EXAMINATION OF MODELS FOR THE PREDICTION OF THE ONSET AND SEVERITY OF POTATO LATE BLIGHT IN OREGON

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Summary

Over the last three years data of environmental conditions in potato fields was collected automatically from weather stations in growers fields. Stations in growers' fields totaled 4 in 1996, 7 in 1997, and 10 in 1998. Temperature, relative humidity, and leaf wetness in the plant canopy and rainfall were recorded every 10 minutes and the data was forwarded via cellular phone daily to the Malheur Experiment Station. Data was used to estimate real time late blight risk, and those estimates were distributed via the station web site, e-mail, and 1-800 telephone number. Also weather data from outside of the crop canopy was collected from 7 AgriMet stations closest to the commercial potato fields where the plant canopy measurements were being made.

Starting in 1996, data was used to provide Treasure Valley growers with regular estimates of the risk of late blight using "Blitecast" and its conventional 90 percent relative humidity criteria. Conventional Blitecast forecasts a "severity" value based on the duration of 90 percent relative humidity periods in the plant canopy and the average temperature during the humid period. Late blight occurrence was compared with the model predictions. In 1997, stations were placed in potato fields in other production areas of the state, expanding service to growers in those areas.

Starting in 1998, leaf wetness sensors were added to the infield weather stations with the idea that a measure of leaf wetness might provide a more accurate estimate of the duration of risk in the arid west, where low relative humidity of the air might underestimate conditions favorable for late blight development. During 1998, a new computer program was developed in Ontario to allow the direct application of raw field weather data to any disease-prediction model.

Objectives and Rationale

Objectives for 1998.

1. Validate the accuracy of the computer model "Blitecast" in predicting the occurrence of potato late blight in the Pacific Northwest.

2. Automate the "Blitecast" calculations from additional weather stations in growers' fields and additional AgriMet stations.

3. Adapt the "Blitecast" model to the relatively arid areas not originally envisioned in the development of the disease model. Growers are suffering economic loss from late blight where the disease was not prevalent before 1995.

4. Make results available in real time during the 1998 season for many potato production areas of the state.

Rationale. Before the 1995 growing season, potato late blight (Phytophthora infestans) was not a management concern in the Treasure Valley, Central Oregon, or the Klamath Basin. During the 1995 season, late blight spread rapidly throughout the Treasure Valley from initial outbreaks in low-lying,
humid areas. Growers made three to six fungicide applications in 1995. Lack of adequate late blight control in 1995 in the Treasure Valley resulted in a loss of yield and a loss of some of the crop during storage. Late blight outbreaks in 1997 and 1998 in the Klamath Basin have caused considerable economic loss.

The ability to predict when the disease is most likely to occur and when conditions are conducive to rapid spread would aid in decisions as to the necessity and timing of fungicide applications. The refinement of late blight predictions could save growers money by improving the efficiency of control measures. Accurate late blight predictions are now needed for areas both where the disease normally occurs and areas, such as the Treasure Valley and the Klamath Basin, where it has not been known to be a problem in the past.

Procedures

During 1998, data was collected from stations in 10 growers' fields and 7 AgriMet weather stations. Each weather station in a grower's fields consisted of a relative humidity sensor, a temperature sensor, a tipping bucket rain gauge, a Campbell Scientific Leaf Wetness Sensor 237LW, a portable stand, a data logger with battery and solar panel, a modem and a cellular phone. Temperature, leaf wetness, and relative humidity in the plant canopy and rainfall were recorded every 10 minutes and the data was forwarded via cellular phone or notebook computer to the Malheur Experiment Station. Weather data from outside of the crop canopy was collected every 15 minutes from 7 AgriMet stations closest to the monitored commercial potato fields and forwarded electronically to the Malheur Experiment Station.

Data was used to estimate real-time, late blight risk via Blitecast, and those estimates were distributed via the station web site, E-mail, and 1-800 telephone number. Various models were tested in 1998, with special emphasis on late blight predictions using leaf wetness.

"Blitecast" is a program module for late blight prediction that is part of the "Wisdom" software for potato crop and pest management from the University of Wisconsin, Madison. The Blitecast model uses the duration of high relative humidity above 90 percent along with the corresponding range of temperatures to calculate the extent to which the daily environment has been favorable for disease development. The Blitecast program accumulates favorable environmental conditions for late blight which are called "severity values". When the "severity value" total reaches 18, late blight is predicted and additional fungicide control measures are indicated.

