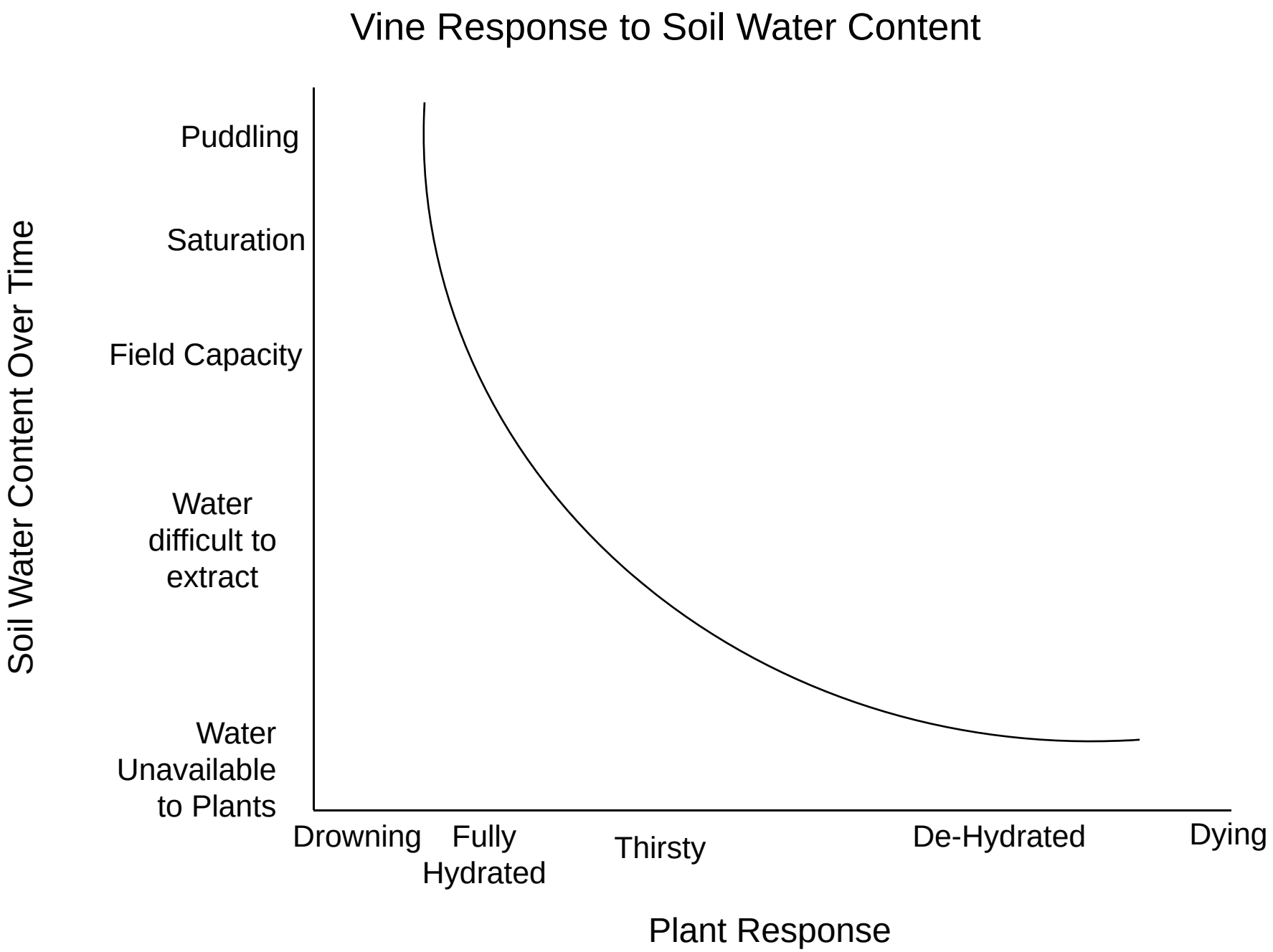
Inducing Water Stress in Grapevines in the Eastern US

Why do we want less water?

- The Eastern US receives more rain during the growing season than any other major wine growing region
- Specifically for red wines, mild water stress is critical in reducing berry size and making the vine switch from growth mode (more shoots and leaves) to reproduction mode (more concentration, color and flavor)
- Other factors that lead to better grapes (e.g. soil nitrogen) are outside the scope of this talk


Vine Response to Soil Water Content
Soil Water Content Over Time
Puddling
Saturation
Field Capacity
Water difficult to extract
Water Unavailable to Plants
Drowning
Fully Hydrated
Thirsty
De-Hydrated
Dying
Plant Response

Soil Texture and Structure

- Texture
  - Sand particles are large, clay particles are small, and silt is in between
- Structure
  - Particles are stuck together to make larger agglomerates
  - Texture can’t be changed, but Structure is affected by everything we do and don’t do
    - Improved by organic matter additions, aeration, cover cropping
    - Degraded by compaction, liberal use of chemical fertilizers and certain herbicides, tillage with the wrong tools
    - Weather, animals and people degrade structure, but only soil life improves it
- Big soil pores hold air, medium size pores hold Plant Available Water, small pores hold water too tightly for a plant to use

