

**PROJECT TITLE: Integrated management of soil and seed-borne diseases, and foliar and tuber diseases of potato crops in Michigan in relation to environment and host specificity.**

**Plant Pathology request is for \$30,000**

Dr. Willie Kirk, Plant Pathology, MSU

Cooperators

**Team Members:** Rob Schafer, Pavani Tumbalam, Jiaming Hao, Plant Pathology; Dr David S. Douches, Dr. Stuart Grandy, Joe Coombs, Chris Long, CSS; George Bird, Entomology; MSU.

Co-operating Agencies

Michigan Potato Industry Commission, MSU (MAES and MSUES), USDA, CSREES, Michigan Dept. of Agriculture, Agrochemical Industry.

### **Introduction**

The key components of integrated disease management are host resistance, pathogen exclusion, pathogen eradication (or more realistically reduction in inoculum), disease prediction and crop protection. Crop protection encompasses eradication and exclusion and is achieved through the use of agrochemicals, biological control or cultural practices that interfere with the process of infection. In order to practice integrated disease management in crops it is necessary to have a research program that addresses current problems and builds to understanding future problems for the potato industry. The crop protection strategies developed in this program aim to optimize agrochemical usage for diseases such as potato late blight, early blight, common scab and seed/soil-borne diseases of potatoes such as dry rot, stem and stolon canker, Corky Ringspot disease and bacterial soft rots and storage diseases such as silver scurf, pythium leak and pink rot.

Potato growers depend heavily on intervention and protection strategies using fungicides and other crop protection materials. Prediction of environmental conditions that influence disease development enables growers to apply appropriate fungicides in response. There are currently several types of fungicide applied routinely for prevention of potato diseases in Michigan. In order to effectively advise growers on the appropriate disease control strategy it is necessary to have information based on a knowledge of fungicide efficacy, varietal susceptibility to particular diseases, intended markets, past and current weather records and future weather predictions for specific areas.

The impact of crop diseases can be minimized provided knowledge of the disease risk is well communicated and the current information base is implemented as a strategy to prevent disease establishment. The pathology program at MSU will continue to concentrate on major problems in Michigan including potato foliar diseases (late and early blight; Brown Leaf Spot and Botrytis grey Mold), potato seed and soil borne diseases (Rhizoctonia stem canker, common scab, Fusarium dry rot, Oomycete disease of tubers). A nationally recognized potato late blight breeding program has already been established by Dr. Douches (CSS) with the co-operation of the plant pathology program. The beneficiaries of this program are the growers, processors and consumers of Michigan potato crop products. Our overall aim is to reduce production costs through an understanding of the interactions of the pathogen with its host and environment.

### **Specific projects and objectives**

1. Evaluate improved cultivars for the potato industry that have foliar and tuber resistance to late blight and other important diseases (applied research).
2. Evaluate, compare and explain the differences in fitness of local genotypes of *Phytophthora infestans* to international genotypes (basic research program).
3. Evaluate minimum amount and duration of protection of seed-treatment or in-furrow at planting applied protectant fungicides required for effective control of potato diseases (such as late blight) in a range of potato varieties expressing different levels of resistance (applied research).
4. Extend to all potato growing regions the late blight and early blight severity value forecasting and in-crop weather-monitoring program already established by MSU and provide a one-stop web site for potato disease information (extension activity).

5. Study the effects of environmental factors (temperature and soil moisture), fungicides (conventional, reduced risk and biological) on foliar, seed-borne and storage diseases of potatoes (basic and applied research).
6. Monitor pathogen populations in potatoes for resistance to fungicides (applied research).
7. Evaluate alternative measures for potato disease control (applied research).
8. Respond to novel situations such as the appearance of sporadic problems like establishment issues caused by viruses, bacteria or fungi, storage problems and sanitary issues (applied research and extension activity).

#### **4. EXPERIMENTAL PROCEDURES**

##### **General**

The Muck Soils Research Farm is now recognized as one of the premier sites in North America for conducting potato late blight research. The plant pathology project carefully engineers epidemics through annual maintenance and preservation of virulence of cultures of *P. infestans*, maintains and manages the irrigation equipment used at the farm, manages the agronomy of all potato trials at the facility and ensures timely inoculation and encouragement of the late blight epidemic. Agrochemical companies utilize the facility for field screening of early development products and to show-case currently registered and novel products. In addition, all trials are planted, treated and harvested using equipment purchased through grants from MPIC, MSU GREEN and the AgChem industry and donations of equipment from Walthers Farms and Lenco. This equipment facilitates efficient potato production from planting through harvest.

