Vinewise℠

Washington Guide to Sustainable Viticulture

SOIL MANAGEMENT

HOW SHOULD I MANAGE MY SOIL?

The long-term viability of the vineyard is dependent on its foundation, the soil. Soil management includes managing the soil in new and existing vineyards, nutrient management of the soil and plant, and managing the surface of the soil through the use of cover crops.

CHECKLIST OF QUESTIONS TO ANSWER

New Vineyard

1. Are any site modifications needed?

To determine if ripping is required, answer the following questions:

- What are the root zone requirements of the variety or varieties to be planted?
- Are there any root growth restrictive zones or compacted layers?
- If yes, ripping should be considered.
- If no, ripping likely is not needed.

2. How variable is the site?

- If very uniform, ripping is not likely needed.
- If there is a lot of variability in soil depth or presence of restrictive zones, rip the entire vineyard to improve uniformity.

3. Is land leveling needed?

- Minimize or avoid this practice. Grapes generally tolerate slopes and land leveling frequently exposes less desirable soil.

4. How do I determine if I need variable rate soil amendment applications?

- An electromagnetic conductivity (EMC) survey is easily conducted on bare soil for a new vineyard. Two types of EMC surveys are commercially available, either using VERIS or EM38 equipment. Surveys can show areas of variability in the field and can be used to decide where soil samples should be collected.
- Collect soil samples for soil pH analysis. Other things to measure are electrical conductivity (EC) and nutrients.

5. What soil amendments (including plant nutrients) should I apply?

- Apply lime and/or sulfur based on field soil testing using variable rate fertilizer application technology to improve uniformity of soil pH.
- Prior to planting a new vineyard, phosphorus, potassium, zinc and plant-available sulfur (sulfate form) should be applied based on field soil testing.

6. What if this is an organic vineyard?

- For organic grape production, a base level of organic matter should be added and incorporated before planting.

Existing Vineyard

1. How should I manage the soil of an existing vineyard?

- Is irrigation water infiltration adequate or is there runoff?
- If there is runoff, consider tillage or shallow ripping between rows, planting cover crops, or applying less water.
- Regular tilling of the soil to reduce weed pressure is a common practice when producing organic grapes but it will increase the risk of deep soil compaction and can encourage erosion and mite problems. Avoid tillage when possible; vary your method and depth of tillage to reduce compaction risk.

2. Is water quality changing your soil chemical properties?

- Monitor soil pH and EC yearly, especially in vineyards with variability. In drip systems, monitor drip zones periodically (every 4 - 5 years).

3. How do I determine a fertilization program?

- Fertilization applications should be based on annual replacement values, soil analysis, crop yields and other factors.
- Soil analysis should be conducted every 3-5 years, with soil adjustments made.

Plant Tissue Analysis

1. Are nutrient amendments needed for canopy and fruit quality management?

Annual sampling at the same growth stage and tracking results will help determine the effectiveness of fertilizer adjustments and identify long-term trends. (Although petiole sampling is a traditional practice in most grape regions, recent Washington State University research has shown that leaf blade sampling is considered more accurate in the dry irrigated soils of the inland Pacific Northwest and that the best time to collect samples is at veraison.)

a. Assessing nutrient needs:

- Sample whole leaf or leaf blade at 30-60 percent bloom and at 40-60 percent veraison for nitrogen. Bloom tissue sampling can confirm any nutrient values outside the range of the previous year's veraison results. Sampling at bloom should be practiced in conjunction with veraison sample collection and analysis. (Note: values are very dependent on irrigation water timing; be consistent and sample at the same time each year.)
- If leaf tissue is low in one or more nutrients, collect a soil sample to determine if the limitation is soil or plant driven.

- Visually observe the canopy for vigor and color. (N can be low in plant tissue in a high vigor situation due to excess growth spreading the N across a large tissue mass.)

b. Other considerations

- Grapes are perennial crops and many nutrients are stored and located in the roots and wood. If a change in nutrient management is needed, make changes slowly over time and evaluate the effects through tissue monitoring.
- When trying new products, especially non-conventional products, treat only part of the field and compare to the area where it was not used.

2. How do I manage nutrients in organic production?

- Nutrient management in organic production is a long-term process. Since nutrients are largely supplied through the decomposition of organic materials, only a portion of the nutrients in the organic matter is released in a single year. Add new organic matter regularly over time to replenish the system.
- Regular additions will eventually result in some 'left over' organic matter for the next season because only a portion is broken down into plant-available nutrients each year.
- Over time, the amount of additional organic matter needed will decrease.

3. How do I add nutrients to non-organic vineyards?

Plants cannot take up nutrients if there is not any soil moisture; add water as well as nutrients.