During 1998, a new computer program "DataHandler" was developed in Ontario to allow the direct application of raw field weather data to any disease prediction model. Model variations used in 1998 included the substitution of the duration of 85 percent relative humidity or leaf wetness for the duration of 90 percent relative humidity. The average temperature during the moist periods was calculated in different ways. The 90 percent relative humidity of Blitecast was substituted for 80 percent relative humidity for AgriMet stations. Five different alternative calculations were made for each weather station measuring conditions in the crop canopy, as the example of Woodburn, OR, demonstrates (Fig. 1).

Blitecast and other predictions were compared to the actual onset and development of the disease in fields located in close proximity to each of the weather stations.

Results, Discussion, and Conclusions

Treasure Valley. Infield data was collected from four stations in 1996 and 1997 and three stations in 1998. Late blight was predicted before it occurred in 1996 and 1997 using "Blitecast". Late blight was first detected close to Parma, ID near the Idaho-Oregon border on August 21, 1996, and on July 17, 1997. In 1998, predictions were made only in Malheur County, and late blight was not predicted by conventional Blitecast until the end of the season (Fig. 2). Late blight was not detected in the county on potato leaves.

Access to late blight predictions and low cost fungicide recommendations starting in 1996 has assisted growers in the Treasure Valley to reduce fungicide costs and control late blight.

Central Oregon. Starting in 1997, the data collection and predictions were expanded to more Oregon environments. Two stations were used near Madras, Oregon during 1998 (Fig. 3). Conventional Blitecast did not predict late blight in either 1997 or 1998, and the occurrence of late blight was not recorded.

Willamette Valley. One station monitored potato canopy conditions in 1997, and that was expanded to two stations in 1998. Late blight occurred on a potato cull pile and tomatoes before potatoes emerged in 1998. Factors promoting the spread of late blight spores before they could be produced on potato plants was a major factor in the early onset of late blight in the Willamette Valley in 1998. Estimated severity using conventional Blitecast rapidly accumulated severity values at Woodburn in 1998 (Figure 4) as it had in 1997. Leaf wetness data may be of benefit for late blight prediction in the Willamette Valley.

Klamath Basin. A single station was set up south of Klamath Falls in 1997, and three stations were used in 1998. In 1997, conventional Blitecast severity values reached 17 at Klamath Falls before late blight was found in Tulelake south of the infield weather station. In 1998, late blight was found July 10 before it was predicted by conventional Blitecast (Fig. 5).

Leaf wetness. Leaf wetness estimates were made starting in 1998 using Campbell Scientific Leaf Wetness Sensors 237LW. Predicted late blight "severity" values accumulated much more rapidly based on leaf wetness than based on relative humidity in the plant canopy because the duration of the wet period proved to be longer than the period of high relative humidity. Marked differences were recorded for accumulated severity values based on 90 percent relative humidity and the conventional Blitecast program as compared with the use of leaf-wetness data in the Klamath Basin (Fig. 6). Leaf wetness estimates may be an important criteria for future late blight predictions.

Irrigation systems and management are important factors in prolonging leaf wetness and late blight risk. Leaf wetness is caused naturally by rainfall and dew. In a Treasure Valley drip irrigated potato field, little severity accumulated based on leaf wetness (Fig. 7).

AgriMet stations. Severity values calculated based on 80 percent relative humidity for the AgriMet stations seem to bear at least some relevance to the relative late blight pressure (Fig. 8). In 1998 the accumulated severity was highest for Corvallis followed by Nampa, ID, followed by Ontario and Madras. AgriMet data using a 80 percent relative humidity criteria predicted early onset of late blight at Corvallis in 1998 as it had in 1997.

In conclusion, conventional Blitecast has worked reasonably well in the Treasure Valley and Madras. Leaf wetness may be a valuable tool in the Willamette Valley, Klamath Basin, and elsewhere. The use of AgriMet data and the 80 percent relative humidity criteria seems to provide results roughly proportional to the late blight pressure between regions.

