CAPCA ADVISER

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MAY / JUNE 1996

A Weather Network To Support Crop Disease Management Decisions

A grant from US EPA will help to advance development and validation of crop disease models to aid decision making.

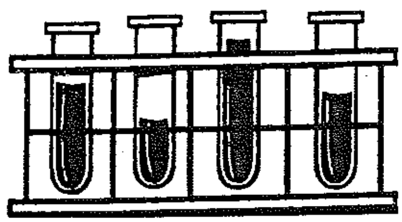
The overall goal of the new project is to expand the use of computer-based crop disease forecasting to improve the timing of fungicide applications. The project will

- develop a public–private weather network in support of research and validation of disease models and
- promote crop disease model research, validation, and outreach to encourage adoption of this new technology.

In recent years public and private sector scientists have made progress in developing models that describe the relationships between environmental variables and disease development. The proposed network will allow validation of these models to make sure that they will work across the California growing areas. After a model is validated, however, PCAs and growers will be updated on use of the new technology and can use either their own or a representative weather station in conjunction with the model to make control decisions.

COOPERATION

A large number of models, crops, and regions can be supported with the participation of the agricultural in-



dustry as funding partners. The US EPA funds will be used primarily for central costs of the network.

A possible scenario for cooperative development of the network includes

- funding for a local acquisition system, its installation and maintenance, phone lines, antennae, software, etc., from the EPA funds.
- purchase of most weather stations by the ag industry.
- on-going station maintenance to be supported by the purchaser.
- a county Cooperative Extension office to house and take care of the local acquisition system.
- UC IPM's computer to gather data from all locations for quality control, storage and dissemination.
- advisers, specialists, and other scientists to carry out field monitoring and field and weather data analysis, funded by traditional funding sources.

see, **Crop Disease,** *page 6*

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Please excuse the typo in the last issue of *CAPCA Adviser*—the computer blinked and deleted four words from the announcement of Ms. Wendy Jenks as the new Executive Director of the Stanley W. Strew Educational Fund.

Crop Disease, *continued from pg. 1*

THE WEATHER NETWORK

Many weather stations examined by the project steering committee have the potential to meet the needs of this project, and most can also provide features such as frost alarms and data for calculating degree-days, irrigation scheduling. The steering committee is currently working with the UC Davis purchasing department to find the manufacturers that can provide the most appropriate product for the best price. Growers, PCAs, and others joining with the project will be able to take advantage of the work going into equipment selection and the quantity pricing quoted to UCD.

Many stations from a variety of manufacturers are available. Stations purchased for this project need to be accurate and reliable; capable of storing data on-site and telemetering it to a remote computer; easy to set-up and use; compatible with the overall network; and competitive for start-up, operating, and maintenance costs.

The network will be made up of several subnetworks of stations that collect data locally, with further collection into UC IPM's statewide system. In configuring the network and determining the type of telemetry to use many issues are being considered, including presence of existing networks, and ability to build on them; regions, specific station locations, and terrain; and start-up, operating, and maintenance costs.

DISEASE MODELS

Many models in various stages of development have been identified by researchers (Figure 1). Table 1 lists those models.

WHAT'S NEXT?

Proposals for additions to the network

A call for proposals was issued in May asking for research, extension, and industry collaboration in requesting support for a weather network. PCAs and growers interested in participating should work with commodity groups or ask their local farm advisor for information about the status of disease modeling in their crop and opportunities for participation.

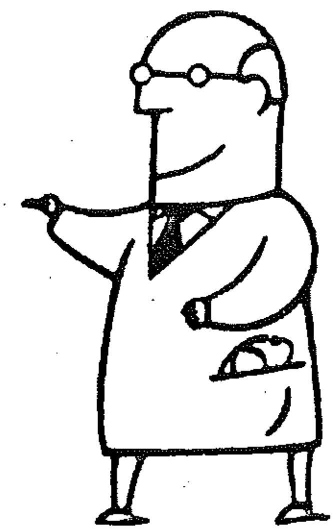

Figure 1 — Developing and Using a Crop Disease Model

Development—quantifies the influence of environmental and biological factors on disease

Validation—evaluates the model's ability to assess or predict disease

Implementation—growers and PCA's use the model to make disease management decisions

