Report submitted to the Pennsylvania Vegetable Marketing and Research Program
Pennsylvania Vegetable Growers Association
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TITLE: Tactics for the management of center rot of onion: Augmented nitrogen fertigation and cultivar selection

PRINCIPLE INVESTIGATOR:

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INTRODUCTION:

At harvest and post-harvest losses due to bacterial diseases remains a challenge for Pennsylvania sweet onion growers. Since management options in-season are limited and the efficacy of bactericides variable, our primary management tools need to be preventative and integrated. One important tool is host resistance. Currently breeders at New Mexico State University and University of Wisconsin are working to improve thrips resistance though manipulation of the foliar waxy cuticle composition. In the long-term this could help with the management of bacterial diseases through the reduction of feeding damage that serves as entry points for the bacteria as well as direct transmission of the pathogens during feeding. In the meantime, the identification of less susceptible commercially available cultivars to the center rot pathogens *Pantoea agglomerans* and *Pantoea ananatis* could provide growers with another management tool. With funding leveraged from the Pennsylvania Department of Agriculture Specialty Crop Block Grant Program, a total of 12 cultivars were evaluated in three replicated research trials conducted at the Penn State Research Farms in Centre and Lancaster Counties over the past two years. Of these cultivars, Spanish Medallion showed the greatest potential in terms of reduced susceptibility to center rot while maintaining the yield potential as well as sugar and pungency characteristics of Candy. In 2017, we evaluated Spanish Medallion grown in three commercial fields as well as in one small replicated research trial to determine its production potential under Pennsylvania production conditions.

Another potential tool to integrated into a management program for bacterial diseases is the augmentation of nitrogen fertility. With funding from the same PDA SCBG, in 2015 and 2016, three replicated trials were conducted to determine the effect of nitrogen (N) rate in combination with application timing (half-season vs. full season) on bacterial disease losses at harvest and post-harvest. Not surprisingly, this relationship has proven to be complex depending on the level of disease pressure however, in all three small plot replicated trials, reducing the total amount of nitrogen applied by 35 and 68% did not significantly reduce marketable yields regardless of the influence on center rot foliar disease severity and bulb rots at harvest. In itself, this could lead to a significant reduction in input costs for growers. In 2017, we conducted a simplified version of this trial to gain better understanding about the interaction between nitrogen rate and disease pressure by eliminating the factor of application timing which had less of an effect on disease severity based on the three previous trials.

METHODS:

To further evaluate the susceptibility and yield potential of cv. Spanish Medallion compared to the commercial standard cv. Candy, four replicated trials were established, one at the Russell E. Larson Research and Education Center and three on commercial farms in Centre and Lancaster Counties

(designated Centre 1, Lancaster 1 and 2, respectively). In each field, three or four replicate 30 ft plots were established of which15 ft was planted with approximately 10 week-old plug transplants (200-cell trays) of Spanish Medallion and 15 ft with Candy using standard four row, six inch spacing. The on-farm plots were managed following the standard practices of the growers and the research farm trial was managed using standard commercial practices. On-farm trials were rated on 6, 16, 28 Jun, 7 and 13 Jul, for visual foliar disease severity on a 0 to 7 scale with 0 = no lesion, asymptomatic; 1 = Local lesion (< 2.5 cm x 2.5 cm); 2 = Expanded lesion but less than ¼ leaf; 3 = ½ of leaf chlorotic or bleached; 4 = Entire leaf is bleached and wilting; 5 = One entire leaf and a portion of another leaf are bleached and wilted; 6 = Multiple fully symptomatic leaves; and 7 = ≥50% of leaves bleached and collapsed. For the on-farm trials, natural inoculum was relied upon. On the research farm to establish more uniform disease pressure, on 1 Jul the fourth leaves from the outside of each plant in 8ft of two rows (one outer, one inner) was toothpick inoculated with a bacterial suspension containing a mix of *Pantoea agglomerans* and *P. ananatis,* isolated approx. 6-in. from the base of the neck. The on-farm trials were harvested on 13 Jul and the onions graded for size (small, medium, jumbo, and colossal), marketability and weight in each class. The research farm trial was harvested on 24 Jul.

