From Soil to Bottle: Sustainable Winegrowing

Topics of Discussion

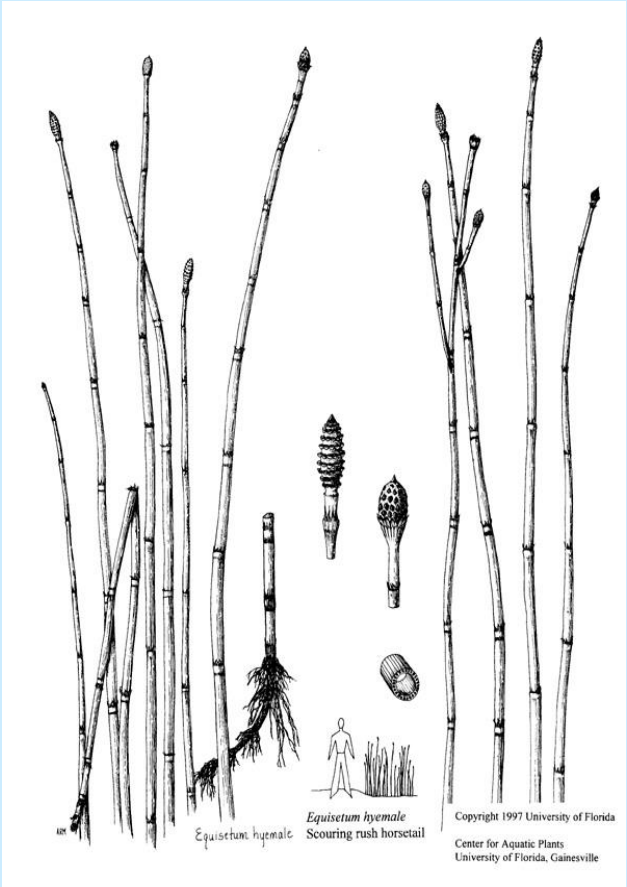
- Sustainable Vineyard background (why is this important?)
- Getting down to the dirt on vineyards
- Winemaking in the vineyard: how management affects wine flavors
  - Timing of watering/fertigation
  - Green vs. ripe tannins & leafing strategies
  - Physical vine cues for picking
- Some winemaking considerations

Conditions driving wine quality in vines

- Light environment
- Air movement
- Photosynthetic capacity
- Soil health
- Soil moisture
- Vine transpiration
- Vine nutritional status
- Vine balance: vegetative vs. reproductive strategy

Sustainable Agriculture

- What is it?
  - a method of farming that views the vines as part of and impacting the ecosystem.
  - A combination of plant biodiversity and integrated management keep this system healthy.
  - Pest and disease control are achieved by use of sustainable substances and cultural practices.
  - Plant responses to different phases of the year's cycle are recognized and incorporated into the management plan.
  - Conservation of resources and quality of life are always considered.



How Does Sustainable Farming Differ from Conventional Farming?

- The philosophy. Standard farming treats diseases and pests with conventional products on a calendar basis, but it is still a reactive method of farming. Sustainable farming tries to be proactive by pre-empting the conditions that allow diseases/pests to become problematic.

- Example: Many fungi that attack plant tissues, normally inhabit the soil and move onto plants when conditions necessitate or facilitate such a move. Sustainable farmers try to maintain a healthy soil environment which keeps these organisms from becoming pathogenic.

Why do we care?