##### **Evaluate improved cultivars for the potato industry that have foliar and tuber resistance to late blight and other important diseases.**

The MSU potato breeding and genetics program has developed a series of late blight resistant advanced breeding lines and cultivars that have diverse sources of resistance to late blight. Since 1995 successful managed epidemics of potato late blight have been established at the Muck Soil research Farm, Bath, MI, even in seasons non-conducive for late blight epidemics, such as 2005 and 2008. Federal and private breeding programs throughout the US now utilize the Muck Farm for early evaluation of late blight resistance in their germplasm.

Tubers from these field trials are used to assess tuber blight resistance using an image analysis technique developed at MSU. Direct tuber tissue inoculation has proven the most effective screening technique. For this technique, different isolates of *P. infestans* are used and test tubers are stored at 50°F to simulate chip processing storage temperature. We have previously used three temperatures to simulate seed and cold processing also (39 and 45°F) but have concluded that the most efficient screening temperature is 50°F.

##### **Evaluate minimum amount and duration of protection of seed-treatment or in-furrow at planting applied protectant fungicides required for effective control of potato diseases (such as late blight) in a range of potato varieties expressing different levels of resistance (applied research).**

Breeding programs at MSU, UMN, NDSU and UW have lines with different levels of resistance to late blight. Each breeding program provides two to three near market lines for assessment each year. The fungicide Bravo WS has consistently provided good late blight control and is used for the experiments. Manufacturers recommended applications rates (MRAR) are applied at 0, 50 and 100% MRAR at 7 and 14-day intervals. The experiment is inoculated with a mixture of *P. infestans* genotypes just prior to canopy closure. This experiment, now in its sixth year is well accepted and has resulted in two refereed publications. This work was funded by NPC, MPIC and MSU over the past six years.

The objectives of the seed treatment project are to (i) determine the efficacy of Phosphonic Acid (PA) for tuber blight control in storage when applied to potato foliage in the field versus tubers post-harvest, (ii) determine the efficacy of CAA, PA and other fungicides in preventing transmission of *Pi* from latently-infected seed tubers to emerged shoots, (iii) assess the susceptibility of commonly used potato cultivars and selected potato genotypes having varying levels of late blight resistance to latent tuber

infections and seed-to-shoot transmission, and (iv) assess PCR and/or ELISA for detection of latent tuber infections caused by *Pi*.

**Extend to all potato growing regions the late blight and early blight severity value forecasting and in-crop weather monitoring program already established by MSU and provide a one stop web-site for potato disease information.**

Daily downloads include data from all potato growing locations in Michigan served by the Michigan Automated Weather Network (MAWN). The late blight risk computer program calculates potato late blight disease severity values (DSV) and p-values for early blight prediction from the downloaded data and to identify appropriate fungicide and application rates. Hourly values, weekly and seasonal totals, and corresponding fungicide application rate recommendations were daily updated on web pages for each station <http://lateblight.org>. Potato disease information is now readily available at <http://potatodisease.org>. We now have published several new bulletins in 2007. This work was funded by MPIC and MSU over the past six years.

**Study the effects of environmental factors, fungicides (conventional, reduced risk and biological) on seed-borne and storage diseases of potatoes.**

Different environmental factors such as exposure time to different temperatures, humidities, fungicides or other factors are tested using the same basic technique in this project. Fungi such as *Colletotrichum coccodes* (Black Dot), *Rhizoctonia solani* and *Fusarium sambucinum* are grown on artificial media amended with different concentrations of fungicides such as fludioxinil (maxim), flutoloni (Moncut) and azoxystrobin (Quadris) and incubated at temperatures from 40 – 70°F. The relative efficacy of the fungicides at the different temperatures is then quantified by comparing growth rates at different combinations of fungicide at a range of concentrations.

In another major experiment we are conducting this spring we hope to evaluate the effectiveness of fungicidal seed treatments and different storage conditions prior to planting for the control of seed-borne seed piece decay and sprout rot. In order to do this the project will have two specific objectives:

1. To evaluate *in vitro* the effectiveness of fungicidal seed treatments and different storage conditions prior to planting for controlling seed piece decay (*Fusarium* and *Pectobacterium* spp.) and sprout rot caused by *P. infestans*, *F. sambucinum*, and *R. solani*.
2. *In vivo* field experiments to evaluate the agronomical effects of fungicidal seed treatments and storage conditions before planting on crop health.