Getting to Thirsty

- Reduced Effective Rainfall
- Faster Soil Drainage
- Reduced Soil – Root Contact
- Faster Evaporation
- More Transpiration

Inducing Mild Water Stress: Site

- Slope
  - Lower effective rainfall through run-off, geometry
- Soil rock content
  - Rock does not hold water and usually drains better
- Shallow soils over fractured rock drain well and have low water holding capacity
- Wind increases both evaporation and transpiration
- Soil texture
    - Sand drains the fastest, but holds little water
    - Clay usually drains slowly, holds lots of water
    - Mixtures of large and small pores drain quickly, hold limited amounts of water but retain enough to avoid de-hydration

Inducing Mild Water Stress: Establishment

- Eliminate Hardpans
  - Hardpans slow drainage, keep roots in the topsoil
  - Deep Ripping before planting (see research by Dr. Alfred Cass)
- Running rows up and down slope allows more run-off (but can degrade structure and lead to erosion)
- Drain Tiling helps get to field capacity quicker, but does nothing beyond that
- Closer row spacing means more transpiration, shorter time from field capacity to water stress

Inducing Mild Water Stress: Avoiding Compaction

- Compaction is the breakdown of large pores into medium size pores through the destruction of Soil Aggregates
- Compaction leads to:
  - Slightly more run-off if on a slope (a positive)
  - Much slower drainage
  - Much greater risk of root drowning
  - Much greater water holding capacity
  - Much slower evaporation
  - Lower transpiration
  - One source estimated 28% lower evapotranspiration from compacted soils
- In contrast, well aggregated soils drain faster, hold less water, allow for fresh air to get to the roots, allow roots to penetrate deep

Causes of Compaction

- Causes of Compaction
  - Heavy equipment, especially when the soil is at or above field capacity
  - Rain on bare soil
  - Wetting and drying of soil aggregates
- How is compaction relieved?
  - Soil life is the only thing that can relieve compaction (microbes, fungi, worms, springtails, nematodes, etc.)
  - Soil life needs air and food to thrive
  - Adding food and especially air is the only way to relieve compaction

Preventing and Relieving Compaction in Row Middles

- Appropriate equipment
  - As light as possible
    - No weights, fluid filled tires, etc.
  - Low ground pressure
  - 4 wheel drive
  - Towed sprayers with floatation tires?
  - Fewer passes through the rows
  - Never, ever drive when the soil is at or above field capacity!
- Row Middle Cover Cropping
  - Slows the impact of rain drops
  - Reduces the impact of heavy equipment
  - Creates channels for air to penetrate
  - Feeds Microbes, soil life
- Green manure additions
  - Feeds the soil life, stabilizes structure
  - Only if done with the proper tillage tools
    - A spader is the best
    - A duck foot plow is ok
    - Discing or rototilling destroys soil structure and should be avoided
  - Best not done too often (once a year or less)
- Small amounts of compost will increase the soil life
- Deep Ripping Row Middles
  - Dr Cass has written extensively on this subject
  - Difficult to do, but can help

Preventing and Relieving Compaction in the Row

- Never use pre-emergent herbicides (sorry)
  - They allow rain drops to compact the soil under the row, which is the worst place to compact
  - They inhibit the soil life that can rebuild the compacted soil
- Rotating tillage equipment (e.g. Weed Badger, Sunflower) is equally as bad
  - Physically grinds the soil aggregates into smaller particles, creating immediate compaction
- Post-emergent herbicides can hurt soil life, but they do allow plants to grow temporarily under the vines, and those plant roots allow air and water to penetrate
- Traditional grape hoes that move soil in and out can hurt structure as well
- Mechanical tillage with a root-slicing blade works well with the right layout and some experience
  - Does very little damage to the soil
  - Incorporates the weeds for the microbes to eat
  - Eliminates roots in the top 6” or so, which has the highest water content
    - This also prevents small quantities of rain from penetrating far enough to reach the vine roots
- Cover crop under the vine is an intriguing concept for higher vigor sites
  - Should lead to excellent soil structure
  - Transpiration from cover crops is lower than evaporation from bare soil, however
- Broadcasting good compost in small amounts will help relieve compaction under the row as well

Adding it all up

- Windy, sloping site with shallow, rocky, loamy soil over fractured bedrock
- Closely spaced vineyard planted up and down the hills
- Crawler tractors with cover cropped row middles, mechanically weeded or cover cropped under the vines
- No tractor work when wet unless absolutely critical (once every 5 or 10 years)
- Compost added regularly
- Spaded row middles every few years to add air and green manure
- Goal is less than 24 hours from saturation to field capacity, less than two weeks from field capacity to mild water stress, and as long as possible from mild water stress to plant shutdown