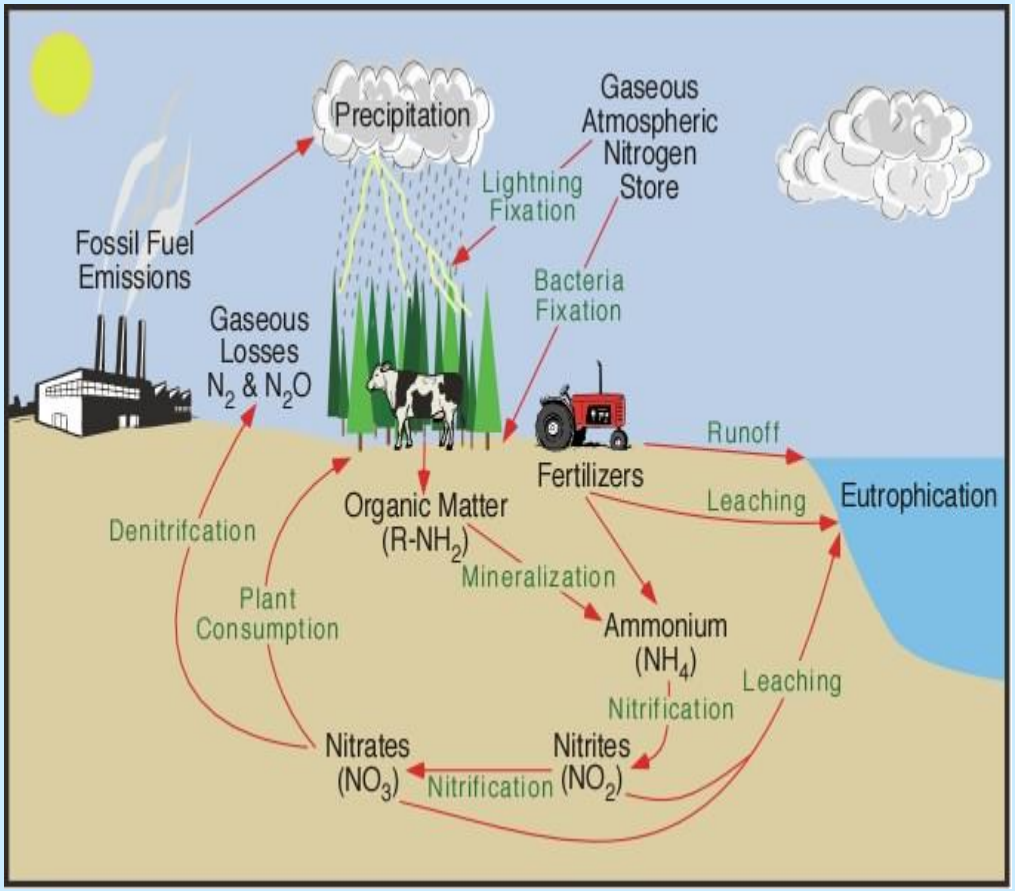
Environment Quality Elegance

The Environment and Agriculture

- In California, 25 to 40% of our water supply comes from ground water.
- 1/3 of California's ground water is thought to be contaminated.
- ¾ of the impaired ground water is contaminated by salinity, pesticides and nitrates.
- Nitrates have caused closure of more public wells than any other contaminant.
    - -feed lots and synthetic fertilizers are the main sources of nitrate contamination. The uncoupling of animal husbandry with crop production has been detrimental to the environment.

The Nitrogen Cycle

- Nutrient availability is affected by several processes.
- Normal nutrient cycling in the soil is disrupted with conventional agriculture practices.
- Excess nitrogen can both pollute drinking water and lead to the production of food with a lower nutritional value.



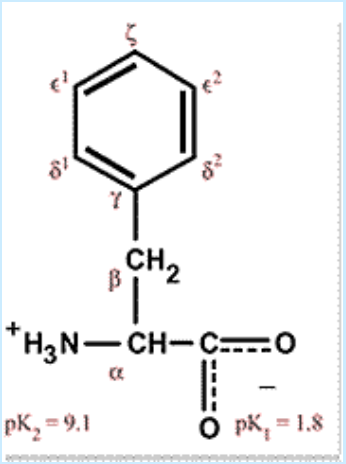
Nitrogen Uptake and Utilization has Important Quality Effects

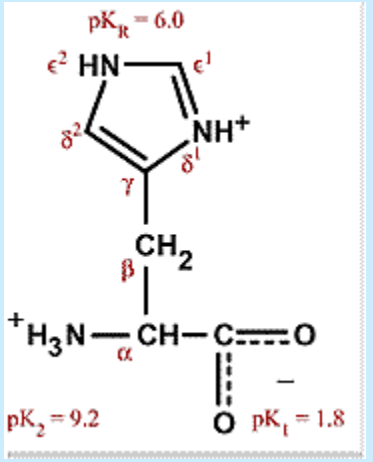
- Proteinaceous compounds indicate the extent to which nitrogen has been incorporated into a complete protein.
- The presence of high amounts of nitrate, free amino acids and amides indicates that the plant is not able to metabolize nitrogen as quickly as it is taken up.
- Sustainable farming in both vines and produce have been shown to increase quality factors such as color and flavor.