Cooperators and Acknowledgments

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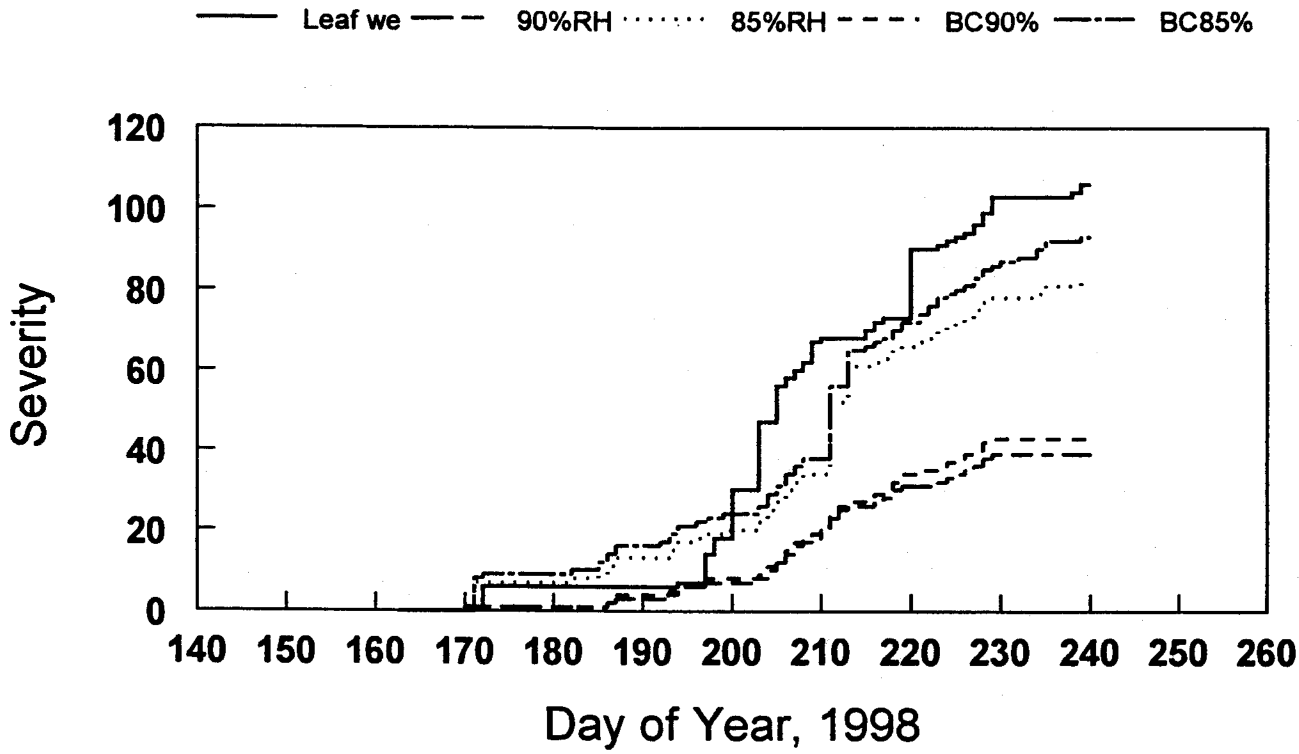

Figure 1. Simultaneous calculation of several late blight models based on data collected in a Woodburn (Willamette Valley) commercial potato crop canopy, Malheur Experiment Station, Oregon State University, Ontario, OR, 1998.