To further understand the effect of nitrogen application rate and bacterial disease pressure on incidence and severity at harvest, a replicated field trial will be established at the Russell E. Larson Research and Education Center at Rock Springs. Based on a soil test and following standard commercial production practices, soil nutrient levels other than N were adjusted prior to establishing the trial on standard black plastic raised beds with a double row of drip irrigation. Bare root transplants cv. Candy were sourced from Sunbelt in Buckeye, AZ. The trial was arranged as a split-plot with four replications with N rate [0, 50, 105 or 160 lb liquid urea ammonium nitrate/A) as the whole plot and inoculation status (uninoculated (low pressure), adjacent to inoculated (medium) and inoculated (high pressure)] as the subplot. Each whole plot was 26 ft in length and the nitrogen was applied using a modified fertigation system that allows for the application of multiple treatments simultaneously. The rates represent the total amount of nitrogen that was applied during the season. On 29 Jun, a third of the plants in each subplot were toothpick inoculated as previously described. All data was collected by sub-sub plot to represent a range of disease pressures. Foliar disease severity data and harvest data were collected using the same methods and on the same dates described for the research farm cultivar trial.

RESULTS:

Cultivar trials. Across all three on-farm trials there were no significant differences in total marketable yield (sum of medium, jumbo and colossal) between Candy and Spanish Medallion. At the Centre 1 location, there was a significantly higher proportion of marketable jumbo and colossal size Candy onions compared to Spanish Medallion (95.9 compared to 85.7% respectively; P = 0.0186). There was no difference in center rot disease incidence between the cultivars within each location or across the three locations within each cultivar. At the Lancaster 2 location, the majority of marketable onions across both cultivars were medium in size as a result of allium leafminer damage early in the season (Table 1) which explains the lack of jumbo and colossal-sized onions.

The higher disease pressure that resulted from toothpick inoculating a subset of plants in the trial at Rock Springs resulted in significantly higher center rot incidence compared to the plots characterized as having low or moderate disease pressure. However this trend was only significant for Candy and resulted in a significantly lower total marketable yield compared to Spanish Medallion plants also subjected to high disease pressure (Table 2).

Table 1. Comparison of marketable yield and incidence of center rot incidence between cvs. Candy and Spanish Medallion at three commercial farm locations in Lancaster and Centre Co., Pennsylvania in 2017.

Field location	Total # harvested (15 ft of bed)		Total marketable yield (%)		% Marketable jumbo/col. size		Center rot (%)	
	Candy	Spanish Medallion	Candy	Spanish Medallion	Candy [z]	Spanish Medallion	Candy	Spanish Medallion
Lancaster 1	108	104	90.5	89.2	60.5	65.4	5.6	5.9
Lancaster 2	97	89	77.8	72.4	2.9	0	3.9	0.6
Centre 1	108	101	94.3	91.7	95.9	85.7*	3.5	2.7

* Denotes a significant difference between Candy and Spanish Medallion within the data type (marketable yield of jumbo and colossal onions) and field location based on a two-sample t-test ($P \leq 0.05$).

Table 2. Comparison of marketable yield and center rot incidence between cvs. Candy and Spanish Medallion in a replicated research trial at Rock Springs in 2017. The trial was toothpick inoculated to create varying levels of disease pressure across the plots. Data was collected separately from each subplot and averaged across four replications.

Disease pressure (based on inoculation)	Total # harvested (7.5 ft of bed)		Total marketable yield (%)		Center rot (%)	
	Candy	Spanish Medallion	Candy [z]	Spanish Medallion	Candy	Spanish Medallion
Low	31	27	90.5 a	95.5	5.7 b	4.5
Moderate	29	29	92.4 a	94.9	6.0 b	4.1
High (inoculated)	29	30	73.4 b	85.3*	24.1 a	10.6*
Ave across plot	89	87	85.5 a	91.6	11.8 b	6.6 *
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[z] Values in the same column followed by the same letter are not significantly different from each other based on Fisher's LSD. NS = no significant differences were observed across the subplots with varying disease pressure for Spanish Medallion.

* Denotes a significant difference between Candy and Spanish Medallion within the data type (total marketable yield or center rot) and level of disease pressure based on a two-sample t-test ($P \leq 0.05$).

Nitrogen trial. Not surprisingly, increasing the total amount of nitrogen applied up until early July during bulb initiation significantly increased the percent of marketable onions that graded as jumbo and colossal in size at harvest ($P = 0.0035$) although no significant differences were observed between the two higher nitrogen rates (105 and 160 lb/A). When the percent of medium sized onions was combine with the total marketable yield this affect was lost ($P = 0.8074$) due to a greater proportion of medium-sized onions being harvested from plots receiving lower rates of nitrogen.

