Progress Report to the Southern Region Small Fruit Consortium

Proposal Category: ___Research _X_Outreach

Proposal Status: _X_ New Proposal ___Previously funded by SRSFC; has been previously funded for ___ years

Title: Development of a web-based grape disease risk assessment system (2011 E-05)

Name, Mailing and Email Address of Principal Investigator(s):

PRINCIPAL INVESTIGATOR:

Mizuho Nita
Grape Plant Pathologist
AHS Jr. AREC; Virginia Tech
595 Laurel Grove Road
Winchester, VA 22602
Phone: (540) 869-2560
FAX: (540) 869-0862
Email: nita24@vt.edu

Collaborators:

Keith Yoder
Professor
AHS Jr. AREC; Virginia Tech
595 Laurel Grove Road
Winchester, VA 22602
Phone: (540) 869-2560
FAX: (540) 869-0862
Email: ksyoder@vt.edu

Peter Sforza
Director of the Center for Geospatial Information Technologies
Virginia Tech
113 Major Williams Hall
Blacksburg, VA 24061-0115
Phone: (540) 231-1867
Email: sforza@vt.edu

Seth Peery
Senior GIS Architect
Enterprise GIS Research and Development Administration
Virginia Tech
Phone: (540) 231-2178
Email: sspeery@vt.edu

Paul Knight
Department of Meteorology
605 Walker Building
University Park, PA 16802
Telephone (814) 863-1842
E-mail: pgk2@psu.edu

Erick De Wolf
Extension Plant Pathologist
Department of Plant Pathology
Kansas State University
4607 Throckmorton Plant Sci. Center
Manhattan, KS 66506
(785) 532-3968
dewolf1@ksu.edu

Objectives:

Establish an online, map-based disease risk assessment system for major fungal and bacterial diseases of grape in Virginia

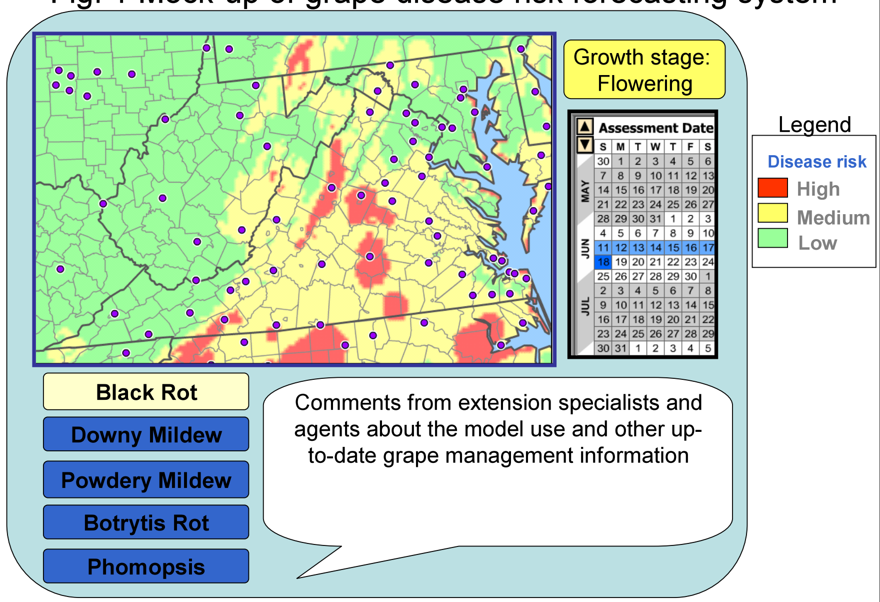
Justification and Description:

Due to high humidity during the growing season, diseases can have a substantial economic impact on the Virginia fruit industry. Timely application of pesticides is critical for management of many of the fungal and bacterial diseases that affect grape and apple. Often time, growers need to apply preventative pesticides prior to an infection event in order to prevent disease, except a few cases where curative pesticides are available (Ellis 2005). Therefore, growers tend to apply pesticides at regular intervals (i.e., every 7 to 10 days) regardless of weather conditions. However, if weather is dry, many of the fungal and bacterial pathogens are not active, and there is no need for pesticide application for these diseases. Thus, a risk assessment tool that provides specific information about the risk of disease development can be a very useful tool for growers' fungicide decision-making, especially for intensively managed crops such as grape and apple (Gadoury et al., 1990).

What we envision for the future of our program is the establishment of a web-based information center for apple and grape diseases for Virginia growers (Table 1, placed in page 5). One of the major components of the system is a disease risk assessment system that provides up-to-date map-based information on the risk of major fungal and bacterial diseases of apple and grape, which we proposed in the 2011 proposal.

