Evaluation of the Influence of Applied Nitrogen on Bacterial Bulb Rot of Onion in New York State

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Introduction

Bacterial bulb rot of onion can cause serious yield losses. The influence of nitrogen fertilizer rate on bacterial bulb rot was studied in four trials conducted in muck-grown onions in New York State in 2018-2019.

On-Farm Small-Plot Field Trials in NY, 2018-2019

Year	2018	2018	2019	2019
Location	Oswego	Elba	Oswego	Elba
No. Varieties	12	7	11	8
Type of Bacterial Infection	• Natural[1]	• Natural[1] • Artificial spray inoculation[2] • Artificial toothpick prick inoculation[3]	• Natural[1]	• Natural[1] • Artificial toothpick prick inoculation[3]
Planting & Harvest Dates	14 May 5 Oct	7 May 20 Sep	22 May 15 Oct	18 May 1 Oct
Amount of Fertilizer Applied At-Planting (lb/A)[4]				
Nitrogen (N)	37 100 150	37 100 150	10 30 60	10 30 60
Phosphorus (P)[5]	138	155	47.3	47.3
Potassium (K)[5]	138	133	50	50

[1]**Natural bacterial infection** was predominantly caused by *Burkholderia cepacia*.
[2]**Artificial spray inoculation:** Using a manually-pressurized backpack sprayer, onions were sprayed to runoff with a mixture of 10^6 cfu/ml each of *Pantoea ananatis* and *P. agglomerans*.
[3]**Artificial Prick inoculation:** The second and third oldest leaves of 10 consecutive plants per plot were pricked 1-inch above the leaf axil with a toothpick that had been freshly dipped in a 10^9 cfu/ml solution of *P. ananatis* or *P. agglomerans*.. Prick inoculated plants were harvested separately and not included in data for the rest of the plot.
[4]**NPK Fertilizer:** Urea (46-0-0), monoammonium phosphate (MAP, 11-52-0) and potash (0-0-62) fertilizers were used for N, P and K, respectively, which were applied by hand and incorporated with the grower's equipment. N in MAP was counted towards total applied N.
[5]**Rate of P and K** used in 2018 trials was according to grower's standard rate in each location. In 2019 trials, rate of P and K was based on what the crop needed according to a pre-plant soil test.

Procedures

The trials were arranged in a split-plot or split-split-plot (Elba 2018 only) design with nitrogen as the main-plot factor and variety (and inoculation type in Elba 2018) as the sub-plot factor(s). Treatments were replicated four times in each trial and randomized according to trial design. Individual plot size ranged from a total of 30-60 feet of onion row, arranged in 2 or 4 rows per plot, following standard grower planting configurations. NPK application extended 5 feet beyond the plot area to act as a buffer between applied N rates. Samples collected for yield and bulb rot evaluations ranged from 100-160 bulb samples per plot.

Composite soil samples were collected across variety by N rate and rep for available nitrate-nitrogen (NO_3-N) analysis at: 1) 3-4 leaf stage (Jun 14-28) 31-44 days after planting (DAP); 2) 8-10-leaf/1" bulbing (Jul 29-Aug 8) 76-82 DAP; and 3) at harvest (Sep 28-Oct 1) 100-136 DAP. Similarly, leaf samples of the 3rd and 4th oldest leaves per plant were collected for complete nutrient analysis at the bulbing sampling. At harvest, bulbs and dried foliage were collected separately from three plants per plot for complete tissue analysis, the results of which were used to estimate crop nutrient uptake.