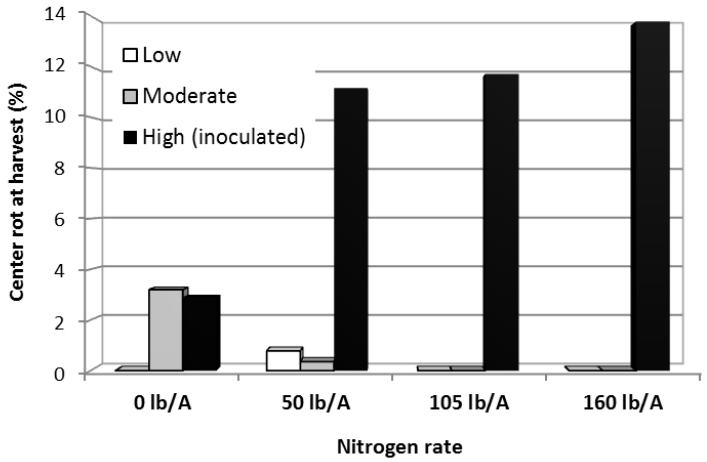

Figure 1. The percent center rot symptomatic onion bulbs at harvest from plots receiving four different rates of nitrogen and subjected to differing levels of disease pressure (low, moderate and high). All the plants in the high disease pressure subplots were toothpick inoculated with bacteria in late June.

In the high disease pressure plots, which were toothpick inoculated, center rot disease incidence at harvest ranged between 0 and 36% across all the plots with the four nitrogen

treatments 0, 50,105 and 160 lb/A averaging 2.9, 11.1, 11.7 and 14.8%, respectively. Although foliar disease symptoms progressed and led to bulb rots in symptomatic inoculated plants, disease did not spread between plants in the plot as has been observed in previous seasons. Within the high disease pressure plots, however, there was a trend towards increased center rot at harvest with increasing nitrogen rate (Figure 1).

There was a significant positive correlation between the increase in foliar disease severity and the percent of incidence of bulb rot at harvest (Adj R^2 = 0.5146; P = 0.0002). Foliar disease severity over the course of the season (calculated as the area under the disease progress curve; AUDPC) also increased significantly as the nitrogen rate increased (P = 0.0482). With foliar disease severity being 2.5 times higher in the plots receiving 160 lb/N during the season compared to those which did not receive any in-season nitrogen applications.

Water soaking characteristic of an early stage center rot foliar lesion that can progress downward and lead to a bulb rot.

DISCUSSION/CONCLUSION:

Similar to bacterial diseases of other vegetable crops, managing center rot of onion requires an integrated approach. Reducing soil temperatures at bulbing through the use of alternative plastics such as reflective silver is one strategy. In cooler regions of the state, reflective silver with a heat strip (black stripe in the center) may be a compromise to maintain warmer early season soil temperatures but gain the benefits of silver later in the season at bulbing. Host resistance is an important disease management tool. Unfortunately, the cultivar Candy is very susceptible to the bacterial disease center rot. In the on-farm small plot trials conducted as part of this research, Spanish Medallion had marketable yields comparable to Candy under the relatively low disease pressure observed in the field. In the replicated research trial under high disease pressure, the inoculated Spanish Medallion plots had higher marketable yields and a lower incidence of bulb rot at harvest. In previous trials, Spanish Medallion also met the soluble solid and pungency requirements for inclusion in the Simply Sweet Onion program. Continued research into identifying less susceptible cultivars such as Spanish Medallion on a larger scale will provide growers with another potential tool.

Managing nitrogen fertility is a balancing act. Not enough nitrogen and marketable yield can be compromised; however, too much nitrogen can exacerbate diseases such as center rot. In this trial, reducing the season-long nitrogen application rate from 160 to 105lb/A did not affect the percentage or total weight (data not shown) of marketable jumbo and colossal sized onions. Although this might not translate into reduced disease every season, it does reduce overall input costs thus saving the grower money.

A special thanks to PVGA and PVMRP for supporting this on-going research on understanding the biology, epidemiology and management of bacterial diseases of onion.

Onion Project Expense Report:

Hourly wages (+ fringe benefits 7.8%) for summer help who assisted in conducting field work for 12 wks at 30hrs/wk at $10.50/hr. This includes a mandatory 2.5% wage increase since the project spans across two fiscal years……..... $ 3874

Fringe benefits (7.8%)……. ..... $ 302

Supplies used to establish, maintain, harvest and evaluate the replicated field trial…….. $ 2500

Travel (in-state)..... $ 500

Total..... $ 7176

Duration of Project: April 1, 2017 to November 30, 2017

Signature: