Title: Decision Support System for IPM in Potato/Tomato

Project Leaders: William E. Fry, Department of Plant Pathology and Plant-Microbe Biology
Art Degaetano, Laura Joseph, Department of Earth and Atmospheric Sciences
Cornell University, Ithaca NY

Abstract: A Decision Support System (DSS) for the management of potato and tomato late blight is being developed. A draft version is being evaluated by growers in New York. The DSS enables growers to access diverse tools in real time to improve their abilities to manage late blight with decreased fungicide. The tools are: i)ready access to site-specific observed weather; ii) ready access to farm-specific weather forecasts; iii) ready access to late blight disease forecasts; iv) models that enable growers to predict the effects of the various factors that influence late blight development. The goals of this project were to improve the components of the DSS and to make the DSS more "user-friendly". The improvements accomplished during the funding period were focused on the user interface of the DSS. The front page was modified to clarify the effects of fungicide, and a "risk alert" was added. The "risk-alert" is designed to inform a user of the relative risk posed by late blight in proximity to the user. The algorithms for the "risk-alert" were calculated and the programming to include this in the DSS was completed. Evaluations of the "risk-alert" will occur in the future. The availability of the "risk alert" and the availability of the DSS are designed to eliminate the use of unnecessary (insurance) fungicide applications.

Background and Justification:

Our project is directed at improving IPM practices with the goal of reducing the amount of fungicide used in potato and tomato disease management. Our innovative technology is a web-based Decision Support System (DSS) used interactively in real-time.

Plant disease forecasts are perhaps the most visible of IPM technologies directed at plant diseases. Most forecasts for foliar plant diseases rely heavily or exclusively on recent (*past*) weather factors to "forecast" the need for a *future* fungicide application. Unfortunately, most forecasts have had limited impact.

We hypothesize that appropriate forecasts can both reduce the amount of fungicide used and improve disease suppression by considering other important factors such as: future weather, host resistance, fungicide characteristics, and magnitude and aggressiveness of the pathogen population. Until recently, it was not feasible technically to consider all of these factors in a plant disease forecast, but now it is. This is due to the availability of i) locally specific weather forecasts via the internet in real time; ii) mechanistic simulation models that reflect the effects of specific fungicides, specific weather, and host resistance on disease development; and iii) dramatic improvements in computing speeds that now enable one to obtain results from the simulation model in one-two seconds.

Potato late blight is an important disease with which to evaluate this hypothesis. The disease is important because huge amounts of fungicide are used to suppress the disease – i.e. more than 2000 tons of active ingredient in 2001 in the USA alone. This large amount of fungicide is used because the disease is so dramatically devastating that the costs of mis-management can lead to bankruptcy. There is increasing pressure on growers to reduce the amount of pesticide used (McDonalds has just announced it will review pesticides and pest management practices on potatoes for fries). In order to maintain profitability growers need to reduce costs, and the costs of materials alone are typically > $250/a. Potato late blight is a disease that is appropriate for testing the hypothesis because we have recently constructed a prototype of an internet-based Decision Support System (DSS) for this disease (http://blight.eas.cornell.edu/blight_dev/). The DSS uses local recent weather, locally specific current weather forecasts (2 km grid), and a reliable mechanistic simulator to integrate the effects of weather, host resistance and fungicide. This system enables a user to predict the effects of future weather and future fungicide applications on future disease development. Such predictions inform a grower's decisions concerning future fungicide applications. Small scale evaluations of the prototype DSS were initiated in the summer (2009), funded by the Empire State Potato Growers. Initial grower response to demonstrations of the DSS at meetings has been very positive.

Objectives:

The major objective was to improve the user interface of the DSS. Additionally, in combination with other funding sources we conducted conduct an initial evaluation of the DSS, and conducted experiments to provide data for future improvements.

Procedures:

The improvements occurred in two general categories. The first was to enhance the "user-friendliness" of the DSS. In this regard much effort was devoted to programming the appearance of the DSS on the web. Additional tabs were constructed to avoid some confusions arising from the previous organization. Second, a "risk-alert" was initiated. This "alert" provides information to a user concerning whether or not a source of late blight in New York might be a factor to that user. A simulation model was used to construct an algorithm for quantifying the risk. This algorithm has been programmed into the DSS. It is now ready for experimental validation.

The "user-friendliness" of the DSS was evaluated in a field experiment conducted in 2010. The ease of operation and the efficacy of the DSS were evaluated.

Results:

This grant partially funded three types of activities. The first was to improve the user interface of the Decision Support System. Most funding went to support the programmer who worked on that aspect. A demonstration version of the new system is available at (http://blight.eas.cornell.edu/blight/). A user's manual was constructed and is available at (http://ppathw3.cals.cornell.edu/Fry/lateblightDSS2010.pdf). The first page is illustrated in Figure 1.

Several additional features are still under development, but not yet incorporated into the system. Perhaps the most exciting is the development of a “risk alert”. This feature quantifies the likelihood that inoculation from some known distant source might have occurred. Weather at the source of the pathogen is monitored and used to develop an index that combines the effects of sporulation, dispersal and survival of sporangia during dispersal. This index is combined with weather monitored at the potato field being managed to predict likelihood of successful inoculation and infection. This index was subjected to a preliminary analysis at the Thompson Research Farm of Cornell University at Freeville NY in 2010. Initial results were very positive.

An evaluation of the DSS was conducted at the Thompson Research Farm. Fungicide was applied to potatoes according to standard grower practice and also according to the DSS. This plot was not inoculated artificially, but there was late blight in the area. The results of this evaluation were very encouraging. Late blight was a significant problem in the unsprayed plots for both a susceptible cultivar and even for the moderately resistant cultivar. At the end of the season, the susceptible cultivar (Katahdin) had 60% disease -- more than half of the foliage had been destroyed by late blight. At the end of the season the moderately resistant cultivar (Kennebec) had more than 10% disease (Figure 2). The most important factor in each of these plots was probably the danger due to tuber infections. There were two treatments: i) standard grower practice of weekly fungicide applications and ii) fungicide applications timed according to recommendations from the DSS. In all treatments, there was excellent suppression of late blight with no disease observed in any of the plots. However, there were different numbers of fungicide applications. There were 8 applications according to standard grower practice on both Katahdin and Kennebec. However, in the plots treated according to the DSS there were only 6 applications made to Katahdin, and only 5 applications made to Kennebec. Thus, the DSS protected potatoes as well as did the standard grower practice, but with fewer fungicide applications – this is despite the occurrence of late blight in the region.

Additionally, for future inclusion in the DSS, we evaluated the efficacy of several diverse fungicides to suppress late blight in the foliage (Figure 2) and also in the tubers. The fungicides evaluated are listed in Table 1. These include standard grower fungicides, as well as compounds (Copper and hydrogen dioxide) that are available to organic growers. Fungicide applications were initiated after late blight was first detected in the plots. Fungicides were applied weekly except for oxidate (oxygen dioxide) which was applied on a daily basis for the first three days after late blight was observed, and then subsequently on a weekly schedule. Several observations are important. In the absence of an effective fungicide, late blight had destroyed essentially all of the foliage by the end of the season (Figure 2) – this is despite using a moderately resistant cultivar (Elba). Most conventional fungicides suppressed late blight in the foliage very well (Figure 3). However, oxidate, (oxygen dioxide) was not appreciably different from the unsprayed control.

The effect of diverse fungicides on suppressing late blight in the tubers was assessed. Infected tubers (i.e. as in Figure 4) were found in almost all plots. Some treatment had very few infected tubers with a high yield, but other plots had many infected tubers with a resultant low yield of healthy tubers (Figure 5). Notable in this regard was Presidio which protected both foliage and tubers so that there was a large yield of healthy tubers. Interestingly, some fungicides (i.e.

Bravo) which protected foliage, did not protect tubers, so that there was only a small yield of healthy tubers in the plots treated with Bravo. The efficacy of these diverse fungicides will be incorporated in the DSS.

The DSS has significant potential to enhance the efficiency with which fungicides are used to suppress late blight. The DSS uses host resistance, weather (past and forecast), and proximity to a source of the pathogen to aid the user in deciding whether or not to use a fungicide, and which fungicide to use. In summer 2010, we used a "stress test" to demonstrate that the DSS provided good assistance even when there was a source of late blight in relative close proximity to the production field. We predict that on average, the DSS could enable growers to save at least two – three sprays per year – a savings of at least $30/a and perhaps up to $75/a. Thus, savings could be $600,000 – 1,500,000/yr, with the added benefit of reduced labor in application and reduced fungicide released into the environment.

The funding from NYS IPM enabled us to improve the "user-friendliness" of the user interface of the DSS.

Project Locations:

Experiments were conducted in Tompkins County and Growers in Steuben and Wayne Counties provided useful feedback on their use of the DSS.

The system will be applicable to all of New York, and also to any potato production region in the USA.

Samples of Resources Developed:

A demonstration version of the new system is available at (http://blight.eas.cornell.edu/blight/). A user's manual was constructed and is available at (http://ppathw3.cals.cornell.edu/Fry/lateblightDSS2010.pdf). The first page is illustrated in Figure 1.

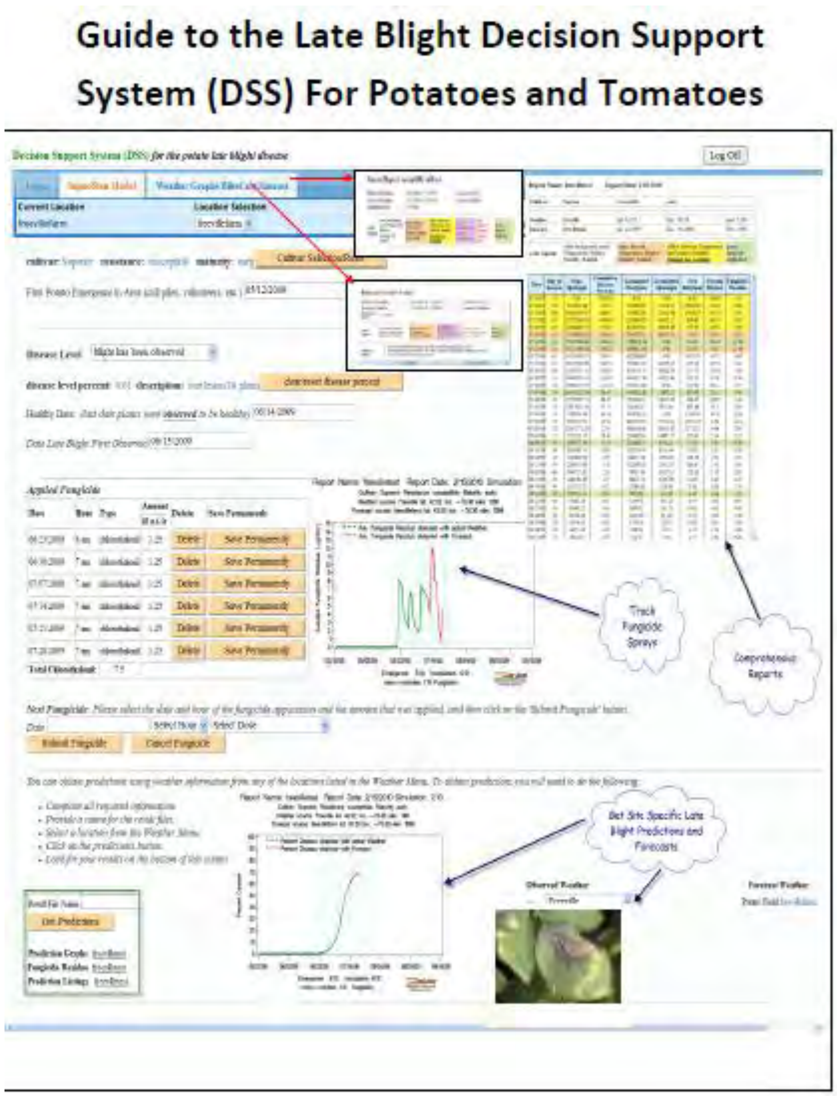
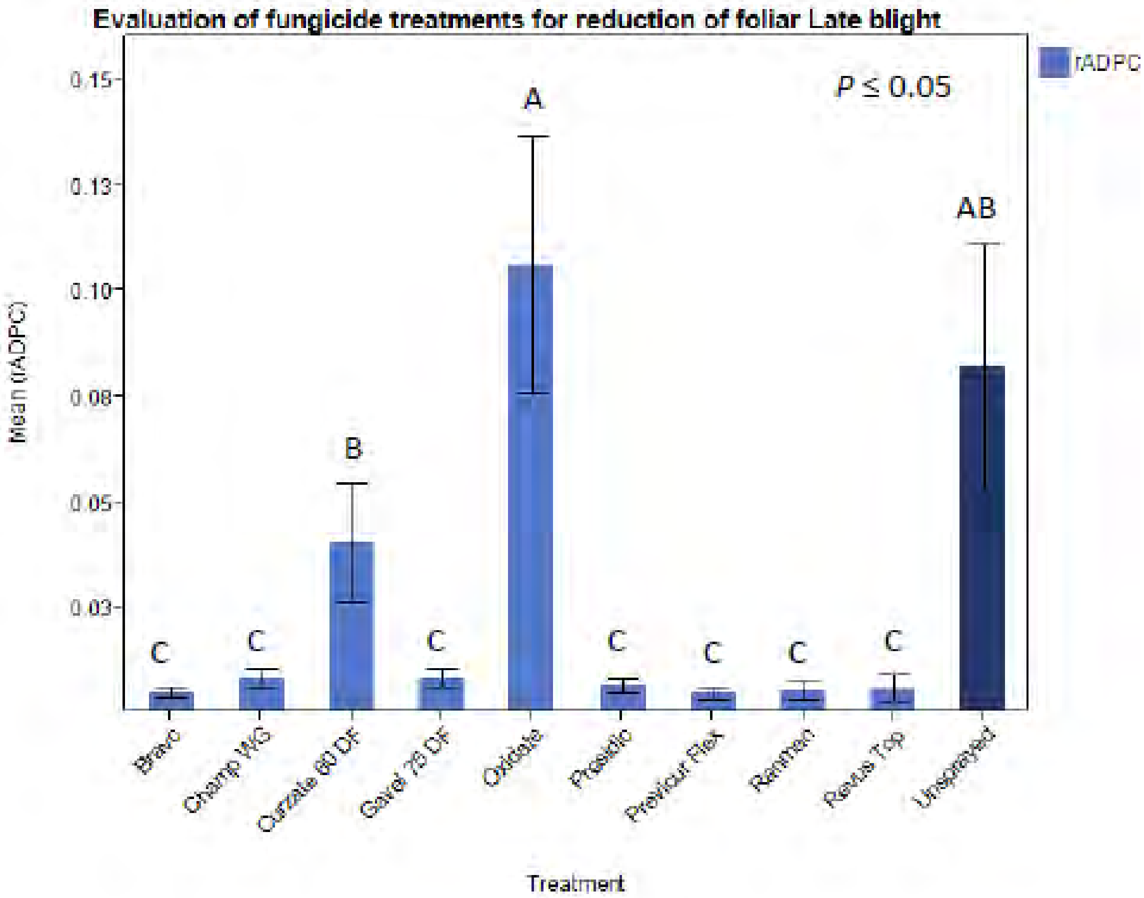


Figure 1. Cover page of the user's manual for the Potato Late Blight Decision Support System. The manual is available at (http://ppathw3.cals.cornell.edu/Fry/lateblightDSS2010.pdf).

Product name	Active ingredients	Rate per acre (maximum label rate)
Bravo	Chlorothalonil (54%)	1.5 pts/a
Champ WG	Copper hydroxide (77%)	1.5 pounds/a
Curzate 60 DF	Cymoxanil (60%)	3.2 oz./a
Gavel 75 DF	Mancozeb (66.7%) & Zoxamide (8.3%)	2.0 lb/a (1.5 lb/a active ingredient)
Oxidate	Hydrogen dioxide (27%)	128 fl. oz. per 100 gallons (30 - 100 gallons per acre)
Previcur Flex	Propamocarb hydrochloride (66.5%)	1.2 pts/a
Ranman	Cyazofamid (34.5%)	2.75 fl. oz./a (0.071 lb ai./a)
Revus Top	Mandipropamid (21.9%) & Difenoconazole (21.9%)	7.0 fl. oz. /a
Presidio	Fluopicolide (39.5%)	4.0 fl. oz. /a (Tomato - late blight rate)

Table 1. Fungicides evaluated for effects on suppressing late blight in the foliage and in the tubers. .

