2013 Pennsylvania Vegetable Marketing and Research Program
Pennsylvania Vegetable Growers Association Report
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Title: Continuing to build upon Blitecast and PA-PIPE: Evaluation of an improved decision support system for late blight

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Introduction:

Late blight caused by *Phytophthora infestans* continues to be an annual concern for tomato and potato growers both in Pennsylvania, New York and across the Northeast. Similar to many pathogens, *P. infestans* has the ability to change over time which impacts our ability to manage the disease. In the 1970's and 1980's mefenoxam was very effective for managing late blight but as the pathogen population shifted so did the efficacy of mefenoxam. Since 2009, the pathogen population has begun to shift towards being sensitive to mefenoxam again. Of the 23 tomato and potato late blight samples collected in PA in 2013, the majority were determined to be US23 which is sensitive to mefenoxam and several growers were able to manage late blight outbreaks using Ridomil this past season. Only one potato sample was US8. In PA, growers have utilized Blitecast to help time fungicide applications based on accumulated environmental conditions. Historically this model was run using weather data collected from in-field weather stations and more recently using real-time mesoscale weather data from Zed X., Inc. and disseminated via the Pennsylvania Pest Information Platform for Extension and Education (PA-PIPE). A more comprehensive decision support system is being developed by Cornell that builds-upon use of the traditional forecasting program and incorporates information about host resistance, fungicide use and pathogen traits. The system is composed of four components that include 1) location specific weather data; 2) disease forecasting models Blitecast and SimCast; 3) late blight disease simulator; and 4) an alert system. The grower sets-up a free account and inputs information regarding location, cultivar, and planting date. This information is saved and can be accessed when logged-in during subsequent sessions when information about fungicides applications is entered. The report provides information regarding past and forecasted temperatures, relative humidity and precipitation as well as both accumulated and forecasted disease severity values based on Blitecast. The first fungicide application is based on blight units (disease severity values) and then subsequent applications are made based on the SimCast thresholds that take into account fungicide residue levels which decline between applications.

Originally developed for potato, expansion of the Cornell Decision Support System (DSS) to tomato and evaluation of this decision support system for managing late blight on tomato under

Pennsylvania growing conditions will provide growers with a more comprehensive tool for managing late blight that also takes into account the changing pathogen population along with host resistance.

Here we report our efforts during the 2013 season to address the following objectives:

1. Evaluate/field-test the use of the Cornell late blight decision support system for managing late blight on tomato and potato in PA.
2. Determine the infrastructure needed to integrate the Cornell late blight DSS and the PA-PIPE.

This research is also part of Ilse Huerta's master's research and will be published in her thesis to be completed this upcoming spring/summer.

Methods:

To evaluate the use of the Cornell late blight decision support system for managing late blight on tomato in PA, two split-split plot field trials were established at the Russell E. Larson Research and Education in Rock Springs, PA and at the Southeast Research and Extension Center in Manheim, PA. Tomato cultivar was used as the main plot, fungicide program as the sub-plot and application timing as the sub-sub plot. Tomato cultivars Mountain Fresh Plus (susceptible) and Plum Regal (heterozygous *Ph-3*), selected based on their differential susceptibility to late blight, were seeded on 6 May. At Rock Springs, treatment rows were hand transplanted into raised bed black plastic with a single row of drip irrigation and guard rows were transplanted into bare soil with a carousal transplanter on 17 Jun. At Landisville, plants were transplanted using a water wheel transplanter into raised bed black plastic with a single row of drip irrigation on 12 Jun. At or just following transplanting, the plants received starter fertilizer and were fertigated following commercial production recommendations for fresh market tomatoes the remainder of the season. Plots were 10 ft long and consisted of a treatment row and an untreated guard row (processing cv. Heinz 9704 and 3406) and a 4 ft break between plots within the row. Both trials were staked and tied using the Florida weave.

Plots within treatment row received either chlorothalonil (Bravo WeatherStik 6F 2.0 pt/A) or copper (Champ WG 4.0 lb/A) following a 7-day weekly schedule, using the Cornell decision support system run using environmental data from an in-field weather station, Blitecast run using interpolated weather (RMTA) data through ZedX, Inc. and the PA-PIPE or remained untreated (no fungicide control) (Figure 1). At Rock Springs, fungicides were applied using a Solo backpack sprayer with a TX-18 hollow cone nozzle at 3 mph delivering 20 gpa down each side of the row for a total of 40 gpa while at Landisville after backpack spraying first two applications, subsequent applications were applied using a tractor mounted CO_2 sprayer with two vertical booms. Both trials were maintenance sprayed to manage for other diseases as necessary using products that are not effective for managing late blight. The weekly fungicide application treatment was initiated on 17 Jun and 26 Jun at Landisville and Rock Springs, respectively.

Plots were rated for late blight foliar disease incidence and severity on a weekly basis using the Horsfall-Barratt scale until the untreated susceptible reached 100% disease severity and the area under the disease progress curve (AUDPC) values were calculated as a measure of disease progression over the course of the season. The higher the AUDPC value, the more disease developed during the season. Fruit incidence was evaluated once at the end of the season by randomly selecting 18 fruit per plot and rating individual fruit for the presence or absence of late blight symptoms. The trials were terminated on 30 Aug and 6 Sep at Rock Springs and Landisville, respectively.

In Rock Springs, symptoms of late blight resulting from natural infection from adjacent guard rows artificially inoculated on 8 Aug with a mix of three Pennsylvania *Phytophthora infestans* isolates US23 were observed on 23 Aug. In Landisville, foliar late blight symptoms resulting from natural inoculum (US23) were first observed on 20 Aug.

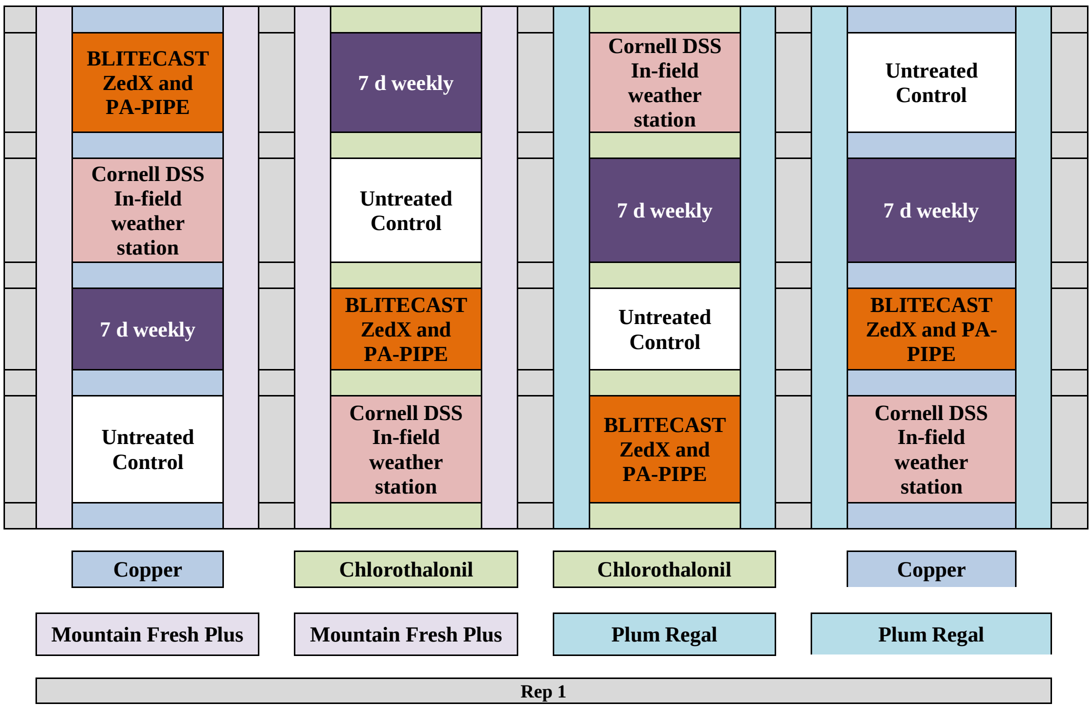

Figure 1. Field trial map representing one of four replicate blocks per trial consisting of two tomato cultivars, two protectant fungicide programs and four application timings. Gray rows represent untreated guard rows of tomatoes which allow for uniform disease spread across the trial.

Results:

Not surprisingly, there was a significant difference in foliar disease severity and fruit incidence between the Mountain Fresh Plus (susceptible) and Plum Regal (heterozygous *Ph-3*). Overall, fruit disease incidence in the unsprayed Mountain Fresh Plus plots was significantly higher at Rock Springs (70%) compared to Landisville (7%). Late blight moved very quickly through the trial at Rock Springs resulting in nine weekly fungicide applications compared to 12 at Landisville (Table 1). Also, chlorothalonil was more effective than copper at managing foliar late blight on Mountain Fresh Plus while both were equally effective on Plum Regal.

Across both trials, fungicide applications based on the forecasting models resulted in a reduction in the number of sprays by 11 to 16% for Blitecast across both cultivars since it does not take into account host resistance and 41 to 44% for the Mountain Fresh Plus sprayed according to the Cornell DSS, compared to a 7-day weekly program. The Cornell DSS classified Plum Regal as resistant and did not recommend any fungicide applications during the season

(Table 1). As a result, disease severity was significantly higher in the Plum Regal following the Cornell DSS compared to Blitecast and a 7-day program at Rock Springs (Figure 2). This difference was not observed in the Landisville trial where disease pressure was less. Although Plum Regal contains the late blight resistance gene, *Ph-3*, it has been observed in this trial as well as in other variety trials in the eastern U.S. to develop foliar late blight symptoms under high disease pressure with the predominant US23 *P. infestans* clonal lineage. Currently, the cultivars that contain both *Ph-2* and *Ph-3* resistance genes such as Mountain Merit and Mountain Magic develop very little, if any, late blight symptoms if any even under high disease pressure.