If N is needed, split into three to four applications, applying the majority of N between bloom and veraison to supply the crop demand.

- Placement: apply nutrients to the soil above the root zone and skip areas where roots are not growing. For example, in a drip-irrigated vineyard, nutrients should be applied in a band under the drip line. Roots are rarely present in the middle of the mid-row area, even in a sprinkler-irrigated vineyard.
  - Applying soluble nutrients through the drip system (fertigation) is a liquid banding technique commonly used.
- Adding foliar nutrients: foliar application is particularly useful for micronutrient supplements if additions are needed. Foliar nutrients may be used in situations where soil conditions limit nutrient availability. Foliar application of N is not recommended.

4. How do I manage nutrients in concert with canopy and crop adjustments?

Significant cultural adjustments needed to manage canopy or crop, such as leaf thinning, indicate that future nutrient additions should be reduced.

4. Pest Management - Nematodes

Nematodes are plant parasitic, unsegmented worms that feed on plant roots. The microscopic worms reduce water and nutrient uptake by the plant, impacting vigor and yield, and they can transmit viruses and assist fungi in entering roots. Five nematode species are present in the Northwest, with the root knot nematode and dagger nematodethe most problematic in Washington State.

a. Monitoring

- Cropping history is very important when considering potential nematode problems and is particularly important when previous crops included mint, potatoes, tree fruit, alfalfa, and corn.

- Soils should be sampled to monitor nematode populations at pre-plant, generally from February through mid-March, and at the end of the growing season in October and November in established vineyards. Sampling should be done when the soil is moist and soil temperature is above 50° F.
- Samples of soil and roots from within the row should be assayed for nematodes. Take samples about a foot from the trunk and a foot deep after removing the top few inches of topsoil.
- Economic thresholds for nematodes have not been set yet for Washington, but yield loss has been associated with populations of 0 to 25 or more dagger nematodes per 250 cubic centimeters of soil if viruses are present and 200 to 300 root knot nematodes per 250 cubic centimeters of soil.

b. Common nematodes in the Northwest
- Root knot nematode
- Dagger nematode
- Ring nematode
- Root lesion nematode
- Citrus nematode

c. Controls
- If nematodes are present in sampling, fumigation of soil before planting is effective. Control with nematicides after vines are established is more difficult. Chemicals must be incorporated into the plants' root zone through drip irrigation or ground application. Information on fumigation can be found in the *Pest Management Guide for Grapes in Washington*.
- Research is studying alternative nematode treatments, including green manures, cover crops, and bionematicides.

SOIL SURFACE MANAGEMENT

1. What purpose or purposes do I want my soil surface management plan to serve?

- Decrease weed pressure?
- Increase soil moisture utilization?
- Decrease soil wind and water erosion?
- Modify the meso or microclimate?
- Reduce potential for soil surface sealing?
- Increase organic matter in soil?
- Increase beneficial arthropods?

2. What is my cover crop goal or goals?

- To protect the soil?
- To provide a nutrient source for my vineyard?
- To manage pest (insect) populations?

3. What choices in soil surface protection (ground cover) do I have?

- Cover crops (most commonly used approach)
- Composts
- Geotextile fabrics
- Mulches (straw, bark, plastic, etc.)

Washington State University recommended plant species for Washington vineyards:
Annual cover crop choices - tilled vineyards
Barley Oats Triticale Wheat Cereal rye Field pea Mustards Brassica spp. Various vetch species
Annual cover crop choices – no till
Red, crimson, and subterranean clovers (Trifolium spp.) Burclover, barrel, and black medics (Medicago spp.)
Perennial cover crop choices include:
Tall, sheep (hard), and red fescues Meadow barley Perennial ryegrass White clover Bunchtype wheatgrasses, such as crested and pubescent wheatgrass Wildflower/forb mixes

Cover Crops as a Floor Management Strategy for Pacific Northwest Vineyards, WSU

4. Why should I consider planting cover crops in my vineyard?

- EROSION CONTROL: Cover crops reduce soil erosion potential from both wind and water. Serious soil losses can occur from bare soil. Your ability to operate equipment in the field can be impacted from bare wet soil that immobilizes equipment; equipment slippage occurs more easily on bare, compacted soil or bare soil with steep slopes. Dust, which can also be a problem from bare soil, can lead to mite flare-ups.
- ORGANIC MATTER: Long term use of cover crops will increase soil organic matter content which leads to improvements in important soil qualities such as water holding capacity, water infiltration, soil structure, and nutrient holding capacity.
- MOISTURE: Cover crops can utilize excess soil moisture, thus decreasing the amount available to vines.
- BIODIVERSITY: Choice of cover crop material influences biodiversity of non-plant species and can be a tool to manage both beneficial and harmful pests (e.g., insects, rodents, virus vectors).