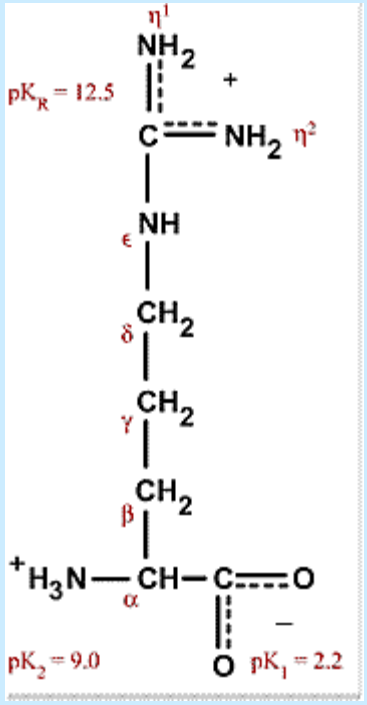
The Yeast Factor

- While it is clear that the quality of grapes set the upper limit for wine quality, yeast play an important role in modifying grape compounds.
- A good example is with amino acids and ester production.

Esters and Wine Aroma Characeristics

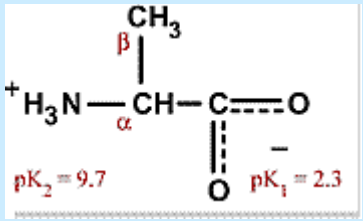






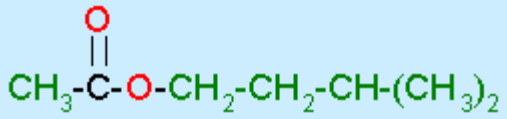
Esters

- Arise from various sources of yeast metabolism.
- Can be formed from amino acid skeletons.
- “Wild Yeasts” can produce significantly greater amounts of esters than *Saccharomyces.*
- Chain length and concentration determine the sensory contribution.



Esters and Sensory Effects

- Short chain esters tend to be fruity and floral. Examples: rose and banana aromas are derived from phenethyl acetate and isoamyl acetate respectively.
- Long chains tend towards more perfume and soap characters.
- At lower concentration, the fruity, floral character dominates, at higher concentration, the perfume character is predominate.

