times more bulb rot (4.6%) than natural curing (1.5%). This field had the shortest drying wall treatment and the lowest incidence of bulb rot at harvest (4.3%) with 2.1% of the bulbs with bacterial disease only in the neck. Thus, this treatment was the least likely candidate for a drying wall treatment to be effective. Field 1 was the only treatment where the onions cured on the drying wall (10.4%) had numerically and almost significantly ($p = 0.1242$) less bulb rot than onions cured naturally (15.6%), by 50%. This field had the full duration of the drying wall curing treatment (23 d) and a relatively high incidence of "neck only" infections at harvest (10.3%). There were also no significant differences between artificial and natural curing for average bulb weight, external sprouts, bulb firmness and skin peeling, except in Field 1, which had significantly less skin peeling with artificially cured onions (data not shown). In this study, slow artificial curing of onions with forced air heated to 65-70°F for 2-3 weeks on a drying wall in a box storage following harvest when neck tissue was already dry did not reduce bacterial bulb rot compared to onions that were naturally cured in 1000-lb wooden boxes stacked outside. Further study should evaluate the effect on bacterial bulb rot of quick artificial curing of onions with forced air heated to 85-88°F for 2-3 days following harvest when neck tissue is green compared to natural outdoor curing. This trial was funded by Specialty Crops Research Initiative Award 2019-51181-30013 of the USDA National Institute of Food and Agriculture.

	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
Treatment Details						
Field location (nearest town)	Elba	Elba	Elba	Fulton	Oswego	Elba
Onion variety	Redwing	SV4643NT	Bradley	Red Mountain	Bradley	Legend
Bulb color	Red	Red	Yellow	Red	Yellow	Yellow
Culture	Direct seed	Direct seed	Direct seed	Direct seed	Direct seed	Transplant
Harvest date	9 Sep	9 Sep	14 Sep	10 Sep	16-17 Sep	30 Sep
Topping technique	Manual	Manual	Manual	Mechanical	Manual	Manual
Drying wall facility	Building 1	Building 1	Building 1	Building 1	Building 1	Building 2
Ozone treatment	Yes	Yes	Yes	Yes	Yes	No
Date placed on drying wall	9 Sep	9 Sep	14 Sep	14 Sep	21 Sep	6 Sep
Date removed from drying wall[z]	6 Oct	6 Oct	6 Oct	6 Oct	6 Oct	25 Oct
Total time on drying wall (d)[y]	23	23	18	18	11	15
Total time naturally cured samples were left outside (d)	56	56	51	51	44	29
5-7 days After Harvest - Pre-curing Incidence of Bacterial Disease in 96-bulb Sample/Field (%)						
Bulb rot (externally detectable)[x]	6.2	1.1	1.1	7.1	0.0	2.1
Bulb rot (detected only by cutting bulbs)[w]	9.3	1.1	4.2	13.1	4.3	15.6
Total bulb rot	15.5	2.2	5.3	20.2	4.3	17.7
Rot only in neck	10.3	6.3	6.3	9.1	2.1	12.5
Total bacterial disease	25.7	8.4	11.6	29.3	6.8	30.2
9 weeks After Curing (4, 6 Jan 22) – Externally Detectable Bacterial Bulb Rot (%)						
Natural outdoor curing	12.9	3.7	2.3	4.9	1.4 b[u]	6.9
Artificial curing on drying wall	9.2	4.5	2.4	5.7	3.3 a	7.6
p value	0.3526	0.6241	0.8405	0.6349	0.0291	0.7615
After 9 weeks Storage (8-9 Mar 22) - Total Bacterial Bulb Rot (%)						
Natural outdoor curing	2.7	2.0	1.3	5.4	0.1	6.5
Artificial curing on drying wall	1.3	0.9	1.2	4.9	1.3	6.0
p value	0.2592	0.1333	0.9778	0.8784	0.0817	0.8425
Total Bacterial Bulb Rot (Jan + Mar) (%)						
Natural outdoor curing	15.6	5.7	3.6	10.3	1.5 b	13.4
Artificial curing on drying wall	10.4	5.4	3.6	10.5	4.6 a	13.5
p value	0.1242	0.8103	0.9910	0.9280	0.0145	0.9503

[z] Heat was turned off and fans reduced to 30 cfm/ton on 2 Oct and 21 Oct at building 1 and building 2, respectively.

[y] Total time on trying wall reflects duration on the wall while heat was turned on and fans were running at 60-80 cfm/ton.

[x] Externally detectable bulb rot could be identified by the bulb feeling soft when squeezed.

[w] When bulb rot is minor and often affects only a single scale while the outer scales remain firm, it is not detected externally when the bulbs are squeezed and only when they are cut open.

[v] Studentized t-test, 2-tailed, type II with 5% significance ($p < 0.05$ is significant).

[u] Numbers in a column followed by the same letter are not significantly different, Studentized t-test, 2-tailed, type II, $p < 0.05$.