Stage 1: Model Developement		Stage 2: Model Validation		Stage 3: Model Implementation
• Biological model • Management model		• Initial validation • Region-specific validation		• Demonstration • Implementation
Requires Researchers *cooperating with* Extension	⇛	**Requires** Researchers and extension *cooperating with* PCA's and Growers	⇛	**Requires** PCA's and Growers *supported by* Extension and researchers

Table I — Crop Disease Models

Crop	Common Name	Stage of Developement
Almond	Shothole	I
Apple	Fireblight Scab	2
Carrot	Leaf blight	I
Celery	Celery blight	2
Grapes	Botrytis bunch rot	2-3
	Powdery mildew	3
Lettuce	Downey mildew	2-3
	Sclerotinia	I
Pear	Fireblight	2
	Scab	2
Pistachio	Alternaria late blight	I
Potato	Late blight	2
Processing tomato	Blackmold	2
	Late blight	2
Stone fruit	Brown rot	I
Strawberry	Botrytis	I
	Powdery mildew	I
Tomato	Powdery mildew	2
Walnut	Walnut blight	I

Additional information

- If you need someone to speak to a group about the project and how they can get involved, or
- If you want to be added to the mailing list to be kept informed of progress, contact Joyce Strand, UC IPM, Davis, CA 95616. (916) 752-8350, email: jfstrand@ucdavis.edu

Editors Note: CAPCA has been a member of the Disease Model and Forecasting Steering Committee since 1995. CAPCA will continue to participate on the Committee and disseminate this information to the PCA professionals.

IMPORTANT FACTS

The Measure of California Agriculture: Its Impact on the State Economy

THE FARMS

- California has 83,000 farms. The number of farms has remained nearly constant over the last 30 years.
- Farms and ranches occupy 30 million of California's 100 million acres. Crop production uses just 7.7 million acres of land, however. Most of the rest is rangeland.
- Land occupied by California's farms and ranches has decreased substantially over the last three decades. Since 1964, 7 million acres of farm land have been lost, mostly rangeland lost to urban growth. Total crop acreage has remained constant.
- The average size of California farms increased from 230 acres in 1940 to 493 acres in 1974. In the last two decades the average size has declined to 368 acres.
- The average California farm is almost 100 acres smaller than the national average.
- California farms average $82,710 each in net income, the highest in the nation and nearly four times the national average of $23,748.
- Corporate farms are a relatively modest part of California's agricultural picture. Some 5,400 California farms are corporations, and 4,700 of those are family operations.

Extracts from a research report by Harold O. Carter, Director of the UC Agricultural Issues Center, and George Goldman, economist, UC Berkeley College of Natural Resources, November 1992. The project was sponsored by the University of California's Division of Agriculture and Natural Resources, Kenneth R. Farrell, Vice President. For additional copies contact: Office of External Relations, (510) 987-0106.

Development of an Infection Model for Botrytis Bunch Rot of Grapes Based on Wetness Duration and Temperature

J. C. Broome, J. T. English, J. J. Marois, B. A. Latorre, and J. C. Aviles

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ABSTRACT

Broome, J. C., English, J. T., Marois, J. J., Latorre, B. A., and Aviles, J. C. 1995. Development of an infection model for Botrytis bunch rot of grape based on wetness duration and temperature. Phytopathology 85:97-102.

Grape berries were dipped in conidial suspensions of *Botrytis cinerea* and incubated for 4, 8, 12, 16, or 20 h of wetness at temperatures ranging from 12–30 C. Berries were infected after 4 h of wetness at all temperatures tested. Incidence of berry infection increased with increasing wetness duration at all temperatures. A multiple regression model described the logit of infection as a function of the interaction of wetness duration and temperature (R^2=0.75). This model was incorporated into an in-field environmental monitoring station and evaluated for two seasons on Thompson Seedless table grapes in the central valley of Chile. Applications of captan (3.2 kg/ha a.i.) or vinclozolin (1 kg/ha a.i.) were made according to the Botrytis model or a standard phenological spray program that consisted of four sprays (at bloom, cluster thinning, veraison, and preharvest) plus additional sprays after major rain events. Disease incidence and severity at harvest were similar whether applications were made according to a standard program (six to nine applications in 1991–1992, four to five in 1992–1993) or according to the Botrytis model (two to four applications in 1991–1992, zero to five in 1992-1993). In some vineyards, postharvest disease was significantly less when sprays were made according to the Botrytis model recommendations compared with the standard spray program.