Development of such a system requires a careful planning and establishment of a good infrastructure so that the system can run efficiently for a long time. Therefore, the entire project was divided into several phases that have specific objectives (Table 1). A portion of the initial two phases of system development was supported by the SRSFC. The key steps during the proposed phase are: 1) the establishment of a data management framework; 2) selection of candidate disease predictive models; 3) development of GIS module/application for visualization of disease risk maps; and 4) implementation of a web-based interactive user interface. The funds were utilized to support student workers who provided support to a) select apple and grape disease models, and b) transfer the model information into GIS modules.

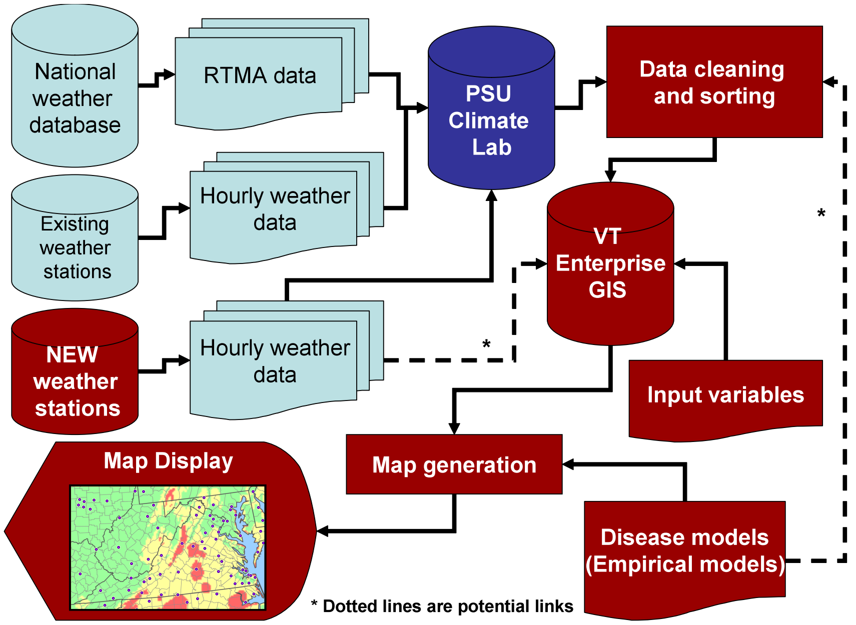
Fig. 1 Mock-up of grape disease risk forecasting system



Methodologies: The proposed risk assessment system will have two layers of spatial hierarchy. The top layer will be similar to the currently available Fusarium system where model-estimated weather data will be utilized to create disease risk maps (Fig. 1). The second layer will be based on weather stations (both public and private) located nearby or within a target field. Public weather stations will be visible on the map display (circle icons in Fig. 1), and a user can select a particular weather station to obtain more accurate information. In order to provide more local weather information, the FAA (Federal Aviation Association) and Virginia Cooperative Extension Service's weather stations are added to the system. The website will deliver disease risk analysis based on disease prediction models, and the result of these models will be displayed as a map (Fig. 1). Once a user (a grower) accesses the site, he/she selects a crop, the growth stage of grape, a target disease, and target time window (current or forecast), and a risk map will be generated based on the input. The display will be an easy to understand, color-coded map with green, yellow, and red areas for low, moderate, and high risk of the disease, respectively (Fig. 1). The weather information will be updated daily so that growers can visit the site in the morning prior to make a decision. Also, up to 7-day weather forecast information will be used for future risk assessment, which will give growers "heads-up" for upcoming events.

Progress made in 2010-2011: 1) Data management and map display: We obtained weather data from two different sources 1) PSU's climatology lab (Real-Time Mesoscale Analysis or RTMA data, Fig. 3) and 2) VCE's mesonet weather station throughout VA (Figs. 2). The Virginia Tech's Enterprise GIS group who hosts the web application on the Virginia Tech Enterprise GIS system developed a database and network structure where these weather data arrive daily. Then the same group developed GIS modules that were based on published (peer-reviewed) results (see step 2 for more details). Since the infrastructure of the VCE mesonet was not designed for our purposes, we spend considerable amount of time developing a protocol for data retrieval. In addition, we made sure to use commonly accepted data format and data management tools so that these can be compatible with other major weather data sources such as MADIS (Meteorological Assimilation Data Ingest System), which is a growing standard for the continental US weather data.