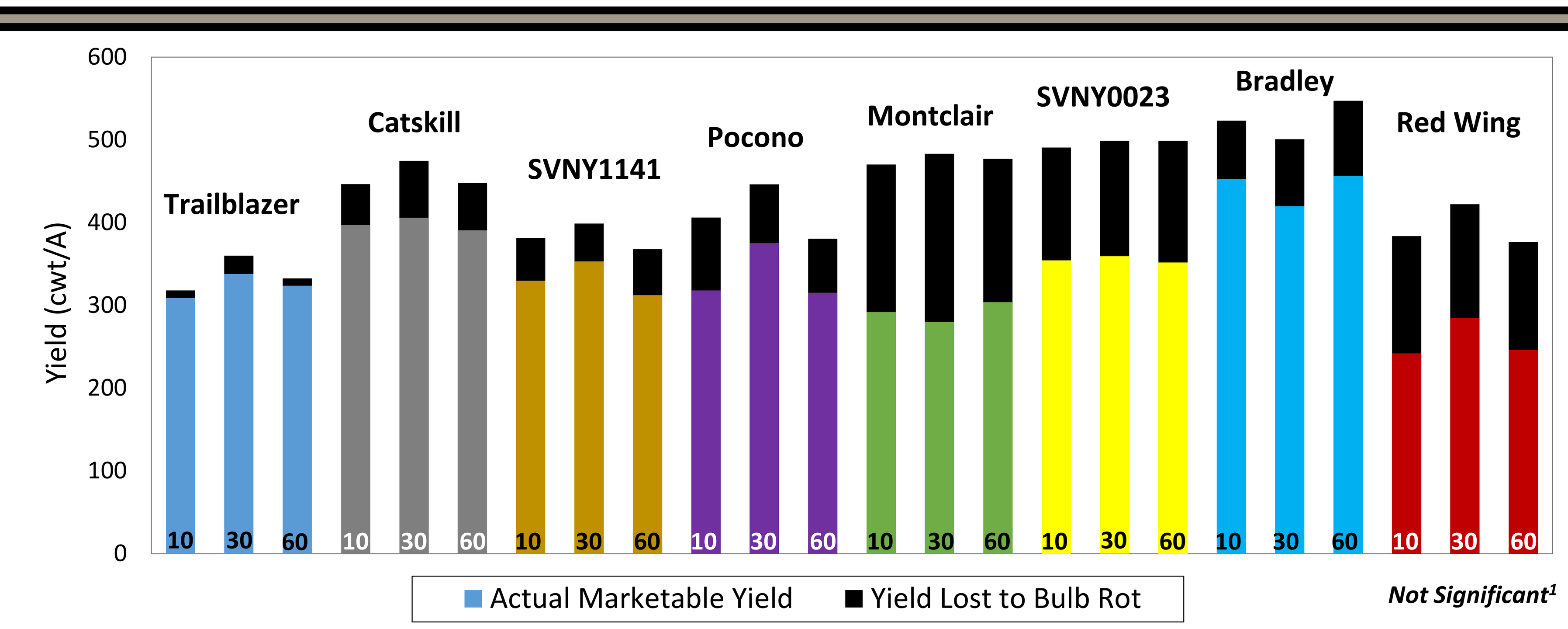
Results

Nitrogen Not Related to Bulb Rot

- **Nitrogen did not significantly affect bulb rot in 3 out of 4 trials**, including in the artificially prick inoculated sub-plots. In the Elba 2018 trial, 100 lb/A N had significantly more bulb rot than 150 lb/A, both of which were not different than 37 lb/A (Fig. 1 top).

No Yield Response to Nitrogen

- **Rate of applied nitrogen had no effect on marketable yield in 3 out of 4 trials**. Where it did (Elba 2018), there was no difference in yield between 37 lb/A and 150 lb/A (Fig. 1 bottom).
- Within varieties, there were no consistent numerical trends between applied nitrogen and yield in 3 out of 4 trials (see Fig. 2 as an example).
- In Elba 2018 trial, yield was influenced by bulb rot; the treatment with the lowest yield (100 lb/A N) also had the most bulb rot (Fig. 1).



[1]Fisher's Protected LSD test, $p > 0.05$.