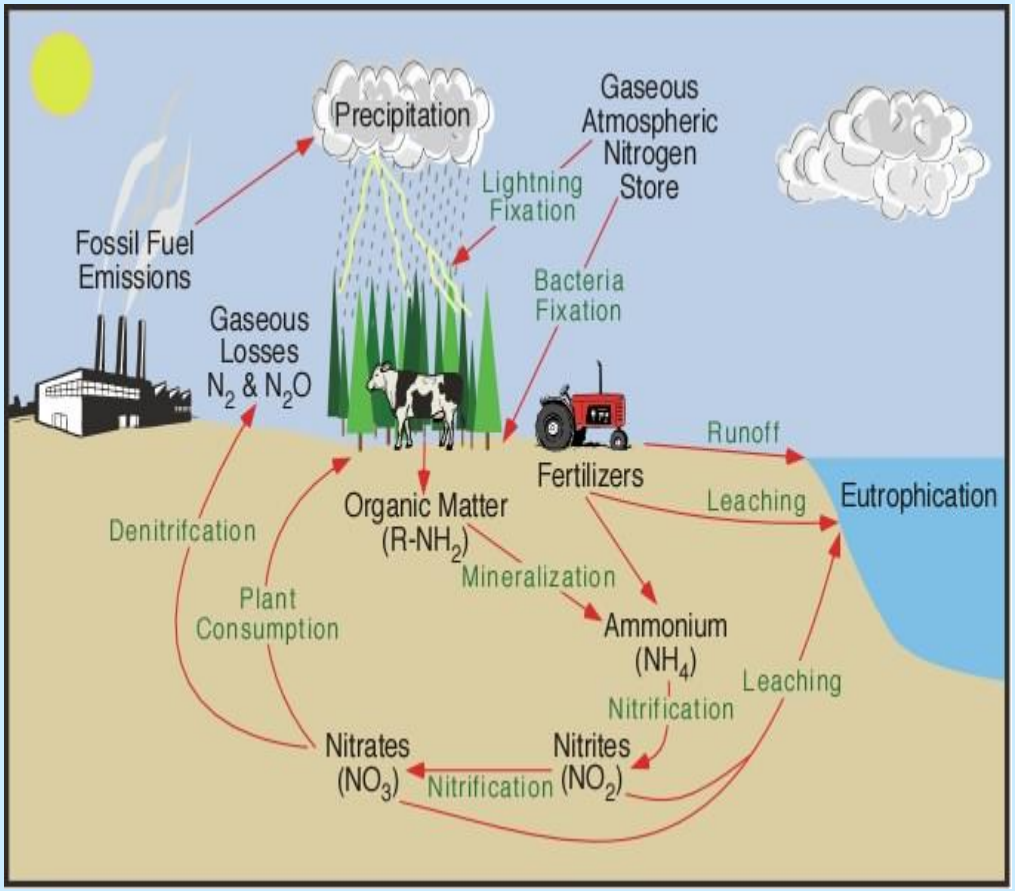


Esters and Vineyard Management

- Unfertilized vineyards tend to produce wines that are lower in aroma and flavor intensity as well as overall wine quality.
- Overly fertilized vines tend to be overly vigorous, which is also detrimental to fruit and wine quality.
- How do we manage fertilizer applications to achieve optimal quality?

The Nitrogen Cycle

- Organic composts increase soil microbial biomass, respiration and earthworm population biomass compared to conventional and no input lots (we come back to this later).



As farmers, we are:

Planting our vineyards to be farmed sustainably.

Encouraging other growers to consider sustainable agriculture options by providing advice and assistance in implementation.

Sourcing new fruit from sustainable vineyards for our winemaking.

Working with other sustainable vineyards and wineries to increase the quality of our environment and the vineyards on which we live and raise our children.

Now for the Real Dirt: Impact of Soil on Winegrowing (more of "why do we care?")

- Drainage
  - Water holding capacity
  - Structure/texture of soil
- pH effects
  - Mineral interactions
  - nutrient uptake
- Organic matter/microorganisms

Drainage

- Based on:
  - Structure/texture of soil
    - Sangiacomo: rocky, cobbled, permissive
    - Van der Kamp: volcanic clays, tufa base
  - This in turn creates H2O-holding cap.
    - SG: little cap but high water table
    - vdK: moderate holding cap

pH Effects & soil amendments

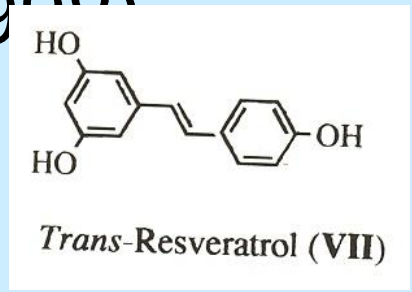
- Drive & are affected by mineral interactions
- Define nutrient uptake
  - Low-pH soils struggle to uptake: need to amend with lime (banding), gypsum (banding, drip fertigation)
  - Affected by buffer capacity, which drives soil amendments
- Minerals: NO translocate to flavor

