Report submitted to the Pennsylvania Vegetable Marketing and Research Program
Pennsylvania Vegetable Growers Association
December 7, 2013

Title: Evaluate the effects of inoculum pressure and onion maturity at harvest on harvest and post-harvest losses due to bacterial diseases.

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Introduction:

Onions are plagued by a number of bacterial diseases that cause both foliar disease and bulb rots. In Pennsylvania, these losses are caused primarily by the center rot pathogens, *Pantoea agglomerans*, *P. ananatis*, the soft rot pathogen, *Pectobacterium carotovorum*, as well as slippery skin caused by *Burkholderia gladioli*. On-going research funded through the Northeast Regional IPM program, is continuing to make progress on identifying on-farm factors most closely associated with increased bacterial disease incidence and severity. Two years of extensive on-farm field data have been collected and are continuing to being analyzed. In 2011, the 28 commercial farms participating in the NE-IPM project experienced losses ranging between 0 and 50% at harvest and 2 to 41% out of storage. In 2012, in-field losses on the 26 participating farms were reduced to 0 to 15% at harvest due to less favorable weather conditions for disease however, post-harvest storage losses were greater and ranged from 6 to 64%. It is not surprising that over the past two years, farms with the greatest at-harvest losses also had greater post-harvest storage losses.

Onions bulbs put on the majority of their size in the last four weeks prior to full maturity, and once mature, onion foliage naturally lodges. Typically, growers will harvest the crop based on the percent of plants lodged, however, pressure from disease and/or time to market occasionally force(s) growers to harvest early. When bacterial diseases are suspected, it is not uncommon for growers to pull onions early and sacrifice large bulb size for a potential reduction in losses from disease. This logic stems from the understanding that once the neck of the onion is dried down, the bacterial pathogens can no longer move from the leaves into the bulb, however, replicated field data from PA does not exist pertaining to the practice of harvesting bulbs early.

In addition, trials funded through the NE-IPM Partnership Program and in collaboration with Cornell demonstrated that bacterial disease incidence at harvest was reduced under narrower plant spacings. It is thought that the higher density planting configurations hasten maturity and produce plants with thinner necks and fewer leaves, thus creating a less favorable environment for the pathogen. In PA however, the reduction in marketable yield as a result of a greater proportion of small and medium sized bulbs currently limits practical use of high density planting. In addition to reduced size, harvesting early when the necks are still green and/or improper curing can also lead to increased problems with Botrytis neck rot, caused by several species of *Botrytis* and black mold caused by *Aspergillus niger*.

As noted above, varying levels of disease pressure can influence the timing of onion harvest. In the PVMRP/PVGA-funded product efficacy trial at Rock Springs in 2012, subplots were established and were composed of inoculated, adjacent to inoculated, and uninoculated plants within the main plots of commercial product efficacy treatments. Harvest levels of disease in those subplots were reflective of the inoculation treatment, with inoculated, adjacent, and uninoculated plants averaging 45%, 21%, and 17% losses at harvest due to bacterial rot, respectively which demonstrate the influence of inoculum pressure on marketable yields at harvest.

Current commercial production practices call for pulling and field curing onions for two to three days before being topped, placed in bins and further dried down either passively or actively with the use of fans. Depending on the stage of maturity and diameter of the neck, this may or may not adequately dry bulb necks down enough to restrict the movement of bacteria from the leaves into the bulb. Here we report of results of two trials conducted to evaluate the effects of inoculum pressure and onion maturity at harvest on harvest and post-harvest losses due to bacterial disease. The goal is to provide growers with additional information on the relationship between the timing of harvest and bacterial disease losses post-harvest so they can make more informed decisions about when to harvest fields under pressure from bacterial diseases.

Methods:

To evaluate the effects of inoculum pressure and onion maturity on harvest and post-harvest losses due to bacterial disease, two split-split plot replicated field trials were established; one at the Plant Pathology Farm at Russell E. Larson Research and Education Center at Rock Springs in Centre Co. and one at the Southeast Research and Extension Center in Landisville, PA. The trials were planted on standard black plastic with a double row of drip irrigation. Each plot consisted of a 40 ft section of bed, 4 rows wide with 6-in. plant spacing within rows and between rows. Each plot was split into inoculated and uninoculated subplots (20 ft each). Plots were arranged in a randomized complete block design with four replications. On 20 and 21 Jun, the fourth leaves from the outside of each plant in the center two rows of the inoculated plots were toothpick inoculated with a bacterial suspension containing a mix of *Pantoea agglomerans* and *P. ananatis* isolated from symptomatic onions collected in PA, approx. 6 in. from the base of the neck. Crop fertility, insects and weeds were managed using standard commercial production practices.