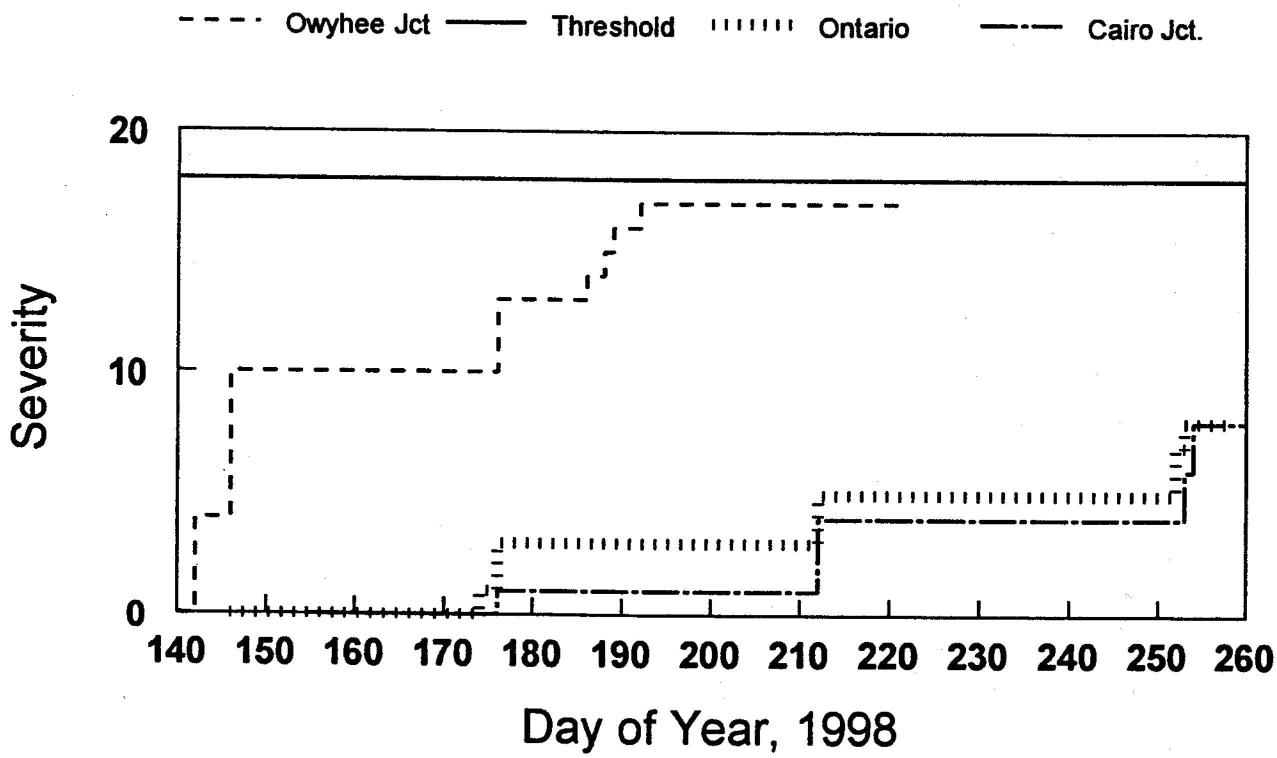

Figure 2. Malheur County accumulation of conventional "Blitecast" severity values to predict potato late blight based on 90 percent relative humidity and temperature in the potato canopies in potato fields at Ontario, Cairo Junction, and Owyhee Junction, Malheur Experiment Station, Oregon State University, Ontario, OR, 1998.

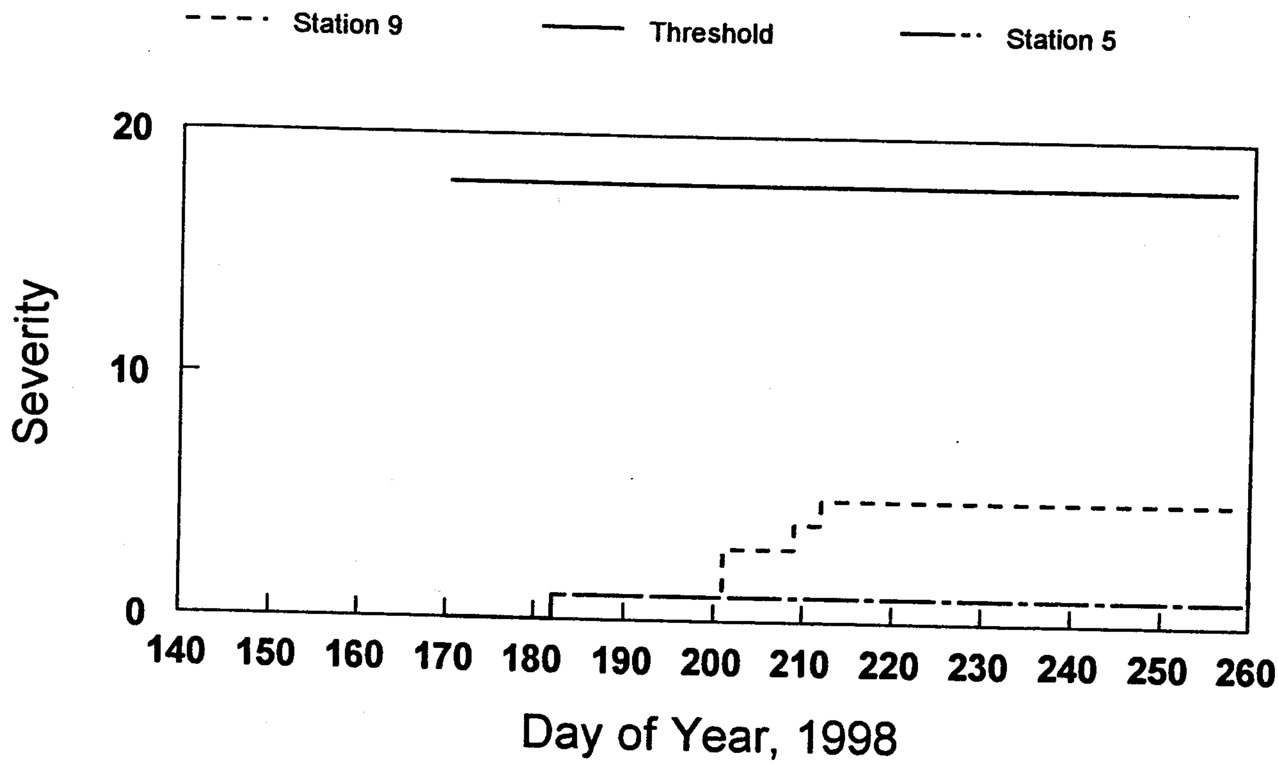

Figure 3. Madras accumulation of conventional "Blitecast" severity values to predict potato late blight based on 90 percent relative humidity and temperature in the potato canopy, Malheur Experiment Station, Oregon State University, Ontario, OR, 1998.