Fig. 2. Effect of rate of nitrogen applied at-planting on actual and potential marketable yield on each variety, Elba 2019 trial. Potential Marketable Yield is an estimate of what the yield would be if the unmarketable rotten bulbs had been healthy. It is the sum of actual yield and yield lost to bulb rot. **Numbers overlaid on the bars** are the rate of applied nitrogen in lb/A.

Other Factors Are More Important

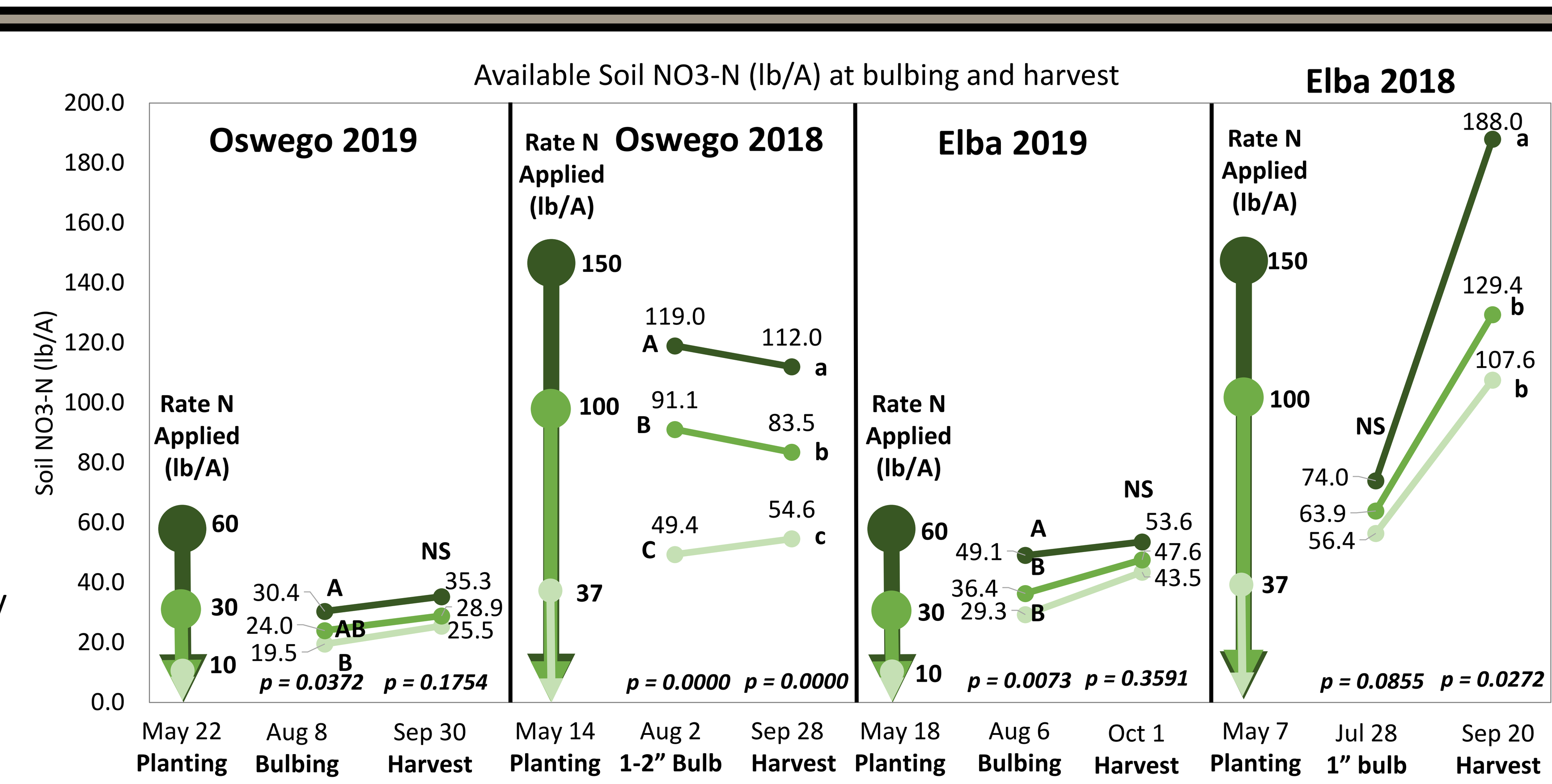
Variety:

- **Variety was the most important factor influencing bacterial bulb rot and marketable yield.** Significant differences by variety for both bulb rot and marketable yield were present in all 4 trials (data not shown).
- Increased susceptibility to bulb rot negated the enhanced yield potential of some high-yielding/high-rotting varieties, providing an overall performance profile similar to that of low-yielding/low-rotting varieties. For example, compare Montclair and SVNY0023 to Trailblazer in Fig. 2.
- Greatest marketable yields occurred in the varieties that had both high potential yield and low levels of bulb rot, such as Bradley and Catskill in Fig. 2.

Location and Growing Season (Year):

- There were large differences in the rate of bulb rot between locations. Elba consistently had approximately twice as much bulb rot as Oswego. The level of bulb rot within each location was similar from year to year (Fig. 1, top).
- Yield was higher in 2019 trials than in 2018 trials at each location, despite lower rates of nitrogen applied in 2019 (Fig. 1, bottom).
- Yield was higher in Oswego than Elba in both years (Fig. 1, bottom).
- Uncontrolled weeds in Elba in 2018 contributed to the very low yields.
- These findings suggest that other factors such as weather or interaction with pests, such as weeds, may influence bulb rot.

Fig. 3. Effect of applied nitrogen rate on available nitrate-nitrogen (NO_3-N) in soil during bulbing and at harvest. Numbers followed by the same letter per assessment date in each trial are not significantly different, Fisher's Protected LSD test, $p > 0.05$.