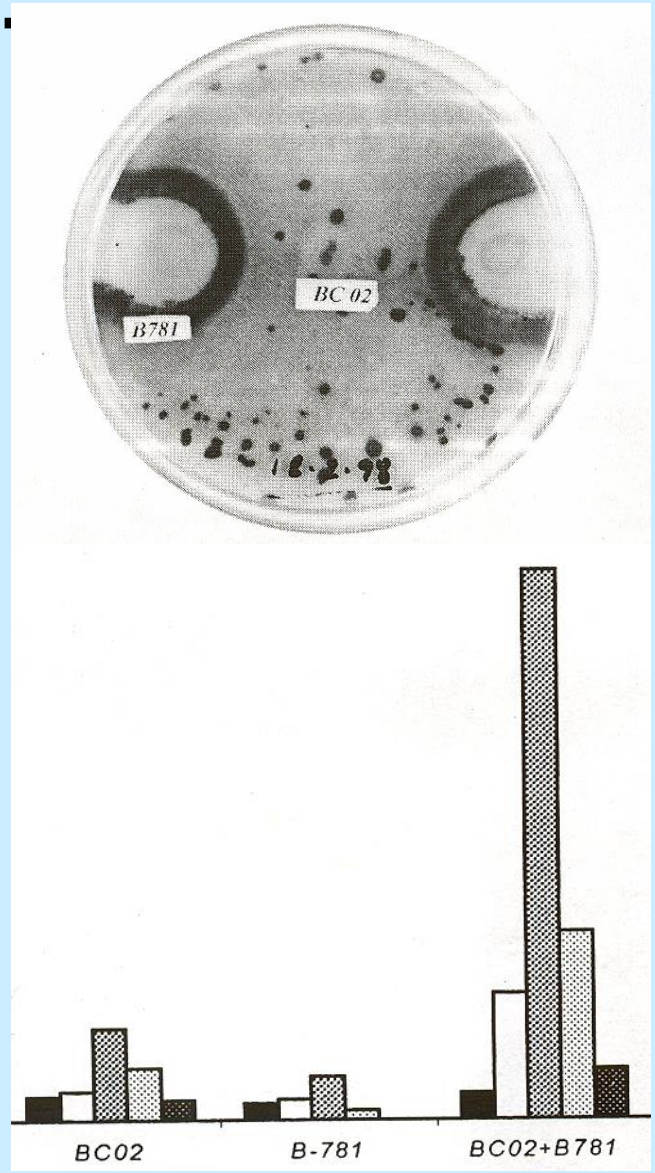
Organic Matter

- Assists in tilth (structure)
- Increases microorganisms
- Increases water holding capacity
- Affects pH/mineral uptake
- Level defines cultural practices
  - Cultivation
  - Composting
- Example of same vineyard before/after

Building Wine Structure Microbially…

- A beneficial soil bacterium, Bacillus sp, both antagonizes Botrytis infections and induces plant natural defense compounds such as resveratrol (Paul et al, 19





Bring it into the winery: How do vineyard practices influence mouthfeel?

- Level of sugar/alcohol
- “Ripeness”/quality of tannins
- Acid/pH balance & related chemistry
- Primary and secondary aroma/flavor characteristics originating from grape
- Quality of grape solids in must:
  - Disease pressure
  - Physical condition of fruit
  - Cluster architecture

5 moments of wine quality in vineyards

- Flowering: defines cluster architecture
- Berry cell division
- Berry cell expansion
- Veraison
- harvesting

Vineyard: where the winemaking begins

- I. Watering: The single most important winemaking decision you make each year is when to begin irrigation
  - Solar exposure is the thread of vnyd practices
  - Reduction of total biomass w/ESD irrigation
  - Shorter internodal length
  - Cessation/slowing of shoot tip growth is key
  - Look for diurnal fluctuation after veraison

Watering: benefits of mild deficit

- Carbohydrate repartitioning
  - More flavor & aroma precursors/benefits
  - Earlier physiological ripening (diff. than sugar)
  - Better tannin ripeness ****
  - Better color development in reds
  - Better vine dormancy
- Harvest chemistry: improved pH, TA etc.
- Overall: better mouthfeel, winemaking
- Caution: don’t overstress vines!