Treatment plots were harvested at weekly intervals on 28 June, 3, 11, 19 and 25 July to reflect increasing stages of maturity. Prior to harvest, 20 plants per plot were rated for visual symptoms (Figure 1) and for lodging (yes/no) before two 15 ft rows of the plot were pulled, topped and graded for size and marketability. The incidence of center and surface rots was recorded separately for inoculated, adjacent to inoculated, and uninoculated sub-sub plots to reflect varying levels of bacterial inoculum pressure. A sub-set of 30 marketable onions from each plot was dried and stored for 12 weeks in a semi-temperature controlled growth room and then graded for post-harvest bacterial disease incidence.

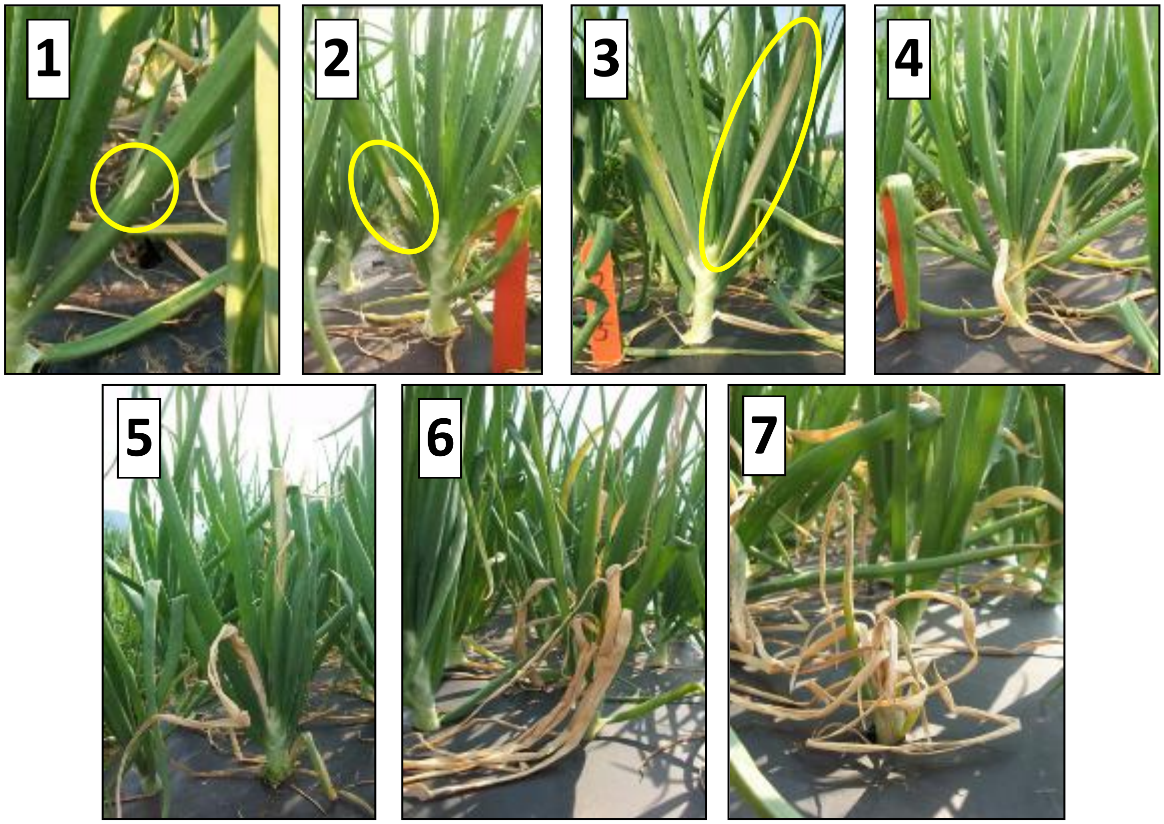

Figure 1. Visual rating scale: 1 = Less than 1 square inch of symptomatic leaf tissue; 2 = Less than one-half of one leaf is symptomatic; 3 = One half of one leaf is symptomatic; 4 = One entire leaf is bleached and wilting; 5 = One entire leaf is bleached and wilted and portion of another leaf is symptomatic; 6 = Multiples leaves are bleached and wilted; and 7 = All or nearly all the leaves are bleached and wilted or dead (Photos: Emily Pfeufer).

Results and Discussion:

With each successive harvest from 28 June to 25 July, the proportion of marketable jumbo and colossal (Rock Springs only) sized onions increased as did the proportion of unmarketable onion bulbs with center rot symptoms. Total marketable yields at Landisville were much lower than Rock Springs in part due to the delayed planting on 23 April compared to 10 April at Rock Springs allowing less time for the onions to size resulting in very few colossal onions (Figure 2). There was also higher pressure from purple blotch which reduces the photosynthetic capacity of the plants.