Figure 2. Effect of fungicides on late blight. There are three plots depicted in this photograph. The plot in the foreground was protected by weekly applications of a fungicide, but the plot in the middle of the photo was not protected by an effective fungicide. The plot in the background was also protected by an effective fungicide.



Figures 3.. The effect of diverse fungicides on suppression of foliar late blight. The Y axis (rAUDPC) is a measure of disease severity. The higher the value, the more severe is disease. Foliage in plots with values approaching 0.10 were totally destroyed by late blight by the end of the season .

Figure 4. Potato tuber with severe late blight. Some parts of the tuber are also suffering from soft rot. Soft rot often exacerbates tuber blight. Some fungicides such as Presidio seemed to suppress late blight in tubers as well as in the foliage.

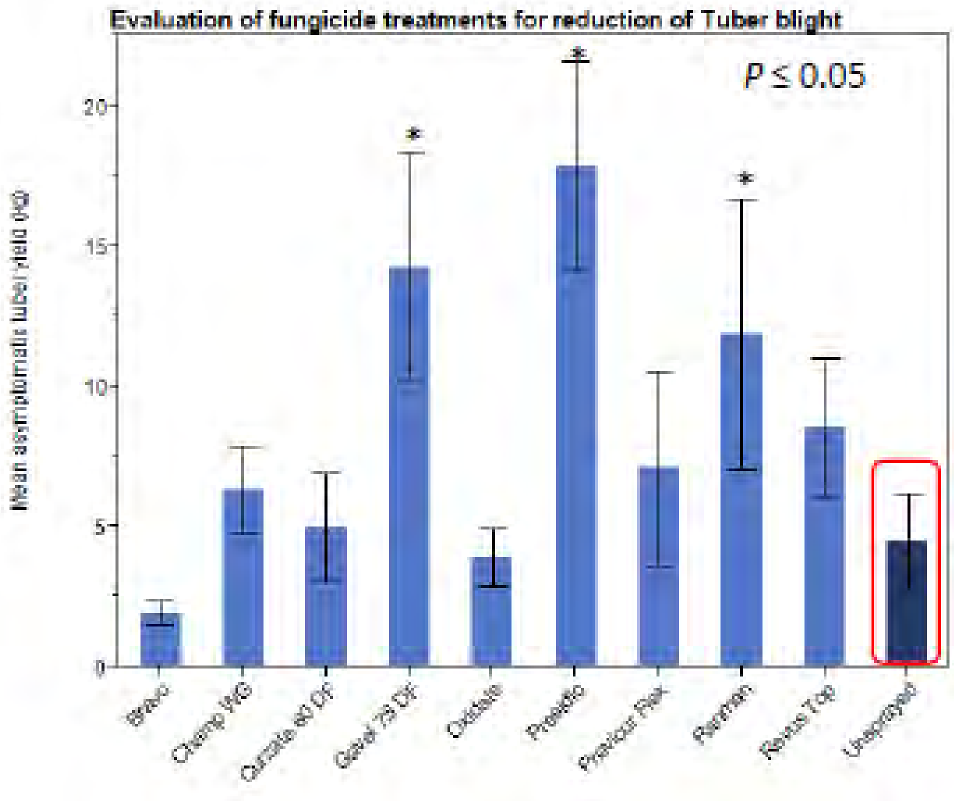


Figure 5. The effect of diverse fungicides on suppressing disease in tubers. Some treatments enabled the production of lots of healthy tubers. Other treatments produced only a small yield of healthy tubers. The reduction in yield was due primarily to late blight infection in the tubers. Thus some treatments very effectively suppressed infection in the tubers. These data will be incorporated into the DSS.