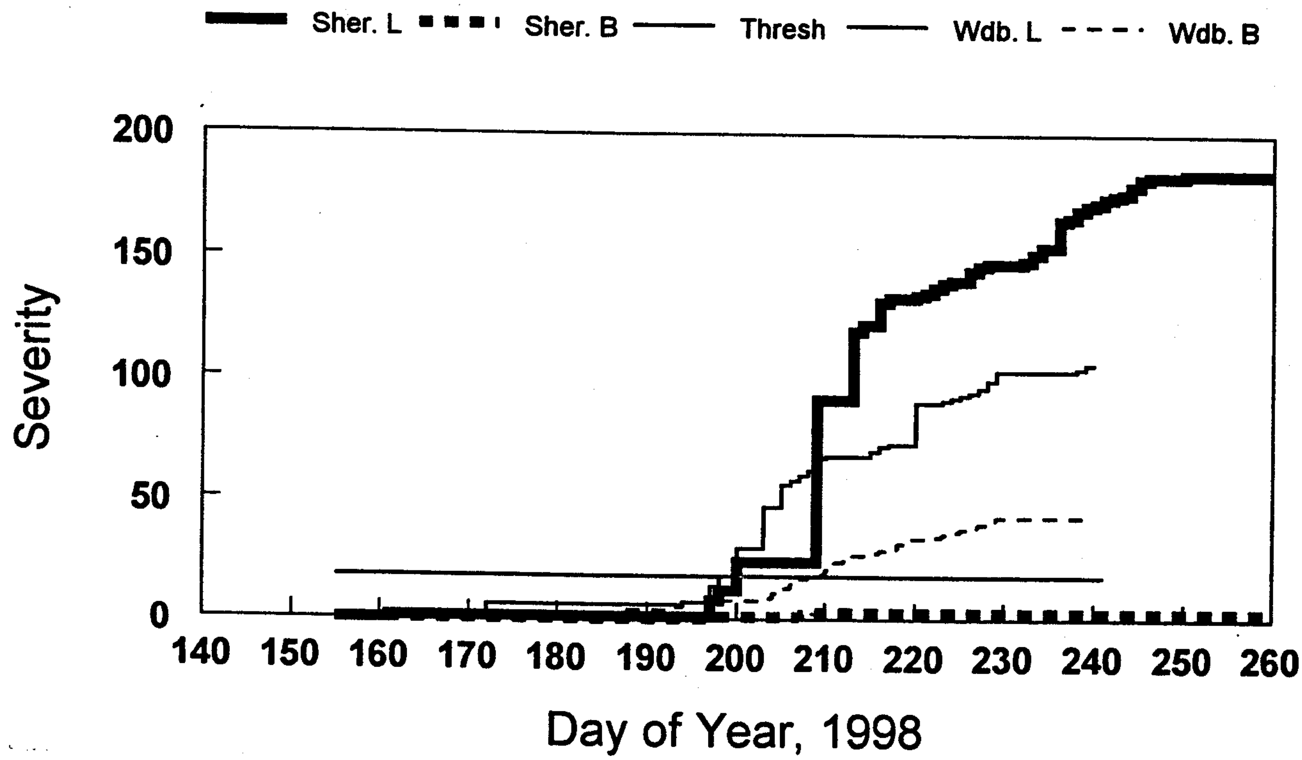

Figure 4. Woodburn and Sherwood, Willamette Valley, accumulation of conventional "Blitecast" severity values to predict potato late blight based on 90 percent relative humidity compared to those accumulated based on leaf wetness, Malheur Experiment Station, Oregon State University, Ontario, OR, 1998.