Another set of experiments will be conducted in the fall to evaluate and compare biofungicides and fungicides for the control of post harvest potato tuber diseases in storage. This work was funded by NPC, MPIC and MSU.

**Monitor pathogen populations in potatoes for resistance to fungicides.**

To illustrate this objective, we currently monitor populations of *Phytophthora infestans*, *P. erythroseptica* and *Pythium ultimum* for resistance to commonly used fungicides such as Ridomil. In 2009 and 2010, isolates of *Fusarium* spp. were and will be collected from seed potato growing regions of MI and sensitivity to seed treatment active ingredients such as thiabendazole evaluated. Basic method was described under the previous objective.

**Evaluate alternative measures for potato disease control.**

The development and use of conventional fungicides for storage disease control in potatoes has not been pursued by the agrochemical industry for registration issues. The use of alternative measures needs to be evaluated. Some measures were described above and it is envisaged that we will pursue funding from IR-4 to further evaluate products such as phosphonates and biocontrols for this use.

**Respond to novel situations such as the appearance of sporadic problems like establishment issues caused by bacteria or fungi, storage problems and sanitary issues.**

To illustrate this objective, in 2009 severe problems with late blight were experienced by several growers in MI. Samples of lesions were collected and the pathogen isolated. In this case the pathogen turned out to be a novel strain of *Phytophthora infestans*. Molecular diagnostic techniques were completed in order to diagnose the pathogen. Funding from MPIC contributes to the cost of these diagnostics.

**Expansion of storage trials.**

**Evaluation and comparison of tuber disease resistance predisposition programs in conjunction with a range of reduced risk fungicides and biofungicides applied post-harvest for the control of potato storage pathogens**

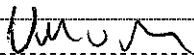
Tests are underway at MSU examining the effect of pre-harvest crop protection programs on predisposition of harvested tubers to various diseases. This project, using a chip processing and a table stock potato cultivar, included crop protection-programs applied in the field based on the use of mefenoxam-, phosphonic acid- (Phostrol) and biofungicide- (Serenade) based strategies and a non-treated control. Tubers will be further treated post-harvest with phosphonic acid *Bacillus subtilis* hydrogen peroxide (Oxidate) and a mixture containing azoxystrobin, fludioxinil + difenoconazole after inoculation with *F. sambucinum*, *P. ultimum*, *Phytophthora infestans* and *P. erythroseptica*. It is anticipated that this project will lead to recommendations on disease management options for tuber storage diseases that initiated during tuber development in the field and that can be enhanced by effective post-harvest options.

#### **5. PLANS TO DISSEMINATE INFORMATION FROM STATED RESEARCH**


Information will be disseminated to stakeholders at grower meetings, extension programs, field days, through extension publications, and on websites. The project has already developed sophisticated information dissemination techniques especially through the internet e.g. <http://lateblight.org>. The educational portion of this project is to promote greater awareness about the potential of integrated crop management and the use of alternative disease control methods to conventional saturation crop protection. Information will also be distributed by more conventional means to other pathologists and crop scientists and researchers by peer-review in scientific journals, presentations at state, regional, national, and international research meetings, and personal communications.

#### **Budget**

**The Plant Pathology request is for \$30,000 to enable continued research and extension activities pertinent to the potato industry particularly in Michigan but also to the rest of North America and internationally.**



William W. Kirk



Ray Hammerschmidt (Department Chair)

Michigan Potato Industry Commission. Budget.

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**Project Principal Investigator: William Kirk**

**Funding Requested**

Budget Item	FY-10	FY-11	FY-12	Matching Funds Received*	Matching Funds Pending*
<b>Personnel Wages</b>	15,000				
A1. Research associates & post-docs					
A2. Technical/Administrative Support					
A3. Other (please list)					
A4. Fringe Benefits** (Must be charged as direct costs.)	6900				
B. Graduate students – including associated fringes***					
C. Undergraduate students****	4100				
<b>Total Personnel Costs A+B+C</b>	25,000				
D. Nonexpendable equipment (Attach explanation)					
E. Materials, Supplies & Publications	4,000				
F. Travel	1,000				
G. Other Direct Costs (Attach explanation, list of items and individual costs.)					
<b>TOTAL D+E+F+G</b>	5000				
<b>Grand Total</b>	30,000				