

Sunset Vista Spray Advisor

User Manual

Vineyard Spray Timing & Phenology Decision-Support Tool

Sunset Vista Enterprises / Vineyards

Petite Pearl · Marquette · Prairie Star · La Crescent · Frontenac Blanc

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1. Overview

Sunset Vista Spray Advisor is a web-based decision-support tool that combines a local Ambient Weather WS-2902 station with the National Weather Service (NWS) forecast to help time fungicide spray applications, track vine growth stage (phenology), and manage product rotation across the vineyard's five cold-climate hybrid blocks.

The application is not a substitute for scouting the vineyard, reading product labels, or professional agronomic judgment. It is a tool for organizing weather data, tracking cumulative conditions over time, and surfacing recommendations — the grower makes the final call on every spray decision.

1.1 What the application does

- Pulls current conditions from the on-site Ambient Weather station every 15–30 minutes.
- Pulls a multi-day forecast from the National Weather Service and identifies dry spray windows.
- Tracks Growing Degree Days (GDD) per block to estimate bud break, veraison, and harvest timing.
- Runs three disease risk models — powdery mildew, downy mildew, and black rot — from accumulated weather data.
- Recommends a next spray date and product per block, accounting for interval, rain, disease pressure, and fungicide resistance (FRAC) rotation.
- Logs every spray application actually applied, building a season history per block.
- Tracks Restricted-Entry Interval (REI) and Pre-Harvest Interval (PHI) for the most recent application per block.

1.2 What the application is not

- It does not replace visual scouting for disease symptoms.
- It does not know your actual spray equipment, coverage quality, or local microclimate variation across the vineyard.
- It does not verify current product labels — label data in the app is a starting reference, not a legal source.
- It does not send alerts or notifications on its own (there is no email/SMS integration at this time).

2. Getting Started

2.1 Logging in

The application uses a single administrator password. Navigate to the site's login page and enter the password configured during setup. A session remains active in the browser until you log out or the session expires.

2.2 Navigation

Every page shares a consistent header with links to:

- Dashboard — the main view (current conditions, forecast, and per-block spray recommendations).
- Log a spray — record a fungicide application against a block.
- Phenology — record observed bud break, veraison, and harvest dates.
- Settings — station configuration, spray timing thresholds, mid-season setup, and the block/product libraries.
- Log out.

3. The Dashboard

The dashboard is the main working screen. It is organized top to bottom as follows.

3.1 Current conditions

Shows the most recent reading pulled from the Ambient Weather station: temperature, humidity, wind speed, rain accumulated today, and the timestamp of the last successful reading. A "Fetch weather now" button sits to the right of this panel — it pulls one reading on demand, useful for testing the station connection without waiting for the next scheduled poll. Hover over the button for a description of what it does.

If no reading has been stored yet, this panel instead shows a diagnostic summary of the current Ambient Weather configuration (with API keys partially masked) and a suggestion of what to check next.

3.2 Forecast summary

Below the current conditions, a three-column row shows:

- Forecast — the detailed NWS forecast text for the current day's period.
- Next rain chance over the configured threshold — the next upcoming forecast period whose precipitation probability exceeds the rain probability threshold set in Settings, or a note that no rain is expected within the visible forecast window.
- Forecast as of — the date and time the cached NWS forecast was last refreshed, so it's clear how current the forecast data is.

3.3 Vineyard-wide disease pressure summary

A single-line summary shows the current site-wide risk level for all three disease models (see Section 6), each shown as a colored chip: light green for low risk, yellow for moderate, light red for high, and solid dark red for severe.

3.4 Per-block recommendation cards

One card is shown per vineyard block (variety). Each card includes:

- A status pill — Overdue, Due soon, On schedule, or Awaiting dry window.
- Last sprayed — date and product of the most recent logged application for that block.
- REI — the Restricted-Entry Interval for the last product applied, showing whether it is still active (bold red) or has cleared, with the clearance date/time.