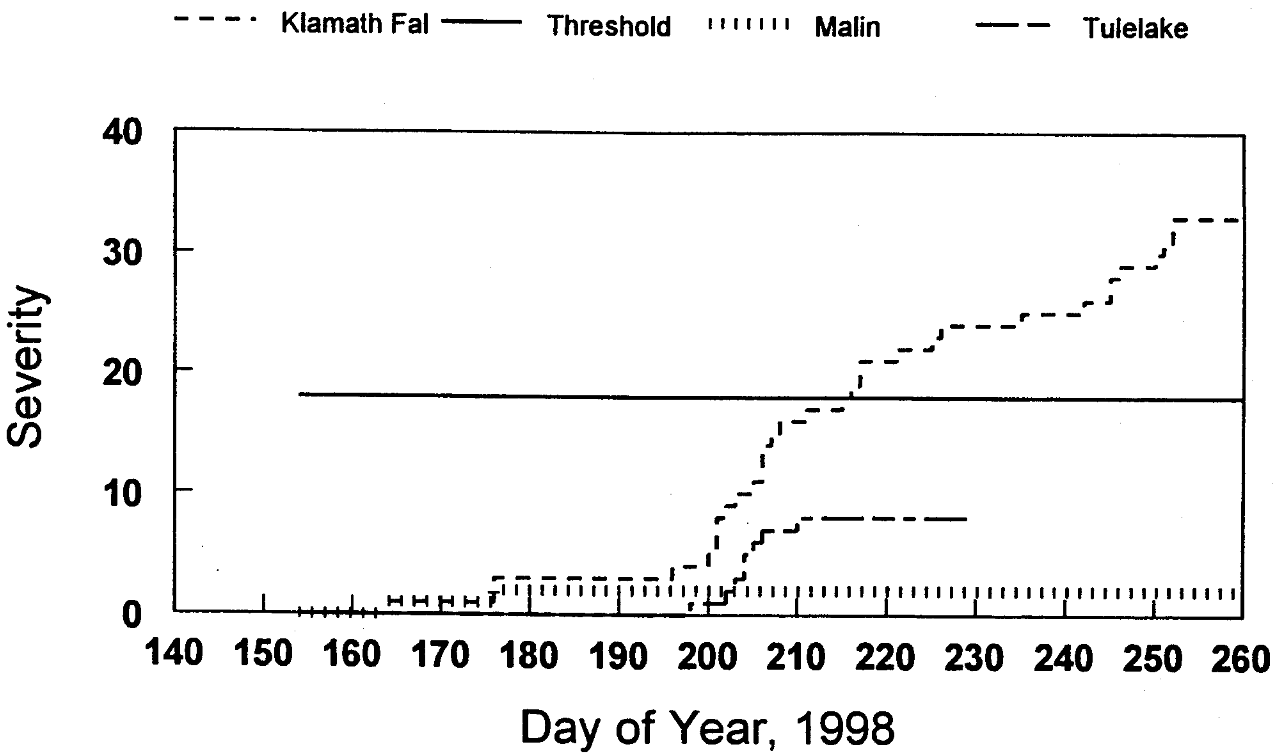

Figure 5. Klamath Basin accumulation of conventional "Blitecast" severity values to predict potato late blight based on 90 percent relative humidity and temperature, Malheur Experiment Station, Oregon State University, Ontario, OR, 1998.