Botrytis bunch rot, caused by *Botrytis cinerea* Perf.:Fr., is an important disease of grapes (*Vitis vinifera* L.) worldwide. The disease can be severe when prolonged periods of moisture coincide with preharvest berry ripening. Bunch rot can be controlled by canopy manipulations that enhance air flow around grape clusters, resulting in conditions unfavorable for *B. cinerea* (6–9,15). For example, on wine grapes in California, which often are supported on a vertical or divided trellis, leaves in the fruit zone are removed to reduce bunch rot development (8). In the event of prolonged rain, the effectiveness of canopy manipulations is reduced. Under such conditions, fungicide applications may be needed.

In Chile, most table grape vines are trained onto overhead arbors. Fruit in these canopies experience high humidity, low temperatures, and low light infiltration: conditions conducive to bunch rot (7). In Chile it is common for table grape growers to make 8–10 fungicide applications a year for control of Botrytis bunch rot. Benzimidazole resistance has been reported widely and there is evidence of resistance to dicarboximides (5).

Recently, research efforts have resulted in the development of models that relate the effects of environmental variables to diseases caused by *Botrytis* spp. (2,11,17,18), and a few models have been used to provide fungicide spray recommendations for control of these diseases (3,14,17). Typically the models have used in-field environmental monitoring stations that warn when conditions conducive to sporulation or infection occur, based on temperature, wetness duration, relative humidity, and crop phenology.

The objective of this study was to develop a model to characterize the infection response of inoculated grape berries in relation to wetness duration and temperature. This model was then validated and refined for two seasons in commercial table grape production vineyards in Chile.

COMPUTER-BASED WEATHER NETWORK IN NAPA VALLEY

Powdery mildew controlled with fewer fungicide applications

by Ed Weber, Dr. Doug Gubler, Ashley Derr

A new computer-based network of weather stations providing daily powdery mildew risk assessments allowed Napa Valley grapegrowers to tailor fungicide application schedules to weather conditions in 1995.

The 1995 grapegrowing year had very high powdery mildew disease pressure in vineyards throughout much of California, yet some Napa Valley growers who used the computer-based network were able to effectively control mildew while making fewer fungicide applications.

Spray/dust intervals were shortened during periods favorable to development of powdery mildew, and extended during periods unfavorable to mildew development. The result was effective mildew control with fewer fungicide applications made during the entire season.

The network utilizes weather stations and computer software from Adcon Telemetry. The weather stations, located in vineyards throughout Napa Valley, collect temperature, precipitation, relative humidity, and leaf wetness data at 15-minute intervals.

The data are transmitted via radio telemetry to a base station receiver located in the University of California Cooperative Extension office in Napa. The receiver automatically downloads the data to a personal computer where Adcon Telemetry's software can immediately plot the information in graphical form.

Dr. Doug Gubler, plant pathologist at U.C. Davis, recently developed a mathematical model to assess the risk of powdery mildew. The model examines temperature, relative humidity, leaf wetness, and precipitation information to determine the likelihood of powdery mildew development from ascospores and conidia, the two spore types responsible for powdery mildew infections. The Adcon Telemetry software utilizes this model and generates daily powdery mildew disease risk indices for every station in the network.

Growers who purchased weather stations and are part of the network connect with the base-station computer by modem and download data to their own personal computers, which have Adcon Telemetry software. They can download data generated by their own weather station and any other station in the network.

Growers can then generate their own up-to-date disease risk indices and weather summaries. The network is a great improvement over stand-alone weather stations because a grower with a single weather station can have access to information from all the stations on the network.

The Napa network

The network is a joint project of the University of California's statewide Integrated Pest Management project (UC IPM), UC Cooperative Extension, U.C. Davis Plant Pathology Department, Adcon Telemetry, and local growers. This network uses weather stations and computer software from Adcon Telemetry.

The network was established in March 1995 with weather stations in 12 vineyards transmitting data to the base station. By the end of the season, weather stations in 23 vineyards had been connected. Radio transmission from each station can extend over an unobstructed distance of 10-12 miles. Data from more remote stations is relayed through closer stations in the network in order to reach the receiver in Napa.