- **Schedule due** — the date the interval-based schedule calls for, and the interval actually used (which may be shortened from the base interval if disease pressure is elevated).
- **Spray Window** — the recommended spray date, and how many days afterward the forecast stays clear of rain above the configured threshold.
- **Disease risk chips** — the same three-model summary as the vineyard-wide row, in this block's context.
- **Suggested next product** — a specific product recommendation with a rationale (see Section 5.3).
- **Phenology** — current growth stage and progress toward the next stage, shown as a progress bar with GDD remaining.
- **Warnings** — e.g. an active PHI restriction, or a black rot / severe downy mildew alert.
- **Variety-specific disease notes** — general susceptibility context for that variety.

4. Weather Data Integration

4.1 Ambient Weather station

A scheduled job (cron/fetch_weather.php) polls the Ambient Weather cloud API on an interval configured in Settings (typically every 15–30 minutes) and stores each reading in a monthly JSON file (data/weather_readings/YYYY-MM.json). Readings include temperature, humidity, dew point, wind speed/gust/direction, rainfall (hourly rate, daily total, event total), solar radiation, UV index, and barometric pressure.

The application does not assume a dedicated leaf wetness sensor is attached to the station. Leaf wetness is instead estimated from a dew-point-spread proxy (temperature minus dew point at or below a configurable threshold counts as "wet") combined with measured rainfall. If a true leaf wetness sensor is added later, this can be switched on in configuration.

4.2 National Weather Service forecast

A separate daily job (cron/daily_rollup.php) fetches the standard NWS 7-day forecast for the vineyard's coordinates (resolved automatically to an NWS gridpoint from latitude/longitude) and caches it for use by the dashboard and the spray recommendation engine.

4.3 Reading frequency and disease model accuracy

All "hours" figures used by the disease risk models (Section 6) are computed from the actual elapsed time between consecutive station readings, not from a count of readings. This means the disease models produce the same result regardless of whether the station is polled every 15 minutes or every 30 minutes — a more frequent polling interval only improves how quickly the dashboard reflects current conditions, not the accuracy of the disease risk calculations themselves.

If two consecutive readings are more than a configured maximum gap apart (default 2 hours — indicating a cron outage or station dropout), that gap is excluded from all continuous-hours and total-hours calculations rather than being counted as qualifying time.

5. The Spray Recommendation Engine

For each block, the recommendation engine combines four inputs to arrive at a recommended spray date and product: the interval schedule, current disease pressure, the forecast, and fungicide rotation history.

5.1 Interval scheduling

Each block has a base target spray interval (typically 9–10 days) and a minimum interval (a hard floor, typically 7 days, to avoid over-application). The schedule due date is the last application date plus the effective interval.

5.2 Disease-pressure interval shortening

The base interval can be shortened — never lengthened — when disease pressure is elevated:

- The powdery mildew risk index directly maps to a suggested interval (14 days when low, 10 when moderate, 7 when high).
- A "high" or "severe" downy mildew risk shortens the interval to 7 days if it would otherwise be longer.
- A black rot infection event (see Section 6.3) shortens the interval to 7 days if it would otherwise be longer.

The effective interval is always the shortest of these, but never shorter than the block's configured minimum interval.

5.3 Rain avoidance and the dry-window search

Starting from the schedule due date, the engine scans forward through the cached NWS forecast looking for a run of consecutive days — the configured rain avoidance window, typically 4 days — where no day's precipitation probability meets or exceeds the configured rain probability threshold (Settings, default 40%). The first qualifying date becomes the recommended Spray Window date. The dashboard also reports how many additional days beyond that date stay clear of rain in the visible forecast, marked with a "+" if the forecast horizon runs out before any rain appears (a lower bound, not a guarantee).

5.4 Product rotation (FRAC group management)

Each fungicide product is tagged with its FRAC (Fungicide Resistance Action Committee) group and a maximum number of consecutive applications allowed before rotating to a different mode of action. When suggesting the next product, the engine:

- Excludes any product whose FRAC group was just used at its consecutive-use limit.
- Prioritizes products that target whichever disease(s) currently show elevated risk.
- Falls back to routine broad-spectrum protectant coverage when no disease is currently elevated.