Fig. 2 Data flow and process: disease risk assessment system



***2) Selection and programming of disease models**:* There are numerous grape diseases in Virginia; however, any of five major fungal diseases (black rot, Botrytis, downy mildew, Phomopsis, powdery mildew, please refer to Table 2) can be a threat if growers failed to manage them. In addition to the major grape diseases, we are investigating for some of major apple diseases in our area. Apple scab, cedar-apple and -quince rusts, sooty blotch and fly speck disease complex, and fire blight has been causing chronic issues, and therefore, well studied. Since the scope of this study is not about creating a new model, but about utilizing existing model and creates a daily risk map based on these well-established models, we selected some of candidate models from existing peer-reviewed works, summerlized the information, and then translated these candidate models into GIS-based environment (Fig. 4).

Summary and Next Steps: We successfully established a weather data network and database, which is the core infrastructure of the system. We also developed GIS modules for disease risk display, and they have been tested using the past weather data. We are entering Phase II (Table 1) where validation of models will be performed on the modules. Currently, we are working on a web interface, and testing the GIS modules with more datasets. Also, we were funded through the USDA SCRI block grant to investigate weather data quality and to develop leaf wetness models. We will set up four weather stations that have multiple leaf wetness sensors, and place them into grape and apple canopies. They will provide more realistic measurements of environmental data in vineyards or orchards, and help us to develop models that characterize the leaf wetness based on the data available through our database (NOAA and other weather stations' data).

Table 2. Examples of disease prediction models considered for development of risk assessment models for major grape fungal diseases in Virginia

Crop	Disease	Pathogen	Selected references
GRAPE	Black rot	*Guignardia bidwellii*	Ellis, M. A., et al. (1986), Funt, R. C., et al. (1990)
	Downy mildew	*Plasmopara viticola*	Tarr S. A. J. (1972), Strizyk, S. (1983), Madden, L. V. et al. (2000), Lalancette, N., et al. (1988)
	Powdery mildew	*Erysiphe necator*	Correiar, B. R. (1999), Sall , M. A.,(1979)
	Botrytis gray mold	*Botrytis cinerea*	Broome, J. C., et al. (1995), Bulit, J, et al. (1970), Nair, N. G., and Allen, R. N. (1993), Shtienberg, D., and Elad, Y. (1997)
	Phomopsis cane and leaf spot	*Phomopsis viticola*	Erincik, O., et al. (2003), Nita, M., et al. (2007)
APPLE	Apple Scab	*Venturia inaequalis*	Jones ed. Skybit (a commercial service)
	Cedar-apple rust	*Gymnosporangium juniperi-virginianae*	Biggs (2009, website), Mid-Atlantic Orhcard Monitoring Guide
	Quince rusts	*Gymnosporangium clavipes*	Biggs (2009, website), Mid-Atlantic Orhcard Monitoring Guide
	Sooty Blotch and Flyspeck	*Peltaster fructicola, Geastrumia polystigmatus, Leptodontium elatus, Zygophiala jamaicensis*	Brown and Sutton (1995)
	Fire blight	*Erwinia amylovora*	KTFREC (Marylblyt Website), Dewdney, et al. (2007)