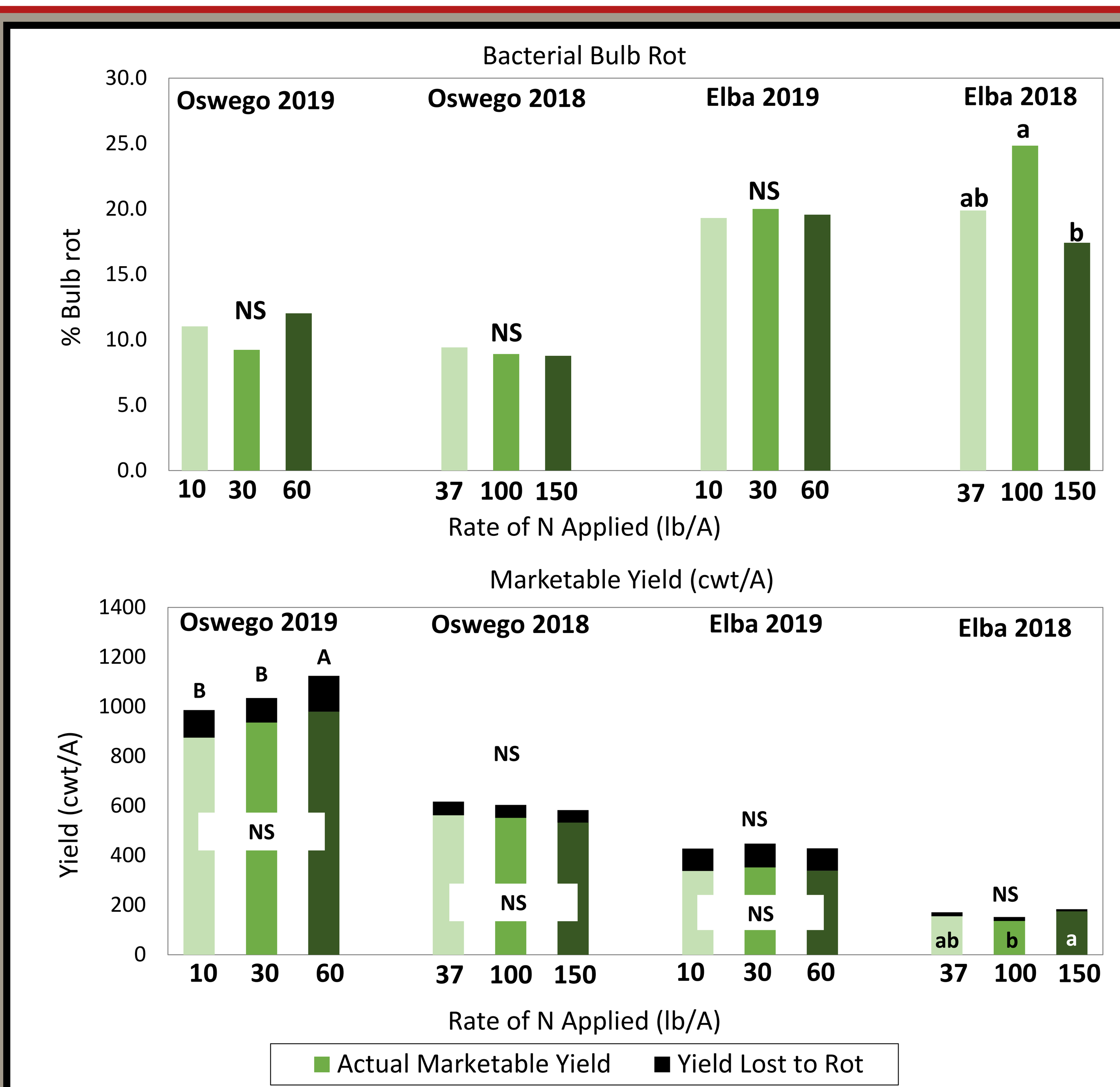


Fig. 1. Effect of rate of nitrogen applied at-planting on onion bulb rot (top) and marketable yield (bottom), in all trials. Results pooled across variety. Bars followed by the same letter are not significantly different, Fisher's Protected LSD test, $p > 0.05$. **Potential Marketable Yield** is an estimate of what the yield would be if the unmarketable rotten bulbs had been healthy. It is the sum of the actual yield and the yield lost to bulb rot.

Soil and Tissue Nitrogen

- At bulbing, significant differences in available soil nitrate-nitrogen (NO_3-N) among applied nitrogen rates occurred in 3 out of 4 trials. At harvest, significant differences occurred only in the high N-rate (37, 100, 150 lb/A) trials in 2018 (Fig. 3). **Available soil NO_3-N at bulbing and harvest increased as applied N increased in every trial.**
- Available soil NO_3-N increased numerically between bulbing and harvest in 3 out of 4 trials (Fig. 3), contrary to the hypothesis.
- Available NO_3-N in the soil at harvest ranged from 25.5 to 188 lb/A with the highest rates occurring in the 2018 high N-rate trials.
- There were no differences among nitrogen rates for % N in leaf tissue. Foliar nutrient levels at bulbing were sufficient in every treatment across trials (data not shown).
- The highest potential yields occurred in the Oswego 2019 trial, which averaged 1048 cwt/A and used an estimated 168 lb/A of N (data not shown).
- In the Oswego 2019 trial, an average of 30 lb/A of available NO_3-N remained in the soil at harvest (only 10-60 lb/A of N applied at planting), demonstrating the importance of muck soil and residue from the previous crop (soybeans) as sources of nitrogen.

Conclusions

- In muck-grown onions in New York, nitrogen is not an important factor influencing onion bulb rot or determining onion yield. Instead, variety, location, and growing season (year) are much more influential.
- Our results suggest that 60 lb/A of applied nitrogen is sufficient for muck-grown onions. We are currently studying the 60 to 120 lb/A range.

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