Multi-site protectants (FRAC group "M", e.g. Captan and Manzate) carry low resistance risk and can be used more flexibly than single-site products, but should still be alternated with single-site products (e.g. Rally, Quintec) for broader disease coverage.

5.5 REI and PHI tracking

Each block card shows the Restricted-Entry Interval (REI) for the most recently applied product, calculated from midnight of the logged application date (applications are logged by date only, not time

of day, so the actual clearance time may be up to several hours later than shown). A warning is also raised if the Pre-Harvest Interval (PHI) for the last product has not yet elapsed.

6. Disease Risk Models

The application implements simplified versions of three widely referenced grape disease risk models. These are decision-support aids based on established general principles in grape pathology — they are simplifications of more complex field models used in extension and research settings, tuned to work from a single on-site weather station rather than a networked array of sensors.

6.1 Powdery mildew — simplified Gubler-Thomas risk index

Based on the University of California, Davis Powdery Mildew Risk Index concept. The model tracks a running index that:

- Increases by 10 points on any day with 6 or more continuous hours between 70–90°F (the fungus's optimal development range).
- Decreases by 10 points on a day with no qualifying stretch.
- Decreases by 20 points on a day with 4 or more total hours above 95°F (sustained heat suppresses the fungus).

The index (floored at zero) maps to a risk label and a suggested spray interval:

Index range	Risk label	Suggested interval
0 – 30	Low	14 days
31 – 60	Moderate	10 days
61+	High	7 days

6.2 Downy mildew — simplified "10-10-24" rule

Based on the traditional "10-10-24" infection-risk guideline (10°C / 50°F minimum temperature, 10mm recent rain, 24-hour high-humidity/wetness window). The model checks three conditions over a rolling 24-hour window:

- Overnight low temperature at or above 50°F.
- At least 0.1" of rain in the prior 24 hours.
- At least 4 hours of estimated leaf wetness overnight.

The number of conditions met maps to a risk label: 0 = Low, 1 = Moderate, 2 = High, 3 = Severe.

6.3 Black rot — temperature-dependent wetness duration (Mills-table style)

Based on the classical relationship between temperature and the minimum leaf-wetness duration required for black rot infection (the cooler the temperature, the longer the required wetness period). The model checks the estimated wetness duration during a wet period against a lookup table:

Average temperature during wet period	Wetness hours required for infection
50 – 53°F	24 hours
54 – 59°F	18 hours
60 – 68°F	12 hours
69 – 86°F	8 hours
87 – 95°F	12 hours

Outside the 50–95°F range, infection is treated as unlikely regardless of wetness duration.

6.4 A note on model simplification and accuracy

These models are simplifications intended for a single-station, JSON-file-based deployment — they are not the exact field-validated models used in university extension decision-support systems, which often incorporate networked sensor arrays, canopy-level microclimate data, and inoculum/spore-trap monitoring. They should inform, not replace, direct scouting of the vineyard for disease symptoms.

7. Growing Degree Days & Phenology Tracking

7.1 GDD calculation method

Growing Degree Days are calculated using the standard "average method": daily GDD = maximum(0, ((daily high + daily low) ÷ 2) – base temperature). The base temperature is 50°F, and accumulation resets each year on April 1st — both standard conventions for cold-climate grape GDD tracking.

7.2 Phenology stage thresholds

Each block has three GDD thresholds marking estimated bud break, veraison, and harvest readiness. Because there is no single universally published GDD model for these particular cold-climate hybrid varieties, the thresholds shipped with the application are starting estimates drawn from general cold-climate hybrid viticulture guidance — not measurements taken at this specific site. The current default thresholds are:

Block / variety	Bud break (GDD)	Veraison (GDD)	Harvest (GDD)
Petite Pearl	100	1,700	2,400
Marquette	90	1,550	2,200
Prairie Star	95	1,500	2,100
La Crescent	105	1,600	2,250
Frontenac Blanc	90	1,650	2,300

7.3 Recording actual observations

The Phenology page lets you record the actual date each stage is observed in each block. After a season or two of recorded observations, the GDD thresholds in Settings should be updated to match this vineyard's real accumulation, which will be substantially more accurate than the generic starting estimates.