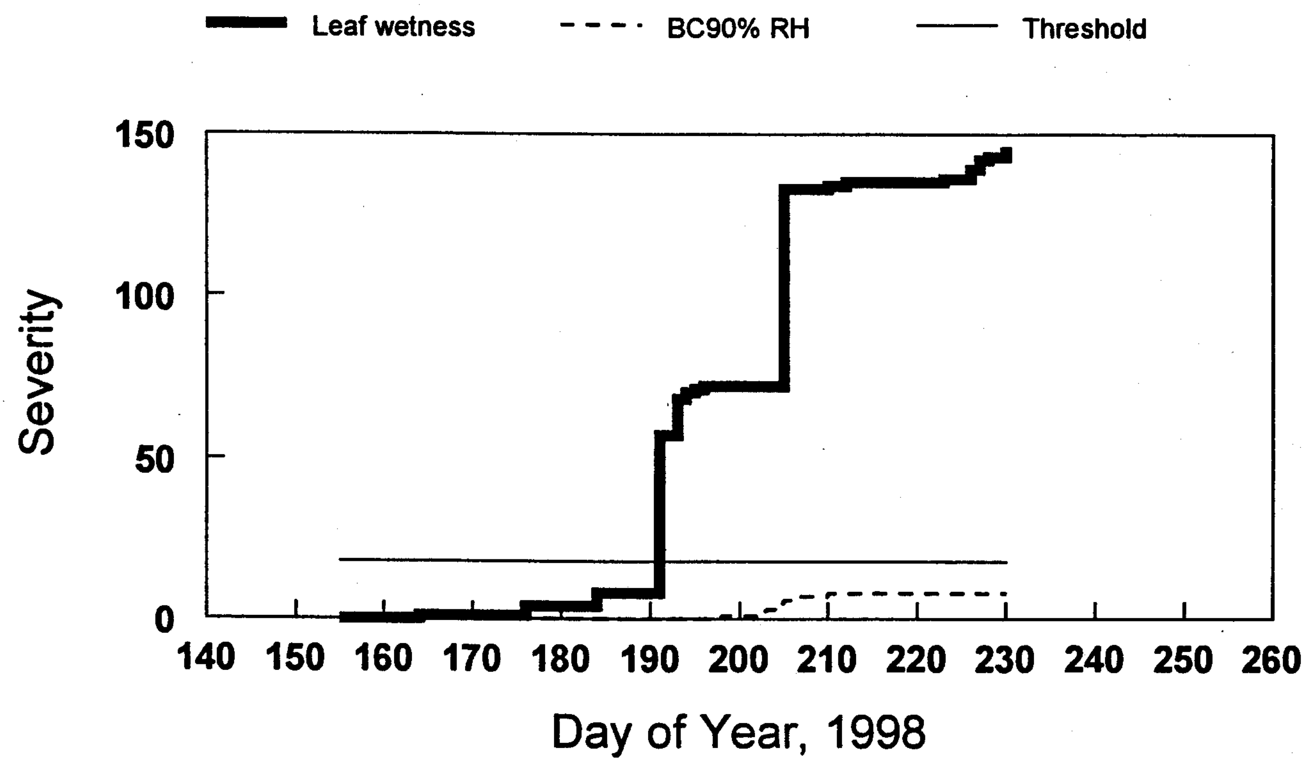

Figure 6. At Tulelake, CA, leaf wetness and conventional "Blitecast" accumulated severity values provided markedly different results, Malheur Experiment Station, Oregon State University, Ontario, OR 1998.