5. What factors should I consider in making cover crop decisions?

- Match your cover crop to your soil and climatic conditions.
- Proper cover crop management typically requires irrigation; cover crop needs should be considered in irrigation system planning and vice versa.
- Nutrient management needs for the cover crop should be monitored.
- Mowing may be needed for weed control; mow above the cover crop. Mowing may also be needed to reduce frost damage potential.
- Cover crop choice, especially broadleaf species, can limit herbicide choices.
- Different cover crop choices have different seedbed preparation requirements.
- Different cover crop materials have different potential for harboring beneficial pests.
- Consideration for supplemental irrigation, such as sprinkler hand lines, should be made in vineyards where cover crops will be planted that won't directly receive irrigation water to help establish the cover crop.

6. What are the potential risks in using cover crops?

- Choice of cover crop can modify your mesoclimate and may increase the risk of frost damage.
- Cover crops may compete with vines for nutrient and water resources. (Competition can be both desirable and undesirable.)
- Cover crop choice may limit herbicide choices.
- Can increase nitrogen in the vineyard if using legume cover crops.
- Can harbor harmful pests.
- Stand establishment timing needs may conflict with other vineyard activities, such as harvest.
- Depending on your cover crop choice, there may be issues with seed. Determine the availability of the material you have chosen as well as the quality; poor quality seed that is cracked or has impurities may result in poor stands or infestation with noxious weeds.

Comparisons between irrigated and non-irrigated cover crops

	Irrigated	Non-Irrigated
Cover crop choices	Broad, based on how much you're willing to manage	Limited, based on what can grow
Nutrient potential	High if using a legume	Low
Soil surface protection	High	Low, but better than bare soil
Weed pressure impact	Reduced weed pressure	Somewhat reduced
Water management	Useful in chlorotic areas of juice grapes to reduce wet soils	Can be used as a canopy management tool in high rainfall areas
Seeding	Seeding date not as critical if irrigation can be used during establishment	Seeding date prior to fall moisture is critical; supplemental irrigation, such as hand lines, should be considered during establishment
Other risks	May increase potential for low temperature damage May increase rodent populations	

Definitions:

Electrical conductivity – Measures the soil's ability to conduct an electrical current.

Erosion – The wearing away of the land surface by running water, wind, ice or other geological agents.

Soil compaction - Process by which a sediment progressively loses it porosity due to the effects of loading. Compaction is often the result of machinery compressing the soil. Affected soils become less able to absorb water, thereby increasing runoff and erosion.

Soil organic matter – The organic fraction of the soil consisting of living biomass of microorganisms, plant and animal residues at various stages of decomposition, and humus, the well decomposed organic material. Organic matter generally averages from 1 to 6 percent of the topsoil weight of most soils. Soils in eastern Washington tend to have very low soil organic matter (less than 1 percent) due to their development in arid conditions.

Soil pH – The degree of acidity or alkalinity of a soil, defined as the negative logarithm of the hydrogen-ion activity of the soil. pH ranges from 0 to 14, with 7 being neutral. Above 7 is basic or alkaline, below 7 is acidic. Soil pH controls many chemical processes that take place in the soil, including nutrient availability by controlling the chemical forms of the nutrient.

- Soil pH levels in eastern and central Washington are typically above 7.0; western Washington below 7.0.
- High pH levels are associated with areas of free calcium carbonate/silicate hardpan know as caliche.
- Reduced availability of some nutrients (phosphorus, zinc, and iron) linked to pH levels of 7.8 or higher.
- Soil pH can be lowered by adding acidifying nitrogen fertilizers or adding elemental sulfur.

Soil salinity – All soils and water contain some salts; as water evaporates, soluble salts are left behind and can accumulate in the soil surface above a high water table or where ground water has moved along rock layers or caliche. Soil salinity is measured as the electrical conductivity of a saturated soil extract.

Resources:

Information about soil properties compiled by Washington State University:
http://soils.tfrec.wsu.edu/webnutritiongood/index

How electromagnetic conductivity sensors work

Washington State University bulletin (includes critical nutrient ranges for grapes):
Sampling Guide for Nutrient Assessment of Irrigated Vineyards in the Inland Pacific Northwest

Cover crop bulletin from Washington State University includes a list of suggested plant species:
Cover Crops as a Floor Management Strategy for Pacific Northwest Vineyards

Oregon State University and Washington State University bulletin:
Monitoring Soil Nutrients Using a Nutrient Management Unit Approach

Fertilizer guide for irrigated vineyards, Washington State University Extension

Robinson, J. B. 992. Grapevine nutrition. p. 7-208. B. G. Coomb and P. R. Dry, Viticulture, Volume 2:
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