	Harvest Analysis						
Treatmnt	Brix	TA g/L	pH	MA g/L	NH3 ppm	NOPA ppm	Solids
B2 Standard	23.4	6.11	3.5	2.57	67	135	2.50%
B2 Deficit	23.8	6.22	3.5	2.68	74	125	2.50%
B3 Standard	23.9	6.53	3.43	2.5	53	112	2.50%
B3 deficit	22.9	7.82	3.3	2.93	53	174	2.50%

Treatment	Final Analysis					
	EtOH	TA	pH	MA	RS	VA
B2 Std	14.60%	4.5	3.63	0.1	0.20%	0.38
B2 Deficit	14.80%	4.65	3.66	0.1	0.60%	0.43
B3 Std	14.80%	4.7	3.53	0.1	0.85%	0.41
B3 deficit	14.40%	5.3	3.44	0.1	0.27%	0.42

II. Green vs. ripe tannins

- Profound influence on mouthfeel
- Dr. Doug Adams work – assay
- You can “see” tannin ripeness
  - Sugar may mask complete tannin profile
- Things that indicate tannin ripeness:
  - Cessation of shoot tip growth
  - Good diurnal fluctuation
  - Seed maturation
  - Skin condition
  - Persistence of vascular bundle to pedicel

Times You Must Water

- Pre-budbreak: if winter rainfall is low
  - This is the Spring Rootflush:
    - ¼ of N, other nutrients taken up here
    - Heathy root hairs increase season metabolism
  - Avoids having to water mid-season when you would be increasing vigor, delaying maturity
- Lack of recovery from daily stress (di-flux)
- Heat events: need water prophyllactically
- Post-harvest fertigation:
  - Make sure shoot tip growth has ceased
  - 60% of N, mineral uptake for next year

Timing leafing & shading issues

- Earlier leafing: 3 most important times in Wine
  - Pre-bloom: increases shatter, ultimately mouthfeel
  - Post-bloom: affects berry cell division
  - Berry cell expansion continues to veraison
- Issues on sunburn: create “early tan”
- Better periderm formation (wood ripening):
  - Lower Brix
  - Better tannins, color, pH/TA relations

III. Timing of Picking

- Weather/vintage conditions
- Parameters for tannin ripeness (diurnal flux, seed/skin conditions, etc.)
- Overall vine health:
  - does it still have the gas to keep going?
  - May be able to gain more texture
- Berry physiology: condition of
  - Pedicel junction: still tight/healthy?
  - Vascular bundle (brush): length, pedicel persistence
  - Berry turgidity