Not surprisingly, the percent of harvested bulbs with visible symptoms of center rot at harvest was highest in the inoculated plots across almost all the harvest dates in both trials. Losses due to center rot increased with each successive harvest especially later in the season on the last two harvest dates on19 and 25 July (Figure 3). By the end of the season, disease losses were greater across all the plots in the Landisville trial at 40.2% compared to 23.3% at Rock Springs, indicating higher disease pressure overall in Landisville.

Across both trials, as foliar disease severity ratings increased from 0 to 7 so did center rot disease incidence at harvest. Onions that were harvested earlier (28 June, 3 and 11 July) tended to have lower foliar disease ratings (≤ 3) and fewer bulbs with center rot at harvest (<10%) compared to those harvested later in the season and were inoculated. However, harvesting this early sacrificed bulb size and total marketable yield (Figure 3) especially the earliest harvests on 28 June and 3 July which occurred only 66 and 70 days after transplanting at Landisville and 79 and 83 days after planting at Rock Springs.

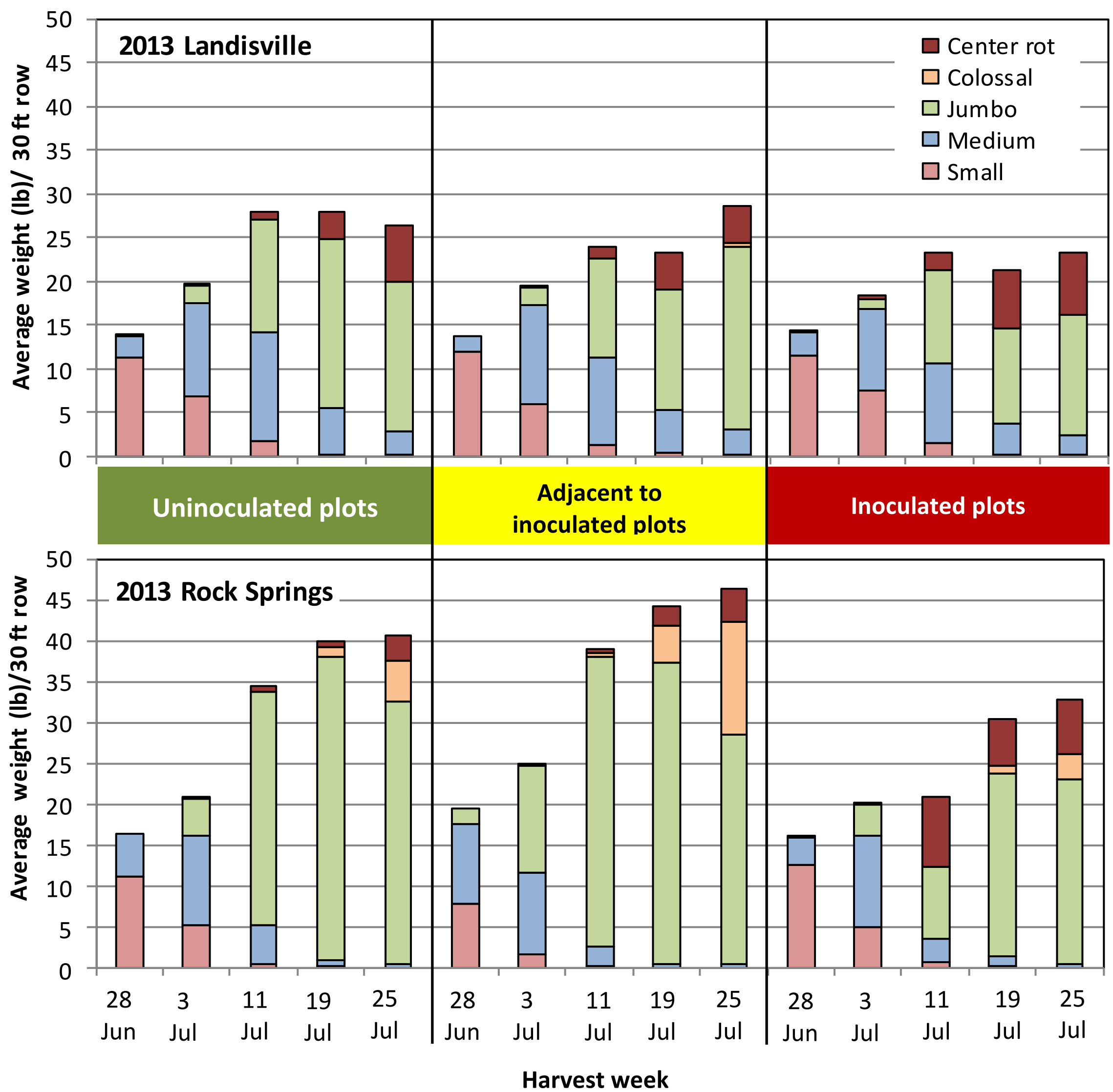

Figure 2. For five consecutive weeks (28 Jun and 3, 11, 19 and 25 Jul), onions were harvested from two 15 ft rows per plot and graded for marketable yield (lb/ 30 ft row) including smalls based on size class (small, medium, jumbo, colossal) at Landisville and Rock Springs. The number and weight (lb) of the onions with visible symptoms of center rot was also recorded. The trials at Rock Springs and Landisville were planted on 10 and 23 April, respectively.

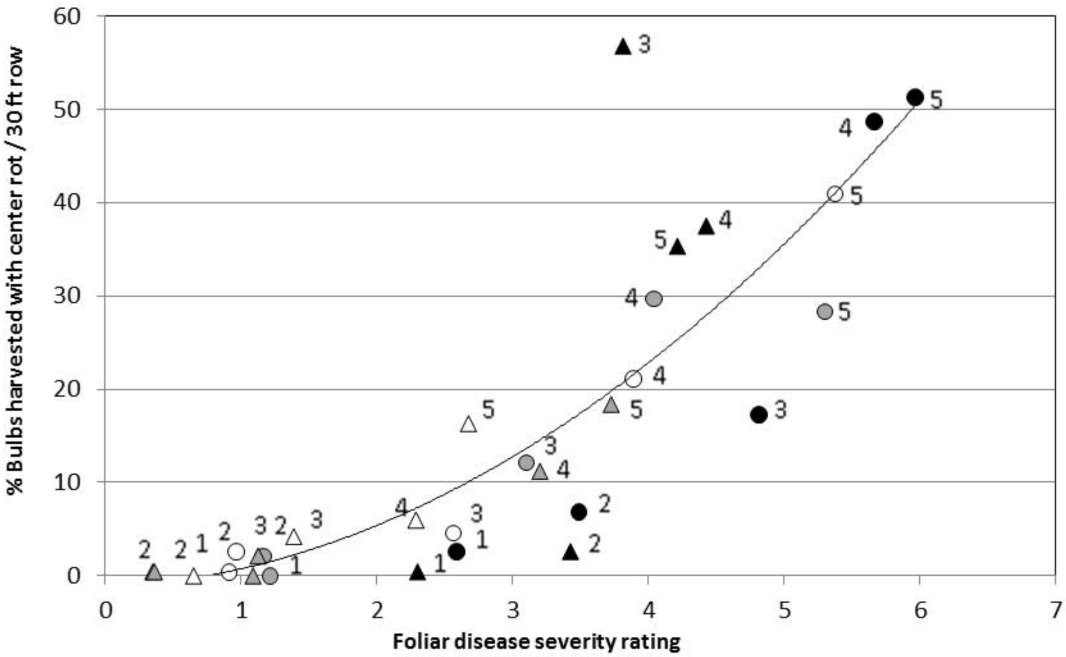