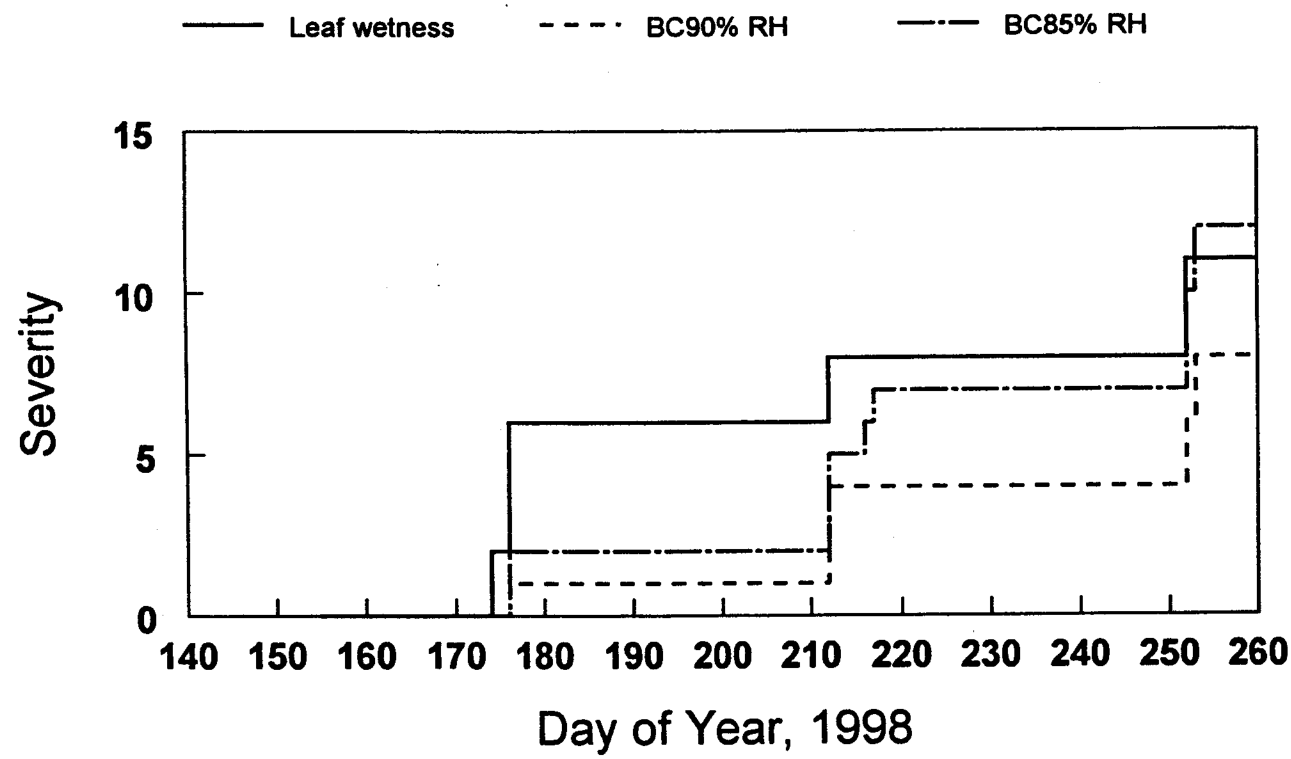

Figure 7. Leaf wetness severity compared with values based on 85 and 90 percent relative humidity in the plant canopy for Treasure Valley drip-irrigated potatoes, Malheur Experiment Station, Oregon State University, Ontario, OR, 1998.

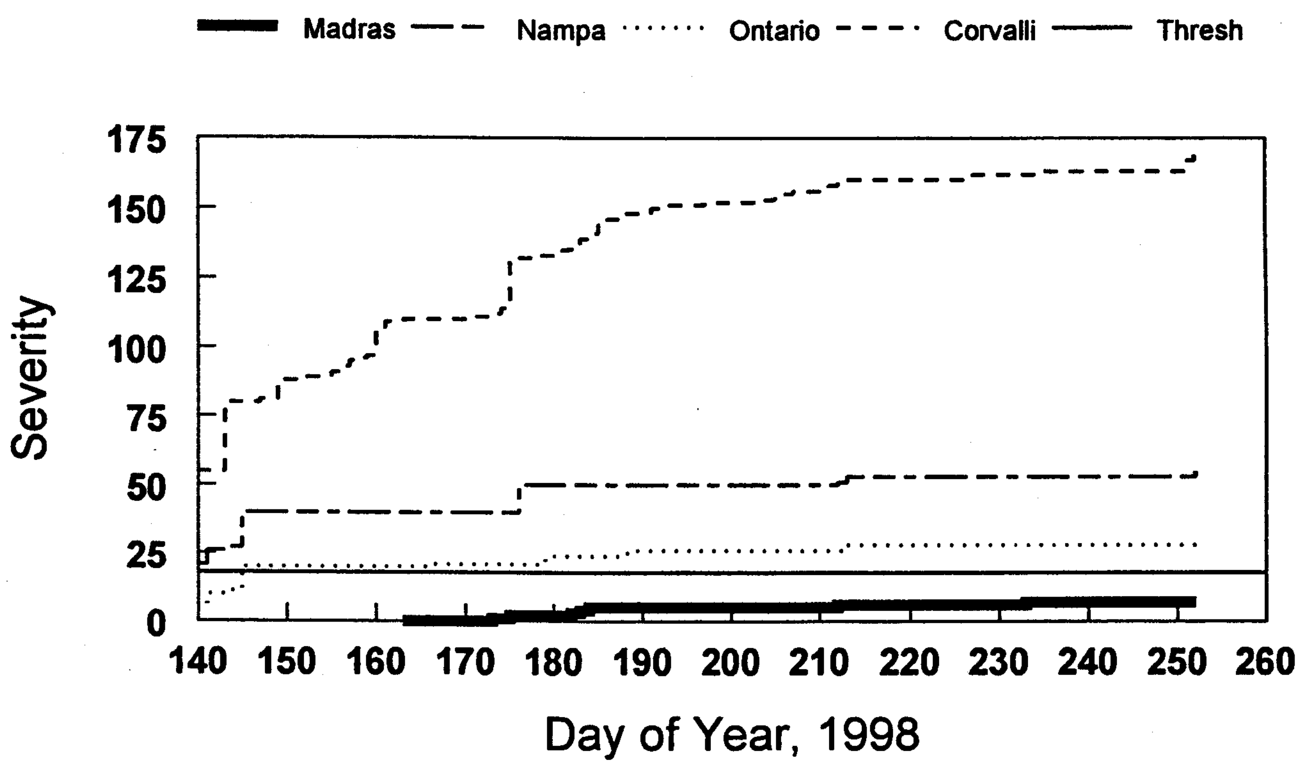

Figure 8. Accumulation of severity values to predict potato late blight based on 80 percent relative humidity and air temperature at AgriMet weather stations in Corvallis, Madras, and Ontario, OR, and in Nampa, ID, Malheur Experiment Station, Oregon State University, Ontario, OR, 1998.