Adcon Telemetry weather station in a vineyard

This ability to link stations allows for development of an extensive network that can cover most of the Napa Valley. Currently, several stations are located in the Carneros region, with others near Napa, Yountville, Oakville, Rutherford, and Calistoga.

Mountains often present a problem for radio telemetry due to signal interference, however there are network weather stations located on Mt. Veeder, Spring Mountain, Diamond Mountain, and Howell Mountain.

The UC model

In most coastal California vineyard regions, powdery mildew infections begin in the spring with release and germination of ascospores from overwintering cleistothecia. When subsequent weather conditions are favorable, mildew can rapidly grow and produce conidial spores, leading to extensive secondary infections throughout the vineyard.

Dr. Gubler's UC model predicts release and infection by ascospores based on temperature and leaf wetness criteria. Knowing when infection occurs lets growers know when mildew is first likely to appear in the vineyards. Prior to ascospore infections, there is little likelihood of powdery mildew development. (In other parts of California, mildew often overwinters as mycelium in dormant buds. In these locations, ascospores are not necessary to start new powdery mildew infections.)

The UC model also generates a disease risk index for conidial spore development and infection. Mildew growth and development are directly influenced by temperature. Within the optimal temperature range of 70-85°F, rapid germination and growth occur. Above or below these temperatures, mildew development is slowed. Extended periods with temperatures above 91°F can kill the fungus. The disease risk index for conidial development is based on temperature. It can range from 0-100.

The disease index increases by 20 each day there are at least six hours with temperatures between 70°F and 85°F. In the spring, three consecutive days with temperatures in this range are required to trigger the index. Once triggered, the index goes up or down on a daily basis. On days with less than six hours in the 70-85°F temperature range, the index decreases 10 points. The index also goes down 10 points on days with a maximum daily temperature above 95°F. The index never goes below zero or above 100.

The risk for powdery mildew development is low when the index is below 30 and high when the index is above 60. During low-risk periods, spray/dust intervals can be extended as the conditions are unfavorable for mildew development. When the risk index is high, fungicides must be applied on a tight schedule.

Skipping applications or extending intervals when the risk index is high will likely result in significant powery mildew development in the vineyard. Table I gives examples of fungicide application intervals at various risk indices.

1995 risk indices

The 1995 risk indices varied for vineyards located in Carneros, Oakville, and Calistoga. Carneros is in the southern end of Napa Valley close to San Pablo Bay. It is one of the coolest portions of Napa Valley and powdery mildew frequently occurs there. Oakville is near the center of Napa Valley. Calistoga is in the much warmer north end with little maritime influence.

In Carneros, mildew pressure remained relatively low until mid-May due to cool temperatures. Spring temperatures were warmer in Oakville and Calistoga, resulting in higher spring mildew indices. Toward the end of May, indices jumped to high levels in all locations and stayed high through much of June. July indices remained high in Carneros, were intermediate in Oakville, and were low in Calistoga due to higher temperatures. August indices were high in Carneros, low/intermediate in Oakville, and low in Calistoga, again due to higher temperatures.

In Carneros in 1995, application intervals could have been stretched in the spring when the risk indices were low, but a tight schedule was necessary for the rest of the season. Intervals were longer in Oakville during early May and in August. In Calistoga, intervals were stretched in early May, July, and August.

Powdery mildew evaluations

As part of a research effort in California vineyards to validate various UC models, including the model for powdery mildew, 18 vineyards with network weather stations were monitored on a weekly basis for powdery mildew, Botrytis, and insect pests. Treatments for mildew in some vineyards were based on the UC model, while others were treated on a standard calendar regime. Researchers wanted to insure that no mildew developed that was unaccounted for by the model.

In five of the vineyards, the grower had comparison blocks where fungicide applications were either made on a typical calendar schedule or according to the UC model. These trials were also monitored weekly, for a total of 23 blocks monitored.

Monitored blocks ranged in size from five to 25 acres. At each site, 20 to 40 vines (approximately a 1% sample) were evaluated weekly. Several leaves and/or clusters were inspected per vine. Disease incidence was reported as the percentage of vines sampled that had any mildew present, while disease severity was an estimate of the percentage of infected berries in clusters with mildew.