8. Logging Spray Applications

The Log a spray page records every application actually made: block, product, date, rate/mix notes, and free-text notes. A snapshot of weather conditions at the time of logging is stored alongside the entry where available. This log is the single source of truth the recommendation engine uses for "last sprayed," REI/PHI tracking, and FRAC rotation history — recommendations will only be accurate if applications are logged promptly, including historical applications when first setting up the application mid-season.

9. Fungicide Product Library

The product library (Settings → Fungicide products) defines every product the recommendation engine can suggest, along with its resistance-management and label data. The library ships with the following four products:

Product	Active ingredient	FRAC group	Type	PHI	REI	Targets
Captan	captan	M4	Multi-site protectant	0 days	48h	Botrytis, anthracnose, phomopsis
Manzate	mancozeb	M3	Multi-site protectant	66 days	24h	Downy mildew, black rot, phomopsis, anthracnose
Rally 40WSP	myclobutanil	3	Systemic (DMI/SI)	14 days	24h	Powdery mildew, black rot, anthracnose
Quintec	quinoxifen	13	Protectant only	21 days*	12h	Powdery mildew only

**Quintec's PHI varies between 14 and 21 days across different state/formulation labels. The library defaults to the more conservative 21 days — always confirm against the physical label in hand.*

Rally and Quintec are single-site products limited to 2 consecutive applications before a mandatory rotation to a different FRAC group. Captan and Manzate are multi-site protectants with low resistance risk and no consecutive-use limit, though rotation with single-site products is still recommended for broad disease coverage.

All product data is editable in Settings and nothing about it is hardcoded into the recommendation logic — PHI, REI, FRAC group, targets, and rotation limits can all be adjusted as labels change or new products are added.

10. Settings

10.1 Ambient Weather station

Application Key, API Key, station MAC address, and vineyard latitude/longitude are configured here. A "Test Ambient Weather connection" button confirms the API credentials work independently of the scheduled cron job.

10.2 Spray timing thresholds

The rain probability threshold (default 40%) used by the dry-window search (Section 5.3) is configured here.

10.3 Mid-season setup

When starting the application partway through a growing season, this section allows entering a starting cumulative GDD value per block (as of a chosen date) and a starting vineyard-wide powdery mildew index, so tracking begins from an accurate baseline rather than zero. Submitting a value here replaces any GDD tracking already recorded for that block, so it is intended as a one-time starting point rather than a routine edit. Historical spray applications and phenology observations already made this season should be entered on the Log a spray and Phenology pages, both of which accept backdated entries.

10.4 Blocks and products (advanced)

Direct JSON editors for the block/variety library and the fungicide product library, for changes beyond what the standard forms cover (e.g. adding a new block or product, or adjusting phenology thresholds after a season of observation).

11. Automation (Scheduled Jobs)

Two scheduled jobs keep the application's data current:

- `fetch_weather.php` — runs every 15–30 minutes; pulls the latest station reading and appends it to the current month's weather log.
- `daily_rollup.php` — runs once daily; computes the prior day's GDD contribution and disease risk index updates, and refreshes the cached NWS forecast.

Both jobs log their activity, and errors are recorded to an application error log for troubleshooting.

12. Data Storage and Security

The application stores all configuration and data as JSON files rather than in a database — weather history, spray logs, phenology observations, GDD accumulation, and disease risk history are each a plain JSON file. This keeps the application portable and easy to inspect or back up directly, at the cost of the query flexibility a database would offer; this tradeoff is appropriate at the scale of a single vineyard operation.

Access to the application requires a single administrator password (stored as a bcrypt hash, never in plain text). Configuration and data directories are protected from direct web access as a defense-in-depth measure, independent of how the web server's document root is configured.

Appendix A: Quick Reference — Status Meanings

Status	Meaning
Overdue	Past the schedule due date — spray as soon as a dry window allows.
Due soon	Within 2 days of the schedule due date.
On schedule	A recommended dry window has been identified ahead of the due date.
Awaiting dry window	Due, but no qualifying rain-free stretch found yet in the current forecast — check back as the forecast updates.