Figure 3. The relationship between increasing foliar disease severity ratings and the increasing incidence of center rot at harvest. Shape: circle = Landisville; triangle = Rock Springs. Color: green (gray shape) = not inoculated; yellow (clear shape) = adjacent to inoculated plot; red (dark shape) = inoculated. Number is the harvest date: 1 = 28 Jun; 2 = 3 Jul; 3 = 11 Jul; 4 = 19 Jul and 5 = 25 Jul. Foliar disease severity ratings are an average of 20 plants per plot and four reps.

In a growing season with the potential for significant losses due to bacterial diseases, the challenge is timing harvest to reduce bacterial disease losses while maximizing marketable yield. Seasonal observations have indicated that environmental conditions around the time of bulbing greatly influence disease development. Harvesting too early significantly reduces the proportion of jumbo and colossal sized bulbs but delaying harvest in fields with higher foliar disease ratings could lead to significant at-harvest losses of greater than 30%. Although these trials need to be repeated and further ground truthed through on-farm observations, this data suggests that foliar disease ratings between 3 and 4 (Figure 1) may be a critical scouting threshold to help growers determine when to harvest onions to maximize yield while minimizing bacterial disease losses at harvest.

Data from these trials as well as others will continue to be analyzed to better understand the factors contributing to bacterial disease losses as well as to develop a set of research based disease management recommendations. The post-harvest data from these trials is still in the process of being analyzed.