Table 1. Number of fungicide applications made based on the late blight disease forecasting programs over the course of the season.

	Number of fungicide applications	
Fungicide application timing	**Rock Springs**	**Landisville**
Untreated control	0	0
7-day weekly	9	12
Blitecast (both cultivars) [a]	8	10
Cornell DSS (Mountain Fresh Plus) [b]	5	7
Cornell DSS (Plum Regal) [b]	0	0

[a] Blitecast does not account for differences in host susceptibility so both cultivars were sprayed the same.

[b] The Cornell DSS accounts for host susceptibility and classified Plum Regal as resistant and therefore did not recommend any fungicide applications during the season.

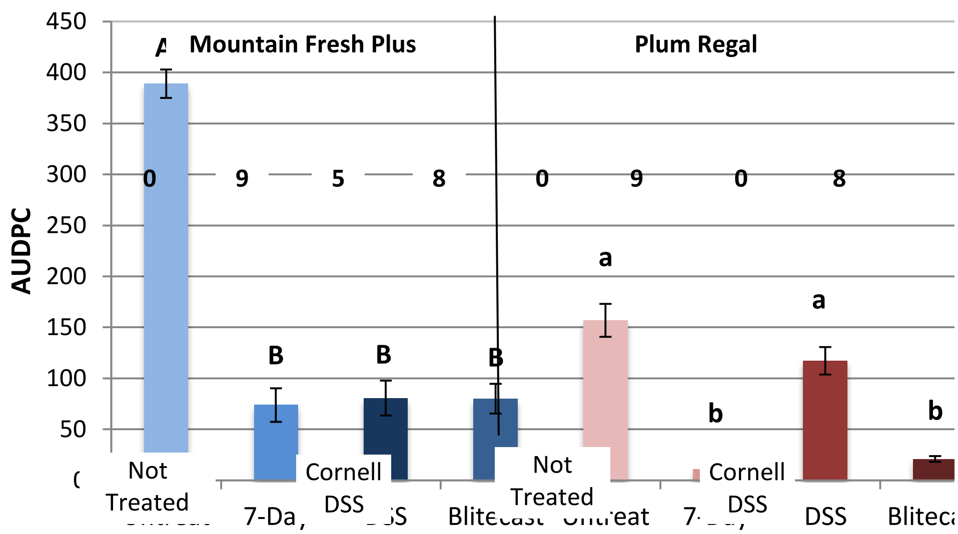

Figure 2. Effect of the fungicide timing programs on late blight disease development over the course of the season (AUDPC) at Rock Springs. The higher the AUDPC value the more disease developed during the season. The numbers indicate the number of fungicide applications made. No fungicides were applied to the Plum Regal plots sprayed according to the Cornell DSS because it was classified as resistant. Differing letters above the bars indicate that treatments were significantly different from each other within each cultivar based on Tukey’s HSD (P<0.05).

General Conclusion:

Overall, our results suggest that cultivar selection has a major impact on disease severity and fruit incidence and the type of fungicide applied was more important for the susceptible cultivar. Use of either forecasting model would significantly reduce grower input and labor costs by reducing the number of fungicide applications needed for disease management compared to the 7-day program. Even with a highly susceptible cultivar like Mountain Fresh Plus, following the Cornell DSS eliminated four to five fungicide applications and still maintained late blight to the same levels as the 7-day program. At Rock Springs, both fungicides reduced the incidence fruit symptoms from 70% in the untreated plots to 22% and 6% in the copper and chlorothalonil treated plots, respectively. Even with a susceptible cultivar, protectant fungicides when applied in a timely manner can reduce disease losses. In both trials, fruit symptoms on Plum Regal were less than 5% across all treatments including the unsprayed control.

In these trials, the Cornell DSS was run using in-field weather data that was downloaded daily from the weather stations then uploaded on-line manually where is was retrieved by the program and used to run the model. The results were then retrieved by logging into the Cornell DSS website. Email and text alerts were also sent when thresholds were reached and fungicide sprays were recommended. Fungicide applications were made as close to these recommended dates as possible. The Cornell DSS is currently available for interested growers. The model would be run using weather data from the closest accessible networked weather station. Please contact me (bkgugino@psu.edu or 814-865-7328) if you are interested in learning more. We can also run series of simulations on specific fields to compare your fungicide application schedule to the Cornell DSS. Blitecast was run using real-time high resolution interpolated (RTMA) weather data which uses NOAA atmospheric data along with a complex set of algorithms to calculate and forecast the weather down to a 6km grid. Although to a lesser extent, this model also reduced the number of fungicide applications made during the season while maintaining disease at the same level as the 7-day program. To reduce the geographic constraints of weather stations, using RTMA weather data to run the Cornell DSS would further advance our ability to time fungicide applications based on the most precise weather data available.

For the Cornell DSS, differentiating cultivars containing known resistance genes and gene combinations into resistant and moderately resistant categories would further refine the forecasting model. Results of this research have reclassified cv. Plum Regal as moderately resistant rather than resistant in the Cornell Decision Support System.