Table II summarizes the fungicide applications and mildew status of the monitored vineyards at veraison. Spray records were obtained for 16 of the 18 monitored vineyards. Included were the five sites with trials comparing the UC model to the growers' standard powdery mildew control program. The number of applications reported in Table II are based on spray records from these 21 locations. The mildew data in Table II is based on monitoring results of all 23 blocks.

Table II shows that following the UC model for mildew development slightly reduced the number of fungicide applications with equal or improved disease control. However, the reduction in fungicide applications also varied geographically due to differing disease indices.

In Carneros, where mildew pressure remained high through most of the growing season, fungicide applications were as numerous in blocks treated by the model as in standard regime vineyards. This is not surprising since Carneros usually has a high incidence of mildew and the standard grower practice includes numerous fungicide applications.

In Oakville, (Table III), where the mildew index was relatively low in August, one sulfur dusting was eliminated by treating according to the model. Disease incidence was somewhat lower in the block treated according to the model, with a similar severity rating.

In Calistoga, (Table IV), where the index was low in July and August, three sulfur dustings were eliminated by treating according to the model. Disease incidence and severity ratings were similar in both blocks.

Table I
Examples of spray intervals for various fungicides during different mildew risk periods as calculated by the UC powdery mildew risk model.

	Powdery Mildew Risk Indices		
	Low	Intermediate	High
Fungicide type	0-30	30-60	60-100
Dusting sulfur	14 days	10 days	7 days
Micronized sulfur	18 days	14 days	10 days
DMI fungicides*	21 days (or label maximum)	17 days	14 days

*Demethylation inhibitors such as Bayleton, Rally, Rubigan.

Table II
Comparison of grape powdery mildew incidence at veraison in Napa Valley vineyards treated on a calendar basis or using the UC model for disease risk assessment.

			Powdery Mildew*	
Treatment Schedule	# Sites	# Applications	Incidence	Severity
Calendar	12	12.0	22.1%	7.1%
UC Model	9	11.4	15.6%	6.2%

*Mildew data based on 13 calendar sites and 10 model sites.

Table III
Comparison of grape powdery mildew incidence at veraison in blocks at the UC Oakville Experimental Vineyard treated on a calendar basis or using the UC model for disease risk assessment.

		Powdery Mildew	
Treatment Schedule	# Applications	Incidence	Severity
Calendar	10	38.1%	1.0%
UC Model	9	23.8%	1.3%

Table IV
Comparison of grape powdery mildew incidence at veraison in a Calistoga vineyard treated on a calendar basis or using the UC model for disease risk assessment.

		Powdery Mildew	
Treatment Schedule	# Applications	Incidence	Severity
Calendar	10	10.0%	1.0%
UC Model	7	11.8%	1.0%

Summary

Though 1995 was a year of extraordinarily high powdery mildew pressure, one to three fungicide applications were eliminated in some vineyards treated according to the UC model with no increase in powdery mildew.

In years with lower disease pressure, it is likely that more sprays can be eliminated. This can be seen in the data from Calistoga where three applications were eliminated as a result of a lower disease index. This reduction in fungicide applications is the reason why the UC IPM project is interested in seeing this technology brought into commercial use. It also helps growers justify the cost of investing in the network.

Besides the direct benefit in reducing fungicide applications, several growers have expressed more confidence in their control programs by having a better sense of how powdery mildew is developing in their vineyards. Being able to systematically evaluate the weather conditions on a daily basis as they relate to mildew development greatly increases the opportunity for effective disease control.

Kern County established a similar network in 1995 in table grape vineyards as part of the same research program conducted in Napa. Additional networks are being established in Sonoma, Mendocino, and Monterey counties. Producers of other commodities including strawberries, lettuce, and tomatoes are utilizing this technology for other diseases.

Growers not directly connected to a network may soon be able to retrieve disease risk indices through a plant pathology computer bulletin board system recently developed at U.C. Davis. The information may also be available through telephone/fax systems. ■

Ed Weber is UC Cooperative Extension Viticulture Farm Advisor in Napa County; Dr. Doug Gubler is Cooperative Extension Plant Pathology Specialist at U.C. Davis; Ashley Derr is research associate in Napa County.

For more information on equipment, capabilities and pricing, please contact AdCon Telemetry, P.O. Box 1053, Calisotga, CA 94515, tel: 707/942-2260.