2022 Pennsylvania Vegetable Marketing and Research Program
Pennsylvania Vegetable Growers Association Report
March 9, 2023

TITLE: Improving onion center rot management through more precise topping at harvest

PRINCIPLE INVESTIGATOR:

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INTRODUCTION:

Bacterial diseases cause losses of >$60 million/year to the U.S. onion industry. Pennsylvania onion growers have reported over 50% losses due to bacterial disease, despite active disease management. These losses tend to be observed postharvest as the bacterial disease center rot often goes undetected at harvest. Center rot pathogens (*Pantoea ananatis* and *P. agglomerans*) enter natural openings or wounds in the leaves, eventually causing bleached lesions that lead to wilt, collapse, and progression of the pathogen through the neck and into the bulb scales. Center rot can sometimes be identified at harvest by inspecting the onion neck after it is topped for a soft, discolored ring but this symptom can be subtle and difficult to see if plants have lodged prior to harvest. If foliar infections were identified and their progression stopped before they made it into the bulb, growers would have another tool in their toolbox for managing center rot.

For over a decade, the Gugino Vegetable Pathology Program has worked to improve disease management using IPM strategies, but an elusive question remains; At what point in disease development can topping the onion plant prevent bacterial disease from moving into the bulb? The goal of this project was to provide growers with a straightforward tool to manage bacterial disease at harvest. Our objective was to safeguard bulbs from bacterial disease through precision hand-topping. In an inoculated field trial, we topped onions at bulb maturation, while documenting how far the foliar lesion was to the bulb, dried and stored the onions, and two months later evaluated bulb disease incidence postharvest. We aimed to identify the minimum distance needed between bulb and leaf lesion to reduce risk of the disease from progressing into the bulb after topping. If the pathogen can be removed at harvest during topping, the proportion of infected bulbs shipped to market will decrease.

METHODS

Bare-root, onion transplants, cv. Candy (Sunbelt Transplant Inc., Buckeye, AZ), were planted at the Penn State Russell E. Larson Agricultural Research Center in PA Furnace, PA (Rock Springs) on April 29, 2022. Onions were grown using standard black plastic with a double row of drip irrigation. The trial consisted of a 150-ft section of bed, 4 rows wide with 6-in. plant spacing within and between rows. Crop fertility and weeds were managed using standard commercial production practices.

On June 23 and 30, 2022, a 110-ft section of the bed was spray inoculated with a bacterial suspension containing a 10^8 cfu/mL mix of *P. ananatis* and *P. agglomerans* originally isolated from symptomatic onions (pathogens that cause center rot). A 30-ft section of bed remained uninoculated as an uninoculated control. A 10-ft break separated the inoculated and uninoculated plots. Once inoculated, disease incidence was monitored weekly until harvest. During the inoculation period, total precipitation was 0.32 in., average air temperature was 69.5°F, and average maximum air temperature was 81.6°F (NEWA, 2023). Overhead misting irrigation was used every other day during the inoculation period to create favorable environmental conditions for disease development.

Once 50% of the plants lodged on July 22, 2022, onions were harvested and grouped according to leaf lesion proximity to bulb shoulder. Lesions proximity was recorded as the distance between the advancing edge of the lesion (margin) and the top shoulder of the bulb. Fifteen representative onions were harvested for each two-inch lesion segment beyond bulb (0 to 2-in. from bulb, 2 to 4-in. from bulb, 4 to 6-in. from bulb, etc). Onions were cured for two days on a wagon bed outdoors under a shade tree canopy when average air temperature was 76.3°F and average maximum air temperature was 89.3°F (NEWA, 2023). Following curing, onions were topped with sanitized pruners leaving a 2-in. neck. Individual onions were graded for size class (small, medium, jumbo, and colossal) and total bulb weight was recorded by lesion proximity treatment. Bulbs were dried with forced air for three weeks in plastic coated wire baskets stored in a protected shed. During the drying period, average air temperature was 72.8°F and average maximum air temperature was 83.0°F (NEWA, 2023). Dried bulbs were transferred to ventilated cardboard boxes and placed in storage at approximately 45°F. Post-harvest center rot incidence (presence or absence of symptoms) was evaluated after two months in storage by slicing each bulb in half longitudinally. Data were analyzed using the one-way analysis of variance procedure in R statistical software (R 4.2.2.). Binomial, post-harvest center rot incidence data (0= no disease, 1= disease) was fit using the general linear model. To analyze data with a linear regression model, data were summarized as proportion of bulbs sampled (n=15) per size class exhibiting disease.

RESULTS

Post-harvest center rot incidence was not significantly different by proximity of foliar lesion to the onion bulb shoulder (P=0.3884). This relationship did not improve when data were summarized as the percentage of post-harvest center rot incidence across size class and fit to a linear regression (Fig. 1; P=0.5519; R^2=0.01798; R^2 close to 1 is a stronger relationship). Surprisingly, even the lesions that were very close to the neck (0 to 2 in. lesion proximity positive control), only had 6.7% bulb disease incidence post-harvest (Table 1). All the other treatments, besides the no lesion negative control, had a similar amount of disease or higher. It is possible that the positive control (0 to 2-in.) did not develop disease as expected due to the ideal drying conditions that occurred post-harvest. Forced air drying in wire baskets allowed for rapid drying of the onion neck, which may have been enough to desiccate center rot pathogens and cease disease development. Perhaps post-harvest drying conditions are more important than lesion proximity in preventing center rot development in the bulb.

