

Evaluation Of Weather-Based Models For Management Of Onion Downy Mildew In California



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INTRODUCTION

- Onion downy mildew (caused by *Peronospora destructor*) has the potential to cause severe damage to onion produced for processing, bulb, or seed in California
- Weather models to detect favorable disease periods, including DOWNCAST, a variant of DOWNCAST, MILIONCAST, and ONIMIL, have been developed to describe the complex conditions required for downy mildew development
- These models were tested in wet oceanic or humid continental climates, and have not been evaluated in the climate of California production regions
- Fungicides are often most effective when applied preventatively before conditions are favorable for disease, but little information is available on the practical use of the models for timing fungicide applications
- Few tools are available for growers to employ the models in commercial production

OBJECTIVES

- Evaluate the effectiveness of weather-based models for scheduling fungicide applications for downy mildew management
- Adapt the models into program that can be accessible to weather stations in commercial fields

METHODS

- Small-plot trials of dehydrated onion were established in October of each year at two locations in Imperial County within the low desert production region: Holtville, CA from 2018 to 2022 and Brawley, CA, from 2020 to 2022. Six seed lines (2.5 in. apart) were planted in beds with 40 in. center spacing.
- Plots measured 2 beds x 25 ft., and were arranged in a randomized complete block with six replications. Plots were separated by 1 to 2 untreated buffer beds
- Timing treatments were: fungicide applications made in response to triggers from one of several models; a standard calendar interval; and non-treated controls (Table 1). One fungicide rotation was used for all timing treatments (Table 2)

Table 1. Fungicide timing treatments.

| Trt # | Model | Interval |
|-------|---------------------------------|----------------------------|
| 1 | Standard Calendar | 7 or 14 |
| 2 | DOWNCAST | Model trigger ^b |
| 3 | DOWNCAST de Visser ^a | Model trigger |
| 4 | DOWNCAST Guelph ^a | Model trigger |
| 5 | MILIONCAST | Model trigger |
| 6 | ONIMIL | Model trigger |
| 7 | Non-treated | - |
| 8 | Non-treated | - |

^a Modifications of the base DOWNCAST model; ^b Applications were made when model indicates conditions in the canopy are favorable for disease

Table 2. Fungicide rotation used for all timing treatments.

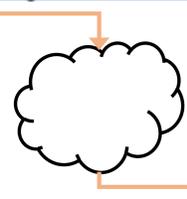
| Code | Product | Rate/A |
|----------------|-------------------------|------------------|
| A ^a | Ridomil Gold Bravo | 2.5 pt |
| B | Dithane F-45 | 2.4 qt |
| C | Orondis Ultra | 5.5 fl oz |
| D | Reason | 5.5 fl oz |
| E | Presidio + Dithane F-45 | 4 fl oz + 2.4 qt |
| F | Zampro | 14 fl oz |

^a For each timing treatment, applications were made in this rotation order when a given model was triggered for the model treatments or on a defined interval for the standard calendar treatments

Monitoring and Alert System



Temperature/relative humidity (canopy), leaf wetness (canopy x2), rain (6 ft)



Model calculations performed in cloud

Report on onion downy mildew favorability for today and the past week at Colusa. Favorability is based on conditions in the canopy measured by an in-field weather station. Date refers to the date of the model run, which occurs in the afternoon. Results for each 6 night through 12:00 PM local time that day.

| Downy Mildew Favorability - Raw Output | | | | | | | | | | |
|--|--------------|--------------|--------------|--------------|------------|---|---|---|---|---|
| | DOWNCAST | DC deVisser | DC Guelph | ONIMIL | MILIONCAST | | | | | |
| | spore infect | spore infect | spore infect | spore infect | spore | | | | | |
| 2021-04-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2021-04-21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2021-04-22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2021-04-23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2021-04-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2021-04-25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Possible values for each model are as follows.

Results delivered daily by email

RESULTS

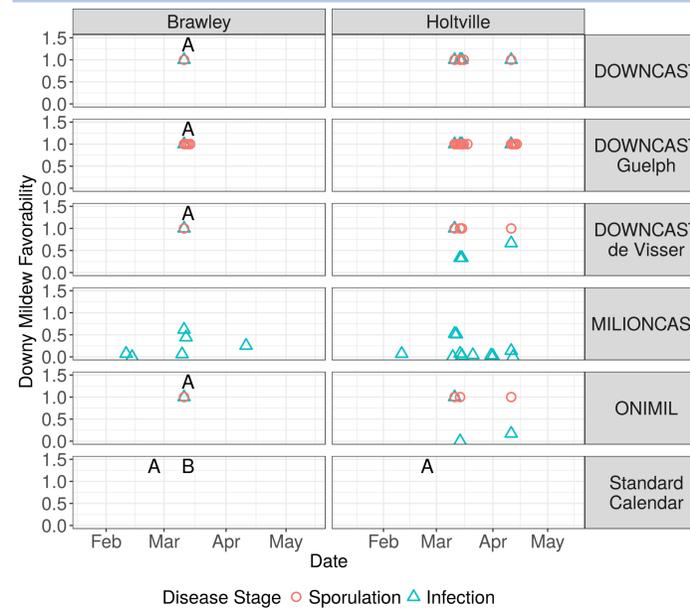


Figure 1. Weather model output at Brawley and Holtville in the 2019-2020 season. Data points indicate conditions from 0800 the previous morning through 1200 the current day were favorable for downy mildew. Values are determined by converting raw model output to a 0 to 1 scale. DOWNCAST and the de Visser and Guelph variants are limited to two (0 or 100%) to four (0, 33, 67, or 100%) discrete values, whereas MILIONCAST and ONIMIL has a continuous range from 0 to 100%. Fungicide application dates are indicated by the fungicide rotation letter code that was applied on that date.