Figure 3 Example of RTMA data stored in VT's CGIS server

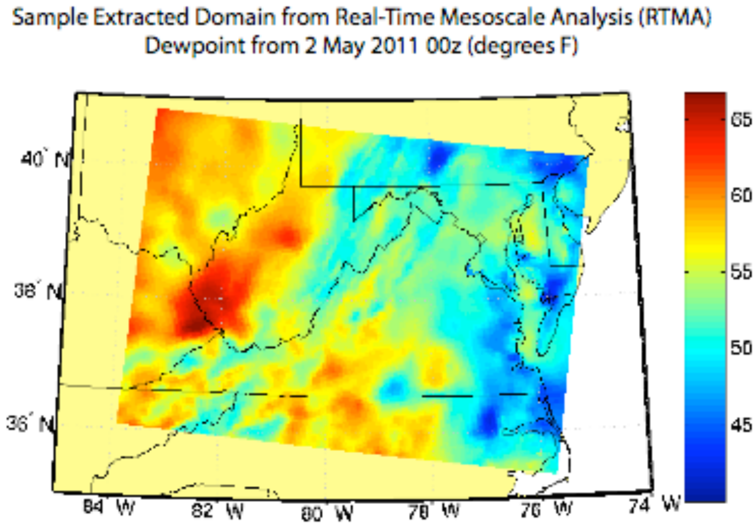


Figure 4 Example of black rot model displayed as a map based on RTMA data

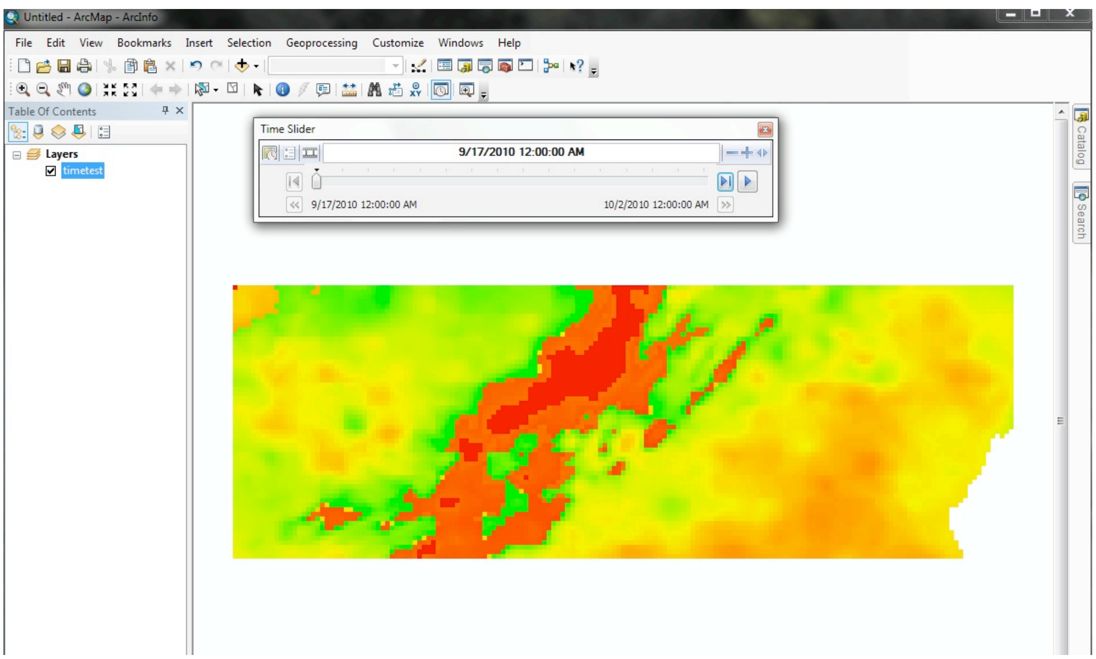


Table 1. A timeline of the proposed disease information systems and its impact

Phase	Timeline	Objective		Impact
I Development of the base system A) Disease risk assessment system **<u>(Proposed in this paper)</u>**	2009-2012	1	Creating the infrastructure: a) Set up a data server; b) Create a web interface; c) Data management	Establish a weather data sharing structure between PSU and VT system
		2	Initial development of grape disease risk assessment tool *2009-2011*: Selection of candidate models based on previous studies (*on-going as of 2009 season*) *2010-2012*: Initial system run: testing and calibration of GIS modules, a hindcast of disease risks with existing datasets	
		3	Public deployment of the alpha system of disease maps	
II Initial runs A) Disease risk assessment system B) Grape and Apple disease information center	2009-2013	1	Validation of models by comparing model outputs with actual observations in the fields	
		2	Validation of weather station input by comparing with national weather service data and RTMA model results (*on-going as of 2009 season*)	
		3	Establishment of the web-interface for grape and apple disease information center	
		4	*2011-2014*: Initiation of experiments where participating plots will be using results of risk models to schedule fungicide application	– Student education – Public awareness development – Extension education
		5	Public deployment of the beta system that includes grape and apple disease information such as factsheets and pesticide spray recommendations (existing information will be fully utilized)	
III Public deployment A) Disease risk assessment system B) Grape and Apple disease information center	2012-2015	1	System deployment and feedback: a) System maintenance and evaluation, b) Conduct survey to obtain user comments and suggestions; c) Continuation of validation of models and weather stations	
		2	Use of disease risk assessment system as an extension education tool	
IV Value addition A) Disease risk assessment system B) Grape and Apple disease information center	2011-2016	1	Toward more comprehensive information system for grape management; 1) Implementation of other disease risk maps (Pierce's disease forecast, grape leafroll virus distribution map, etc); 2) Establish links to existing disease databases (e.g., ipmPIPE products) and other information sources 3) Establish apple disease module which is another important fruit crop in VA	– More extended collaboration among faculties and institutions – Extension education beyond mid-Atlantic grape and apple production
		2	Expansion of the system beyond VA and plant pathology: 1) Continuation of the validation of the system; 2) Expansion of the system to other states; 3) Consult viticulturists and entomologists for application of the system; 4) Expansion of the system beyond grape plant pathology.	