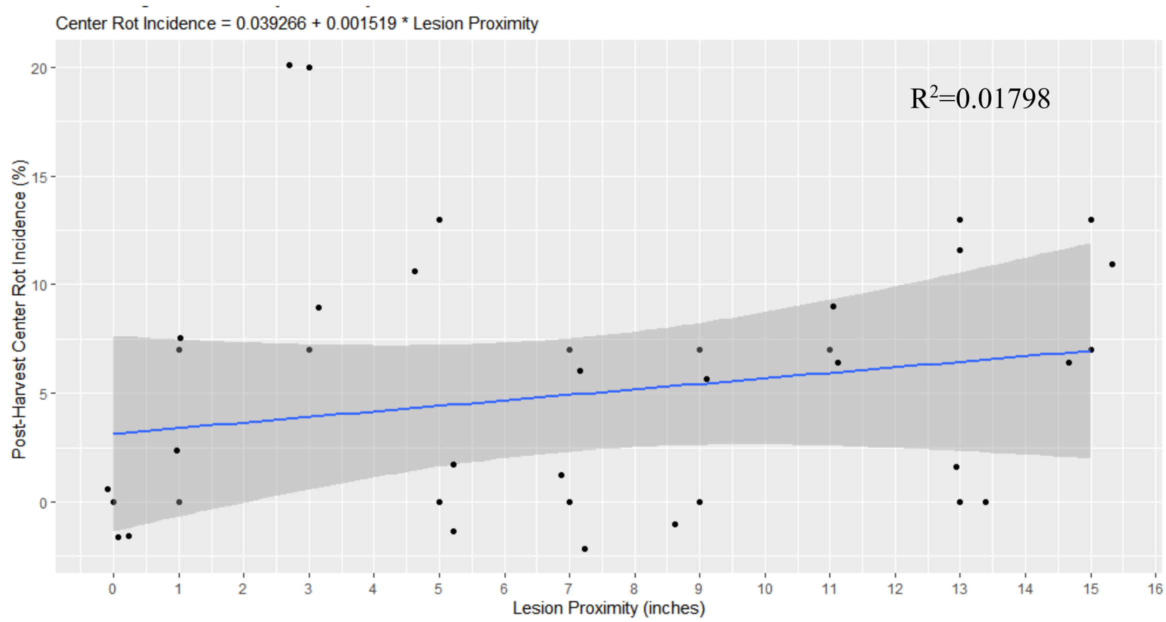

Figure 1. Relationship between lesion proximity and post-harvest center rot incidence (n=15) (P=0.5519; R^2=0.01798). Significance was determined by fitting a linear regression model using R version 4.2.2.

Lesion proximity did likely impact marketable yield in this study. Marketable yield, as a measure of average bulb weight and % of jumbo and colossal-sized bulbs, was highest in the treatments where the observed lesions were furthest from the bulb shoulder (14 to16-in. lesion proximity treatment; Table 1). Lesions were generally located on the leaf tips for the 14 to16-in. treatment. It is normal for leaf tips to dry and discolor in healthy onion plants, even under optimal production conditions, so perhaps bacterial lesions located in this same area do not negatively impact bulb yield. Comparatively, average bulb weight and % jumbo and colossal-sized bulbs were lowest in the 0 to 2-in. and 2 to 4-in. lesion proximity treatments (Table 1). Center rot may have contributed to the lower yields observed in these treatments where center rot symptoms developed closer to the bulb. When center rot lesions reduce the foliar photosynthetic area or kill leaves prematurely, bulb size will be reduced. Future studies would need to be designed to evaluate the relationship between foliar lesion proximity and marketable yield.

Table 1. Yield and post-harvest center rot incidence in onion cv. Candy by lesion proximity. Average bulb weight, the percentage of jumbo- and colossal-sized bulbs, and the percentage of onion bulbs with bacterial symptoms post-harvest is out of the total bulbs harvested per treatment (n=15).

Marketable Yield			**% onion bulbs with center rot symptoms post-harvest**
Proximity of foliar lesion to the onion bulb shoulder (in.)	**Average bulb weight (lb)**	**% jumbo/ colossal size**	
*0-2 (positive control)	0.54	67	6.7
2-4	0.55	67	20.0
4-6	0.59	80	13.3
6-8	0.63	93	6.7
8-10	0.67	73	6.7
10-12	0.60	73	13.3
12-14	0.61	87	13.3
14-16	0.82	100	20.0
**No lesions (negative control)	0.60	80	0

*0-2-in. treatment had symptomatic scales in the onion neck after topping to represent a positive, diseased control.
**No lesion treatment was symptom free at the time of harvest to represent a negative control.

CONCLUSION

The data collected from this one-year trial has helped us understand that lesion proximity is likely not the primary factor determining whether center rot disease develops in bulbs post-harvest and our efforts at properly curing and drying bulbs after harvest may be more important. The negative results from this research were also essential in determining which factors to include in a diagnostic picture tool to help growers determine when to harvest onions to minimize disease losses. Our previous research supported by PVGA/PVMRP determined harvest recommendations based upon a disease severity threshold and will be the focus of this diagnostic picture tool. These results, in conjunction with our previous work, have helped identify which cultural practices have the greatest influence on onion bacterial disease and will be summarized for one of the upcoming editions of the Vegetable and Small Fruit Gazette.

A special thanks to PVGA and PVMRP for supporting this on-going research on understanding the biology and management of bacterial diseases of onion. These results will help support the Specialty Crops Research Initiative (SCRI) Stop the Rot project, a grant from the USDA National Institute of Food

and Agriculture (NIFA) and will support a national team of researchers working collectively to address bacterial diseases of onion on a national scale.

REFERENCES

Network for Environment and Weather Applications (NEWA). 2023. Cornell University, Ithaca, NY. Accessed online (March 7, 2023): https://newa.cornell.edu/