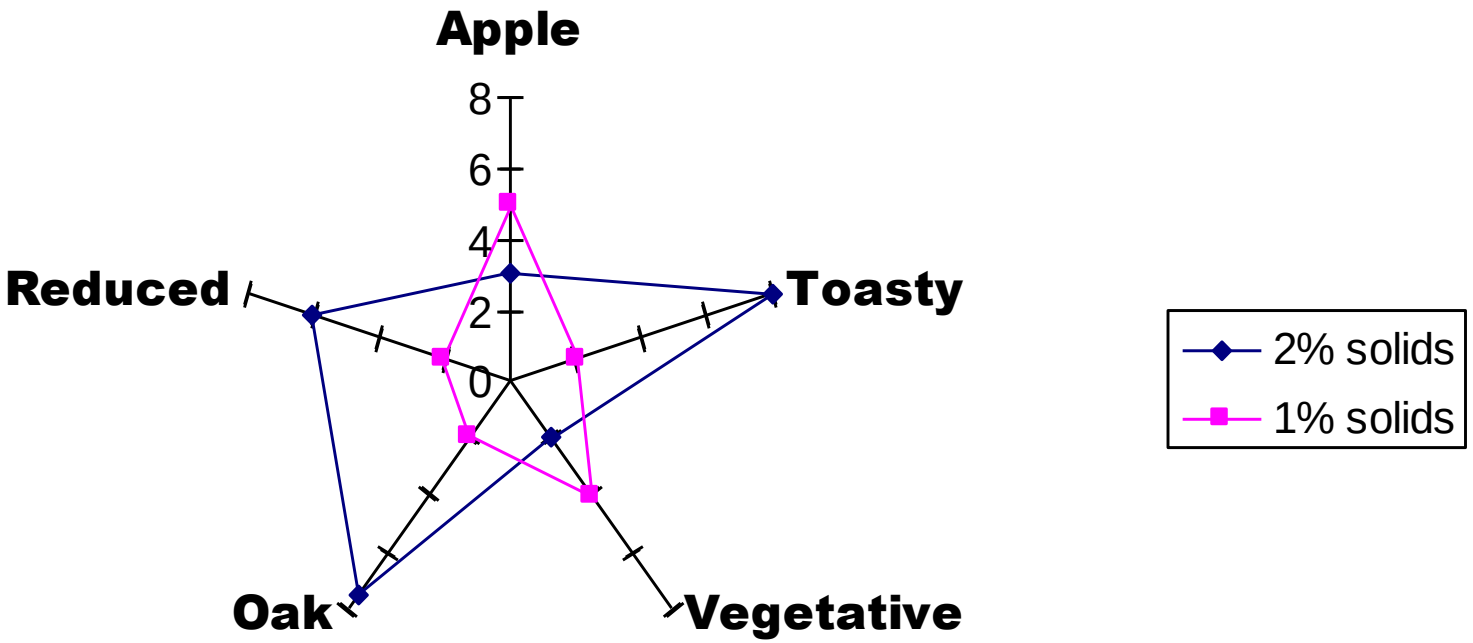
Sugar

- Timing of picking should not be about Brix
  - Water adds, dealcoholization valid techniques
- If your Brix are high and your flavors & tannins are not there, you need to be doing more work in the vineyard. Look at:
  - Vine balance
  - Water relations
  - Vine husbandry
  - Site interactions

Bring the vineyard into the cellar (Process Flow)

- Higher % solids = more texture/richness
  - Work done by La Follette, R-M Canals
  - Greater risk, downsides (ex: sulfides)
  - Dependent on how you process & settle
    - Whole cluster vs. destemmed: get the solids you want up front via choices in
      - Destemming
      - Crushing
      - Press cycle choices
    - Little or no juice racking (straight to barrel)
  - Depends on vineyard, fruit conditions

1% soli


Apple
8
6
4
2
0
Reduced
Toasty
Oak
Vegetative
2% solids
1% solids

Where are the landmines?

- Review vineyard spray programs
  - Late S = increased risk
  - Increase settling time, reduce solids
  - Use appropriate yeast
  - Avoid excessive yeast stress
- Analyze must for N: low levels – high risk
- Know your vineyards (takes a few years)
- Lees monitoring
  - Sample lees directly
  - Copper *dodine* for stirring

Microbiology

- Disadvantages of wild microbiology:
  - Not practicing safe winemaking
  - Takes much more scrutiny/attention
- Advantages of native yeast:
  - Higher RS = increased perceived viscosity
  - Fructose:glucose ratio 10:1 or greater
    - Fructose = twice the sensory impact
    - Fructose = more microbe stability
    - Long, late struggling fermentations give this

Microbiology (cont.)

- Struggling yeast: matter of biology
  - Stress can be related to:
    - Nutrients
    - Heat stress
  - Increased membrane fluidity = increased mucopolysaccharides, glycoproteins (Llaubers, Ferrari & Feuillat, Canals)
    - Postulated to give increased mouthfeel
- Nutrient additions can decrease stress aroma signatures (ex: 4-et-phenethanol)

Experimentation: charting courses

- Different amount of solids in barrels
- Go to bbl (reds) at different ferm. times
- PN: to bbl anaerobic vs. aerobic
- Different stirring regimes (red AND white)
- Yeast trials (ex: UCD-522 Montrachet vs. wild vs. a *bayanus*)
- Don’t stress out – let the yeast do it!

Summary

- Vineyard is the key: soil, water relations, balance, tannin devel., picking decisions
- Process flow is locked in step to vineyard
  - Must reflect vineyard conditions for max. expression of mouthfeel & flavor
- Microbiology has a profound influence on mouthfeel (research still needed)
- Finishing a wine is critical & vnyd dependent

No substitute for knowing your vineyard

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