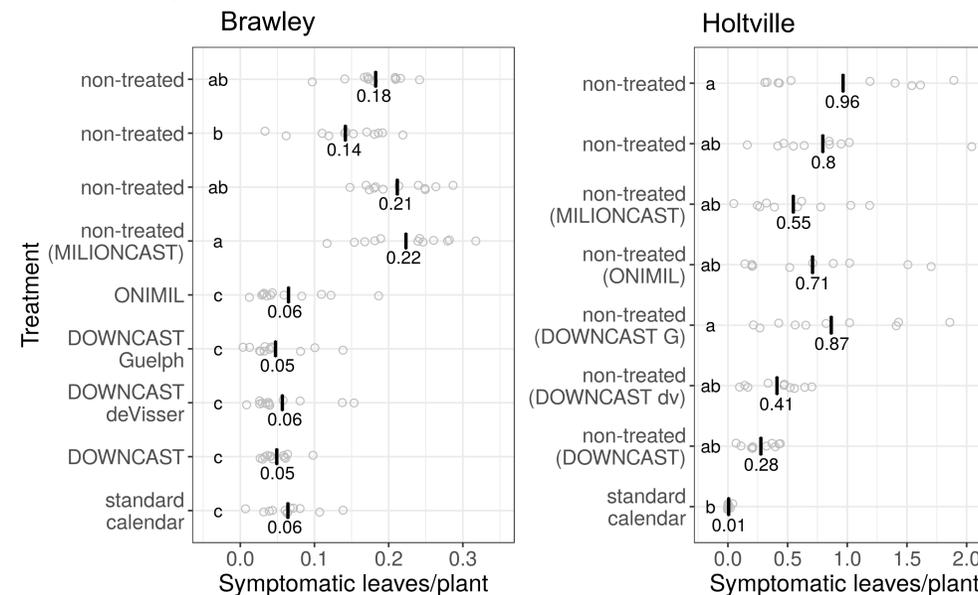


Figure 2. Downy mildew incidence at Brawley (14 April) and Holtville (10 April) in the 2019-2020 season. Treatments labeled as "non-treated" did not receive any fungicide, although most were assigned to model-based treatments in parentheses. Raw data from each replicate plot (n=5) and bed within each plot (n=2) are shown as hollow circles. Vertical bars and the associated number label indicate the treatment means. Treatments associated with the same letter are not significantly different.

- Downy mildew pressure was low in Imperial County in 2017-2018 and 2018-2019, and disease was not observed in our trial despite one to two model trigger events during 2018 (Table 3)
- Downy mildew pressure was high in the region in 2019-2020 and downy mildew was observed at both locations. Model triggers occurred on March 11 at both locations and on April 11 at Holtville (Figure 1)
- At Brawley, downy mildew incidence was a statistically significant 70% lower on average in treated plots compared to non-treated plots (Figure 2)
 - The standard calendar (2 applications) and the four model treatments (1 application) provided statistically similar levels of control
- At Holtville, the standard calendar treatment, which received a single application on Feb. 25, provided nearly complete disease control, but this treatment was not statistically different from some non-treated plots (Figure 2)

Table 3. Total number of fungicide applications and model alerts.

| Year | Location | Std Cal | Timing Treatment ^a | | | | | ONIMIL |
|------|-----------|---|-------------------------------|--------------------|---------------------|--------------------|--------------------|--------|
| | | | DOWNCAST | DC de Visser | DC Guelph | MILIONCAST | CAST | |
| | | # fungicide applications (# model alerts) | | | | | | |
| 2018 | Holtville | 4 (-) | 1 (1) | 2 (2) | 1 (2) | - ^b (6) | 0 (0) | |
| 2019 | Holtville | 2 (-) | 0 (0) | 0 (0) | 0 (0) | - (8) | 0 (0) | |
| 2020 | Brawley | 2 ^c (-) | 1 (1) | 1 (1) | 1 (4) | - (23) | 1 (1) | |
| 2020 | Holtville | 1 (-) | 0 ^c (5) | 0 ^c (8) | 0 ^c (12) | - (31) | 0 ^c (3) | |
| 2021 | Brawley | 0 (-) | 0 (0) | 0 (0) | 0 (0) | 0 (1) | 0 (0) | |
| 2021 | Holtville | 1 (-) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | |

^a Timing treatments were: Std Cal, standard calendar intervals; or made in response to weather-based models DOWNCAST, DOWNCAST de Visser, DOWNCAST Guelph, MILIONCAST, or ONIMIL
^b MILIONCAST was not implemented in the model system until the 2021 season
^c Additional applications were required for these treatments, but were not made due to a combination of flooded conditions and COVID travel restrictions

KEY POINTS

- Weather-based fungicide application schedule can reduce the number of fungicide applications under no to low disease pressure
- An application made prior to or immediately during a favorable period can reduce downy mildew under low to moderate disease pressure
- We developed a minimally functional version of a cloud-based alert system that sends model results in daily emails
- Models assess conditions measured in the onion canopy for the past day

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